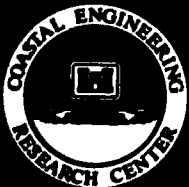
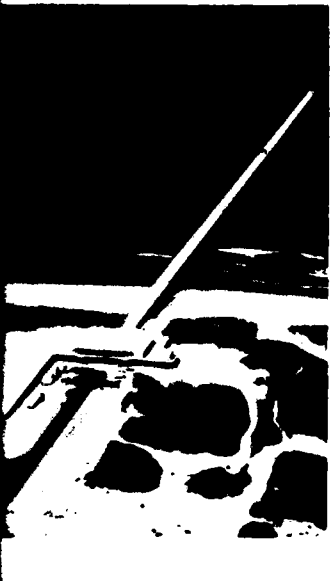


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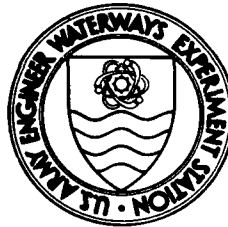
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# PROTOTYPE TIDAL DATA ANALYSIS FOR MISSISSIPPI SOUND AND ADJACENT AREAS

by

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September 1983

Final Report

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  Prototype tidal elevation and current data acquired in Mississippi Sound during the spring, summer, and fall of 1980 were analyzed as a part of a study to establish existing hydrodynamic conditions and and to estimate changes in tidal and wind-driven circulation patterns for proposed dredged material disposal practices. The results of the prototype tidal data analy- sis will be used for numerical tidal circulation model calibration and (Continued)		

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20. ABSTRACT (Continued).

verification. The results also provide a characterization of the tidal regime in the study area.

Data were included in the analysis from 22 surface elevation stations, three bottom pressure stations in the Gulf, and 21 velocity stations. Conductivity/temperature transect data were collected for 40 stations at intervals of approximately 3 weeks during the data acquisition period.

Tidal analysis results show that the diurnal O1 and K1 surface elevation constituents have the largest amplitude in the Mississippi Sound study area, with an amplitude of approximately 0.5 ft. Principal semidiurnal surface elevation tidal constituents were M2 and S2, with amplitudes of 0.13 ft or less. Minimum salinity levels were observed near Lake Borgne in the western part of the Sound.

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PREFACE

The prototype data analysis reported herein was to provide data for calibration and verification of numerical models to be used for evaluating effects of proposed dredged material disposal practices in the study area.

Project administration and funding were provided by the U. S. Army Engineer District, Mobile.

Data acquisition and analysis were conducted by the U. S. Army Engineer Waterways Experiment Station (WES) in the Wave Dynamics Division (WDD) of the Hydraulics Laboratory (HL) under the general supervision of Messrs. H. B. Simmons and F. H. Herrmann, Jr., Chief and Assistant Chief, respectively, HL, and under the supervision of Mr. C. E. Chatham, Acting Chief, WDD. The Wave Dynamics Division was transferred to the Coastal Engineering Research Center of the Waterways Experiment Station on 1 July 1983 under the supervision of Dr. R. W. Whalin, Chief. This report was prepared by Mr. D. G. Outlaw. Data analysis was conducted by Mr. Outlaw with the assistance of Mr. K. A. Turner and Ms. M. A. Hampton.

Commanders and Directors of WES during data acquisition and analysis and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

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

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

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
degrees (Fahrenheit)	5/9	Celsius degrees or Kelvins*
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
knots (international)	0.5144444	metres per second
miles (U. S. statute)	1.609344	kilometres

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\* 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:  $K = (5/9)(F - 32) + 273.15$ .

PROTOTYPE TIDAL DATA ANALYSIS FOR  
MISSISSIPPI SOUND AND ADJACENT AREAS

PART I: INTRODUCTION

Background

1. The study area, Figure 1, ranges from Lake Borgne and Chandeleur Sound on the west to Mobile Bay on the east and extends offshore from the barrier islands to approximately the 120-ft\* depth contour of the Gulf of Mexico. Mississippi Sound is roughly six times longer than it's width and has a total wetted surface area at mean high water (MHW) of 92,702 acres (U. S. Army Engineer District, Mobile, 1979). The average depth is just less than 12 ft. The sound is separated from the Gulf by five barrier islands. Two deep draft channels, the Gulfport Ship Channel (30 ft depth and 220 ft width) and the Pascagoula/Bayou Casotte Ship Channel (38 ft depth and 300 ft width) cross the sound approximately north to south.

2. The Mobile Ship Channel is 40-ft deep and is 400-ft wide. The Intracoastal Waterway crosses the southern part of the bay. In Mississippi Sound, the Waterway is 150-ft wide and 12-ft deep. Mobile Bay has a total surface area at MHW of 264,470 acres with an average depth just less than 10 ft.

3. Mean tides in Mississippi Sound are 1.5 ft, and, in Mobile Bay, 1.4 ft. Principal river inflows to the study area are the Pearl River, Pascagoula River, and the Mobile River.

Purpose of Study

4. The purpose of the Dredged Material Disposal Study being conducted by the U. S. Army Engineer District, Mobile (SAM), is to

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\* A table for converting inch-pound units of measurement used in this report to metric (SI) units can be found on page 3.

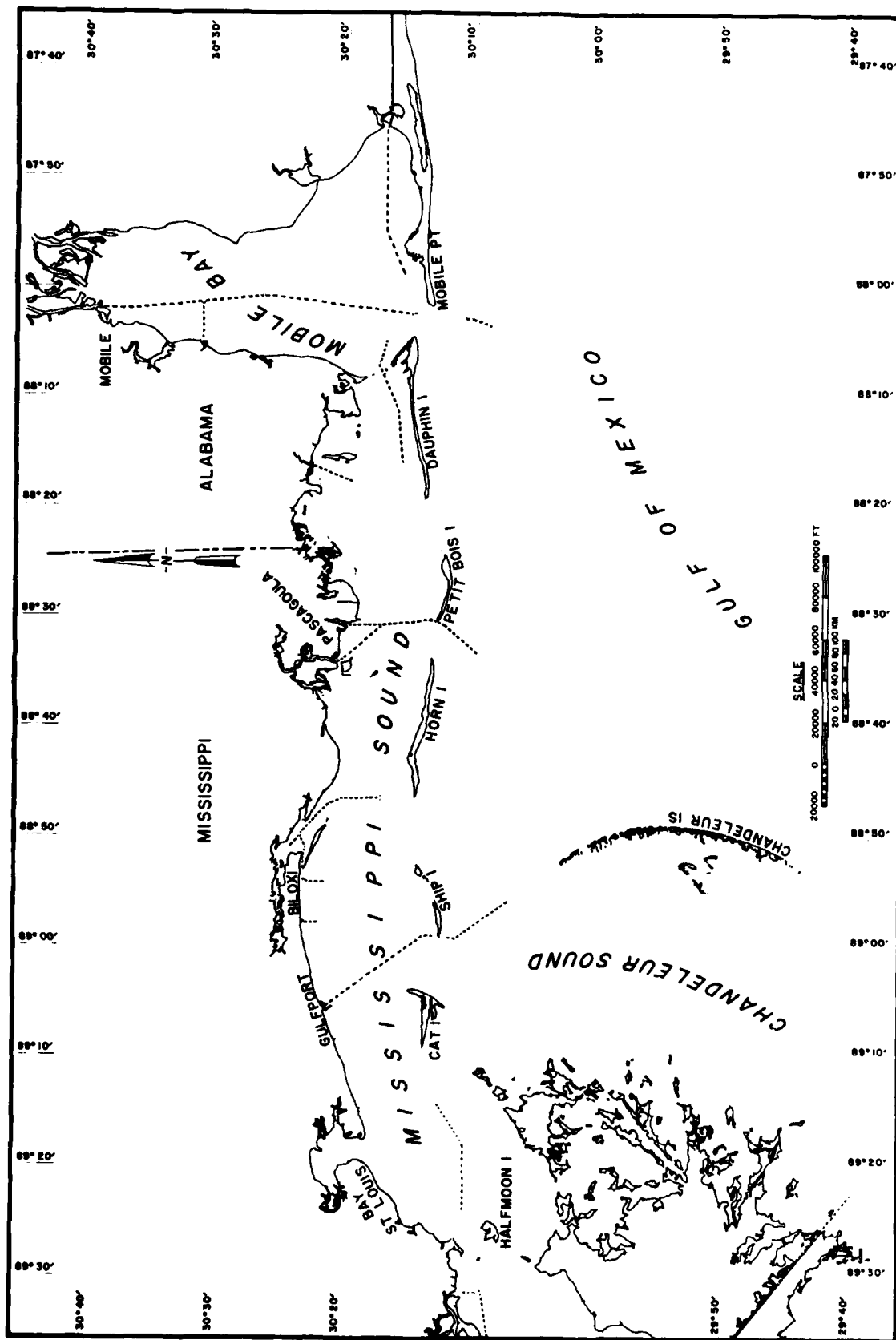


Figure 1. Mississippi Sound and vicinity

investigate the existing dredging and dredged material disposal practices of the study area and to determine how these practices should be modified, considering possible development of a regional dredging program, new dredging equipment and the environmental quality of the area. A numerical circulation model of Mississippi Sound is being developed at the U. S. Army Engineer Waterways Experiment Station (WES) and will be used to establish existing hydrodynamic conditions and to estimate changes in hydrodynamic circulation patterns for proposed project plans. The results of the prototype data analysis will be used for model calibration, verification, and characterization of the tidal regime in the study area.

## PART II: PROTOTYPE DATA PROGRAM

### Data Acquisition

5. Prototype data from Mississippi Sound and the associated study area were collected and analyzed as a part of the numerical hydrodynamic circulation study. The prototype data acquisition program included:

- a. Water surface elevation data from twenty-two surface elevation stations.
- b. Pressure cell data from three stations in the Gulf.
- c. Velocity data from twenty-one stations.
- d. Conductivity/temperature data from five stations.
- e. Meteorological data (wind speed, direction, air temperature, and barometric pressure of five stations.
- f. Periodic salinity/temperature data at forty stations taken at intervals of approximately three weeks.
- g. Bathometric survey data to supplement chart bathometric data at various channels and passes.

6. The tidal elevation data acquisition program was conducted by SAM in cooperation with the National Ocean Survey (NOS). During the program, NOS monitored the contract for installation of tidal elevation stations and data acquisition, edited the elevation data, combined data record sets from each station to form the complete record, and provided elevation data for each station on magnetic tape.

7. The remaining data were collected by Raytheon Oceans Systems Company (ROSC) under contract to SAM. ROSC installed and maintained instruments, listed the observed data, and provided magnetic tapes of the velocity, pressure, meteorological, and conductivity/temperature data. The tabulated data and data plots were provided to SAM by ROSC. Examples of both the observed surface elevation and velocity data are included in this report and the complete data set will be available in the Mississippi Sound data base to be maintained by SAM.

8. The prototype data primarily used in the tidal constituent analysis were the surface elevation, pressure cell, and velocity data.

The barometric pressure from the meteorological data was required for conversion of pressure cell data to surface elevations. Salinity data, calculated from the conductivity/temperature data, are briefly discussed but were not required for tidal constituent analysis. The complete data series will be required during model simulation of actual conditions including non-tidal effects that occurred in the Sound during the data acquisition period.

9. Other data not discussed in paragraph 5 were collected in the Mississippi Sound area as a part of the general study by SAM and included water quality and other environmental parameters.

10. Additionally, an intensive data acquisition program was conducted during September 1980 for use in conjunction with Nimbus G Coastal Zone Scanner satellite data. The intensive program included three day transect surveys of:

- a. Turbidity.
- b. Water temperature.
- c. Conductivity.
- d. TOC.
- e. Chlorophyll.
- f. Settling velocity.
- g. Bottom aggregates.
- h. Bottom clay mineralogy.
- i. Bottom particle size distribution.
- j. Bottom moisture content.

The data were collected for use in further studies of the Sound and were collected during the same time interval to provide a complete synoptic data set. These data also are included in the Mississippi Sound data base.

#### Station Locations

11. Surface elevation tide gage locations, designated by the prefix 873 in Alabama, 874 in Mississippi, and 876 in Louisiana, are given

in Table 1 and include the latitude and longitude of each station. The locations of the three pressure cells in the Gulf (Stations 22-24) also are included in Table 1. Station locations are shown in Figure 2 with exception of the North Pass and Breton Island stations south of the Chandeleur Sound area.

12. The elevation (NOS 1981) of mean lower low water (MLLW) at each tide station relative to the National Geodetic Vertical Datum (NGVD) is included in Table 1 along with the location data. MLLW data relative to NGVD for four stations, one at Dauphin Island and the three Louisiana stations, were not available. The three pressure cells were located along an east-west line at a depth of approximately 100 ft.

13. Velocity station locations are shown in Figure 3. The latitude and longitude of each of the twenty-one stations are given in Table 2. Current meter height above local bottom and number of meters installed at each station are given in Table 3. Five stations at which conductivity/temperature meters were installed also are shown in Table 3.

14. The latitude and longitude of meteorological stations are given in Table 4 and the locations are shown in Figure 4. Meteorological data were recorded approximately 10 metres above the water surface. The forty stations at which salinity/temperature data were taken at intervals of approximately three weeks are shown in Figure 5. The latitude and longitude for each station are given in Table 5.

#### Equipment

15. Leupold and Stevens recorders were used at all surface elevation stations. The level recorder and stilling well at each station were installed in accordance with NOS standards. Surface elevations were recorded at 6 min. intervals with an accuracy of  $\pm 0.005$  ft.

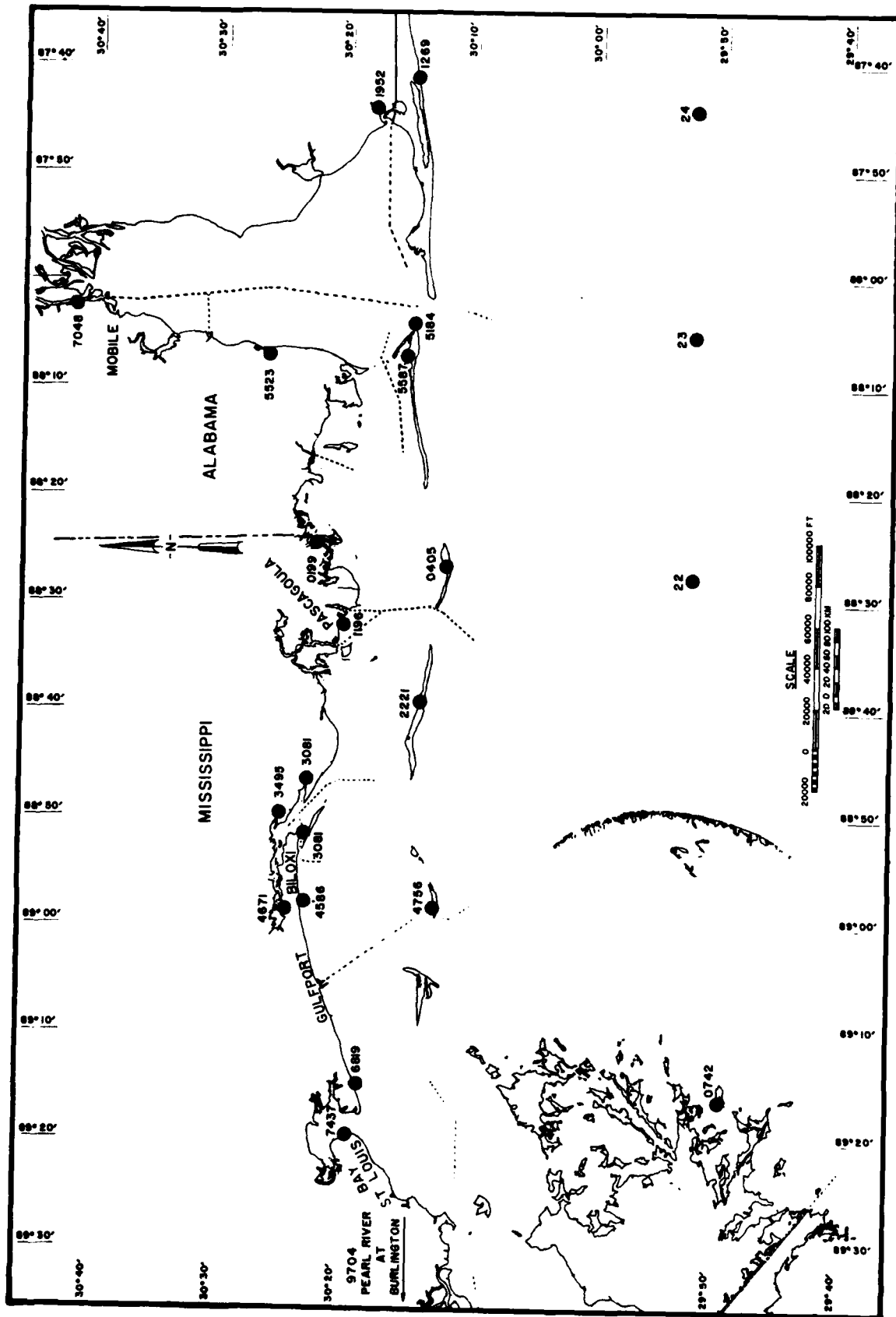


Figure 2. Surface elevation stations



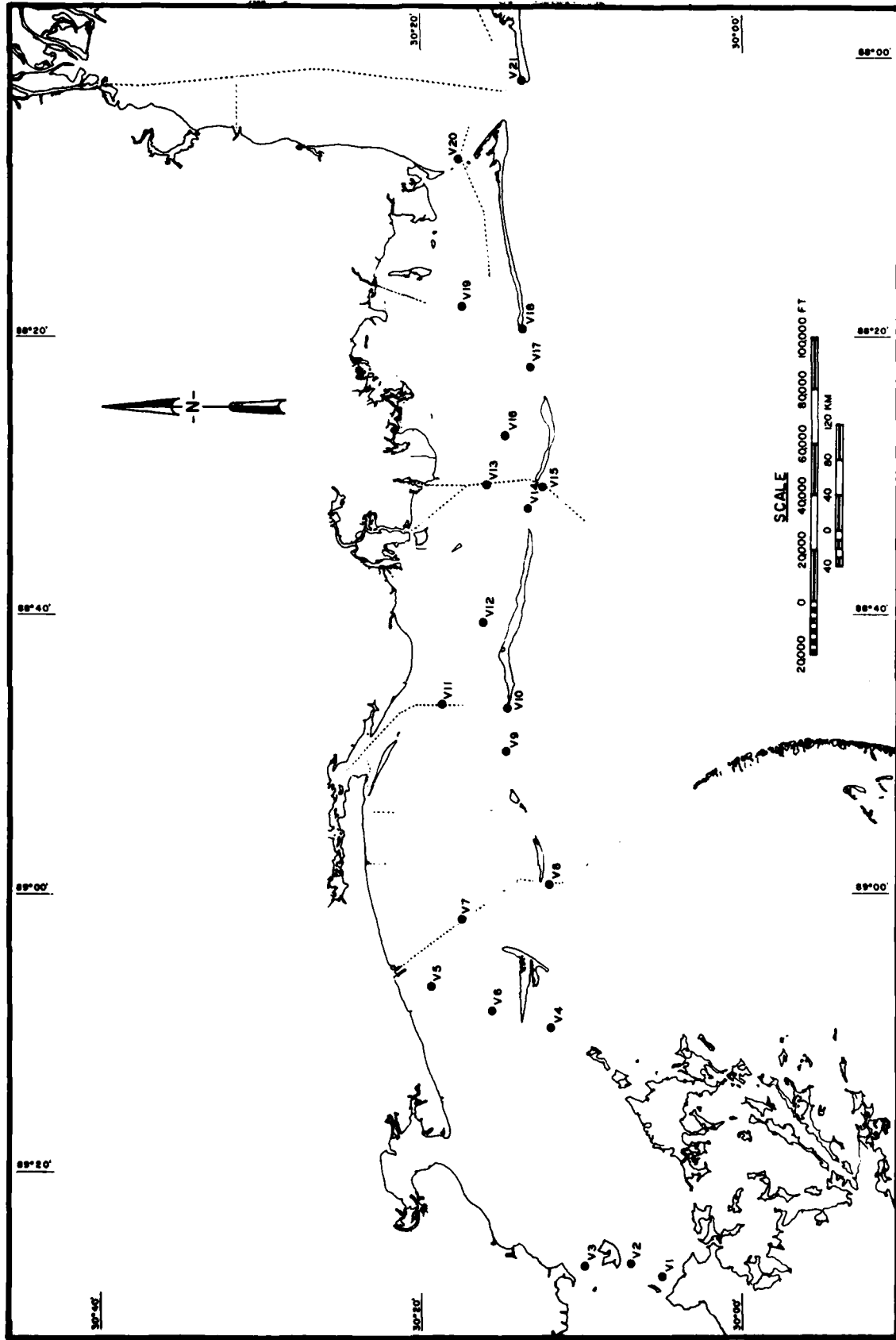


Figure 3. Velocity stations

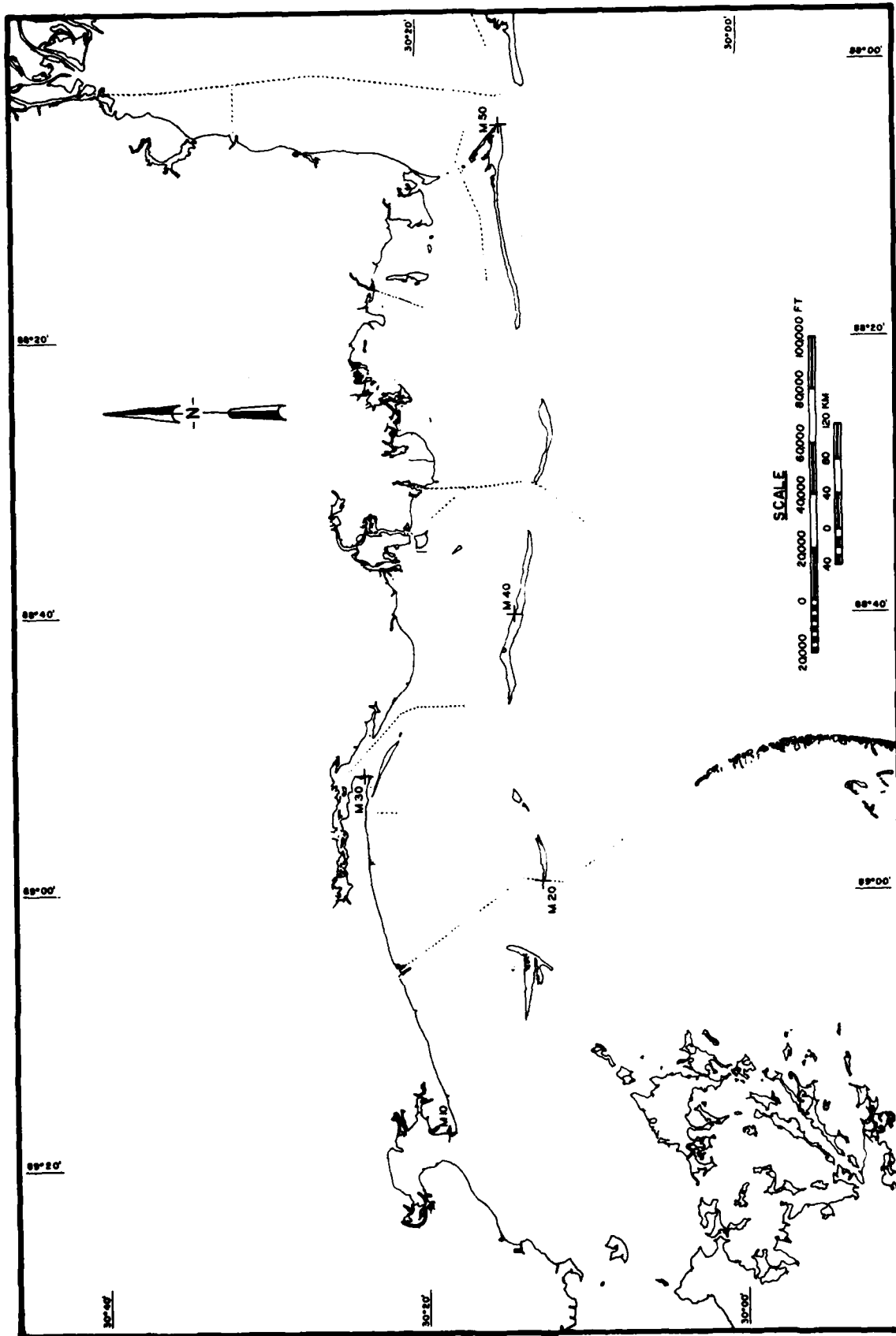


Figure 4. Meteorological stations

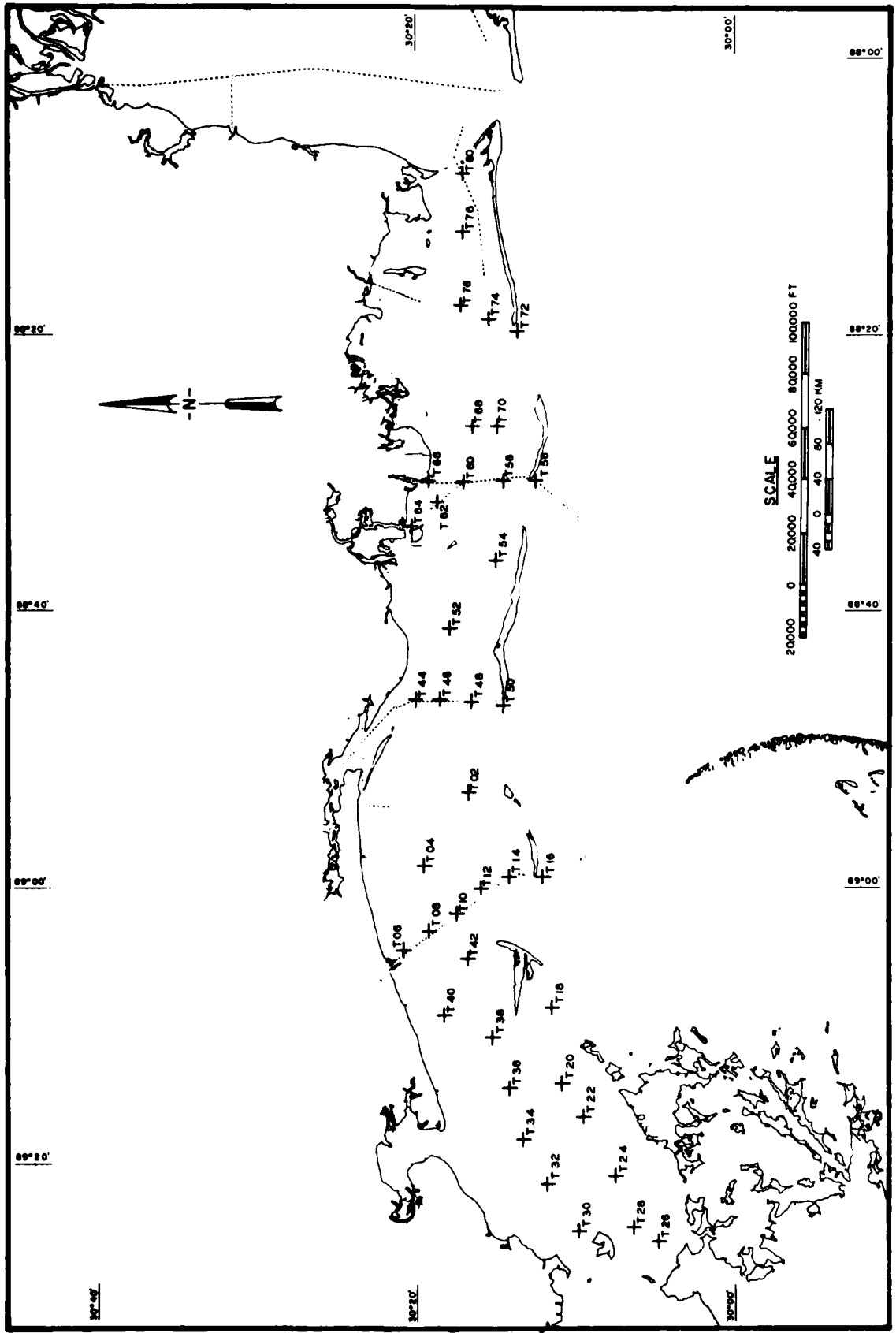


Figure 5. Salinity/temperature stations

16. The following equipment was used by ROSC.

<u>Data Type</u>	<u>Equipment</u>
Velocity	ENDECO 105 Current Meter
Conductivity/Temperature	AANDERAA RCM-4 Conductivity/Temperature Gage
Water Pressure	AANDERAA WLR-5 Water Level Recorder
Meteorological	AANDERAA Meteorological Station with Wind Speed Sensor 2593 Wind Direction Sensor 2053 Air Temperature Sensor 1289A Barometric Pressure Sensor 2056
Salinity	BECKMAN Portable Salinometer R55-3

Manufacturer's equipment specifications, reproduced from the ROSC Quality Assurance Plan submitted to SAM, are given in Appendix A.

## PART III: TIDAL DATA ANALYSIS

### Harmonic Analysis

#### Approach

17. Similar analysis techniques were used for both the surface elevation and current data. The following steps were included in the analysis procedure:

- a. Remove mean of the data record.
- b. Filter to remove high- and low-frequency trends from the data.
- c. Harmonic analysis for tidal constituents.

The surface elevation data had been edited by NOS and were continuous over the record length.

18. Editing of velocity data was necessary to fill in short sequences of missing data. Missing data sequences (2 or 3 points) usually occurred during servicing of the meter and limited missing data sequences were inserted using linear interpolation. In the edit procedure, the proper time phase relationship of the data was maintained. At stations where data were available at two or three depths, longer sequences of missing velocity data were inserted in the data record by correlation with data observed at the adjacent depth.

#### Digital Filter

19. A digital band-pass filter was applied to attenuate high and low frequencies in the surface elevation and current data. The period range considered in the harmonic analysis was approximately 10 to 28 hr. Short-term trends, less than 9 hr, can be caused by changes in the wind field due to local thunderstorms moving across the study area. Trends longer than 28 hr may be caused locally by river outflows, persistent winds of longer duration, or general raising or lowering the mean water level near the study area due to large-scale meteorological effects.

20. An eight-pole Butterworth filter, characterized by a smooth power gain with maximum flatness in the passband and the stop band along with a reasonably sharp cutoff, was applied to the surface elevation and

current data. Power gain, the squared amplitude response, for the filter is shown in Figure 6. Half-power frequencies are  $0.3086 (10^{-4}) H_2$  and  $0.0842(10^{-4}) H_2$  or 9 hr and 33 hr, respectively. The start and end of each data record were affected by the filter and 50 hr were deleted for the start and end of each data record during analysis.

#### Least Squares Harmonic Analysis

21. Elevation of the prototype tide at a station can be represented (Schureman 1958) by

$$h(t) = H_0 + \sum_{i=1}^J f_i H_i \cos [\bar{a}_i t + (V_0 + u)_i - K_i] \quad (1)$$

where

$h$  = elevation at time  $t$

$t$  = time reckoned from some initial epoch

$H_0$  = mean height above reference datum

$J$  = total number of constituents

$f_i$  = factor to reduce mean amplitude to year of prediction

$H_i$  = mean amplitude of  $i^{\text{th}}$  constituent

$\bar{a}_i$  = angular speed of  $i^{\text{th}}$  constituent

$(V_0 + u)_i$  = equilibrium argument of the  $i^{\text{th}}$  constituent for  $t = 0$

$K_i$  = local epoch of  $i^{\text{th}}$  constituent

The coefficients  $f_i$ ,  $\bar{a}_i$ , and the equilibrium  $(V_0 + u)$  can be calculated or obtained from tables (Schureman 1958). Equation 1 may be rewritten as

$$h(t) = H_0 + \sum_{i=1}^J A_i \cos (\omega_i t + \phi_i) \quad (2)$$

where

$A_i = f_i H_i$  = amplitude of the  $i^{\text{th}}$  constituent

$\omega_i$  = angular frequency of the  $i^{\text{th}}$  constituent

$\phi_i$  = phase of the  $i^{\text{th}}$  constituent

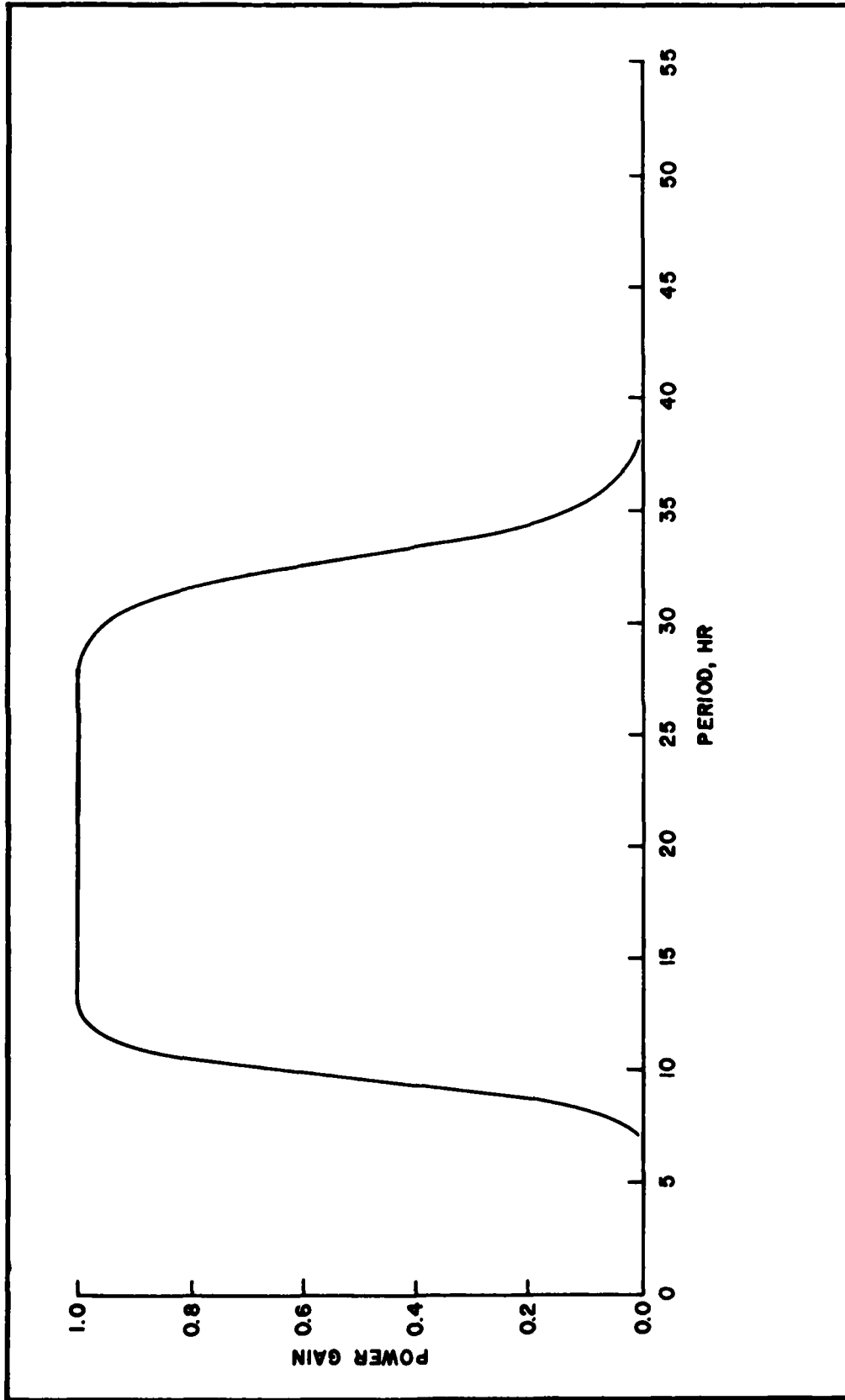


Figure 6. Filter response

22. Observed prototype surface elevation data  $h_p$  can be represented as

$$h_p(t) = \bar{h}_p(t) + \epsilon(t) = a_0 + \sum_{i=1}^J (a_i \cos(\omega_i t) + b_i \sin(\omega_i t)) + \epsilon(t) \quad (3)$$

where

$\bar{h}_p$  = the calculated tidal elevation represented by a harmonic series of known frequencies

$\epsilon(t)$  = noise in observed data

$a_0$ ,  $a_i$ , and  $b_i$  = coefficients

The noise level is not known and the unknown coefficients (amplitudes and phases) are solved using a least squares procedure by minimizing the variance of the sum of the squared difference between the observed prototype tidal elevation data and the form represented by Equation 2.

23. The least squares procedure (Outlaw, 1981) minimizes the variance  $E$  such that

$$E = \sum_{n=1}^N \epsilon(n\Delta t)^2 = \sum_{n=1}^N [\bar{h}_p(n\Delta t) - h_p(n\Delta t)]^2 \rightarrow \text{minimal} \quad (4)$$

where  $N$  is the total number of data samples and  $\Delta t$  is the time interval between consecutive samples. To minimize the variance, set

$$\frac{\partial E}{\partial a_i} = 0, \quad i = 1, \dots, J \quad (5)$$

and

$$\frac{\partial E}{\partial b_i} = 0, \quad i = 1, \dots, J \quad (6)$$

or, from Equations 3 and 4, Equation 5 can be written

$$\frac{\partial E}{\partial a_i} = \frac{\partial}{\partial a_i} \left\{ \sum_{n=1}^N \left[ (\bar{h}_p(n\Delta t))^2 - 2\bar{h}_p(n\Delta t) \cdot \left[ \sum_{i=1}^J (a_i \cos(\omega_i n\Delta t)) \right] \right] \right\}$$



$$\begin{aligned}
& + b_i \sin (\omega_i n \Delta t) \Big] + \left[ \sum_{i=1}^J (a_i \cos (\omega_i n \Delta t) \right. \\
& \left. + b_i \sin (\omega_i n \Delta t) \right]^2 \Big\} = 0 \tag{7}
\end{aligned}$$

Equation 6 may be expressed similarly. Combining terms, Equations 5 and 6 become

$$\begin{aligned}
\frac{\partial E}{\partial a_i} = \sum_{n=1}^N \left\{ -2 \bar{h}_p (n \Delta t) \cdot \sum_{i=1}^J \cos (\omega_i n \Delta t) + 2 \cos (\omega_i n \Delta t) \right. \\
\left. \cdot \sum_{i=1}^J [a_i \cos (\omega_i n \Delta t) + b_i \sin (\omega_i n \Delta t)] \right\} = 0 \tag{8}
\end{aligned}$$

$$\begin{aligned}
\frac{\partial E}{\partial b_i} = \left\{ \sum_{n=1}^N -2 \bar{h}_p (n \Delta t) \cdot \sum_{i=1}^J \sin (\omega_i n \Delta t) + 2 \sin (\omega_i n \Delta t) \right. \\
\left. \cdot \sum_{i=1}^J [a_i \cos (\omega_i n \Delta t) + b_i \sin (\omega_i n \Delta t)] \right\} = 0 \tag{9}
\end{aligned}$$

Equations 8 and 9 form a set of simultaneous equations that may be solved for  $a_i$  and  $b_i$ .

24. For each tidal constituent, the amplitude  $A_i$  and the phase  $\phi_i$  can be determined from

$$A_i = (a_i^2 + b_i^2)^{1/2} \tag{10}$$

and

$$\phi_i = \arctan \frac{b_i}{a_i} \tag{11}$$

After calculating the equilibrium argument, results from the least squares analysis may be expressed as the tidal constituent amplitude

and local epoch. The harmonic analysis of the velocity data is conducted using the same procedure to find the mean velocity amplitude after removing the mean of the observed velocity record.

### Tidal Constituents

25. Tidal constituents in the data analysis included diurnal, semidiurnal, and shallow-water overtide components and were:

<u>Harmonic Constituent</u>	<u>Symbol</u>	<u>Period, hr</u>
<u>Diurnal</u>		
Principal lunar	O1	25.82
Lunisolar diurnal	K1	23.94
Principal solar diurnal	P1	24.07
Smaller lunar elliptic	M1	24.84
Small lunar elliptic	J1	23.10
Larger lunar elliptic	Q1	26.87
<u>Semidiurnal</u>		
Principal lunar	M2	12.42
Principal solar	S2	12.00
Larger lunar elliptic	N2	12.66

26. Previous harmonic analyses by the Coast and Geodetic Survey (1942) of tidal elevation data from several stations in and near Mississippi Sound indicated that the principal tidal components were the diurnal constituents K1, O1, P1, and the semidiurnal constituents S2 and M2.

### Pressure Submergence Conversion

27. The equation for converting pressure data to surface elevation data is

$$h(t) = \frac{P_p(t)}{\gamma_s} - \frac{P_b(t)}{\gamma_s} \quad (12)$$

where

$h(t)$  = depth of submergence  
 $P_p(t)$  = pressure measurement  
 $\gamma_s$  = specific weight of sea water  
 $P_b(t)$  = barometric pressure

The barometric pressure recorded at meteorological station 5 was used for calculating surface elevation at Stations 22-24. Due to the remote location of Stations 22-24, an elevation datum was not established and the elevations calculated from Equation 12 represent the average depth of submergence of the pressure sensor.

PART IV: SURFACE ELEVATION ANALYSIS RESULTS

Prototype Observations

28. Typical observed elevation data with the mean of the data record removed for NOS stations 873-1269 at Gulf Shores, AL, station 874-1196 at Pascagoula, MS, station 874-4756 at Ship Island, MS, and station 876-0595 at Breton Island, LA, are presented in Plates 1-28. The elevation of the record mean relative to mean lower low water is given in Table 6 for the NOS stations. The record length is 130 days at Ship Island, 150 days at Breton Island, and exceeded 180 days at Gulf Shores and Pascagoula.

29. Surface elevation data calculated from pressure cell data at Station 22 in the Gulf are shown in Plates 29-36. The record length is 196 days.

30. The surface elevation data at Gulf Shores, Pascagoula, Ship Island, and Breton Island are representative of the data nearshore and along the barrier islands. The minimum elevation, maximum elevation, and range of the data referenced to the mean elevation of the record at each of the four NOS stations over the observation period were:

<u>Station</u>	<u>Location</u>	<u>Elevation and Date</u>				<u>Range, ft</u>
		<u>Min, ft</u>	<u>Date</u>	<u>Max, ft</u>	<u>Date</u>	
873-1269	Gulf Shores, AL	-1.43	15 Jul 80	2.33	17 May 81	3.76
874-1196	Pascagoula, MS	-1.59	25 Oct 80	2.58	13 Apr 81	4.17
874-4756	Ship Island, MS	-1.73	27 Jul 80	1.92	4 Sep 80	3.65
876-0595	Breton Isl. LA	-1.65	27 Jun 80	1.92	4 Sep 80	3.57

Although occurring at different times, the tidal range at the two nearshore stations varied by only 0.41 ft. At the two barrier island stations the range was less than the nearshore stations and varied by 0.08 ft. The larger variation at the nearshore gages is probably due to the influence of the nearshore bathymetry. The preceding range data should not be interpreted as the tidal range but as the combined influence of the tides, meteorological affects, and other long term trends such as

river outflow or possible standing wave formation in the Gulf. The gage datum for the pressure cells in the Gulf may change at each service period and similar data for stations 22-24 are not presented.

Harmonic Analysis Results

31. Filtered prototype surface elevation data for station 874-1196 at Pascagoula and station 22 in the Gulf are shown in Plates 37-50 for the analysis record lengths of 182 days. The calculated tide from the harmonic constituent analysis results also are included on Plates 37-50. The diurnal tidal cycle and times of the spring and neap tidal range are readily apparent. The minimum elevation, maximum elevation, and range of the filtered elevation data over the observation period referenced to the mean elevation of the record at the two stations are:

<u>Station</u>	<u>Location</u>	<u>Elevation, ft</u>		<u>Range, ft</u>
		<u>Min.</u>	<u>Max.</u>	
874-1196	Pascagoula	-1.23	1.23	2.46
22	Gulf	-1.05	1.13	2.18

The maximum range of the elevation data occurred on 16-17 May 1980 for each station and shows that the observed tidal range nearshore at Pascagoula was higher than in the Gulf.

32. Mean amplitude and local epoch data for each constituent at the offshore and nearshore stations are given in Tables 7 and 8. The record length used in the harmonic analysis and the root-mean-square (RMS) value of the residual of the observed data after the calculated tide has been subtracted are given in Table 9 for each station.

33. The mean amplitude of the O1 and K1 constituents are approximately equal (near 0.5 ft) and tend to be slightly higher at the nearshore stations along the coast and barrier islands than at the three offshore stations. The P1 constituent mean amplitude tends to be approximately one-fourth to one-third of the K1 constituent and the Q1 constituent mean amplitude is generally less than the P1 mean amplitude. The M2 and S2 semidiurnal constituent mean amplitudes are less than the P1

constituent at all gages. Maximum mean amplitudes of the O1, K1, P1, Q1, M2, and S2 constituents for all stations were 0.56 ft, 0.57 ft, 0.16 ft, 0.14 ft, 0.13 ft, and 0.12 ft respectively. The mean amplitude and local epoch of the O1 constituent are shown in Figure 7. The mean amplitudes reach a maximum near Biloxi Bay and decrease from 0.56 ft at station 874-4671 to 0.45 ft at station 873-1269. Seaward in the Gulf, the mean amplitude of the O1 constituent is 0.46-0.47 ft.

34. The filtered observed elevation data and calculated tidal elevation data shown in Plates 37-50 agree well. The RMS error was 0.10 at station 874-1196 and 0.05 at station 22. The RMS values ranged from 0.18 ft at station 874-4671 to 0.05 ft at stations 22 and 23. Observed and filtered tidal elevation data from station 874-1196 may be compared using the data from Plates 10-16 and 37-43. Trends in the observed data at nontidal periods are attenuated by the data filter, and the regular variation from the neap to spring tidal range is evident in the filtered data. During the numerical model calibration period (20-25 September 1980), the mean elevation of the observed data is approximately 0.4 ft higher than the filtered data and is probably due to persistent winds from the south during the calibration period. Tropical storm Hermine occurred during 20-25 September and crossed the Yucatan Peninsula into the Gulf on the 23rd. Winds were not as persistent during the first several days of the 12-17 June 1980 period selected for model verification, although they were relatively similar in magnitude, and the mean elevations of observed and filtered data were similar. There were no tropical storms in the vicinity of the Gulf during the verification period.

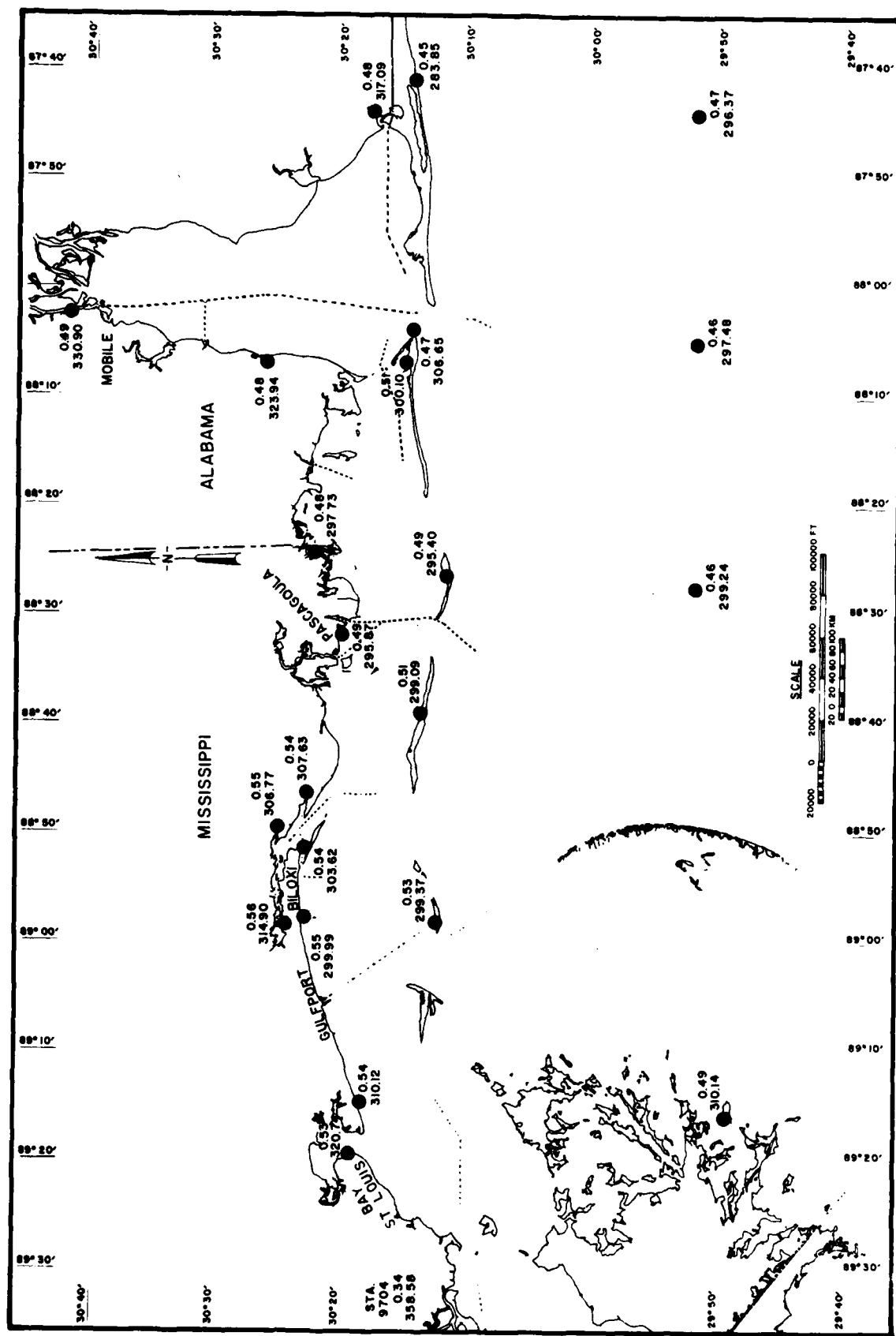


Figure 7. Mean amplitude and local epoch of the O1 constituent

## PART V: VELOCITY ANALYSIS RESULTS

### Prototype Observations

35. Prototype velocity data were collected at stations V1-V21 from approximately mid-April to late October 1980. From mid-June to mid-July, the current meters were removed to prevent meter loss due to the shrimp season. With the exceptions of stations 9 and 10, a gap of approximately 5 days occurred in August due to removal of the current meters during the passage of Hurricane Allen, again to prevent meter losses. The available length of data record for each current meter is shown on Plate 51. Other gaps in the velocity data records were due to fouling of the meter impeller, meter displacement, or meter malfunction. Short breaks in the velocity records during station service intervals are not shown.

36. Generally, the data record prior to removal of the current meters during the shrimp season and Hurricane Allen was used during the harmonic analysis for tidal current constituents. At several stations, the velocity data record was significantly longer after the shrimp season and Hurricane Allen and was used in the analysis.

37. Typical velocity data records edited for analysis are shown in Plates 52-103 for stations V3-S, V3-B, V15-S, V15-M, V15-B, V21-S, V21-M, and V21-B. Station V3 was located at St. Joe Pass in the western part of the Sound, station V15 near the Pascagoula Ship Channel at Petit Bois Island, and station V21 at the eastern side of the Mobile Bay Channel as shown in Figure 3. The first plate for each station location is a summary plot of velocity magnitude and direction. The remaining plots are of the north-south and east-west components of the velocity. The direction shown on the plots has been converted from the observed magnetic direction to true north.

38. At station V3, the flow was aligned with the St. Joe Pass channel in both flood flow into Lake Borgne and ebb flow out of Lake Borgne. The velocities generally decreased slightly at the bottom station but the flow direction was similar at both surface and bottom



meter locations. The north/south component mean (net) velocity over the record length at the surface and bottom positions was 0.00 fps and 0.05 fps N, respectively. The east/west component mean velocity was 0.02 fps E and 0.03 fps E at the surface and bottom. Over the record length at station 3, the mean velocity data does indicate a net eastward component flow at the surface and a net eastward and northward component flow at the bottom.

39. At station V15 near the Pascagoula Ship Channel at Petit Bois Island, the flood/ebb flow direction into Mississippi Sound as shown on the velocity summary plots was approximately north-south. Comparison of the component velocity data does indicate a decrease in maximum velocity from the surface to the bottom at station V15. At the bottom, maximum north/south component velocities also generally lag the maximum surface velocities slightly. The north/south component mean velocity over the analysis period at the surface, middepth, and bottom positions was 0.05 fps N, 0.012 fps N, and 0.13 fps N, respectively, and indicates a net northward flow component into the Sound at station V15. The east/west component mean velocity at the surface, middepth and bottom was 0.03 fps W, 0.07 fps W, and 0.11 fps W, respectively, and indicates a net westward flow component during the analysis period.

40. At station V21, direction of flood flow is approximately north-northwest into Mobile Bay with ebb flow in the opposite direction. The shore and bottom contours of the bay near the station are aligned approximately in the same direction. The north/south component mean velocity during the analysis interval at the surface, middepth, and bottom was 0.51 fps S, 0.34 fps S, and 0.29 fps S, respectively. The east/west component mean velocity at the same three depths was 0.33 fps W, 0.19 fps W, and 0.10 fps W. The component mean velocities indicate a net ebb flow at station V21, but represent a single vertical velocity profile and should not be considered as representative of the velocity regime across the entire Mobile Bay Channel. A similar restriction applies to the other velocity stations as well.

## Harmonic Analysis Results

41. Filtered component elevation data for stations V3-S, V15-S, and V21-S are presented in Plates 104-119 for the analysis periods. The velocities calculated from the harmonic constituent analysis also are included in Plates 104-119. The mean of the component velocity data has been removed from the plotted data. The mean amplitude and local epoch for each tidal constituent are given in Tables 10 and 11 for the north/south component and Tables 12 and 13 for the east/west component for stations V1-V15 and V17-V21. The continuous velocity record lengths of 21 and 15 days at station V16-S and V16-B were not adequate for accurate harmonic analysis results and this station is not included in the analysis. The component mean velocity at each station is given in Table 14. The length of the analysis record at each station and the analysis RMS error are given in Table 15. The P1 constituent was not included in the velocity data analysis due to the relatively short analysis record lengths (31 to 67 days), with the exception of the 99 day records at stations V10-S and V10-B. Records of less than 120 days (Outlaw, 1981) are not of sufficient length to properly separate the K1 and P1 constituents if noise is present in the tidal data.

42. The O1 velocity component mean amplitude is shown as a vector plot in Figure 8 at each station. The O1 constituent mean amplitude for the north/south component ranges for 0.01 fps at station V1-M to 0.56 fps at station V18-M. For the east/west component, the O1 constituent mean amplitude ranged from 0.03 fps at station V13-B to 0.48 fps at station V3-S. The minimum K1 constituent mean amplitude (Table 10) in the north/south direction was 0.03 fps at station V6-S and the maximum mean amplitude was 0.72 fps at station V21-S. In the east/west direction, the minimum K1 constituent mean amplitude (Table 12) was 0.01 fps at station V15-M and the maximum mean amplitude was 0.63 fps at station V3-S. Maximum mean velocity amplitude was 0.31 fps in the north/south direction for the M2 constituent at station V18-M and, in the east/west direction, 0.19 fps at station V8-S.

43. An unusual event occurred in the observed velocity data near

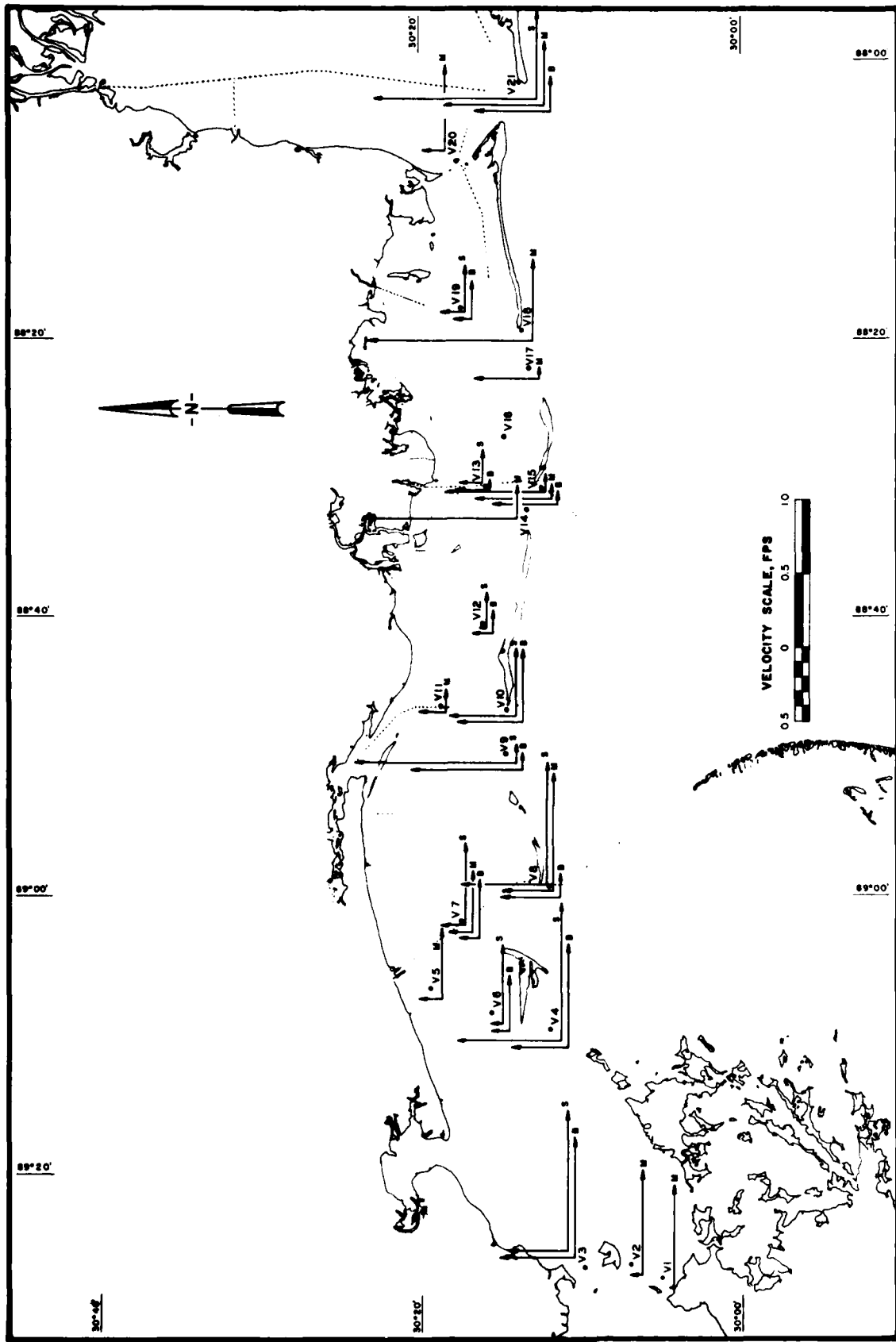


Figure 8. North/south and east/west average velocity amplitude for the O1 constituents. Meter position is indicated by S, M, or B for surface, middepth, or bottom.

mid-May which is easily seen in the filtered north/south velocity component data for station V15-S (Plate 110). No unusually severe meteorological conditions occurred during mid-May which should have had a strong influence on currents in the Mississippi Sound area. However, the volcanic eruption of Mt. St. Helens in Washington State did occur on 17 May 1980. As shown on Plate 30, the tidal elevation in the Gulf at station V22 rapidly dropped approximately 1.2 ft on 17 May and rose again within one hour. A similar decrease in elevation also occurred at Gulf Shores (Plate 3) and at Pascagoula (Plate 11). The decrease in elevation at Breton Island (Plate 24) was approximately 0.4 ft. The coincidence of the events at Mt. St. Helens and the rather unusual surface elevation and velocity data observed in the Mississippi area suggests these events may be interrelated. However, further investigation of the interrelationship, if any, is beyond the scope of this study.

## PART VI: SALINITY OBSERVATIONS

44. Data from transect surveys of 21 and 22 May, 23 and 24 July, and 6 and 7 November were selected to show typical salinity conditions during the spring, summer, and fall seasons and correspond with the beginning, mid-point, and conclusion of the prototype data acquisition period. Surface salinity data taken at a depth of approximately 1 ft at the 40 transect stations are shown on Plates 120-122 for the three periods. The transect data extend from the east side of the Sound at Pass aux Herons to St. Joe and Le Petit Passes on the west side of the Sound.

45. During the 21 and 22 May survey, salinity varied from a low of 1.5 ppt at St. Joe Pass between Lake Borgne and the Sound to a maximum of 19.9 ppt at the Pascagoula ship channel entrance near Petit Bois Island. Generally, surface salinity is lower near sources of river outflow such as Lake Borgne, Biloxi Bay, Pascagoula, and Mobile Bay.

46. The salinity data from the 21 and 22 May survey did vary with depth at many stations and the depth variation at transect station T10 and T16 in the Gulfport Ship Channel, T36 near mid-sound at Bay St. Louis, T30 at St. Joe Pass near Lake Borgne, T46 and T50 in the Biloxi Bay Channel, T54 near mid-sound north of Horn Island, T56 and T60 in the Pascagoula ship channel, T76 near mid-sound north of Dauphin Island, and T80 near Mobile Bay are given in Plates 123 and 124 for 21 and 22 May as well as the remaining two survey periods.

47. During the 21 and 22 May survey, the salinity at St. Joe Pass (Station T30) between the Sound and Lake Borgne was relatively constant with depth (1.5 ppt-1.6 ppt). At mid-sound near Bay St. Louis (T36), the salinity had increased to 7.7 ppt and was constant over depth. In the entrance to Gulfport ship channel at Ship Island (T16), the surface salinity was 15.5 ppt but increased to 21.9 ppt-24.6 ppt at a depth of 15 ft and below. Near mid-Sound along the channel (T10), the salinity decreased to 12.2 ppt at the surface and increased to 19.9 ppt-21.4 ppt at a depth of 10 ft and below.

48. Near mid-Sound between Gulfport and Biloxi Bay (T2), the sali-

nity varied from 14.2 ppt at the surface to 18.8 ppt near bottom. In the Biloxi ship channel, the surface salinity at the entrance (T50) was 18.6 ppt and increased to 27.1 ppt at the 20 ft depth. Near mid-sound (T40), the salinity increased from 4.7 ppt to 14.8 ppt at a depth of 5 ft and was 15.2 ppt near the bottom. In the Pascagouls ship channel entrance (T56), the surface salinity was 19.9 ppt and increased to 30.6 ppt at the bottom. Near mid-sound in the channel (T60), the surface salinity decreased to 10.7 ppt. Between the 5 ft depth and the bottom, the salinity increased from 17.0 ppt to 28.0 ppt. North of Dauphin Island at T76, the salinity increased from 13.6 ppt at the surface to 22.3 ppt near the bottom. Between the Sound and Mobile Bay at T80, the salinity was 4.8 ppt near the surface and 11.6 ppt near the bottom.

49. Surface salinity variation for 23 and 24 July and 6 and 7 November (Plates 121 and 122) was less than for the spring period and the salinity was generally above 20 ppt except near Lake Borgne on the west end of the Sound.

50. Salinity variation with depth (Plates 123 and 124), again for the twelve stations, decreased for the summer and fall periods.

51. The transect salinity data indicated that portions of the Sound were vertically stratified during the spring but that the Sound was relatively well-mixed during the July and November surveys. A horizontal salinity gradient did exist in the sound near Mobile Bay and near Lake Borgne as well as near sources of river inflow for all three surveys.

52. Conductivity and temperature were observed continuously at velocity stations V6 (surface and bottom), V10 (surface and bottom), V15 (surface and bottom), and mid-depth at stations V18 and V21 during the first two transect periods. Data from these stations (not given in this report) are presented in the ROSC prototype data report and indicate that a tidal variation in the salinity may occur. Stations V10, V15, V18, and V20 were located near transect stations T50, T56, T76, and T80, respectively. Minimum, maximum, and range of the salinity data during the first and second two day transect surveys are given in Table 16 for corresponding stations. Station V10 and V15 are near the barrier islands

and V18 and V20 are at the eastern end of the sound as shown in Figure 3. The variation on the salinity range at corresponding stations was 5.3 ppt to 9.3 ppt during the first survey period and 0.9 ppt to 7.6 ppt during the second survey period. At each comparison station, however, the range decreased during the second survey period.

## PART VII: CONCLUSIONS

53. Conclusions from analysis of surface elevation and velocity data acquired during 1980 in Mississippi Sound and vicinity are:

- a. O1 and K1 are the principal surface elevation diurnal tidal constituents in the study area with a mean amplitude near 0.5 ft.
- b. P1 and Q1 diurnal surface elevation constituents are less significant with mean amplitudes of 0.16 ft or less.
- c. Principal semidiurnal surface elevation constituents are M2 and S2 with mean amplitudes of 0.13 ft or less.
- d. O1 and K1 are the principal diurnal velocity constituents with maximum mean amplitudes of 0.56 fps (Station V18) and 0.72 fps (Station V21-S) in the north/south velocity component.
- e. Maximum semidiurnal mean velocity amplitude was 0.31 fps in the north/south direction at Station V18-M.
- f. Salinity transect data from 21 and 22 May 1980 had a surface horizontal variation of 18.4 ppt and, at some stations, variation with depth (total difference of 17.1 ppt at Station T60). Minimum salinity levels were observed near Lake Borgne in the western part of the Sound.
- g. Surface salinity levels increased at all transect stations during the surveys of 23 and 24 July and 6 and 7 November 1980. Variation in vertical salinity also decreased.

54. Results from the harmonic analysis of prototype surface elevation and velocity data will be used as a data base for calibration and verification of a numerical tidal circulation model of the Mississippi Sound area and vicinity.



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Outlaw, D. G., "Lake Pontchartrain and Vicinity Hurricane Protection Plan, Report 1, Prototype Data Acquisition and Analysis," TR H1-81- , U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

U. S. Department of Commerce, Coast and Geodetic Survey, "Tidal Harmonic Constants, Atlantic Ocean Including Arctic and Antarctic," TH-1, Washington, DC, January 1942.

TABLE 1

## Tide Station Locations

Station	Mean Lower Low Water, Ft	Latitude (N)	Longitude (W)	Location
22	--	29°52.8'	88°27.6'	Gulf of Mexico
23	--	29°52.8'	88°05.0'	Gulf of Mexico
24	--	29°52.8'	87°44.0'	Gulf of Mexico
873-1269	-0.29	30°14.9'	87°40.1'	Gulf Shores, AL
873-1952	-0.21	30°18.2'	87°44.1'	Bon Secour, AL
873-5184	--	30°15.0'	88°04.5'	Dauphin Island, AL
873-5523	-0.24	30°26.6'	88°06.8'	Fowl River, AL
873-5587	-0.40	30°15.5'	88°06.8'	North Point, AL
873-7048	--	30°42.3'	88°02.4'	Mobile, AL
874-0199	-0.24	30°20.5'	88°24.4'	Grand Batture Island, MS
874-0405	-0.26	30°12.2'	88°26.5'	Petit Bois Island, MS
874-1196	-0.30	30°20.4'	88°32.0'	Pascagoula, MS
874-2221	-0.29	30°14.1'	88°39.2'	Horn Island, MS
874-3081	-0.44	30°23.2'	88°46.4'	Davis Bayou, MS
874-3495	--	30°25.2'	88°49.7'	Old Fort Bayou, MS
874-3735	-0.36	30°23.4'	88°51.4'	Cadet Point, MS
874-4586	-0.42	30°23.3'	88°57.8'	Broadwater Marina, MS
874-4671	--	30°24.8'	88°58.5'	Popps Ferry Bridge, MS
874-4756	-0.28	30°12.7'	88°58.3'	Ship Island, MS
874-6819	-0.39	30°18.6'	89°14.7'	Pass Christian, MS
874-7437	-0.27	30°19.5'	89°19.5'	Bay Waveland, MS
874-9704	--	30°14.7'	89°36.8'	Pearl River at Burlington
876-0412	--	29°12.3'	89°02.2'	North Pass, LA
876-0595	--	29°29.6'	89°10.4'	Breton Island, LA
876-0742	--	29°49.4'	89°16.2'	Comfort Island, LA

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 MLLW referenced to NGVD

TABLE 2

Velocity Station Locations

<u>Station</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>
V1	30 04.78	89 27.70
V2	30 06.77	89 26.58
V3	30 09.74	89 27.02
V4	30 11.79	89 09.67
V5	30 19.32	89 06.62
V6	30 15.66	89 08.24
V7	30 17.43	89 01.79
V8	30 11.95	88 59.20
V9	30 14.70	88 49.78
V10	30 14.60	88 46.74
V11	30 18.70	88 46.56
V12	30 16.14	88 40.82
V13	30 15.96	88 30.61
V14	30 13.32	88 32.40
V15	30 12.45	88 30.75
V16	30 14.83	88 27.08
V17	30 13.18	88 22.38
V18	30 13.73	88 19.72
V19	30 17.49	88 18.05
V20	30 17.64	88 07.30
V21	30 13.77	88 01.74

TABLE 3

## Current and Conductivity/Temperature Meter Installation

<u>Station</u> *	<u>Approximate Local Depth, ft</u>	<u>Meter Height Above Bottom, ft</u>	<u>Conductivity Temperature Meter</u>
1	12	6	
2	9	4.5	
3-S	31	26	
3-B		5	
4-S	25	20	
4-B		5	
5	10	5	
6-S	31	8	X
6-B		5	X
7-S	15	10	
7-B		5	
8-S	28	23	
8-M		14	
8-B		5	
9-S	20	15	
9-B		5	
10-S	24	19	X
10-B		5	X
11	11	5.5	
12-S	15	10	X
12-B		5	X
13-S	17	12	
13-B		5	
14	10	5	
15-S	20	15	X
15-M		10	
15-B		5	X

(Continued)

TABLE 3 (Concluded)

Current and Conductivity/Temperature Meter Installation

<u>Station*</u>	<u>Approximate Local Depth, ft</u>	<u>Meter Height Above Bottom, ft</u>	<u>Conductivity Temperature Meter</u>
16-S	17	12	
16-B		5	
17	12	6	
18*	15	7.5	
19-S	13	8	
19-B		5	
20	10	5	X
21-S	30	25	
21-M		15	
21-B		5	

---

\* S, M, and B denote surface, mid-depth, and bottom meter locations.

TABLE 4

## Meteorological Station Locations

<u>Station</u>	<u>Latitude(N)</u>		<u>Longitude(W)</u>	
M10	30	18.4	89	17.7
M20	30	12.6	88	59.1
M30	30	23.5	88	51.6
M40	30	14.3	88	40.0
M50	30	14.8	88	04.7

TABLE 5

Salinity/Temperature Station Locations

<u>Station</u>	<u>Approx. Depth, ft</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>
T2	17	30 16.7	88 53.1
T4	13	30 19.4	88 58.4
T6	30	30 20.7	89 04.6
T8	29	30 19.1	89 03.3
T10	30	30 17.3	89 01.9
T12	32	30 15.8	89 00.1
T14	34	30 14.1	88 59.2
T16	35	30 12.0	88 59.2
T18	42	30 11.4	89 08.6
T20	15	30 10.8	89 14.8
T22	13	30 09.4	89 17.5
T24	12	30 07.3	89 22.6
T26	12	30 04.7	89 27.9
T28	12	30 06.3	89 26.7
T30	14	30 09.7	89 27.0
T32	11	30 01.7	89 23.2
T34	12	30 13.3	89 19.4
T36	12	30 14.2	89 15.1
T38	16	30 15.2	89 11.0
T40	12	30 18.1	89 09.1
T42	15	30 16.7	89 05.2
T44	12	30 19.9	88 46.5
T46	14	30 18.4	88 46.5
T48	17	30 16.5	88 46.6
T50	24	30 14.5	88 46.9
T52	12	30 17.8	88 41.4
T54	14	30 15.1	88 36.3
T56	48	30 12.5	88 30.7
T58	42	30 14.6	88 30.6
T60	45	30 16.9	88 30.8
T62	40	30 18.6	88 32.3
T64	41	30 20.3	88 34.0
T66	42	30 19.2	88 30.8
T68	11	30 16.4	88 26.7
T70	18	30 14.9	88 26.7
T72	16	30 13.6	88 19.8
T74	14	30 15.4	88 18.9
T76	13	30 17.2	88 17.9
T78	8	30 17.0	88 12.7
T80	18	30 17.0	88 08.4

TABLE 6

Mean Elevation of Observed NOS Data Record  
Relative to Mean Lower Low Water

<u>Station</u>	<u>Elevation ft</u>
873-1269	0.71
873-1952	0.69
873-5184	-
873-5523	0.73
873-5587	0.96
873-7048	0.85
874-0199	0.85
874-0405	0.88
874-1196	0.88
874-2221	0.90
874-3081	1.07
874-3495	-
874-3735	1.01
874-4586	1.04
874-4671	-
874-4756	0.90
874-6819	0.99
874-7437	0.87
874-9704	-
876-0412	0.56
876-0595	0.71
876-0742	0.92



TABLE 7

## Surface Elevation Mean Amplitude

Station	O1	K1	F1	M1	J1	Q1	M2	S2	N2
STA 22	0.46	0.47	0.15	0.01	0.02	0.11	0.09	0.05	0.02
STA 23	0.46	0.48	0.15	0.01	0.02	0.10	0.09	0.05	0.02
STA 24	0.47	0.47	0.14	0.02	0.02	0.12	0.09	0.06	0.02
873-1269	0.45	0.46	0.16	0.01	0.02	0.12	0.10	0.05	0.02
873-1952	0.48	0.48	0.13	0.01	0.02	0.11	0.07	0.01	0.01
873-5184	0.40	0.41	0.13	0.01	0.03	0.11	0.04	0.02	0.01
873-5523	0.48	0.48	0.16	0.03	0.01	0.11	0.08	0.02	0.02
873-5587	0.51	0.51	0.15	0.02	0.03	0.12	0.10	0.04	0.03
873-7048	0.49	0.47	0.16	0.01	0.02	0.12	0.08	0.05	0.02
874-0199	0.48	0.48	0.13	0.02	0.02	0.10	0.09	0.05	0.02
874-0405	0.49	0.49	0.14	0.01	0.03	0.11	0.09	0.04	0.02
874-1196	0.49	0.47	0.14	0.02	0.03	0.12	0.09	0.05	0.02
874-2221	0.51	0.51	0.15	0.02	0.02	0.12	0.09	0.05	0.02
874-3081	0.54	0.52	0.14	0.03	0.03	0.13	0.11	0.08	0.03
874-3495	0.55	0.53	0.14	0.03	0.03	0.14	0.12	0.09	0.04
874-3735	0.54	0.54	0.13	0.02	0.02	0.13	0.11	0.08	0.03
874-4586	0.55	0.53	0.14	0.03	0.03	0.14	0.11	0.08	0.03
874-4671	0.56	0.57	0.13	0.02	0.03	0.13	0.13	0.10	0.04
874-4756	0.53	0.51	0.15	0.03	0.02	0.14	0.11	0.05	0.03
874-6819	0.54	0.55	0.15	0.02	0.02	0.13	0.11	0.08	0.03
874-7437	0.53	0.57	0.13	0.02	0.01	0.12	0.10	0.08	0.03
874-9704	0.34	0.38	0.13	0.02	0.03	0.10	0.06	0.04	0.02
876-0412	0.36	0.36	0.14	0.00	0.02	0.07	0.04	0.03	0.01
876-0595	0.42	0.44	0.13	0.01	0.01	0.09	0.05	0.02	0.01
876-0742	0.49	0.52	0.15	0.02	0.01	0.12	0.09	0.06	0.02

TABLE 8

## Surface Elevation Local Epoch (deg)

Station	O1	K1	P1	M1	J1	Q1	M2	S2	N2
STA 22	299.1	309.2	305.8	351.5	303.7	286.8	320.6	328.6	345.8
STA 23	297.5	308.1	304.3	349.7	289.7	283.7	312.0	321.9	330.3
STA 24	296.4	309.9	300.5	338.0	320.5	281.1	311.0	321.5	329.4
873-1269	283.8	293.6	292.6	348.9	268.8	266.0	278.5	285.4	297.8
873-1952	317.1	326.9	331.3	54.4	332.3	306.6	356.9	9.6	8.0
873-5184	313.3	325.7	326.2	332.8	281.3	293.3	321.0	309.6	339.1
873-5523	323.8	334.9	347.8	22.2	250.6	320.8	24.7	55.1	55.6
873-5587	300.1	307.9	308.4	356.2	299.5	290.6	332.8	332.0	347.4
873-7048	330.9	348.5	350.8	27.7	327.3	319.8	45.6	75.2	76.2
874-0199	297.7	307.9	313.7	9.4	294.1	285.0	323.2	341.0	354.3
874-0405	295.4	305.2	304.2	356.5	287.3	280.8	320.8	327.4	346.0
874-1196	295.9	306.6	309.4	359.8	284.3	283.7	323.6	339.5	350.9
874-2221	299.1	309.0	310.5	356.0	288.1	288.1	334.0	349.3	359.4
874-3081	307.6	322.4	328.9	353.4	290.0	297.3	3.7	30.5	37.0
874-3495	306.8	322.3	329.0	350.3	267.7	293.5	4.7	30.3	39.2
874-3735	303.6	317.3	324.3	351.4	266.0	288.1	355.3	24.5	21.1
874-4586	300.0	314.9	319.9	340.5	255.0	286.6	349.2	11.0	16.6
874-4671	315.1	329.8	336.0	7.4	278.4	295.2	26.1	60.3	59.7
874-4756	299.4	311.1	309.8	4.5	266.3	297.6	344.7	2.3	354.5
874-6819	310.1	327.0	334.5	355.5	245.7	299.7	15.0	29.4	43.8
874-7437	320.6	336.4	354.4	8.2	195.7	305.0	35.1	49.8	67.4
874-9704	358.8	16.9	353.9	62.8	318.4	344.0	119.8	133.8	129.8
876-0412	286.1	297.6	289.3	356.9	310.1	270.1	295.5	299.5	320.2
876-0595	302.5	312.4	316.7	21.2	282.9	295.7	1.3	14.2	30.3
876-0742	310.3	323.8	335.4	6.6	245.8	301.0	22.2	32.9	38.9

TABLE 9

Surface Elevation Record Length and Root Mean Square (RMS) Error

<u>Station</u>	<u>Analysis Record Length, Days</u>	<u>RMS Error, ft</u>
873-1269	182	0.06
873-1952	182	0.13
873-5184	182	0.09
873-5523	141	0.12
873-5587	182	0.10
873-7048	182	0.15
874-0199	182	0.10
874-0405	182	0.08
874-1196	182	0.10
874-2221	182	0.09
874-3081	182	0.16
874-3495	182	0.17
874-3735	182	0.16
874-4586	182	0.16
874-4671	182	0.18
874-4756	122	0.10
874-6819	182	0.16
874-7437	182	0.17
874-9704	182	0.17
876-0412	182	0.07
876-0595	146	0.06
876-0742	182	0.11
22	182	0.05
23	182	0.05
24	159	0.09

TABLE 10

North/South Velocity Component Mean Amplitude (ft)

Station	01	K1	M1	J1	Q1	M2	S2	N2
V1-M	0.01	0.04	0.02	0.04	0.06	0.01	0.01	0.02
V2-M	0.04	0.05	0.01	0.01	0.02	0.01	0.01	0.00
V3-S	0.20	0.26	0.02	0.03	0.05	0.06	0.03	0.01
V3-B	0.25	0.31	0.02	0.02	0.06	0.04	0.05	0.01
V4-S	0.33	0.44	0.03	0.05	0.08	0.05	0.05	0.01
V4-B	0.19	0.27	0.01	0.01	0.05	0.06	0.03	0.01
V5-M	0.08	0.06	0.01	0.03	0.02	0.02	0.04	0.01
V6-S	0.04	0.03	0.01	0.02	0.00	0.01	0.02	0.01
V6-B	0.06	0.04	0.02	0.02	0.01	0.03	0.03	0.00
V7-S	0.08	0.10	0.01	0.01	0.02	0.02	0.02	0.01
V7-M	0.08	0.06	0.01	0.03	0.01	0.02	0.01	0.01
V7-B	0.07	0.11	0.03	0.05	0.04	0.02	0.02	0.01
V8-S	0.29	0.36	0.02	0.05	0.09	0.12	0.08	0.03
V8-M	0.17	0.23	0.02	0.01	0.04	0.08	0.05	0.03
V8-B	0.08	0.12	0.03	0.03	0.05	0.02	0.03	0.02
V9-S	0.55	0.69	0.03	0.05	0.13	0.21	0.15	0.07
V9-B	0.38	0.51	0.01	0.03	0.13	0.15	0.06	0.06
V10-S	0.23	0.20	0.02	0.01	0.05	0.08	0.04	0.02
V10-B	0.22	0.18	0.02	0.03	0.04	0.07	0.05	0.01
V11-M	0.09	0.13	0.03	0.02	0.02	0.04	0.03	0.03
V12-S	0.02	0.06	0.01	0.03	0.01	0.02	0.02	0.03
V12-B	0.07	0.07	0.00	0.03	0.01	0.02	0.03	0.02
V13-S	0.11	0.20	0.03	0.02	0.08	0.02	0.05	0.01
V13-B	0.13	0.23	0.03	0.03	0.07	0.03	0.06	0.02
V14-M	0.51	0.61	0.04	0.04	0.14	0.16	0.10	0.04
V15-S	0.34	0.35	0.06	0.05	0.15	0.12	0.07	0.06
V15-M	0.26	0.34	0.03	0.03	0.11	0.07	0.06	0.05
V15-B	0.22	0.28	0.02	0.02	0.06	0.06	0.04	0.01
V17-M	0.22	0.16	0.02	0.03	0.04	0.09	0.05	0.03
V18-M	0.56	0.43	0.07	0.10	0.17	0.31	0.14	0.10
V19-S	0.08	0.10	0.00	0.02	0.04	0.04	0.03	0.01
V19-B	0.06	0.09	0.00	0.01	0.03	0.02	0.02	0.01
V20-M	0.07	0.07	0.01	0.03	0.06	0.03	0.02	0.01
V21-S	0.55	0.72	0.02	0.03	0.07	0.19	0.07	0.05
V21-M	0.34	0.47	0.02	0.04	0.05	0.22	0.06	0.04
V21-B	0.26	0.30	0.04	0.03	0.04	0.21	0.08	0.03

TABLE 11

## North/South Velocity Component Local Epoch (deg)

Station	01	K1	M1	J1	Q1	M2	S2	N2
V1-M	342.3	281.2	58.3	326.4	300.9	160.7	160.2	87.7
V2-M	110.8	112.2	224.2	60.1	55.0	341.5	218.0	301.3
V3-S	126.2	127.1	213.3	282.8	75.1	342.3	275.8	276.0
V3-B	135.1	131.7	210.3	46.6	97.5	328.0	244.7	274.3
V4-S	283.9	284.5	42.7	171.0	253.0	138.4	339.7	75.4
V4-B	279.6	271.3	18.9	359.5	241.2	106.9	10.6	12.6
V5-M	112.0	131.8	242.1	66.1	83.9	255.0	260.2	250.7
V6-S	152.6	150.3	352.8	2.4	139.9	225.8	281.5	157.6
V6-B	140.5	143.6	25.3	17.7	53.3	250.7	239.5	210.9
V7-S	258.4	277.2	24.3	64.1	136.5	324.3	343.5	252.4
V7-M	250.1	229.9	43.9	347.1	255.1	341.6	282.0	255.3
V7-B	216.0	262.4	327.1	312.2	245.8	65.5	291.9	354.6
V8-S	238.7	253.3	9.2	177.4	246.4	56.6	353.4	2.1
V8-M	246.3	241.8	315.4	178.6	225.8	39.3	329.1	336.7
V8-B	274.4	244.7	229.2	302.8	198.5	30.0	356.5	280.5
V9-S	236.0	245.3	350.3	113.9	224.2	52.2	330.2	329.9
V9-B	238.3	249.8	338.0	43.3	219.2	48.3	339.0	341.5
V10-S	239.0	266.8	256.5	162.3	222.0	38.9	350.3	327.7
V10-B	237.4	269.7	284.1	83.9	215.5	43.2	327.3	318.1
V11-M	272.4	231.7	337.6	251.9	324.4	91.0	322.3	90.0
V12-S	156.0	233.4	123.6	19.3	126.9	281.9	314.9	345.4
V12-B	138.6	199.1	143.8	21.7	241.9	233.0	281.3	284.1
V13-S	247.9	250.0	326.5	300.6	214.1	8.6	306.7	348.4
V13-B	262.0	250.2	327.5	4.7	222.5	58.0	315.6	337.9
V14-M	228.8	227.2	322.4	223.0	208.8	27.5	301.1	327.4
V15-S	214.5	221.2	194.7	286.8	191.8	17.7	302.0	290.1
V15-M	232.4	231.5	193.4	230.0	191.7	18.4	291.4	298.7
V15-B	237.4	232.1	147.5	227.7	191.5	29.9	291.9	334.1
V17-M	219.5	228.2	308.6	137.1	214.5	6.0	288.7	264.9
V18-M	210.5	213.8	304.9	176.6	208.2	354.2	262.4	278.1
V19-S	194.2	220.2	7.4	298.4	199.2	332.2	292.1	251.1
V19-B	205.9	238.3	333.1	331.1	211.0	323.0	287.3	290.4
V20-M	248.9	249.4	184.4	301.6	227.3	13.7	313.7	309.5
V21-S	250.9	250.4	147.0	228.3	193.6	51.2	330.9	297.9
V21-M	234.8	231.2	346.0	92.4	159.3	40.8	5.2	254.8
V21-B	236.8	219.8	315.7	136.0	171.9	20.5	15.9	293.3

TABLE 12

East/West Velocity Component Mean Amplitude (ft)

<u>Station</u>	<u>01</u>	<u>K1</u>	<u>M1</u>	<u>J1</u>	<u>Q1</u>	<u>M2</u>	<u>S2</u>	<u>N2</u>
V1-M	0.35	0.44	0.02	0.03	0.10	0.08	0.07	0.04
V2-M	0.36	0.44	0.03	0.05	0.08	0.07	0.07	0.03
V3-S	0.48	0.63	0.04	0.01	0.13	0.08	0.11	0.03
V3-B	0.41	0.54	0.03	0.02	0.11	0.08	0.09	0.03
V4-S	0.47	0.62	0.02	0.02	0.14	0.11	0.07	0.02
V4-B	0.35	0.45	0.01	0.04	0.09	0.11	0.04	0.02
V5-M	0.24	0.30	0.10	0.03	0.08	0.08	0.04	0.03
V6-S	0.27	0.36	0.02	0.04	0.03	0.08	0.03	0.01
V6-B	0.19	0.26	0.02	0.02	0.03	0.05	0.01	0.01
V7-S	0.28	0.34	0.03	0.02	0.06	0.07	0.05	0.00
V7-M	0.21	0.15	0.04	0.03	0.08	0.05	0.03	0.01
V7-B	0.20	0.24	0.02	0.04	0.05	0.07	0.02	0.03
V8-S	0.42	0.43	0.00	0.08	0.06	0.19	0.13	0.03
V8-M	0.40	0.40	0.02	0.04	0.13	0.16	0.10	0.03
V8-B	0.20	0.26	0.03	0.06	0.07	0.13	0.07	0.02
V9-S	0.07	0.09	0.02	0.03	0.02	0.04	0.04	0.02
V9-B	0.06	0.09	0.01	0.02	0.04	0.03	0.00	0.02
V10-S	0.23	0.19	0.02	0.01	0.05	0.07	0.03	0.02
V10-B	0.25	0.20	0.03	0.01	0.05	0.08	0.05	0.01
V11-M	0.08	0.06	0.03	0.00	0.04	0.01	0.01	0.02
V12-S	0.12	0.12	0.01	0.03	0.02	0.03	0.03	0.02
V12-B	0.08	0.12	0.02	0.02	0.03	0.02	0.02	0.01
V13-S	0.08	0.11	0.02	0.01	0.03	0.01	0.01	0.01
V13-B	0.03	0.07	0.01	0.01	0.02	0.01	0.02	0.01
V14-M	0.11	0.16	0.01	0.01	0.04	0.01	0.02	0.02
V15-S	0.06	0.06	0.01	0.01	0.02	0.01	0.01	0.01
V15-M	0.05	0.01	0.01	0.00	0.02	0.01	0.01	0.01
V15-B	0.04	0.06	0.01	0.02	0.02	0.02	0.02	0.02
V17-M	0.04	0.02	0.01	0.00	0.01	0.02	0.02	0.00
V18-M	0.28	0.20	0.03	0.04	0.07	0.14	0.08	0.04
V19-S	0.16	0.19	0.01	0.04	0.04	0.03	0.03	0.01
V19-B	0.13	0.14	0.01	0.03	0.04	0.02	0.02	0.00
V20-M	0.29	0.33	0.01	0.04	0.10	0.09	0.02	0.02
V21-S	0.30	0.39	0.06	0.06	0.01	0.10	0.05	0.03
V21-M	0.22	0.28	0.02	0.01	0.04	0.14	0.04	0.02
V21-B	0.12	0.13	0.01	0.01	0.02	0.09	0.04	0.01

TABLE 13

## East/West Velocity Component Local Epoch (deg)

Station	O1	K1	M1	J1	Q1	M2	S2	N2
V1-M	136.1	124.4	263.8	350.8	101.3	344.9	240.4	281.5
V2-M	128.7	126.7	230.6	16.0	108.8	340.5	238.6	275.4
V3-S	129.4	126.0	189.0	84.2	105.8	316.9	225.9	289.5
V3-B	126.1	126.0	196.7	54.3	99.4	322.2	231.5	279.7
V4-S	100.1	100.7	212.5	301.6	65.4	286.2	186.3	237.7
V4-B	106.0	91.7	119.4	220.5	50.3	284.8	198.5	178.8
V5-M	97.3	95.1	350.7	274.2	56.4	282.6	178.2	198.5
V6-S	109.1	104.1	229.2	19.8	63.0	291.0	216.5	278.9
V6-B	105.1	103.4	240.9	302.7	1.0	289.6	228.9	286.2
V7-S	96.1	104.8	218.5	14.3	89.1	284.1	199.3	53.0
V7-M	93.8	107.2	154.9	249.7	53.1	271.7	177.4	141.6
V7-B	95.6	95.9	155.7	120.2	93.9	272.1	199.1	209.8
V8-S	38.9	50.2	342.4	251.3	28.6	217.9	153.4	161.7
V8-M	43.1	51.4	181.8	322.1	50.5	212.2	152.0	125.9
V8-B	28.4	41.4	296.5	1.1	349.6	195.7	142.6	79.2
V9-S	56.8	45.8	15.0	172.3	344.7	224.2	141.5	80.4
V9-B	53.0	68.1	25.3	113.0	36.0	235.6	144.6	155.6
V10-S	240.2	256.6	260.0	348.0	194.6	33.6	292.3	331.1
V10-B	235.5	263.4	279.6	115.8	221.5	42.5	331.4	316.3
V11-M	4.8	326.2	91.1	357.7	65.0	295.9	39.0	255.8
V12-S	330.3	347.1	58.1	192.1	347.7	204.7	94.0	136.1
V12-B	340.8	332.1	44.2	118.7	243.6	145.4	90.0	30.8
V13-S	331.3	312.2	49.6	174.4	253.9	219.7	65.9	141.1
V13-B	328.9	331.7	264.0	171.4	314.8	170.7	91.8	106.2
V14-M	246.8	245.3	27.5	231.4	241.3	78.2	324.8	318.7
V15-S	319.8	297.5	8.0	81.1	354.3	275.2	245.6	263.0
V15-M	285.2	292.0	292.9	53.3	309.2	113.4	313.6	279.1
V15-B	331.3	38.6	115.2	203.7	320.2	132.2	23.5	291.2
V17-M	4.4	306.0	67.5	328.4	76.4	151.0	95.4	64.1
V18-M	28.7	30.3	120.4	356.0	29.2	169.5	81.1	91.8
V19-S	277.7	266.2	297.0	343.5	262.1	20.0	340.7	341.2
V19-B	266.1	258.7	253.6	340.2	243.9	10.3	351.3	3.6
V20-M	286.8	285.7	260.4	307.0	243.4	94.0	41.9	23.0
V21-S	241.1	247.6	23.7	162.0	185.4	36.0	323.6	305.2
V21-M	241.7	228.5	330.0	6.5	157.0	45.7	47.0	317.3
V21-B	240.5	221.3	269.5	41.2	182.0	31.5	45.4	8.7

TABLE 14

## Velocity Component Mean (Net) Velocity

<u>Station</u>	<u>Mean, fps</u>	
	<u>North/South</u>	<u>East/West</u>
V1-M	0.01 N	0.16 E
V2-M	0.01 S	0.11 E
V3-S	0.00	0.02 E
V3-B	0.05 N	0.03 E
V4-S	0.02 N	0.02 W
V4-B	0.08 N	0.00
V5-M	0.04 N	0.05 E
V6-S	0.01 N	0.12 E
V6-B	0.04 N	0.05 E
V7-S	0.02 N	0.12 E
V7-M	0.01 S	0.02 E
V7-B	0.04 N	0.01 E
V8-S	0.08 N	0.13 W
V8-M	0.08 N	0.18 W
V8-B	0.05 N	0.03 W
V9-S	0.14 S	0.06 E
V9-B	0.00	0.00
V10-S	0.02 S	0.01 E
V10-B	0.14 N	0.04 E
V11-M	0.03 S	0.02 E
V12-S	0.01 S	0.10 E
V12-B	0.01 N	0.10 E
V13-S	0.01 S	0.05 E
V13-B	0.05 N	0.03 E
V14-M	0.07 S	0.11 E
V15-S	0.05 N	0.03 W
V15-M	0.12 N	0.07 W
V15-B	0.13 N	0.11 W
V16-S	-	-
V16-B	-	-
V17-M	0.02 N	0.00
V18-M	0.02 N	0.07 W
V19-S	0.06 S	0.06 E
V19-B	0.03 S	0.05 E
V20-M	0.08 N	0.05 W
V21-S	0.51 S	0.33 W
V21-M	0.34 S	0.19 W
V21-B	0.29 S	0.10 W



TABLE 15

Velocity Component Record Length and  
Root-Mean Square (RMS) Error

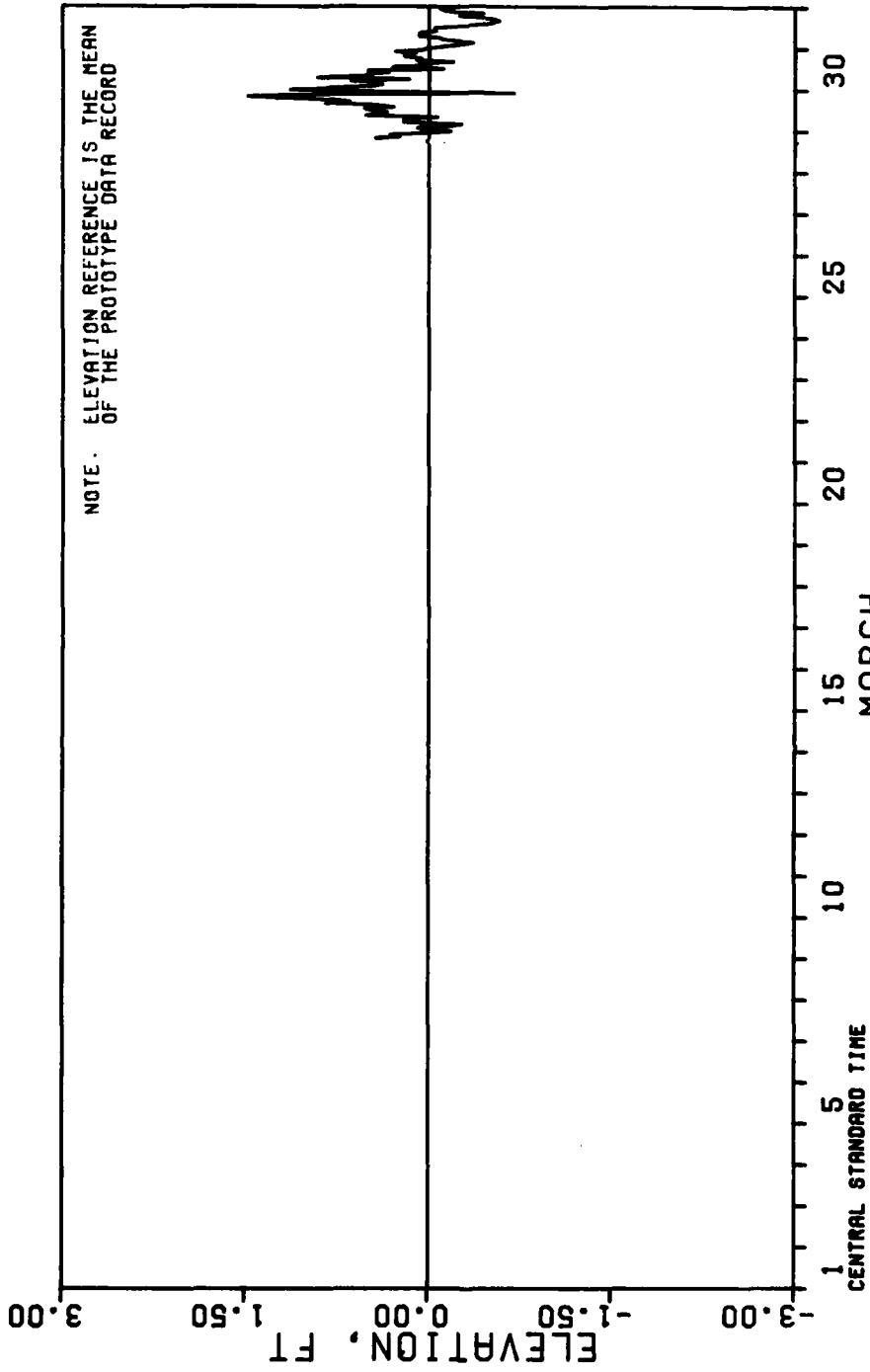
<u>Station</u>	<u>Record Length, days</u>	<u>RMS Error, ft</u>	
		<u>North/South</u>	<u>East/West</u>
V1-M	65	0.09	0.15
V2-M	65	0.04	0.13
V3-S	54	0.09	0.16
V3-B	54	0.09	0.14
V4-S	65	0.15	0.18
V4-B	65	0.10	0.14
V5-M	48	0.07	0.12
V6-S	64	0.07	0.11
V7-S	64	0.09	0.13
V7-M	31	0.06	0.07
V7-B	46	0.09	0.10
V8-S	64	0.17	0.25
V8-M	64	0.12	0.20
V8-B	28	0.08	0.13
V9-S	64	0.25	0.12
V9-B	43	0.17	0.06
V10-S	99	0.13	0.09
V10-B	99	0.10	0.11
V11-M	40	0.08	0.07
V12-S	41	0.08	0.12
V12-B	60	0.10	0.10
V13-S	66	0.11	0.11
V13-B	66	0.13	0.09
V14-M	66	0.19	0.11
V15-S	44	0.21	0.09
V15-M	42	0.17	0.07
V15-B	61	0.17	0.10
V16-S	--	-	-
V16-B	--	-	-
V17-M	67	0.08	0.05
V18-M	67	0.25	0.14
V19-S	61	0.09	0.10
V19-B	61	0.10	0.11
V20-M	60	0.09	0.16
V21-S	55	0.23	0.17
V21-M	55	0.17	0.11
V21-B	50	0.15	0.09

TABLE 16

Minimum, Maximum, and Range of Salinity Data  
at Corresponding Velocity and Transect Stations

Velocity Station	Corresponding Transects Station	Salinity, ppt					
		21-22 May 1980		23-24 July 1980			
		Minimum	Maximum	Range	Minimum	Maximum	Range
V10-S*	T50	15.5	24.2	8.7	25.7	27.7	2.0
V10-B	-	14.4	23.7	9.3	27.5	28.4	0.9
V15-S	T56	17.6	25.2	7.6	-	-	-
V15-B	-	21.5	26.8	5.3	-	-	-
V18-M	T76	19.1	27.6	8.5	18.0	25.6	7.6
V20-M	T80	3.0	10.0	7.0	15.1	18.6	3.5

\* S, M, and B denote near surface, middepth and near bottom locations



OBSERVED TIDAL  
ELEVATIONS  
STATION  
873-126p

MARCH  
1980

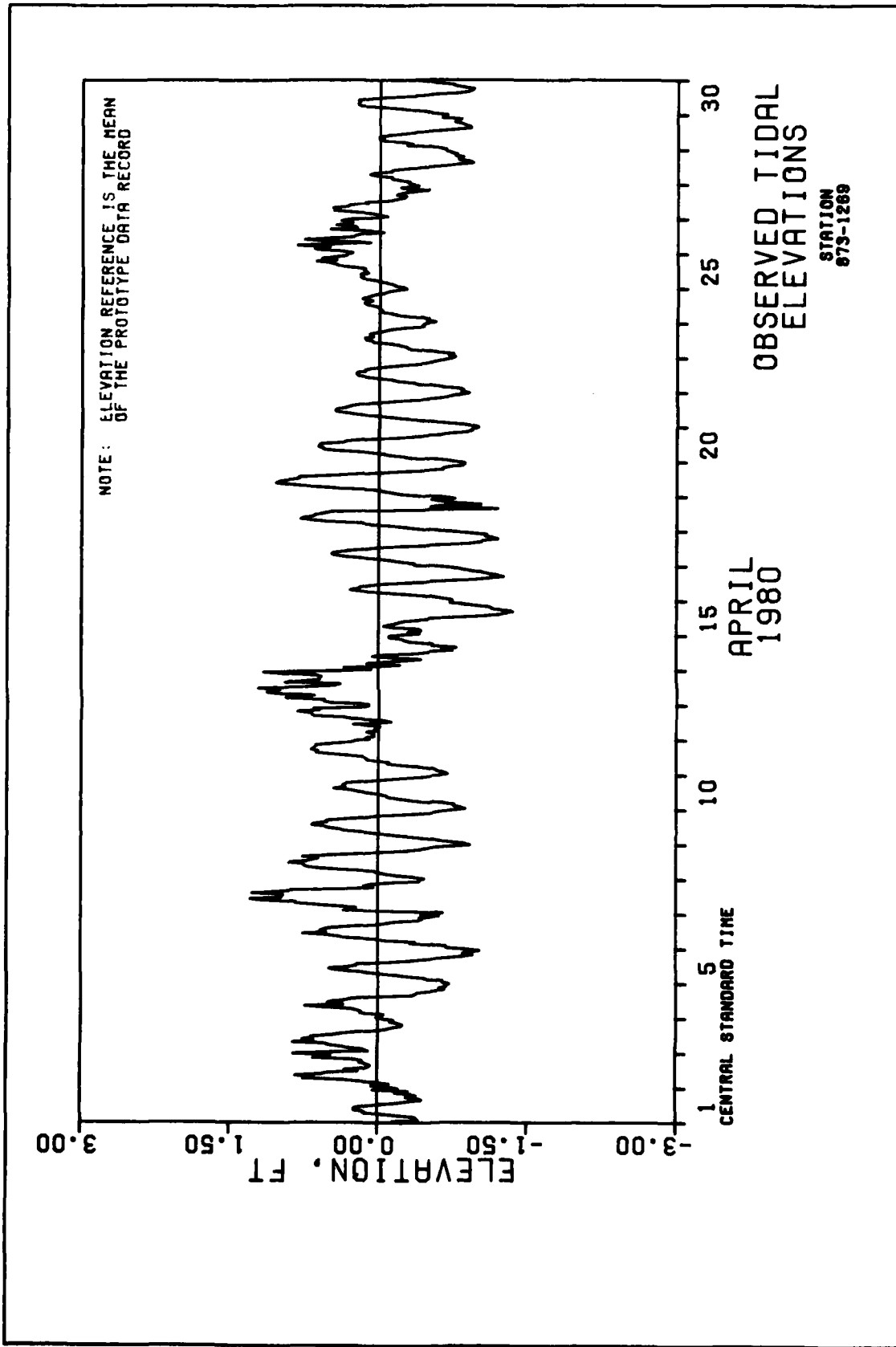


PLATE 2

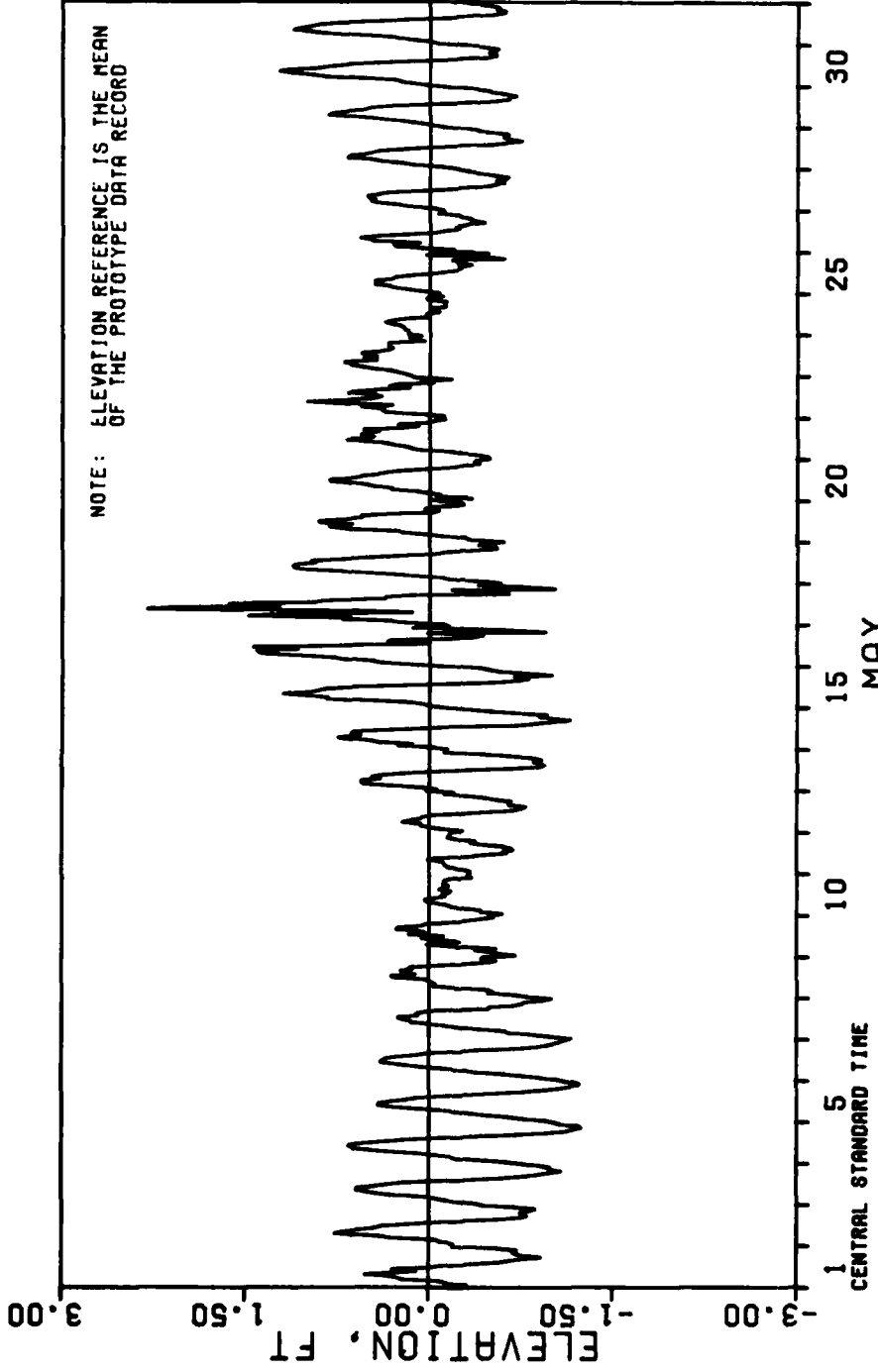


PLATE 3

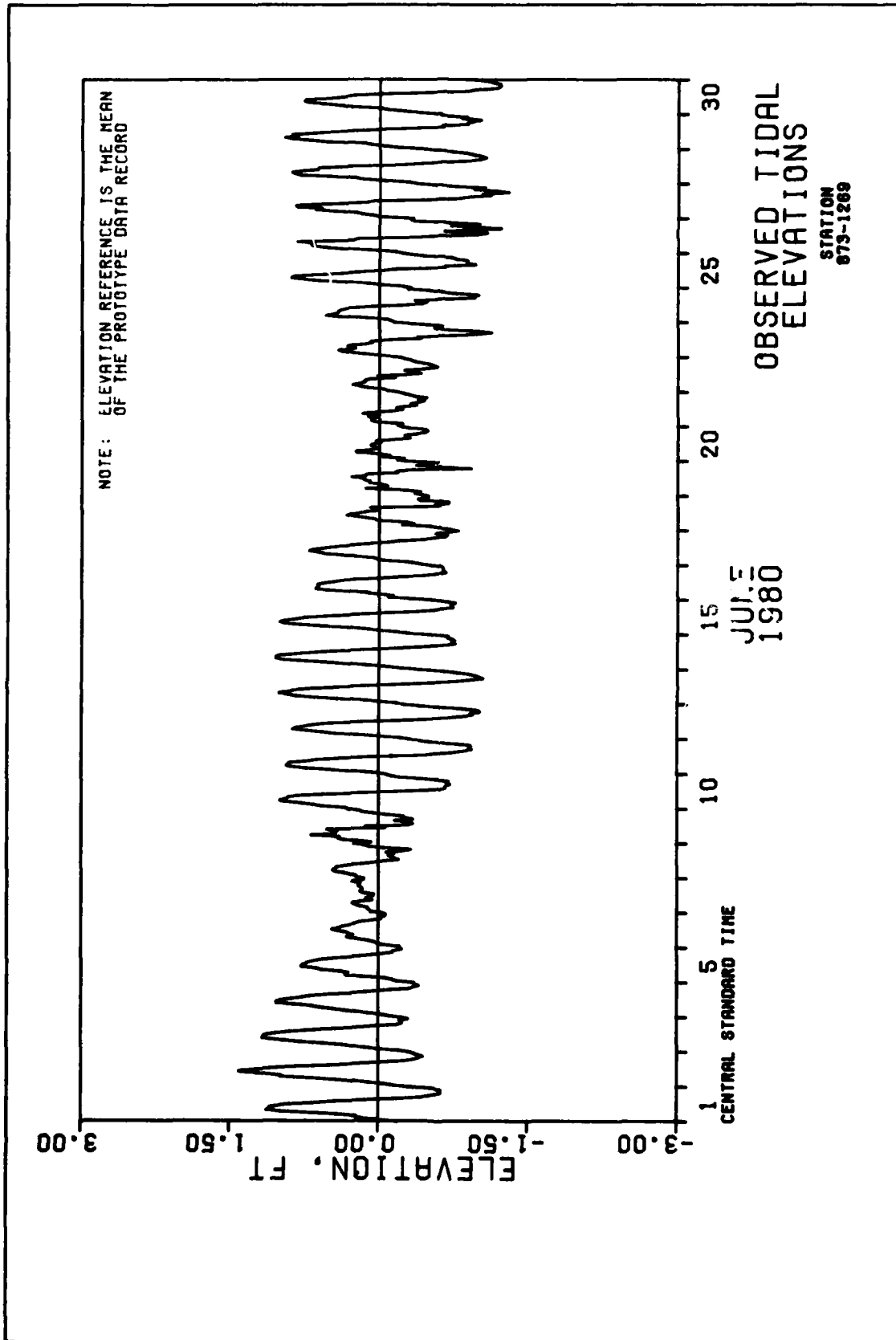
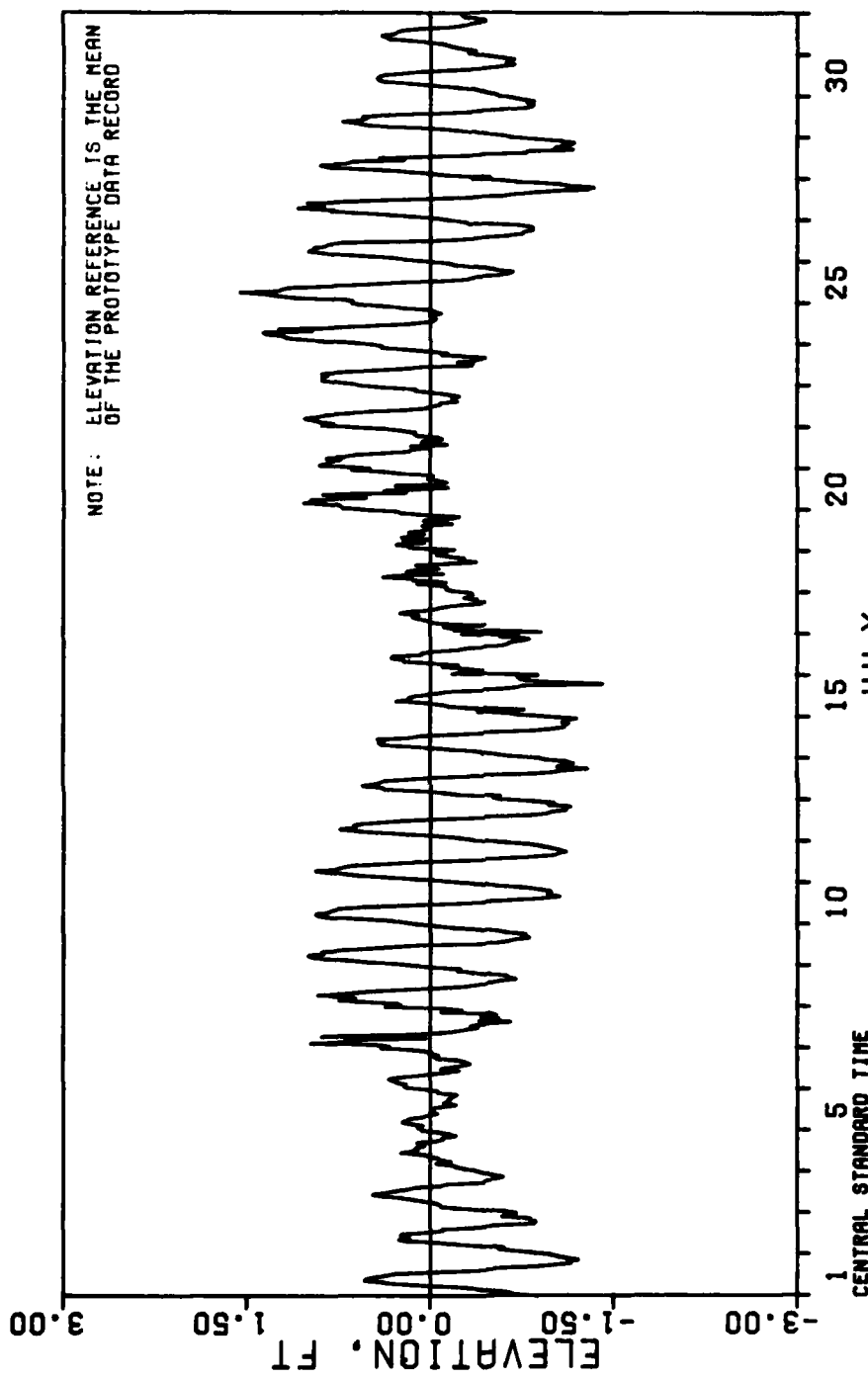


PLATE 4

NOTE: ELEVATION REFERENCE IS THE MEAN OF THE PROTOTYPE DATA RECORD



OBSERVED TIDAL ELEVATIONS  
STATION 673-1269

JULY 1980

CENTRAL STANDARD TIME

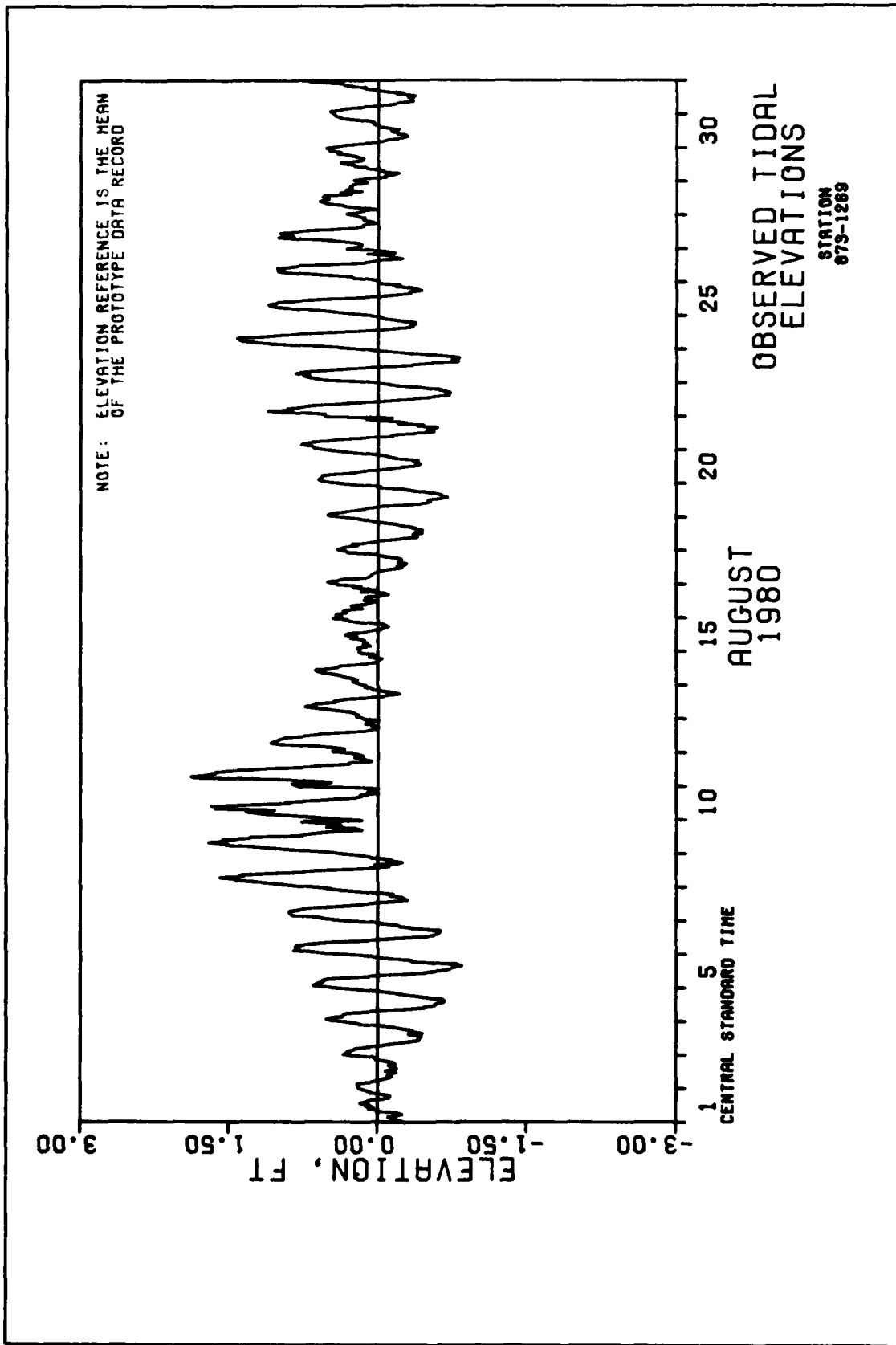
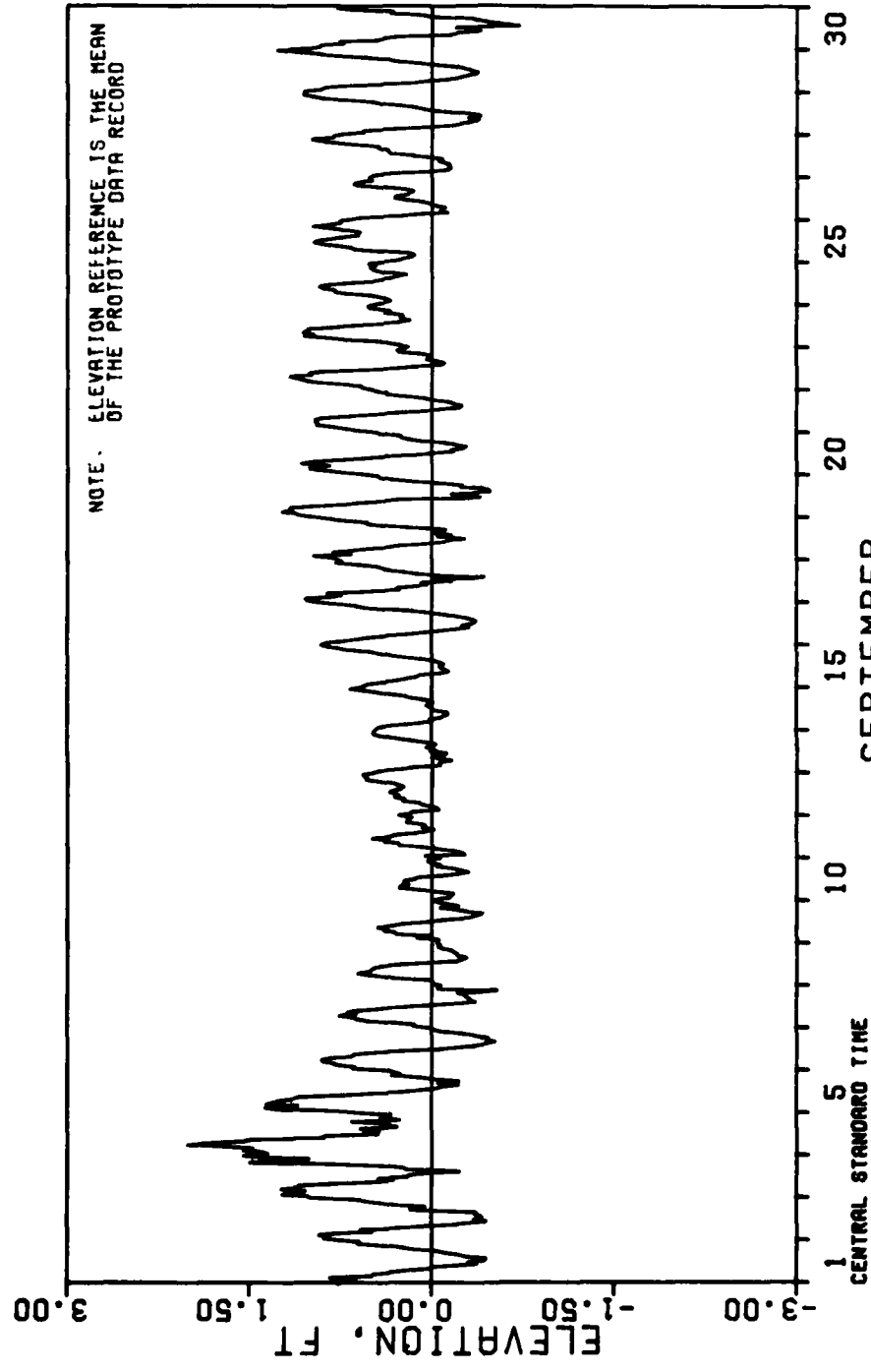


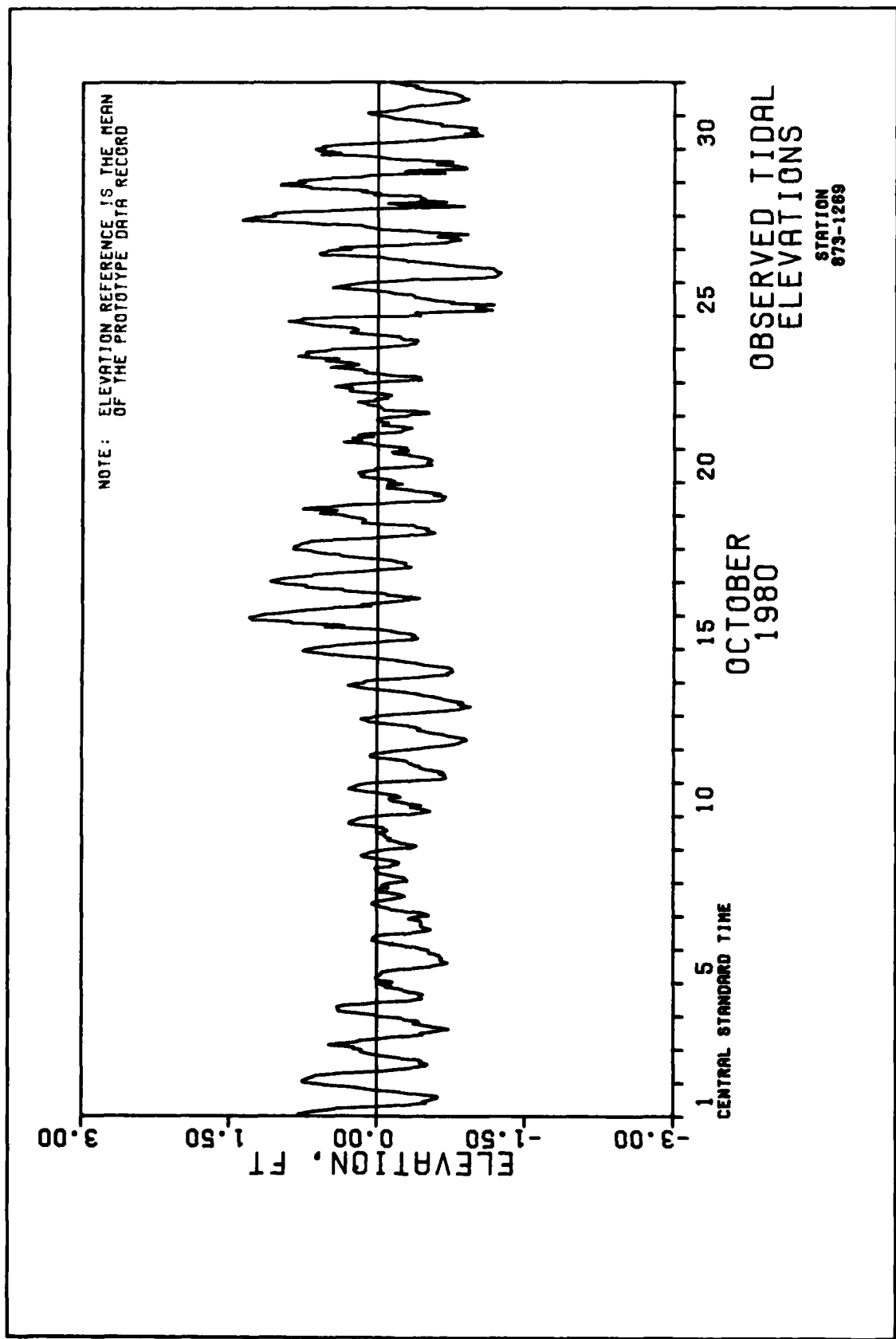
PLATE 6



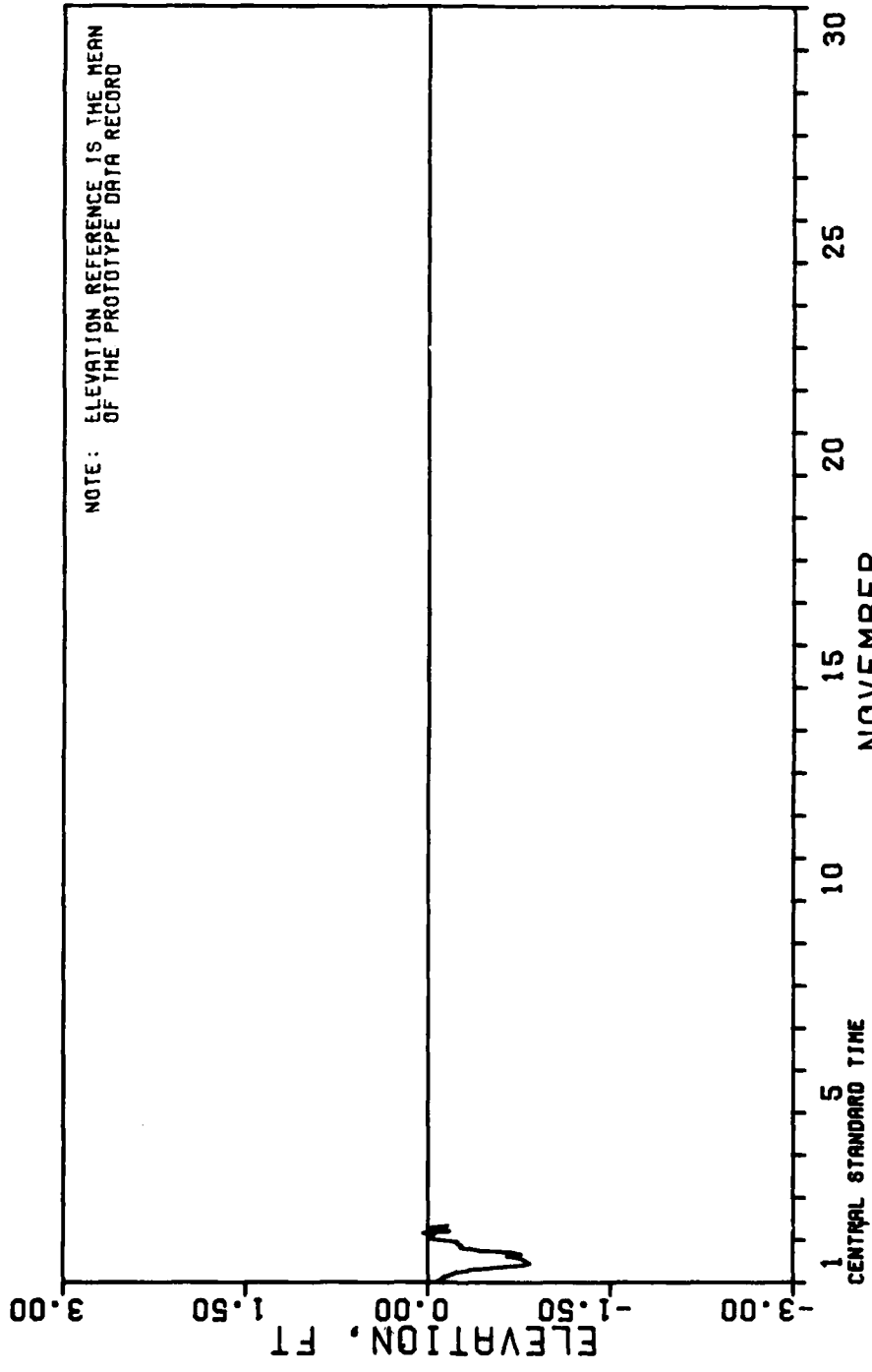


NOTE. ELEVATION REFERENCE IS THE MEAN OF THE PROTOTYPE DATA RECORD

SEPTEMBER 1980  
 OBSERVED TIDAL ELEVATIONS  
 STATION 873-1269



NOTE: ELEVATION REFERENCE IS THE MEAN OF THE PROTOTYPE DATA RECORD



NOVEMBER 1980  
OBSERVED TIDAL ELEVATIONS  
STATION 873-1269

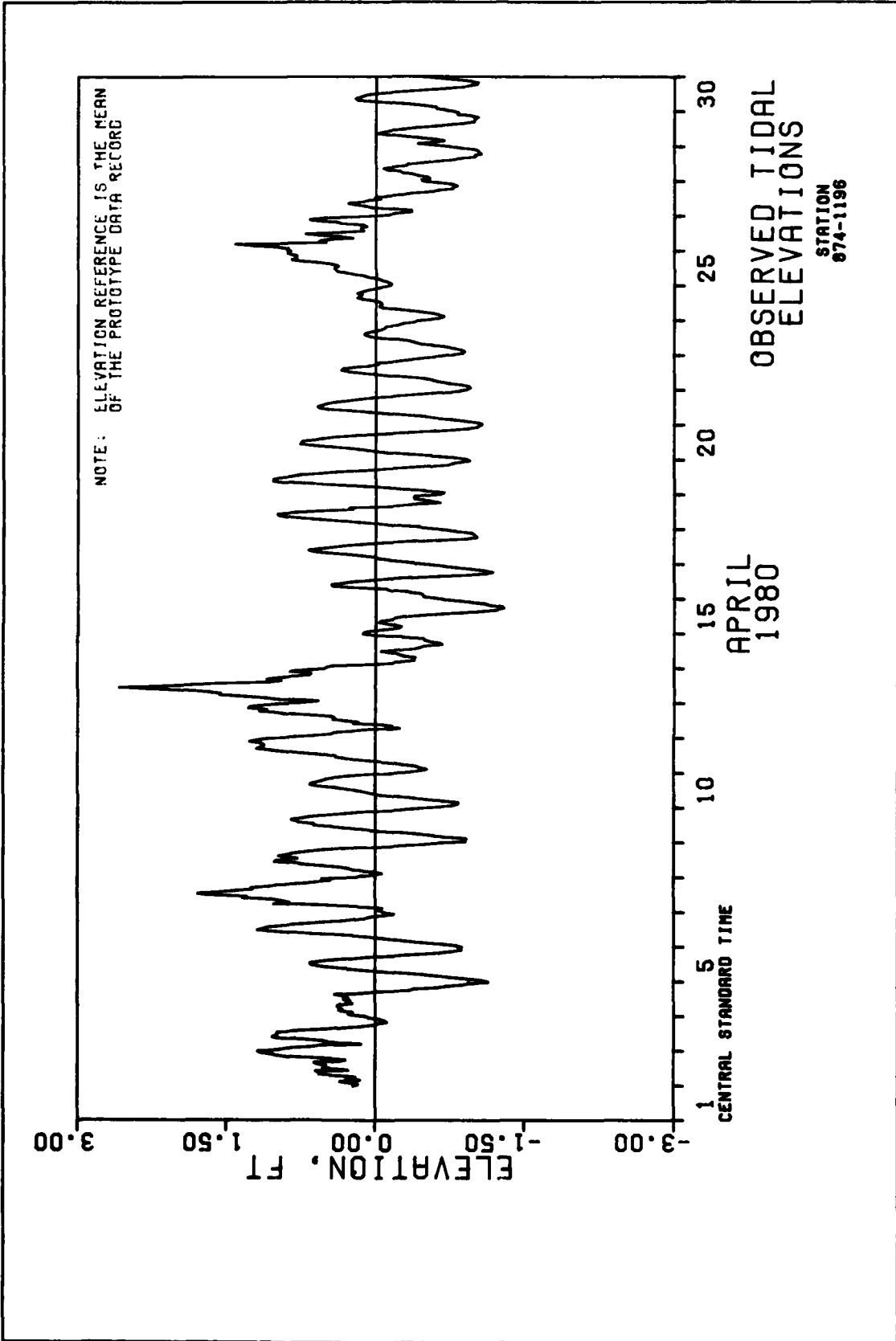


PLATE 10

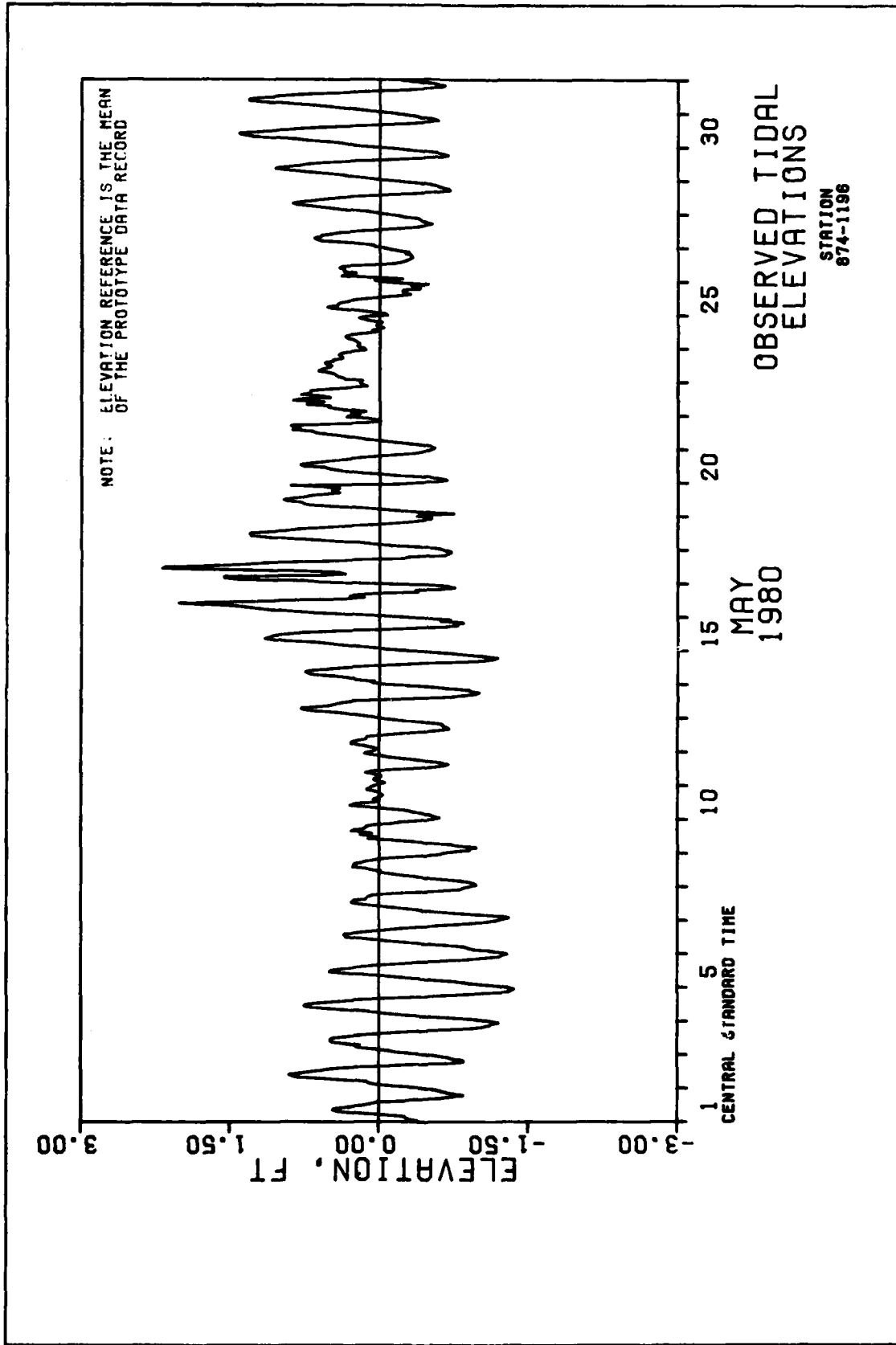


PLATE 11

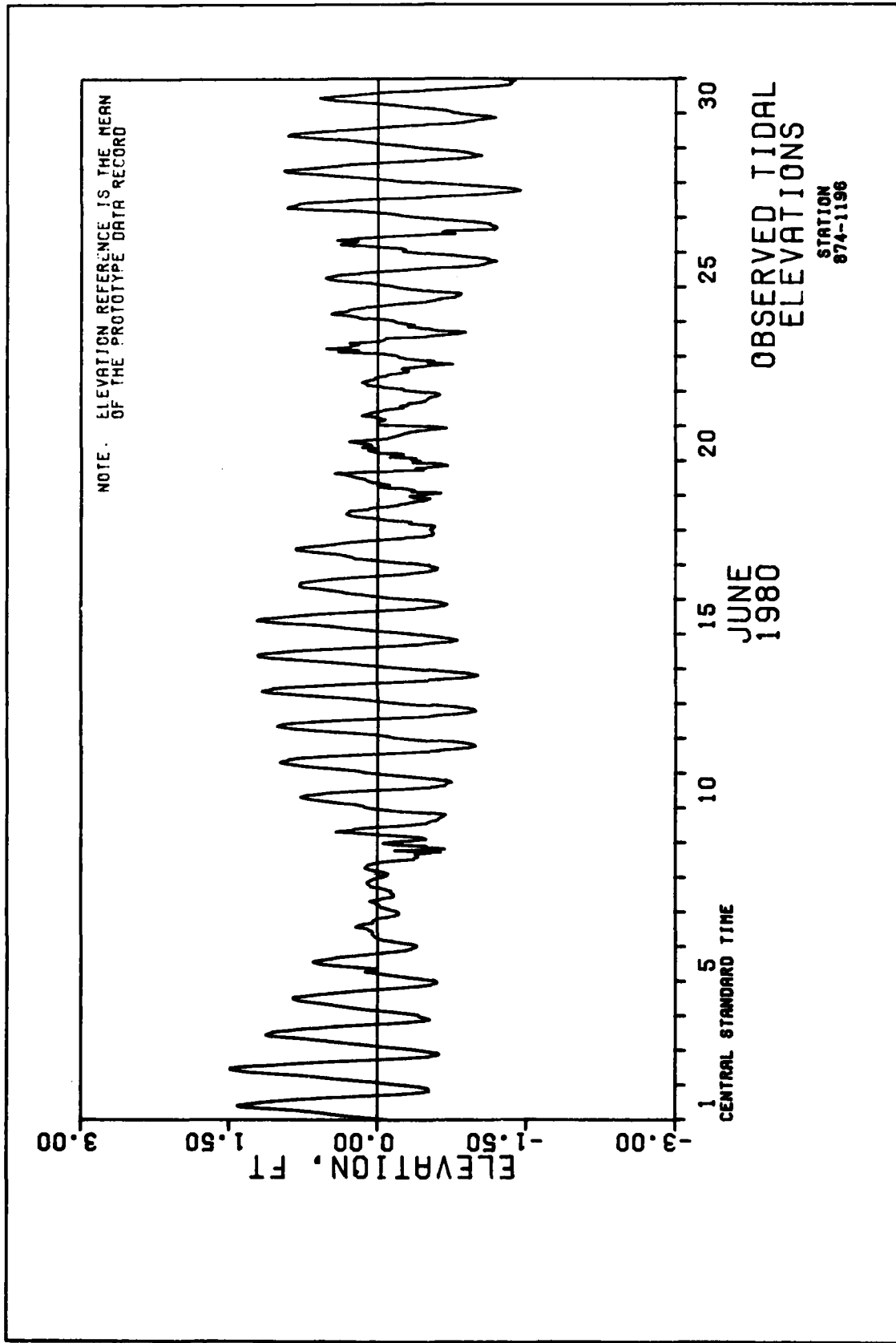
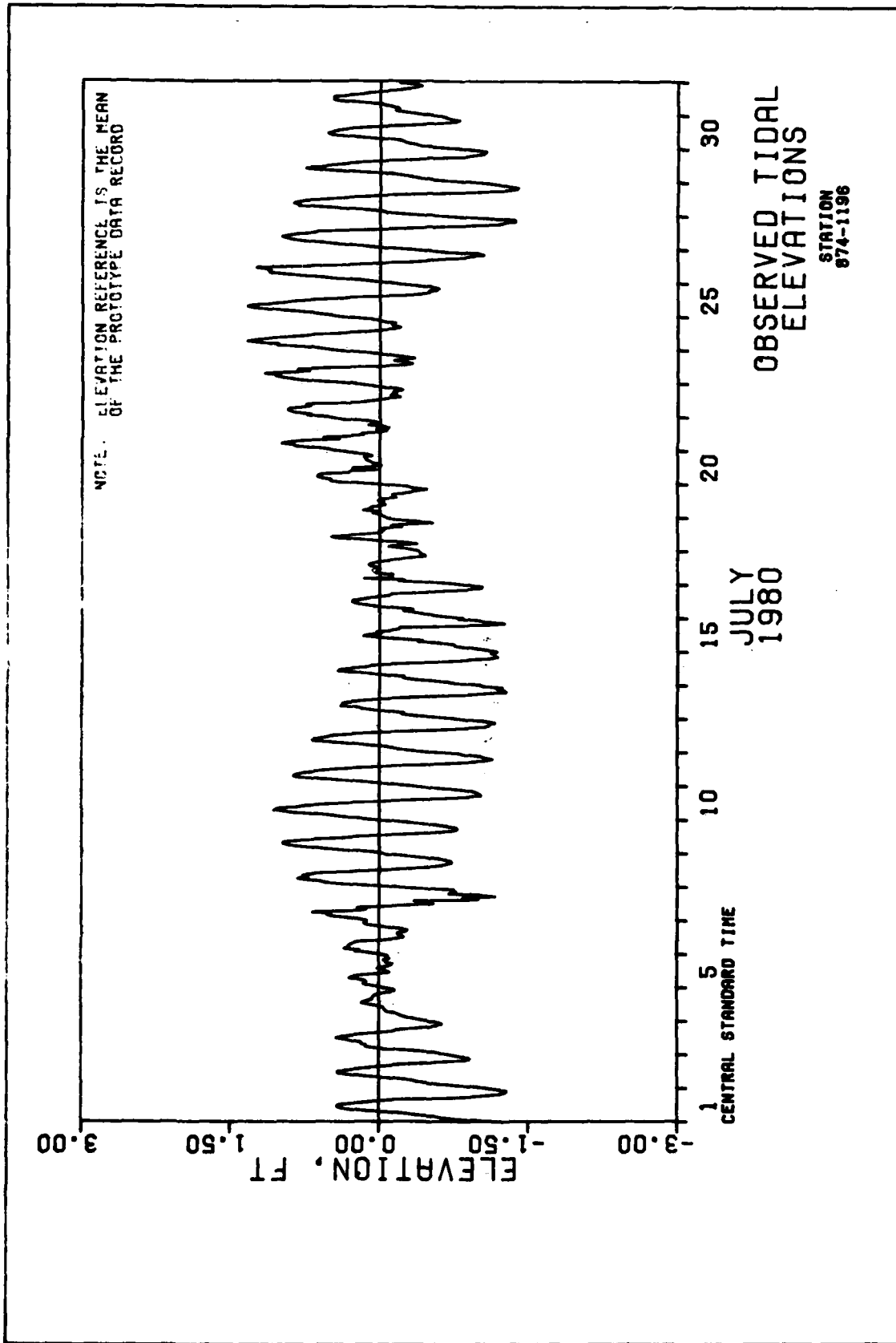


PLATE 12



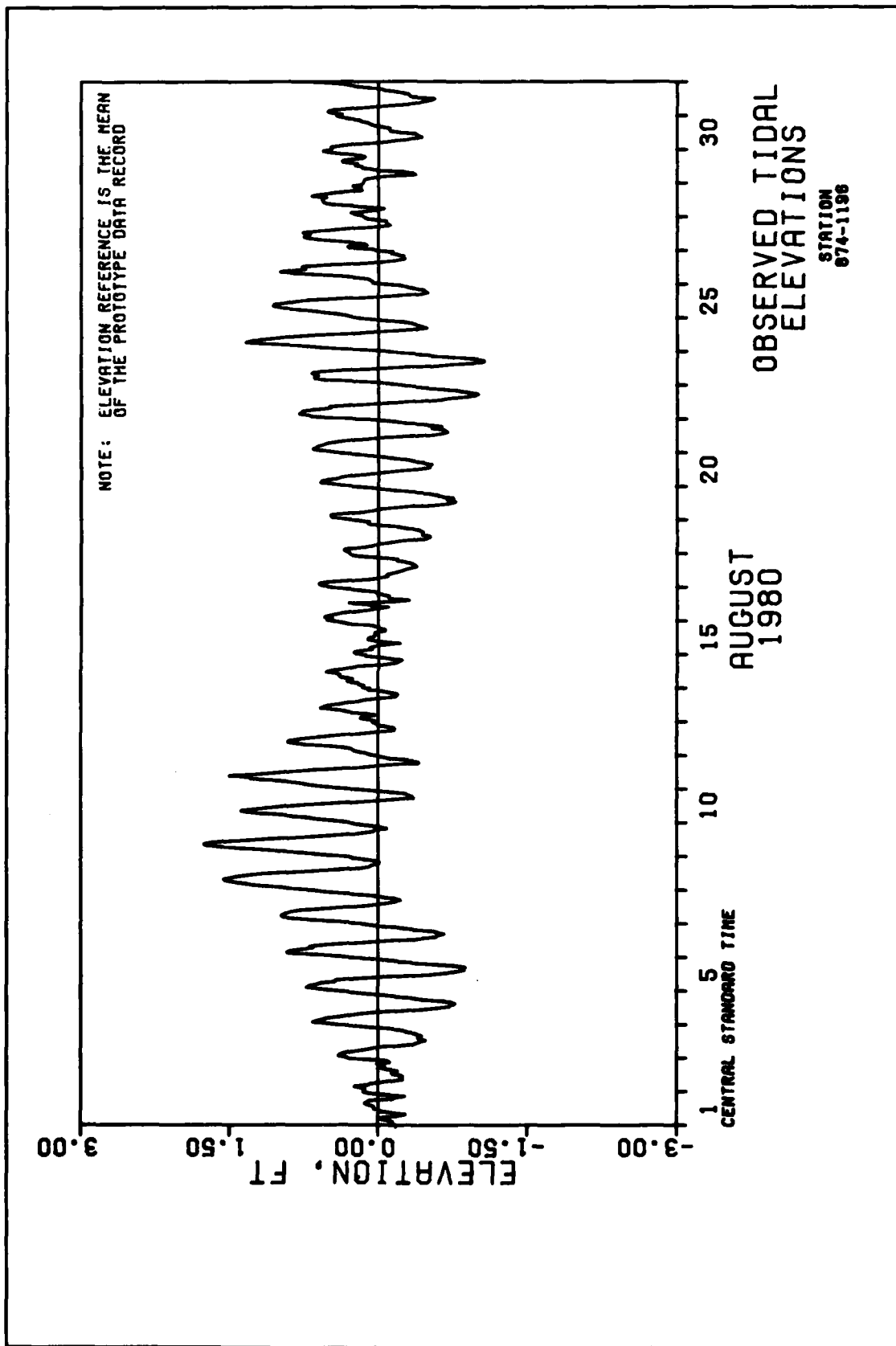


PLATE 14



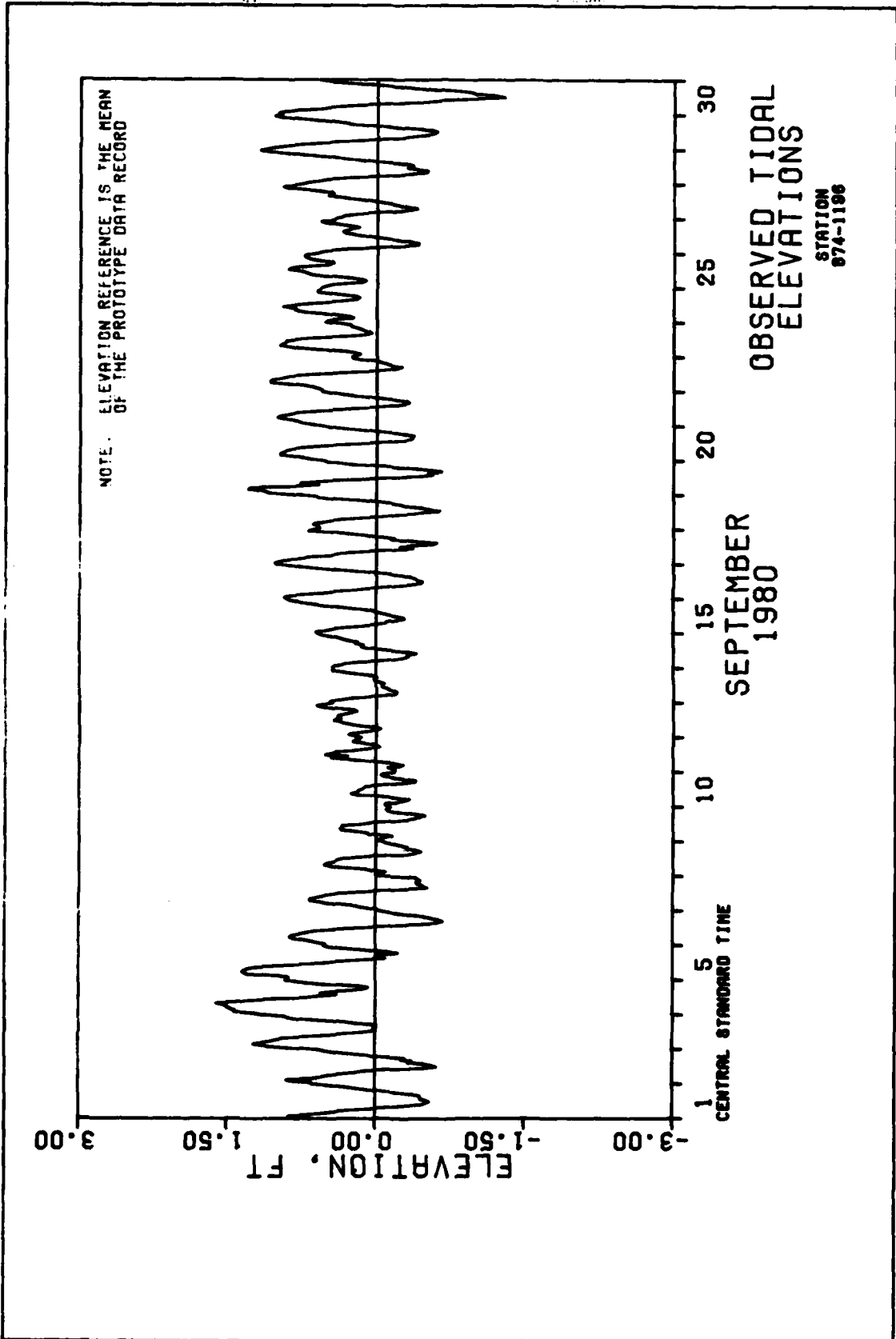


PLATE 15

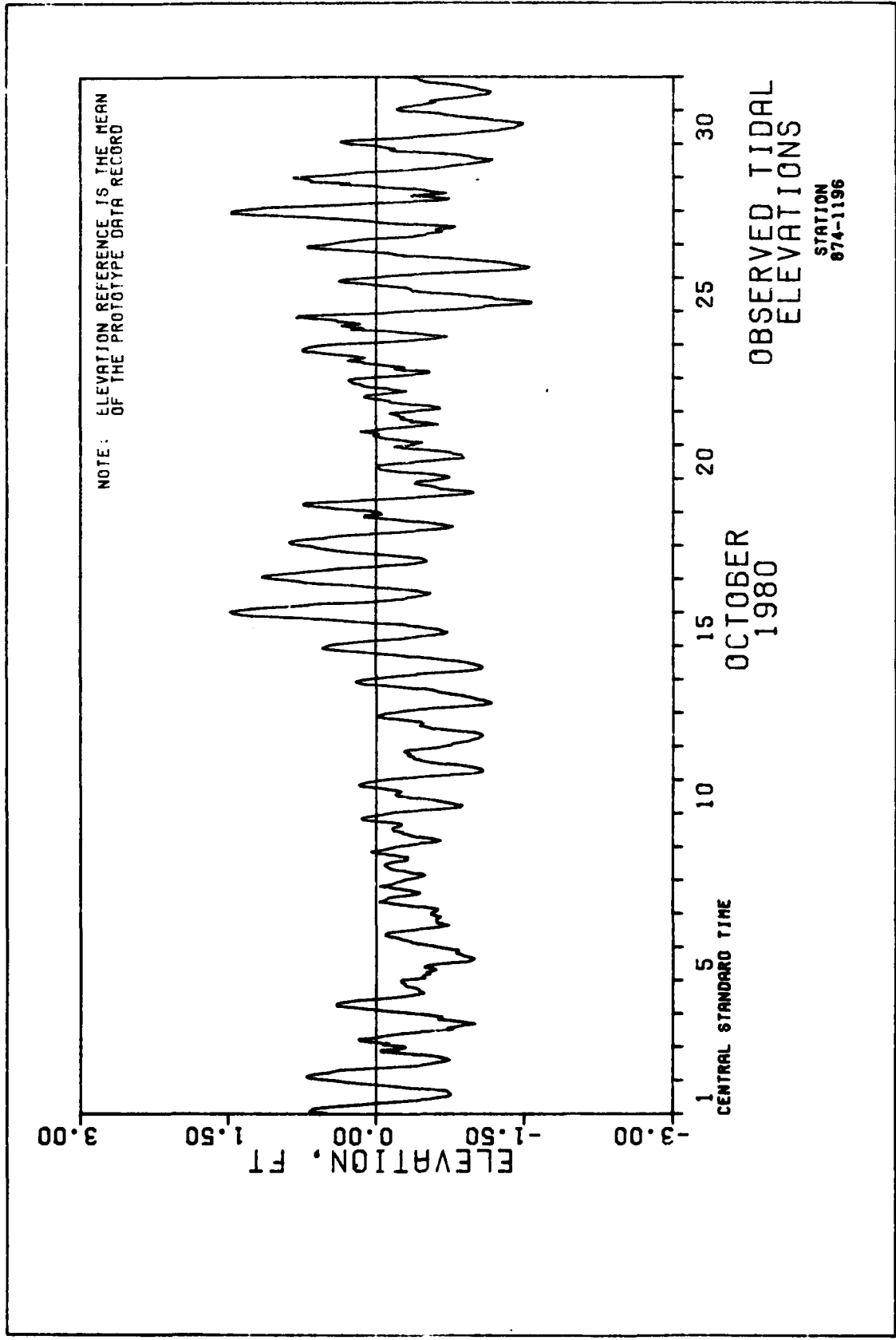
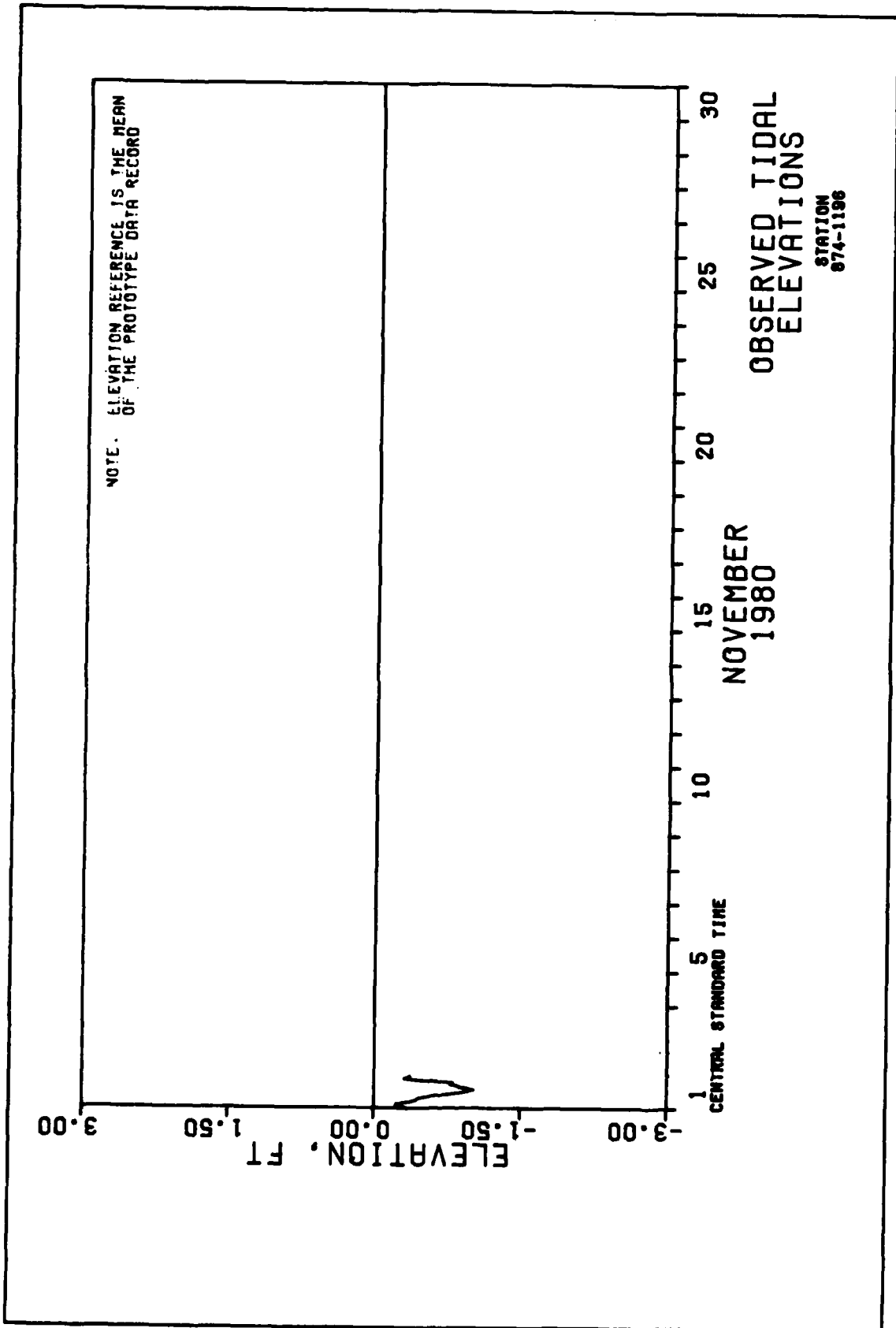


PLATE 16



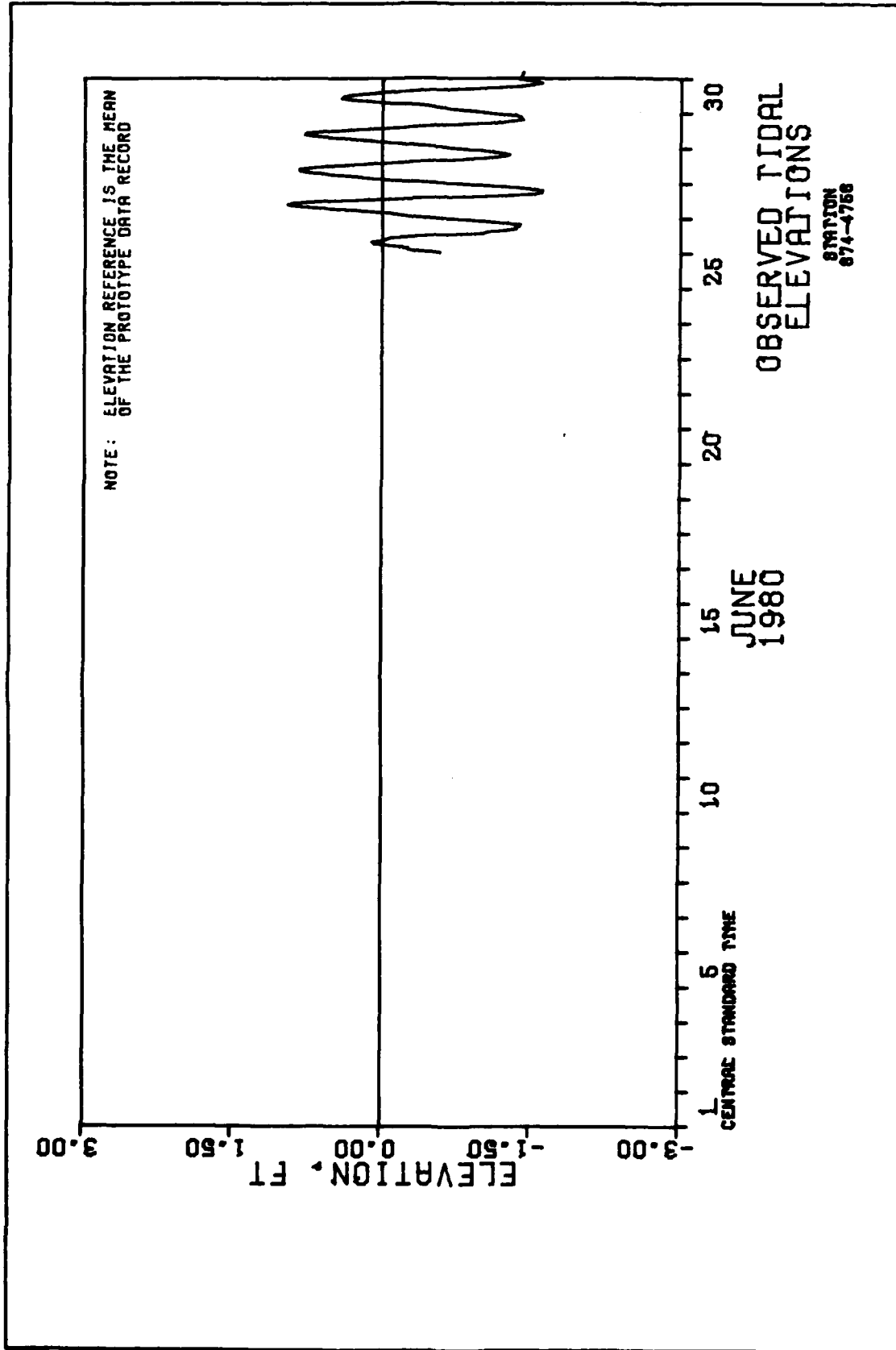
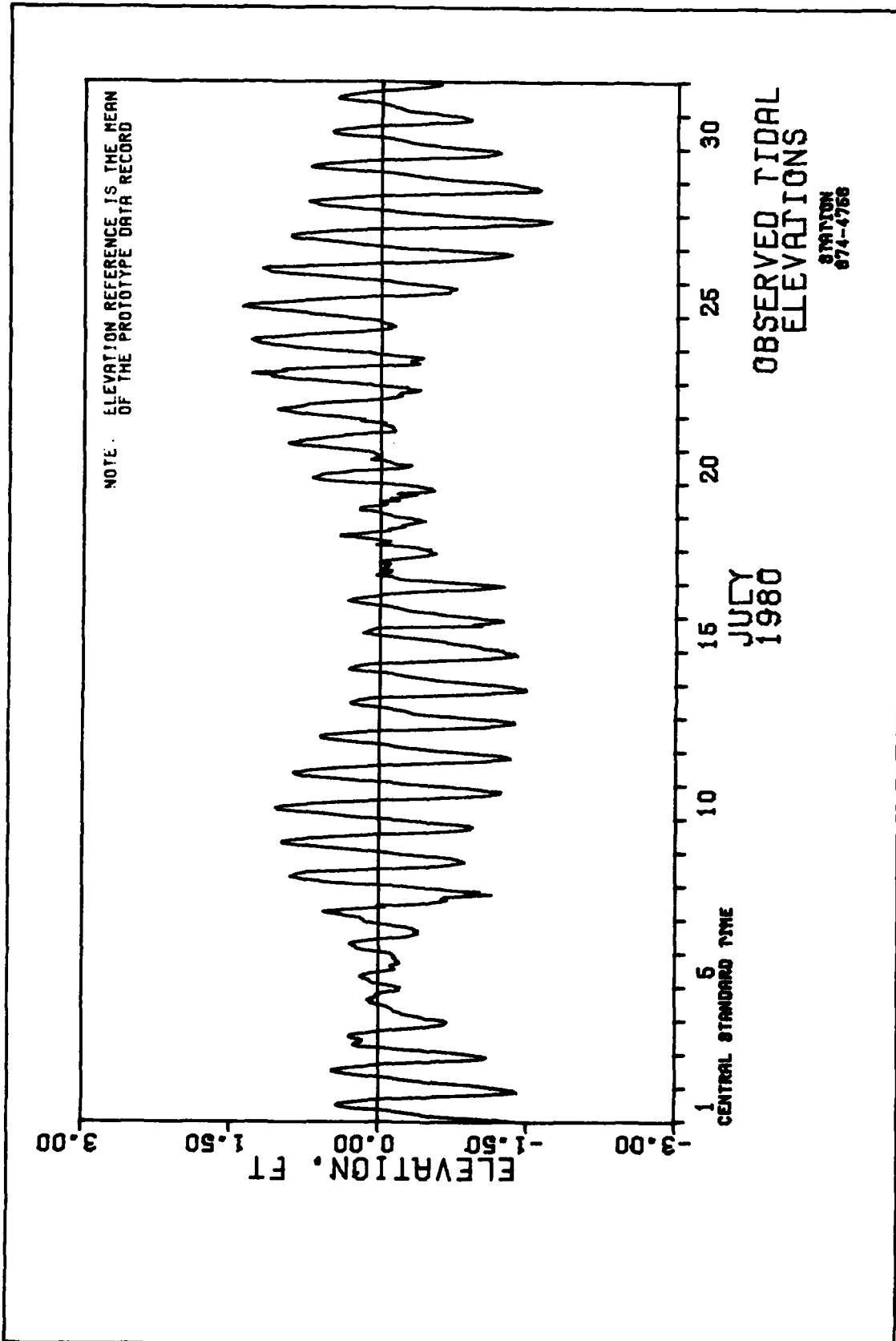
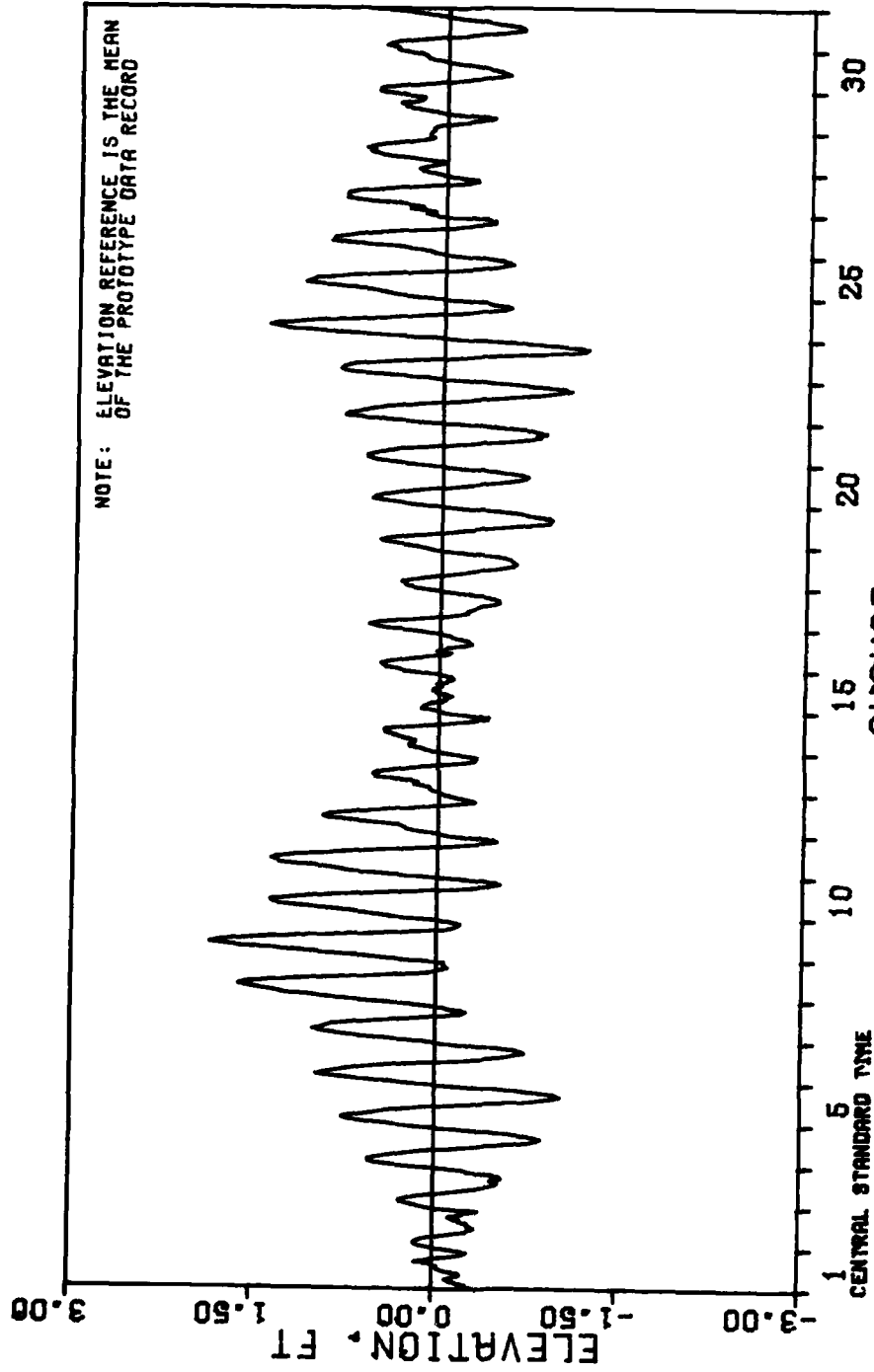


PLATE 18



NOTE: ELEVATION REFERENCE IS THE MEAN  
OF THE PROTOTYPE DATA RECORD



OBSERVED TIDAL  
ELEVATIONS  
STATION  
874-4786

AUGUST  
1980

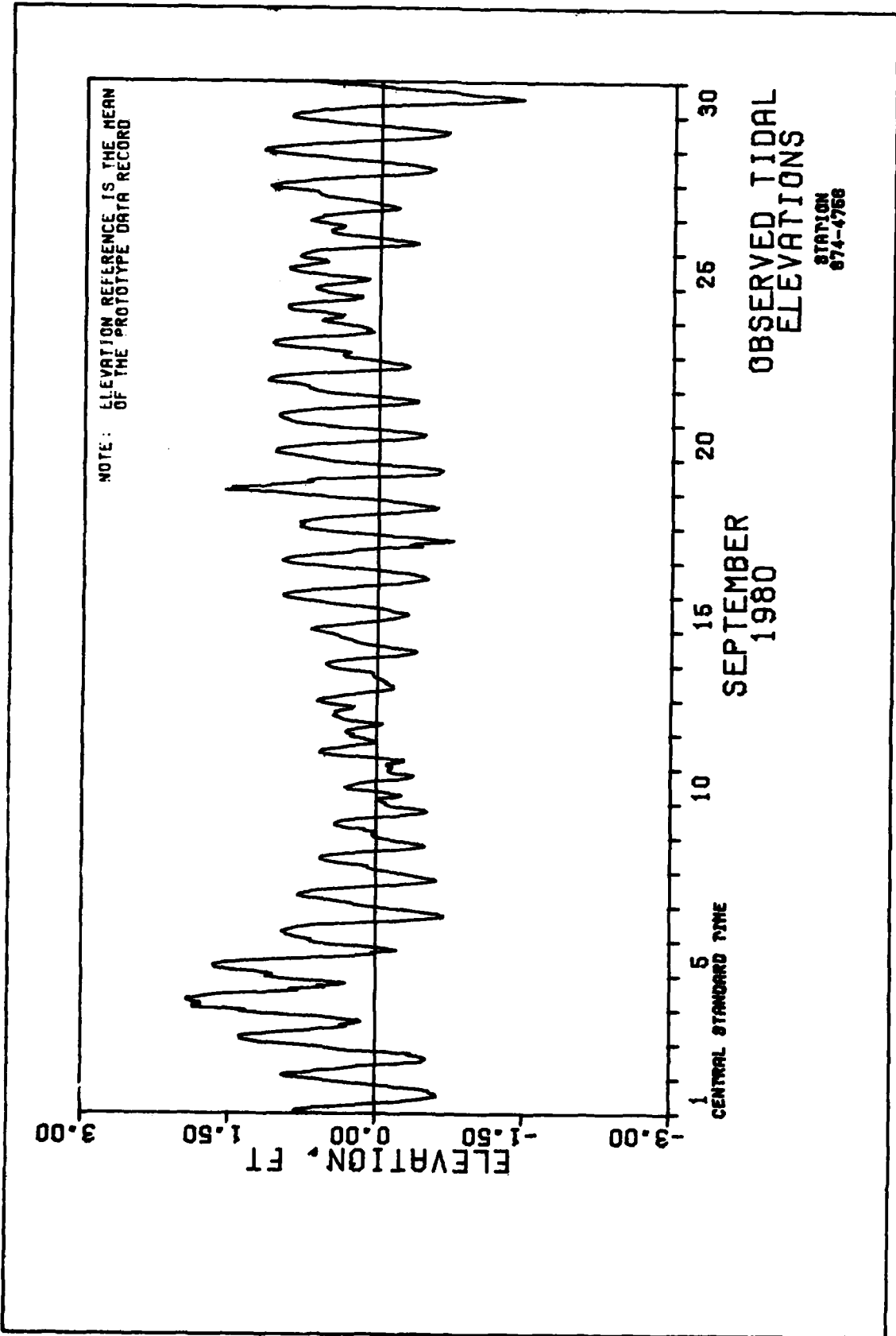


PLATE 21

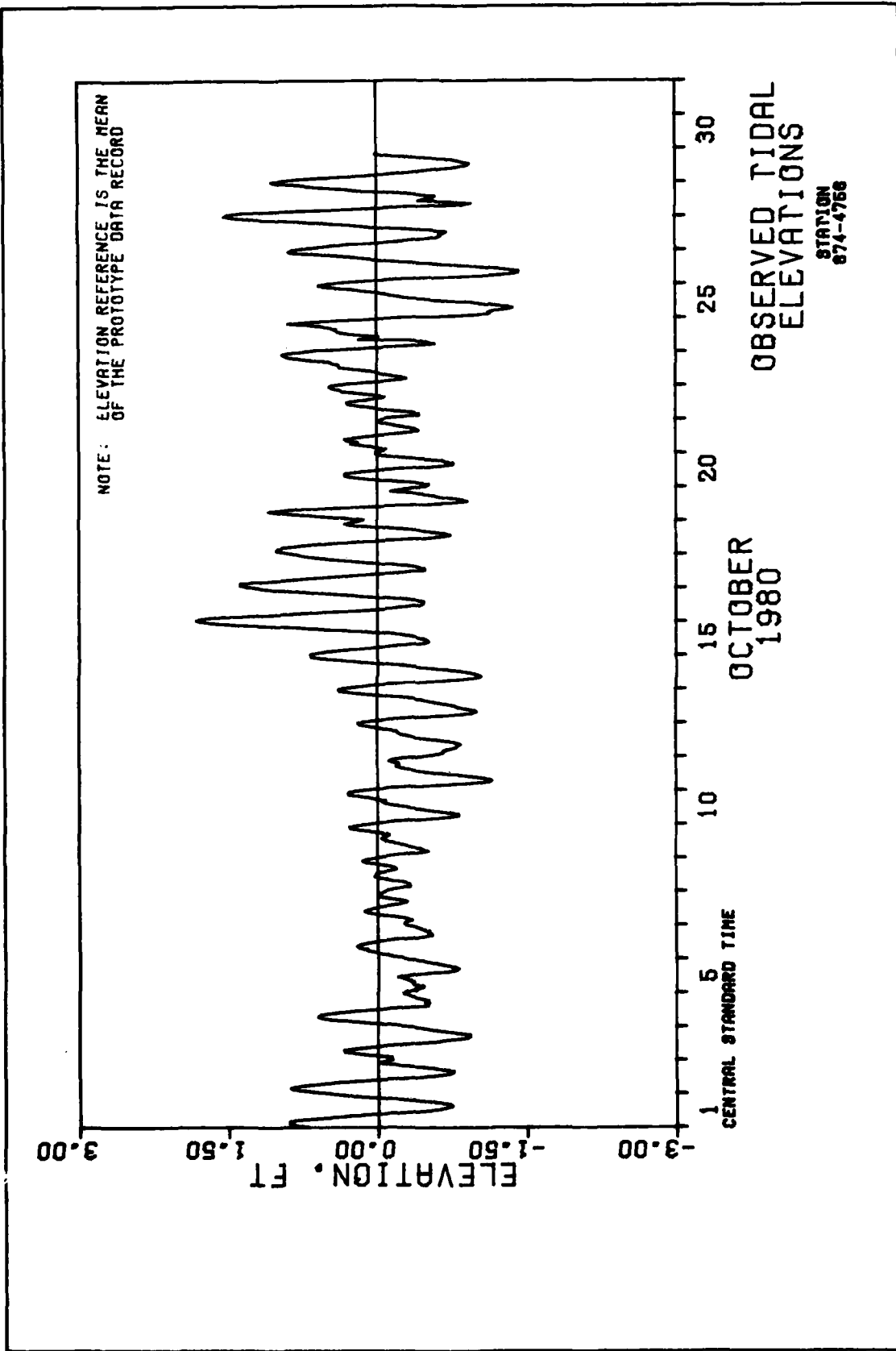
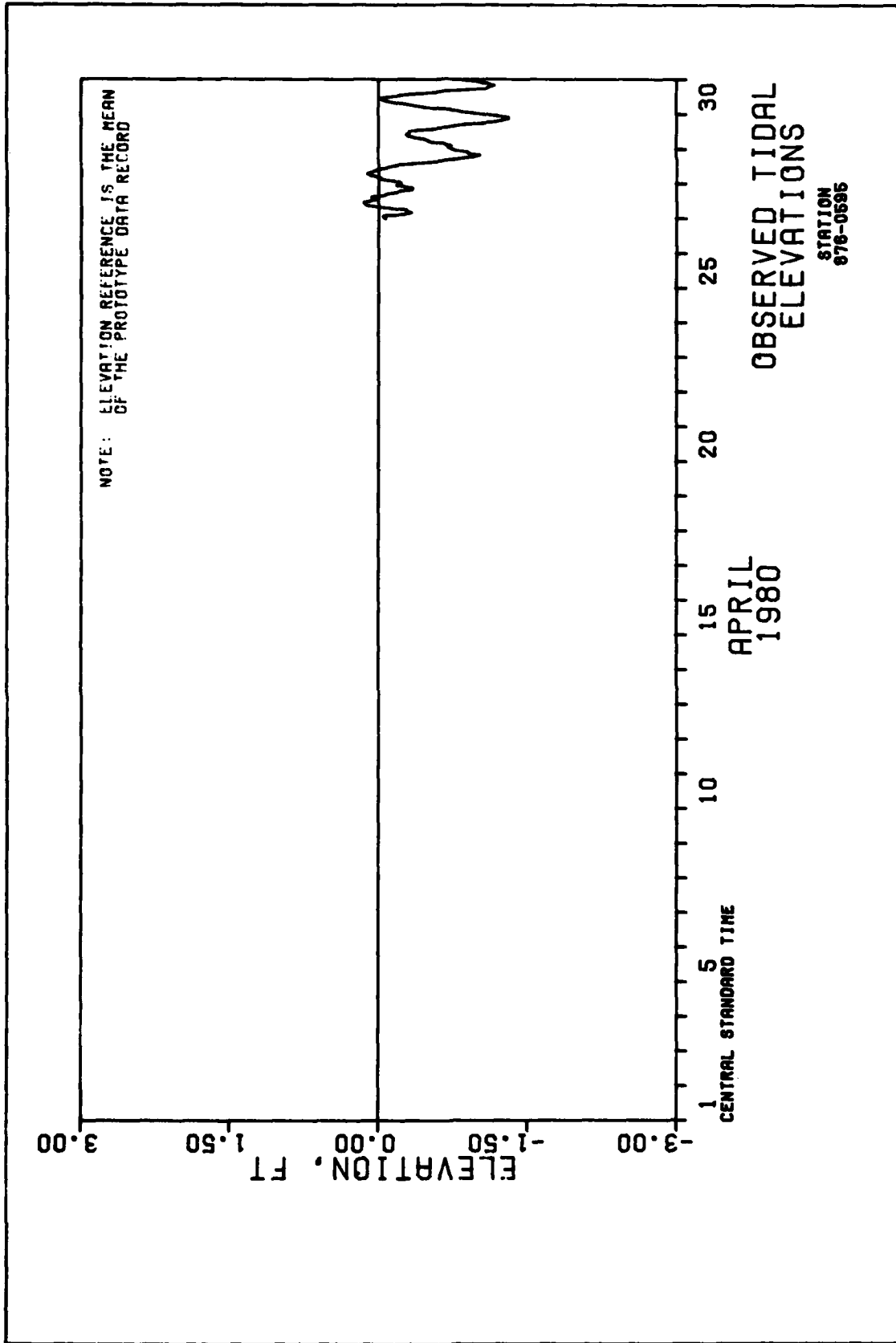


PLATE 22





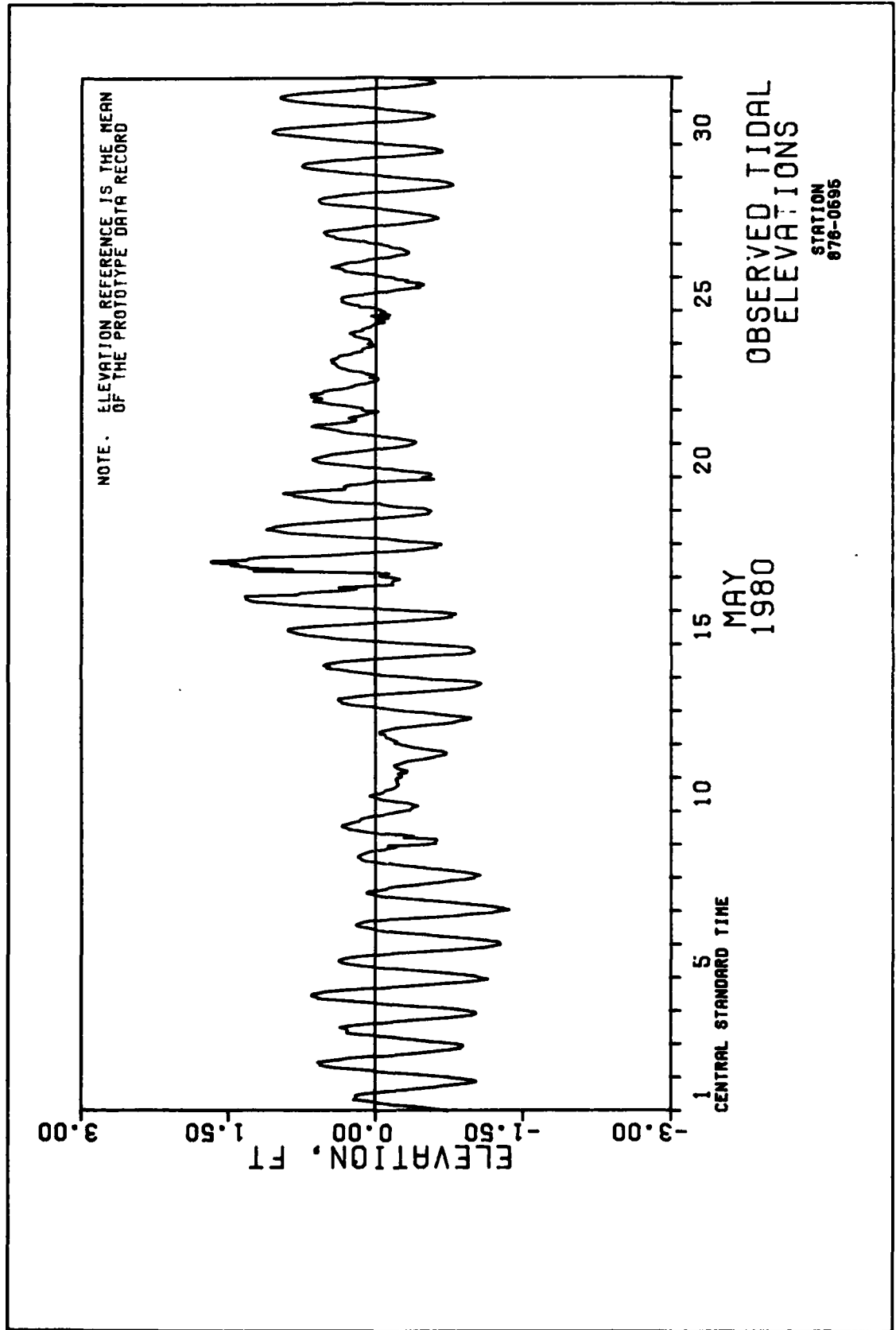
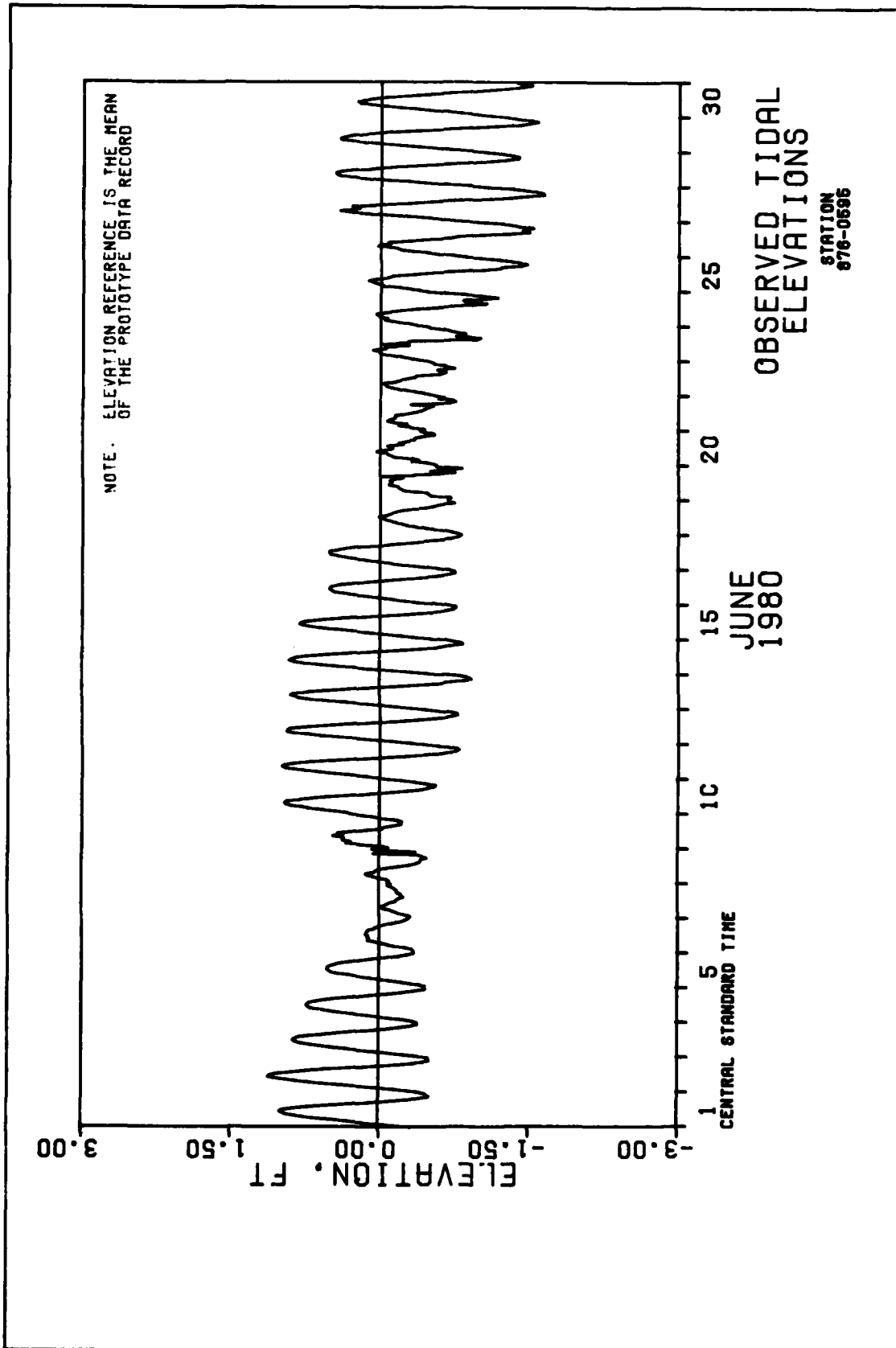


PLATE 24



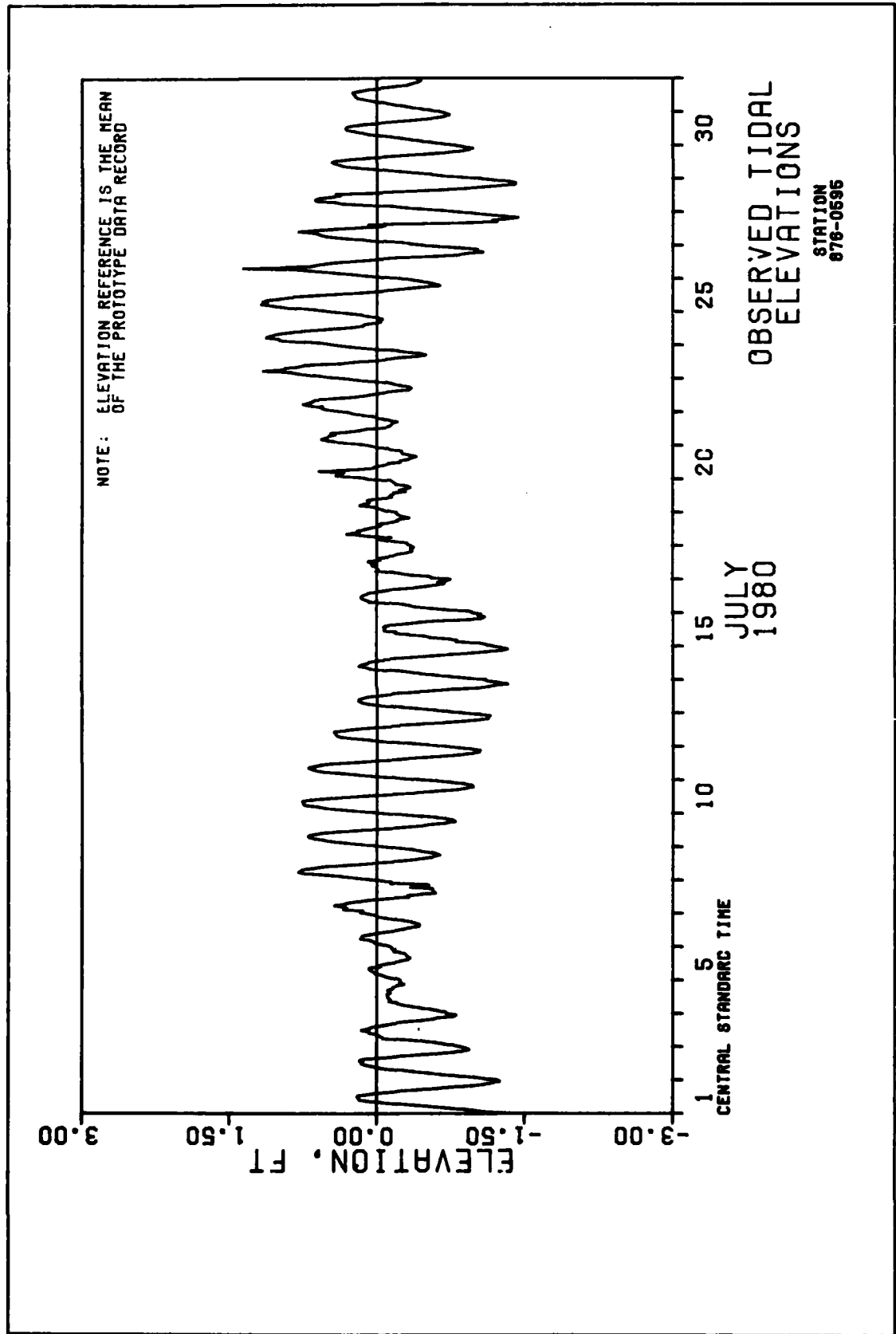
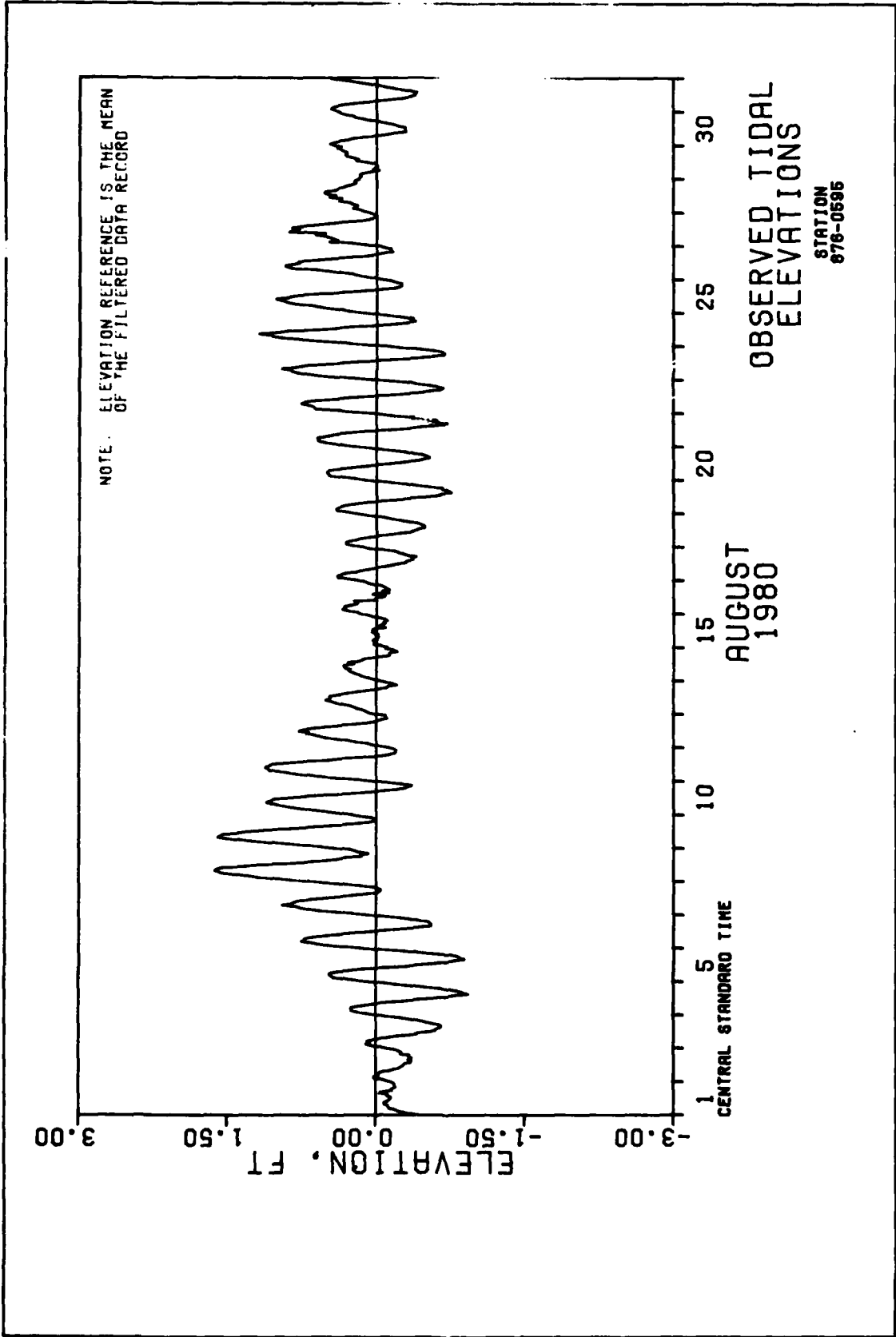


PLATE 26



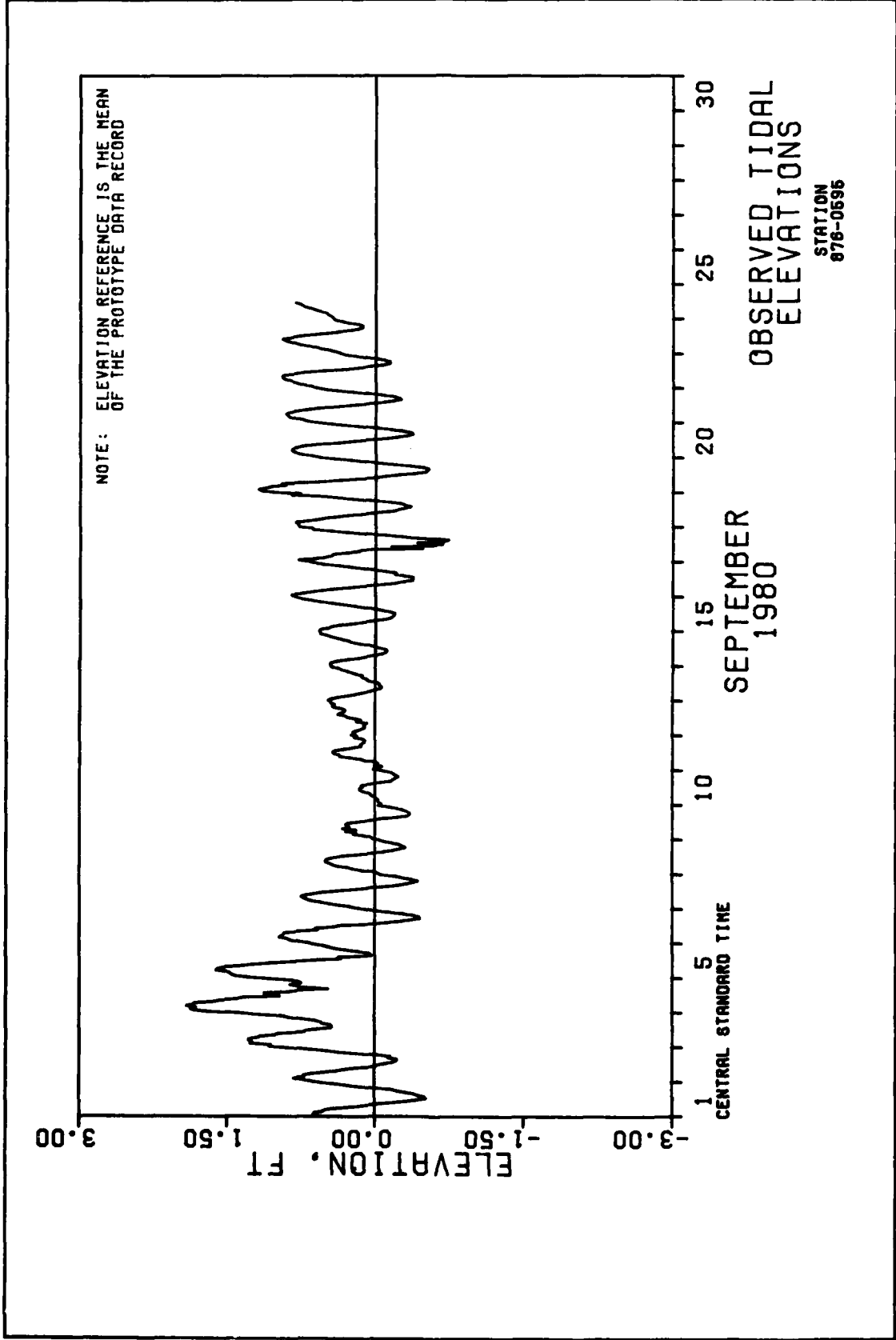


PLATE 28

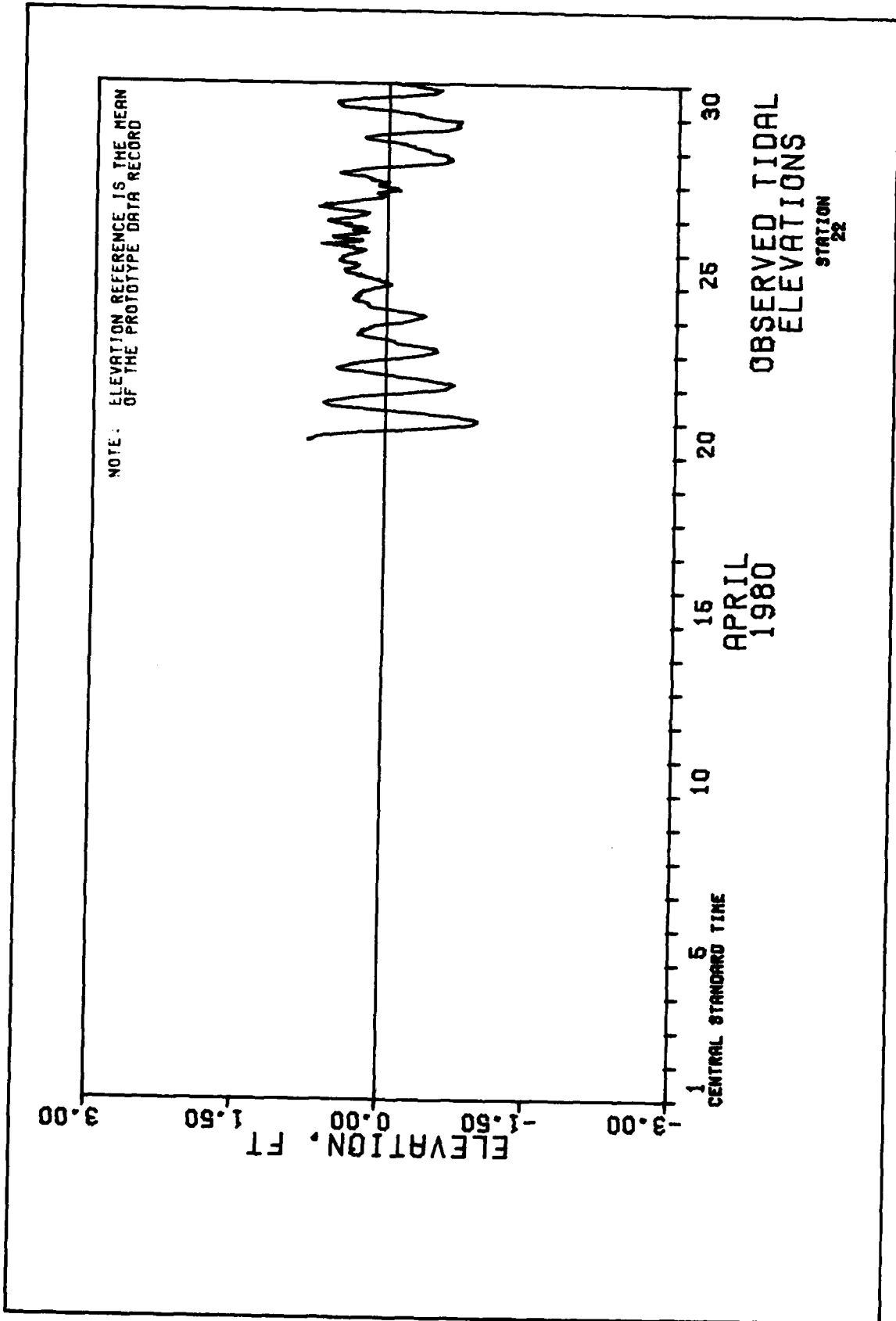


PLATE 29

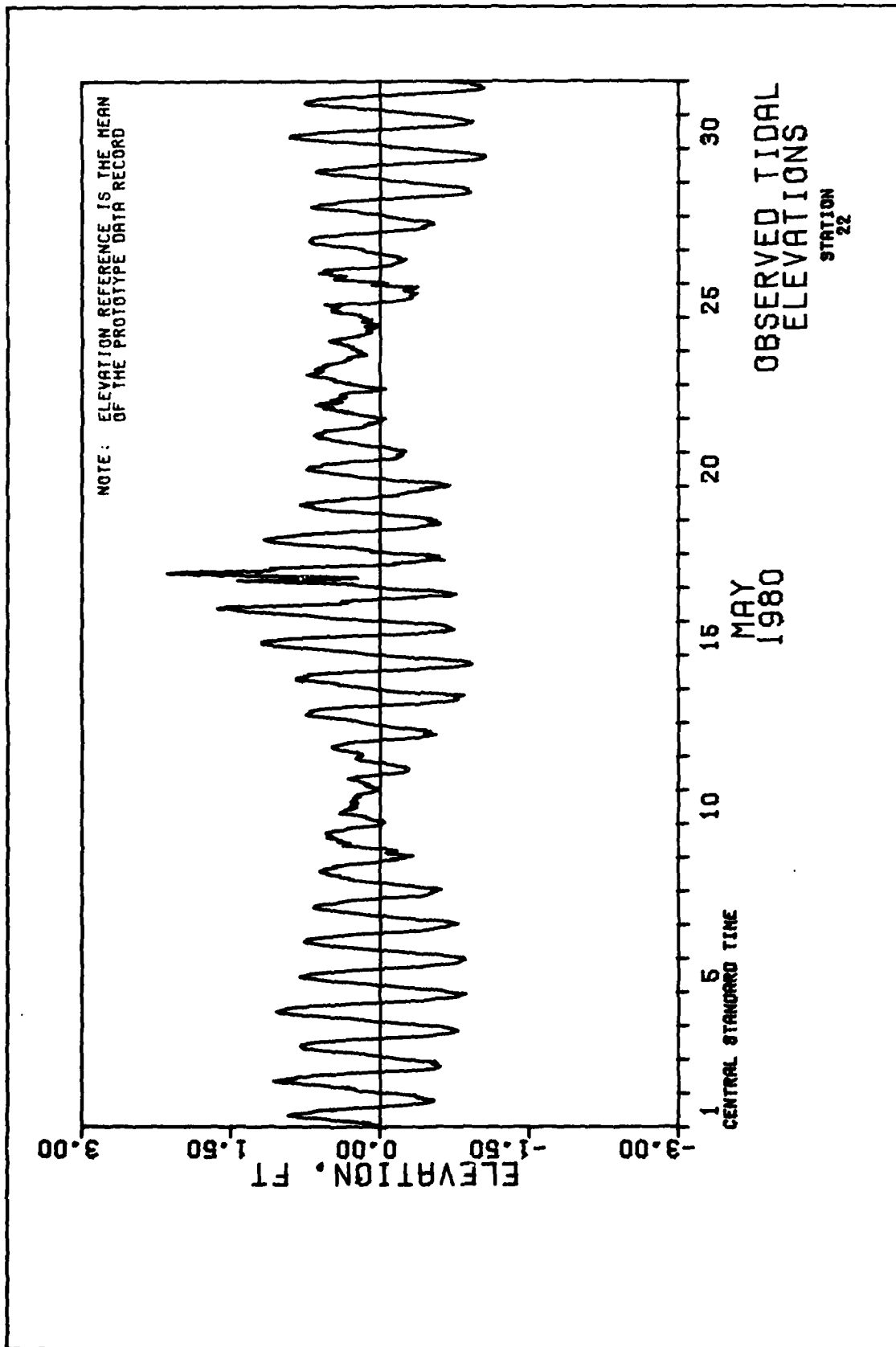


PLATE 30



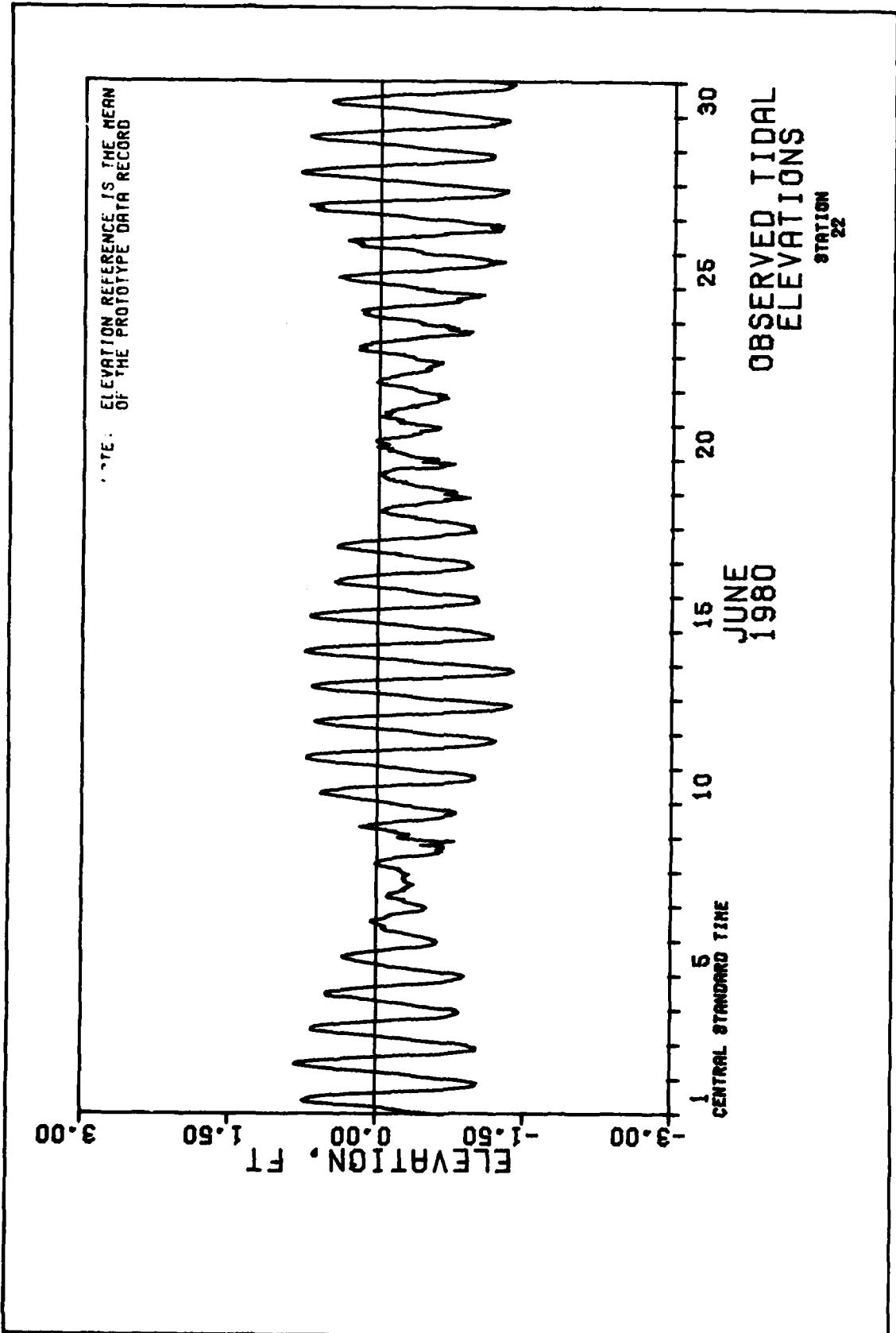
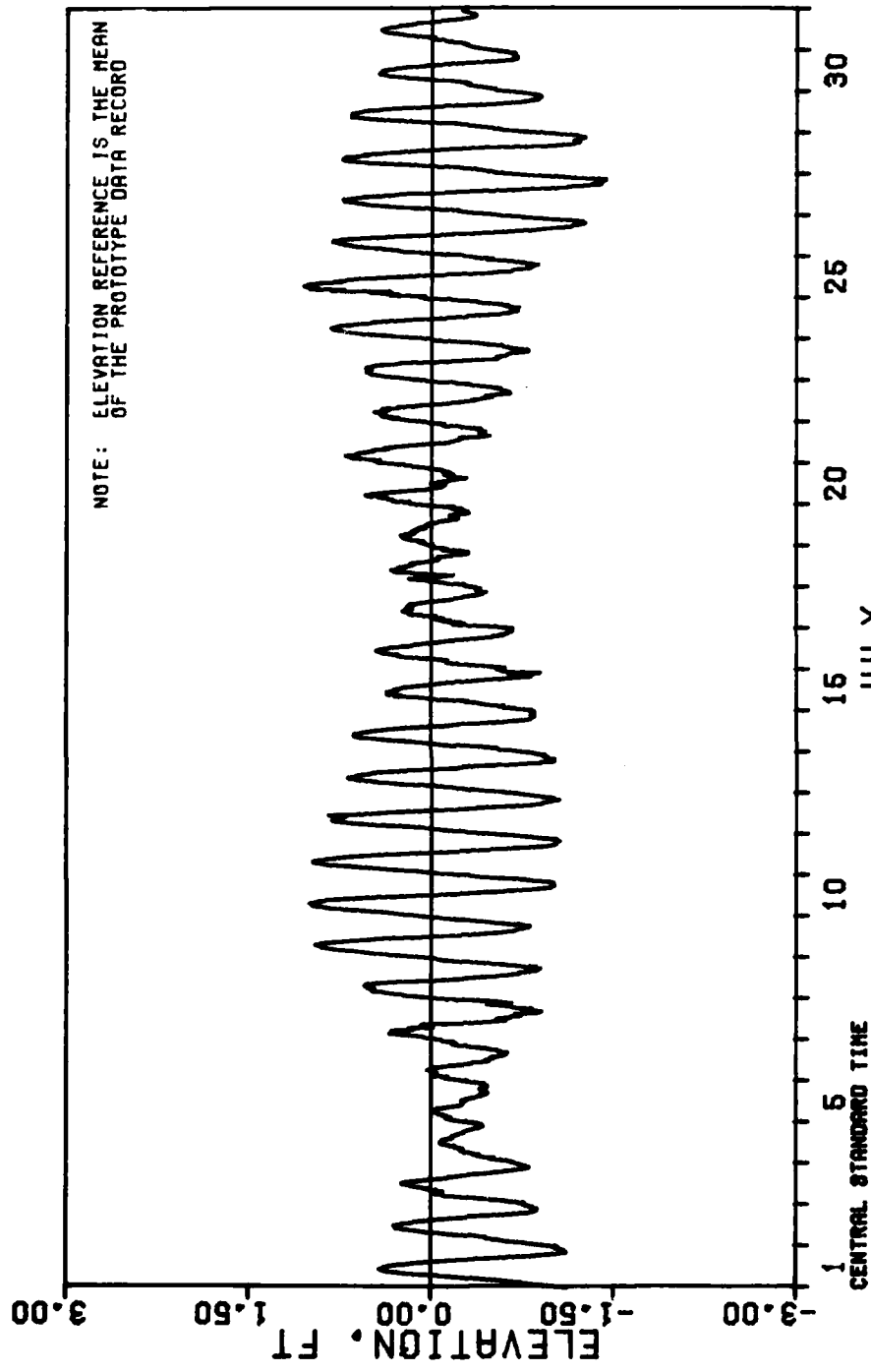


PLATE 31

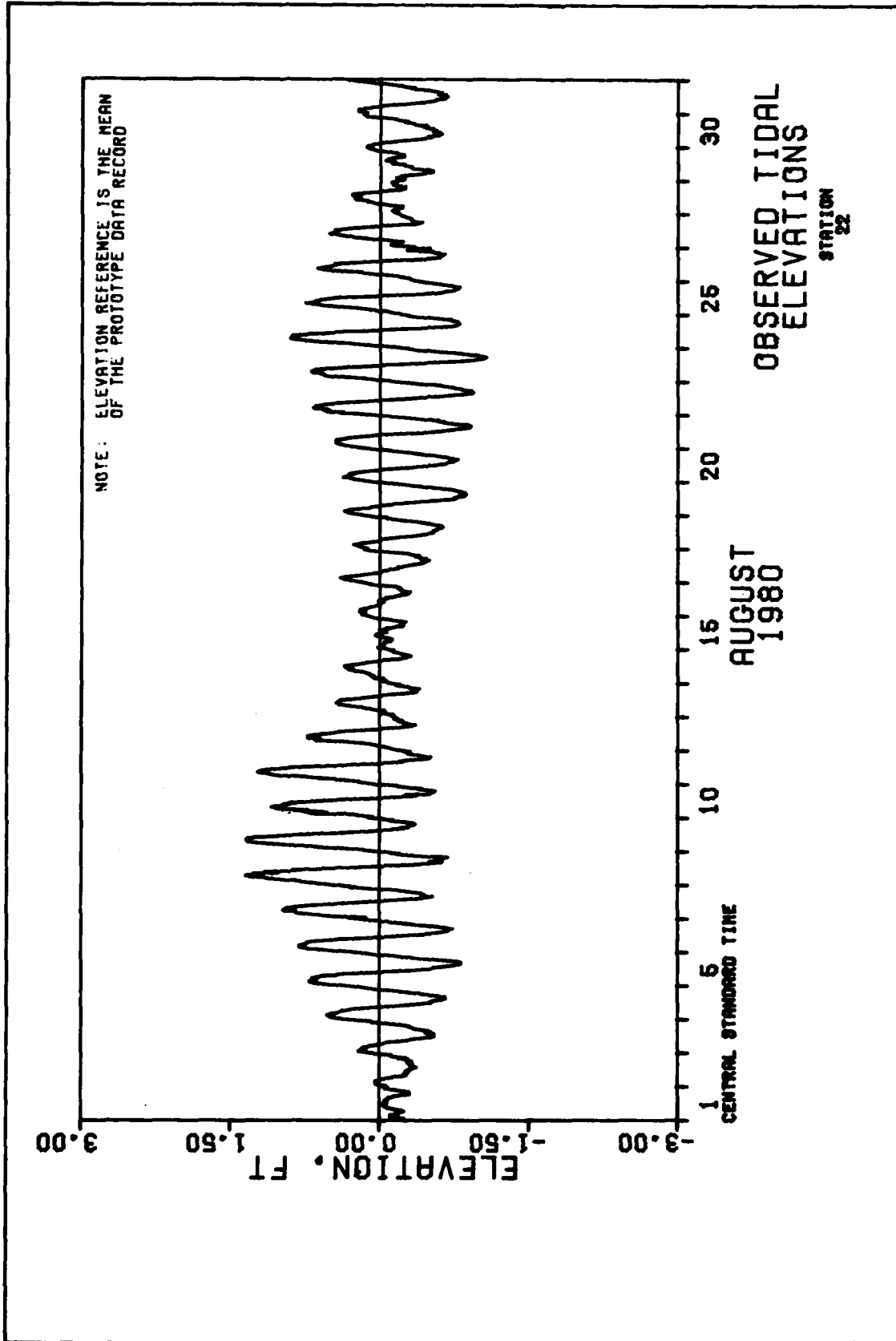
NOTE: ELEVATION REFERENCE IS THE MEAN  
OF THE PROTOTYPE DATA RECORD

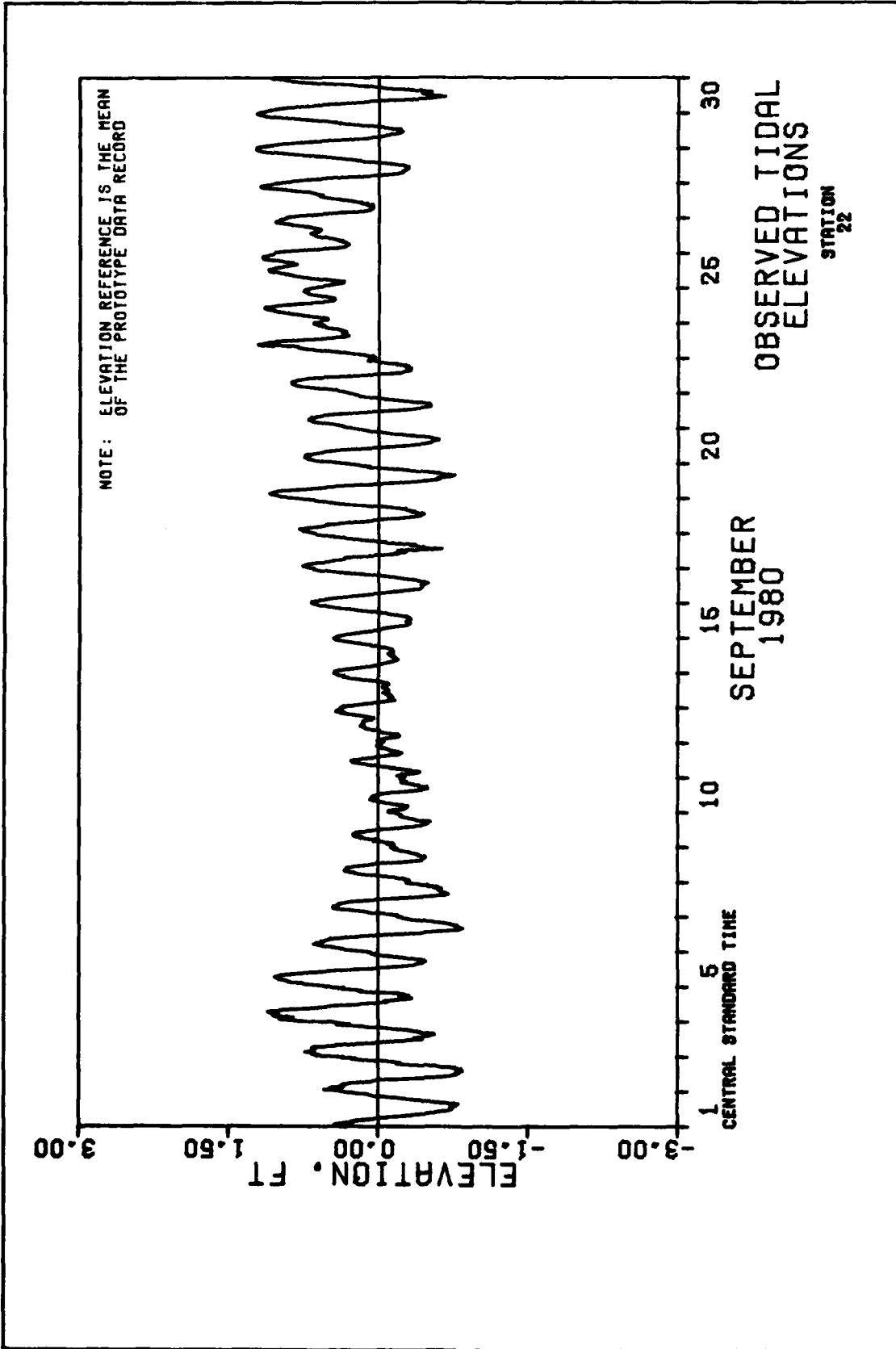


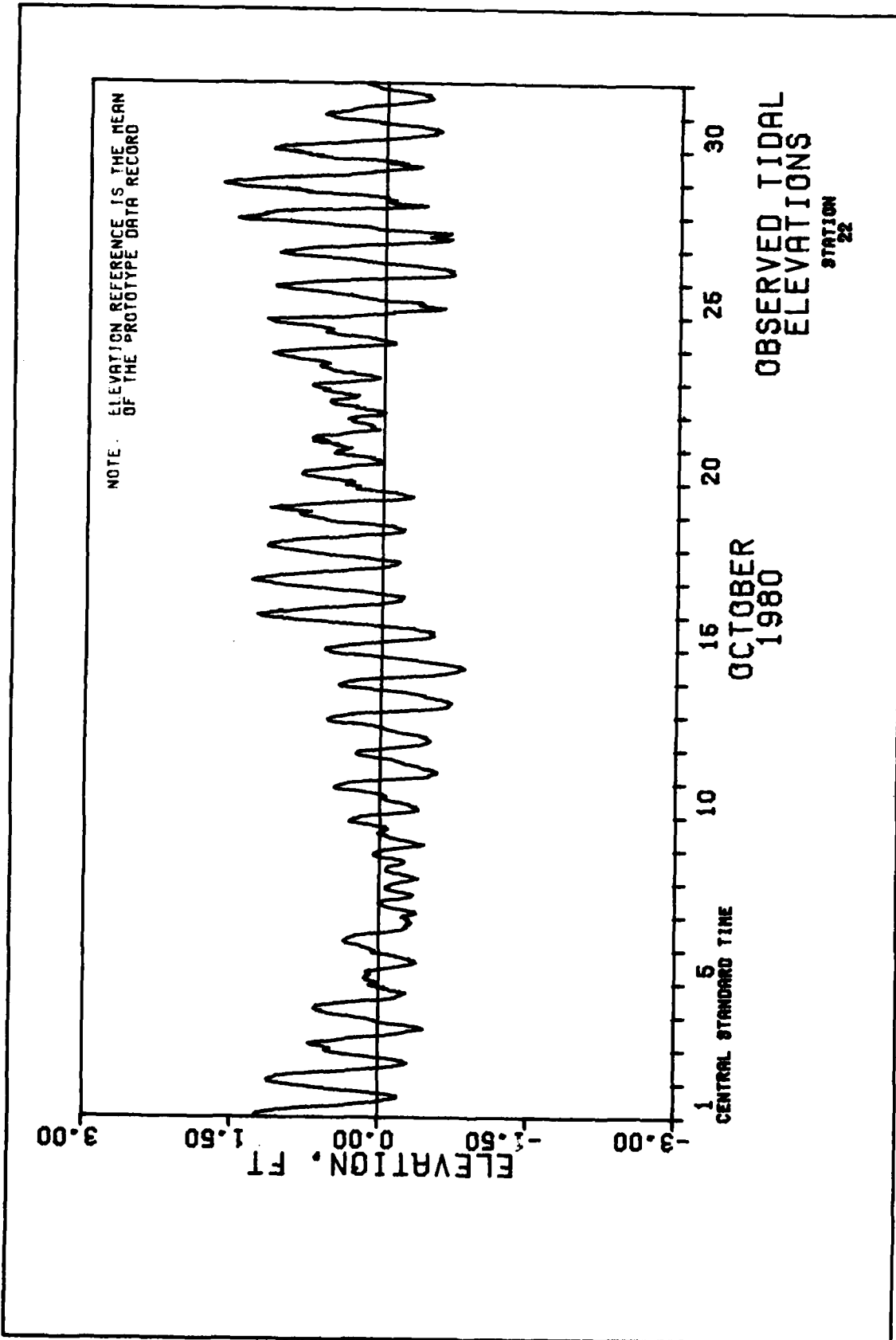
OBSERVED TIDAL  
ELEVATIONS  
STATION  
22

JULY  
1980

CENTRAL STANDARD TIME







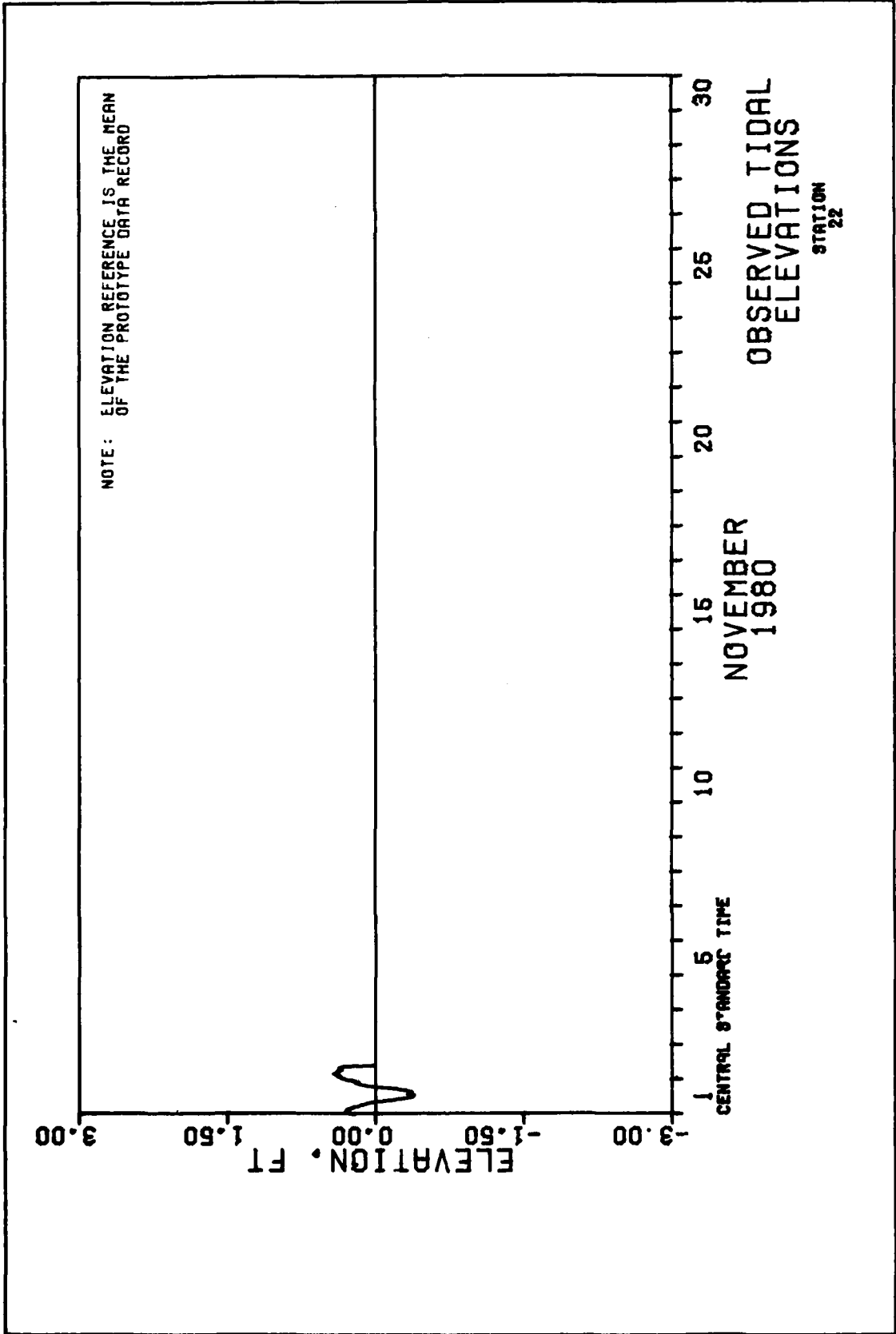
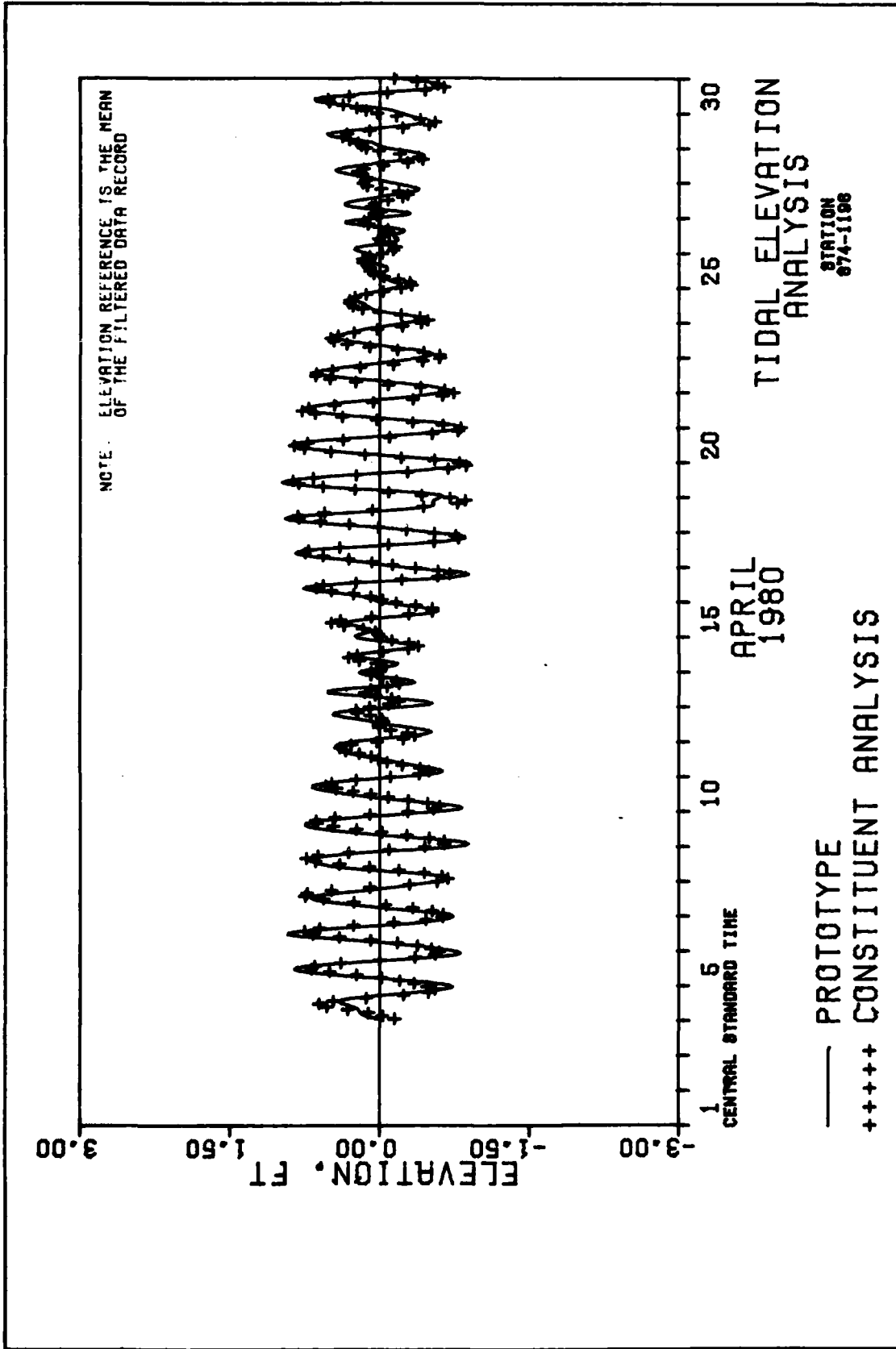
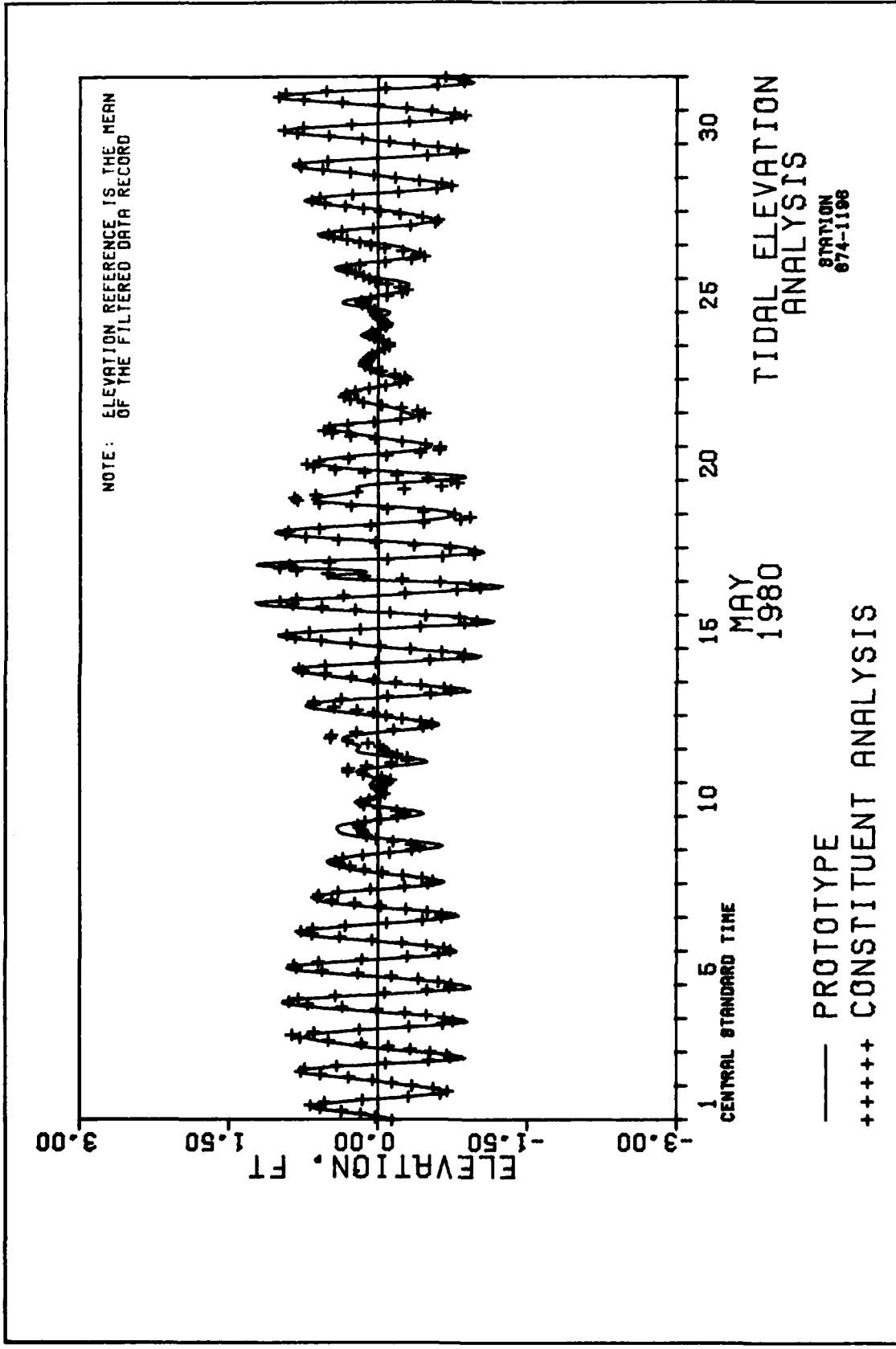
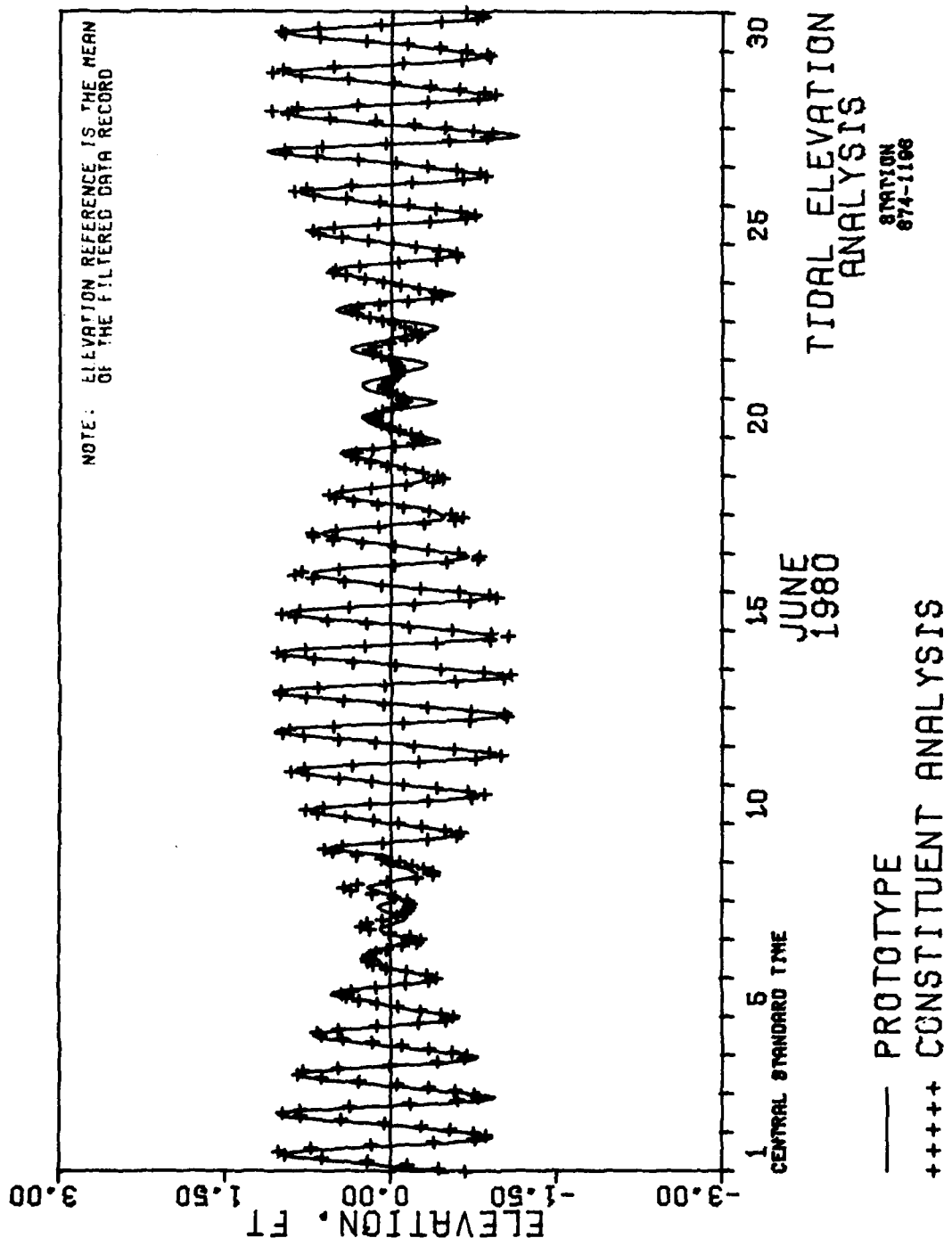


PLATE 36









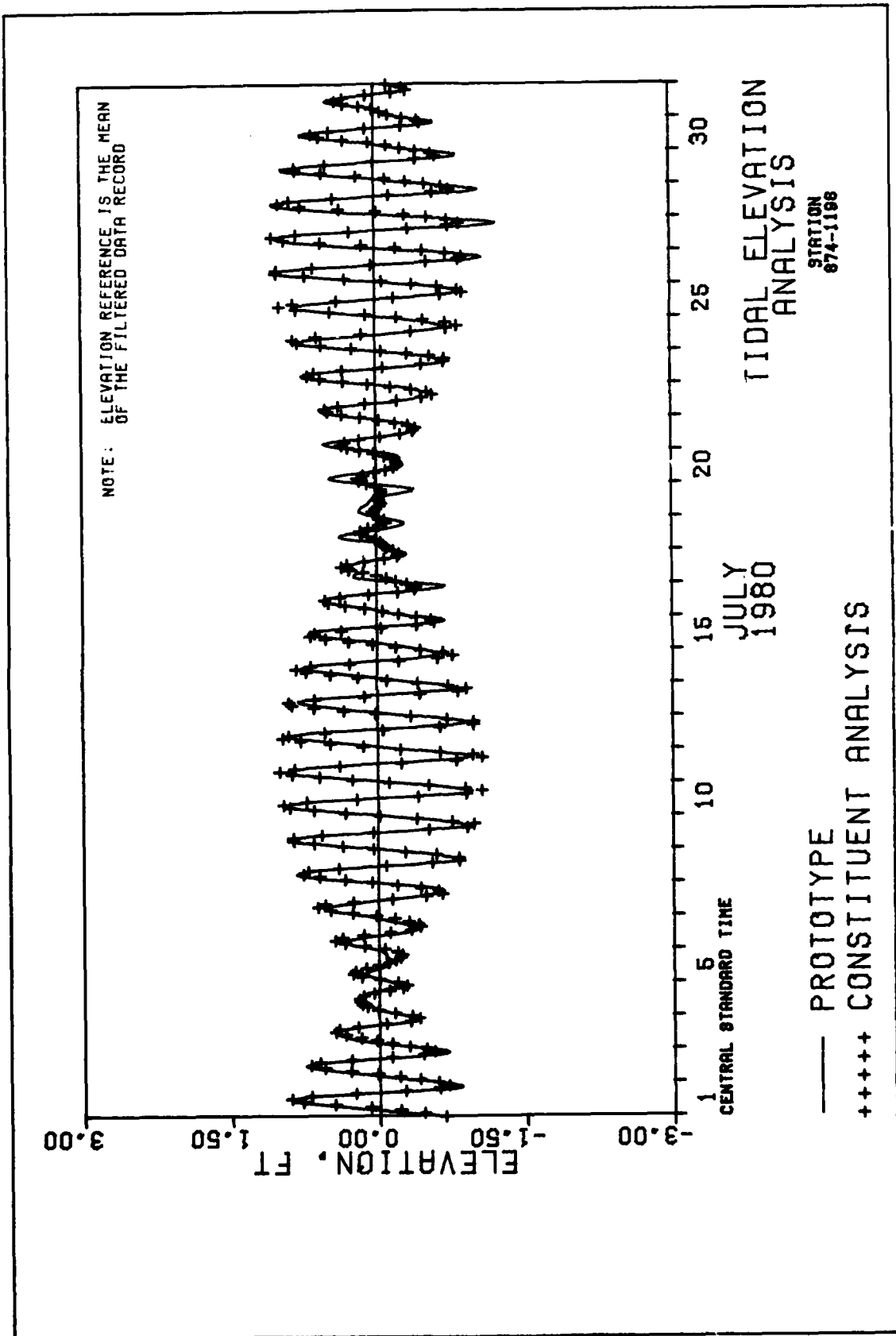
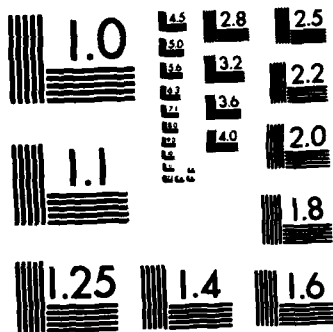
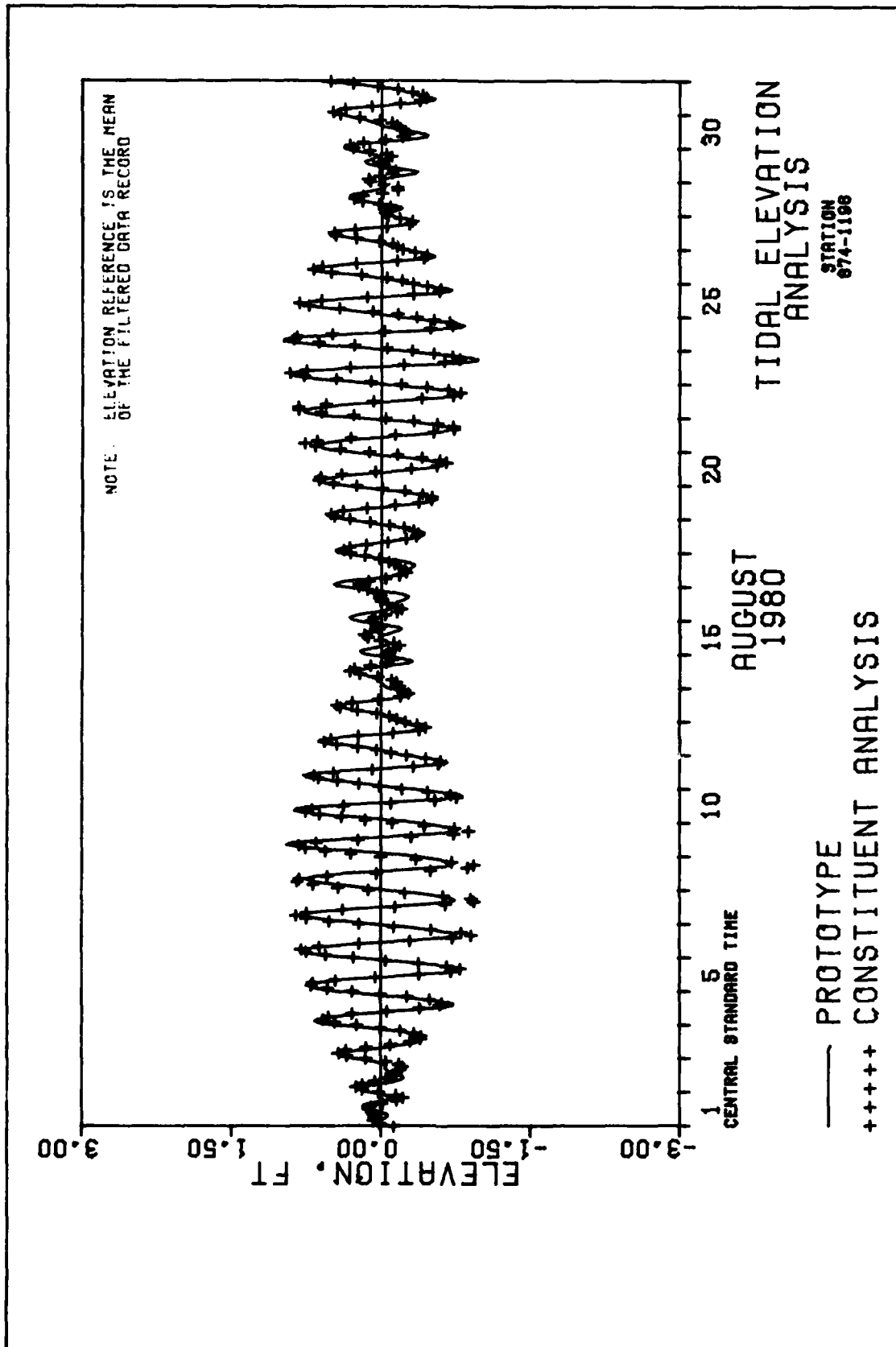


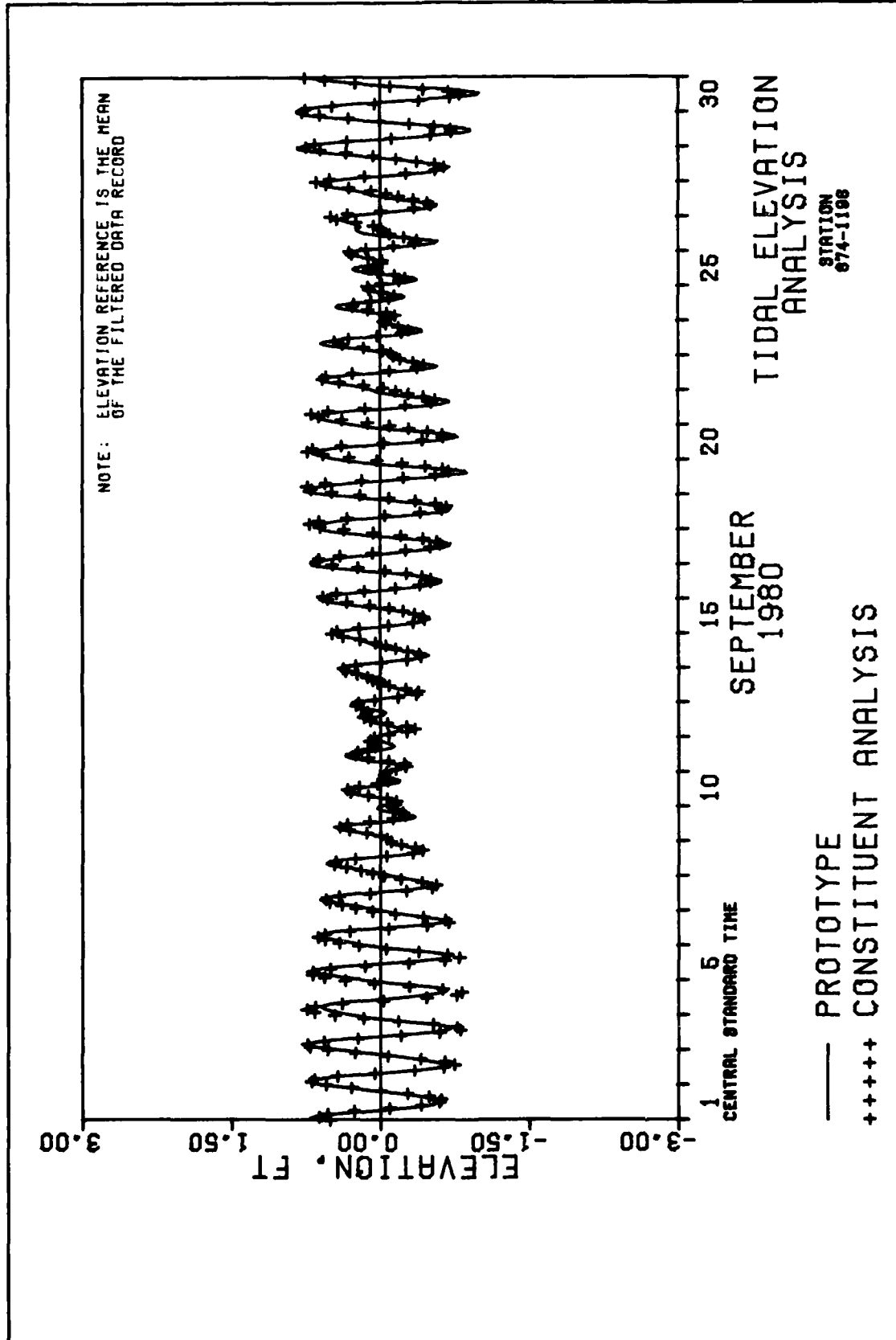
PLATE 40

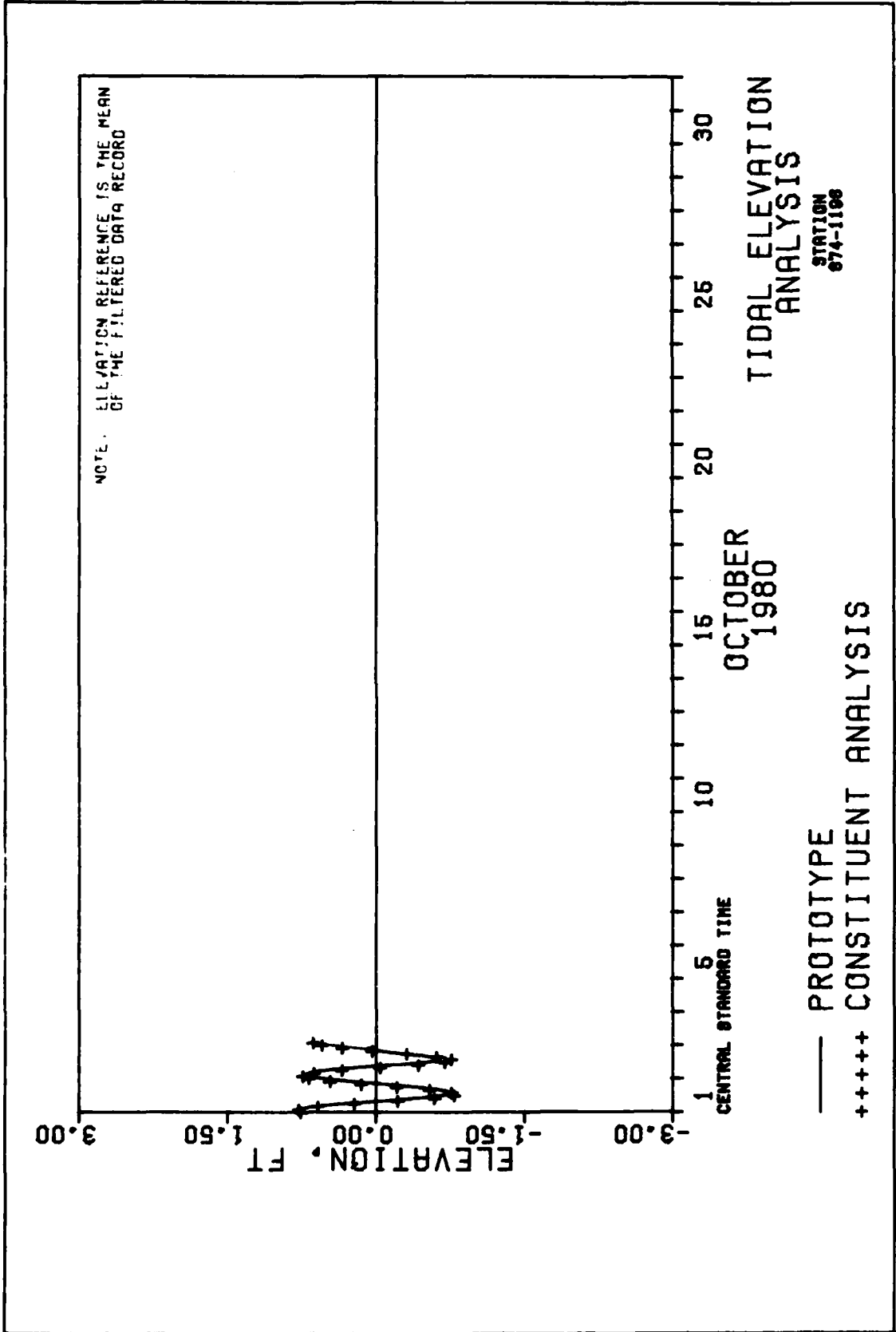




MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A







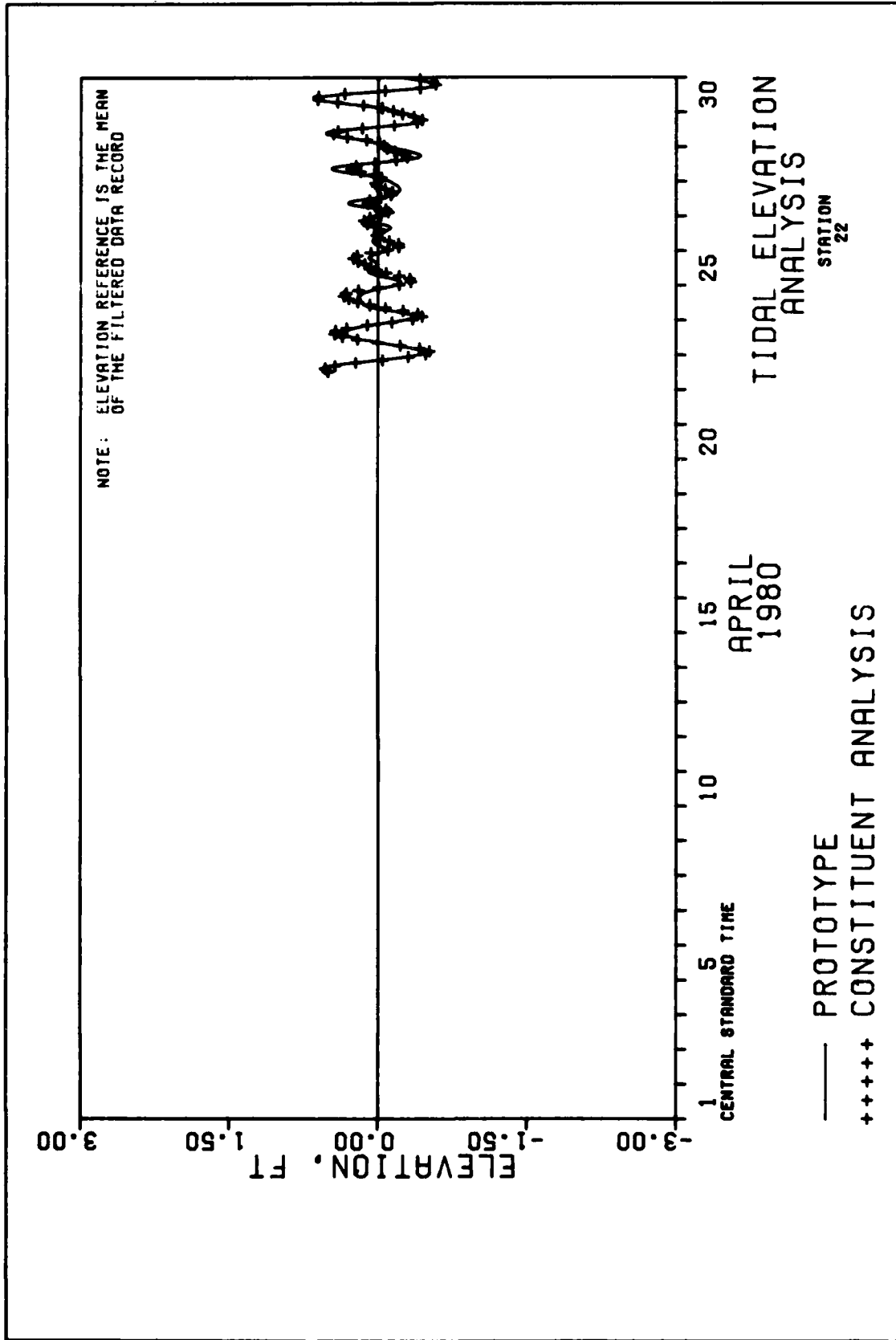
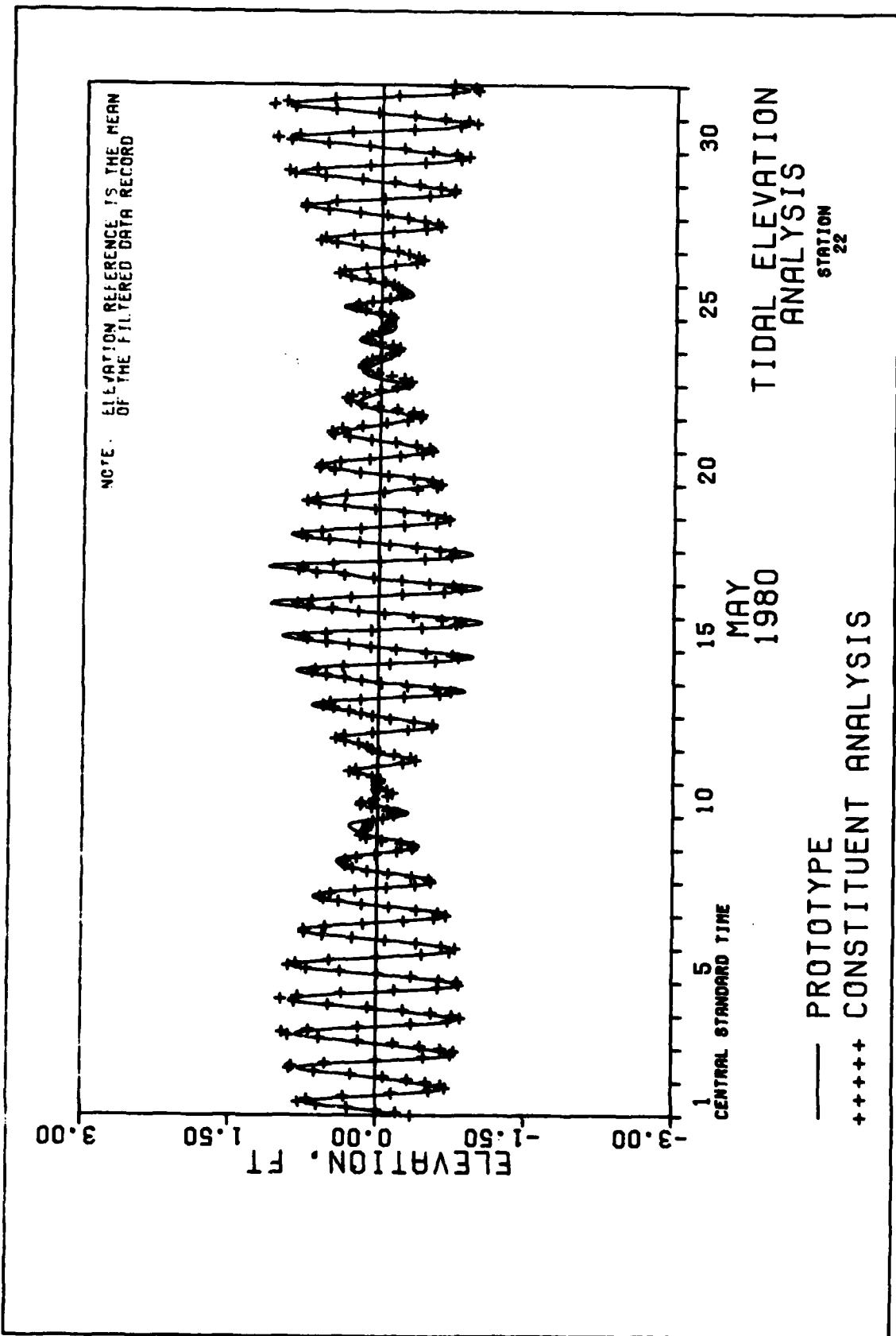


PLATE 44





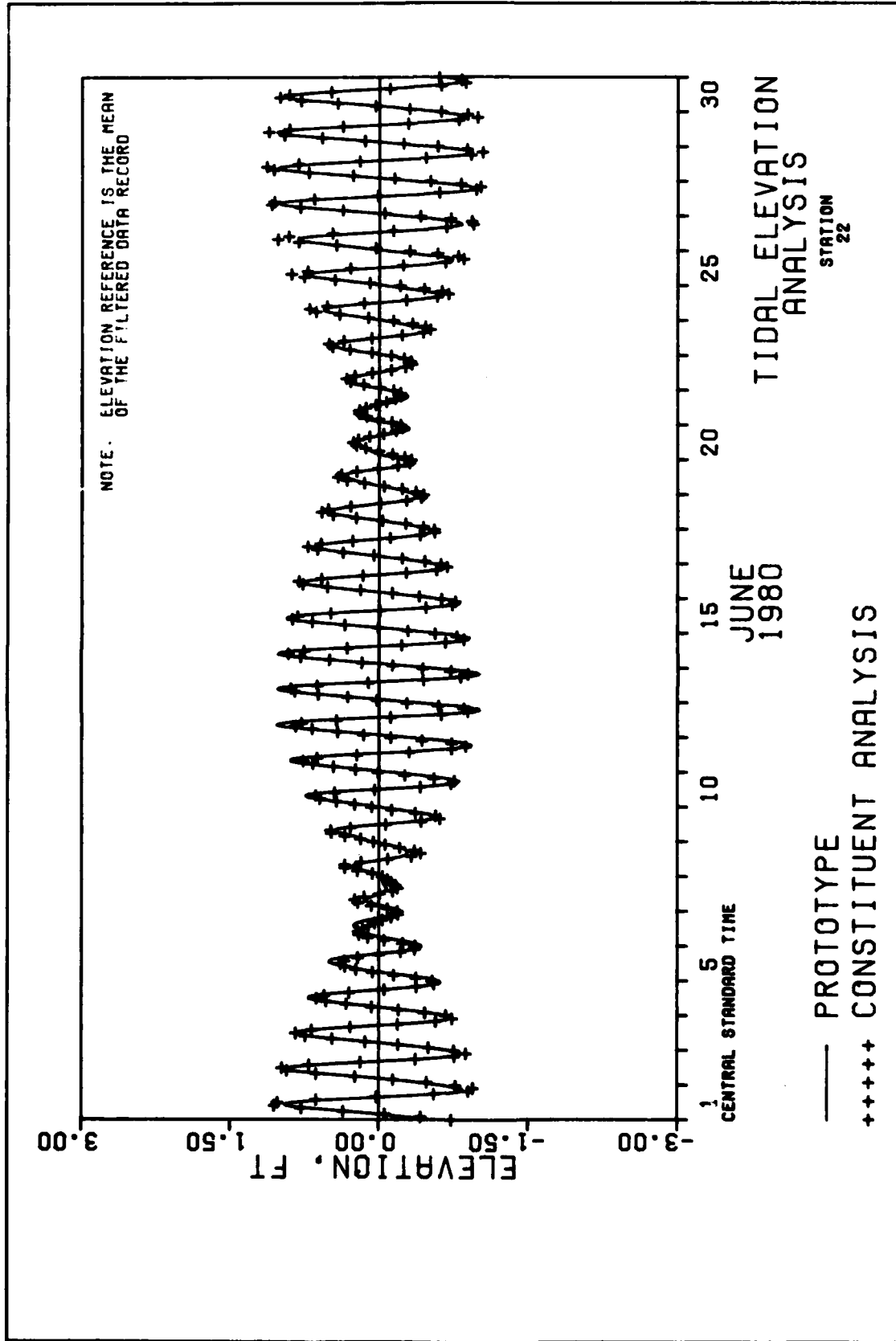
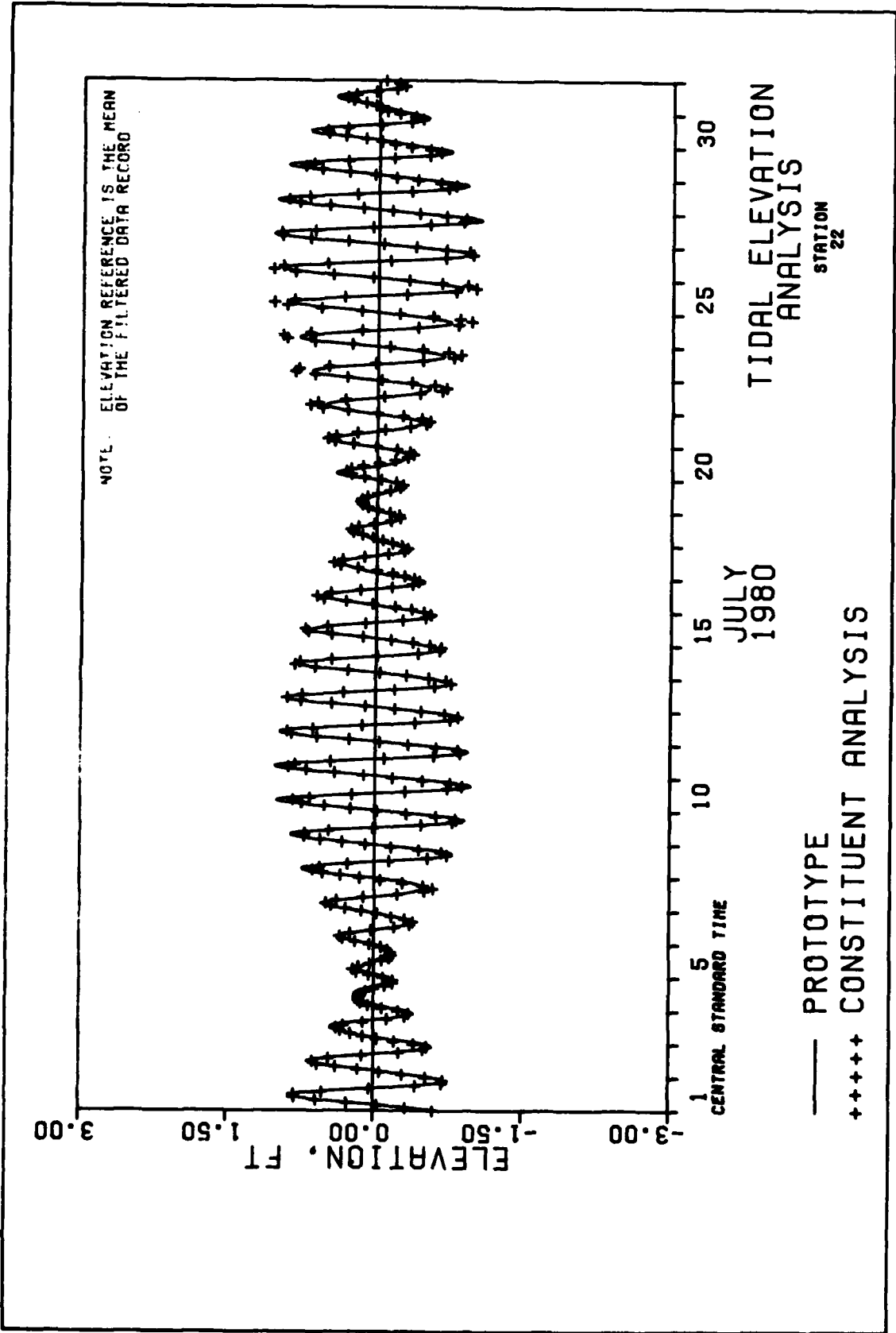


PLATE 46



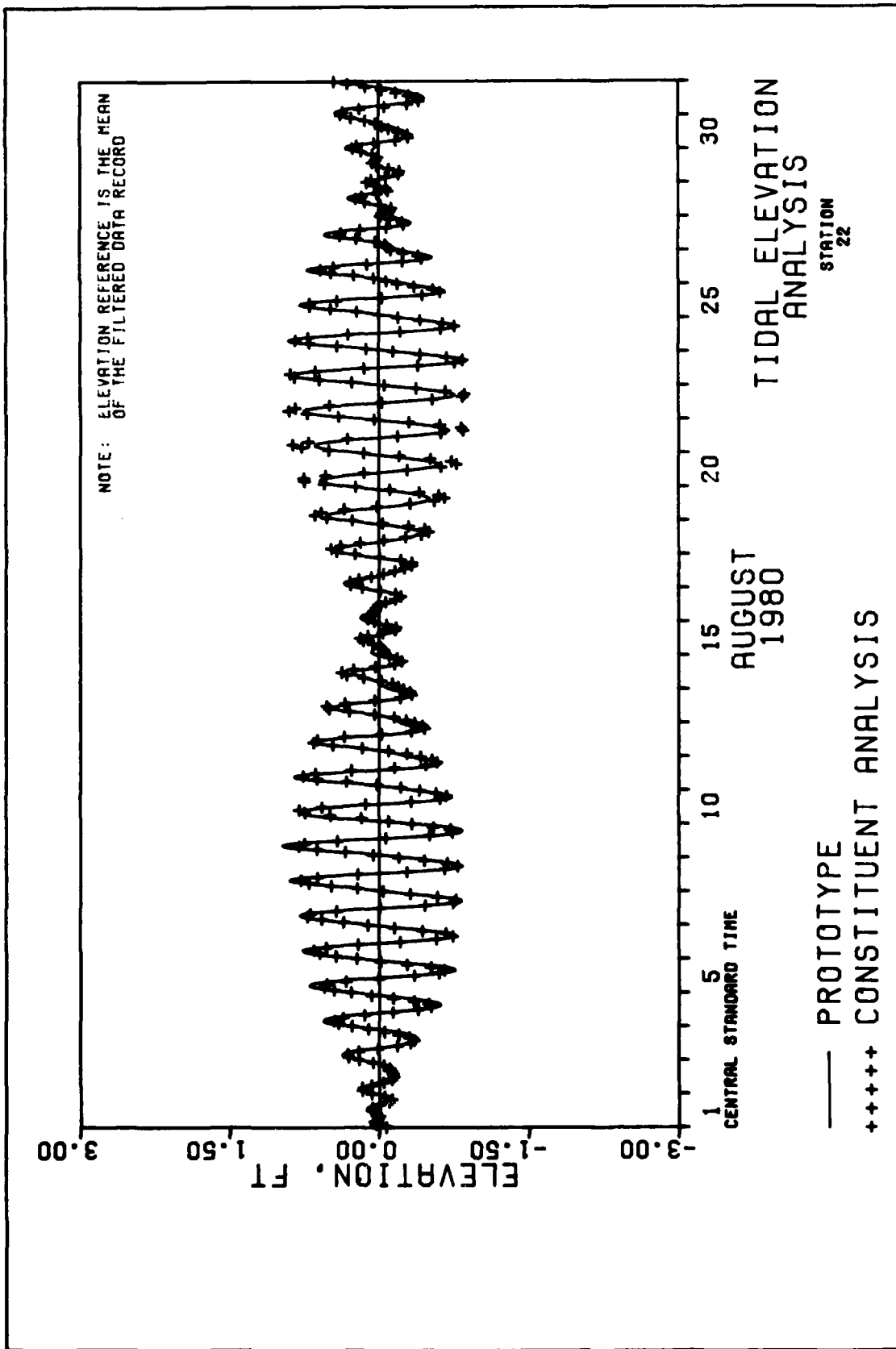
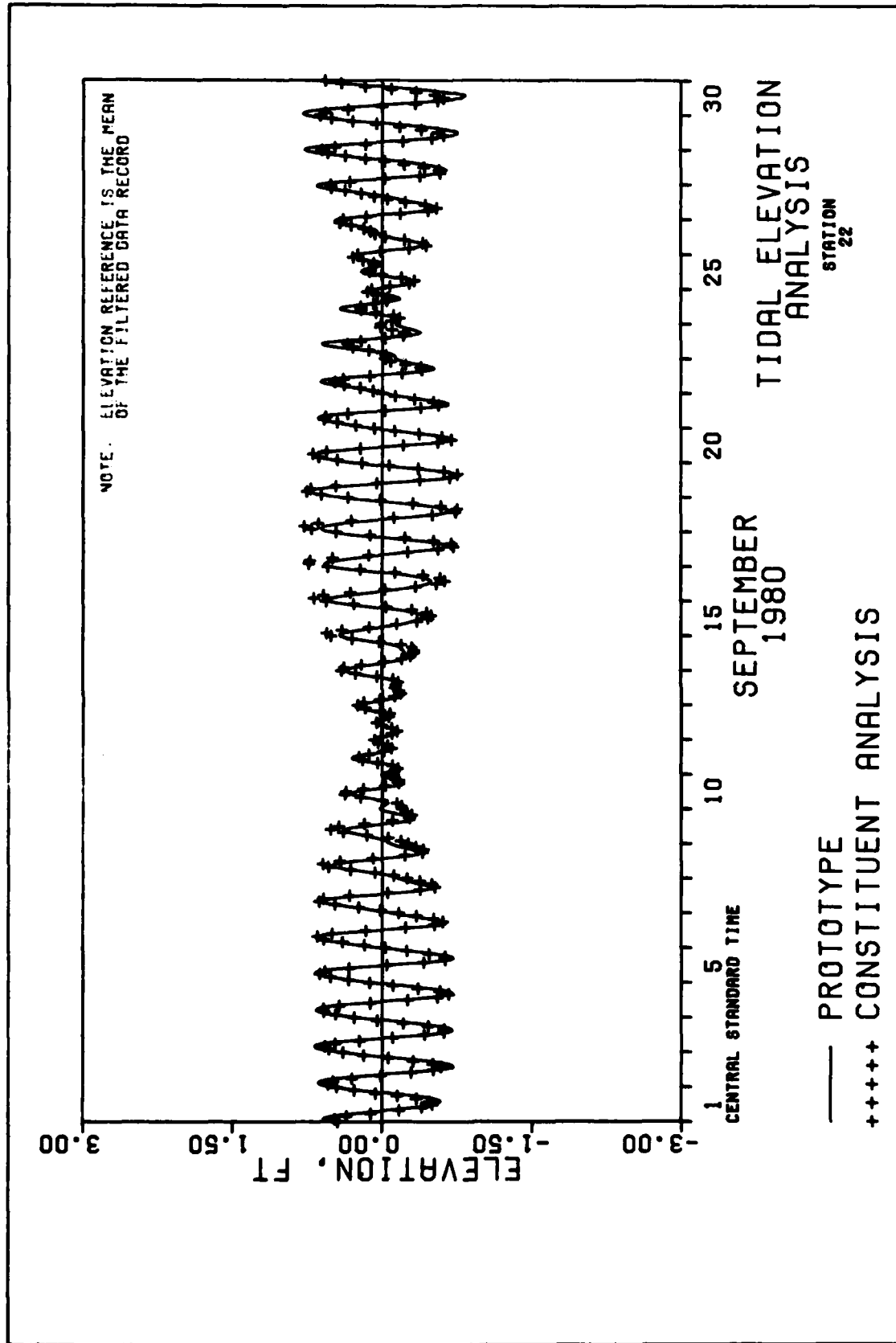
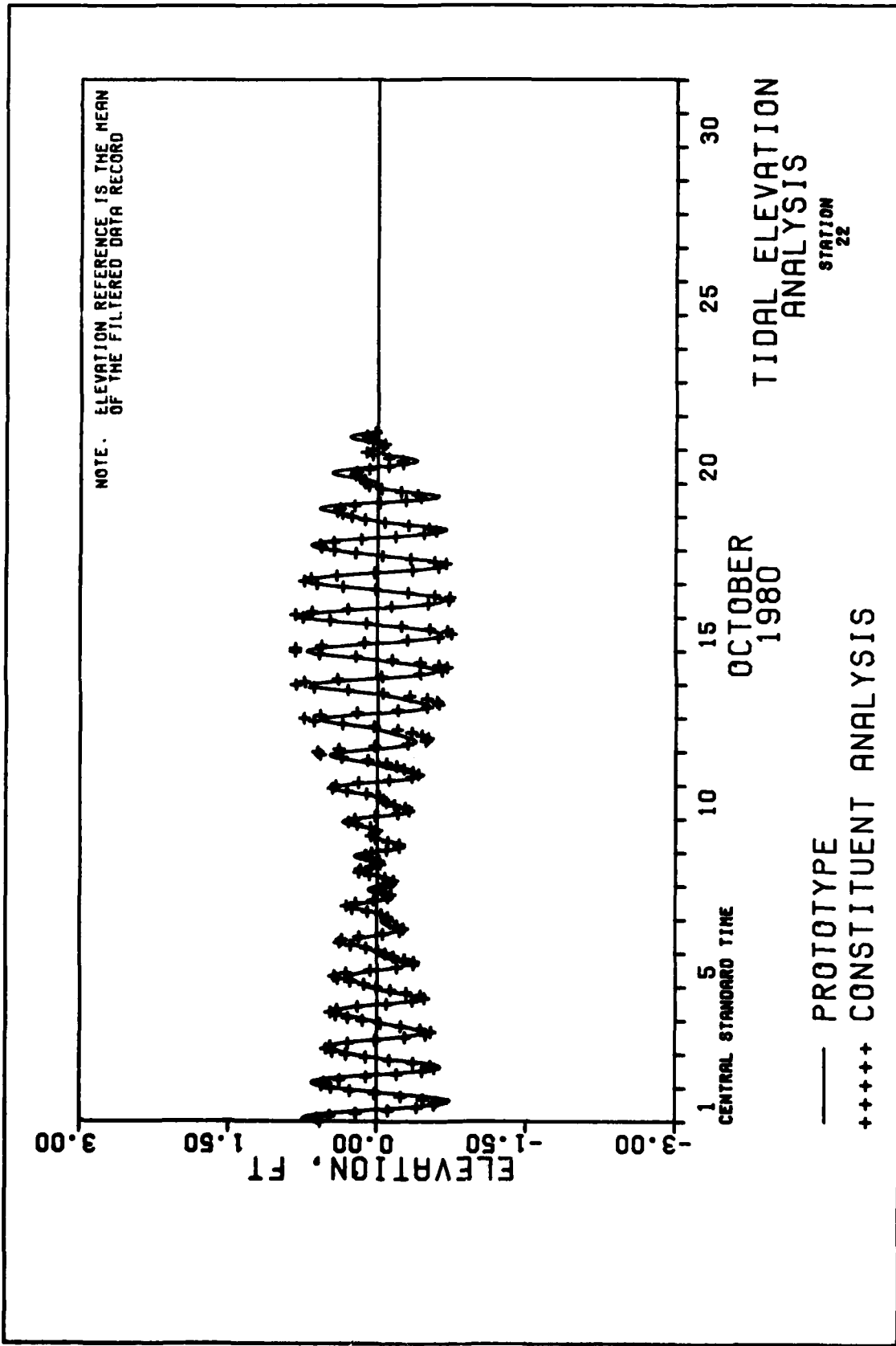
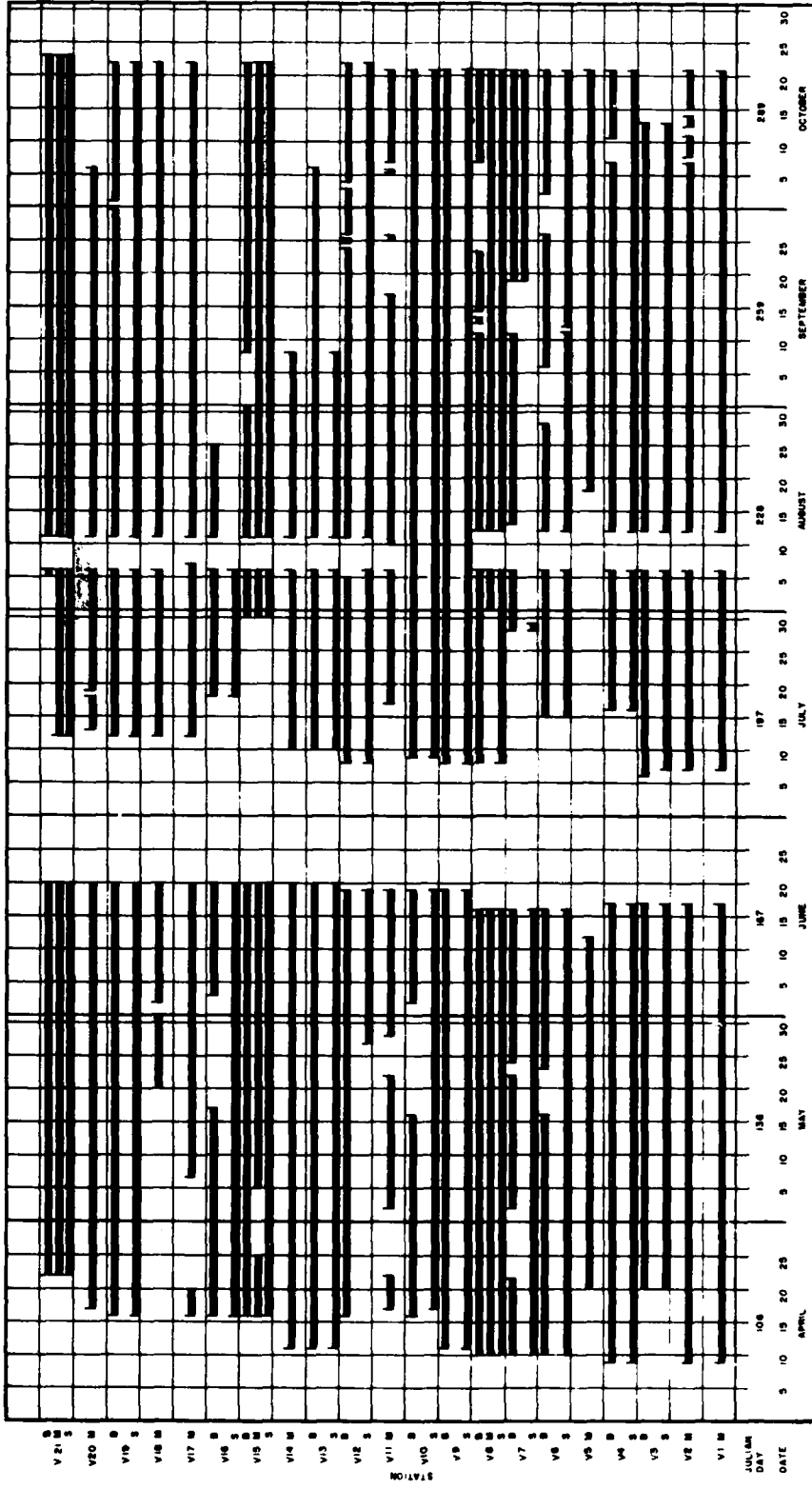


PLATE 48







OPERATIONAL STATUS  
AND SENSOR PLACEMENT

CURRENT METER STATIONS

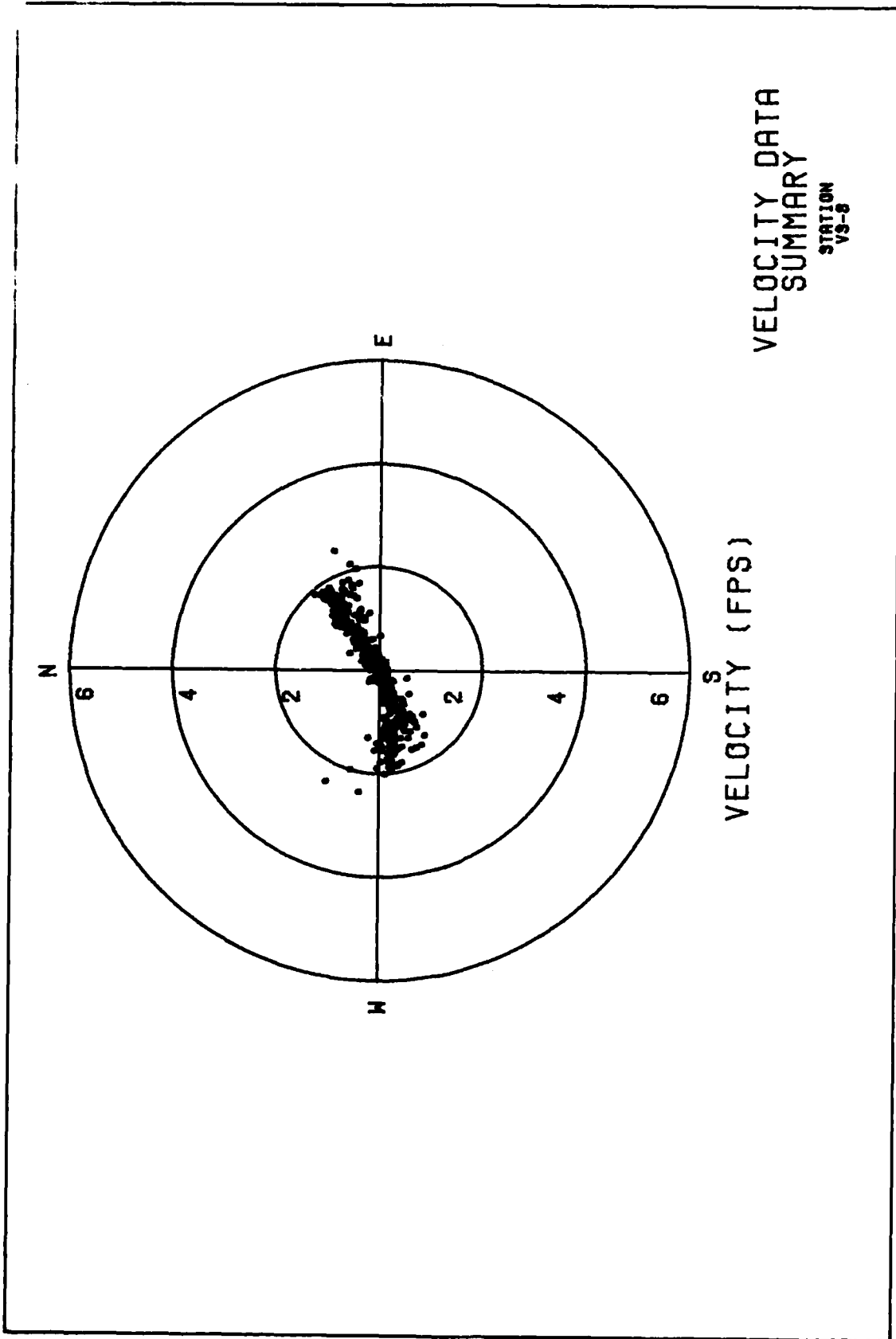
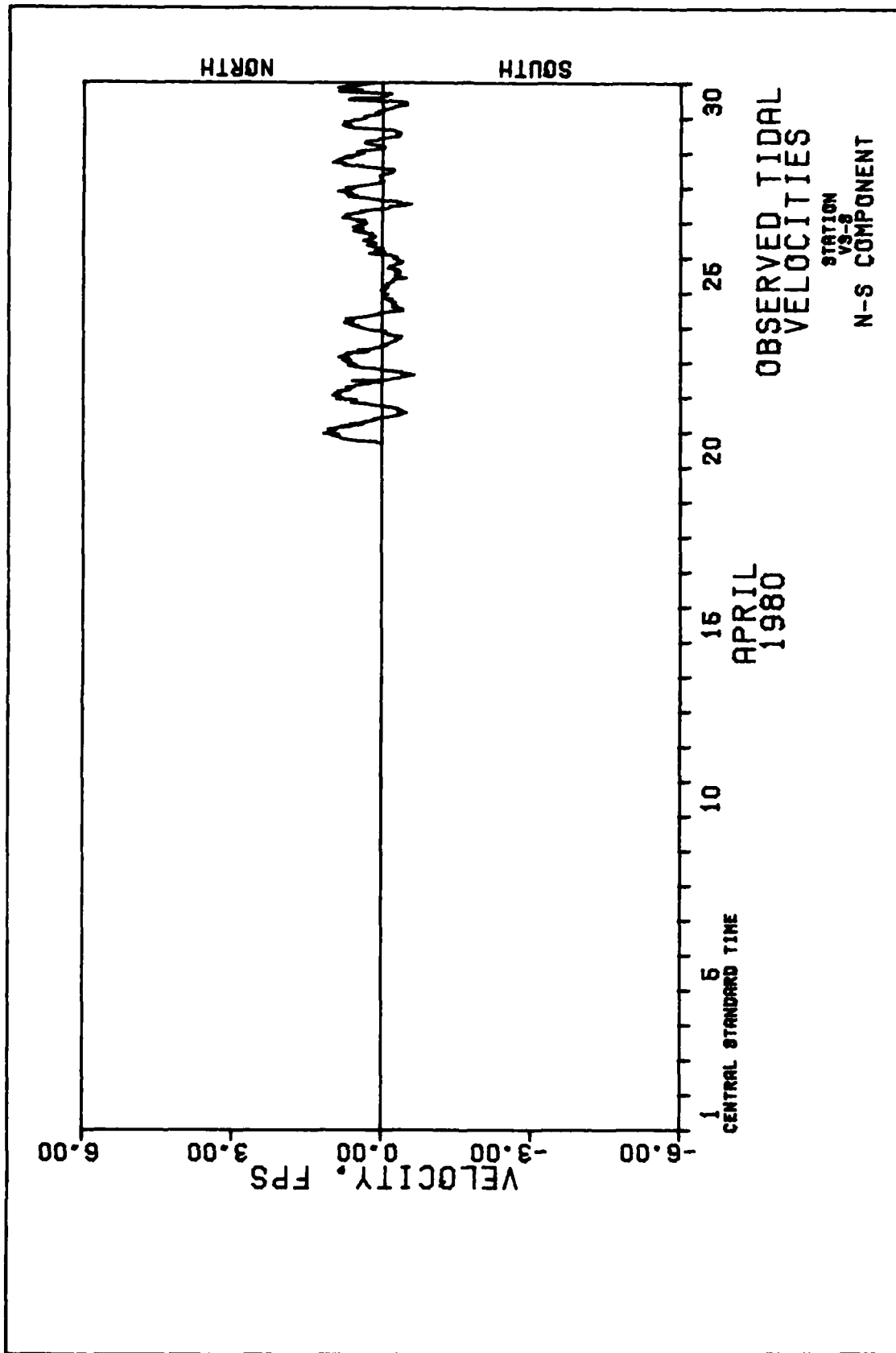


PLATE 52





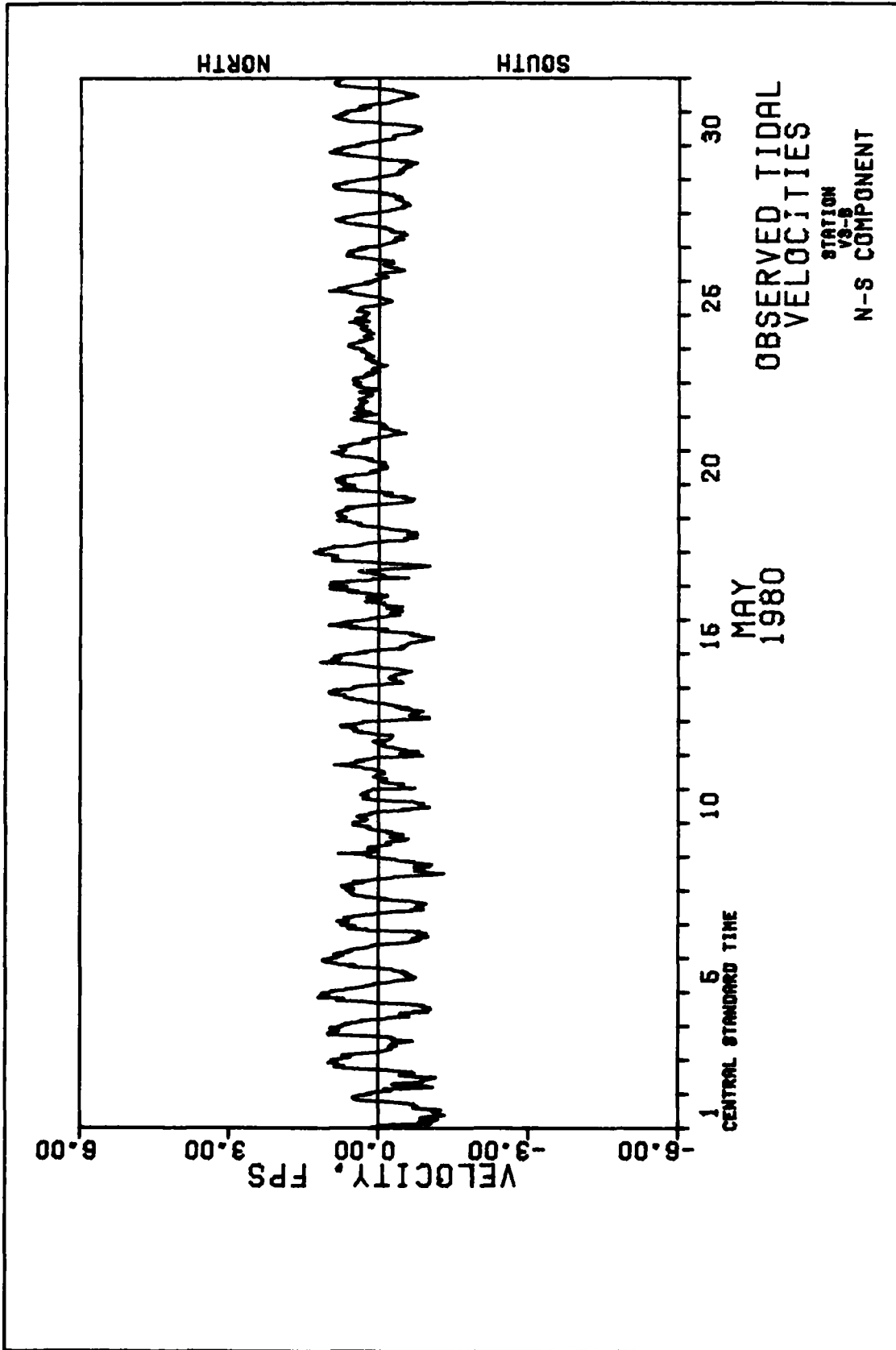


PLATE 54

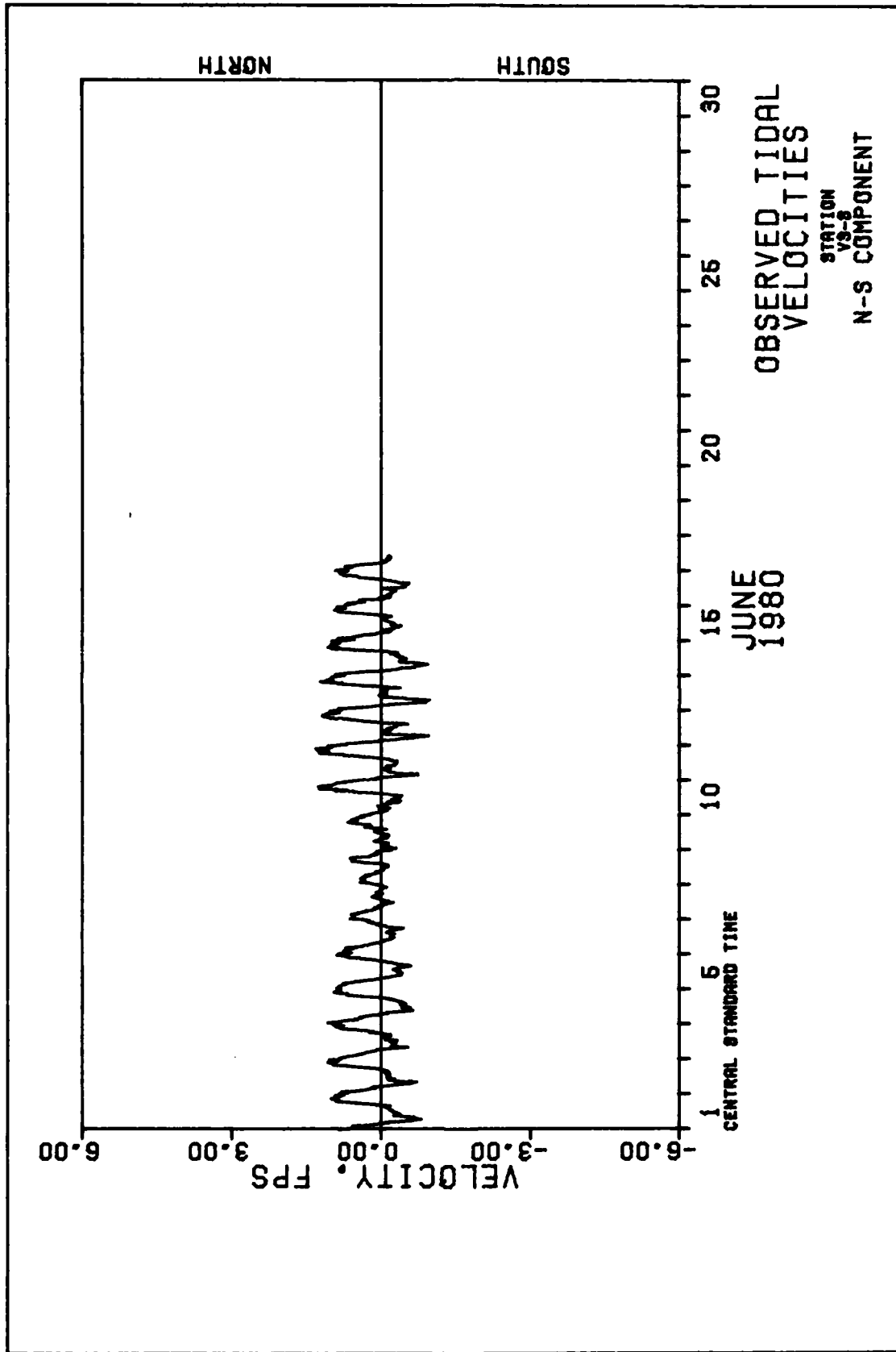


PLATE 55

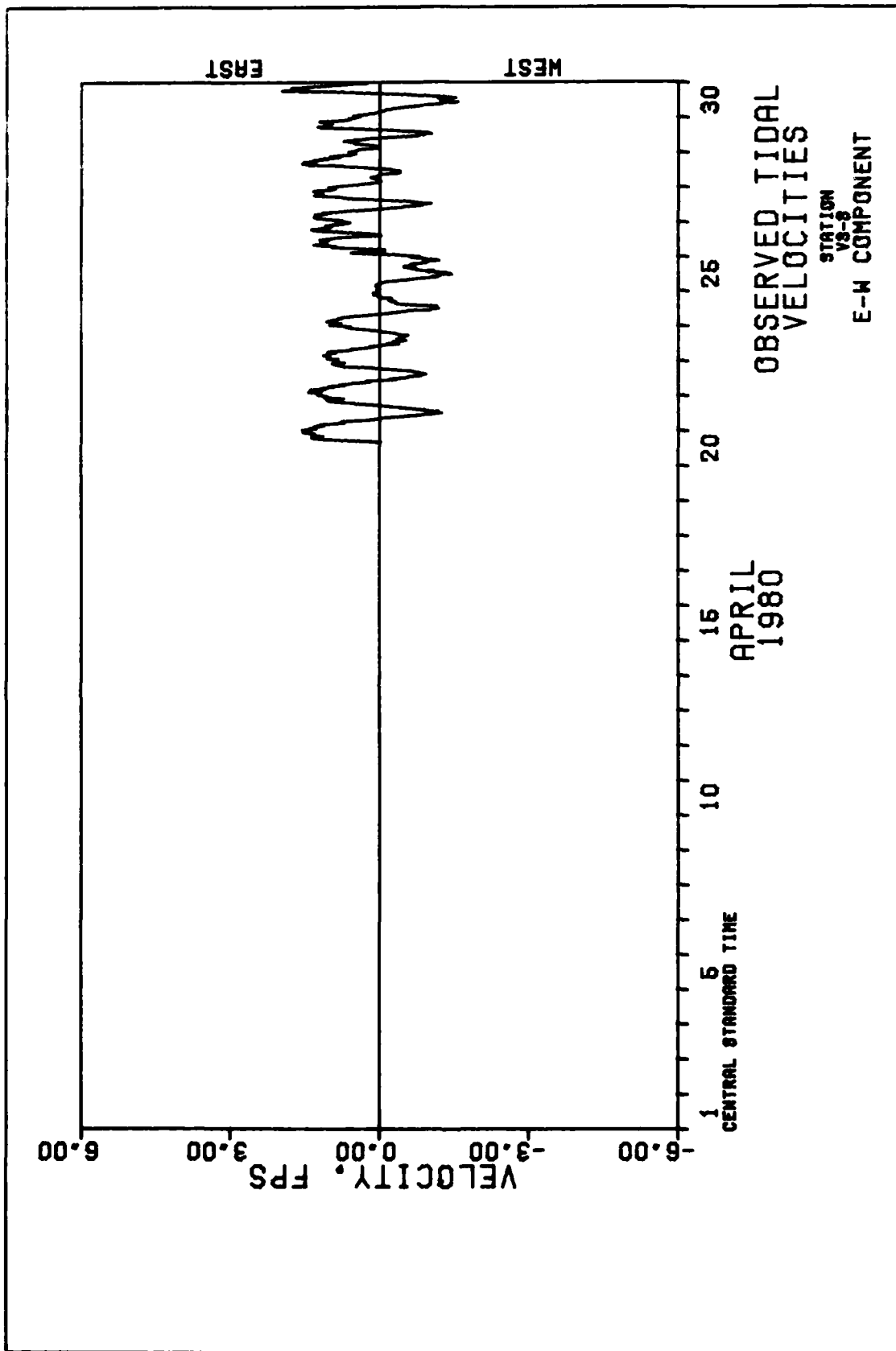


PLATE 56

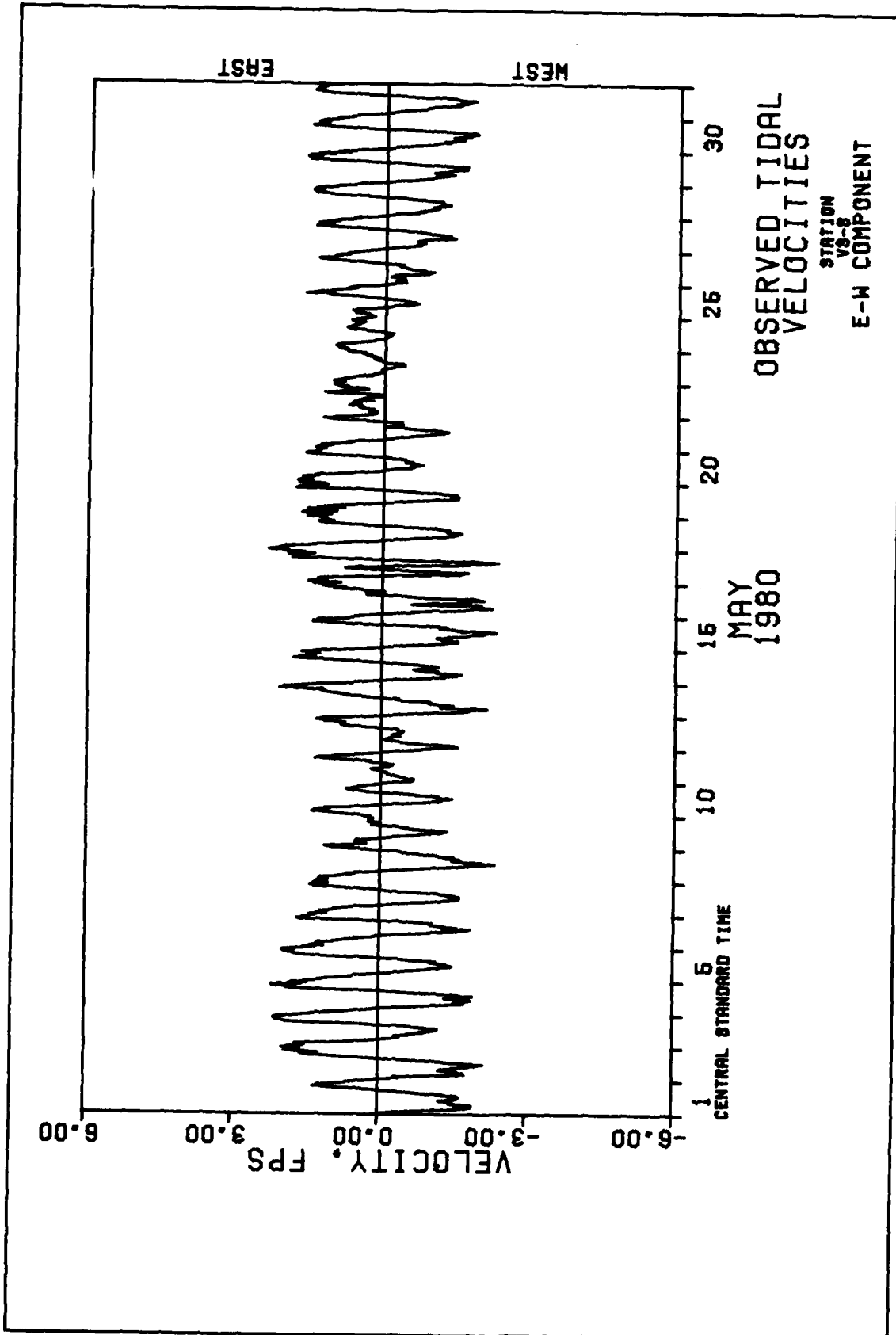


PLATE 57

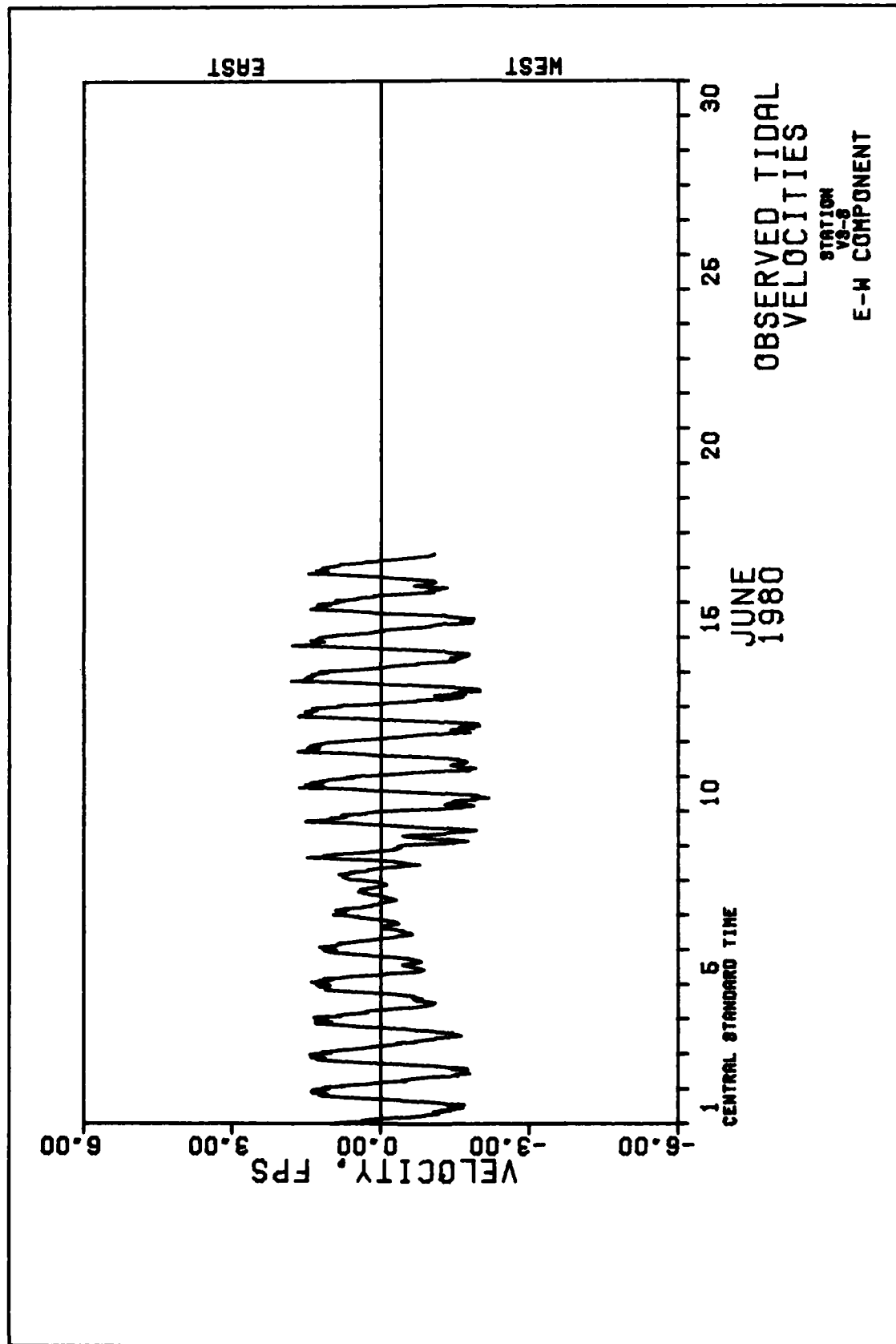
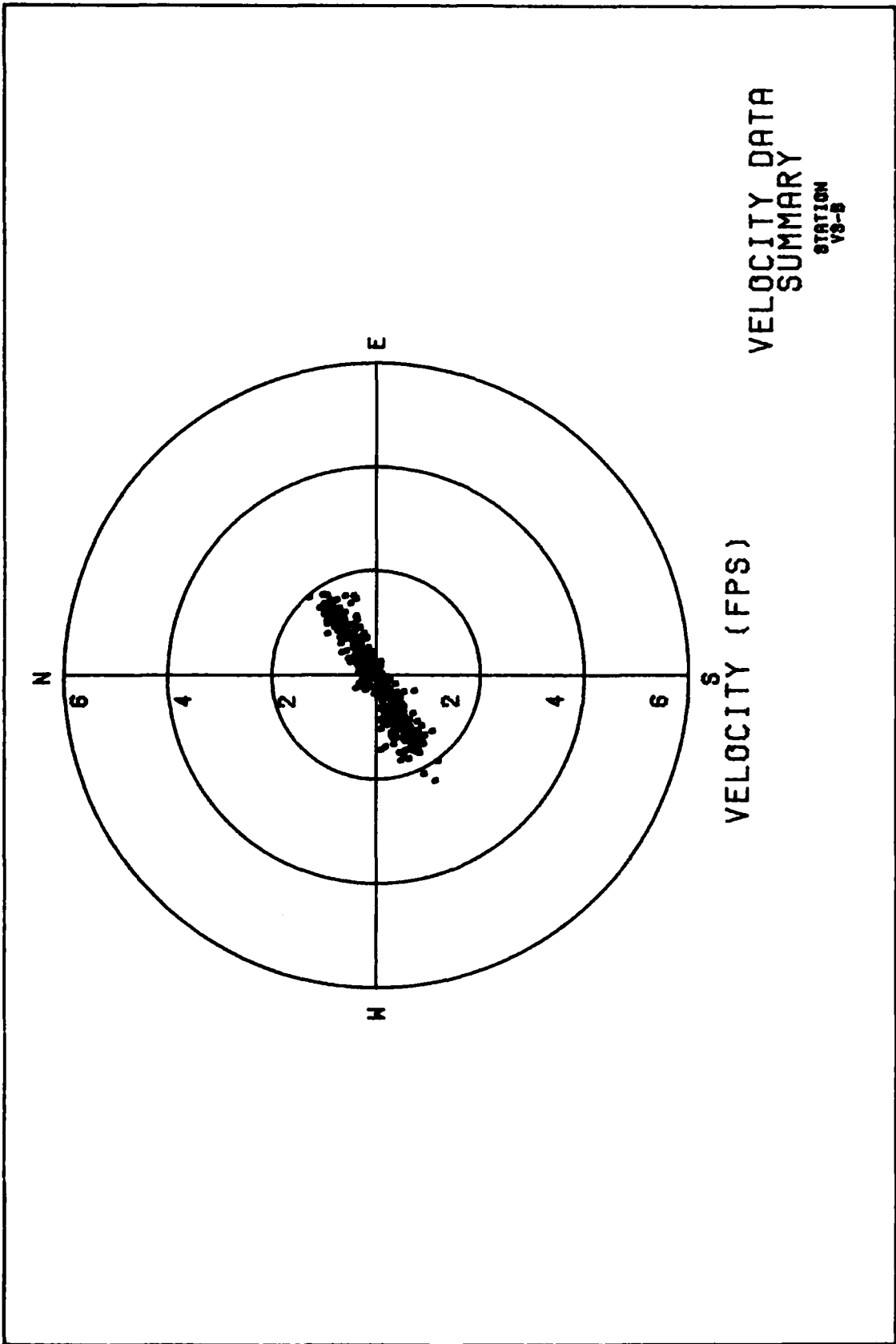


PLATE 58



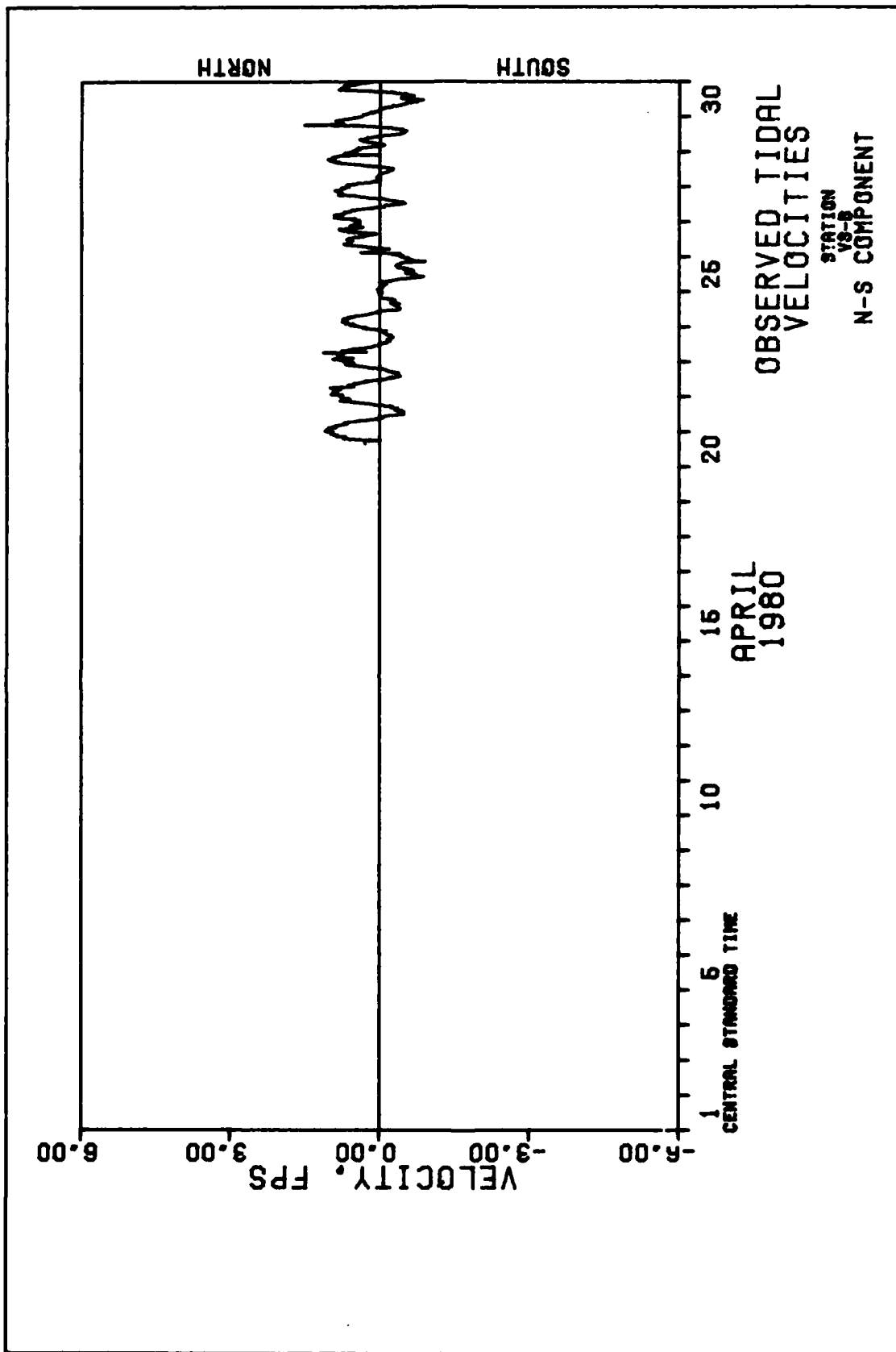


PLATE 60



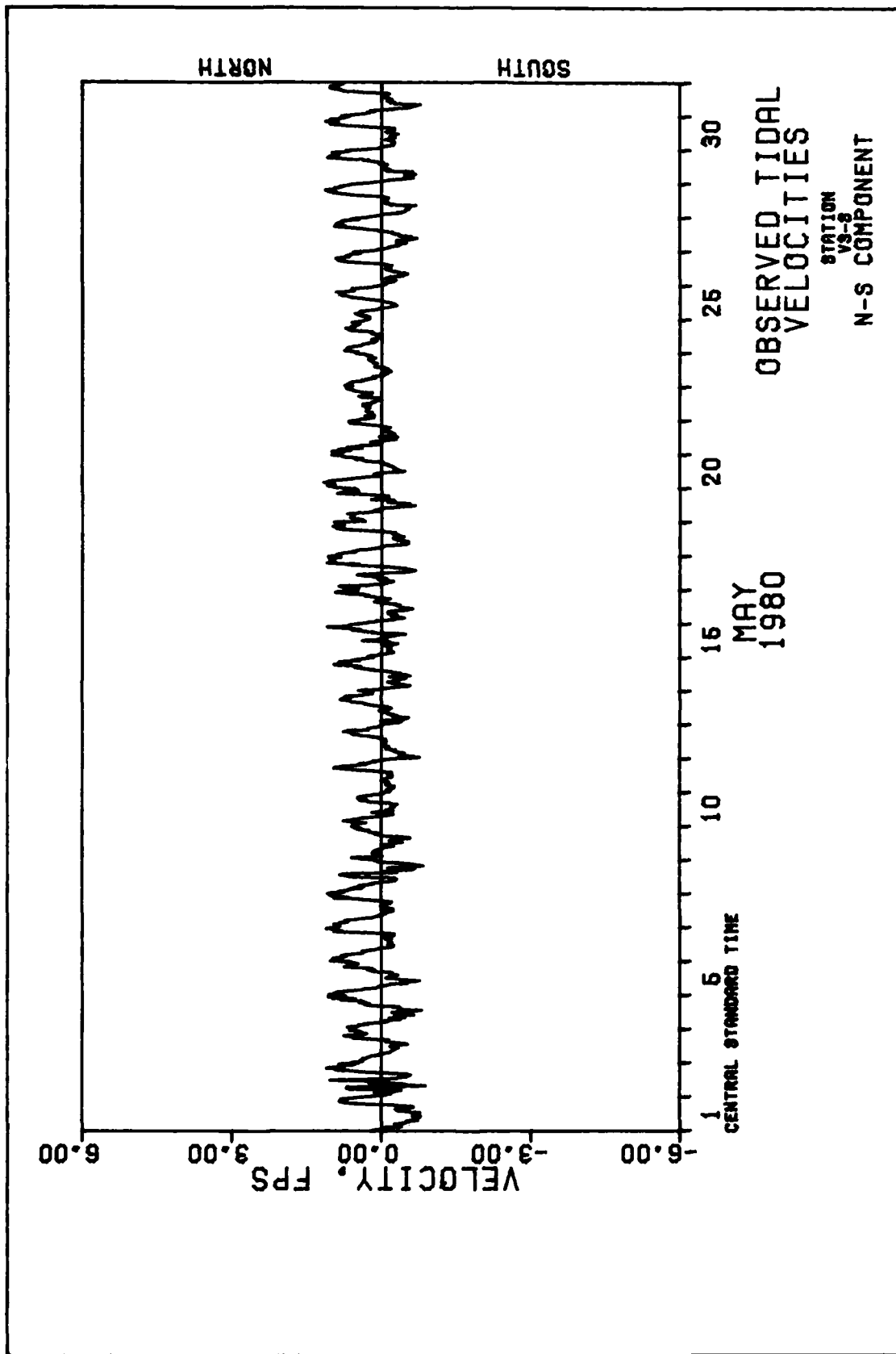


PLATE 61

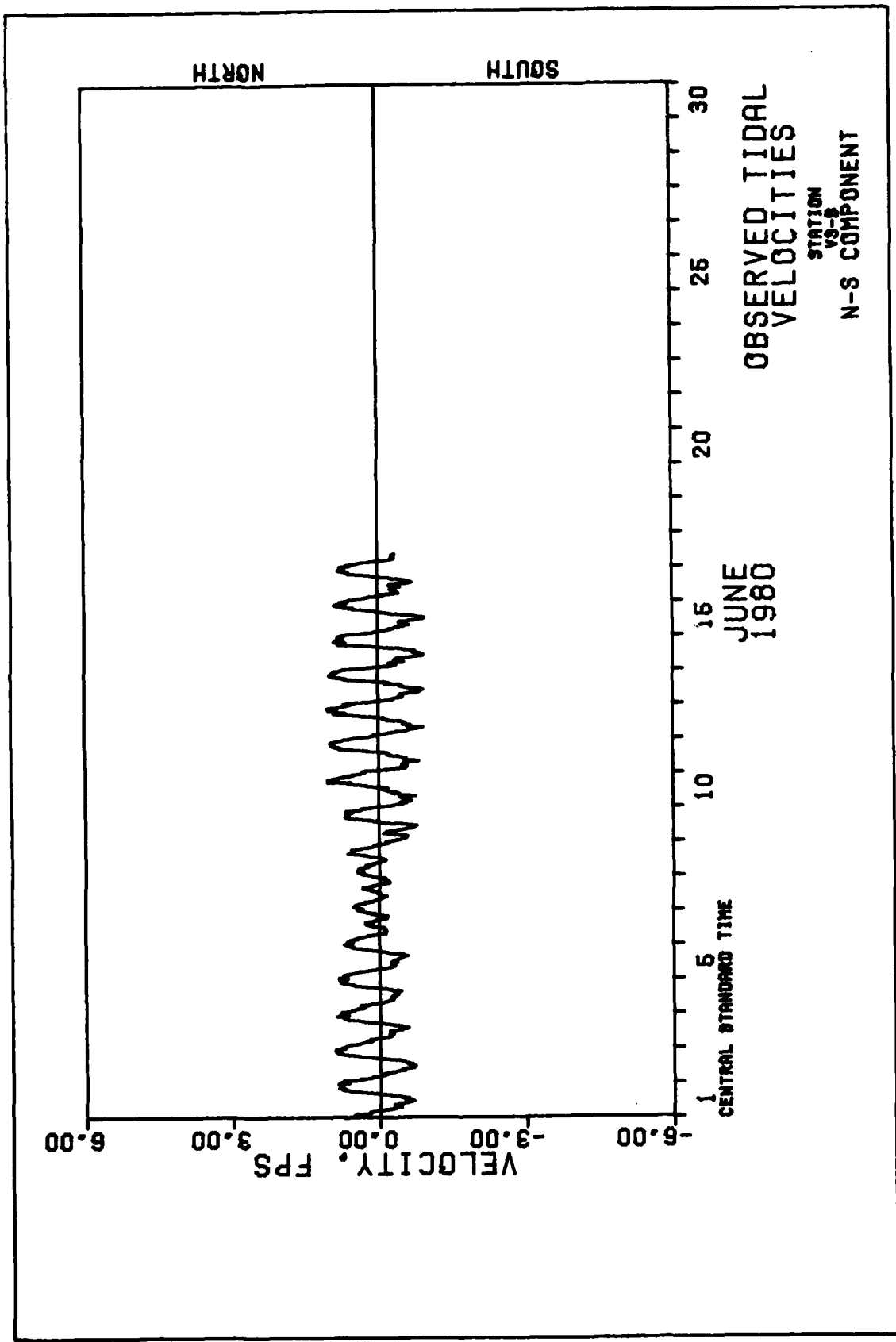


PLATE 62

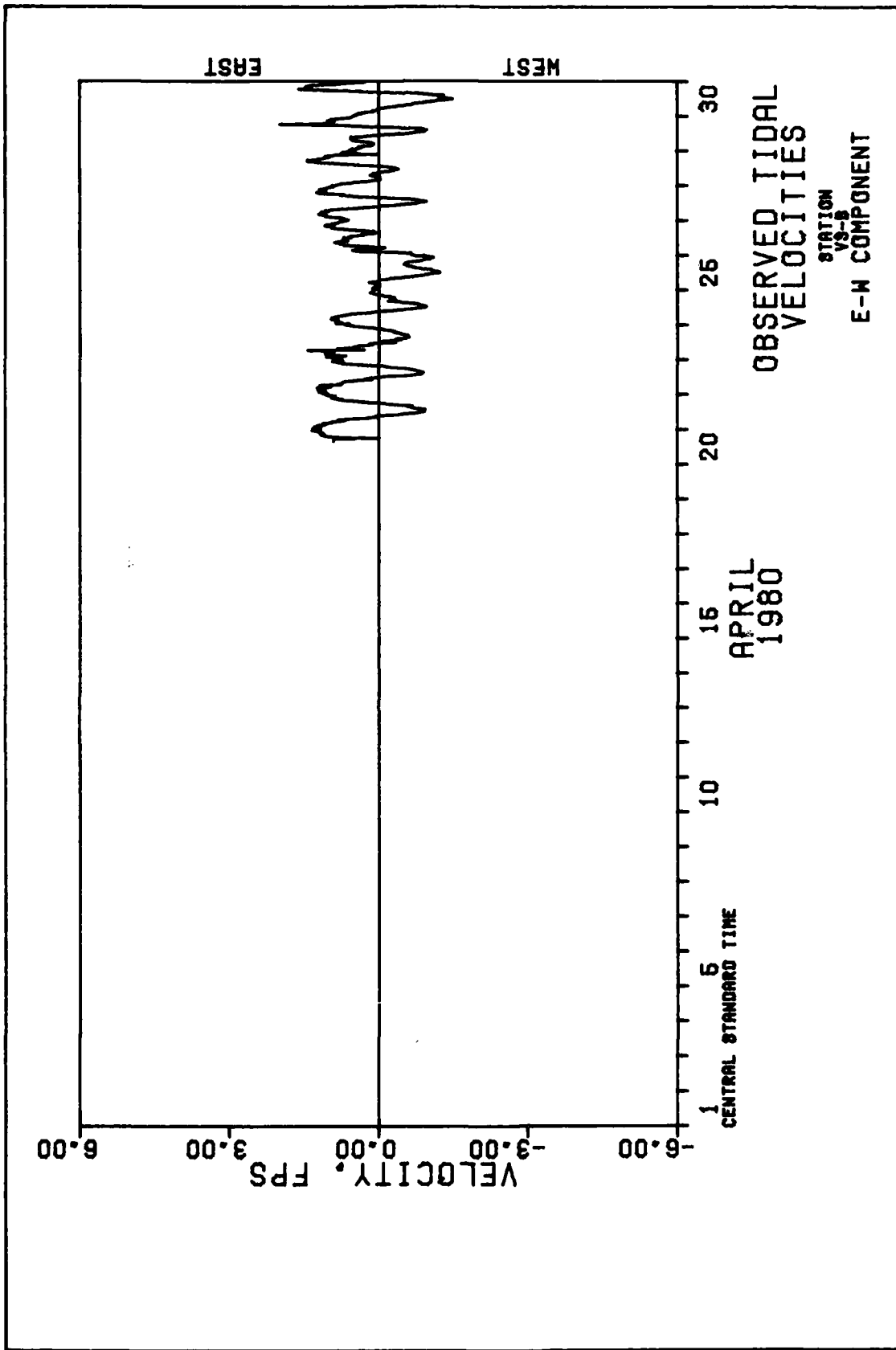


PLATE 63

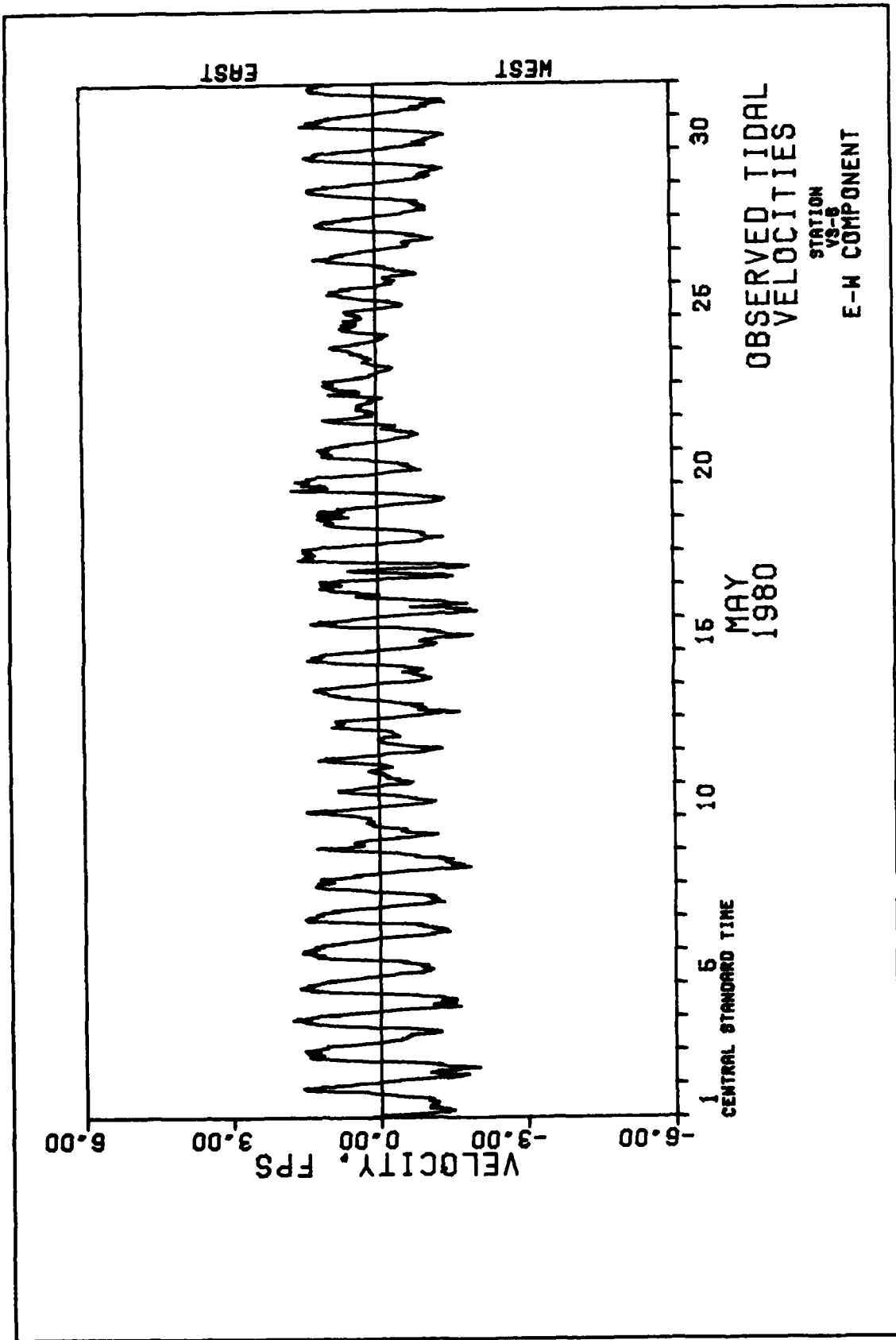


PLATE 64

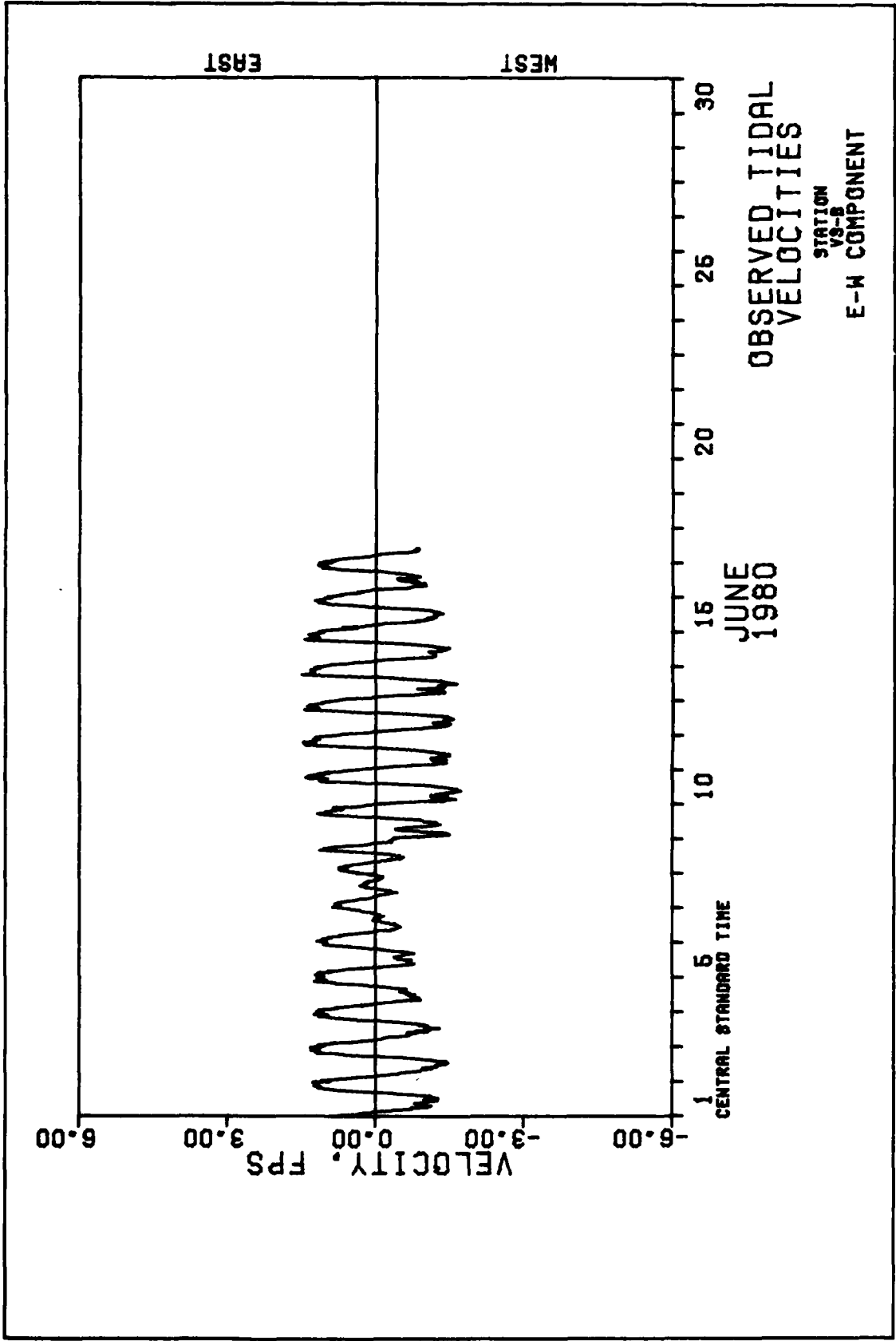


PLATE 65

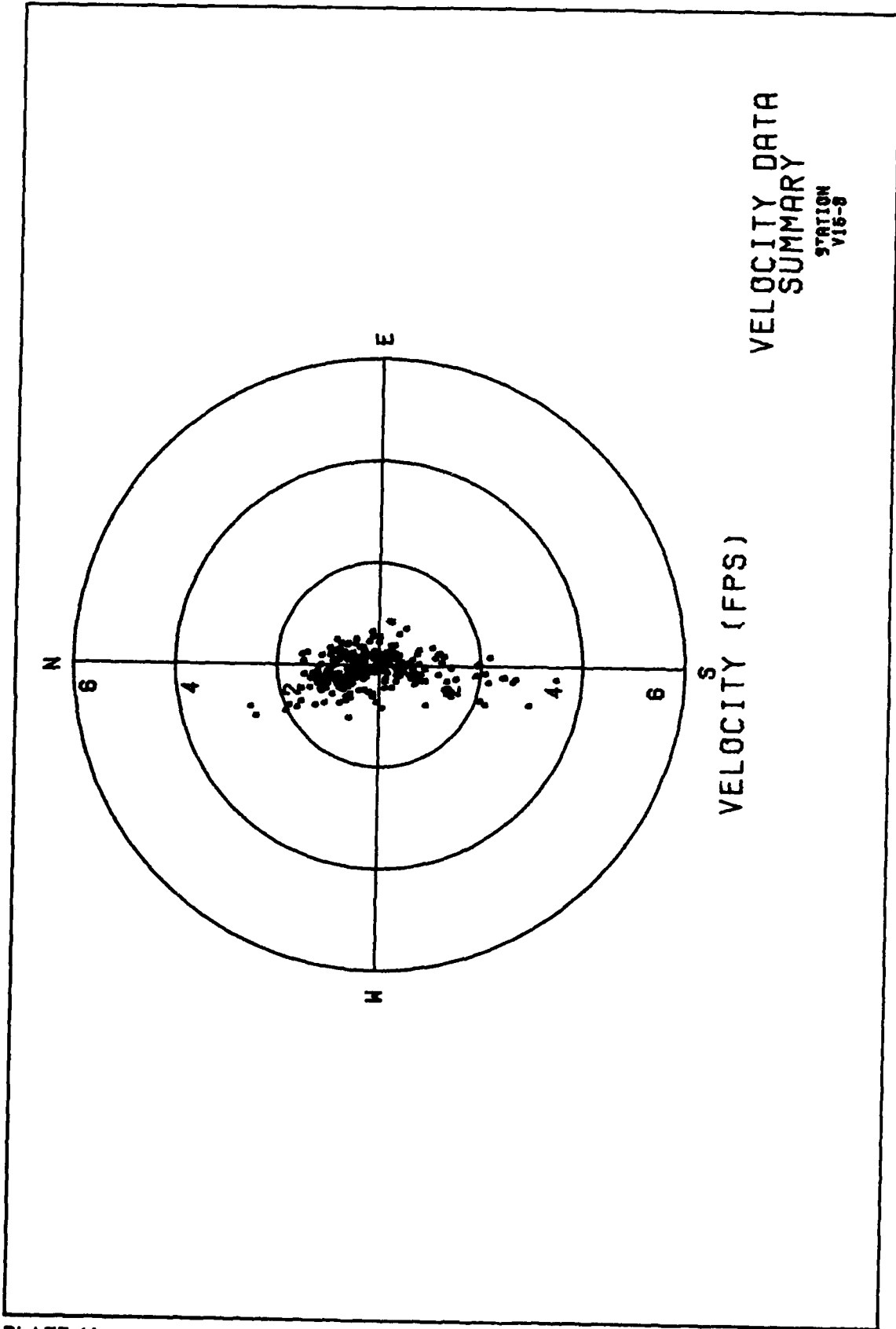
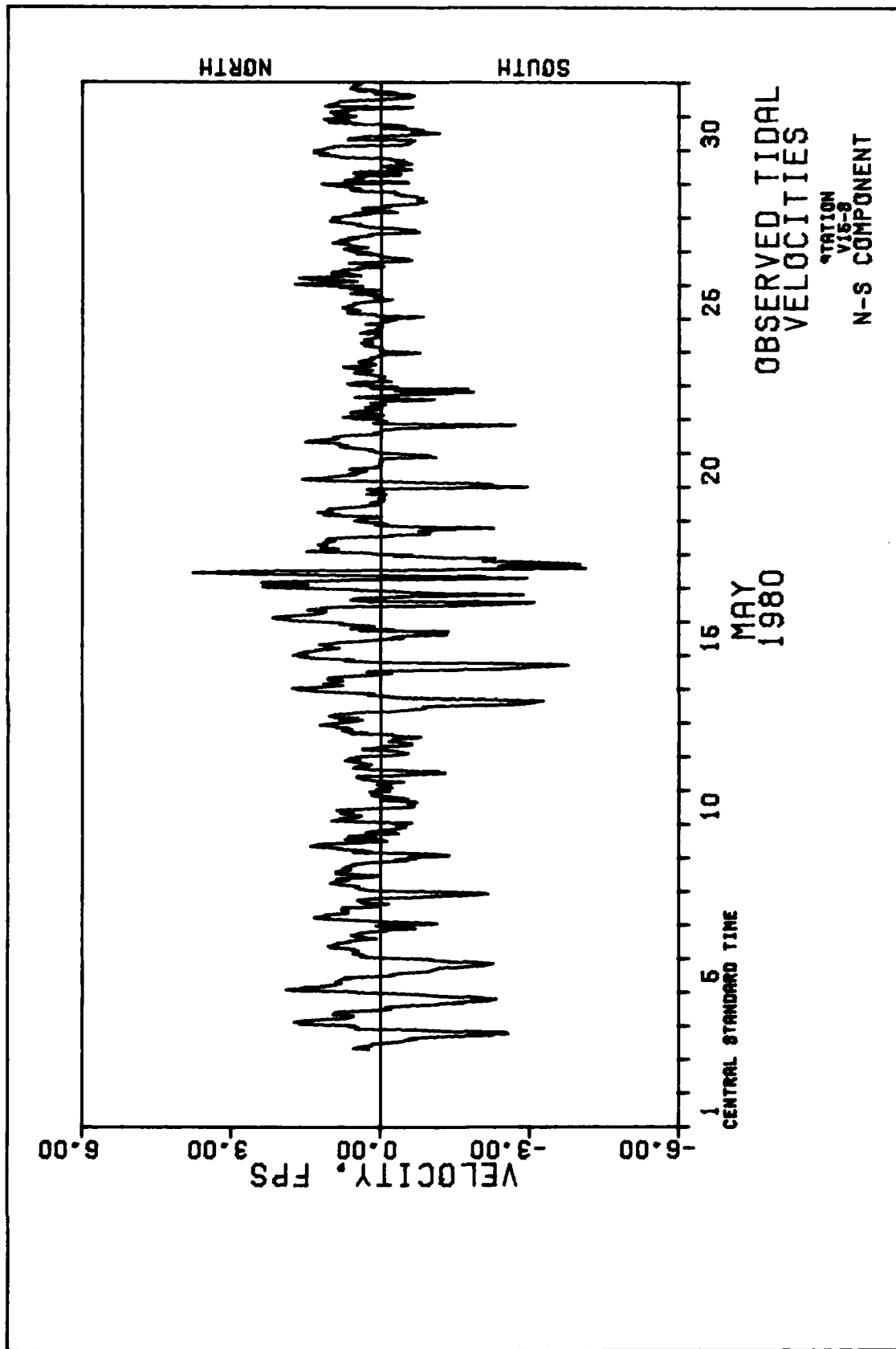


PLATE 66



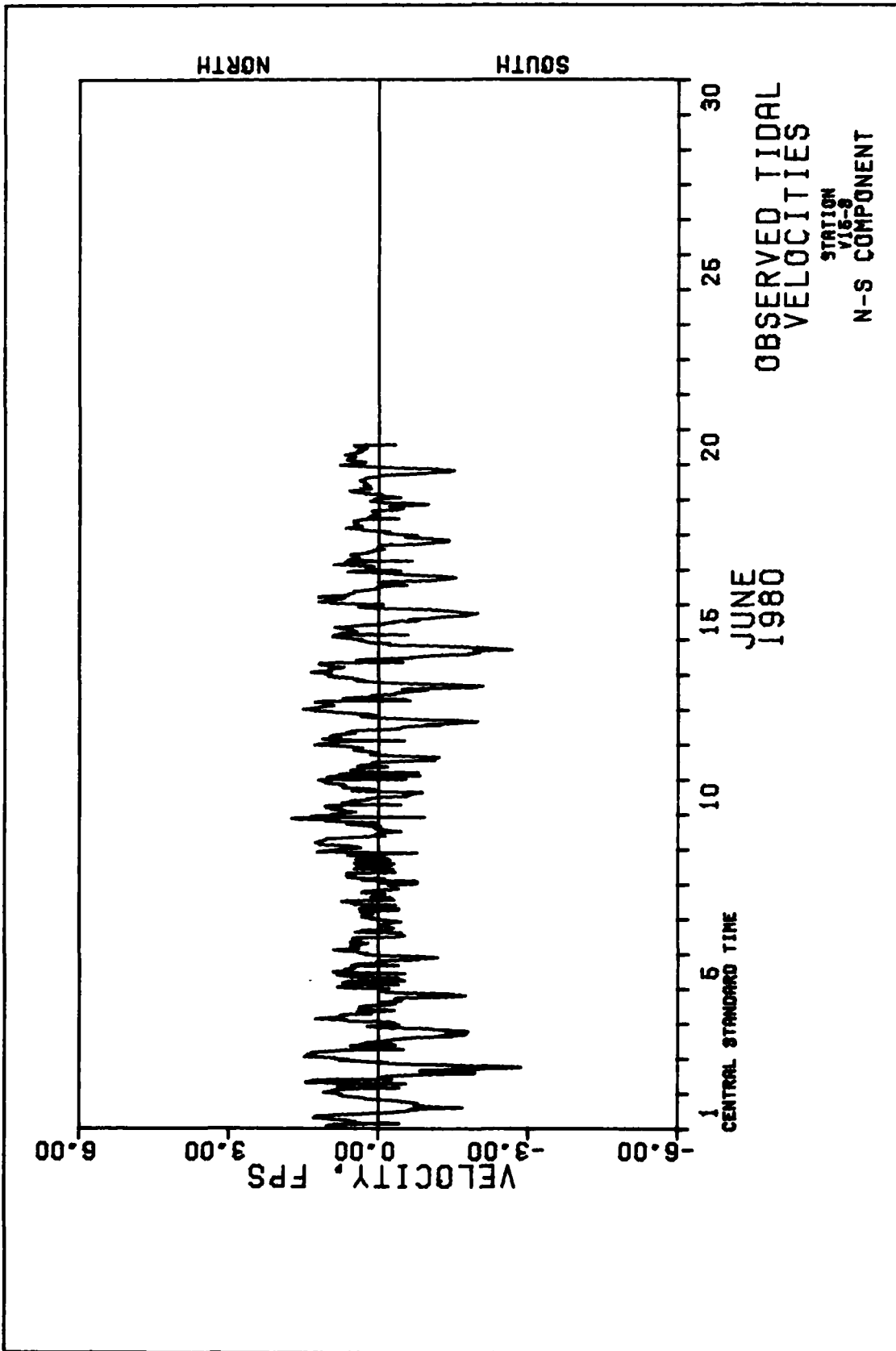
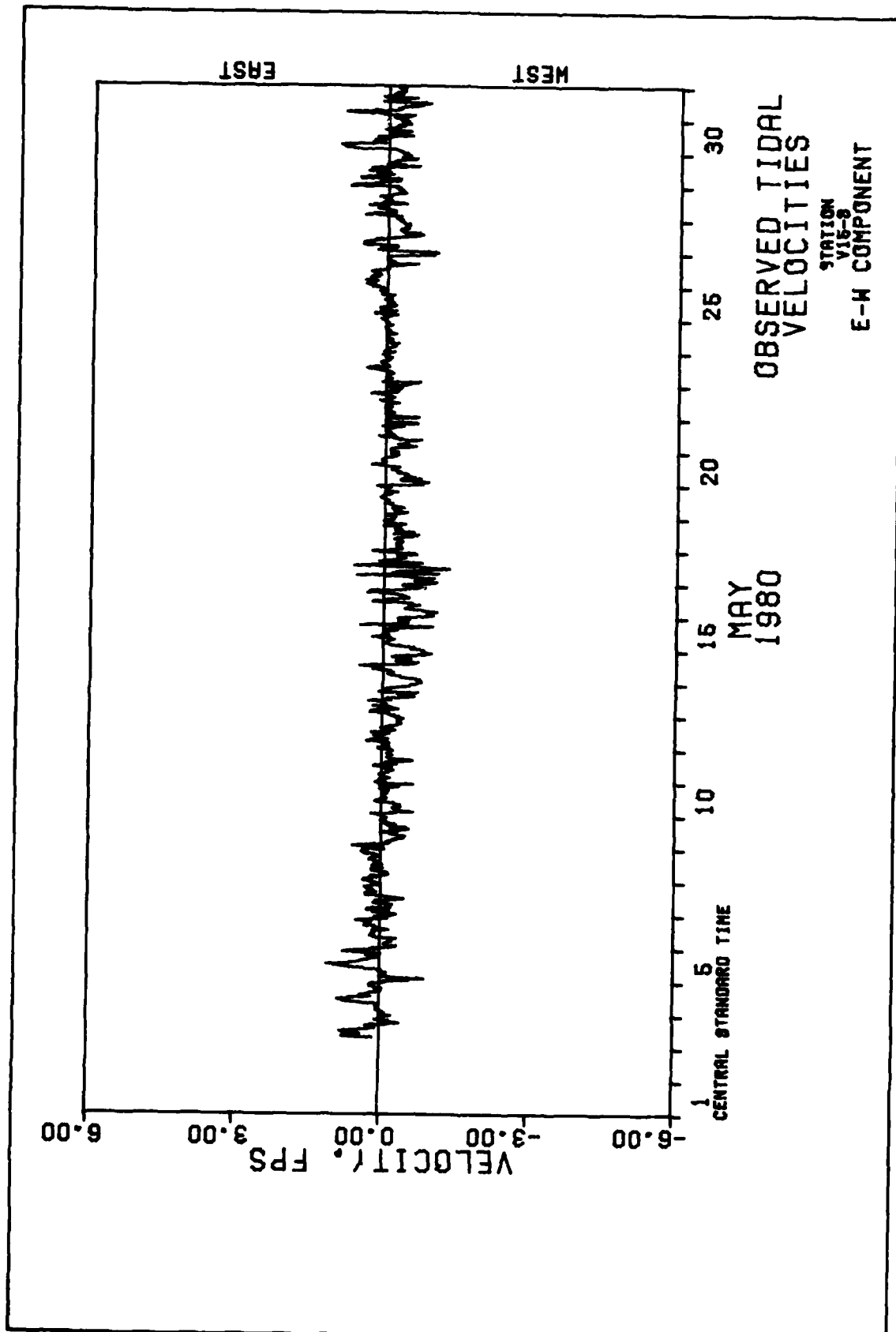


PLATE 68





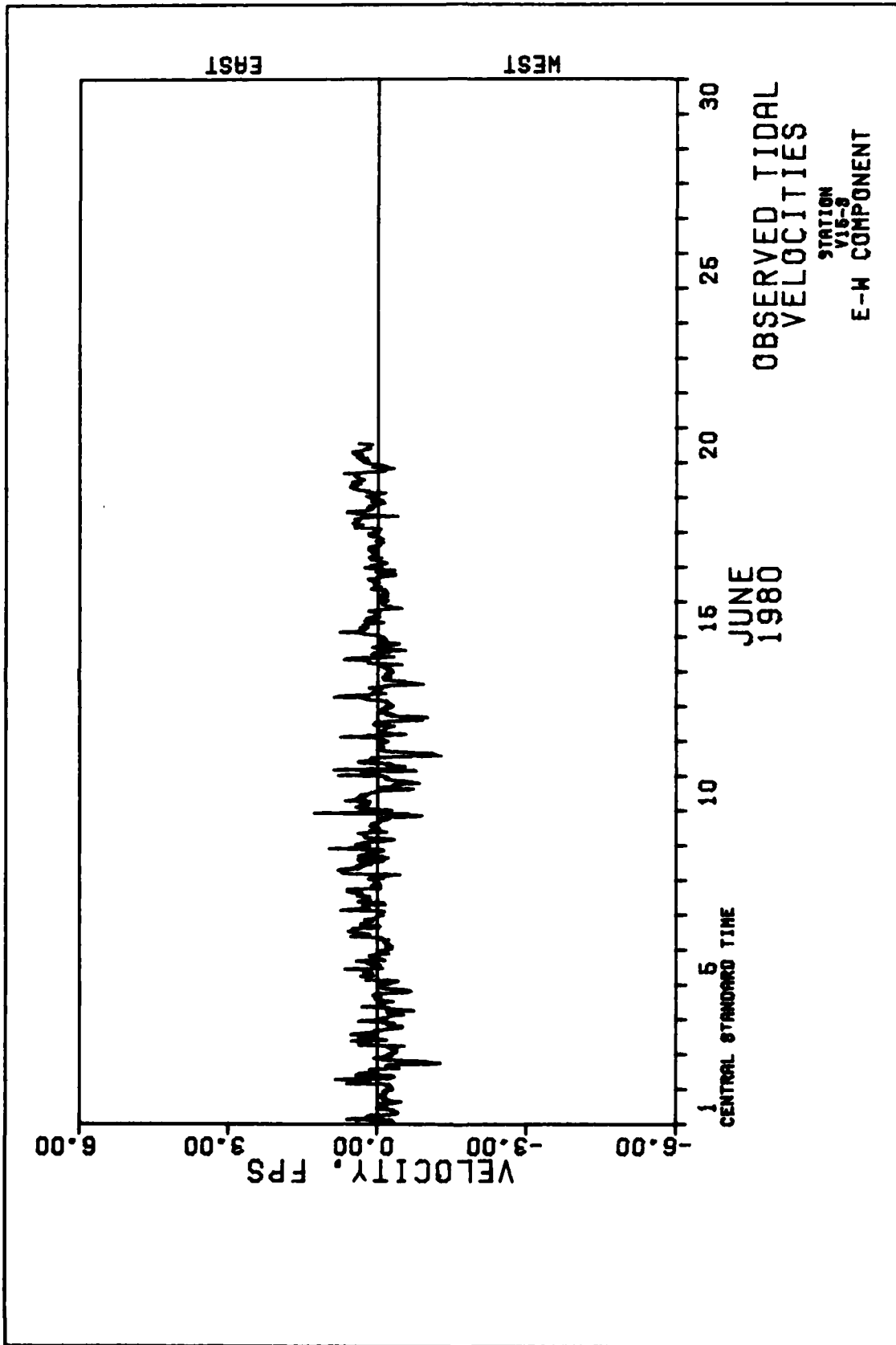
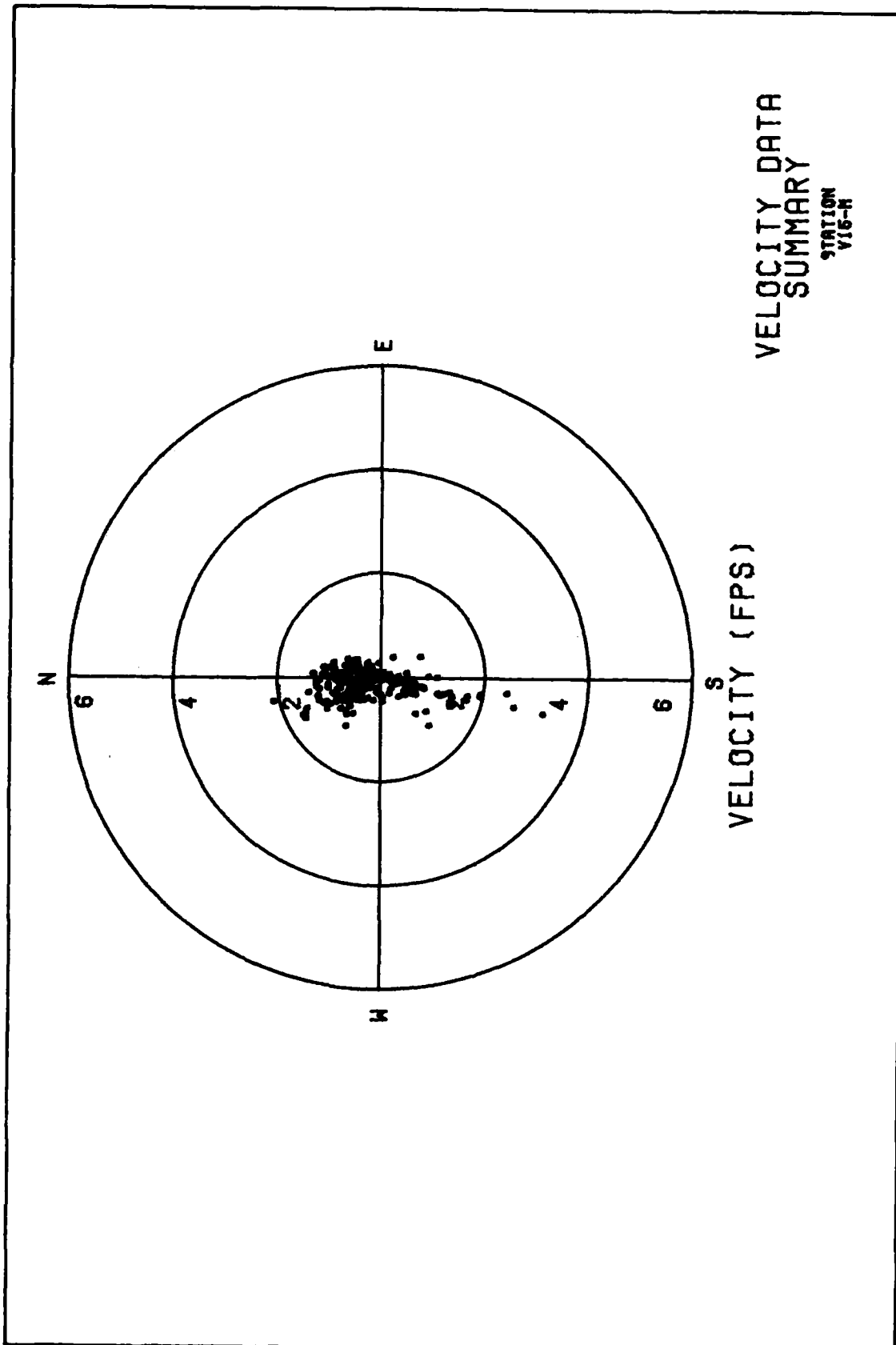


PLATE 70



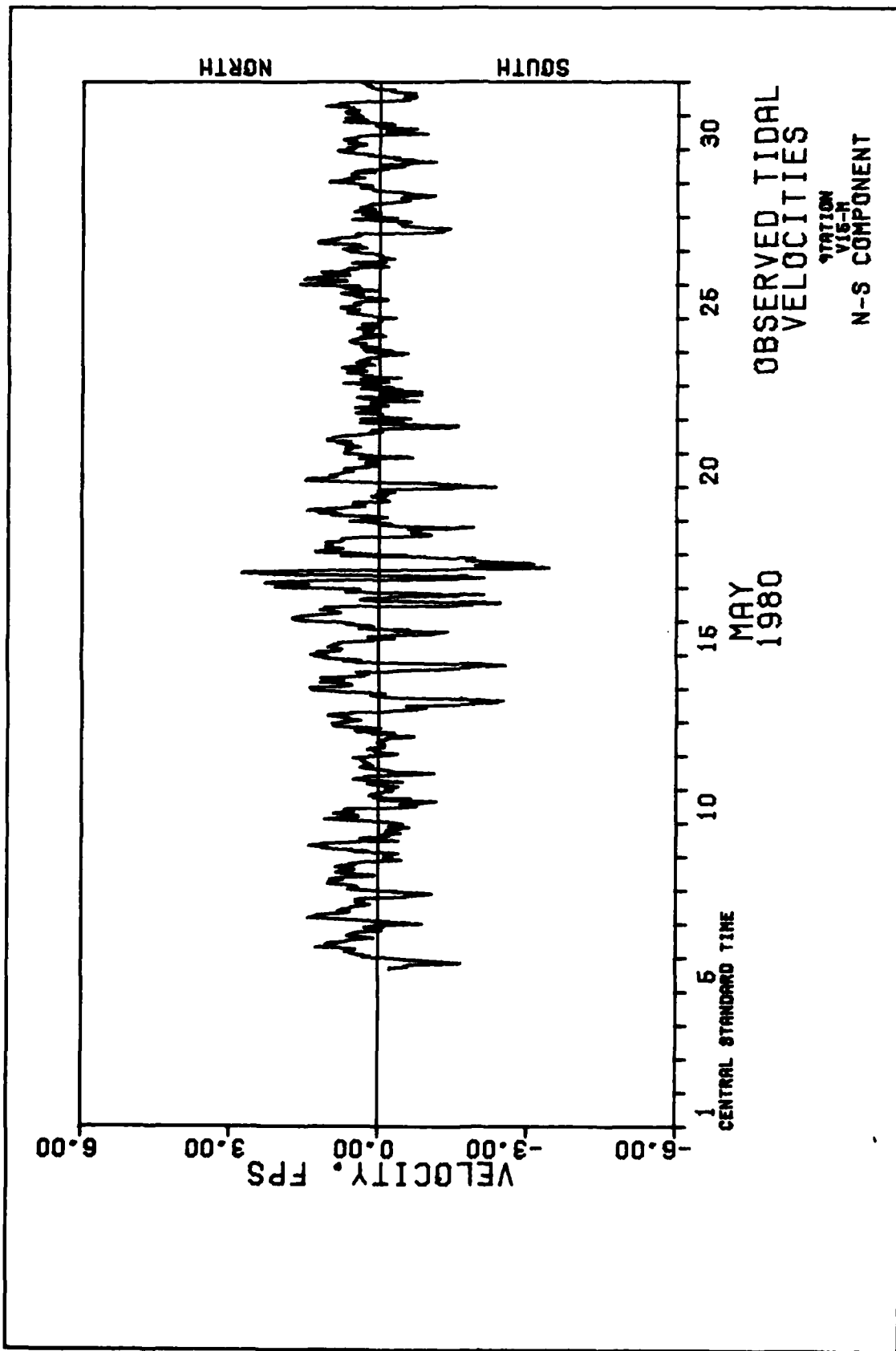


PLATE 72

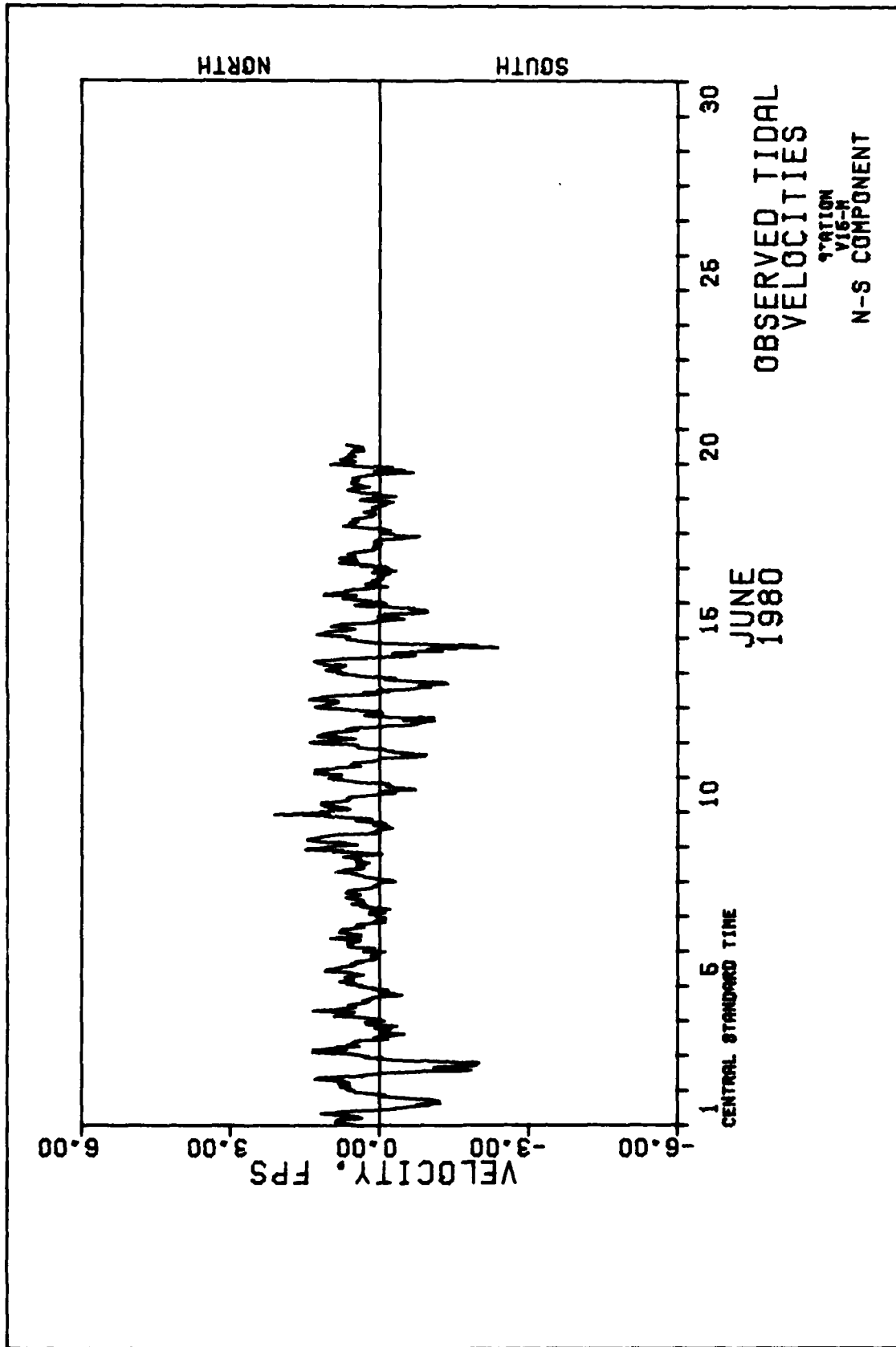


PLATE 73

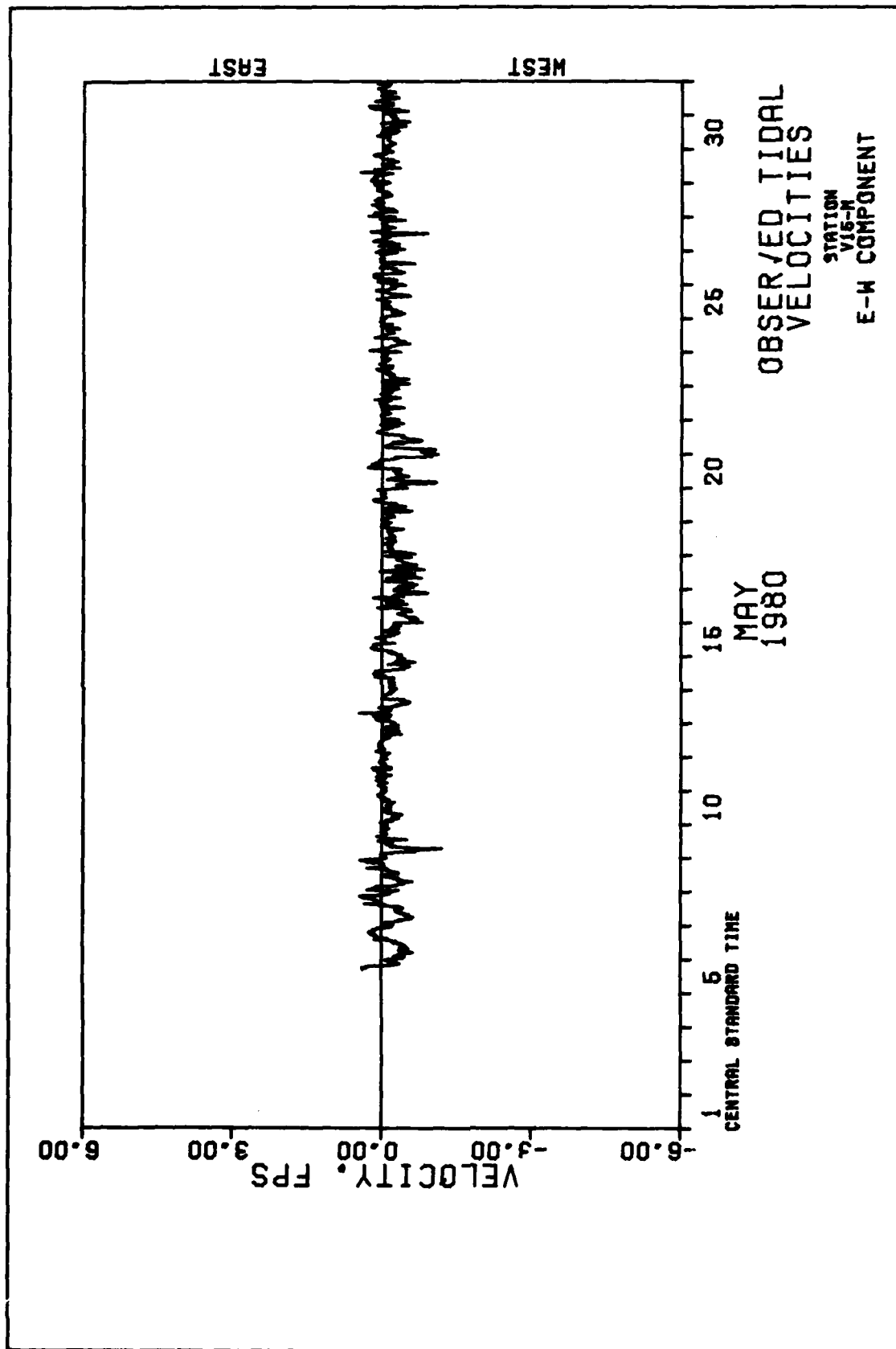
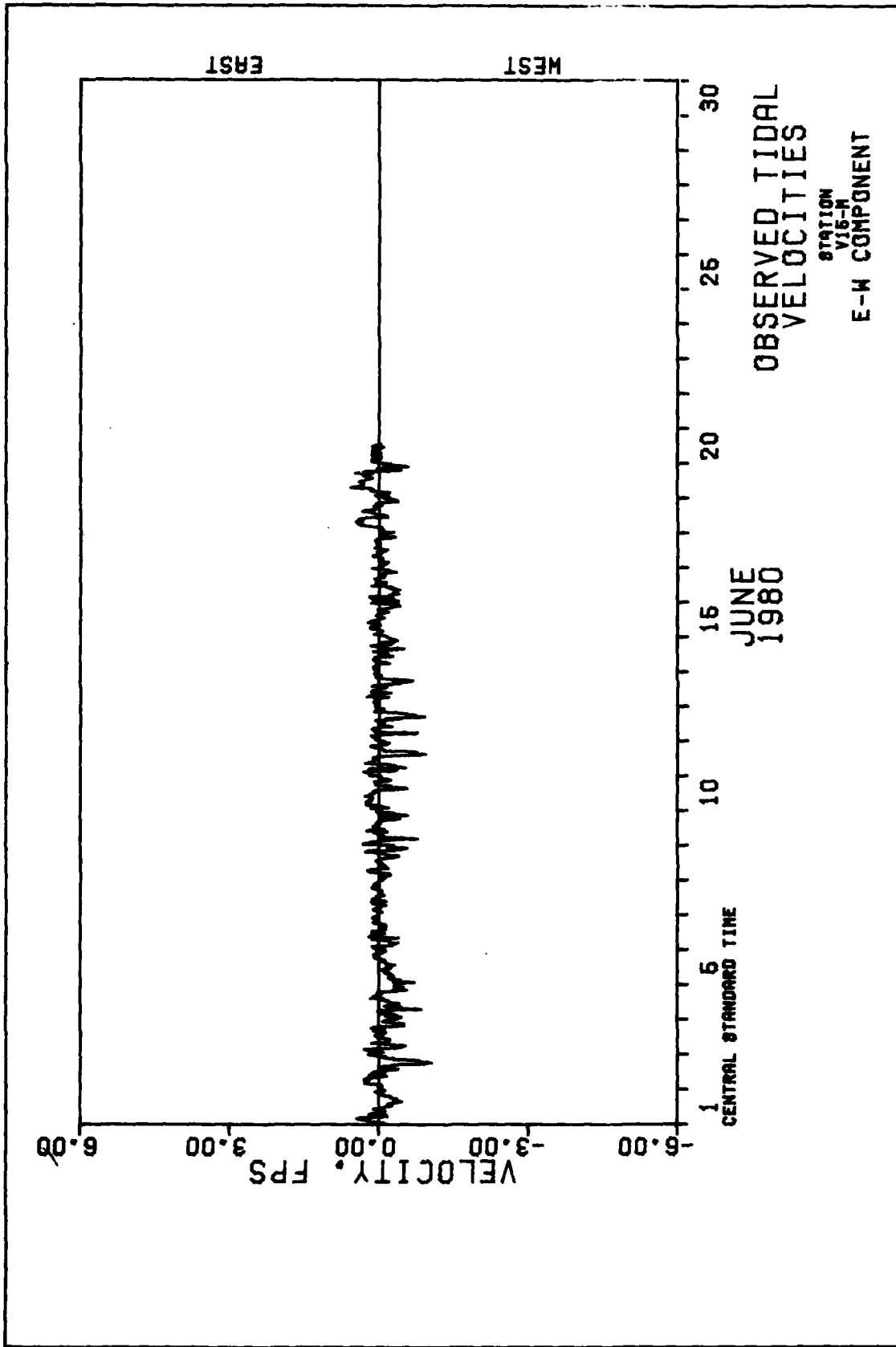


PLATE 74



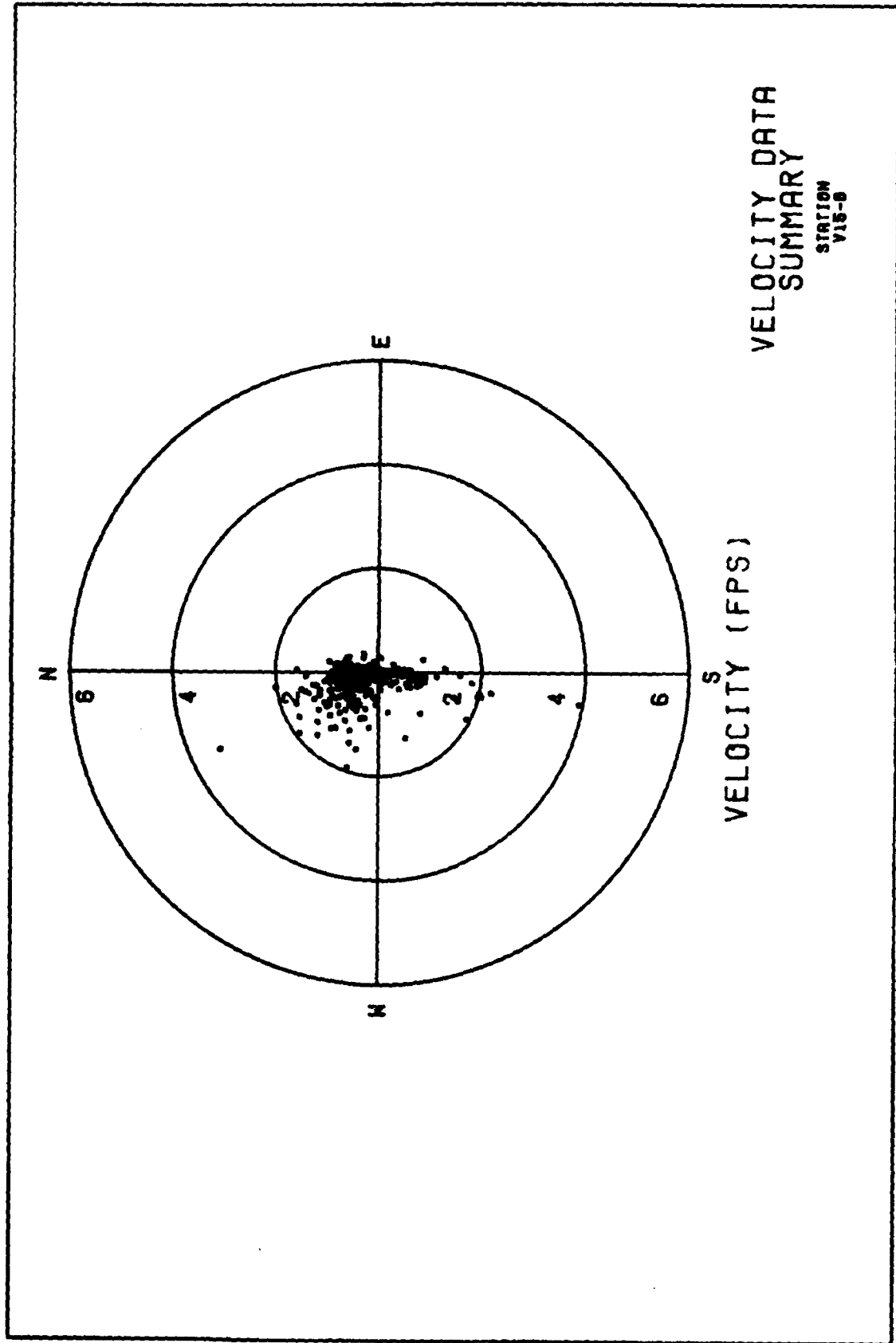
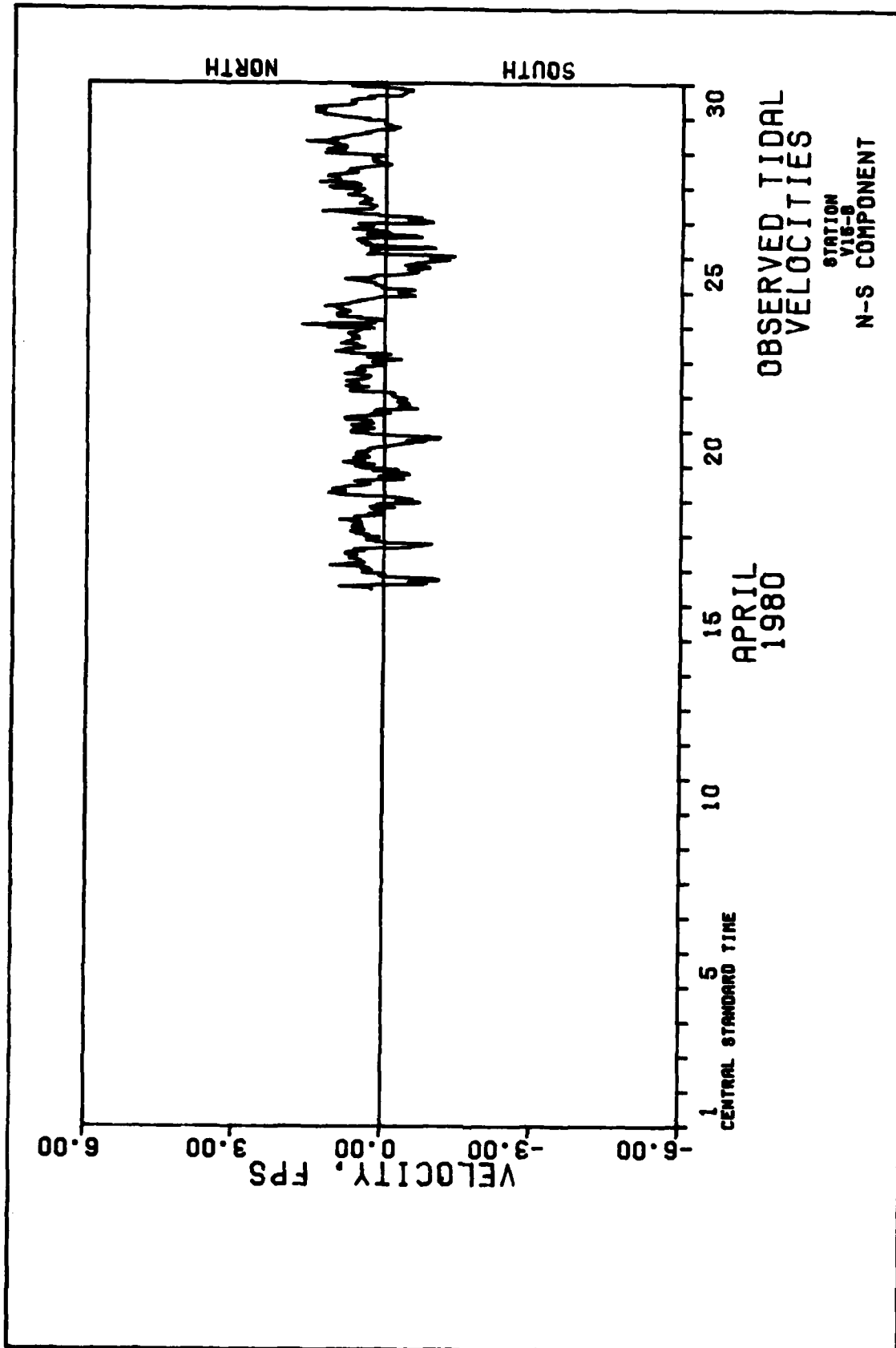


PLATE 76





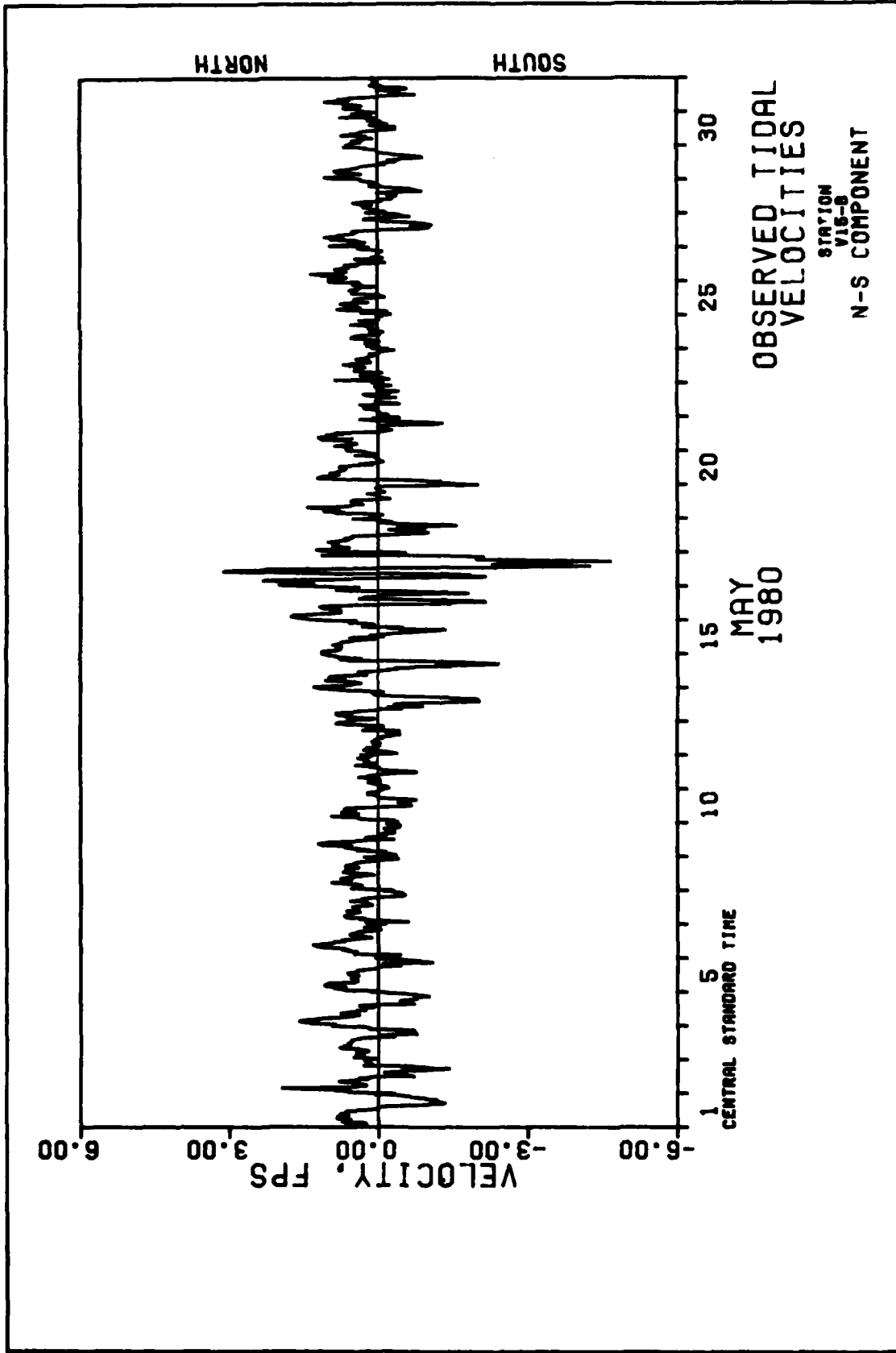


PLATE 78

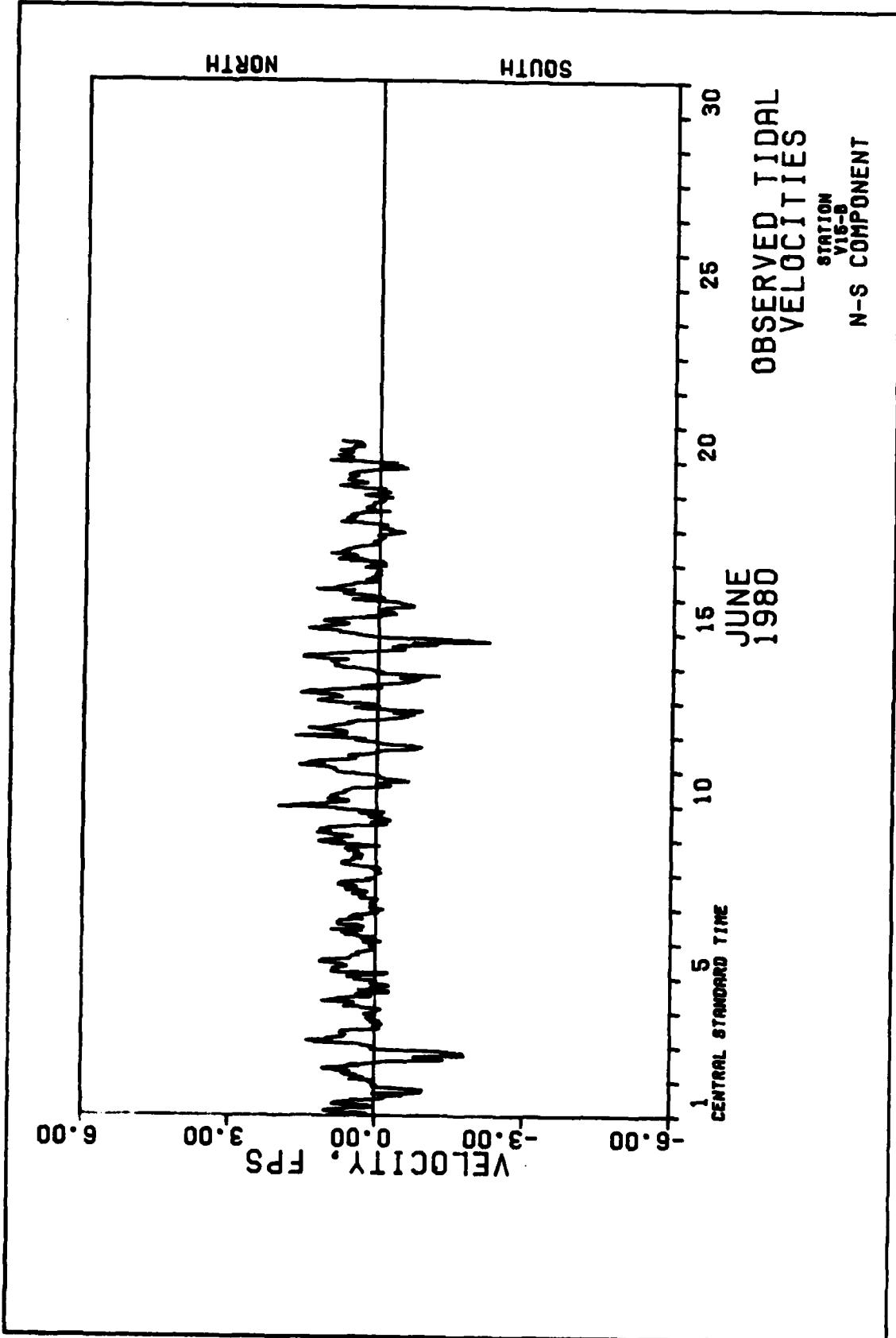
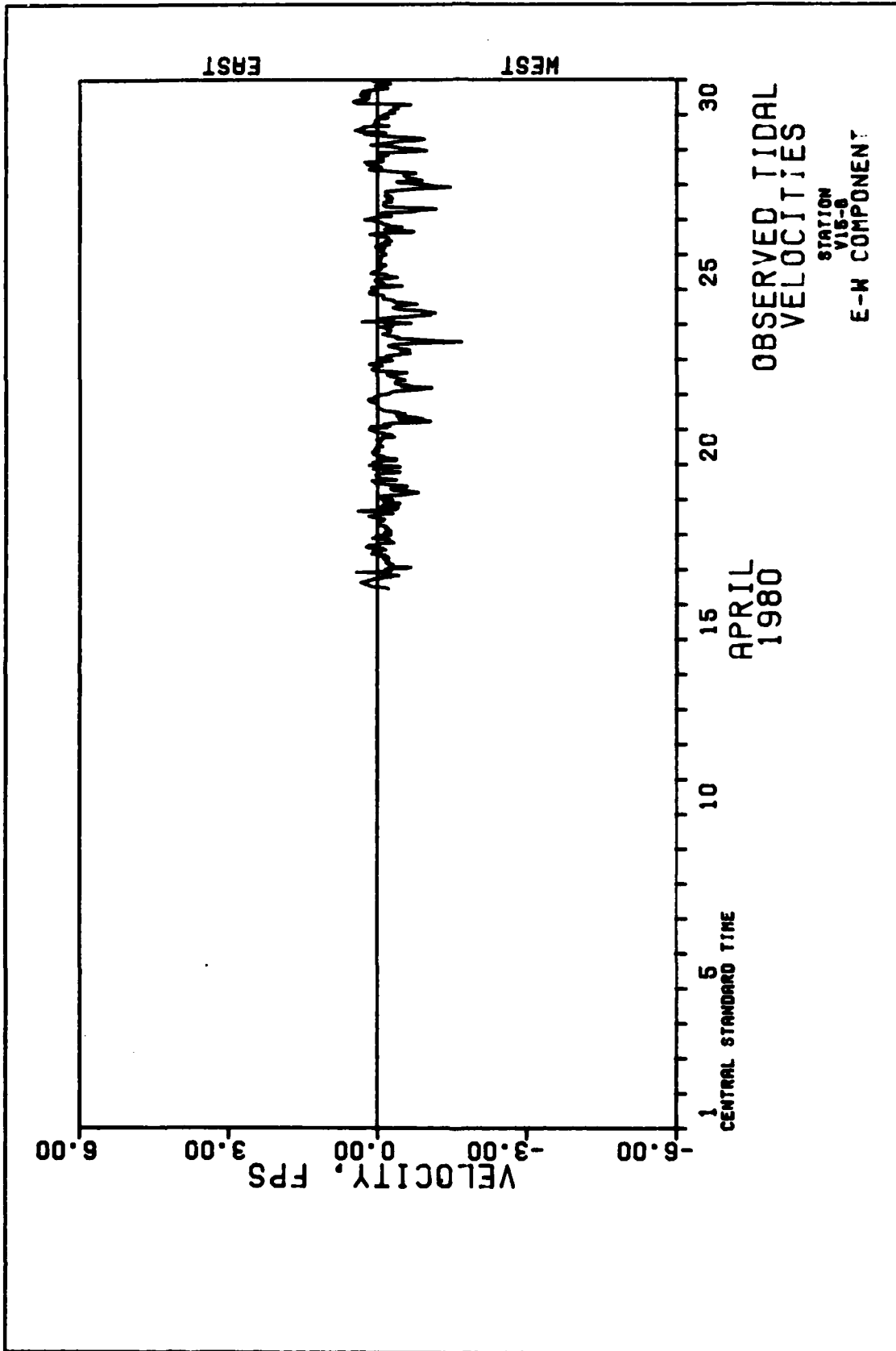
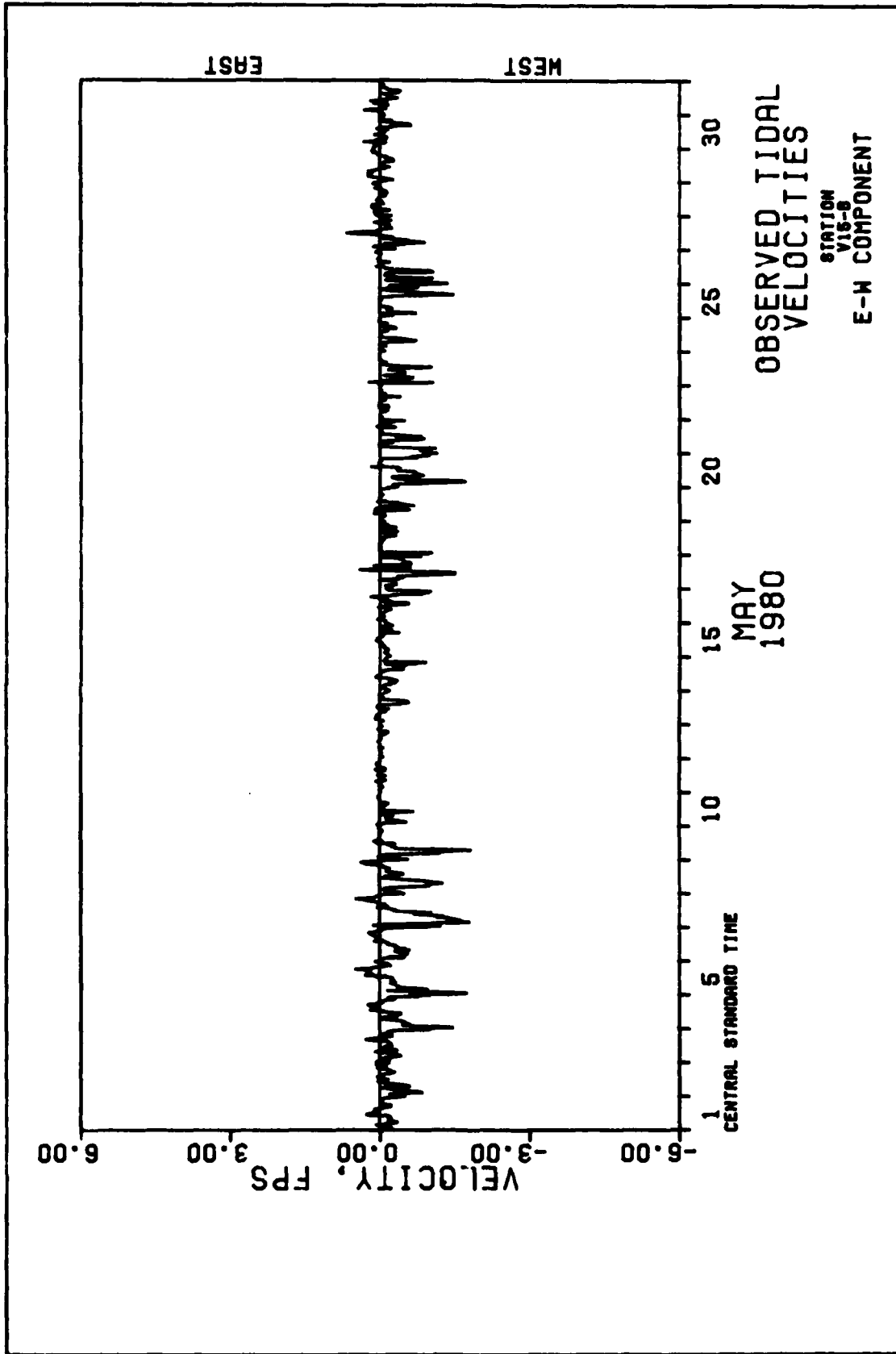


PLATE 79





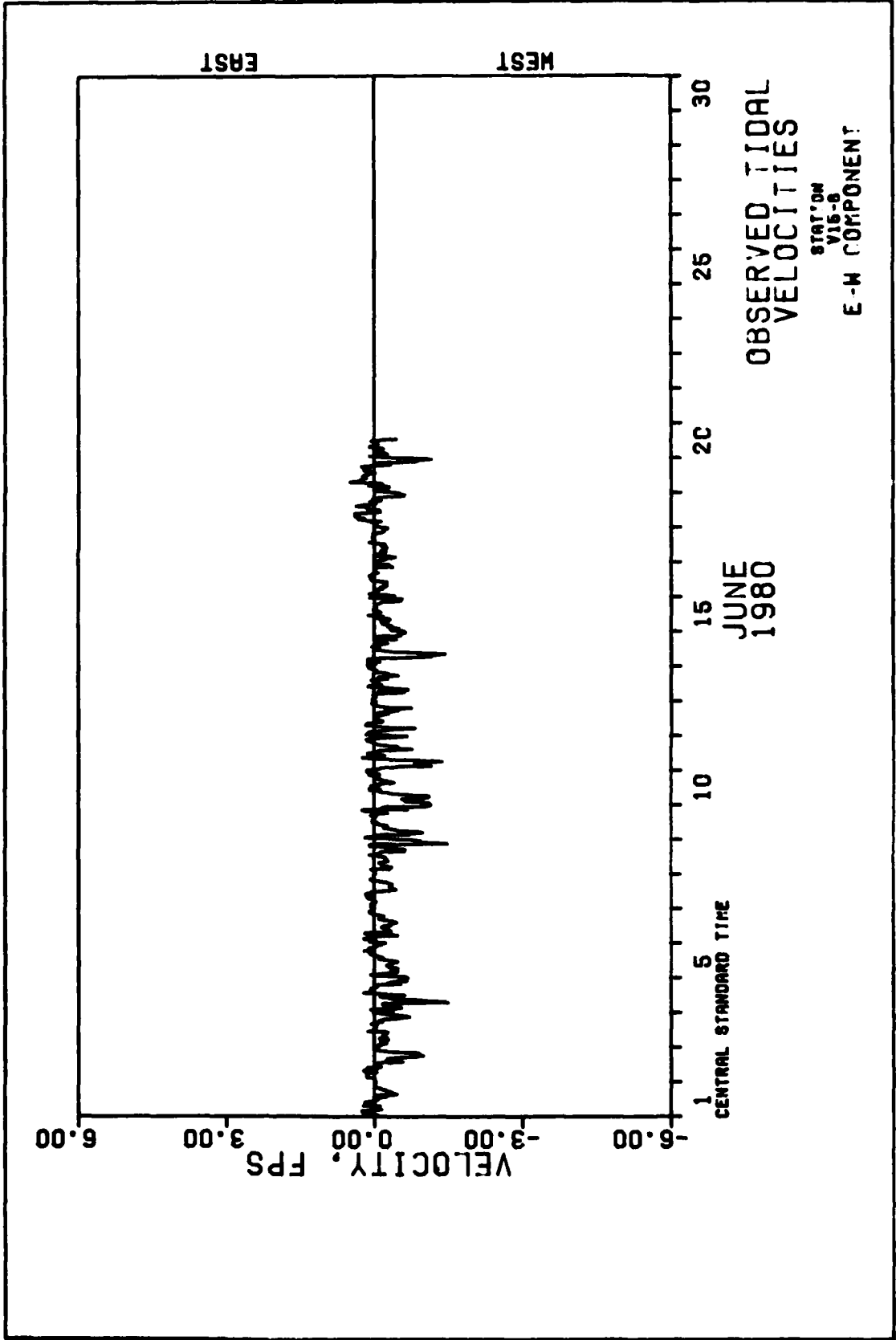
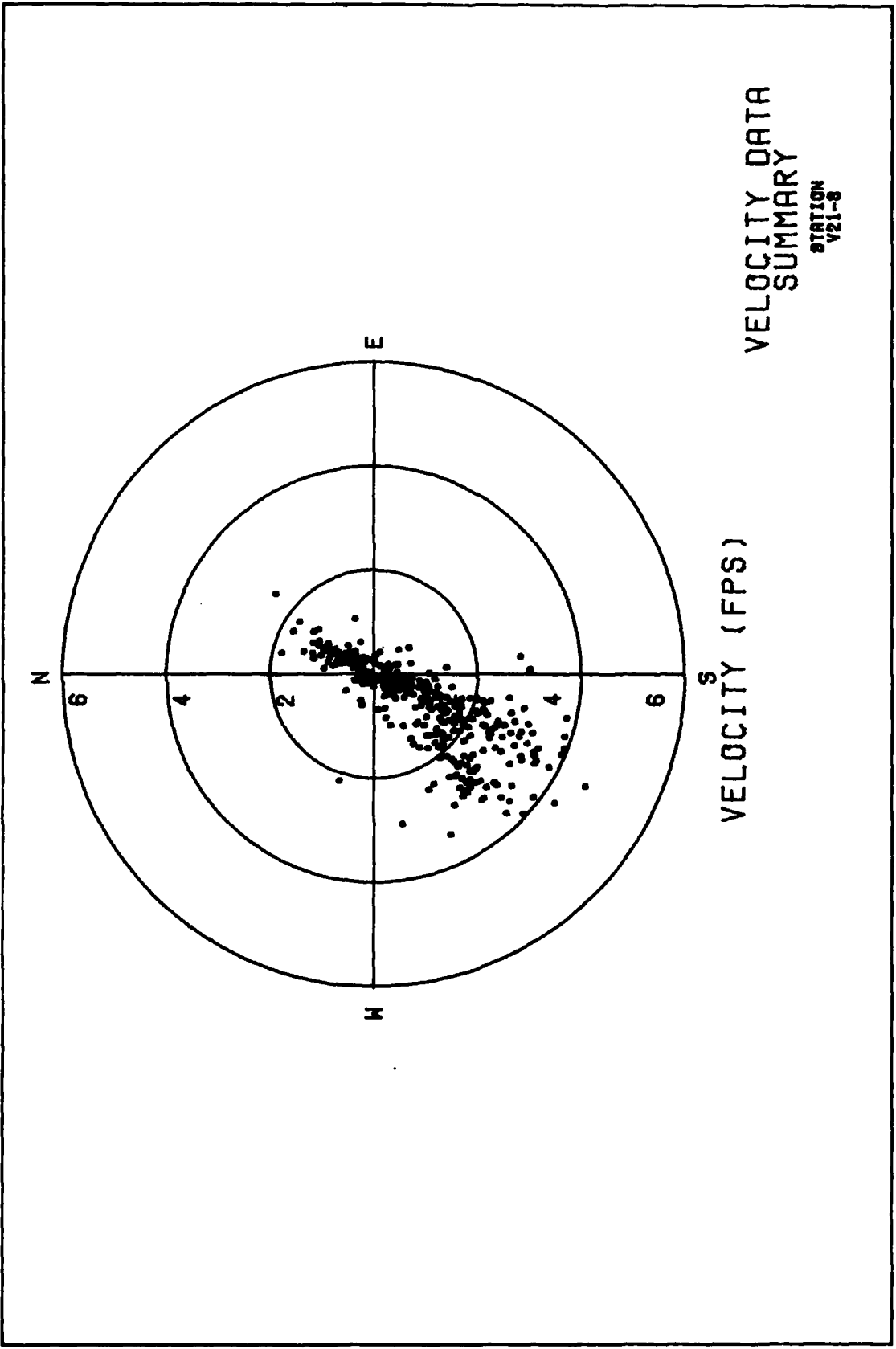


PLATE 82



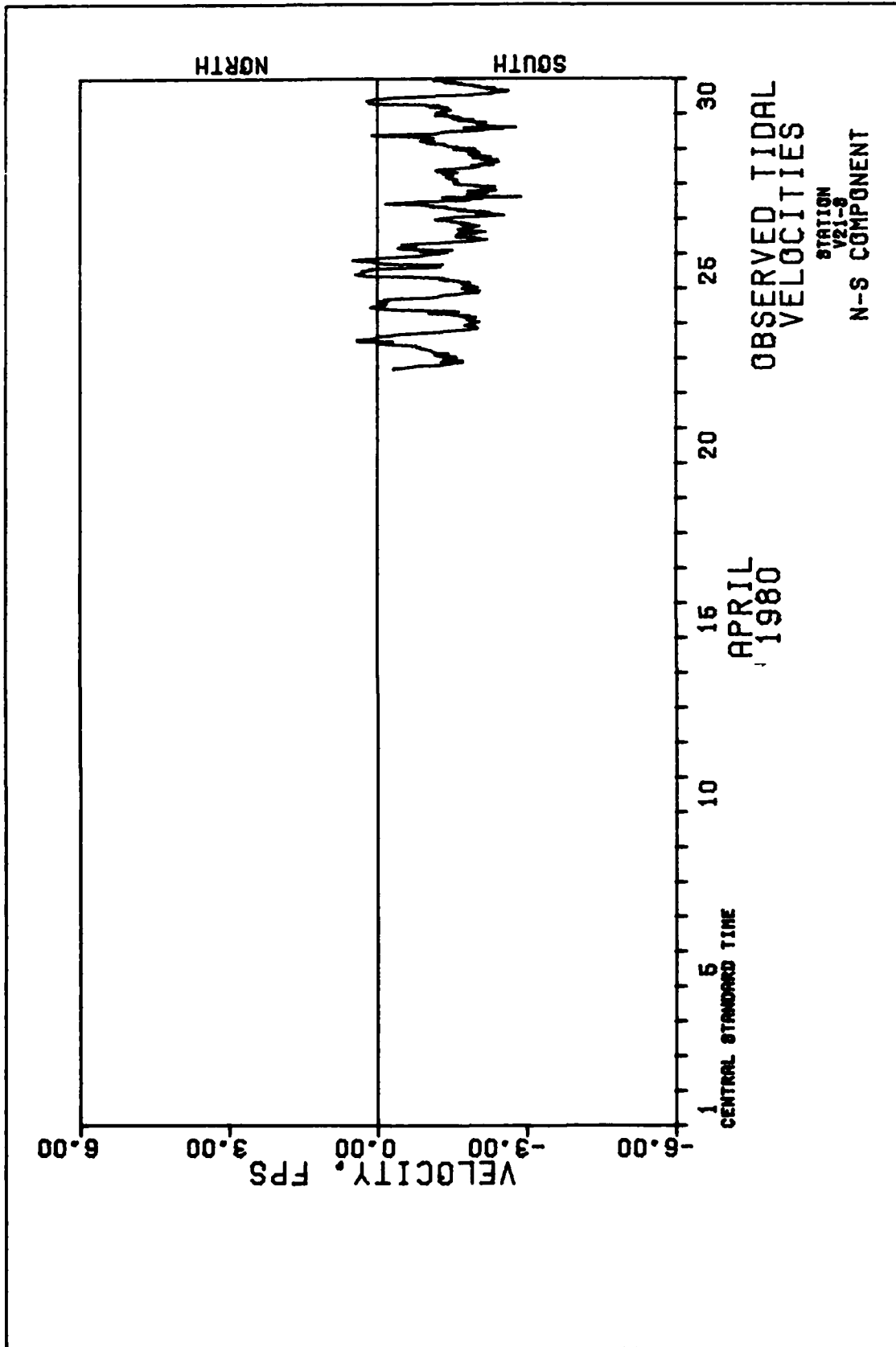


PLATE 84



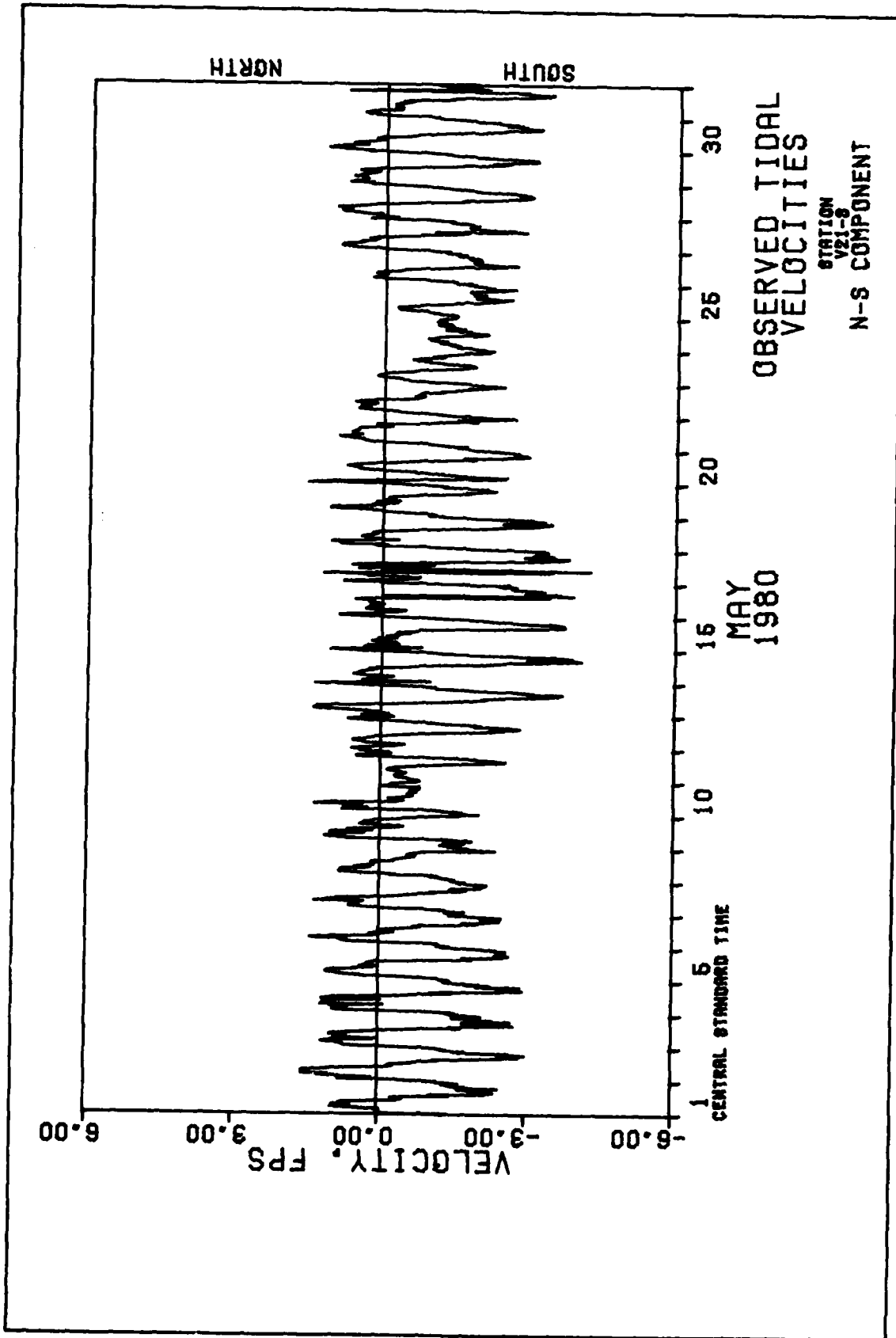


PLATE 85

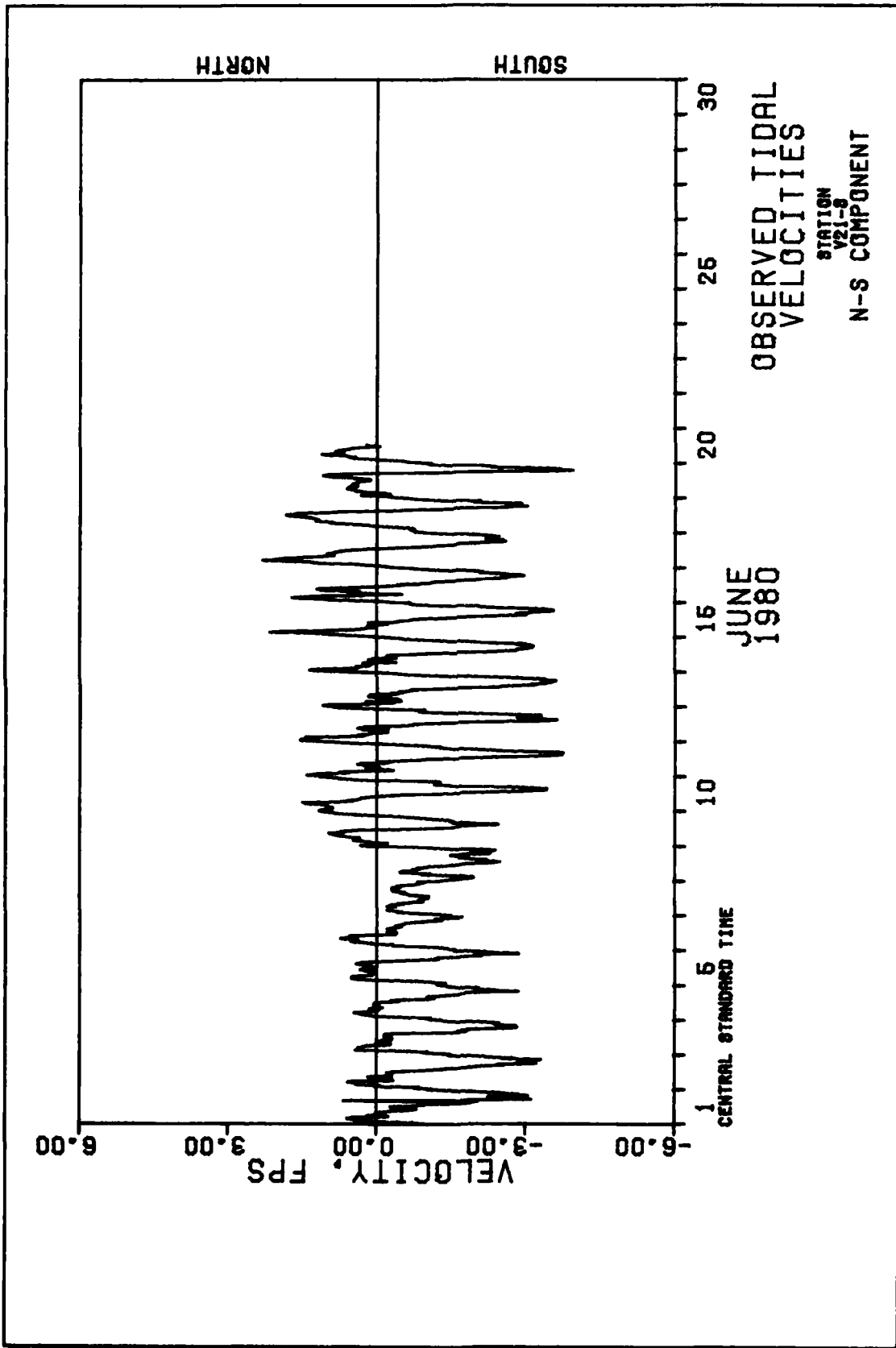


PLATE 86

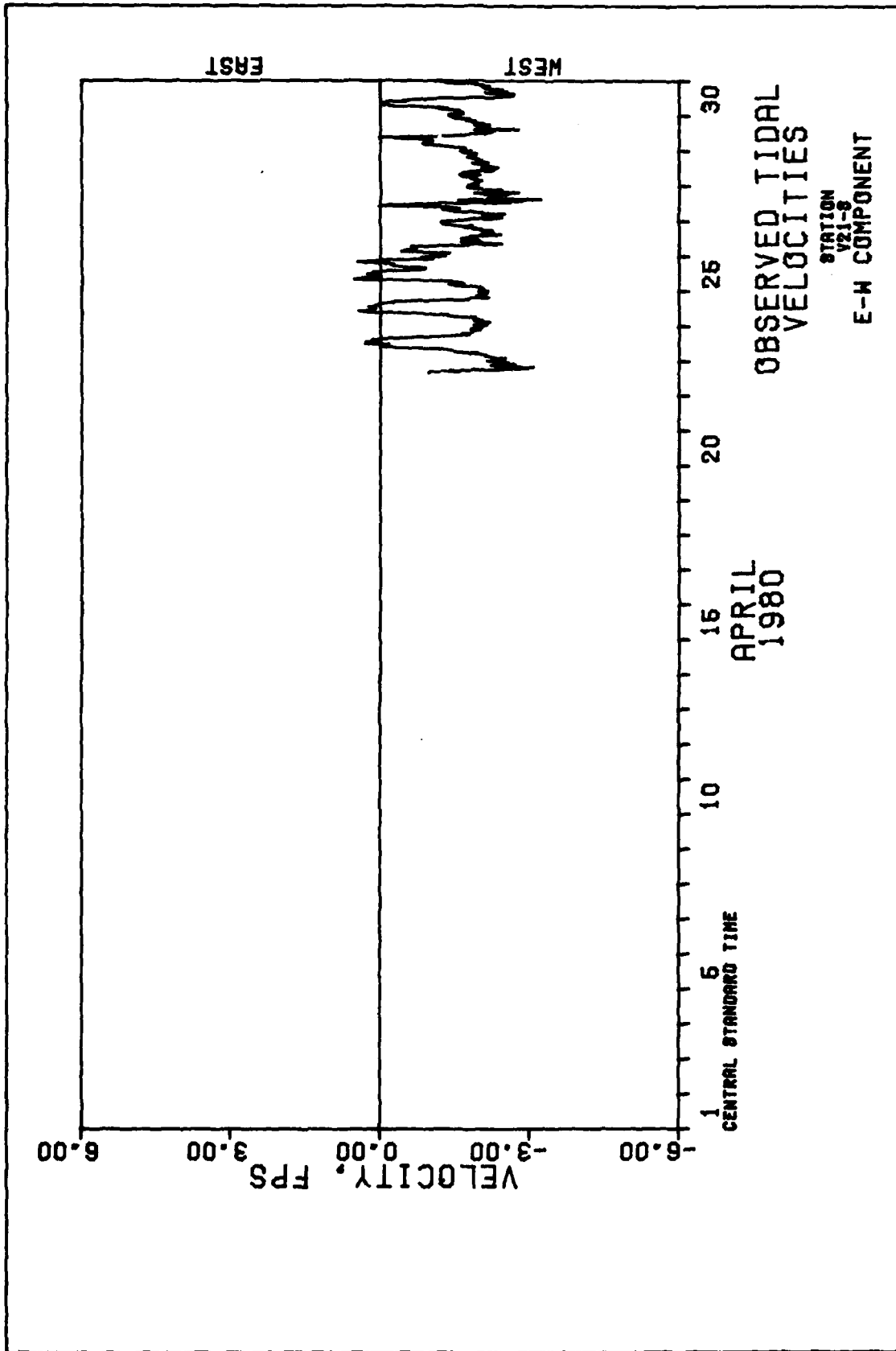
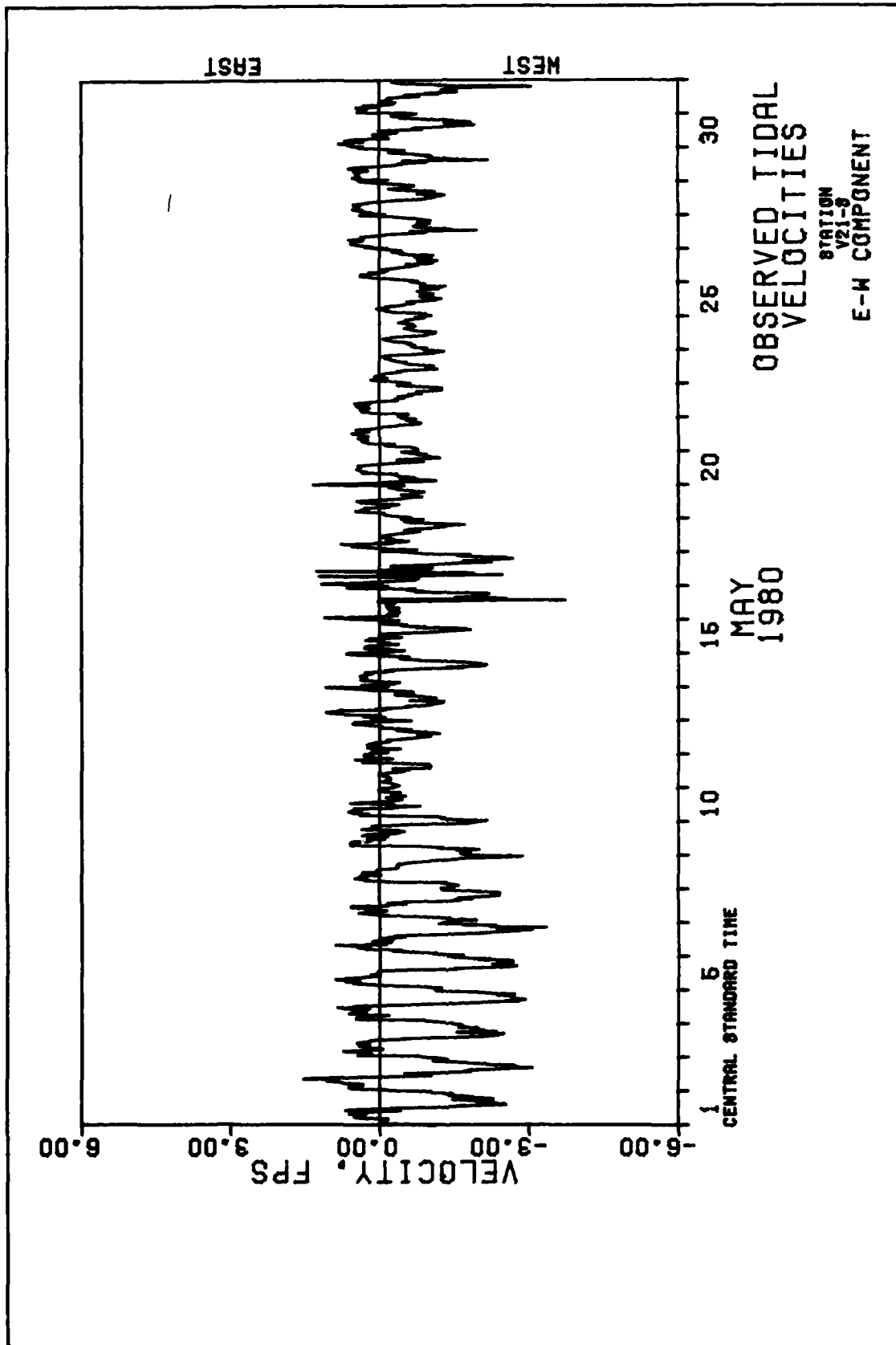
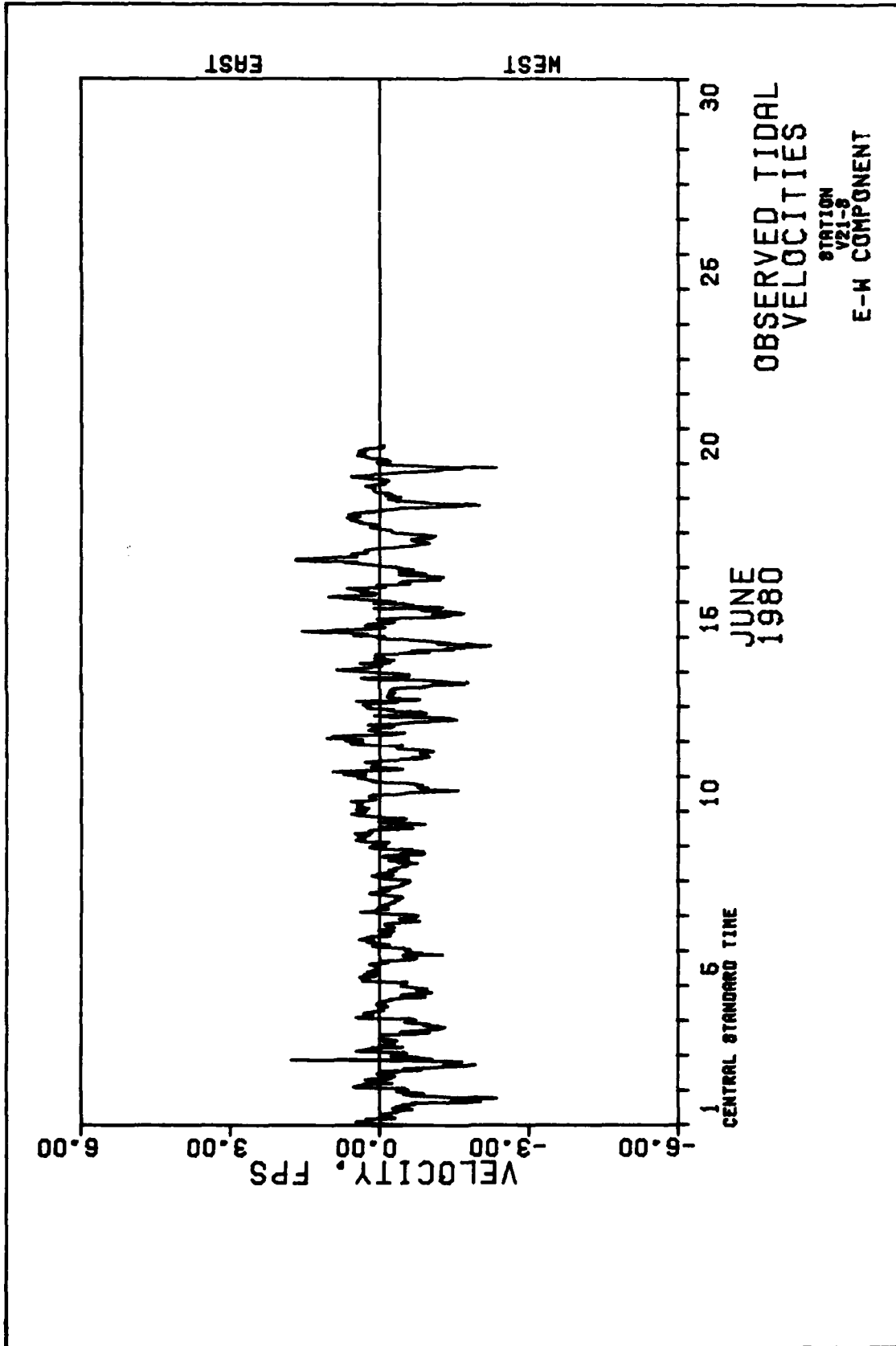


PLATE 87





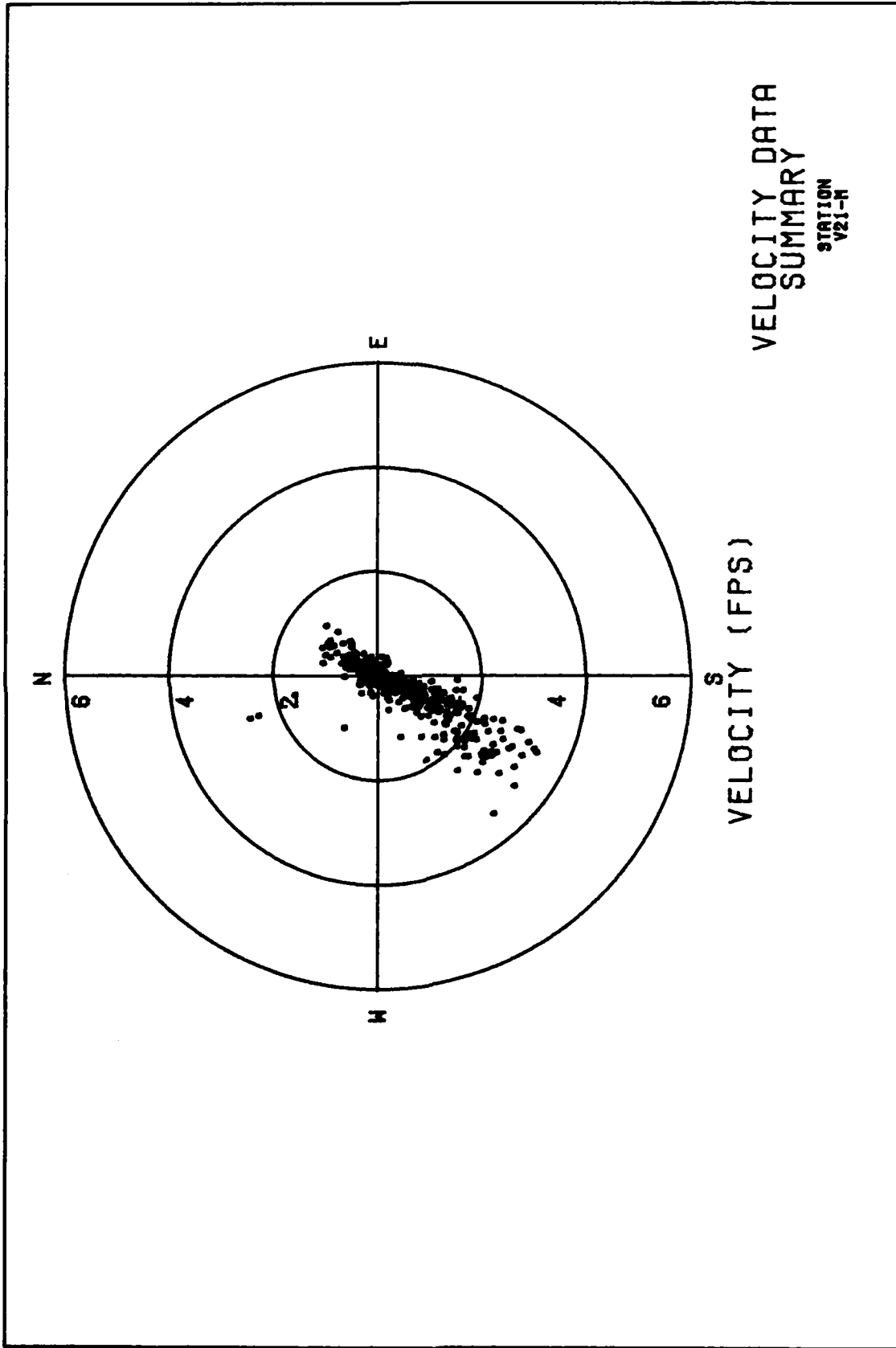


PLATE 90

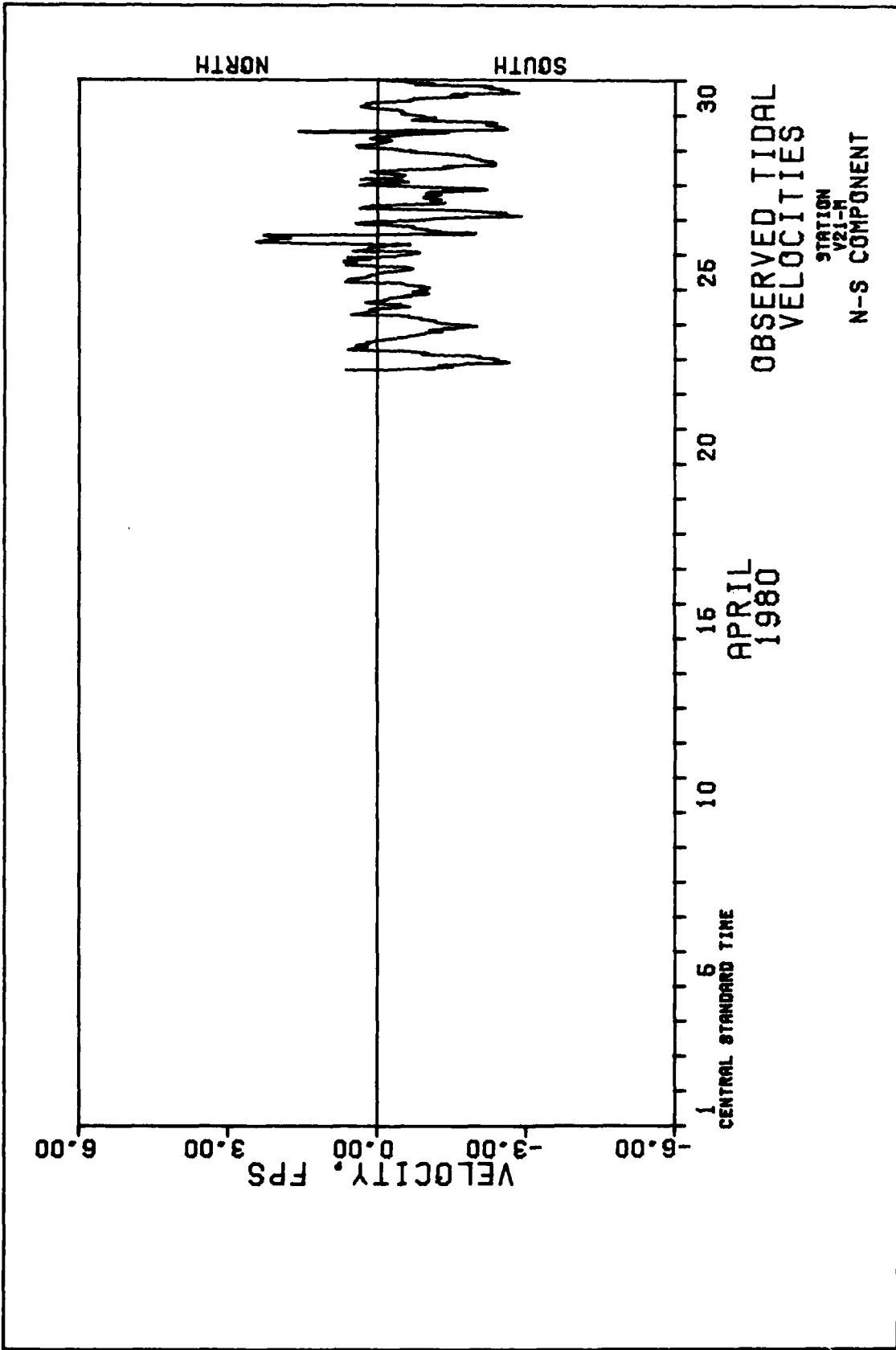


PLATE 91

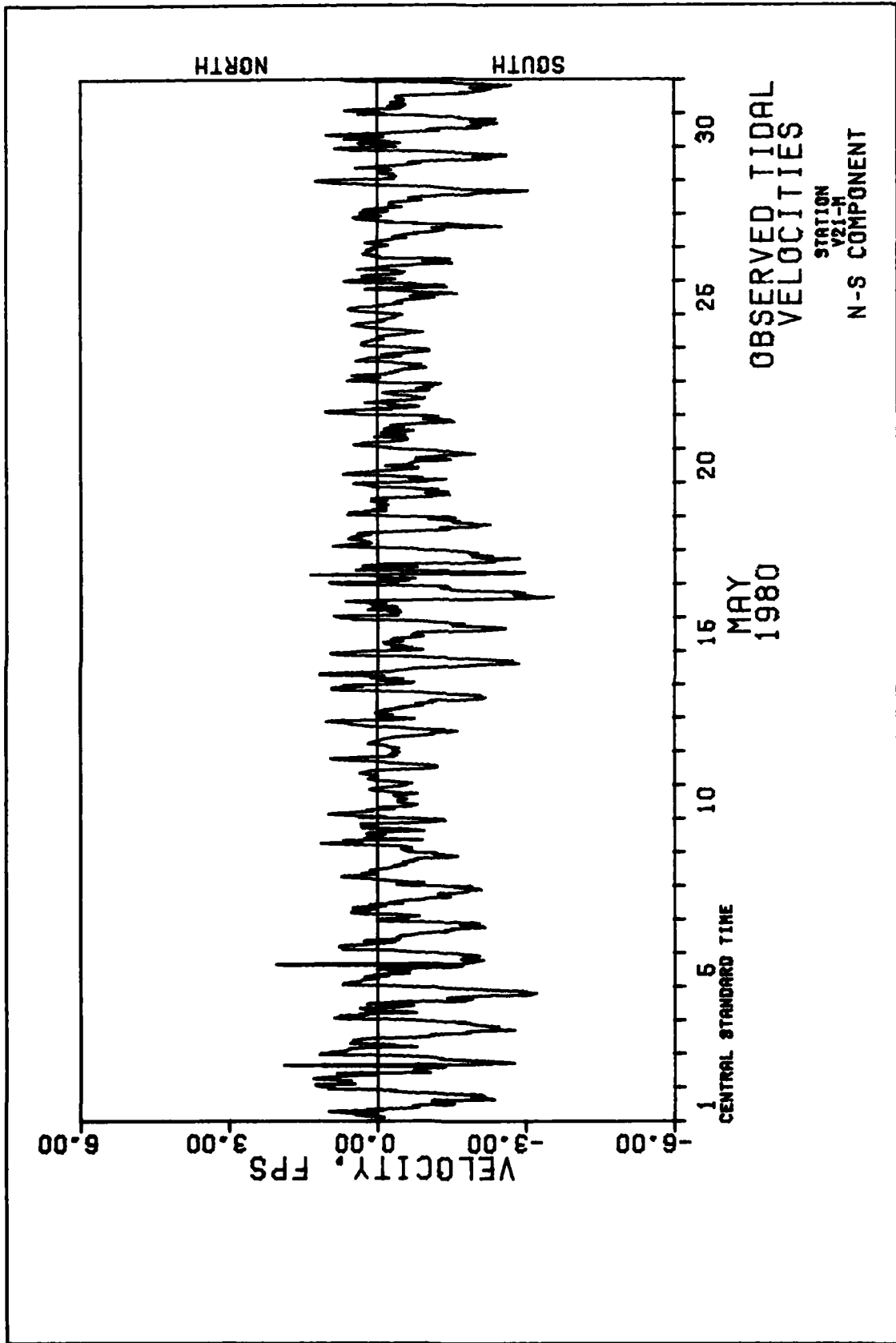


PLATE 92



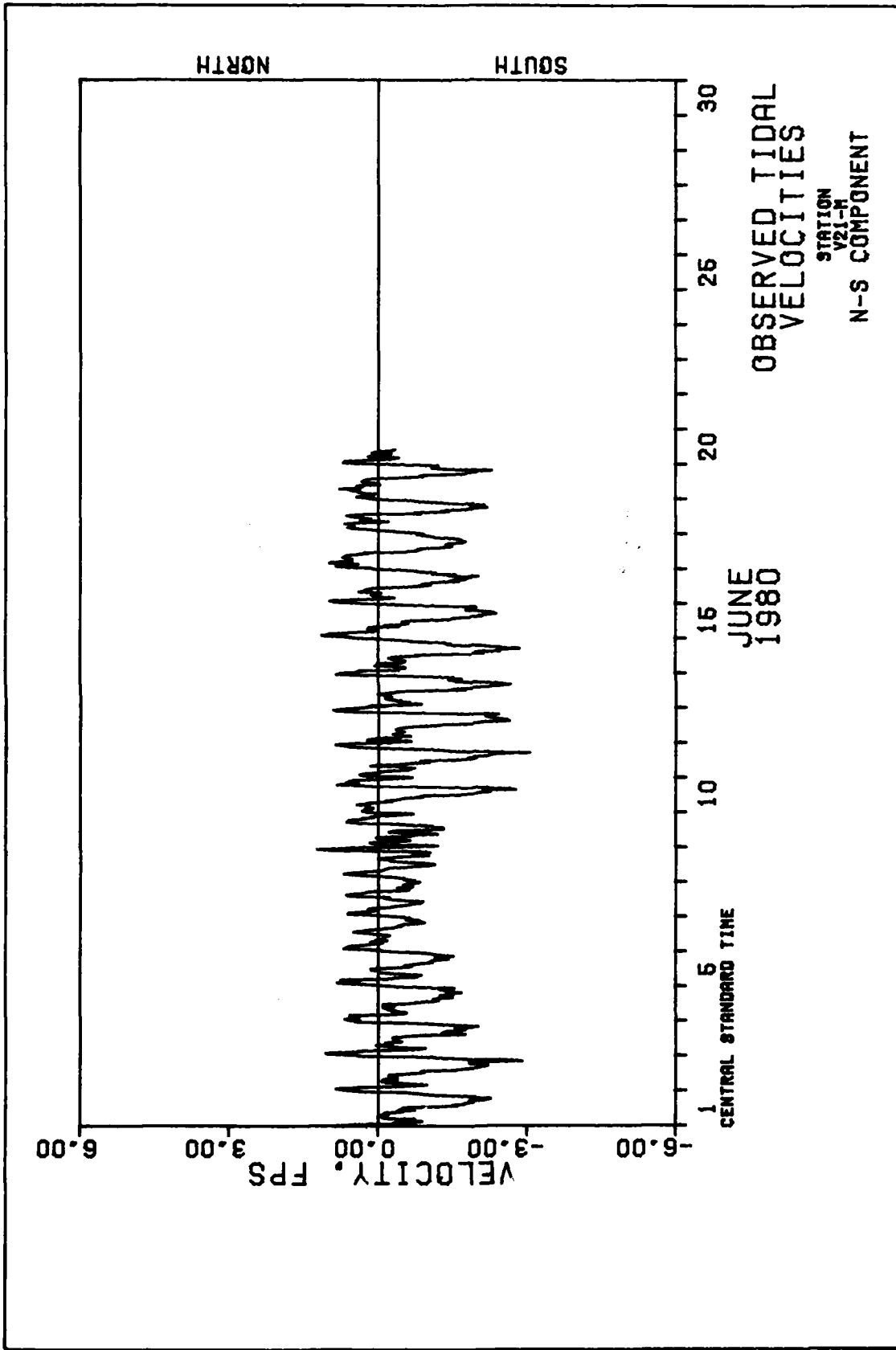
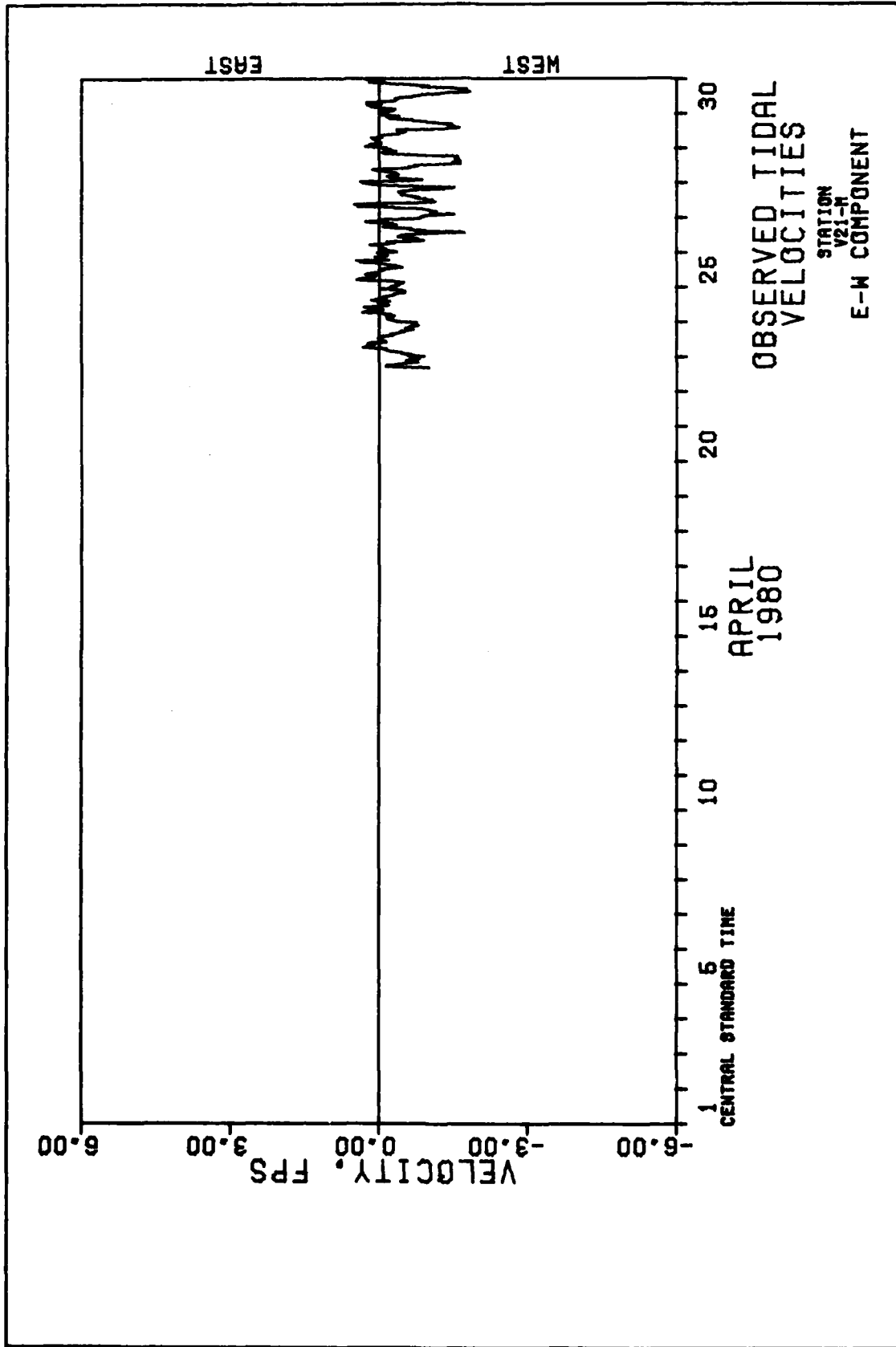
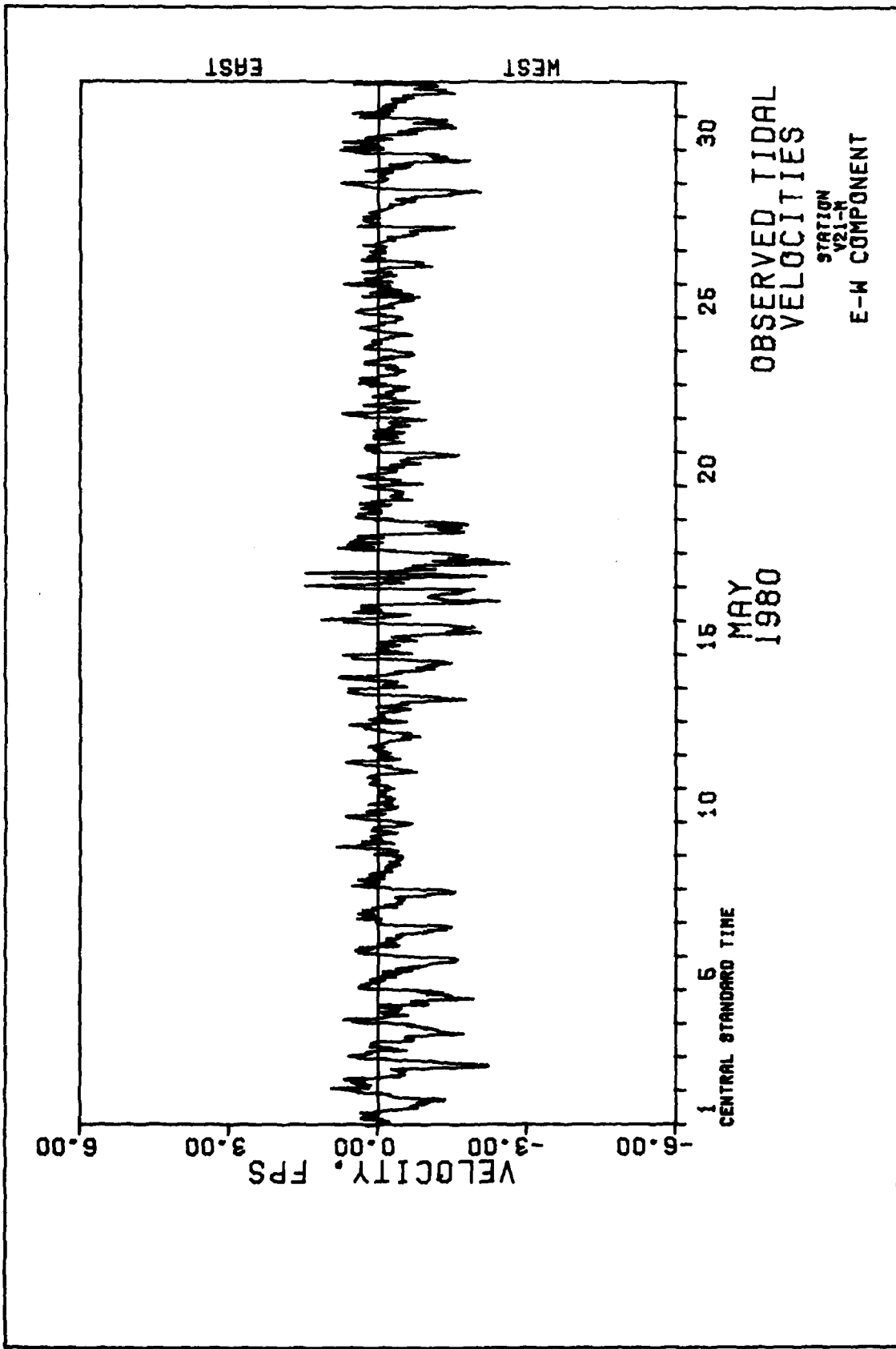


PLATE 93





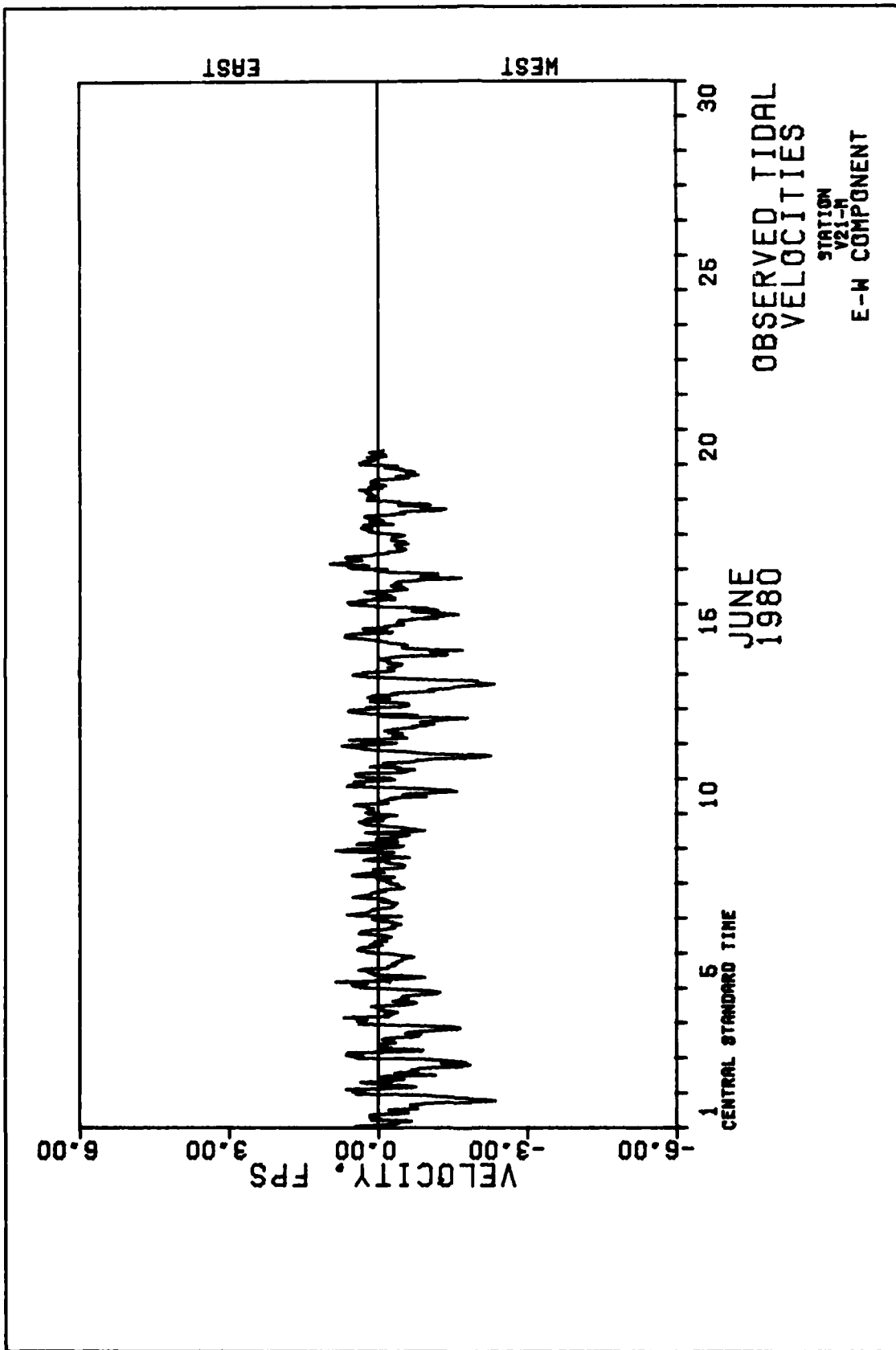
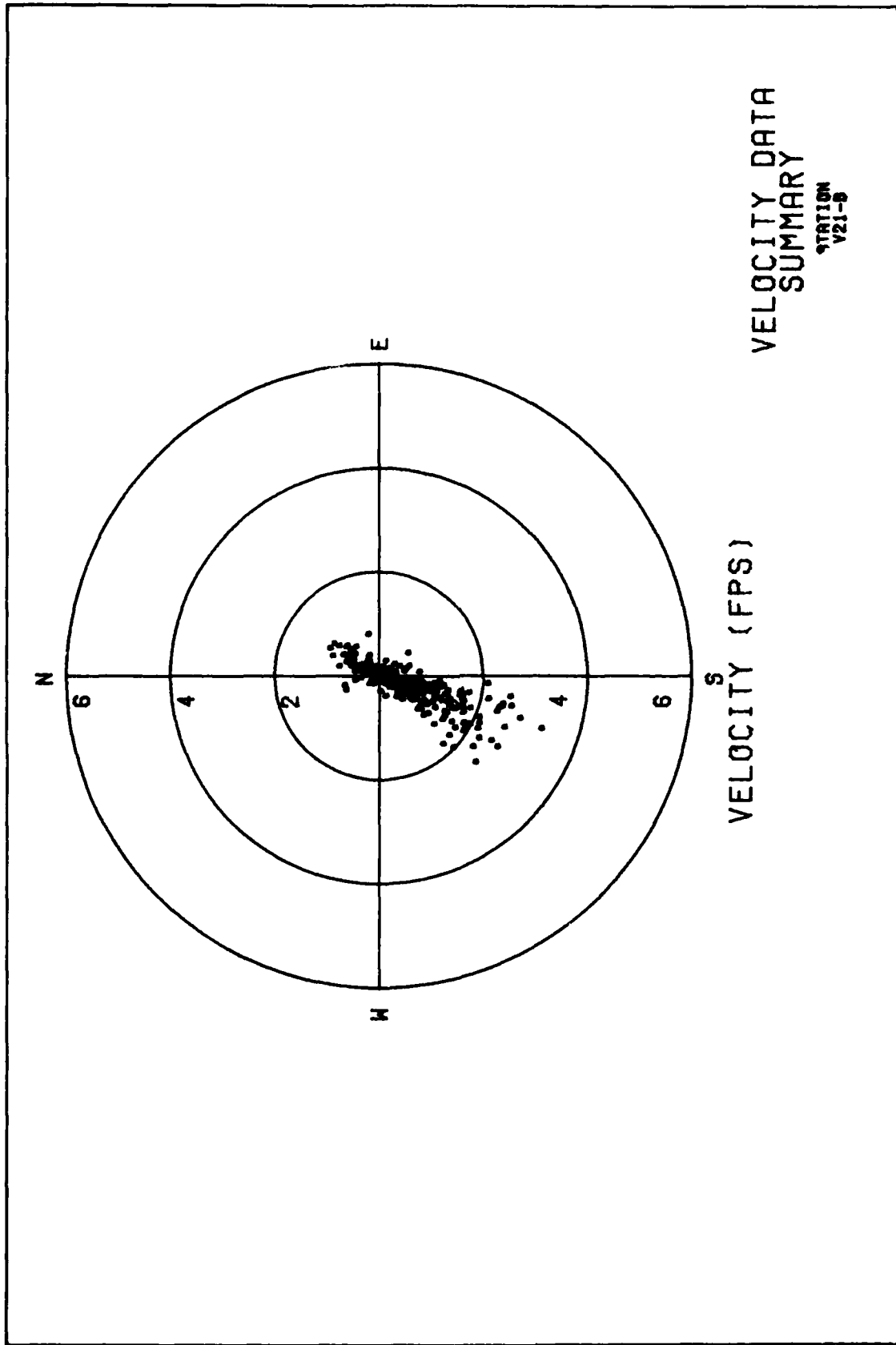


PLATE 96



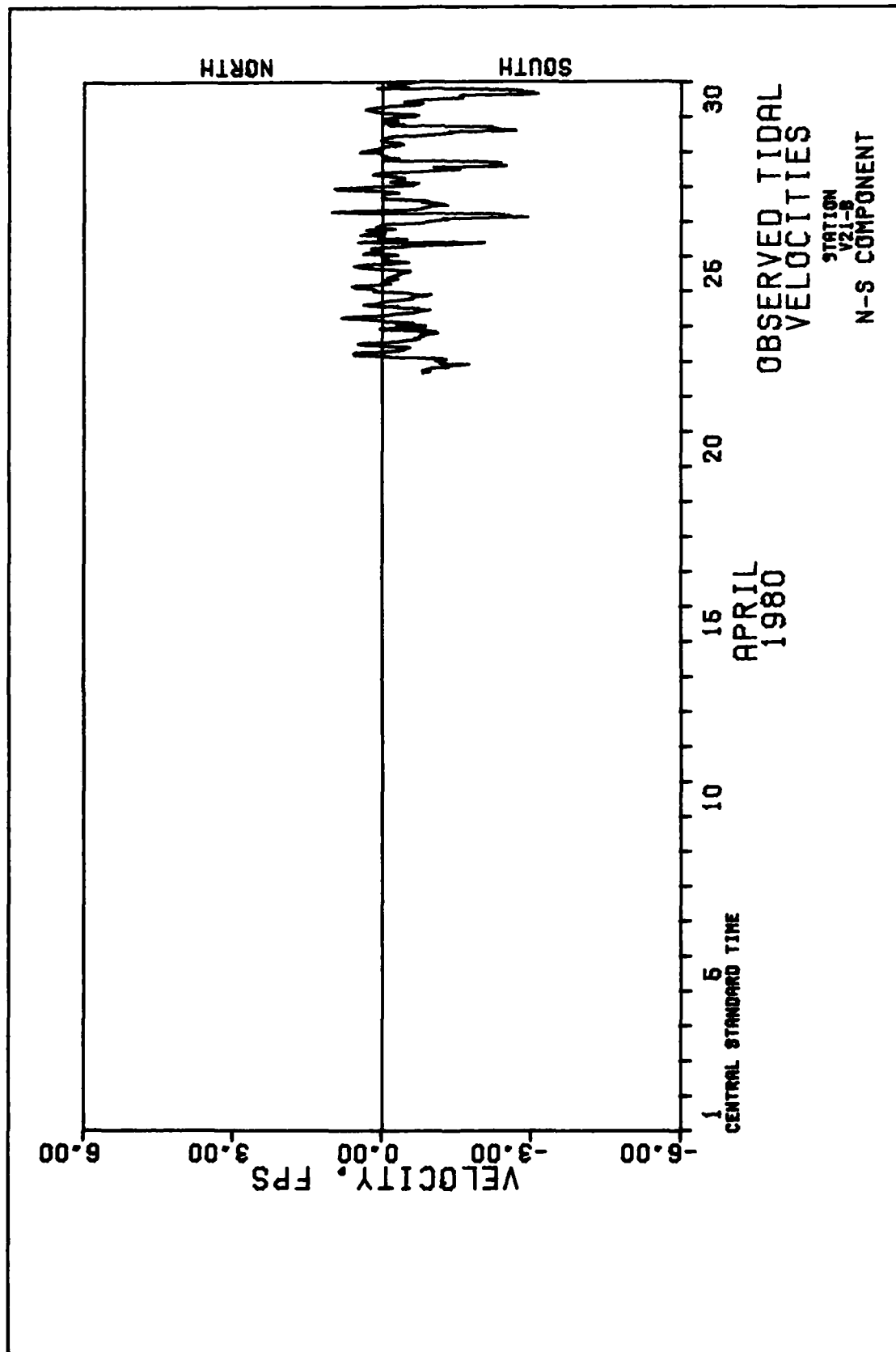
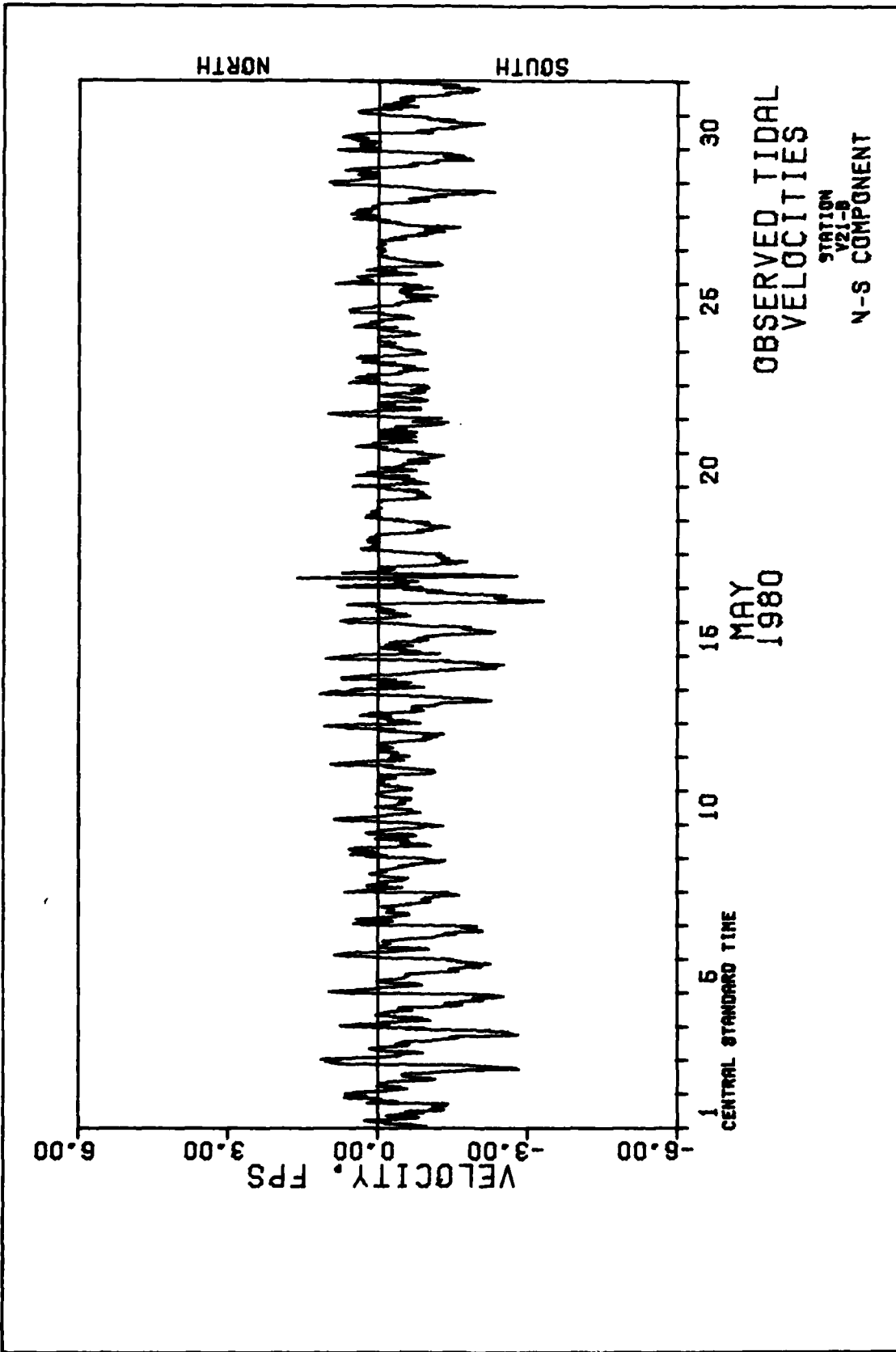


PLATE 98



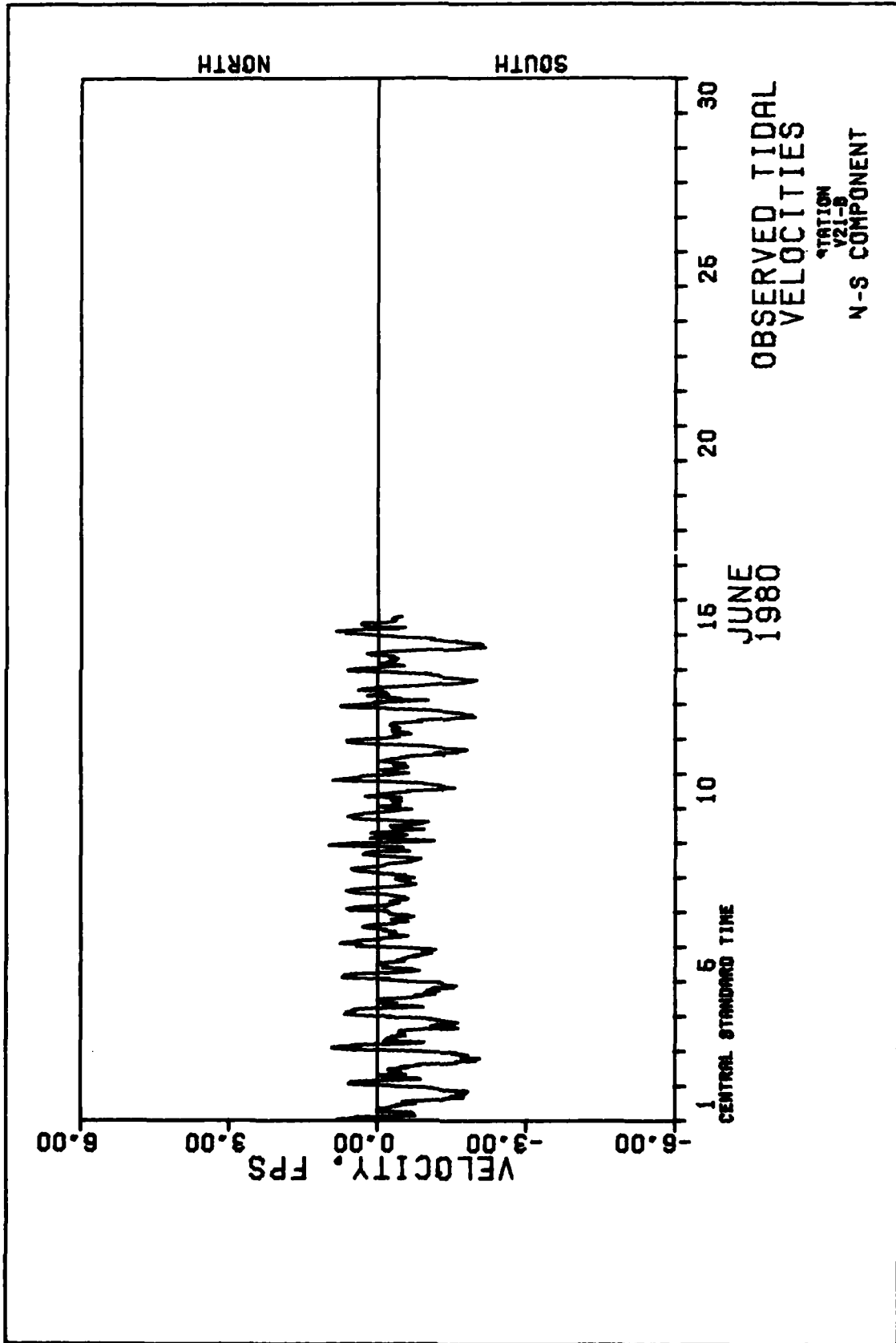
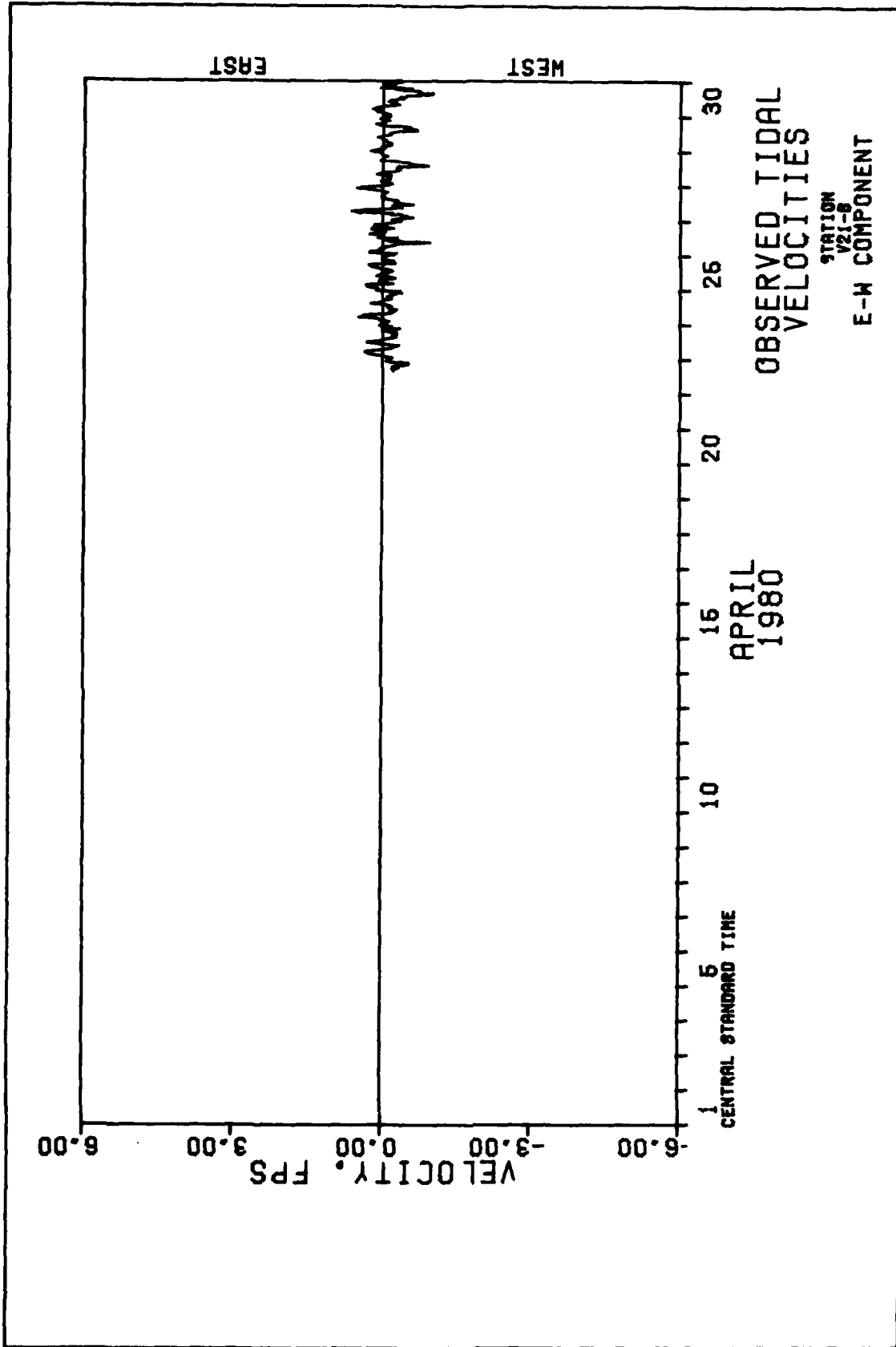


PLATE 100





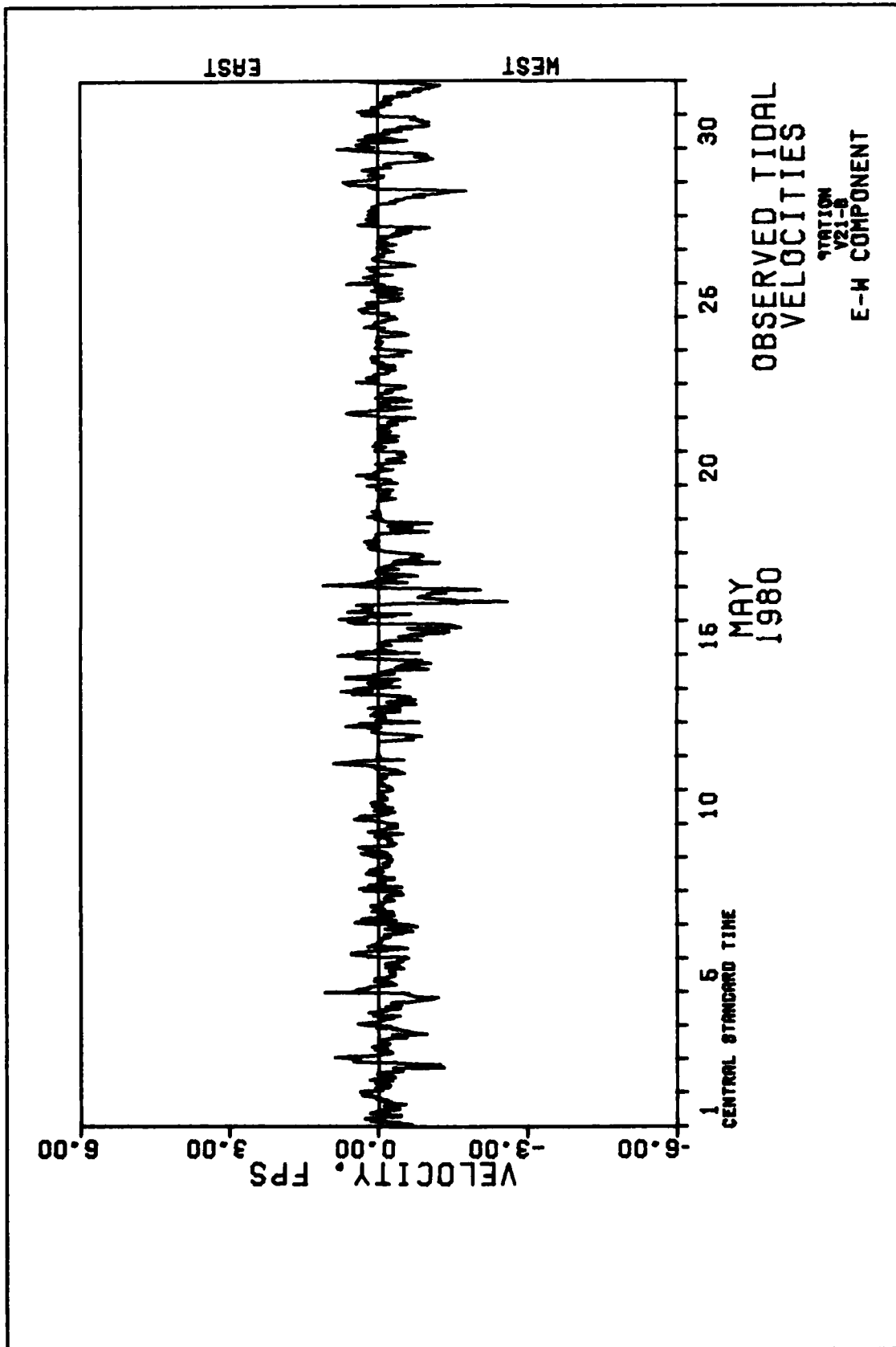
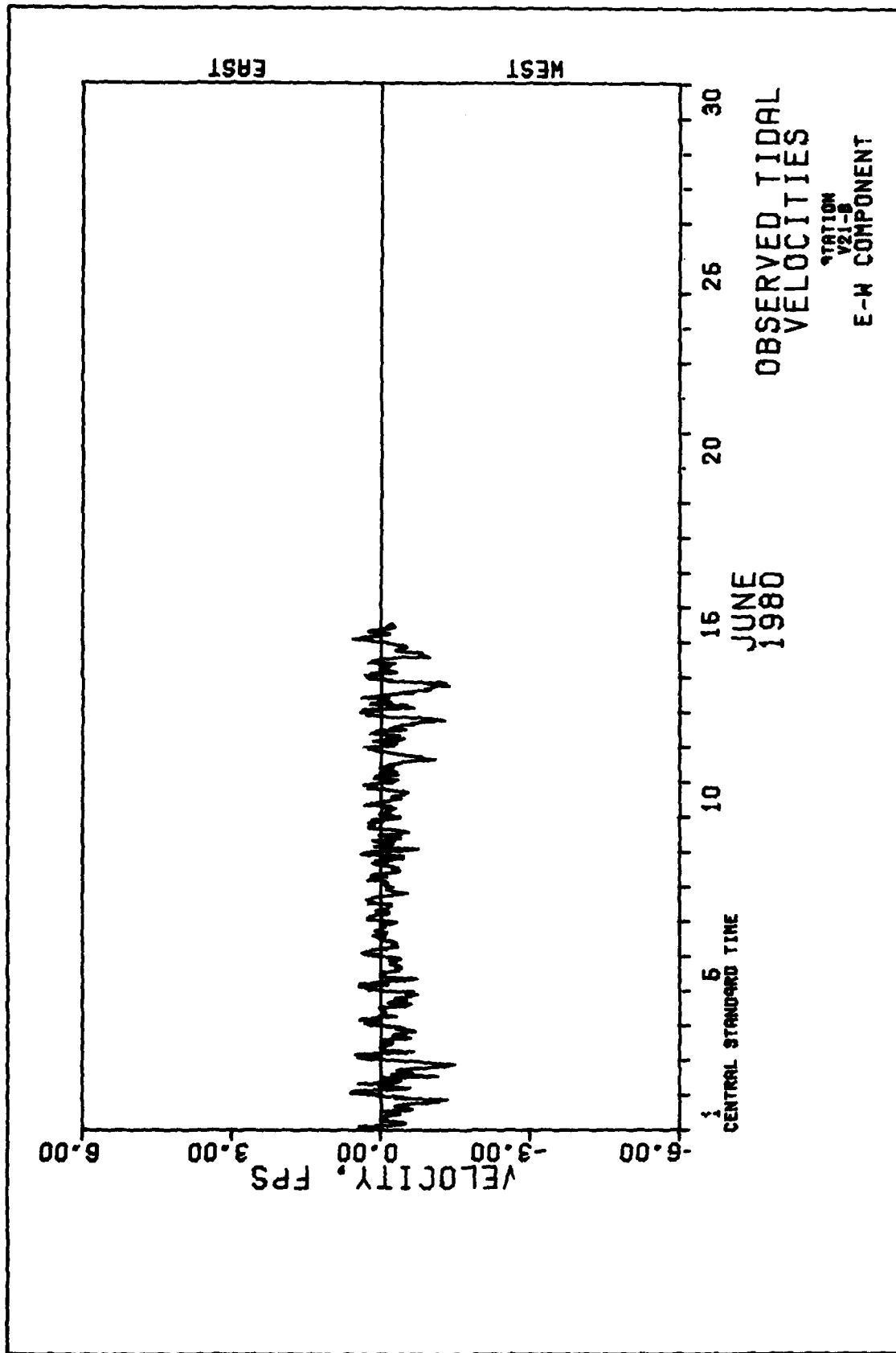


PLATE 102



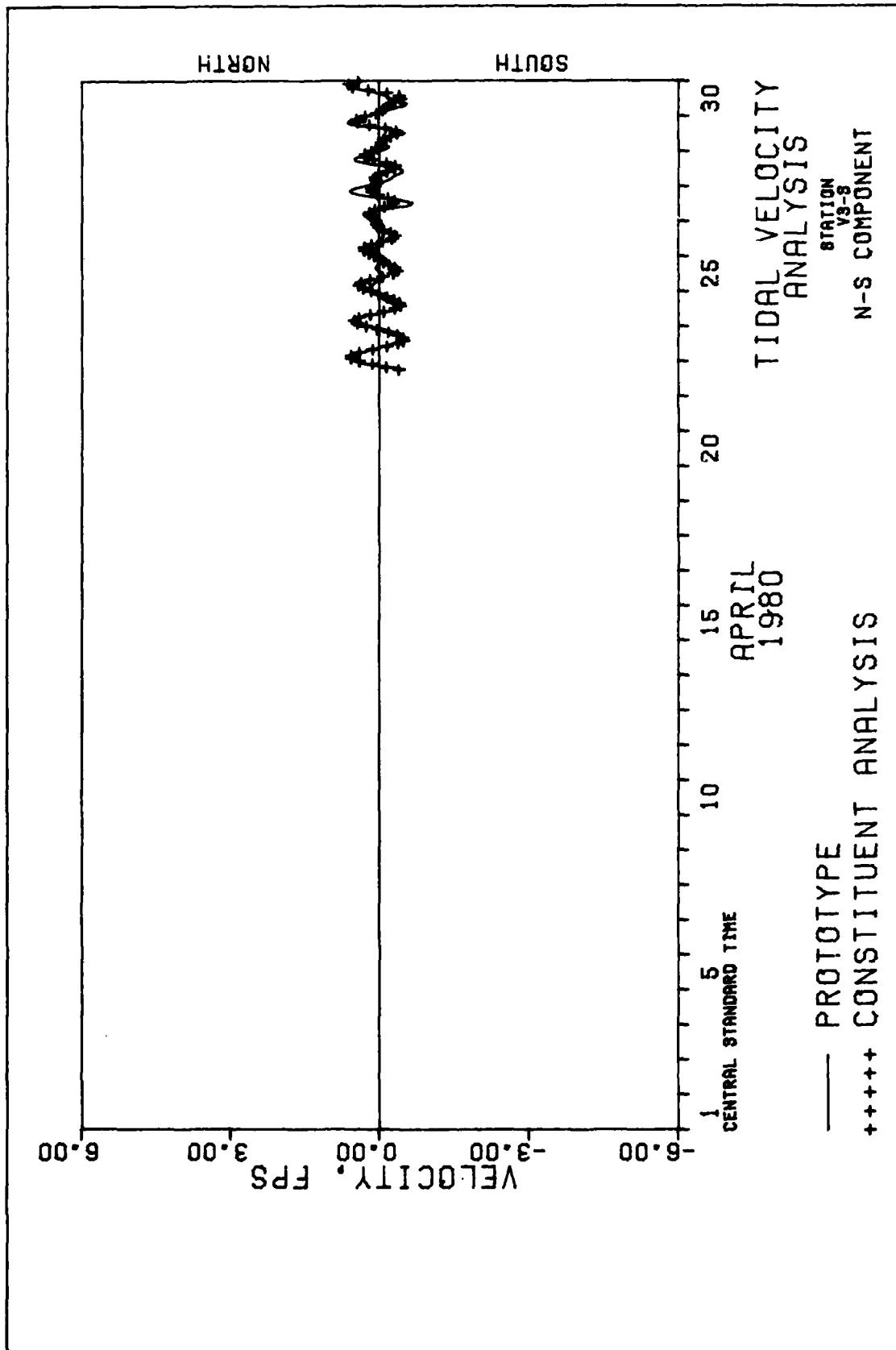
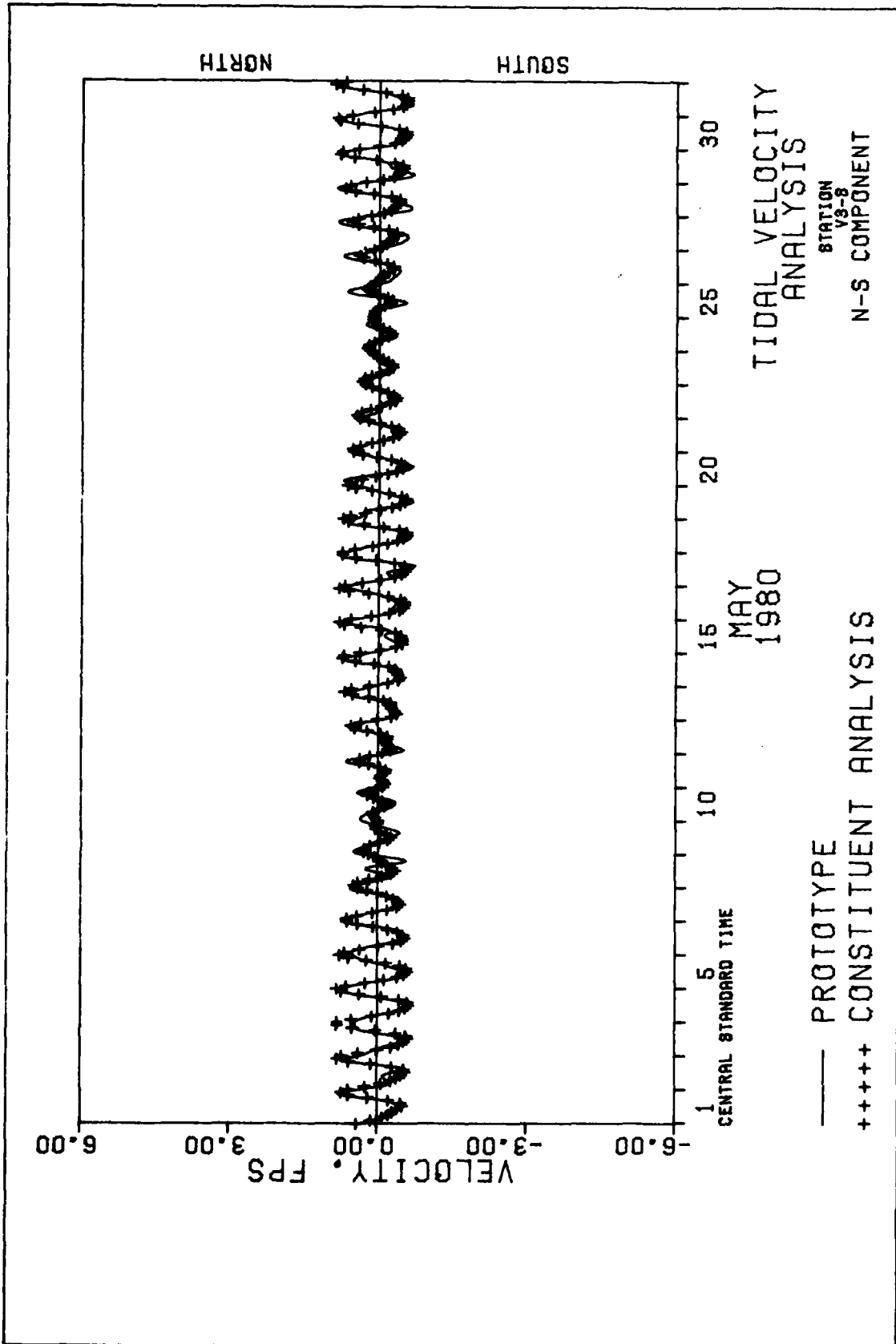
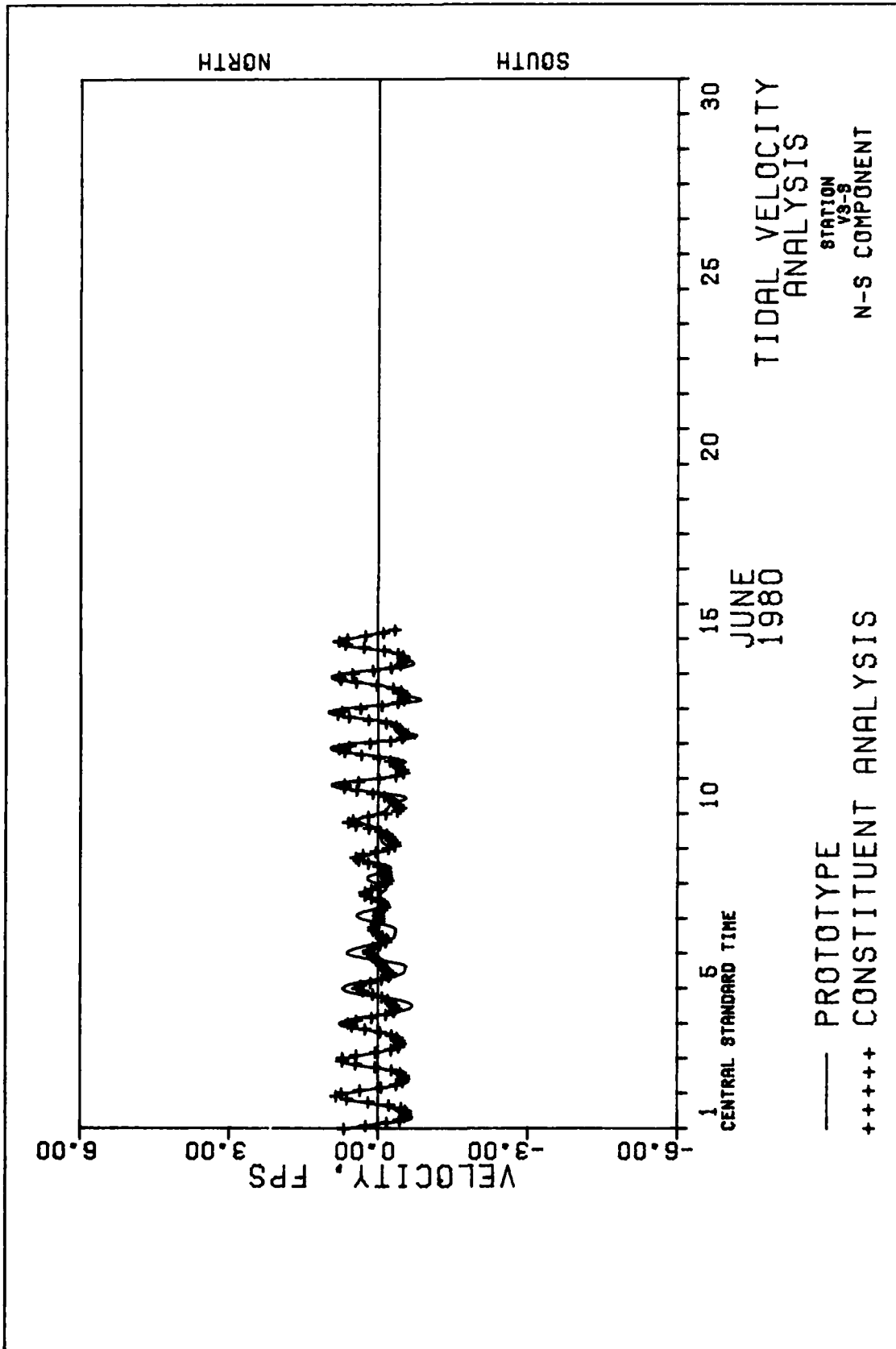
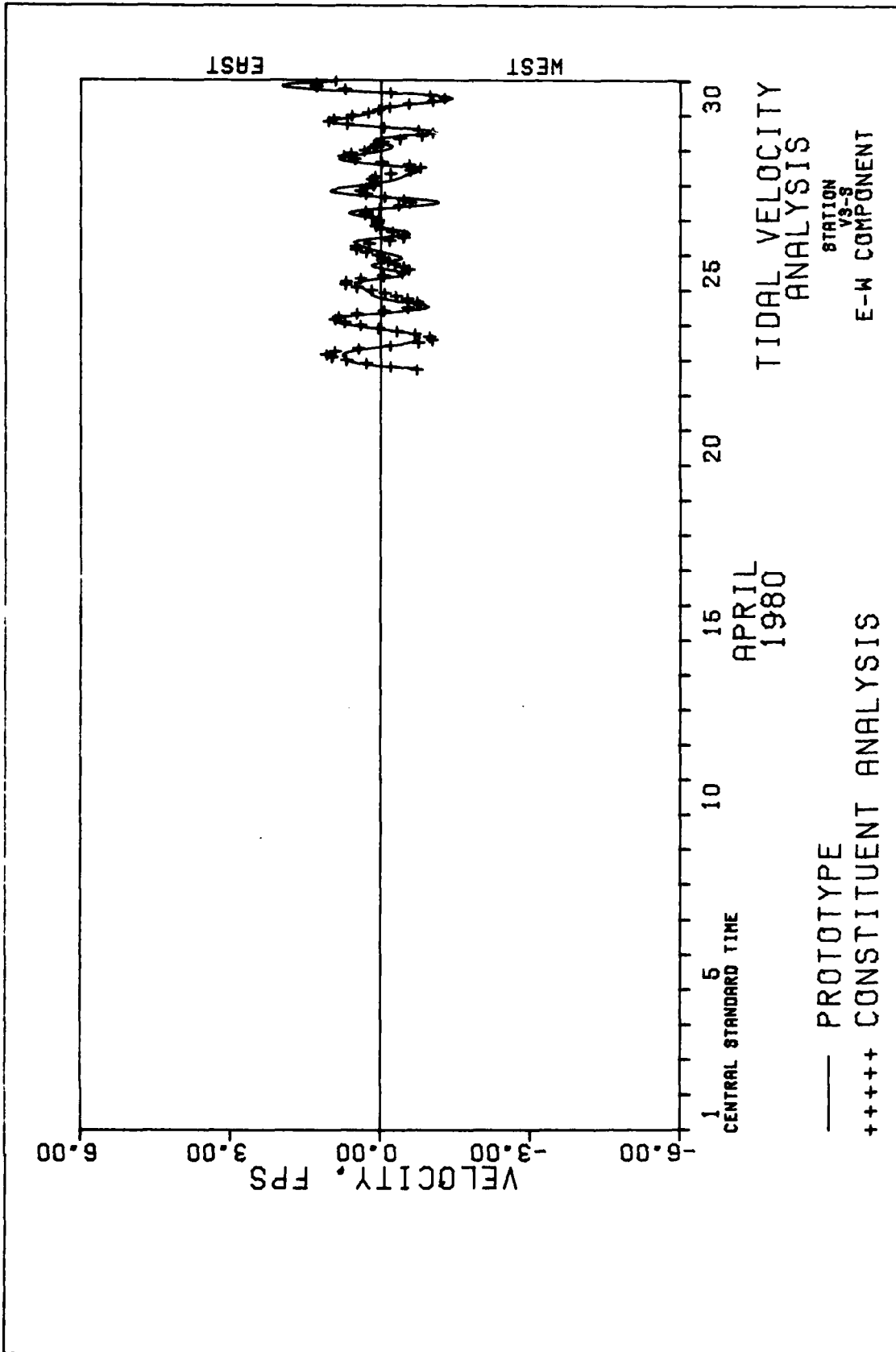


PLATE 104







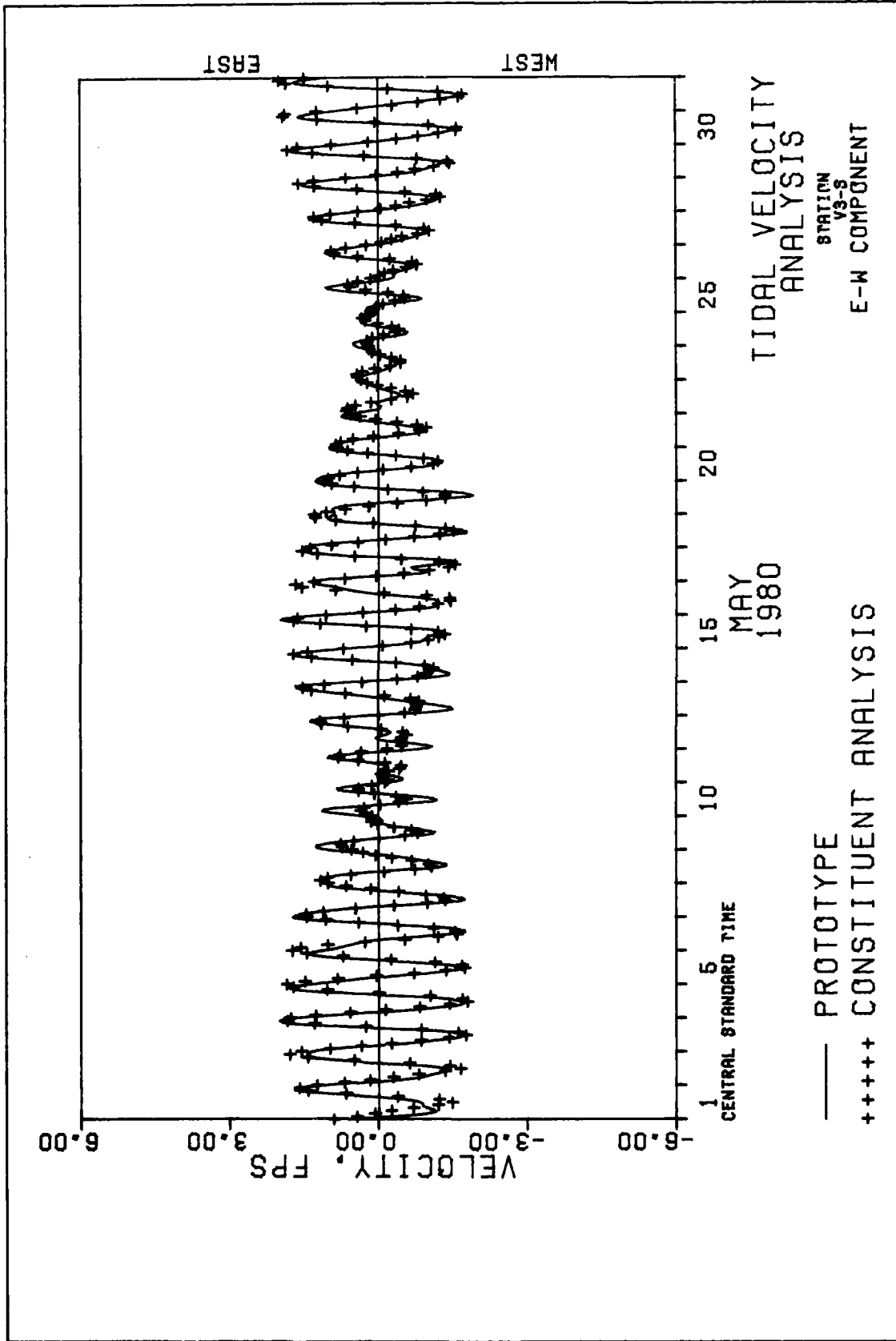
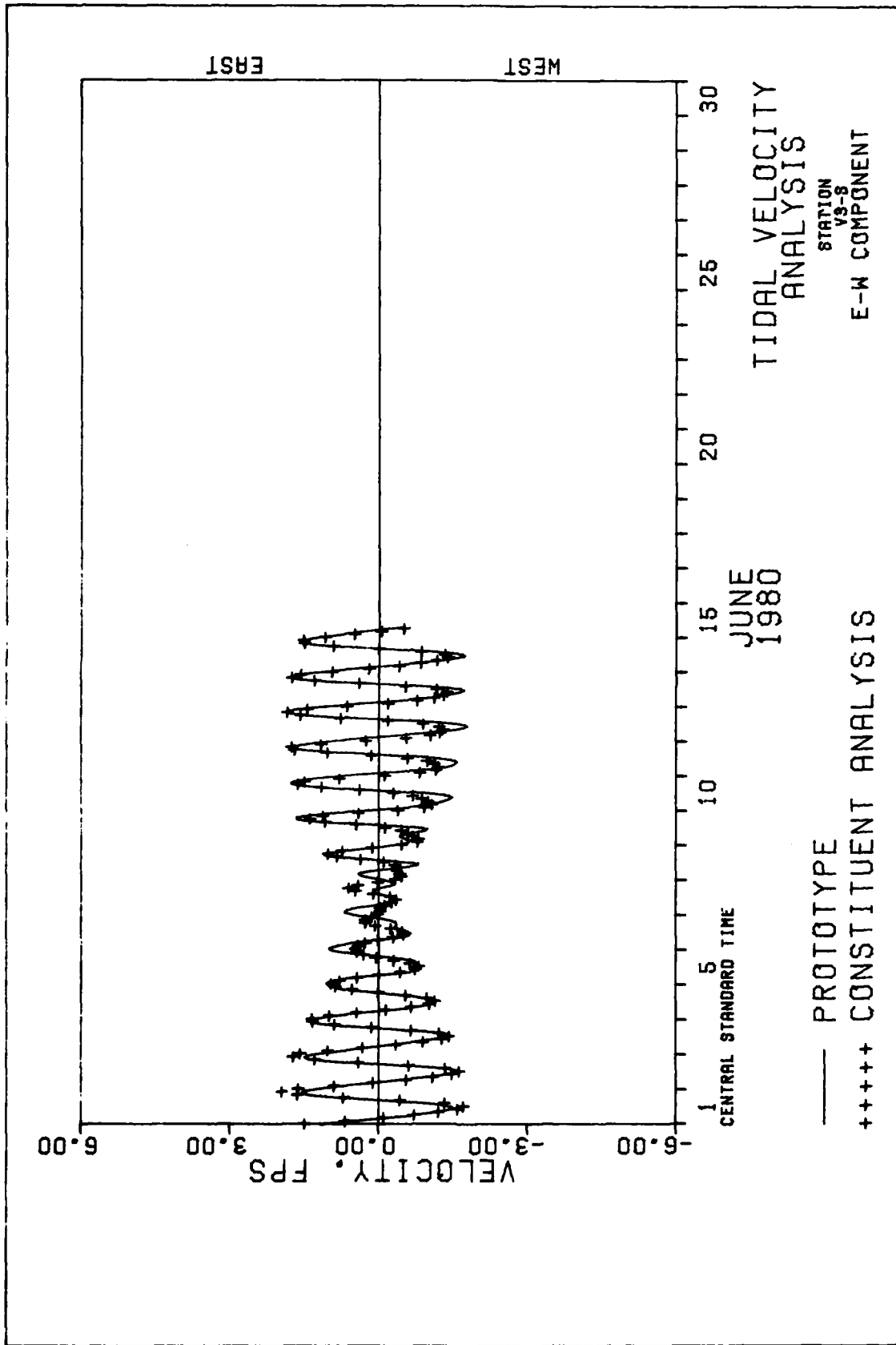


PLATE 108





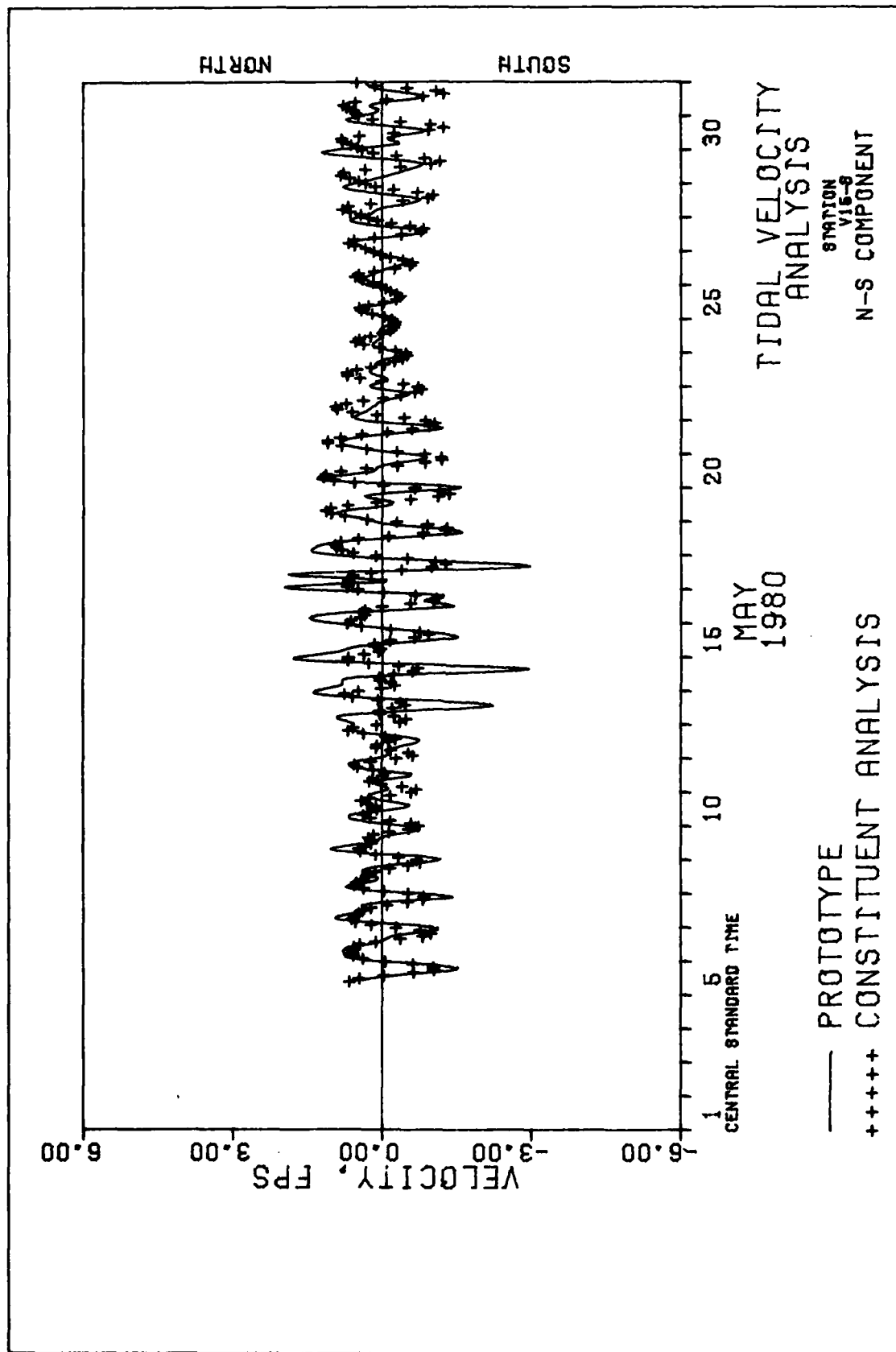
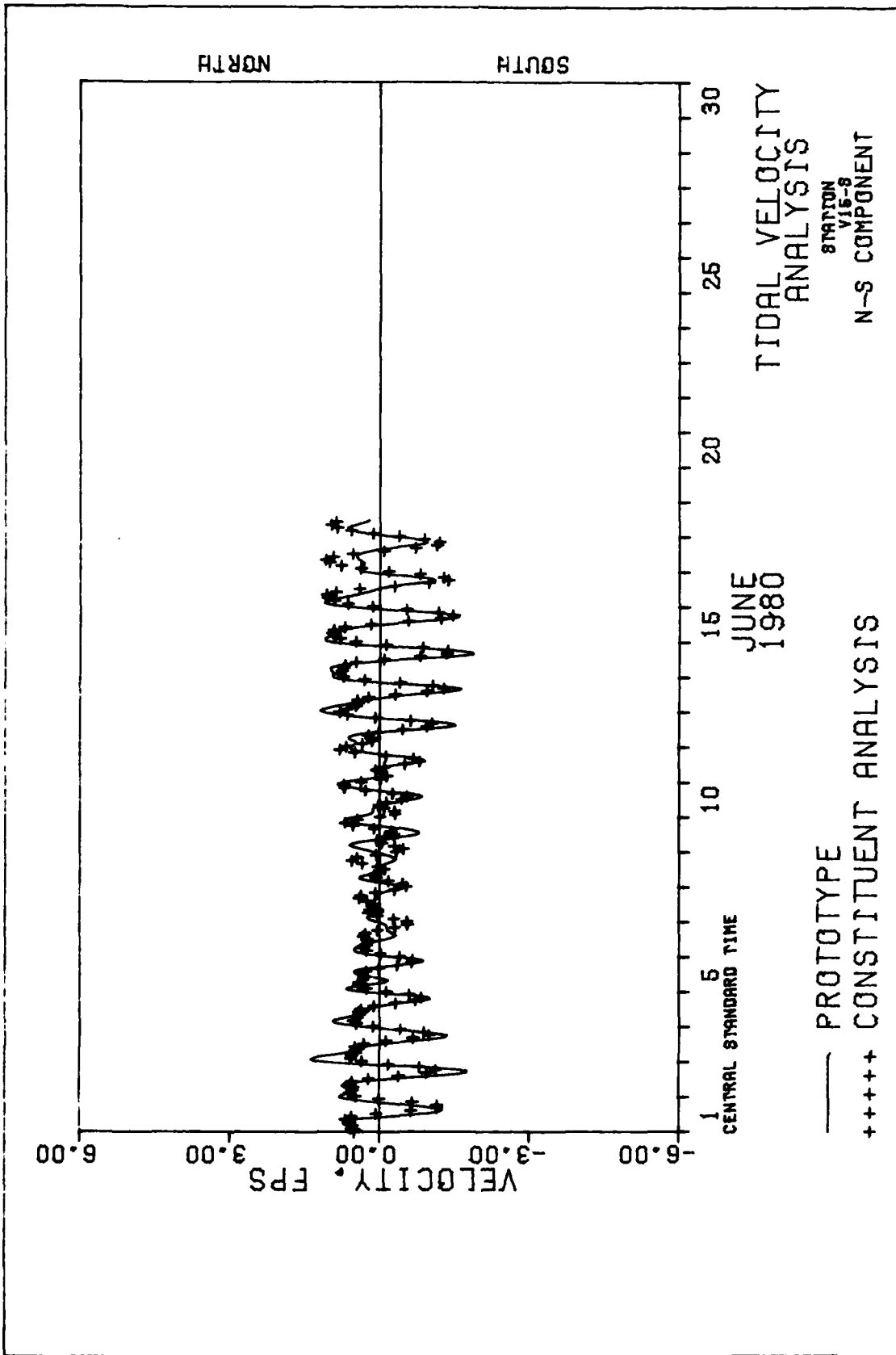


PLATE 110



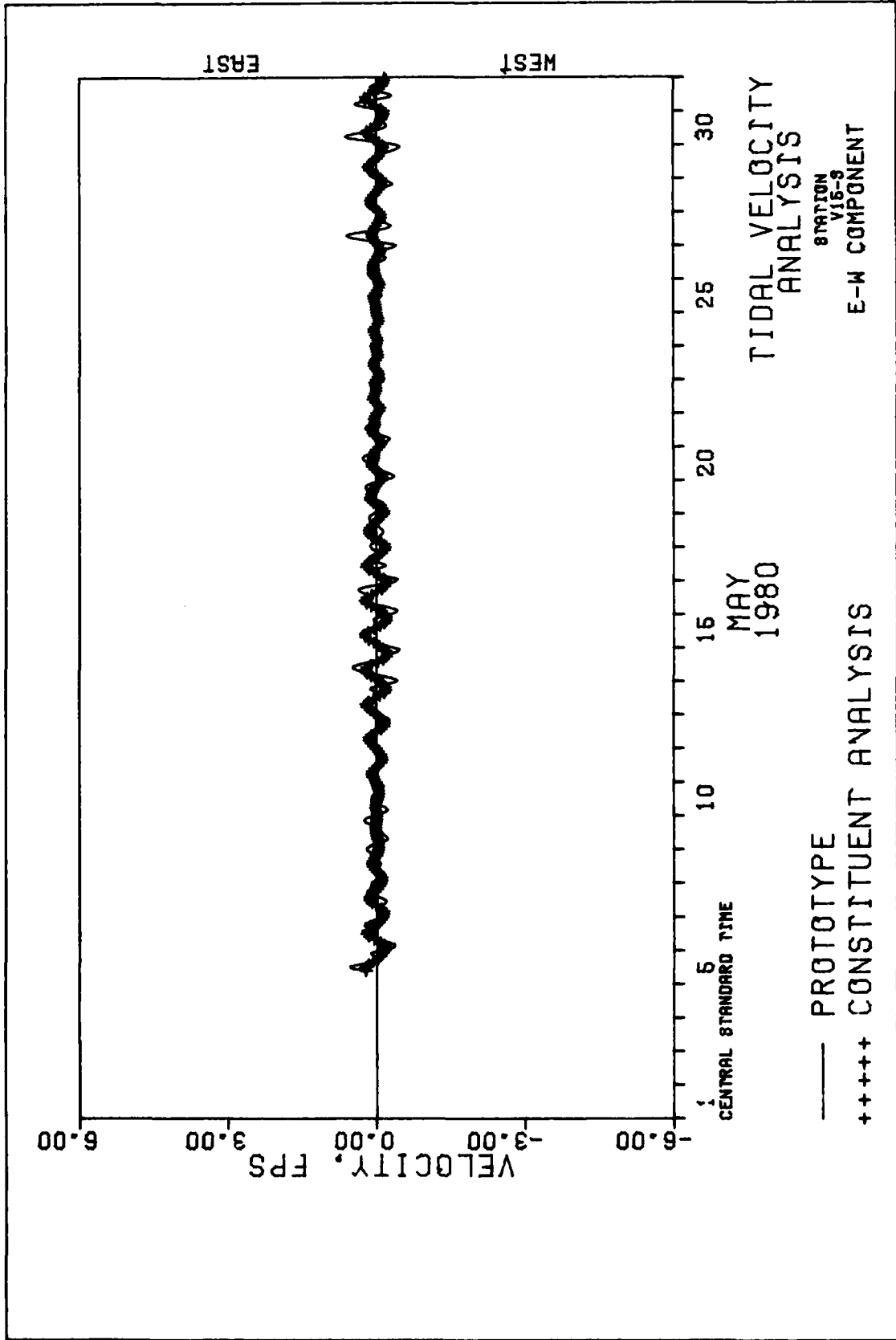
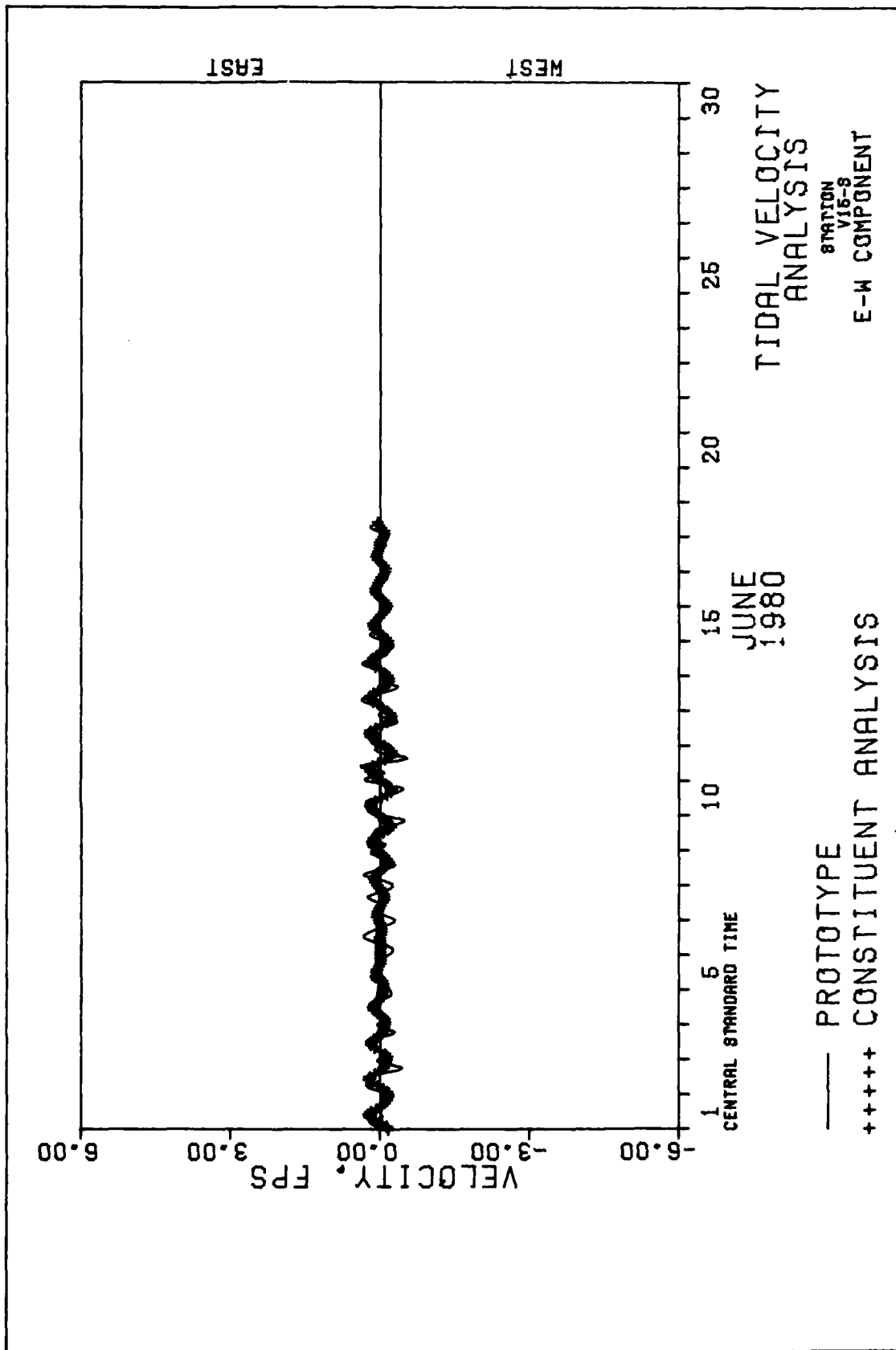


PLATE 112



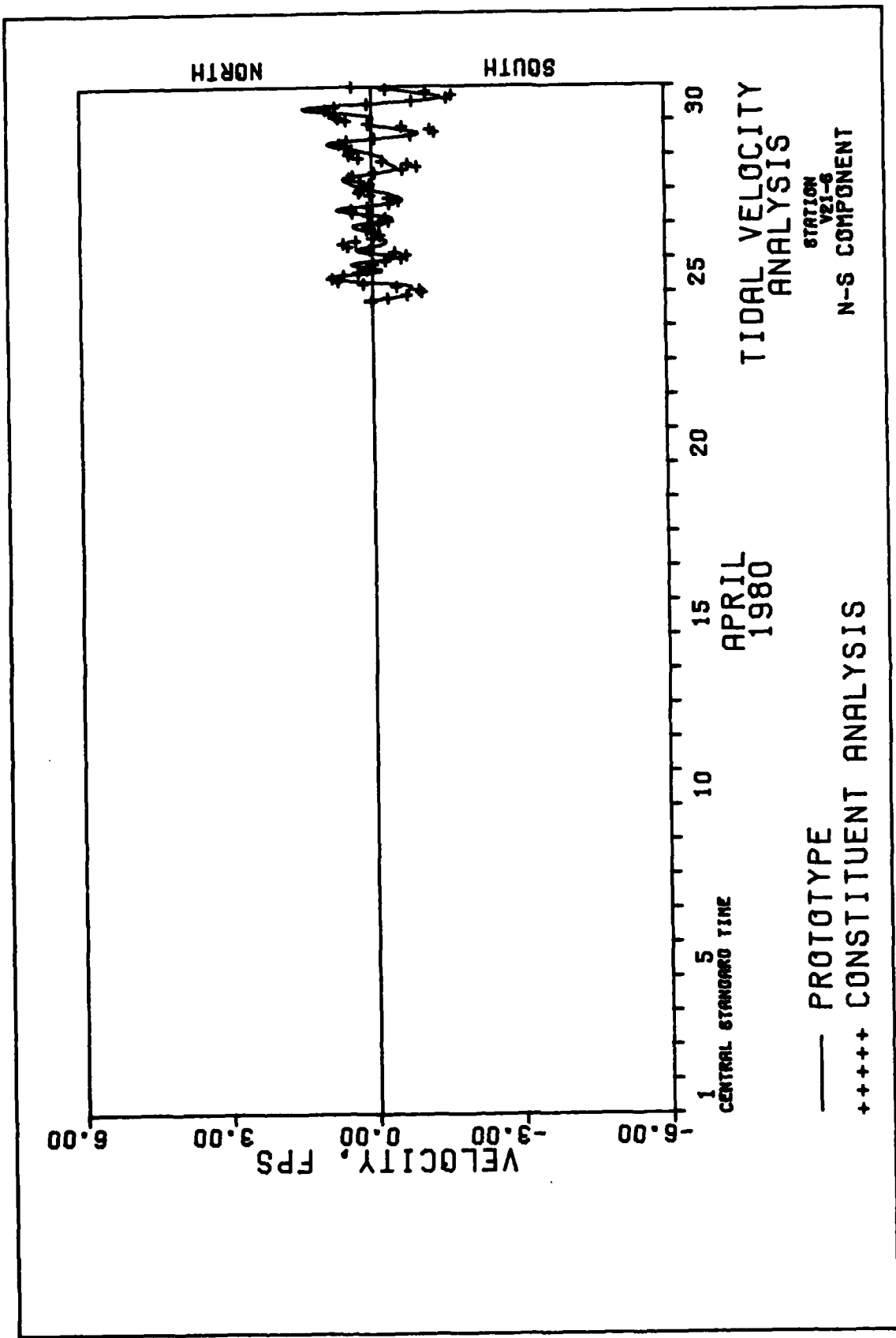
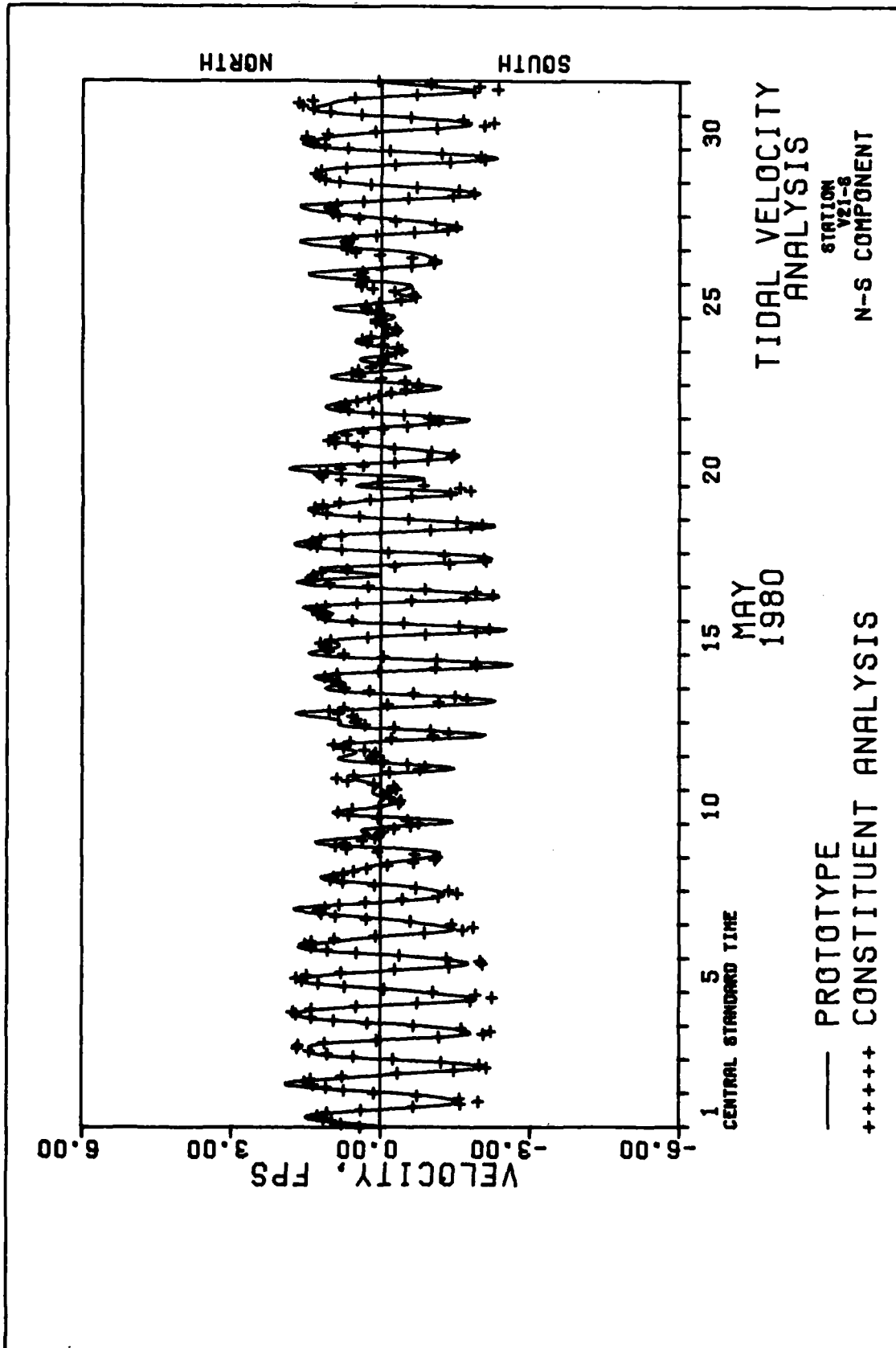


PLATE 114



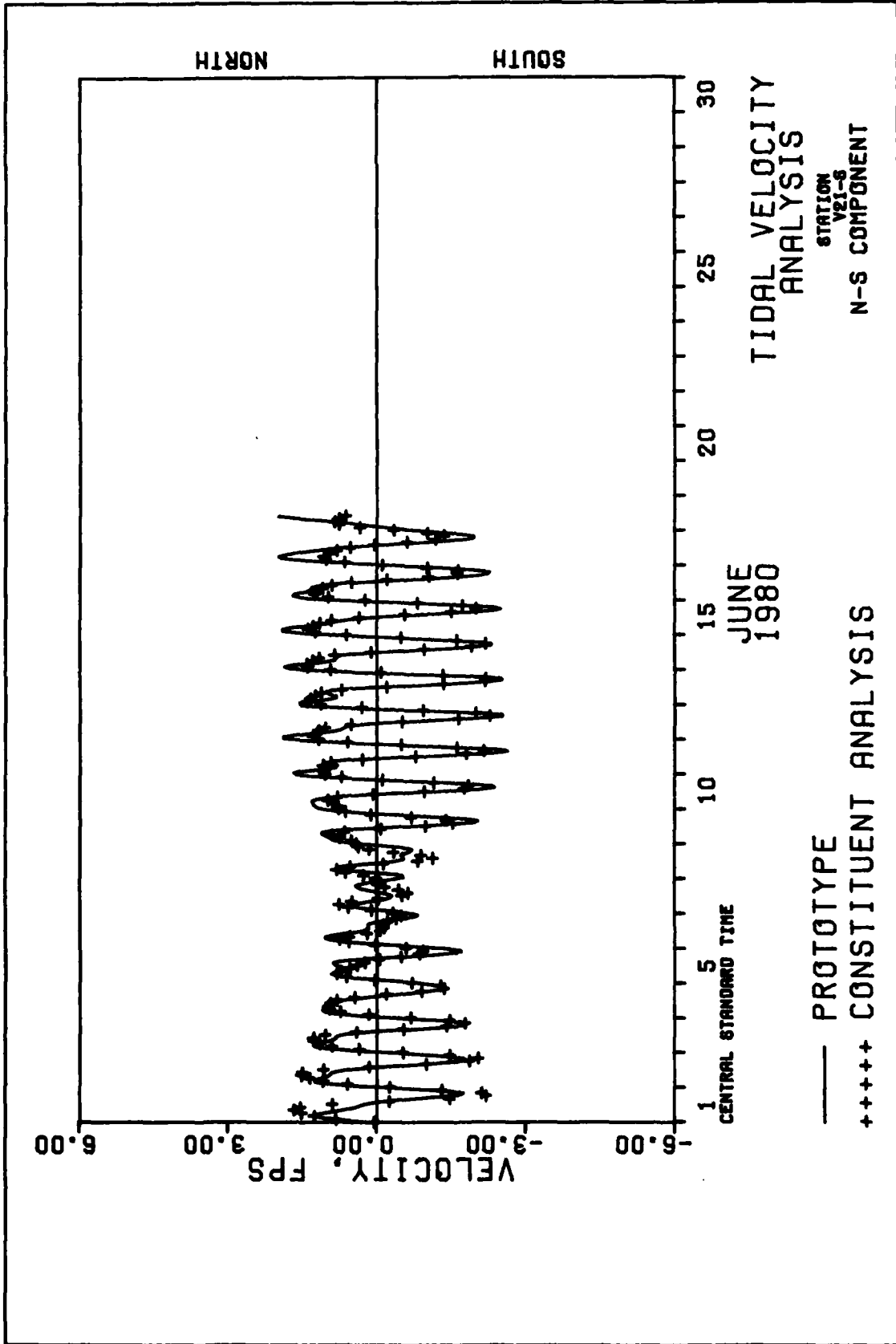
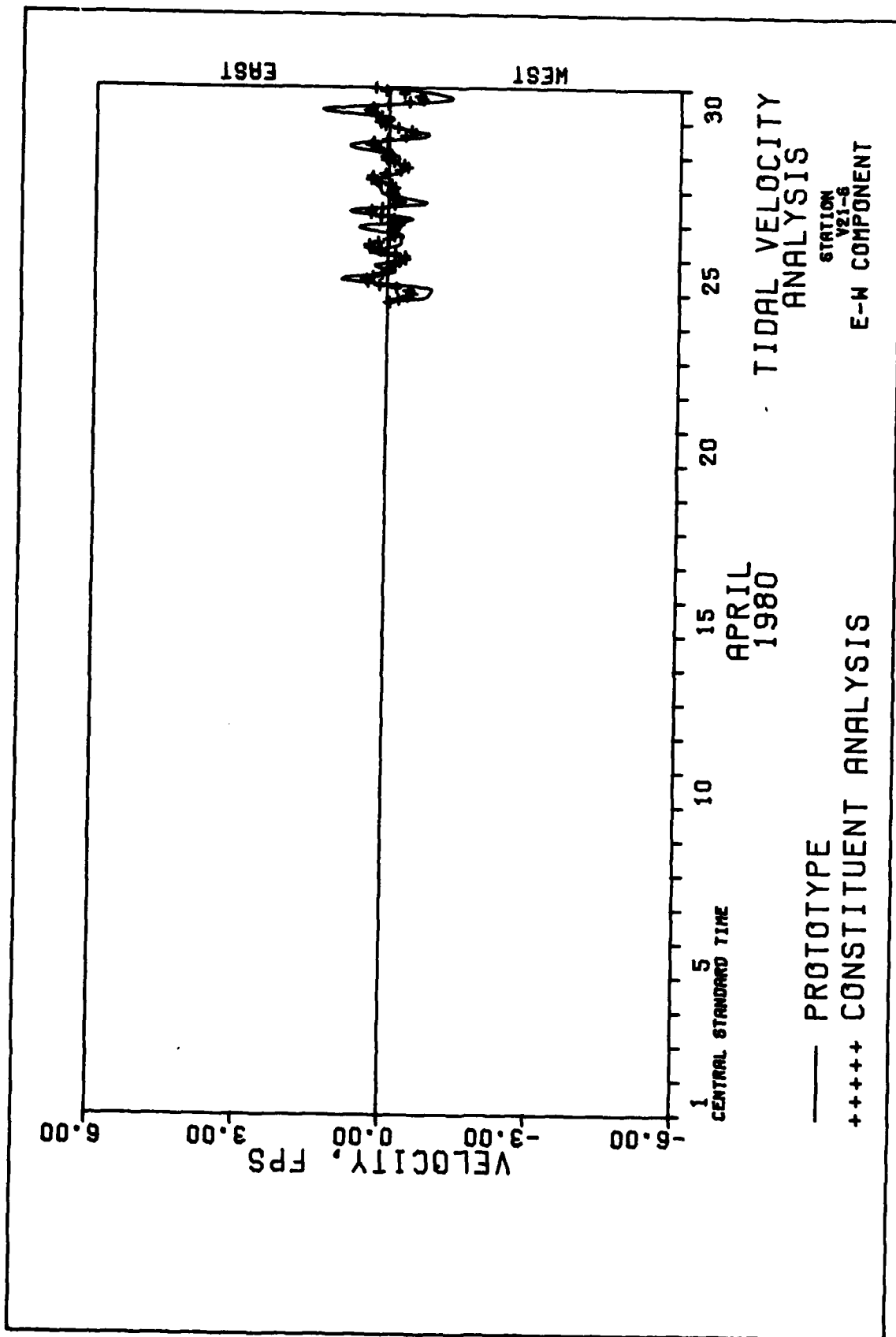


PLATE 116





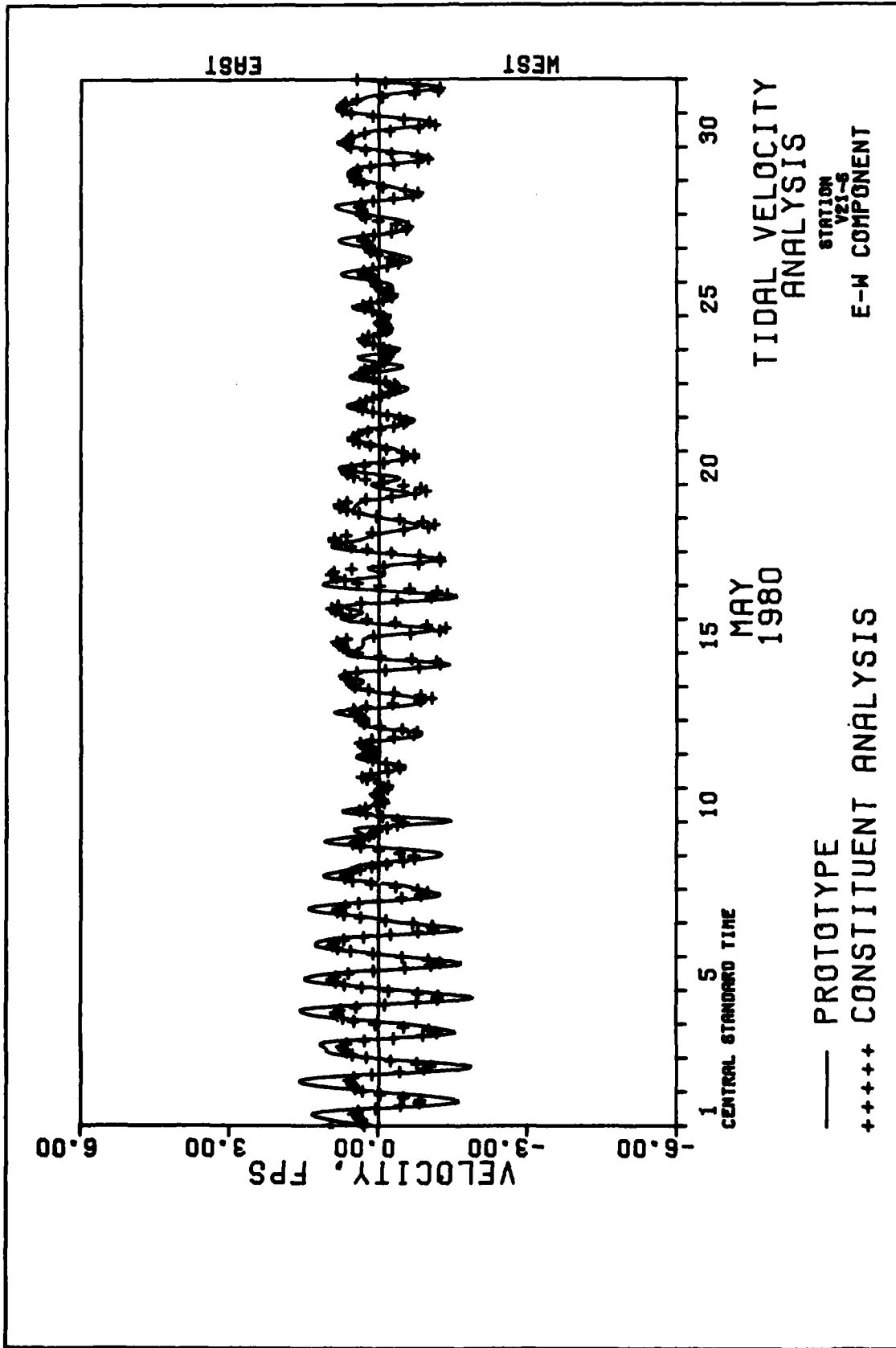


PLATE 118

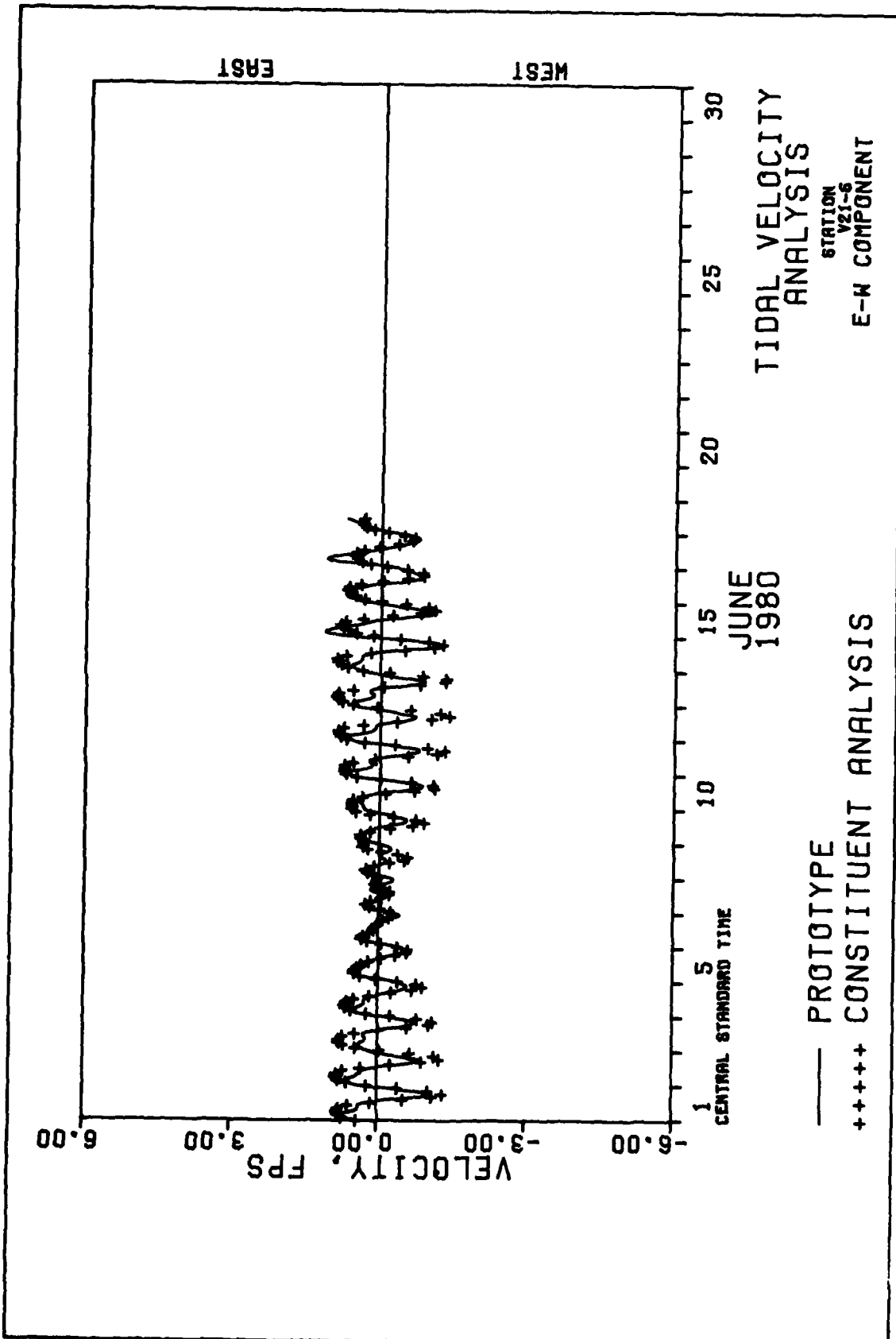


PLATE 119

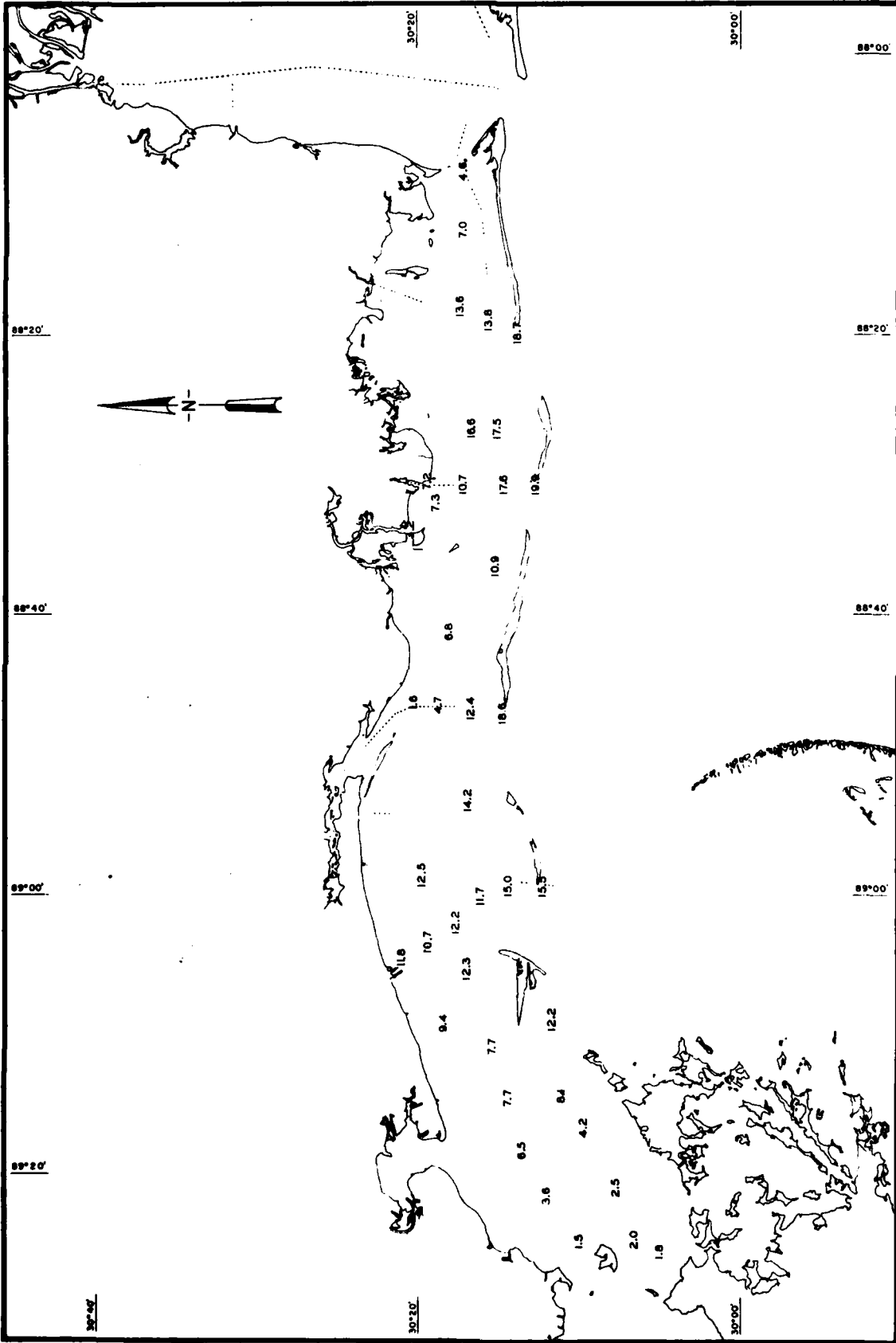


PLATE 120

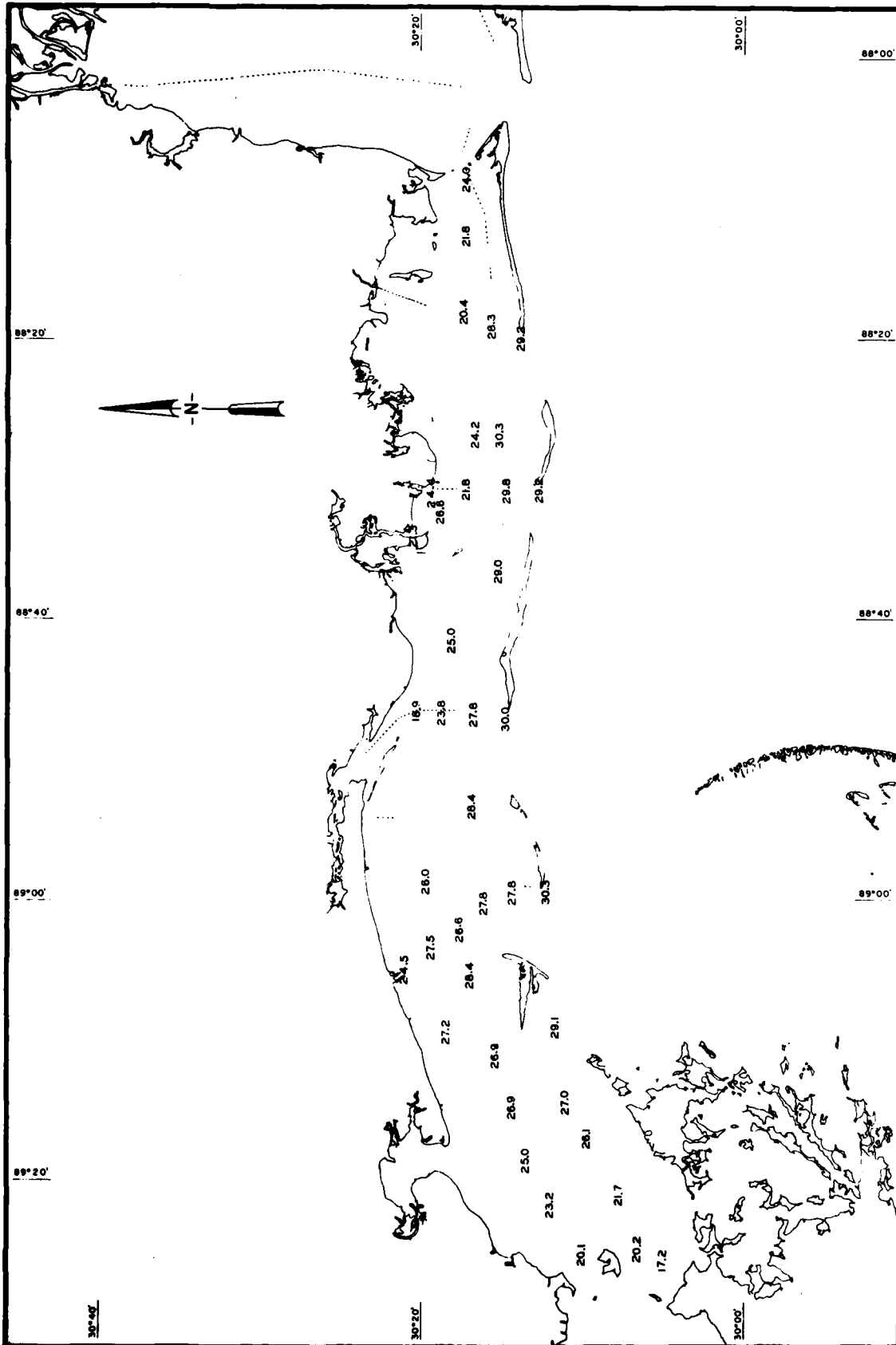


PLATE 121

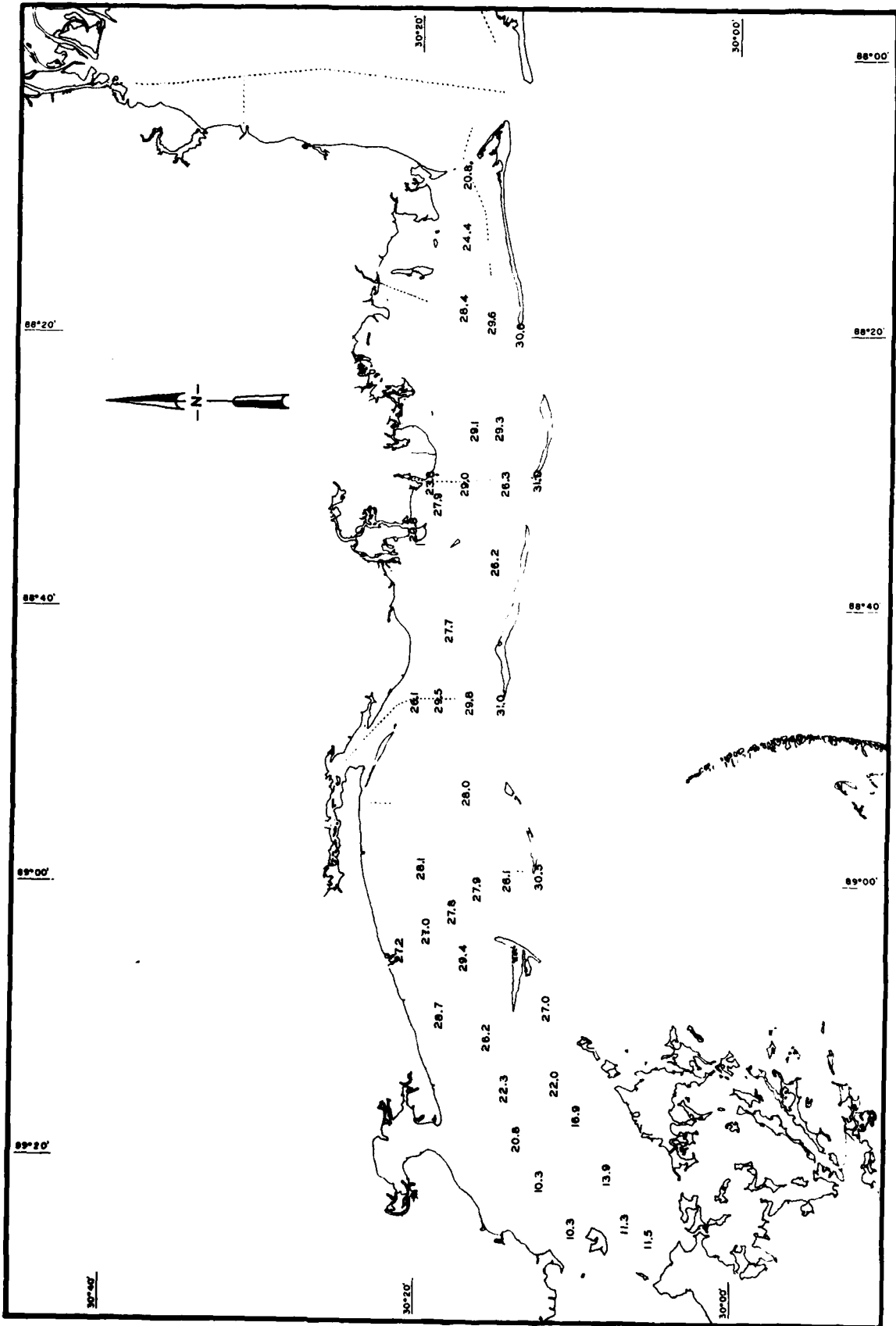
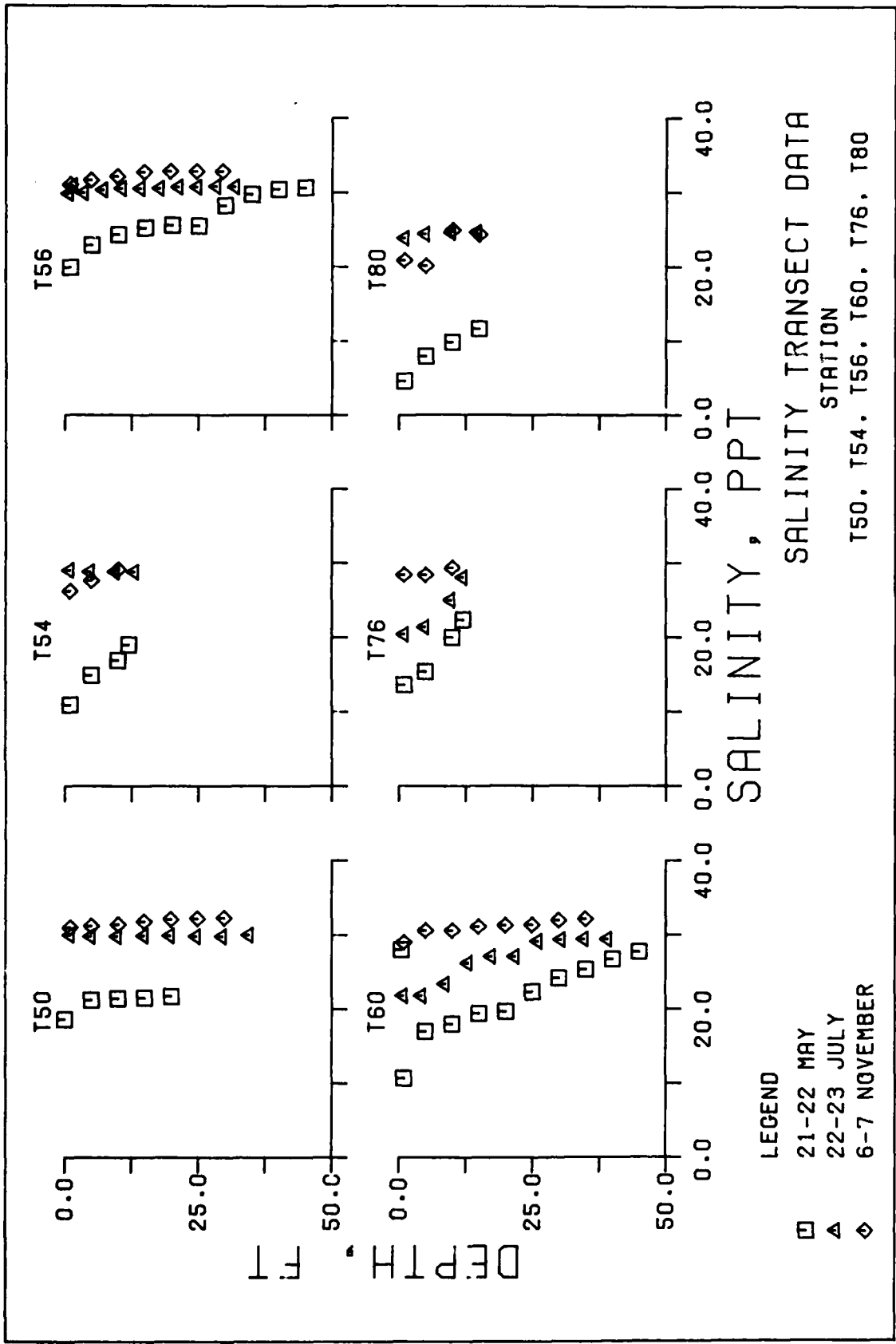
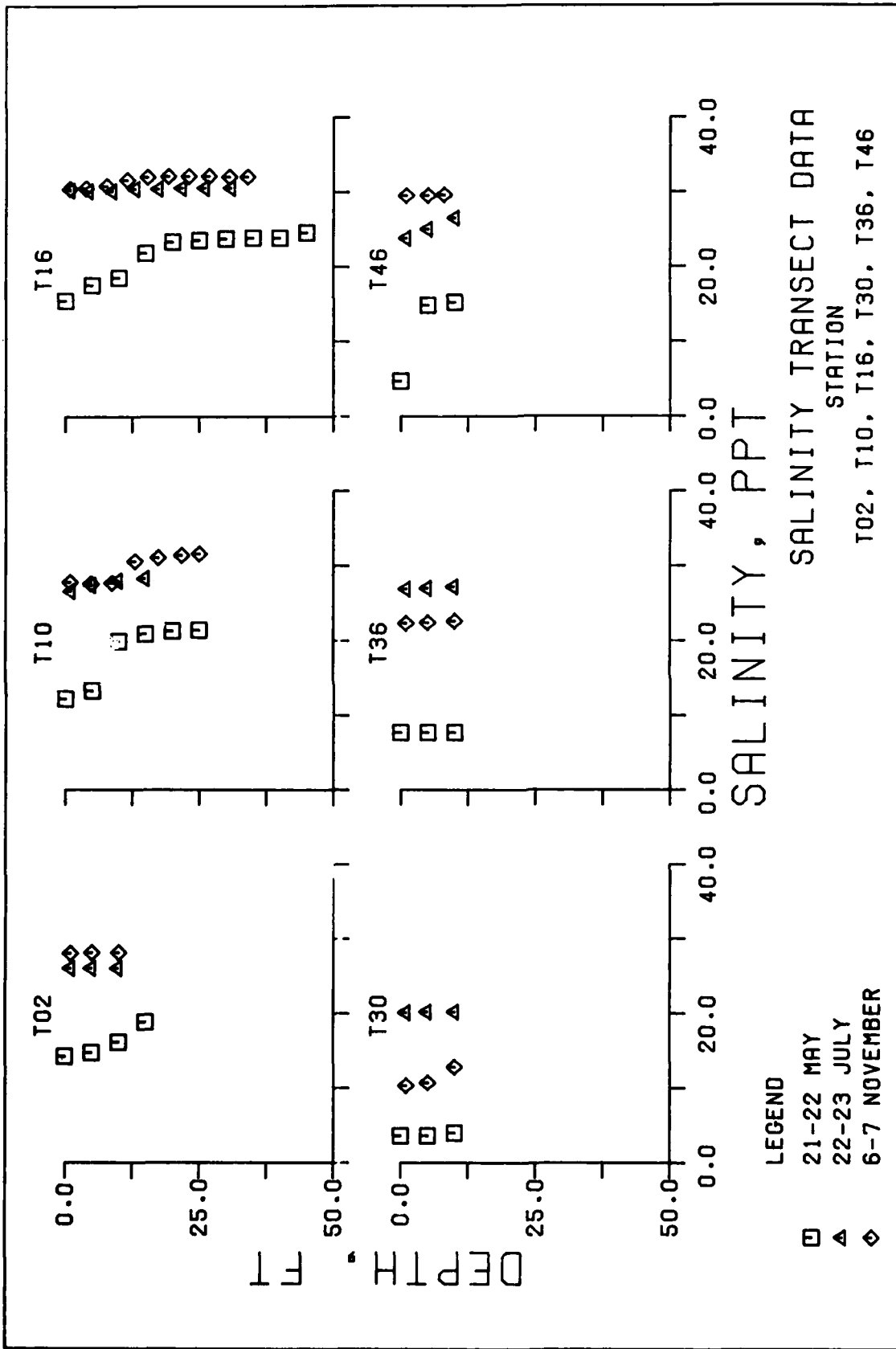


PLATE 122





SALINITY, PPT

SALINITY TRANSECT DATA  
STATION

T02, T10, T16, T30, T36, T46

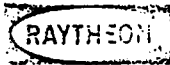
LEGEND

- 21-22 MAY
- △ 22-23 JULY
- ◇ 6-7 NOVEMBER



APPENDIX A

MANUFACTURER'S EQUIPMENT SPECIFICATIONS



MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: ENDECO Type 105 In-Situ Tethered Current Meter (TCM)

PARAMETER(S): Current Speed and Direction

SPECIFICATIONS:

1. Current Speed

- Sensor Type: Ducted impeller
- Sensitivity: 53.7 RPM/knot
- Speed Range: 0-3.50 knots (0-180.2 cm/sec) at 1 reading/30 minutes
- Impeller Threshold: Less than 0.05 knot (2.57 cm/sec)
- Resolution: 0.05 knot (2.57 cm/sec)
- Speed Accuracy:  $\pm$  3 percent of full scale

2. Current Direction

- Magnetic Direction: 0-360°
- Sensitivity:  $\pm$ 5° at 0.05 knot (2.57 cm/sec)
- Resolution:  $\pm$ 1°
- Accuracy: 2 percent above 0.05 knot (2.57 cm/sec) when referenced to computer calibration

Applies to both current speed and direction:

- Number of readings: 3600
- Recording rate: 1 reading/30 minutes
- Time reference: 24-hour light emitting diode provided by ENDECO Type 124 crystal timer
- Maximum recording period: 45 days at 1 reading/30 minutes
- Recording Medium: Direct photographic time exposure of sensor outputs on 16mm cine Kodak magazine
- Recording Format: Analog/Bar Graph
- Power: Four, 1.5 volt standard "D" size cells with non-metallic case
- Material: PVC plastic
- Finish: All surfaces painted for resistance to marine growth
- Hardware: 300 series stainless steel and plastic

## QUALITY ASSURANCE PLAN: MISSISSIPPI SOUND DATA COLLECTION PROGRAM

## MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: AANDERAA RCM 4

PARAMETER(S): Conductivity and Water Temperature

## SPECIFICATIONS:

1. Water Temperature

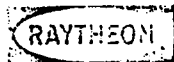
Sensor: Thermistor (Fenwal GB32JM19)  
Accuracy:  $\pm 0.15^{\circ}\text{C}$   
Resolution: 0.1 percent of range  
Range:  $-0.34^{\circ}\text{C}$  to  $32.17^{\circ}\text{C}$   
63% Response Time: 12 seconds

2. Conductivity

Sensor: Inductive cell  
Range: 0-70 mmho/cm  
Accuracy:  $\pm 0.15$  mmho/cm  
Resolution: 0.1 percent of range

Applies to both Water Temperature and Conductivity:

Recording Intervals: 0.5, 1, 2, 5, 10, 15, 20, 30, 60, and 180 minutes  
Time Reference: Quartz clock 2574  
Recording Period: 208 days at 30 min. sampling interval  
Recording Medium:  $\frac{1}{4}$ " mag tape  
Power: 9-volt battery



MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: AANDERAA Water Level Recorder WLR-5

PARAMETER(S): Pressure

SPECIFICATIONS:

Accuracy:	$\pm 0.04$ psia
Resolution:	0.004 psia
Range:	0-400 psia
Recording Interval:	0.5, 1, 2, 5, 10, 15, 20, 30, 60, and 180 minutes
Recording Period:	50 days at 5 minute sampling interval
Recording Medium:	$\frac{1}{2}$ " magnetic tape
Time Reference:	Quartz crystal clock
Power:	9-volt battery
Integration Time:	7 and 55 seconds, 7.5 and 29 minutes approximately

## MANUFACTURER'S EQUIPMENT SPECIFICATIONS

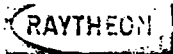
EQUIPMENT: AANDERAA INSTRUMENTS Wind Speed Sensor 2593

PARAMETER(S): Wind Speed

## SPECIFICATIONS:

Threshold:	30-50 cm/sec
Maximum Speed	74.6 m/sec
Accuracy:	$\pm 2$ percent
Resolution:	.075 m/sec
Sampling Interval:	0.5, 1, 2, 5, 10, 15, 20, 30, 60, and 180 minutes
Recording Period:	30 days at 10 minute sampling interval
Time Reference:	Quartz crystal clock
Recording Medium:	$\frac{1}{4}$ " magnetic tape
Power:	9-volt battery

NOTE: THIS INSTRUMENT RECORDS AVERAGE WIND SPEED MEASURED DURING THE SAMPLING INTERVAL AND THE MAXIMUM WIND SPEED THAT OCCURED OVER A TWO-SECOND PERIOD AT ANY TIME DURING THE SAMPLING INTERVAL.



MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: AANDERAA Wind Direction Sensor 2053

PARAMETER(S): Wind Direction

SPECIFICATIONS:

Accuracy:	Better than $\pm 5^\circ$
Resolution:	0.35°
Tracking:	Less than 30 cm/sec
Sampling Interval:	0.5, 1, 2, 5, 10, 15, 20, 30, 60, and 180 minutes
Recording Period:	30 days at 10-minute sampling interval
Recording Medium:	$\frac{1}{4}$ " magnetic tape
Time Reference:	Quartz crystal clock
Power:	9-volt battery

## QUALITY ASSURANCE PLAN: MISSISSIPPI SOUND DATA COLLECTION PROGRAM

## MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: AANDERAA Air Pressure Sensor 2056

PARAMETER(S): Barometric Pressure

## SPECIFICATIONS:

Accuracy:	+0.6 percent of full scale
Resolution:	0.34 mbar
Range:	720 --1070 mbar
Sampling Interval:	0.5, 1, 2, 5, 10, 15, 20, 30, 60, and 180 minutes
Recording Period:	30 days at 10-minute sampling interval
Recording Medium:	½" magnetic tape
Time Reference:	Quartz crystal clock
Power:	9-volt battery



MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: AANDERAA Temperature Sensor 1289A

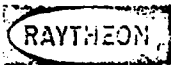
PARAMETER(S): Air Temperature

SPECIFICATIONS:

Accuracy:	$\pm 0.15^{\circ}\text{C}^*$
Resolution:	0.05°C
Range:	-8°C to +41°C
Sampling Interval:	0.5, 1, 2, 5, 10, 20, 30, 60, and 180 minutes
Recording Period:	30 days at 10 minute sampling interval
Recording Medium:	$\frac{1}{2}$ " magnetic tape
Time Reference:	Quartz crystal clock
Power:	9-volt battery

\*Accuracy quoted is for second order curve. If calibrated, accuracy is  $\pm 0.05^{\circ}\text{C}$ .





MANUFACTURER'S EQUIPMENT SPECIFICATIONS

EQUIPMENT: Beckman Portable Salinometer RS5-3

PARAMETER(S): Salinity, Temperature, and Conductivity

SPECIFICATIONS:

1. Conductivity

Accuracy:  $\pm 0.5$  mmho/cm by direct readout  
 $\pm 0.05$  mmho/cm by calibration curves  
Sensitivity: 0.01 mmho/cm  
Range: 0-60 mmho/cm

2. Temperature

Accuracy:  $\pm 0.5^\circ\text{C}$  by direct readout  
 $\pm 0.05^\circ\text{C}$  by calibration curves  
Sensitivity:  $0.01^\circ\text{C}$   
Range: 0 -40°C

3. Salinity

Accuracy:  $\pm 0.3\%$  by direct readout  
 $\pm 0.05\%$  by calibration curves  
Range: 0 -40‰

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