July 1993
Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
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.

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. Table 2 and Figure 3 identifies the location of the instruments. Figure 2 shows weather and ocean conditions for the month. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

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

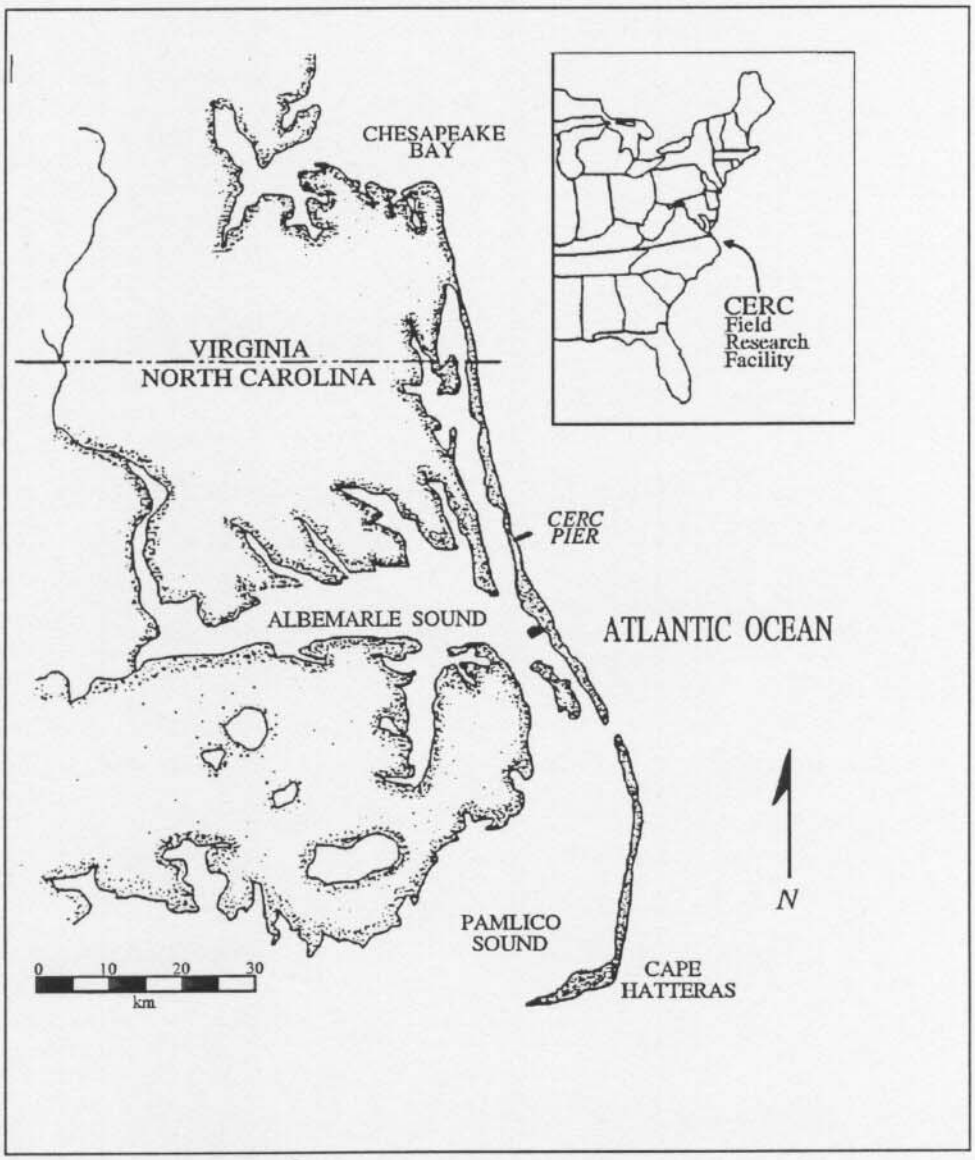

Figure 1. FRF Location Map

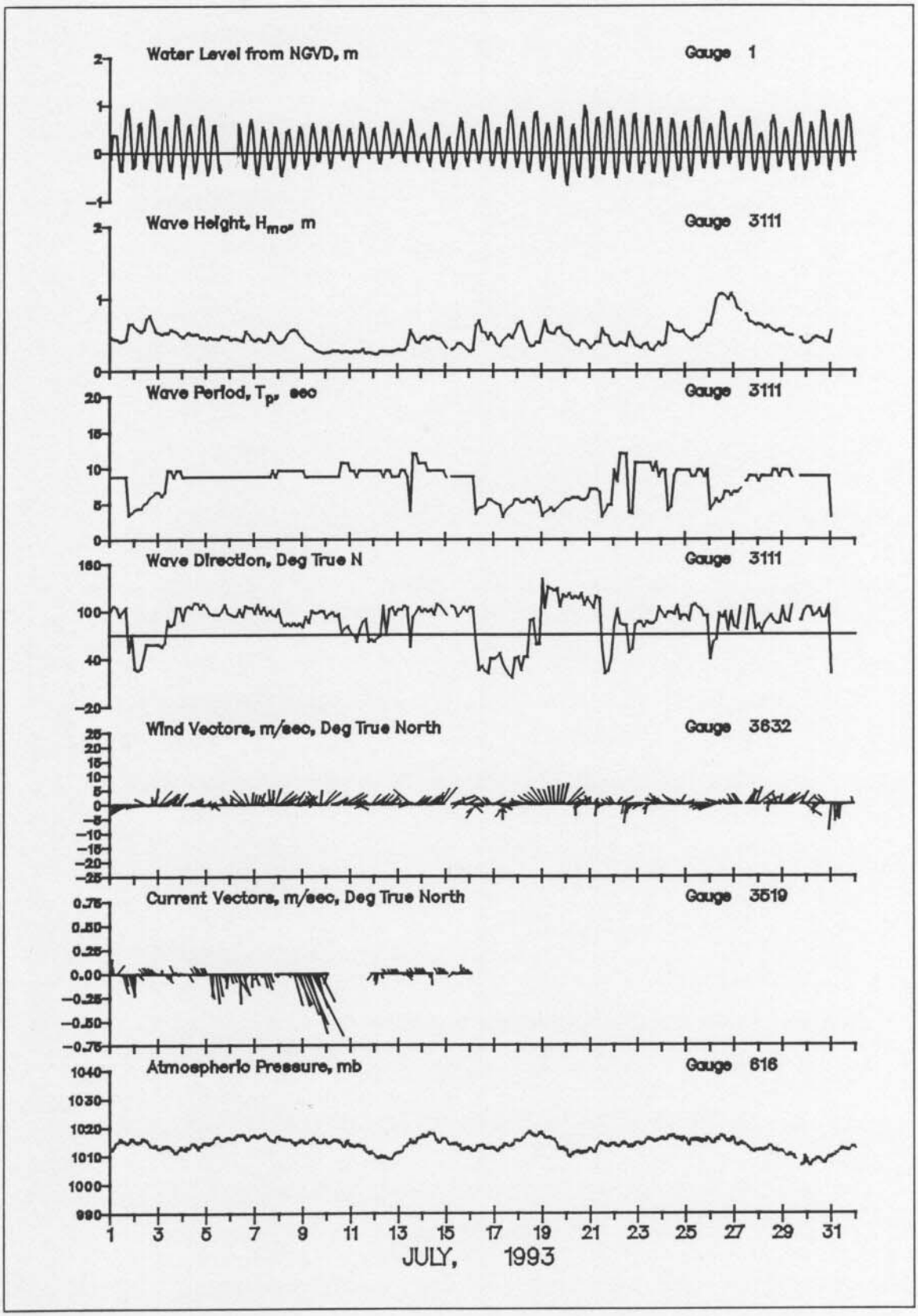

Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

July 1993

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	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	/	*	/	/	*		
632	Anemometer on top of building	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
932	Anemometer at seaward end of pier	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*
641	Pressure Gauge at station 780 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff at station 1860 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 243 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
511	Pressure Gauge 243 m north of FRF pier (0.9 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	/	*	
519	Current meter 320 m north of FRF pier (0.9 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	-	-	/	/	/	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Data Collected	*	*	*	*	*	*	*	*	-	-	/	/	/	/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	NOAA tide station at seaward end of FRF 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 X	FRF Coordinates Y	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Barometer	36 10′ 45.48"	75 44′ 37.39"	11.60	569.00	----	----
632	Building Anemometer	36 10′ 45.24"	75 44′ 39.53"	21.45	515.83	19.94	----
932	EOP Anemometer	36 11′ 2.64"	75 44′ 46.50"	585.20	517.30	19.5	----
641	780 Pressure	36 10′ 51.96"	75 44′ 42.21"	239.11	516.64	-1.64	-1.96
625	1860 Baylor	36 11′ 2.10"	75 44′ 46.31"	568.00	516.64	Surface	-8.36
3111	8m Array	36 11′ 15.90"	75 44′ 38.88"	914.43	825.52	-7.76	-8.08
511	Pressure N Tripod	36 11′ 15.95"	75 44′ 38.69"	914.36	830.46	-6.86	-7.94
630	Waverider	36 12′ 16.44"	75 47′ 19.23"	3934.96	-2400.81	Surface	-17.0
519	Current N tripod	36 11′ 15.95"	75 44′ 38.69"	914.36	830.46	-5.55	-7.94
1	NOAA Tide	36 11′ 2.95"	75 44′ 46.76	596.49	514.2	Surface	-7.62

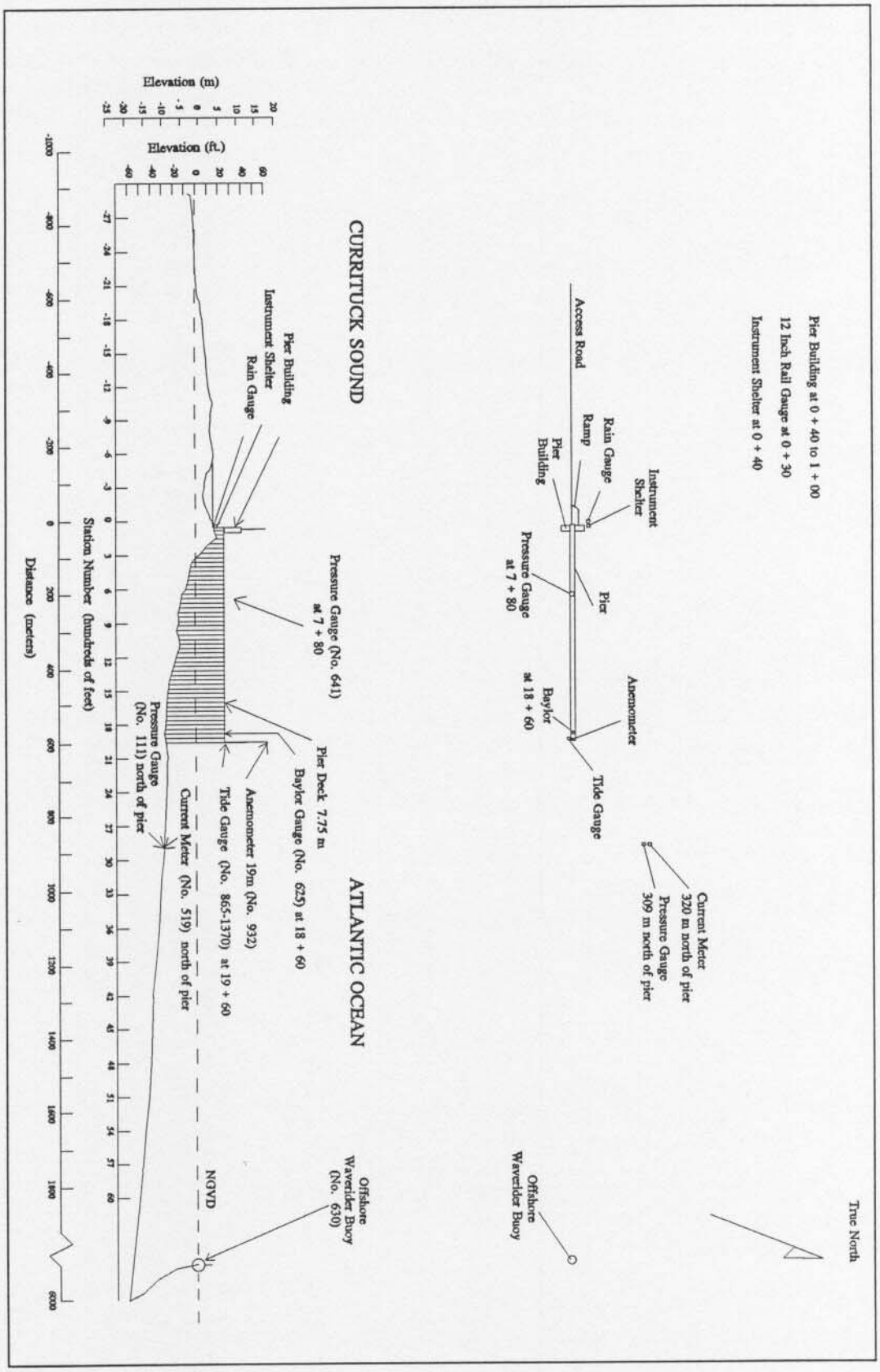

Figure 3. Instrument Locations. (Elevations from NGVD)

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored using a Digital Equipment Corporation VAX 11/750. 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 2) 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 2 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

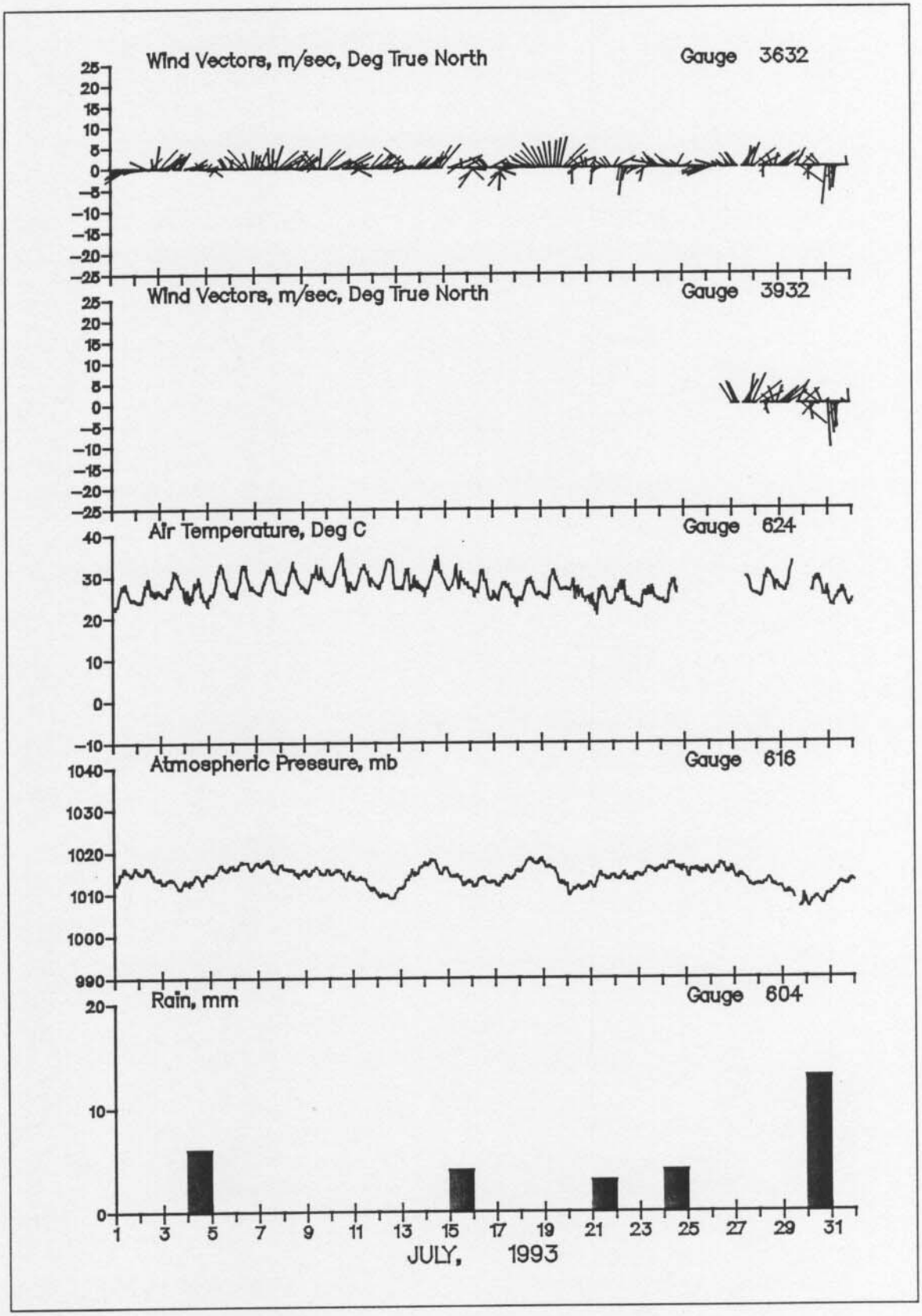

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

July 1993

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	1	142	22.6	1013.0	0
	700	1	51	25.3	1014.8	0
	1300	4	66	28.1	1015.3	0
	1900	6	70	24.4	1015.0	0
2	100	2	70	24.1	1015.1	0
	700	2	96	25.8	1015.4	0
	1300	4	116	28.9	1015.3	0
	1900	2	173	25.4	1013.5	0
3	100	6	223	26.0	1012.7	0
	700	5	230	26.7	1013.3	0
	1300	5	1	30.0	1012.8	0
	1900	4	219	28.7	1011.4	0
4	100	1	1	24.2	1012.6	0
	700	2	1	25.4	1012.9	6
	1300	3	249	27.8	1014.2	0
	1900	2	144	25.2	1013.5	0
5	100	1	227	24.8	1014.5	0
	700	3	307	27.2	1015.2	0
	1300	2	79	32.8	1016.4	0
	1900	2	147	27.4	1016.0	0
6	100	2	192	25.6	1016.1	0
	700	2	224	27.9	1017.4	0
	1300	5	125	32.3	1017.5	0
	1900	4	161	27.6	1016.2	0
7	100	3	189	26.3	1017.1	0
	700	4	200	27.7	1017.4	0
	1300	3	142	31.6	1017.1	0
	1900	4	182	28.0	1015.2	0
8	100	6	228	26.3	1016.5	0
	700	5	245	27.9	1015.7	0
	1300	2	218	32.9	1015.3	0
	1900	5	212	28.8	1014.7	0
9	100	4	233	26.8	1015.1	0
	700	4	270	28.2	1015.5	0
	1300	4	133	32.6	1015.8	0
	1900	4	186	30.7	1014.7	0
10	100	6	229	28.3	1014.8	0
	700	5	251	29.0	1015.4	0
	1300	3	239	34.0	1015.0	0
	1900	7	240	29.8	1014.4	0

Table 3
Meteorological Data (continued)

July 1993

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	6	241	27.9	1013.9	0
	700	4	296	28.6	1013.8	0
	1300	2	57	32.4	1013.3	0
	1900	2	132	28.2	1010.9	0
12	100	5	237	28.0	1010.3	0
	700	4	219	28.5	1010.0	0
	1300	4	246	33.6	1009.1	0
	1900	0		31.7	1009.8	0
13	100	1	215	27.2	1011.2	0
	700	2	258	30.4	1013.3	0
	1300	7	130	27.3	1014.9	0
	1900	4	227	28.7	1015.8	0
14	100	3	227	26.7	1017.4	0
	700	4	235	27.9	1017.8	0
	1300	3	210	33.0	1016.9	0
	1900	6	210	31.2	1015.2	0
15	100	7	1	27.7	1015.2	0
	700	8	249	27.8	1014.3	0
	1300	2	54	28.0	1013.6	0
	1900	2	174	28.6	1012.6	4
16	100	4	277	27.2	1012.4	0
	700	5	36	26.5	1013.0	0
	1300	2	71	31.2	1013.8	0
	1900	2	142	25.7	1012.6	0
17	100	4	240	26.0	1012.3	0
	700	3	326	26.5	1012.8	0
	1300	5	39	27.4	1014.0	0
	1900	3	67	25.0	1014.1	0
18	100	3	104	24.4	1015.3	0
	700	4	91	25.9	1017.1	0
	1300	5	122	29.2	1018.0	0
	1900	5	127	25.6	1017.2	0
19	100	7	146	25.6	1017.4	0
	700	5	161	25.0	1016.5	0
	1300	6	176	31.2	1015.2	0
	1900	7	188	27.0	1012.4	0
20	100	7	224	27.0	1011.5	0
	700	6	250	27.5	1011.0	0
	1300	2	51	27.3	1011.5	0
	1900	3	131	24.8	1011.2	0

Table 3
Meteorological Data (concluded)

July 1993

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	2	173	23.9	1012.3	0
	700	4	7	22.1	1013.4	0
	1300	2	45	26.8	1014.1	3
	1900	2	121	24.1	1013.5	0
22	100	2	146	23.8	1014.1	0
	700	5	241	27.6	1013.9	0
	1300	6	7	25.3	1013.9	0
	1900	2	31	23.7	1013.4	0
23	100	2	45	23.0	1014.5	0
	700	1	67	25.9	1014.8	0
	1300	3	54	25.7	1016.0	0
	1900	4	148	24.9	1015.4	0
24	100	2	139	24.2	1016.3	0
	700	8	101	23.4	1017.0	0
	1300	2	120	29.0	1016.5	0
	1900	3	210		1015.4	4
25	100	1	245		1015.3	0
	700	2	294		1015.6	0
	1300	3	66		1015.6	0
	1900	2	56	Gauge	1015.1	0
26	100	3	1		1015.0	0
	700	6	69		1016.0	0
	1300	1	1	Inoperative	1016.9	0
	1900	2	127		1015.3	0
27	100	3	140		1014.5	0
	700	4	142		1014.5	0
	1300	5	214		1013.4	0
	1900	4	188	26.9	1011.8	0
28	100	6	231	25.6	1012.1	0
	700	5	244	26.4	1012.5	0
	1300	2	42	30.7	1013.1	0
	1900	3	156	26.5	1011.6	0
29	100	5	231	27.0	1011.1	0
	700	5	226	27.5	1010.5	0
	1300	4	211		1009.1	0
	1900	4	208	Gauge	1006.8	0
30	100	3	225	Inoperative	1007.8	13
	700	3	359		1008.3	0
	1300	2	43	29.0	1008.6	0
	1900	3	140	25.7	1008.3	0
31	100	9	6	24.3	1009.8	0
	700	4	359	24.1	1011.3	0
	1300	4	42	25.8	1012.3	0
	1900	0		23.5	1012.5	0
		Resultant		Mean	Mean	Total
		1	190	27.3	1013.9	30

3 Wave Data

Wave data are collected from a Baylor staff gauge (Gauge 625), two pressure wave gauges (641 and 511) and a Waverider buoy (Gauge 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 programmed to sample the gauges for two hour and forty-eight minute time frames. The sampling rate is two times per second which equals five contiguous 34 minute records per collection period. 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 deg 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. When this analysis is complete, the data are written to optical disc.

Table 3 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 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 3 and Figure 3) 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

July 1993

Day	Hour	641 Pressure Gauge Hmo,m	641 Pressure Gauge Tp,sec	625 Baylor 1860 Hmo,m	625 Baylor 1860 Tp,sec	511 Pressure Gauge Hmo,m	511 Pressure Gauge Tp,sec	630 Waverider Hmo,m	630 Waverider Tp,sec
1	0100	0.25	5.12	0.44	9.48	0.46	9.48	0.49	8.53
	0700	0.23	9.14	0.38	8.83	0.41	8.53	0.46	8.83
	1300	0.21	8.53	0.37	8.83	0.40	8.53	0.45	8.83
	1900	0.39	3.28	0.57	3.33	0.45	3.33	0.66	3.41
2	0100	0.32	3.88	0.56	4.00	0.52	4.13	0.64	4.20
	0700	0.33	4.49	0.47	4.57	0.47	4.49	0.60	4.41
	1300	0.31	4.66	0.60	5.12	0.57	5.22	0.70	5.02
	1900	0.33	5.69	0.64	6.09	0.64	5.95	0.73	6.40
3	0100	0.20	5.12	0.48	6.56	0.48	6.74	0.63	6.56
	0700	0.23	9.14	0.44	8.53	0.46	6.09	0.53	9.48
	1300	0.19	5.82	0.50	9.48	0.50	9.48	0.58	9.48
	1900	0.34	9.14	0.46	8.83	0.50	8.83	0.54	8.53
4	0100	0.18	8.83	0.38	9.48	0.42	9.14	0.54	9.14
	0700	0.29	9.14	0.45	9.48	0.49	9.14	0.57	9.14
	1300	0.22	4.92	0.44	9.48	0.48	9.14	0.55	8.83
	1900	0.31	8.83	0.41	8.83	0.41	9.48	0.54	9.14
5	0100	0.19	9.48	0.41	8.83	0.44	9.14	0.48	8.83
	0700	0.26	8.83	0.45	8.83	0.41	9.14	0.52	9.14
	1300	0.16	8.83	0.37	9.14	0.44	9.48	0.45	9.14
	1900	0.25	8.83	0.40	8.83	0.46	8.83	0.51	8.83
6	0100	0.19	8.83	0.38	8.83	0.44	8.83	0.50	9.48
	0700	0.25	8.83	0.39	8.53	0.44	9.14	0.44	8.83
	1300	0.18	8.26	0.38	8.83	0.37	8.83	0.49	8.53
	1900	0.32	8.53	0.50	8.83	0.48	8.53	0.60	8.53
7	0100	0.22	9.14	0.41	9.14	0.39	9.14	0.50	9.14
	0700	0.22	9.14	0.40	8.53	0.38	8.83	0.44	8.53
	1300	0.19	8.83	0.36	8.53	0.37	8.83	0.40	8.53
	1900	0.29	9.14	0.47	9.48	0.44	9.14	0.58	8.53
8	0100	0.21	9.48	0.38	9.48	0.36	9.85	0.47	9.48
	0700	0.19	9.14	0.39	9.85	0.40	9.48	0.44	9.85
	1300	0.21	9.48	0.45	9.14	0.53	9.85	0.49	9.48
	1900	0.21	9.85	0.51	9.85	0.49	9.48	0.55	9.14
9	0100	0.23	9.48	0.42	9.48	0.41	9.85	0.48	9.48
	0700	0.17	8.83	0.35	8.83	0.33	9.14	0.39	8.83
	1300	0.17	9.14	0.27	9.14	0.28	9.14	0.34	8.53
	1900	0.16	8.83	0.29	8.83	0.25	8.83	0.32	9.48
10	0100	0.14	8.83	0.25	9.85	0.23	8.83	0.31	8.83
	0700	0.12	9.14	0.25	8.83	0.24	9.48	0.28	9.48
	1300	0.17	4.83	0.26	10.24	0.25	9.48	0.27	9.14
	1900	0.13	11.13	0.26	10.67	0.26	10.24	0.32	9.85

Table 4
Wave Data (continued)

July 1993

Day	Hour	641 Pressure Gauge Hmo,m	641 Pressure Gauge Tp,sec	625 Baylor 1860 Hmo,m	625 Baylor 1860 Tp,sec	511 Pressure Gauge Hmo,m	511 Pressure Gauge Tp,sec	630 Waverider Hmo,m	630 Waverider Tp,sec
11	0100	0.13	8.83	0.23	10.24	0.24	10.24	0.28	10.24
	0700	0.14	5.12	0.25	9.85	0.26	8.83	0.26	9.85
	1300	0.20	5.22	0.26	8.83	0.27	9.14	0.34	8.53
	1900	0.13	10.67	0.23	10.24	0.24	9.85	0.27	9.48
12	0100	0.13	6.92	0.23	9.48	0.22	9.48	0.27	9.85
	0700	0.14	4.57	0.24	9.48	0.24	10.24	0.29	9.14
	1300	0.17	8.53	0.24	9.48	0.23	9.48	0.28	9.14
	1900	0.14	9.48	0.25	9.48	0.25	9.14	0.31	8.53
13	0100	0.19	9.14	0.27	9.14	0.27	10.24	0.33	10.24
	0700	0.16	4.66	0.27	9.14	0.26	8.83	0.31	9.14
	1300	0.43	3.28	0.61	2.84	0.45	3.33	0.63	3.08
	1900	0.26	4.06	0.40	12.19	0.37	11.64	0.49	11.64
14	0100	0.25	10.67	0.38	10.67	0.43	10.67	0.48	10.67
	0700	0.24	10.67	0.44	10.24	0.43	10.24	0.51	10.24
	1300	0.30	9.48	0.41	9.48	0.49	9.85	0.54	9.48
	1900	0.28	9.85	0.45	9.85	0.40	9.48	0.56	9.14
15	0100	0.18	9.14	0.29	9.14	0.32	9.14	0.43	9.48
	0700	0.15	8.53	0.25	8.83	0.29	9.14	0.37	8.83
	1300	0.20	8.83	0.31	8.83	0.30	8.53	0.37	9.14
	1900	0.23	4.27	0.34	9.14	0.32	9.14	0.44	9.14
16	0100	0.14	8.53	0.24	8.26	0.27	8.53	0.32	8.83
	0700	0.30	2.78	0.49	2.75	0.34	3.24	0.54	2.91
	1300	0.39	4.27	0.53	4.41	0.47	4.34	0.64	4.41
	1900	0.31	4.92	0.37	4.74	0.36	5.22	0.58	4.74
17	0100	0.22	5.45	0.44	5.57	0.43	5.57	0.54	5.45
	0700	0.19	4.49	0.32	4.74	0.31	4.92	0.34	5.02
	1300	0.29	3.88	0.44	3.66	0.36	3.94	0.51	3.88
	1900	0.34	4.57	0.40	4.49	0.37	4.83	0.52	4.66
18	0100	0.26	4.27	0.59	5.69	0.56	5.45	0.68	5.45
	0700	0.38	5.33	0.54	5.22	0.52	5.12	0.61	5.45
	1300	0.20	2.64	0.39	5.02	0.32	5.57	0.44	5.45
	1900	0.25	4.83	0.39	5.82	0.34	5.82	0.45	4.92
19	0100	0.28	3.16	0.52	3.08	0.38	3.12	0.62	3.28
	0700	0.36	3.94	0.47	3.94	0.44	4.06	0.69	4.06
	1300	0.30	4.34	0.46	4.34	0.40	4.34	0.69	4.34
	1900	0.40	4.66	0.56	5.69	0.52	4.66	0.66	4.66
20	0100	0.29	4.83	0.43	5.45	0.43	5.33	0.63	5.45
	0700	0.33	5.57	0.40	5.82	0.37	6.40	0.48	5.57
	1300	0.18	4.74	0.31	6.56	0.32	6.24	0.42	5.69
	1900	0.32	5.12	0.42	5.33	0.38	5.57	0.52	5.45

Table 4
Wave Data (concluded)

July 1993

Day	Hour	641 Pressure Gauge Hmo,m	641 Pressure Gauge Tp,sec	625 Baylor 1860 Hmo,m	625 Baylor 1860 Tp,sec	511 Pressure Gauge Hmo,m	511 Pressure Gauge Tp,sec	630 Waverider Hmo,m	630 Waverider Tp,sec
21	0100	0.18	4.57	0.28	6.74	0.30	6.24	0.35	7.11
	0700	0.24	6.92	0.31	7.11	0.37	7.31	0.43	7.11
	1300	0.23	5.33	0.37	6.92	0.34	6.24	0.46	5.82
	1900	0.37	4.34	0.46	4.41	0.43	4.41	0.53	5.57
22	0100	0.17	4.57	0.32	8.83	0.31	10.24	0.36	4.74
	0700	0.20	5.22	0.32	7.53	0.33	11.13	0.38	8.00
	1300	0.18	3.56	0.34	11.64	0.33	8.26	0.34	10.24
	1900	0.26	3.71	0.39	3.82	0.38	3.66	0.43	3.88
23	0100	0.19	10.67	0.31	10.24	0.32	10.24	0.36	9.48
	0700	0.19	9.85	0.34	10.24	0.31	11.13	0.37	9.85
	1300	0.19	9.48	0.31	10.67	0.27	10.24	0.33	9.85
	1900	0.15	9.48	0.31	9.14	0.29	9.48	0.32	8.83
24	0100	0.22	4.74	0.37	9.14	0.31	10.24	0.39	9.85
	0700	0.34	3.77	0.59	3.12	0.45	9.14	0.71	3.66
	1300	0.36	5.02	0.53	4.83	0.45	10.24	0.61	4.83
	1900	0.27	4.34	0.49	9.48	0.47	9.85	0.58	9.48
25	0100	0.30	9.85	0.46	9.48	0.46	9.48	0.56	10.24
	0700	0.21	9.48	0.39	9.48	0.41	9.48	0.43	9.48
	1300	0.25	8.53	0.39	9.48	0.42	9.48	0.51	9.48
	1900	0.28	4.92	0.48	9.85	0.48	9.85	0.56	9.14
26	0100	0.37	4.06	0.62	3.94	0.53	9.48	0.66	3.94
	0700	0.38	3.61	0.90	5.33	0.81	5.45	0.98	5.33
	1300	0.47	5.45	0.95	5.45	0.97	5.33	1.19	5.22
	1900	0.46	6.74	0.94	6.92	0.93	6.56	1.04	6.09
27	0100	0.52	5.95	1.01	6.24	0.91	5.95	1.14	6.40
	0700	0.31	4.74	0.78	6.92	0.77	6.09	0.88	8.00
	1300	0.40	4.92	0.68	8.00	0.72	8.53	Inoperative	
	1900	0.31	3.88	0.59	9.48	0.62	8.83	0.69	8.83
28	0100	0.32	8.83	0.54	8.00	0.60	8.53	0.67	8.00
	0700	0.20	9.85	0.55	9.85	0.54	9.48	0.60	9.48
	1300	0.27	9.85	0.49	9.85	0.61	8.83	0.63	9.14
	1900	0.23	9.85	0.47	9.48	0.51	9.14	0.50	9.14
29	0100	0.24	9.85	0.49	8.53	0.54	9.14	0.60	9.14
	0700	0.22	9.48	0.46	9.48	0.47	9.85	0.55	9.48
	1300	0.24	9.48	0.47	9.48	0.47	9.14	0.56	8.83
	1900	0.25	9.14	0.41	9.48	0.42	9.48	Gauge	
30	0100	0.17	11.64	0.34	9.48	0.36	8.83	Inoperative	
	0700	0.23	4.66	0.36	11.64	0.39	9.14	0.48	9.48
	1300	0.23	4.34	0.42	9.48	0.43	9.14	0.47	8.53
	1900	0.24	10.24	0.37	9.14	0.36	9.48	0.45	8.26
31	0100	0.27	2.75	0.49	9.14	0.37	9.48	0.51	9.85
	0700	0.60	4.34	0.78	4.57	0.73	4.83	0.91	4.57
	1300	0.37	4.41	0.58	4.57	0.58	4.49	0.68	4.83
	1900	0.34	4.74	0.52	8.53	0.48	6.56	0.60	6.56
Mean		0.25	6.90	0.43	7.93	0.42	8.03	0.51	7.75
Std dev		0.09	2.49	0.15	2.25	0.14	2.14	0.17	2.16

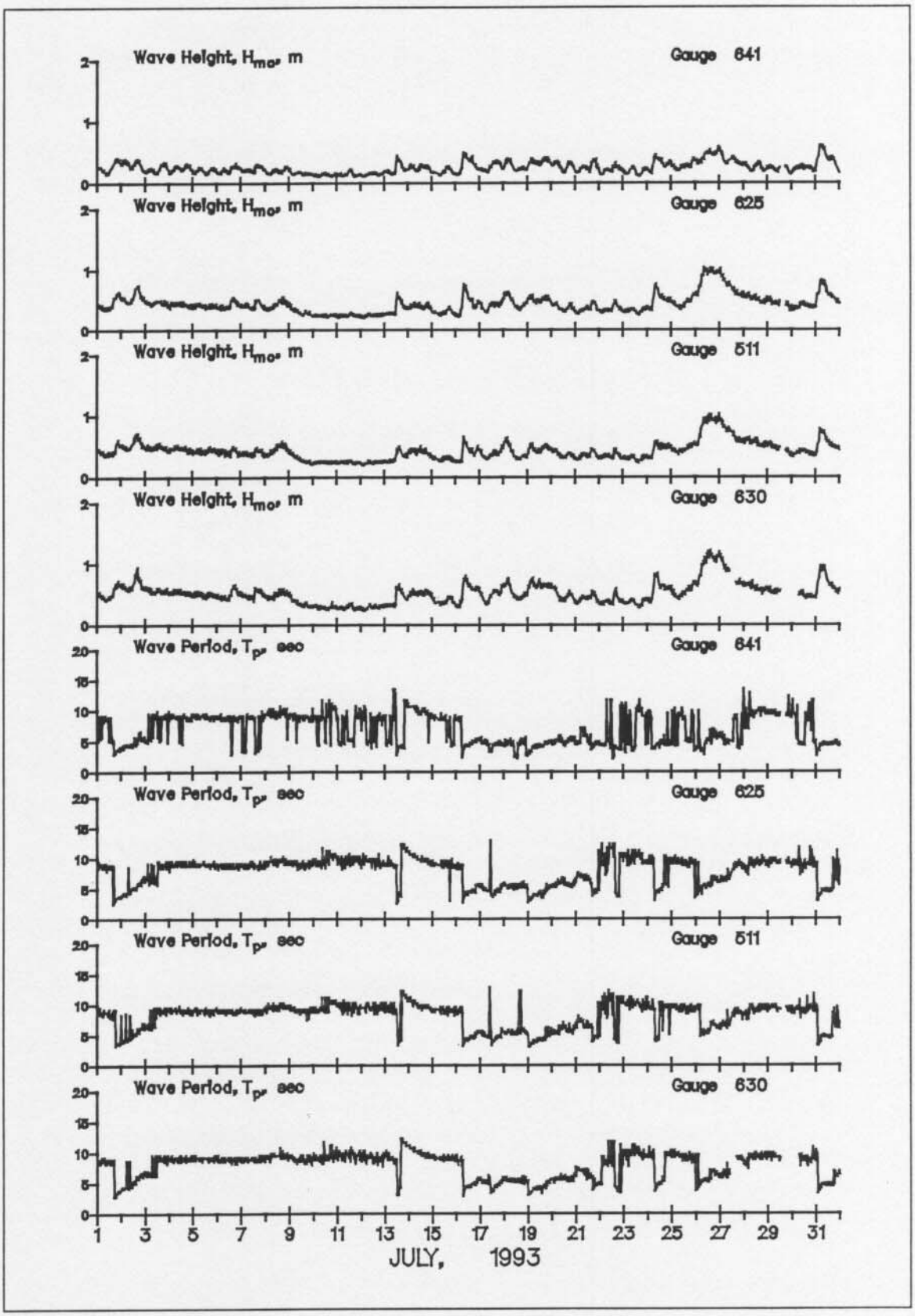

Figure 5. Time History of Wave Heights and Periods

4 Current Data

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of dye 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 5).

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.

IMPORTANT NOTE

Direction resultants regarding the current meter data (gauge 519) may be in error by 5 degrees due to the uncertainty of the orientation. Please call us if you must use this data.

Table 5
Current Meter Data - Gauge 519

July 1993

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	3	-13	15	7
	700	8	-7	11	41
	1300	0	20	20	164
	1900	0	21	21	163
2	100	-6	18	19	181
	700	-1	0	2	282
	1300	-1	-5	6	324
	1900	-1	-5	6	318
3	100	-1	0	2	284
	700	1	5	5	144
	1300	-1	6	6	179
	1900	0	0	0	
4	100	0	0	0	
	700	1	8	8	151
	1300	-1	-5	6	324
	1900	0	-5	6	327
5	100	0	-5	6	333
	700	-7	21	22	181
	1300	-3	22	22	170
	1900	0	7	7	171
6	100	0	8	8	168
	700	4	20	20	150
	1300	0	22	22	163
	1900	-4	3	5	217
7	100	0	11	11	160
	700	0	3	3	161
	1300	0	16	16	162
	1900	Inoperative			
8	100	-1	2	3	206
	700	-1	0	2	264
	1300	3	3	4	109
	1900	3	34	34	155
9	100	1	45	45	159
	700	-3	64	64	163
	1300	0	37	37	160
	1900	3	31	31	155
10	100	-5	8	10	198
	700				
	1300				
	1900	Inoperative			
11	100				
	700				
	1300	Inoperative			
	1900				
12	100	-2	6	7	187
	700	0	4	4	162
	1300	0	-2	3	319
	1900	0	-2	3	335
13	100	0	-2	3	320
	700	4	8	9	135
	1300	-1	-2	4	308
	1900	0	-3	4	340
14	100	0	-4	5	326
	700	0	4	4	161
	1300	Inoperative			
	1900	0	-3	4	335
15	100	0	-3	4	321
	700	-3	2	4	228
	1300	6	-2	6	45
	1900	0	-3	4	318
16	100	0	-2	3	319
	700				
	1300				
	1900				
17	100				
	700				
	1300				
	1900				
18	100				
	700				
	1300				
	1900	Inoperative			
19	100				
	700				
	1300				
	1900				
20	100				
	700				
	1300				
	1900				
21	100				
	700				
	1300				
	1900				
22	100				
	700				
	1300				
	1900				
23	100				
	700				
	1300	Inoperative			
	1900				
24	100				
	700				
	1300				
	1900				
25	100				
	700				
	1300				
	1900				
26	100				
	700				
	1300				
	1900				
27	100	Inoperative			
	700				
	1300				
	1900				
28	100				
	700				
	1300				
	1900				
29	100				
	700				
	1300				
	1900				
30	100	Inoperative			
	700				
	1300				
	1900				
31	100				
	700				
	1300				
	1900				
	1900				

KEY:

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

Table 6
Visual Observed Current Data

July 1993

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	0	-4	4	340	0	6	6	163	South	2	N
2	0	28	28	160	0	0	0		North	6	S
3	18	-11	21	40	6	-20	21	357	South	6	N
4	3	-9	9	357	2	-19	19	346	South	2	N
5	0	102	102	160	-15	-15	22	295	South	23	N
6	10	34	35	143	6	8	10	123	North	5	N
7	6	-12	14	7	7	-13	15	9	South	9	N
8	7	-14	15	7	1	-5	5	354	South	8	N
9	16	10	19	102	0	0	0		North	2	N
10	-3	9	9	179	0	0	0		South	2	S
11	-25	9	27	230	-7	16	17	184	North	5	S
12	3	30	31	154	0	0	0		South	1	N
13	0	0	0		0	0	0		South	1	N
14	7	23	24	143	2	17	18	154	South	13	N
15	0	0	0		6	-4	8	34	South	5	N
16	-15	34	37	184	-9	30	32	177	South	20	S
17	0	55	55	160	2	32	32	157	South	10	S
18	-5	-6	8	298	-8	-14	16	309	South	2	N
19	0	-55	55	340	0	-36	36	340	South	45	N
20	0	0	0		0	0	0		South	22	N
21	-4	8	9	187	1	-9	9	346	South	5	S
22	0	0	0		0	0	0		South	1	S
23	-5	32	32	169	0	0	0		South	1	S
24	0	0	0		3	-34	34	346	South	41	N
25	0	0	0		0	0	0		South	25	N
26	0	20	20	160	0	21	21	160	South	29	S
27	5	-16	17	357	-5	-30	31	331	South	39	N
28	0	0	0		7	-12	14	11	South	0	
29	8	-13	15	11	0	0	0		South	18	N
30	0	41	41	160	0	0	0		South	18	N
31	0	38	38	160	-2	44	44	163	South	49	S

KEY:
+crosshore = offshore, cm/sec
-crosshore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 6) 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

July 1993

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 Temp.,C	Density g/cc	Secchi Vis.,m
1	0535	70			10	21.7	1.0213	2.7
2	0850	55	85		29	24.4	1.0187	2.7
3	0710	70			9	17.5	1.0225	2.7
4	0945	85			21	20.8	1.0216	4.3
5	0955	90			43	23.9	1.0180	2.4
6	0740	85			21	23.4	1.0182	2.1
7	0740	95	125		9	21.9	1.0210	5.5
8	0850	100		inoperative	8	14.2	1.0243	2.7
9	0710	80			12	14.7	1.0239	2.4
10	0850	80			5	15.8	1.0222	3.4
11	0935	90	5		4	25.9	1.0179	5.8
12	0620	110			12	24.2	1.0189	3.7
13	0640	110	80		12	26.7	1.0179	3.4
14	0620	95	75		5	25.8	1.0186	4.6
15	0615	90			4	15.8	Inoper	2.4
16	0625	50	70		5	21.4	1.0210	4.6
17	0830	25			10	25.5	1.0185	4.6
18	1040	55	100		5	26.3	1.0185	2.7
19	0615	95			11	25.7	1.0200	2.7
20	0720	100	75		9	12.5	1.0235	3.0
21	0615	90	75		8	15.8	1.0238	3.4
22	0635	90	65		9	23.9	1.0180	2.7
23	0630	90	70		7	23.9	1.0185	3.7
24	0955	85			22	23.9	1.0185	3.4
25	0930	90	70		8	24.4	1.0179	2.7
26	0620	60	85		16	23.9	1.0182	3.7
27	0640	85	65		23	23.8	1.0189	2.7
28	0645	80			17	15.8	1.0232	1.5
29	0640	90	70		15	16.9	1.0229	3.4
30	0625	95	75		9	20.1	1.0217	4.0
31	0820	55	85		44	21.9	1.0209	2.4

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 Leupold-Stevens digital recording float-type tide gauge is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 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 7 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

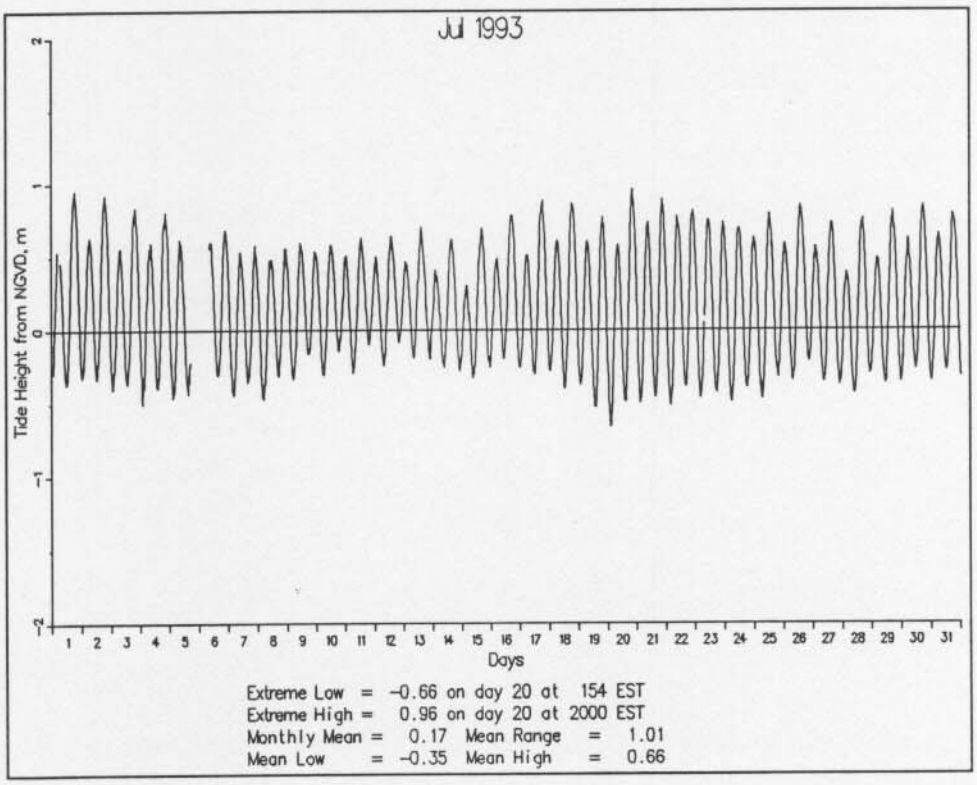

Figure 6. Water Level Time History

Table 8
Water Levels, m NGVD

July 93

	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	1	No data for this tide cycle						16	1654	0.78	16	2330	-0.26	0.29	1.05
1	1736	0.95	1	2336	-0.32	0.33	1.27	17	0512	0.51	17	1130	-0.30	0.11	0.81
2	0548	0.63	2	1142	-0.34	0.14	0.96	17	1806	0.88	17	2354	-0.28	0.31	1.16
2	1830	0.92	3	0030	-0.40	0.30	1.32	18	0606	0.61	18	1148	-0.40	0.12	1.01
3	0712	0.56	3	1218	-0.36	0.05	0.92	18	1818	0.86	19	0054	-0.37	0.27	1.23
3	1912	0.83	4	0054	-0.51	0.23	1.34	19	0642	0.60	19	1324	-0.53	0.05	1.13
4	0806	0.59	4	1330	-0.40	0.09	0.99	19	1918	0.77	20	0154	-0.66	0.08	1.43
4	2012	0.80	5	0154	-0.47	0.19	1.27	20	0754	0.58	20	1324	-0.49	0.03	1.07
5	0742	0.62	5	1430	-0.43	0.07	1.05	20	2000	0.96	21	0206	-0.50	0.25	1.46
5	1547	No data for this tide cycle						21	0842	0.73	21	1436	-0.46	0.13	1.19
6	413	No data for this tide cycle						21	2030	0.89	22	0312	-0.52	0.19	1.41
6	2036	0.68	7	0342	-0.45	0.14	1.13	22	0836	0.77	22	1600	-0.38	0.18	1.16
7	0900	0.53	7	1506	-0.36	0.07	0.89	22	2142	0.81	23	0342	-0.46	0.19	1.28
7	2124	0.58	8	0406	-0.48	0.05	1.05	23	604	No data for this tide cycle					
8	1036	0.48	8	1612	-0.31	0.08	0.79	23	2236	0.73	24	0512	-0.50	0.12	1.23
8	2154	0.55	9	0448	-0.33	0.10	0.89	24	1148	0.70	24	1754	-0.40	0.15	1.09
9	1030	0.60	9	1712	-0.16	0.19	0.76	24	2330	0.62	25	0606	-0.47	0.09	1.10
9	2224	0.54	10	0530	-0.31	0.13	0.84	25	1212	0.79	25	1906	-0.32	0.23	1.11
10	1148	0.58	10	1748	-0.14	0.22	0.73	26	0036	0.59	26	0706	-0.34	0.14	0.93
11	0006	0.51	11	0542	-0.29	0.11	0.80	26	1318	0.85	26	1954	-0.21	0.33	1.06
11	1218	0.63	11	1830	-0.10	0.25	0.73	27	0130	0.56	27	0824	-0.36	0.12	0.92
12	0042	0.50	12	0654	-0.24	0.13	0.74	27	1442	0.73	27	2106	-0.37	0.22	1.11
12	1306	0.64	12	1918	-0.09	0.27	0.73	28	0254	0.39	28	0918	-0.44	-0.02	0.82
13	0100	0.47	13	0730	-0.19	0.15	0.66	28	1612	0.76	28	1018	-0.35	0.23	1.11
13	1412	0.70	13	2112	-0.20	0.27	0.90	29	0348	0.48	29	1024	-0.37	0.07	0.85
14	0136	0.41	14	0900	-0.26	0.08	0.66	29	1642	0.81	29	2248	-0.36	0.26	1.17
14	1430	0.62	14	2130	-0.28	0.20	0.90	30	0506	0.62	29	2342	-0.32	0.13	0.94
15	0318	0.30	15	0830	-0.33	-0.01	0.63	30	1742	0.85	31	0000	-0.35	0.28	1.20
15	1600	0.70	15	2300	-0.26	0.24	0.95	31	0606	0.65	31	0030	-0.30	0.17	0.96
16	0506	0.49	16	1006	-0.20	0.14	0.69	31	1724	0.79	31	2348	-0.31	0.32	1.11

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 June 1993 and the survey(s) in July 1993 on profile line 188, located 517 m south of the pier.

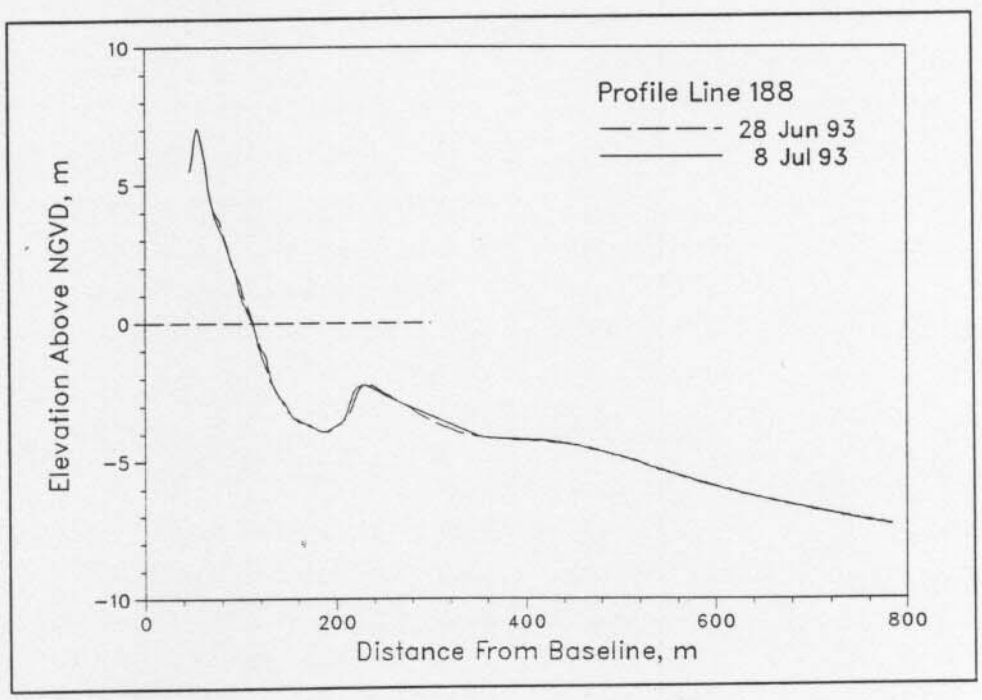

Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1993. Cross-hatched areas indicate changes to the annual envelope which occurred in July.

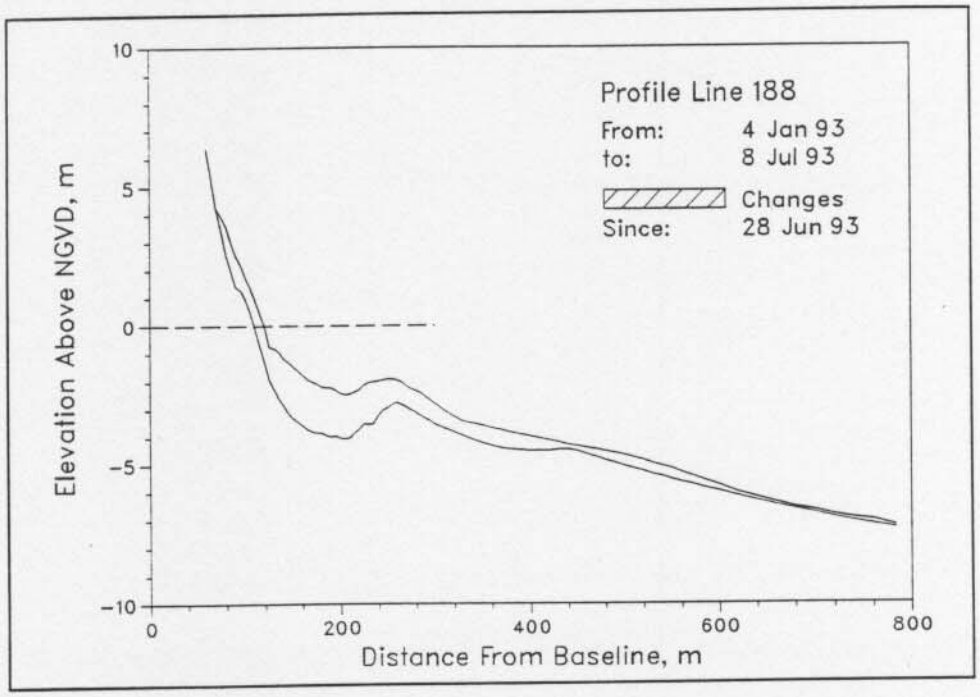

Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 8 July. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

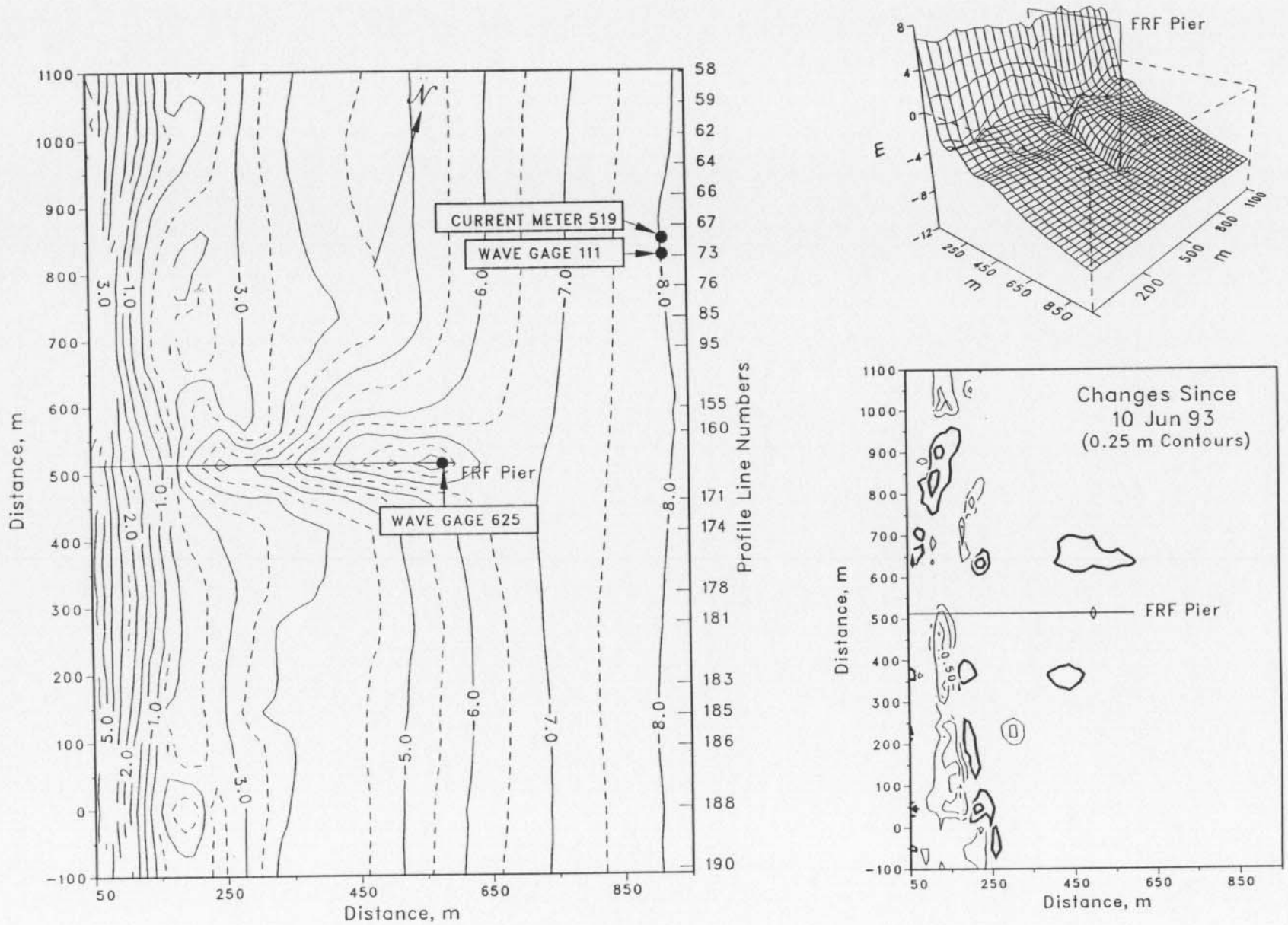

Figure 9. FRF bathymetry 8 Jul 93 depths relative to NGVD

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)