US Army Corps of Engineers
Waterways Experiment Station

Preliminary Data Summary for August 1994 CERC Field Research Facility

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Coastal Engineering Research Center

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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Several substitutions were made in this report relative to other months.

1) Wave direction information was computed from a pressure gauge and current meter (gauge 3511) and is substituted for the 8 Meter Array (gauge 3111). 3511 is at the same location as the 8 Meter Array.

2) Suvey line 62, located 407m north of the pier, is being substituted for line 188, which is located 517m south of the pier.

3) Precipitation is now being read daily rather than four times a day.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

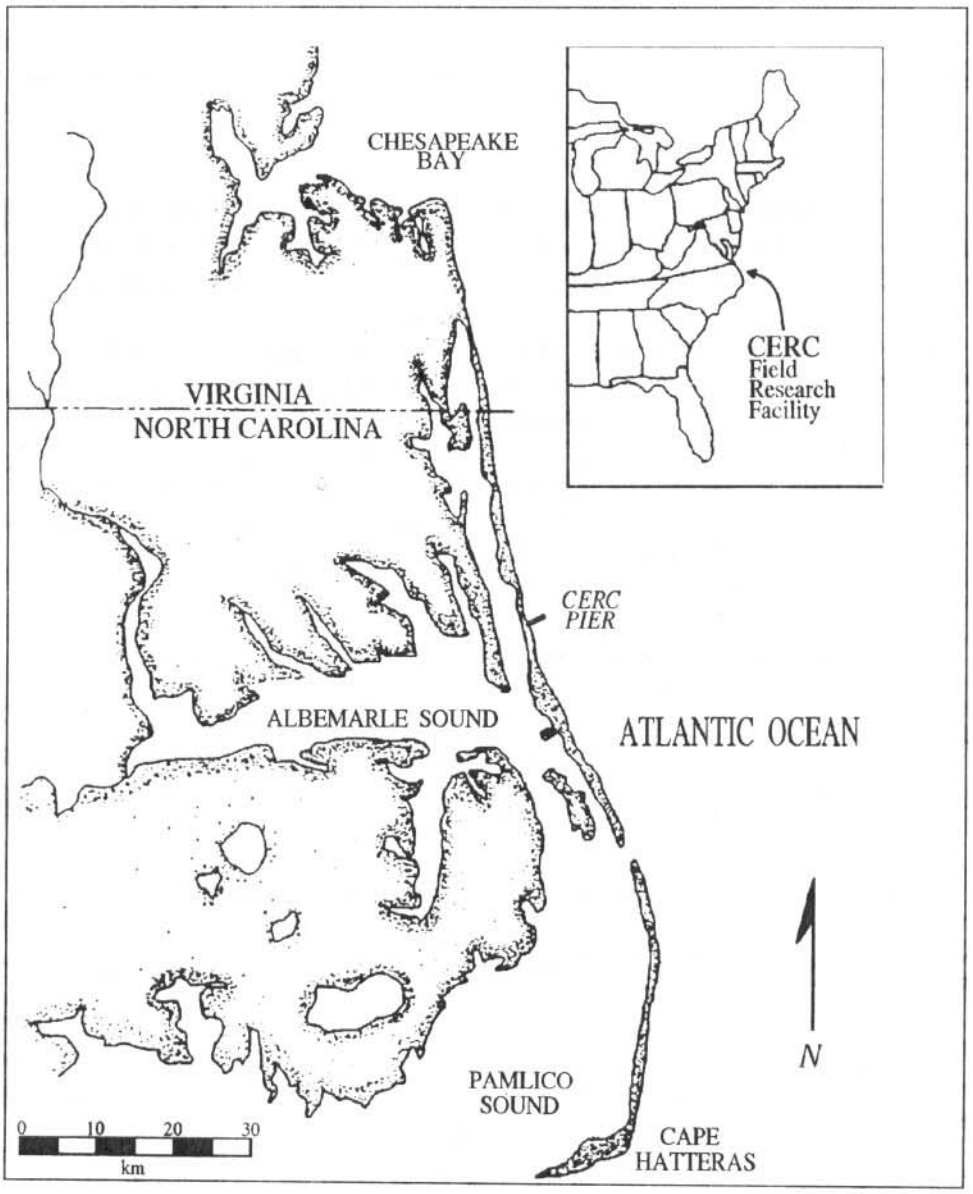

Figure 1. FRF Location Map

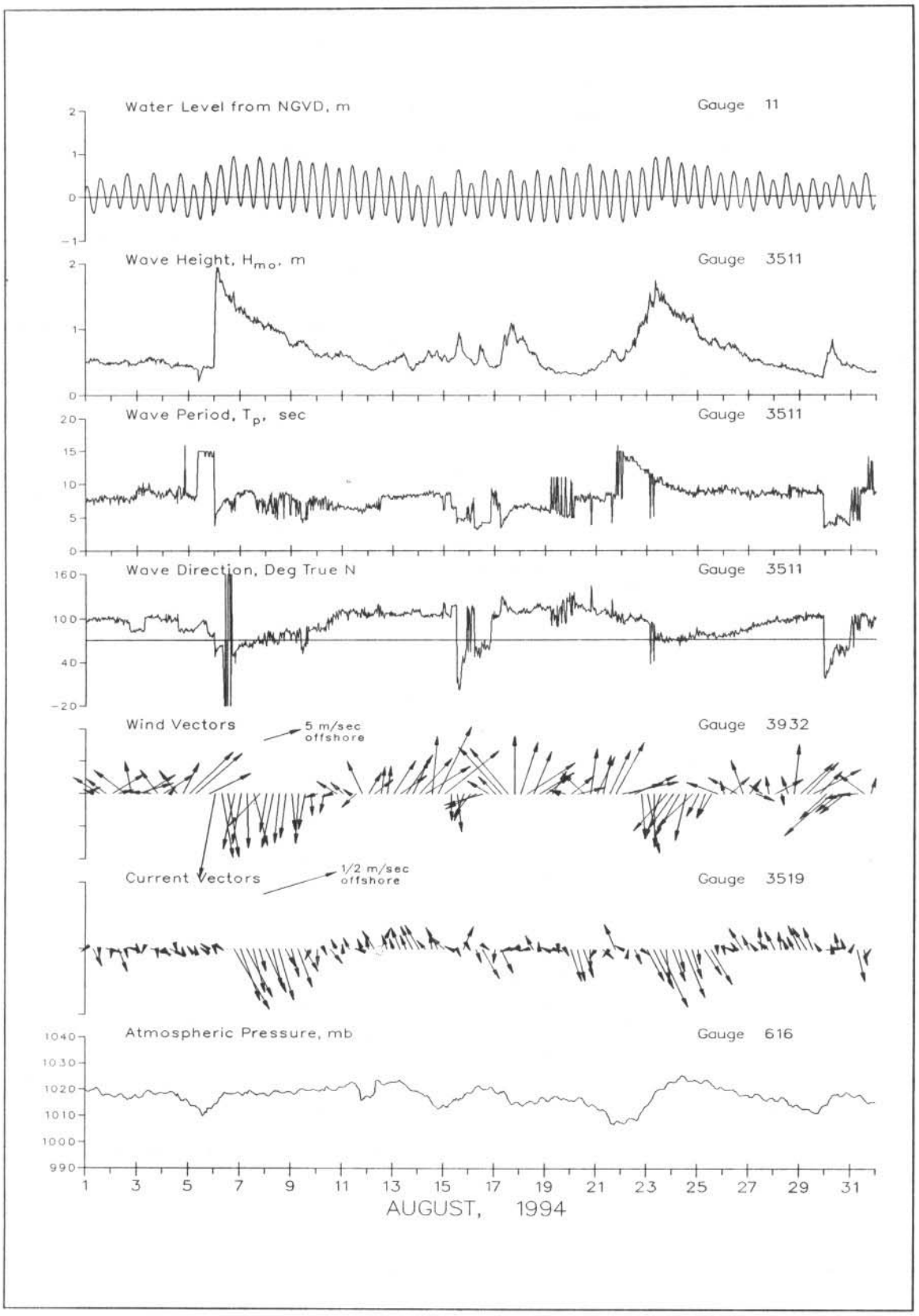

Figure 2. **Month at a Glance**

Table 1
Instrument Status/Data Availability

August 1994

Day of the month

Gauge ID	Description/Remarks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*
3519	Current meter and	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3511	Pressure Gauge 434 m north of FRF pier (0.9 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Gauge Status * = Operational / = Partial - = Non-Operational
Data Collected * = All / = Partial - = None
Visual Observations * = Complete / = Partial - = None

Table 2
Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crosshore m	FRF Coordinates Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10′ 57.03"	75 45′ 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11′ 1.23"	75 44′ 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10′ 57.71"	75 44′ 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11′ 1.04"	75 44′ 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11′ 19.14"	75 44′ 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11′ 11.28"	75 44′ 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11′ 13.70"	75 44′ 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11′ 12.48"	75 44′ 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11′ 14.06"	75 44′ 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10′ 5.10"	75 41′ 59.30"	3934.96	-2400.81	Surface	-17.00
3519	Current Meter	36 11′ 17.90"	75 44′ 35.93"	914.76	950.00	-5.30	-7.90
3511	Pressure Gauge	36 11′ 17.90"	75 44′ 35.93"	914.76	950.00	-6.70	-7.90
11	NOAA Tide Gauge	36 11′ 1.25"	75 44′ 42.60"	596.49	514.20	Surface	-7.62

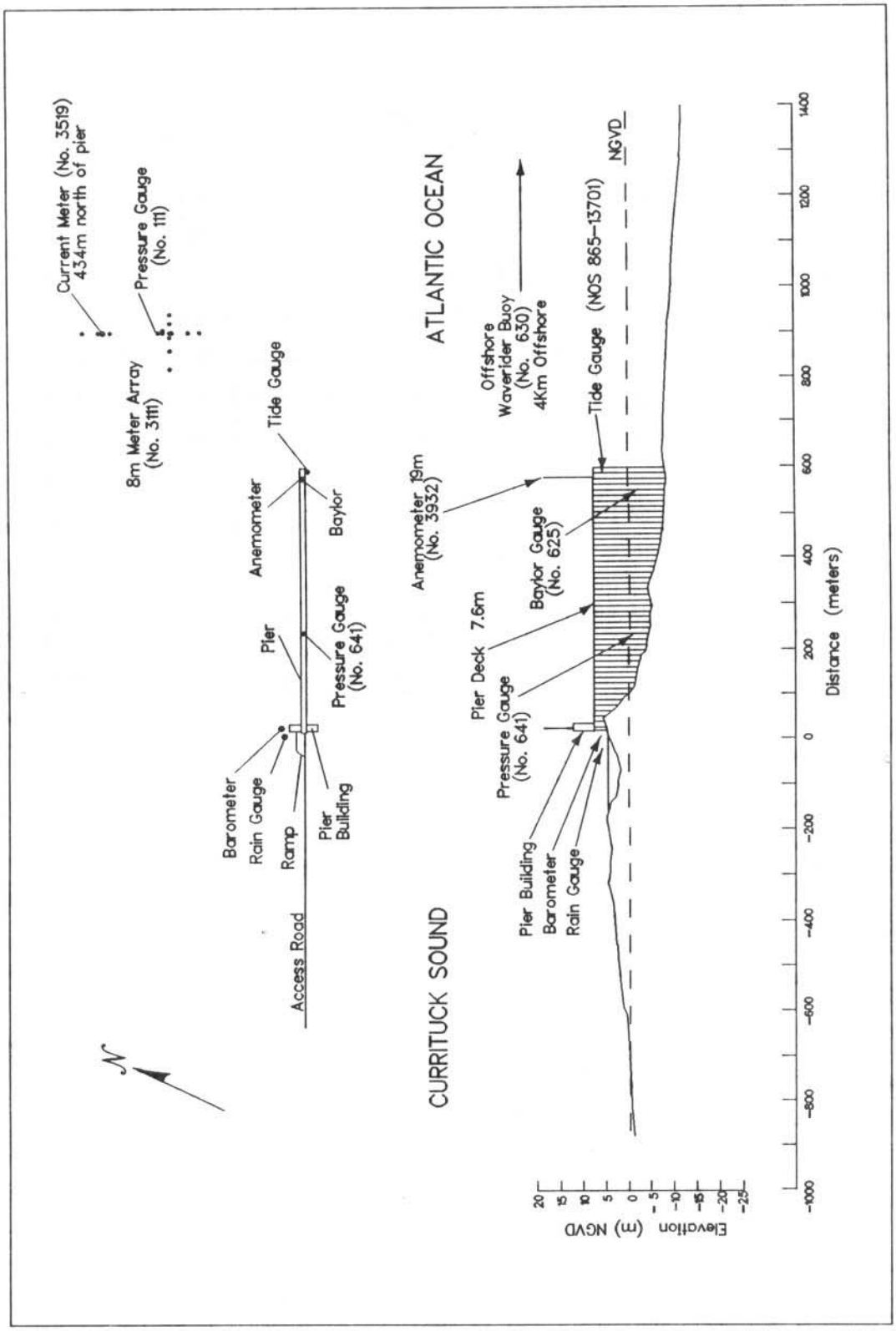

Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 4) using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
   mm x .03937 = in.

2. Millibars (mb) to inches of mercury (in. Hg) -
   mb x 0.02953 = in. Hg

3. Degrees Celsius (C) to degrees Fahrenheit (F) -
   (C x 9/5) + 32 = F

4. Meters per second (m/s) to knots (kn) -
   m/s x 1.943 = kn

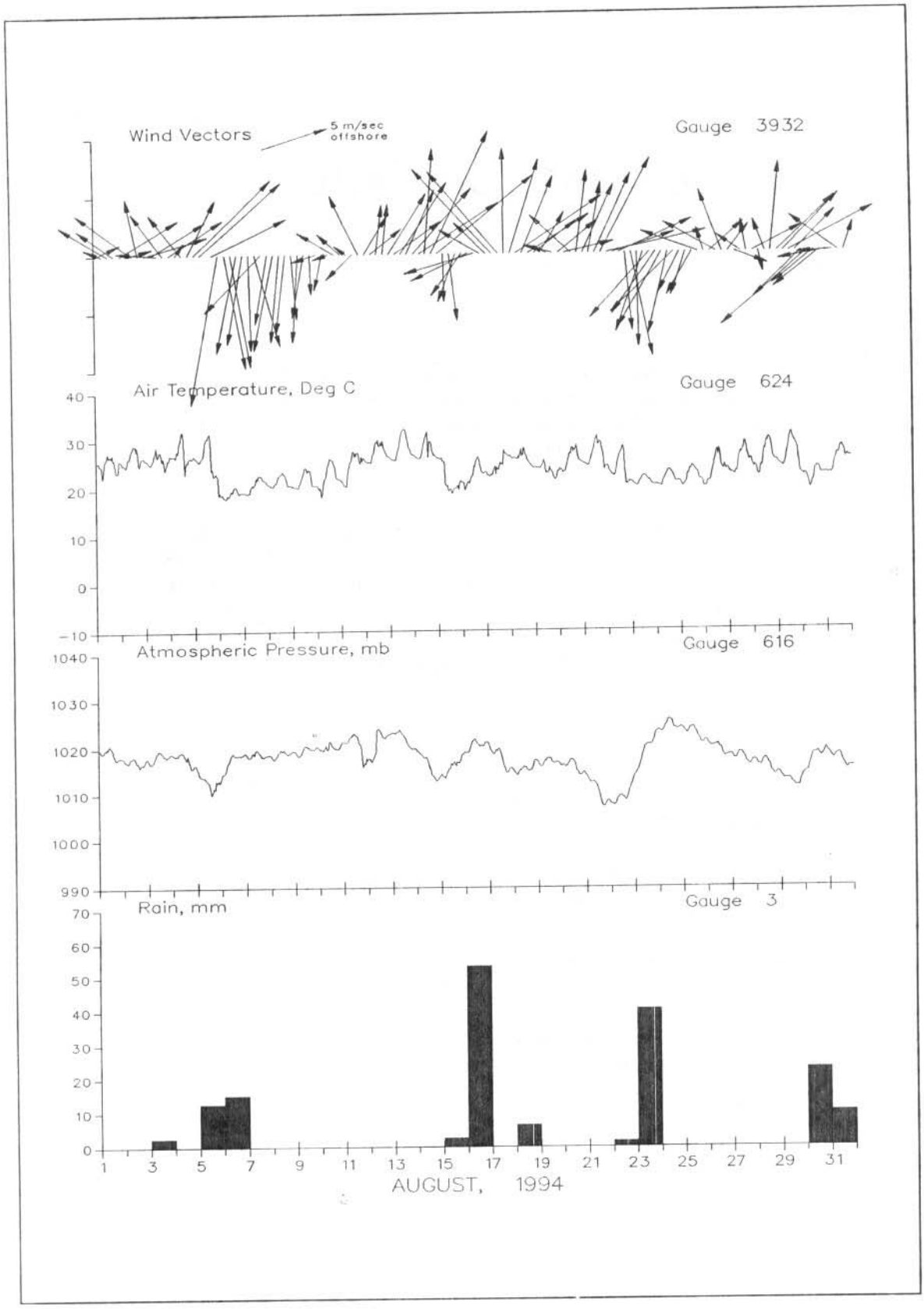

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Aug 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	2	240	25.6	1019.8	0
	700	1	116	23.9	1019.8	0
	1300	4	126	26.8	1019.9	0
	1900	3	131	23.6	1018.0	0
2	100	5	234	25.4	1017.6	0
	700	2	252	26.3	1017.8	0
	1300	5	131	28.9	1017.0	0
	1900	5	170	25.3	1016.5	0
3	100	5	250	25.9	1017.1	0
	700	5	234	25.9	1018.0	3
	1300	3	95	27.4	1019.3	0
	1900	4	148	24.1	1018.2	0
4	100	5	232	26.8	1018.6	0
	700	1	210	27.9	1019.1	0
	1300	4	147	30.5	1017.6	0
	1900	5	203	26.4	1015.7	0
5	100	9	221	26.4	1015.1	0
	700	9	223	26.3	1013.8	13
	1300	9	211	30.5	1011.7	0
	1900	6	240	22.6	1012.7	0
6	100	13	8	19.1	1014.4	0
	700	10	351	18.1	1017.0	15
	1300	10	351	19.3	1018.4	0
	1900	9	9	18.9	1018.3	0
7	100	8	8	19.2	1018.4	0
	700	8	358	20.3	1018.8	0
	1300	8	347	22.2	1018.9	0
	1900	6	39	21.8	1018.3	0
8	100	6	8	20.8	1018.2	0
	700	8	9	21.1	1018.8	0
	1300	8	4	23.0	1019.5	0
	1900	7	5	20.7	1018.8	0
9	100	6	356	20.3	1018.9	0
	700	8	2	21.1	1019.3	0
	1300	6	8	24.1	1020.2	0
	1900	3	358	20.7	1019.7	0
10	100	2	70	20.4	1019.5	0
	700	3	9	21.7	1020.0	0
	1300	1	68	26.1	1020.4	0
	1900	3	125	22.5	1019.8	0

Table 3
Meteorological Data (continued)

Aug 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	2	137	21.2	1021.1	0
	700	1	129	23.8	1022.3	0
	1300	3	41	26.5	1022.4	0
	1900	5	158	25.1	1015.9	0
12	100	4	207	25.4	1017.5	0
	700	3	227	26.7	1018.6	0
	1300	4	186	28.9	1022.9	0
	1900	4	185	27.7	1022.6	0
13	100	6	208	26.2	1023.0	0
	700	4	230	26.9	1023.7	0
	1300	7	209	31.9	1021.9	0
	1900	6	201	28.2	1019.7	0
14	100	7	218	26.6	1019.1	0
	700	7	233	26.7	1017.7	0
	1300	9	184	31.6	1015.4	0
	1900	11	202	26.9	1012.8	0
15	100	10	227	26.1	1014.2	0
	700	4	359	21.1	1014.7	3
	1300	6	354	19.5	1016.8	0
	1900	4	16	20.4	1017.0	0
16	100	4	31	21.1	1018.7	0
	700	5	60	20.8	1021.1	53
	1300	5	71	25.1	1020.6	0
	1900	4	125	23.1	1020.4	0
17	100	3	139	22.5	1019.6	0
	700	9	141	23.5	1019.3	0
	1300	9	144	24.9	1017.0	0
	1900	9	180	26.9	1014.8	0
18	100	8	195	25.9	1014.5	0
	700	8	232	26.0	1015.1	6
	1300	7	199	27.9	1015.3	0
	1900	6	233	24.8	1015.8	0
19	100	4	228	24.0	1016.3	0
	700	4	207	24.6	1016.9	0
	1300	1	116	23.0	1017.3	0
	1900	2	107	21.9	1016.6	0
20	100	4	226	23.7	1016.1	0
	700	4	254	24.1	1016.5	0
	1300	4	138	28.0	1016.2	0
	1900	7	186	25.7	1013.9	0

Table 3
Meteorological Data (concluded)

Aug 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	6	202	24.8	1013.4	0
	700	6	189	25.9	1012.4	0
	1300	7	202	30.3	1009.8	0
	1900	9	204	27.2	1007.5	0
22	100	8	255	23.8	1007.6	0
	700	5	249	22.4	1008.8	0
	1300	6	242	27.3	1009.0	0
	1900	7	355	20.4	1011.0	0
23	100	9	350	20.7	1014.0	0
	700	8	359	20.9	1017.6	41
	1300	7	16	22.0	1020.3	0
	1900	7	37	20.6	1021.6	0
24	100	6	31	20.3	1023.1	0
	700	7	26	21.3	1024.4	0
	1300	7	11	23.3	1025.2	0
	1900	7	41	21.0	1023.5	0
25	100	4	24	20.5	1023.3	0
	700	4	16	22.6	1023.7	0
	1300	4	26	23.8	1022.8	0
	1900	4	113	21.3	1020.5	0
26	100	2	165	19.9	1020.3	0
	700	4	223	22.7	1020.0	0
	1300	5	123	26.4	1019.5	0
	1900	5	162	23.8	1017.8	0
27	100	3	213	23.0	1017.8	0
	700	3	294	22.9	1018.5	0
	1300	2	129	27.3	1017.4	0
	1900	3	172	25.8	1016.2	0
28	100	4	238	24.3	1016.4	0
	700	2	350	23.9	1016.8	0
	1300	3	162	29.5	1016.0	0
	1900	8	185	26.3	1013.7	0
29	100	6	222	24.6	1013.4	0
	700	6	220	24.8	1012.8	0
	1300	7	238	31.0	1011.7	0
	1900	5	220	27.9	1011.5	0
30	100	5	41	22.3	1014.2	0
	700	9	44	19.8	1017.7	23
	1300	4	47	23.5	1018.4	0
	1900	5	47	22.4	1018.3	0
31	100	4	78	22.4	1017.9	0
	700	2	86	24.0	1017.8	10
	1300	5	131	27.4	1016.7	0
	1900	3	195	25.8	1015.2	0
		Resultant		Mean	Mean	Total
		1	204	24.2	1017.6	167

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first consists of a pressure gauge co-located with a biaxial electromagnetic current meter, collectively referred to as gauge number 3511. The current meter measures two orthogonal horizontal water velocities, U and V, and the pressure sensor measures water depth and dynamic wave pressure P. The computation of wave height and direction is based on the first five Fourier coefficients of the auto- and cross-spectra of pressure and current velocity. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Aug 1994

Day	Hour	641 Pressure Gauge Hmo,m	Tp,sec	625 Baylor Gauge Hmo,m	Tp,sec	3511 8 Meter PUV Hmo,m	Tp,sec	Dir,TN	630 Waverider Hmo,m	Tp,sec
1	0100	0.35	7.8	0.41	8.1	0.50	7.4	94	0.54	8.3
	0700	0.34	6.8	0.52	7.0	0.53	7.8	102	0.60	7.0
	1300	0.43	8.1	0.46	8.3	0.52	8.1	96	0.55	7.8
	1900	0.30	8.3	0.46	7.8	0.46	8.3	99	0.52	8.1
2	0100	0.33	7.8	0.42	7.8	0.48	8.1	103	0.52	8.1
	0700	0.31	8.3	0.46	7.8	0.46	7.0	99	0.51	7.8
	1300	0.35	8.3	0.47	8.3	0.55	7.6	97	0.55	7.4
	1900	0.36	8.3	0.44	8.3	0.45	8.3	81	0.55	8.9
3	0100	0.39	10.3	0.49	9.9	0.49	9.2	83	0.59	9.2
	0700	0.37	9.5	0.46	9.5	0.50	9.5	87	0.60	9.2
	1300	0.42	8.9	0.53	9.2	0.58	9.2	100	0.53	8.6
	1900	0.49	8.1	0.49	8.3	0.54	8.3	106	0.62	8.6
4	0100	0.41	8.3	0.52	8.3	0.54	8.1	99	0.63	8.9
	0700	0.33	8.9	0.41	8.9	0.45	9.2	103	0.52	8.9
	1300	0.40	8.3	0.44	9.2	0.44	9.2	96	0.54	8.6
	1900	0.41	8.3	0.44	8.6	0.44	8.3	81	0.54	8.9
5	0100	0.36	7.4	0.44	8.3	0.46	8.6	83	0.52	8.3
	0700	0.34	15.1	0.39	15.1	0.42	8.1	87	0.53	8.9
	1300	0.33	15.1	0.44	15.1	0.43	15.1	0	0.49	15.1
	1900	0.39	14.3	0.39	15.1	0.43	14.3	80	0.56	15.1
6	0100	0.62	4.5	1.17	4.5	1.15	4.4	52	1.27	4.5
	0700	0.94	6.6	1.45	6.3	1.72	6.8	62	1.89	6.6
	1300	0.61	7.0	1.28	8.3	1.50	8.1	274	1.43	7.8
	1900	0.94	7.0	1.26	7.4	1.44	8.1	54	1.50	5.6
7	0100	0.55	6.5	1.26	8.6	1.36	8.6	62	1.59	7.8
	0700	0.78	4.7	1.12	8.9	1.18	9.2	61	1.35	9.2
	1300	0.55	4.4	1.11	8.3	1.09	8.9	69	1.30	8.3
	1900	0.75	6.3	1.06	7.6	1.10	7.4	70	1.23	7.6
8	0100	0.60	5.5	1.04	5.7	1.03	5.7	62	1.13	5.7
	0700	0.70	5.1	1.00	5.6	1.04	6.1	80	1.27	5.6
	1300	0.53	5.4	0.99	7.8	0.97	8.1	72	1.12	7.4
	1900	0.62	4.7	0.87	8.9	0.90	8.9	83	1.02	6.3
9	0100	0.42	4.9	0.77	4.9	0.77	7.6	79	0.89	5.2
	0700	0.57	5.1	0.79	7.8	0.83	5.5	73	0.94	5.5
	1300	0.43	4.7	0.81	4.6	0.79	5.1	67	0.86	4.7
	1900	0.43	5.9	0.66	6.6	0.69	7.8	84	0.78	6.6
10	0100	0.31	6.1	0.64	6.6	0.62	7.2	91	0.66	7.8
	0700	0.38	6.3	0.57	7.8	0.60	7.8	82	0.69	6.6
	1300	0.33	6.1	0.67	7.2	0.58	7.0	95	0.61	8.1
	1900	0.47	6.8	0.71	6.6	0.59	6.8	103	0.74	6.5

Table 4
Wave Data (continued)

Aug 1994

		641 Pressure Gauge		625 Baylor Gauge		3511 8 Meter PUV			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.46	6.6	0.79	6.8	0.59	6.6	111	0.78	6.6
	0700	0.45	6.1	0.71	6.5	0.58	6.5	106	0.71	6.3
	1300	0.37	6.3	0.48	6.3	0.49	6.3	110	0.58	6.3
	1900	0.35	5.9	0.47	5.6	0.47	5.6	112	0.56	6.0
12	0100	0.31	6.6	0.42	6.6	0.40	7.2	101	0.50	7.2
	0700	0.29	6.3	0.40	6.6	0.39	6.6	112	0.47	5.7
	1300	0.41	8.6	0.40	6.6	0.46	8.1	103	0.55	6.1
	1900	0.38	7.4	0.50	8.6	0.49	8.3	107	0.65	8.1
13	0100	0.43	8.3	0.50	8.6	0.54	8.3	105	0.65	8.1
	0700	0.44	7.8	0.62	8.3	0.59	8.1	103	0.71	8.3
	1300	0.46	8.3	0.46	8.3	0.56	8.1	109	0.56	8.6
	1900	0.29	8.3	0.45	8.3	0.36	8.6	113	0.52	8.3
14	0100	0.44	8.3	0.45	8.3	0.52	8.3	112	0.58	8.6
	0700	0.38	9.2	0.56	8.3	0.55	8.3	105	0.71	8.6
	1300	0.53	8.9	0.52	8.9	0.56	8.9	101	0.67	8.6
	1900	0.44	4.7	0.58	8.9	0.60	8.6	104	0.90	5.2
15	0100	0.54	6.0	0.54	6.0	0.61	6.3	118	0.85	6.3
	0700	0.38	6.3	0.48	8.3	0.53	6.8	116	0.68	7.0
	1300	0.70	7.0	0.72	4.6	0.78	4.6	20	1.04	4.5
	1900	0.56	5.1	0.67	5.0	0.65	4.5	38	0.81	4.9
16	0100	0.52	7.0	0.57	4.5	0.55	4.2	54	0.65	6.3
	0700	0.37	5.9	0.53	3.0	0.48	3.4	56	0.57	6.8
	1300	0.50	4.5	0.66	4.4	0.70	4.3	63	0.76	3.9
	1900	0.30	4.5	0.48	4.2	0.45	4.1	56	0.50	5.6
17	0100	0.30	7.2	0.43	9.2	0.44	9.2	100	0.53	6.1
	0700	0.42	4.1	0.74	3.4	0.56	3.8	128	0.77	3.4
	1300	0.70	5.9	0.85	5.4	0.92	5.5	112	1.08	5.9
	1900	0.73	6.6	0.90	6.5	0.98	7.0	108	1.09	5.9
18	0100	0.63	6.8	0.91	6.8	0.85	7.0	107	1.05	6.0
	0700	0.65	7.0	0.66	7.0	0.73	7.2	108	0.95	7.0
	1300	0.53	6.5	0.62	6.5	0.63	6.6	114	0.79	6.5
	1900	0.41	6.1	0.43	6.5	0.46	6.1	120	0.63	6.8
19	0100	0.31	6.1	0.44	6.3	0.40	6.1	113	0.53	6.0
	0700	0.31	6.1	0.34	8.3	0.38	7.6	106	0.52	5.9
	1300	0.27	5.7	0.35	11.2	0.34	6.1	110	0.43	5.4
	1900	0.29	5.9	0.32	5.5	0.36	11.2	92	0.46	5.3
20	0100	0.28	5.0	0.42	5.1	0.33	5.0	131	0.39	5.5
	0700	0.30	7.4	0.33	7.8	0.32	7.6	112	0.41	8.3
	1300	0.23	5.3	0.37	8.3	0.35	7.4	114	0.39	8.1
	1900	0.33	8.3	0.40	3.8	0.37	8.1	108	0.54	7.8

Table 4
Wave Data (concluded)

Aug 1994

		641 Pressure Gauge		625 Baylor Gauge		3511 8 Meter PUV			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.30	4.7	0.44	7.6	0.41	8.3	103	0.56	8.3
	0700	0.48	8.6	0.46	7.6	0.51	7.6	110	0.64	7.6
	1300	0.44	5.2	0.61	8.6	0.59	8.3	102	0.73	8.6
	1900	0.55	15.1	0.54	8.1	0.65	8.3	106	0.80	8.3
22	0100	0.40	15.1	0.50	15.1	0.54	8.1	105	0.68	14.3
	0700	0.55	14.3	0.53	13.5	0.65	13.5	103	0.75	14.3
	1300	0.54	13.5	0.79	13.5	0.78	13.5	95	0.89	13.5
	1900	0.83	12.9	0.95	12.2	1.04	12.2	99	1.22	12.8
23	0100	0.72	11.7	1.02	11.7	1.23	12.2	94	inoperative	
	0700	1.00	10.7	1.25	5.6	1.43	11.2	90	1.21	11.2
	1300	0.70	11.7	1.33	10.3	1.44	11.2	80	1.66	11.2
	1900	0.83	10.3	1.25	10.3	1.38	9.5	69	1.53	10.3
24	0100	0.64	9.9	1.17	9.9	1.19	9.9	70	1.41	9.5
	0700	0.70	9.2	1.15	8.9	1.23	8.9	61	1.25	9.2
	1300	0.63	9.5	1.14	9.2	1.13	8.9	72	1.22	8.9
	1900	0.66	8.6	1.17	8.6	1.09	8.9	76	1.36	8.9
25	0100	0.46	9.2	0.83	9.2	0.88	9.9	74	0.94	8.6
	0700	0.44	8.3	0.77	9.9	0.86	8.3	76	0.95	8.9
	1300	0.37	9.2	0.76	9.2	0.74	8.6	78	0.95	7.8
	1900	0.35	8.9	0.75	8.3	0.76	8.9	73	0.86	8.9
26	0100	0.28	9.5	0.68	8.9	0.67	9.5	76	0.71	8.9
	0700	0.30	8.6	0.68	8.6	0.77	9.2	81	0.77	9.2
	1300	0.39	9.2	0.65	9.2	0.67	9.5	78	0.74	9.5
	1900	0.33	8.9	0.59	8.6	0.57	8.9	83	0.65	8.9
27	0100	0.30	9.2	0.49	8.9	0.50	8.3	84	0.57	8.9
	0700	0.31	8.6	0.49	8.1	0.52	8.1	89	0.57	8.6
	1300	0.34	8.3	0.44	8.6	0.49	9.2	91	0.51	9.2
	1900	0.29	9.2	0.42	9.2	0.45	8.9	96	0.53	8.9
28	0100	0.30	9.2	0.41	8.6	0.43	9.2	96	0.49	8.9
	0700	0.25	9.2	0.42	8.9	0.40	7.8	96	0.47	8.9
	1300	0.30	8.1	0.36	8.3	0.40	8.6	98	0.40	8.1
	1900	0.20	9.5	0.36	9.2	0.38	9.5	100	0.43	8.6
29	0100	0.25	9.5	0.34	9.2	0.35	8.9	101	0.40	8.6
	0700	0.20	9.2	0.30	8.9	0.33	8.6	102	0.35	8.9
	1300	0.24	9.2	0.27	8.6	0.32	8.9	104	0.34	9.2
	1900	0.17	9.2	0.26	9.5	0.27	9.2	100	0.30	8.6
30	0100	0.42	3.6	0.58	3.6	0.52	3.7	28	0.59	3.5
	0700	0.55	4.6	0.88	4.5	0.84	4.3	40	0.95	4.5
	1300	0.38	4.5	0.56	5.4	0.53	5.3	47	0.65	5.4
	1900	0.30	3.6	0.51	4.1	0.44	4.3	55	0.59	5.0
31	0100	0.30	8.6	0.47	4.3	0.40	9.2	101	0.54	5.1
	0700	0.25	4.1	0.44	4.3	0.41	9.5	103	0.50	4.9
	1300	0.25	9.2	0.39	8.9	0.37	8.6	105	0.43	9.5
	1900	0.21	9.2	0.36	9.2	0.36	13.5	84	0.38	9.2
Mean		0.44	7.8	0.63	7.9	0.65	8.0	91	0.75	7.8
Std dev		0.17	2.5	0.27	2.3	0.30	2.1	27	0.32	2.2

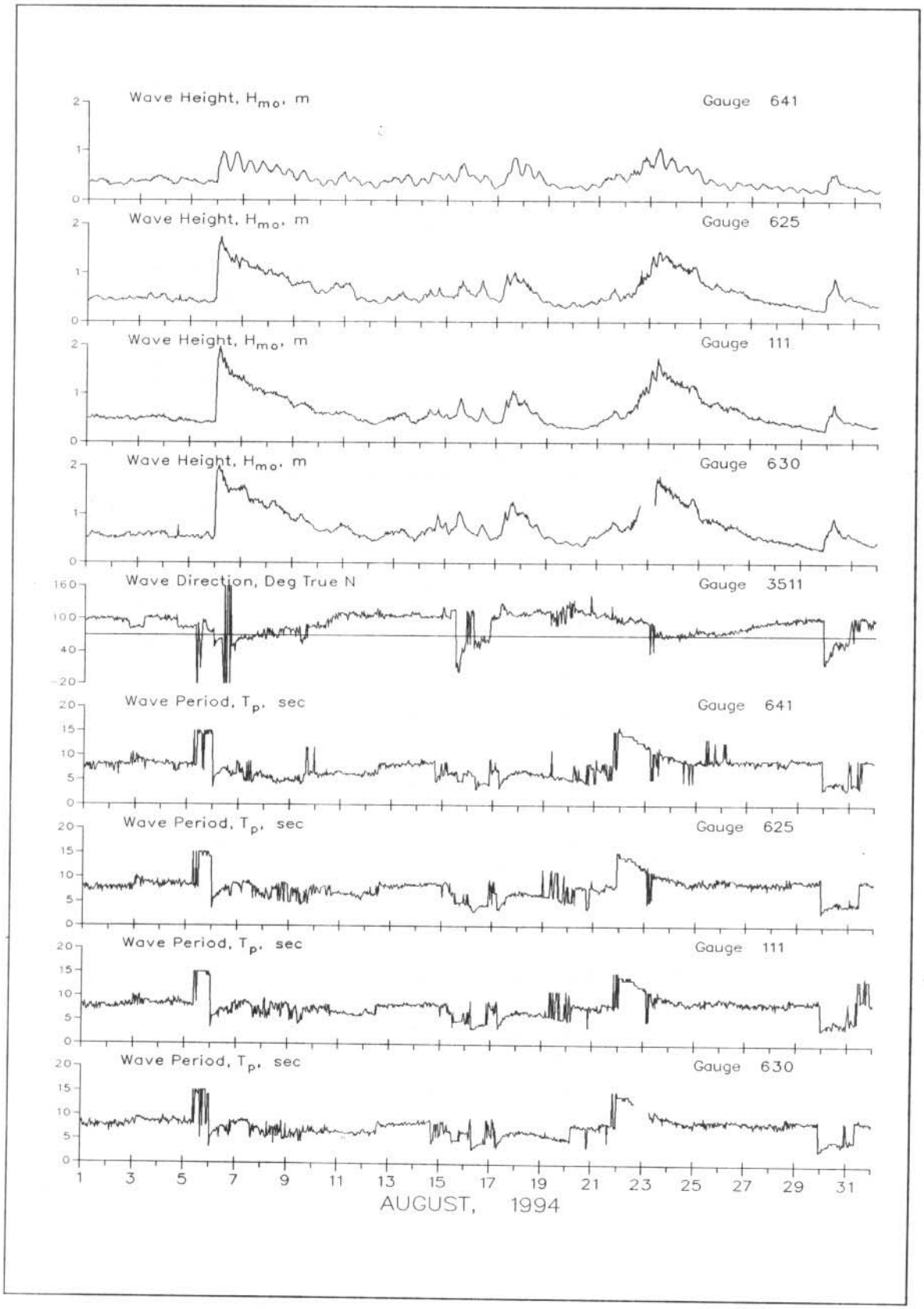

Figure 5. **Wave Heights and Periods**

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3519

AUGUST 1994

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	-3	2	4	229
	700	1	15	15	155
	1300	-1	6	7	177
	1900	9	7	11	106
2	100	-3	7	8	188
	700	0	18	18	161
	1300	0	8	8	163
	1900	-1	-1	3	284
3	100	1	-3	4	348
	700	-2	3	4	199
	1300	11	9	14	109
	1900	-1	7	7	175
4	100	2	7	7	142
	700	7	9	12	121
	1300	0	3	3	168
	1900	0	0	0	
5	100	0	-1	2	323
	700	0	-1	2	349
	1300	0	0	0	
	1900	-2	-4	6	305
6	100	0	4	4	163
	700	1	2	2	128
	1300	0	0	0	
	1900	6	51	51	153
7	100	0	41	41	162
	700	3	40	40	155
	1300	-3	34	34	167
	1900	-1	17	17	166
8	100	1	36	36	158
	700	-3	29	30	167
	1300	-3	40	40	166
	1900	2	15	15	153
9	100	-2	22	22	167
	700	0	30	30	162
	1300	3	19	19	152
	1900	-5	6	9	205
10	100	-3	12	13	178
	700	0	5	5	155
	1300	4	13	14	143
	1900	0	-7	8	334
11	100	1	-3	4	353
	700	0	-8	9	336
	1300	0	0	0	
	1900	0	-7	8	337
12	100	2	-8	9	350
	700	-2	-15	16	329
	1300	11	-11	16	22
	1900	0	-10	11	342
13	100	0	-7	8	340
	700	0	-16	17	340
	1300	0	-10	11	338
	1900	-1	-18	19	335
14	100	-2	-19	20	333
	700	-2	-7	9	318
	1300	3	-11	12	355
	1900	-1	-17	18	334
15	100	-4	-11	13	316
	700	-2	-2	4	300
	1300	1	6	6	155
	1900	12	-13	18	21
16	100	0	1	1	150
	700	0	11	11	161
	1300	3	25	25	153
	1900	0	1	1	129
17	100	-3	10	11	184
	700	1	20	20	157
	1300	-4	0	5	252
	1900	-2	1	3	234
18	100	-6	-2	8	276
	700	-4	0	5	252
	1300	0	-11	12	333
	1900	1	-4	6	355
19	100	-1	-1	3	296
	700	6	4	7	101
	1300	0	3	3	174
	1900	1	6	6	152
20	100	-1	25	25	164
	700	-2	24	25	168
	1300	0	22	22	163
	1900	-4	15	16	179
21	100	-6	5	8	215
	700	4	9	10	136
	1300	-5	4	7	217
	1900	0	-19	20	339
22	100	-2	-3	5	303
	700	0	0	0	
	1300	1	12	12	157
	1900	4	6	7	126
23	100	2	26	26	155
	700	2	32	32	156
	1300	2	47	47	158
	1900	-6	24	25	175
24	100	0	25	25	161
	700	-1	17	17	168
	1300	0	39	39	161
	1900	0	23	23	163
25	100	-2	11	11	175
	700	4	22	22	150
	1300	4	29	30	152
	1900	0	4	4	173
26	100	0	4	4	164
	700	-2	-2	4	292
	1300	-1	-5	6	323
	1900	-2	-17	18	330
27	100	0	-10	11	336
	700	-1	-5	6	321
	1300	4	-15	17	353
	1900	-3	-7	9	310
28	100	-1	-14	15	334
	700	3	-12	13	352
	1300	0	-7	8	337
	1900	0	-9	10	334
29	100	0	-18	19	336
	700	-2	-17	18	331
	1300	0	-16	17	338
	1900	0	-5	6	326
30	100	11	3	12	86
	700	1	-3	4	350
	1300	2	-11	13	348
	1900	0	-7	8	340
31	100	3	-2	5	25
	700	-3	25	25	169
	1300	-1	12	12	170
	1900	1	0	1	31

KEY:

+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Aug 1994

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	0	24	24	160	0	0	0		South	11	N
2	0	30	30	160	0	0	0		North	3	N
3	0	0	0		0	-12	12	340	South	0	
4	0	19	19	160	0	0	0		South	0	
5	34	23	41	104	10	-19	21	7	South	8	N
6	-8	55	56	169	0	87	87	160	North	37	S
7	-14	47	49	177	-6	61	61	166	North	42	S
8	0	87	87	160	0	87	87	160	North	30	S
9	0	61	61	160	0	51	51	160	North	0	
10	0	17	17	160	0	0	0		North	0	
11	0	0	0		0	-16	16	340	South	0	
12	0	-23	23	340	0	-15	15	340	South	0	
13	0	-29	29	340	0	-30	30	340	South	5	N
14	0	-23	23	340	0	-30	30	340	South	14	N
15	0	0	0		0	0	0		North	3	S
16	0	-18	18	340	0	0	0		South	6	N
17	0	0	0		0	-41	41	340	South	30	N
18	7	-14	15	7	0	-25	25	340	South	11	N
19	4	-17	18	354	11	-7	13	36	South	2	N
20	17	68	70	146	0	0	0		South	0	
21	7	-28	29	354	20	-20	29	25	South	42	N
22	15	20	25	70	15	20	25	70	South	3	N
23	-11	36	37	177	0	51	51	160	North	89	S
24	-9	27	28	179	0	61	61	160	North	48	S
25	0	14	14	160	0	41	41	160	North	25	S
26	-14	-23	26	309	-8	-10	13	303	South	11	N
27	-5	-15	16	323	0	-10	10	340	South	9	N
28	0	-29	29	340	0	-14	14	340	South	9	N
29	6	-20	21	357	6	-16	17	2	South	15	N
30	-8	10	13	250	-12	29	31	182	North	23	S
31	0	24	24	160	-2	20	20	154	North	0	

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Aug 1994

Day	Time	Wave Approach Angle at Pier End deg from True N Primary	Secondary	Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End Temp.,C	Density g/cc	Secchi Vis.,m
1	0630	110			9	19.7	1.0251	4.6
2	0630	110			5	22.0	1.0225	3.7
3	0630	140	80		4	18.3	1.0255	3.0
4	0615	140	80		9	21.7	1.0240	3.7
5	0545	90	120		15	16.1	1.0260	2.7
6	0620	50		inoperative	116	19.4	1.0252	2.4
7	0615	50		59	110	20.0	1.0212	2.4
8	0630	65		68	13	21.7	1.0200	1.8
9	0630	50		70	11	21.6	1.0205	2.1
10	0630	50	70		11	21.9	1.0200	1.8
11	0630	110	70		5	22.2	1.0219	3.0
12	0630	110	70		7	22.8	1.0210	3.0
13	0700	85			12	20.0	1.0243	1.8
14	1030	100	80		10	20.0	1.0250	1.8
15	0700	140	70		11	18.3	1.0250	1.8
16	0700	70			9	21.7	1.0243	3.7
17	0645	115		100	11	23.3	1.0204	3.7
18	0713	95		115	108	18.3	1.0259	2.1
19	0751	100			5	19.4	1.0254	3.0
20	0602	100			2	21.9	1.0211	3.7
21	1026	110	135	103	18	20.6	1.0246	4.6
22	0630	85			66	18.6	1.0261	3.0
23	0720	60	90	45	191	20.6	1.0025	2.4
24	0630	60		55	134	22.2	1.0211	1.8
25	0625	65	75	65	108	22.2	1.0201	2.7
26	0707	65	75		82	22.5	1.0211	2.1
27	1020	80			7	22.8	1.0220	3.4
28	1020	80			9	23.9	1.0227	5.5
29	0640	90			41	22.8	1.0236	2.4
30	0700	60		inoperative	84	23.3	1.0231	3.7
31	0607	90			13	23.9	1.0181	3.0

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

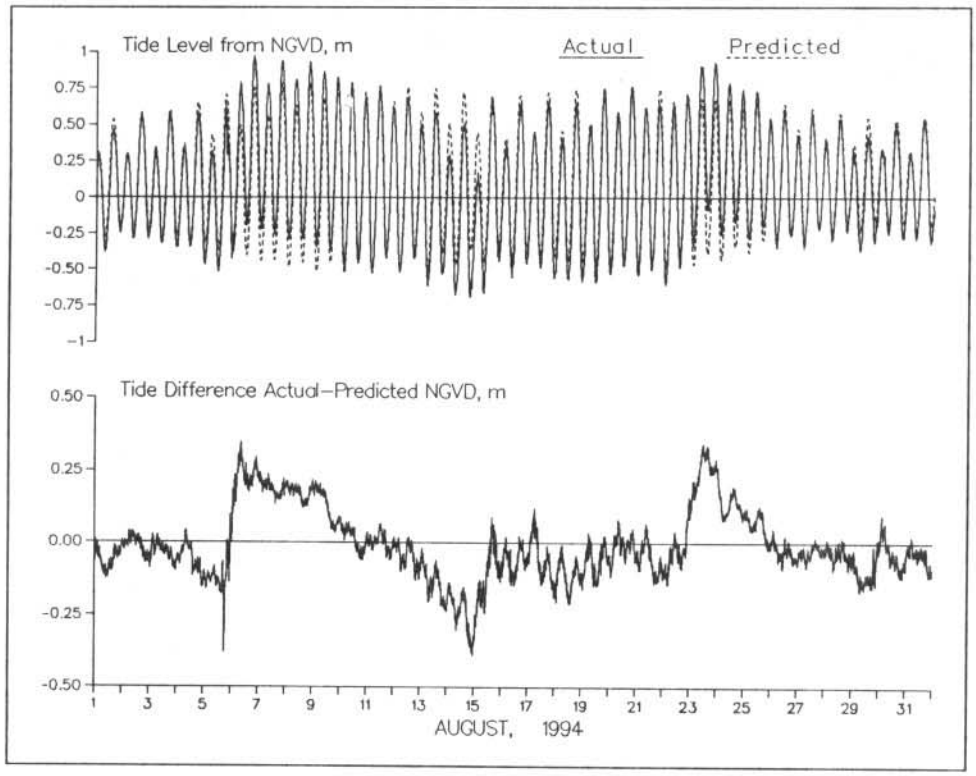

Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

AUG 1994 Tide Levels

	High			Low		Mean	Range		High			Low		Mean	Range
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day	Time	m	m	m
1	0136	0.31	1	0742	-0.38	-0.04	0.69	16	1512	0.64	16	2154	-0.46	0.10	1.10
1	1512	0.46	1	2042	-0.25	0.11	0.71	17	0342	0.45	17	1000	-0.48	0.01	0.94
2	0300	0.30	2	0818	-0.29	0.03	0.59	17	1624	0.65	17	2224	-0.56	0.05	1.21
2	1518	0.58	2	2148	-0.29	0.14	0.87	18	0424	0.41	18	1100	-0.57	-0.08	0.98
3	0318	0.34	3	0942	-0.32	0.01	0.66	18	1706	0.65	18	2318	-0.58	0.03	1.22
3	1606	0.59	3	2306	-0.35	0.11	0.94	19	0524	0.50	19	1106	-0.59	-0.03	1.09
4	0454	0.34	4	1024	-0.34	0.01	0.69	19	1748	0.75	20	0006	-0.53	0.09	1.28
4	1648	0.58	4	2342	-0.47	0.06	1.05	20	0630	0.59	20	1212	-0.47	0.06	1.06
5	0512	0.32	5	1124	-0.51	-0.08	0.83	20	1836	0.76	21	0112	-0.54	0.12	1.30
5	1718	0.62	5	2306	-0.43	0.10	1.05	21	0630	0.62	21	1254	-0.50	0.08	1.12
6	0630	0.79	6	1212	-0.19	0.30	0.99	21	1906	0.64	22	0136	-0.60	0.03	1.25
6	1830	0.97	7	0118	-0.22	0.38	1.20	22	0812	0.62	22	1418	-0.48	0.08	1.11
7	0654	0.78	7	1254	-0.25	0.27	1.04	22	1948	0.70	23	0148	-0.34	0.19	1.04
7	1918	0.94	8	0130	-0.29	0.33	1.23	23	0806	0.90	23	1454	-0.09	0.42	0.99
8	0754	0.81	8	1418	-0.28	0.27	1.09	23	2024	0.93	24	0306	-0.26	0.35	1.19
8	1954	0.94	9	0200	-0.35	0.31	1.28	24	0918	0.79	24	1500	-0.17	0.30	0.95
9	0824	0.87	9	1430	-0.36	0.27	1.23	24	2112	0.74	25	0324	-0.28	0.22	1.03
9	2036	0.82	10	0306	-0.49	0.18	1.32	25	0936	0.73	25	1600	-0.20	0.25	0.93
10	0900	0.79	10	1512	-0.46	0.16	1.25	25	2130	0.55	26	0430	-0.34	0.10	0.89
10	2130	0.69	11	0342	-0.52	0.09	1.21	26	1036	0.61	26	1700	-0.26	0.15	0.87
11	0954	0.77	11	1542	-0.40	0.17	1.17	26	2242	0.43	27	0442	-0.35	0.04	0.77
11	2230	0.62	12	0424	-0.52	0.05	1.14	27	1100	0.57	27	1736	-0.22	0.16	0.79
12	1100	0.69	12	1706	-0.43	0.13	1.11	27	2306	0.39	28	0512	-0.30	0.05	0.69
12	2300	0.50	13	0524	-0.61	-0.04	1.11	28	1212	0.54	28	1830	-0.23	0.15	0.77
13	1100	0.58	13	1800	-0.53	0.03	1.11	29	0006	0.32	29	0618	-0.37	-0.01	0.68
14	0006	0.29	14	0612	-0.68	-0.18	0.97	29	1242	0.42	29	1854	-0.31	0.06	0.73
14	1330	0.51	14	1918	-0.69	-0.07	1.20	30	0124	0.34	30	0730	-0.25	0.07	0.59
15	0130	0.17	15	0730	-0.67	-0.22	0.84	30	1318	0.51	30	2030	-0.28	0.11	0.79
15	1342	0.69	15	2054	-0.44	0.11	1.13	31	0200	0.31	31	0818	-0.28	0.03	0.59
16	0230	0.36	16	0842	-0.56	-0.06	0.91	31	1442	0.54	31	2100	-0.31	0.12	0.86

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in July 1994 and the survey(s) in August 1994 on profile line 62, located 407 m north of the pier.

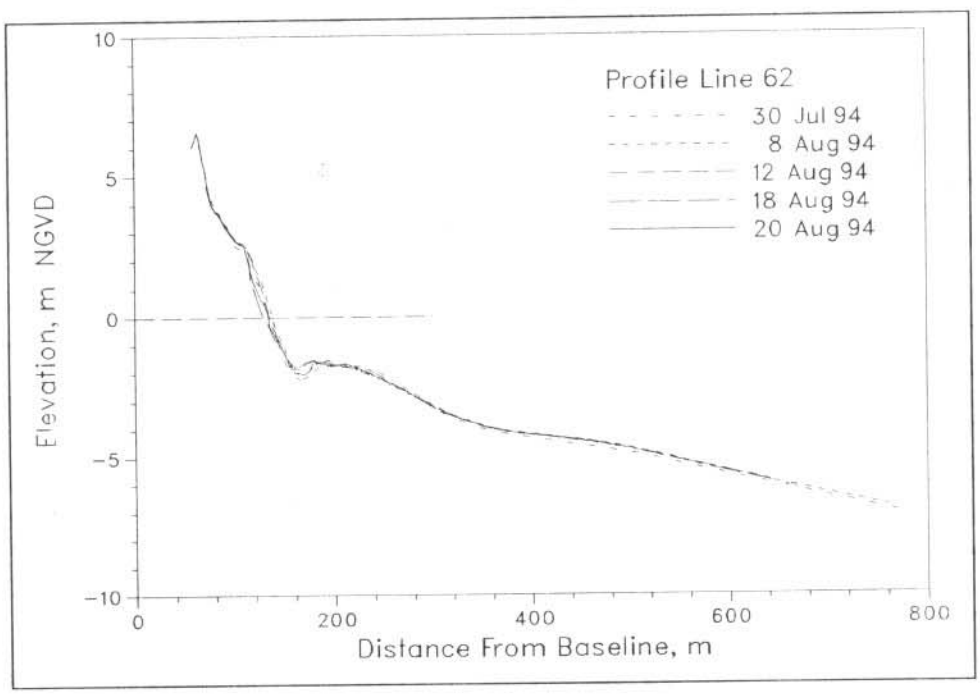

Figure 7. Monthly CRAB Profiles on Profile Line 62.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1994. Cross-hatched areas indicate changes to the annual envelope which occurred in August.

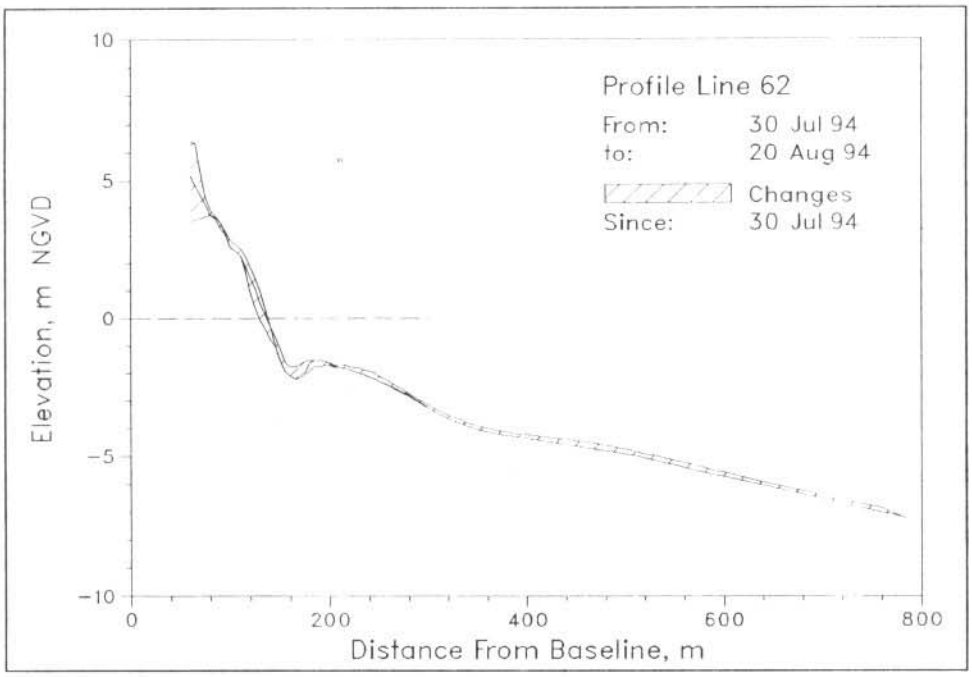

Figure 8. Profile Envelope - Profile Line 62.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 30 July. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey in August. Figure 9 is included for reference only.

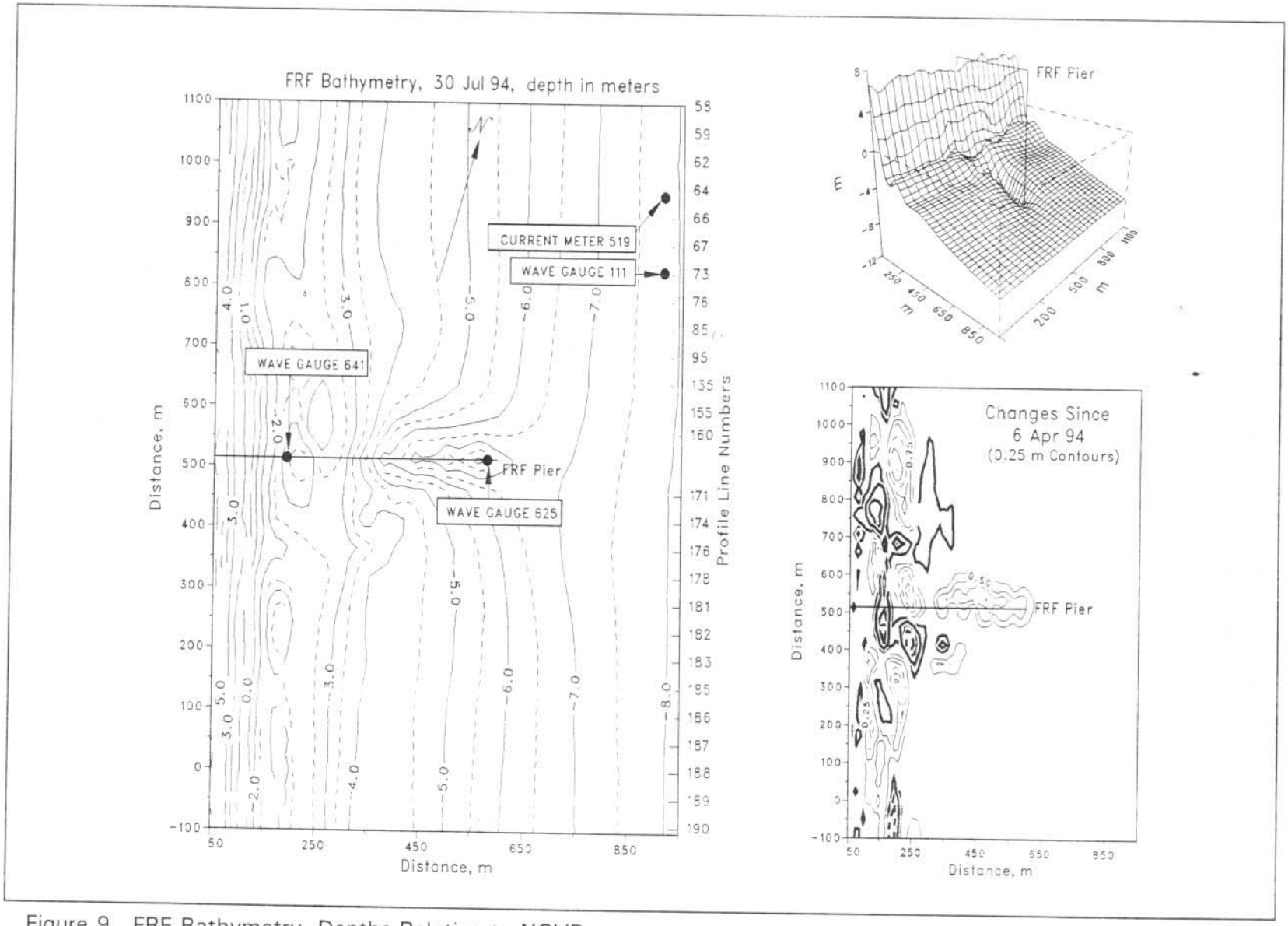

Figure 9. FRF Bathymetry, Depths Relative to NGVD

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge
USACE-OCE
USACE-SAD
USACE-NAP
USACE-SAW
USACE-WES
NAVSAC
NOAA/NOS/OMS
National Marine Fisheries
U.S. Geological Survey
U.S. Library of Congress
U.S. National Park Service
U.S. National Weather Service
U.S. Naval Academy
U.S. Naval Civil Eng. Lab
U.S. Naval Oceanographic Off.
U.S. Naval Research Lab

Colleges/Universities:

Bucknell University
California Inst. of Tech.
Duke Marine Lab
East Carolina University
Florida Inst. of Tech.
M.I.T.
Naval Post Graduate School
NC State University
Old Dominion University
Oregon State University
Prince George's College
Scripps Institution of Oceanography
Stockton State College
University Calif-Berkeley
University of Florida
University of Maryland-College Park
University of Maryland-Baltimore
University of North Carolina
University of N C-Seagrant Program
University of Virginia
Va. Inst. of Marine Science
Rutgers University

Others:

Allied Signal Aerospace Co.
Applied Physics Lab
Cape Hatteras Nat. Seashore
Coastal and Est. Res., Inc.
Coastal Science & Eng., Inc.
Dr. Cy Galvin
GEOMET Tech., Inc.
Mr. Hodges
Dr. Hylton
Mr. Mason
Mr. Rodgers
WCTI-TV
MEC Systems Corporation
Moffatt & Nichol, Eng.
N.C. Div. Coastal Management
Oregon Inlet & Waterways Commis.
Raleigh-Durham Airport
Mr. Rowland
Mr. Savage
Science Application Int'l. Corp
Sherwood Industries
SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)