APPENDIX II

EVALUATION OF WAVE DATA OBTAINED
FROM A NON-DIRECTIONAL WAVE GAGE
LOCATED AT THE MOUTH OF THE
SAUGUS RIVER IN REVERE, MASSACHUSETTS

JULY 1993

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Evaluation of Wave Data Obtained from a Non-Directional Wave Gage Located at the Mouth of the Saugus River

1. Purpose

This report presents the results of wave gage data obtained by the Coastal Engineering Research Center, Waterways Experiment Station, for the New England Division. The information herein should be used as a supplement to the Saugus River and Tributaries, Lynn, Malden, Revere and Saugus, Massachusetts Flood Damage Reduction Project Volume 2, Appendix B Summary of Locally Generated Wave Results, page B-67; and as support for Water Control Division, Hydraulics and Water Quality Branch's part of the General Design Memorandum for the proposed Saugus River Flood Reduction Project. It is intended to help provide assistance in understanding the wave climate at the site of the tidal gate structure for the proposed project.

2. Siting of the Wave Gage

The general description of the Saugus River watershed and surrounding area is presented in the above referenced, Volume 2. The wave gage was established in the existing ship channel, about 200 feet southeast of the Lynn Fishing Pier, and about 500 feet northeast of the Point of Pines Yacht Club (see Figure 1). This approximates the location of the tidal gate structure of the proposed Saugus River Flood Reduction Project. It is sheltered by Lynn Harbor to the north, Point of Pines to the south, and the Nahant Causeway to the northeast and east. Wave generation is both fetch limited due to these sheltering features and depth limited because of the tidal flats to the northeast and east.

3. Reasons for Installing the Gage

During September 1990, the Committee on Tidal Hydraulics held its 99th meeting at NED. At that time NED invited this committee to review the proposed Saugus River Flood Reduction Project and make comments and "any suggestions, big or small, to improve project design". Of the several suggested improvements included in its November 21, 1990 memorandum to NED, one was that a wave gage be deployed near the mouth of the Saugus River.

The Committee on Tidal Hydraulics recommended that wave data (to include wave direction, amplitude, and period) be collected in the vicinity of the floodgate structure for this proposed project. They stated that this information would be "quite valuable for design of the structure, evaluating navigability, and analyzing sediment transport patterns." The Committee, recognizing that obtaining directional wave data might delay this proposed project, stated that an "acceptable alternative" would be to deploy a single non-directional wave gage.

4. Wave Gage Installation and History

NED contracted with the Coastal Engineering Research Center (CERC), CEWES-CD-P, to install a non-directional wave gage near the site of the proposed floodgate structure. Because this was an internally recording device, arrangements were made with CERC to make two additional site visits within the six month deployment period of this gage in order to recover the internally recorded data.

The gage was installed in December 1990 in the ship channel near the site of the existing navigation channel marker RN-10 at state coordinates (NAD 1927) N526320, E744760. It was set in about 14 feet of water and the device was calibrated to make a wave record every three hours.

CERC made two retrievals of the raw data. However, because of a manufacturer's defect in the equipment it was unable to convert the machine readings into usable information. This initial effort was abandoned and the gage removed from the site in May 1991.

A new gage was reinstalled at about the same location in time for the 1991-92 winter storm season. This device was a digi-quartz pressure gage connected to shore using an armored electrical cable. Then, via telephone, the wave information was transmitted directly to CERC's computer that automatically performed quality control checks and data analysis. This gage was set in approximately 14 feet of water and collected a wave record every three hours. Data collection began at 3:00 p.m. on October 28, 1991 and was discontinued at 9:00 p.m. on April 30, 1992.

5. Review of the Wave Gage Records and Observations

Inspection of the wave gage records from CERC (copies are attached at the end of this report) reveals no significant waves being generated in the Saugus River at the site of the wave gage during the period of record. This was true even during significant storm periods. The wave gage was in place during the "Halloween" storm of October 1991. This storm is considered one the worst Northeasters on record, lasting over 114 hours and generating 12 meter high waves in the open ocean. Although 3+ meter waves were carried into Broad Sound from Massachusetts Bay, the gage showed no significant waves made their way into the Saugus River. The maximum significant wave (Hmo) recorded during this Oct. 91 storm was 0.17 meters (0.6 ft) with a water depth of 8.5 meters (27.9 ft) and a wave period of 14.3 seconds.

6. Conclusions

Previous assumptions that the area is sheltered and wave generation is restricted appear valid. Neither the October 1991 event nor the December 1991 or January 1992 lesser storms produced any significant waves in this area. It would appear that a complex wave refraction and defraction environment exists which produces small amplitude poorly defined waves for storm intensities such as those recorded by the wave gage at this site.

Because of the limited data set available for waves in this area it is not reasonable to conclude that a lesser wave climate exists than previously assumed in the report referenced in paragraph 1. above. Conversely, it would appear reasonable to assume from this data that the previously published design wave recommendations are acceptable.

7. Recommendations

The wave information published in the report referenced in paragraph 1. above, Table 22, is valid for an Hmo = 2.4 ft at the floodgate structure; and, for design, the maximum SPN wave heights along this structure would be H10% = 1.27Hmo = 3.0 ft to no more than H1% = 1.67 Hmo = 4.0 ft.

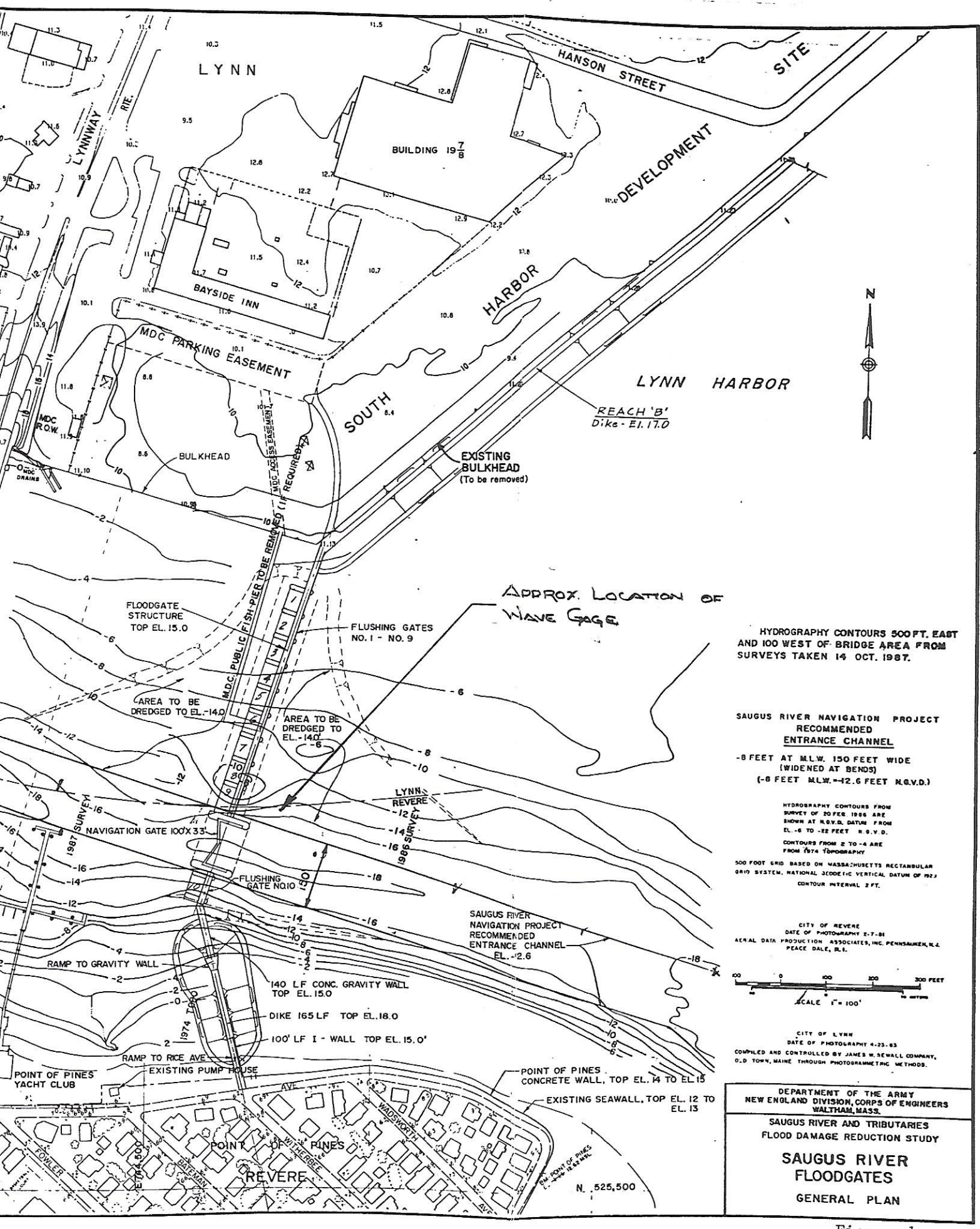

LYNN
HANSON STREET
SITE
DEVELOPMENT
BUILDING 19 7/8
LYNNWAY
RTE.
BAYSIDE INN
MDC PARKING EASEMENT
SOUTH
HARBOR
LYNN HARBOR
REACH 'B'
Dike - El. 17.0
EXISTING BULKHEAD
(To be removed)
BULKHEAD
MDC ROW
MDC DRAINS
MDC ACCESS EASEMENT
MDC PUBLIC FISH PIER TO BE REMOVED (IF REQUIRED)
APPROX. LOCATION OF WAVE GAGE
FLOODGATE STRUCTURE TOP EL. 15.0
FLUSHING GATES NO. 1 - NO. 9
AREA TO BE DREDGED TO EL. -14.0
AREA TO BE DREDGED TO EL. -14.0
LYNN
REVERE
1987 SURVEY
1986 SURVEY
NAVIGATION GATE 100'X 33'
FLUSHING GATE NO. 10
SAUGUS RIVER NAVIGATION PROJECT RECOMMENDED ENTRANCE CHANNEL EL. -12.6
RAMP TO GRAVITY WALL
140 LF CONC. GRAVITY WALL TOP EL. 15.0
DIKE 165 LF TOP EL. 18.0
100' LF I - WALL TOP EL. 15.0'
1974 TOPO
RAMP TO RICE AVE.
EXISTING PUMP HOUSE
POINT OF PINES YACHT CLUB
POINT OF PINES CONCRETE WALL, TOP EL. 14 TO EL. 15
EXISTING SEAWALL, TOP EL. 12 TO EL. 13
POINT OF PINES
REVERE
FOWLER
BATEMAN
WITHERBEE
WADSWORTH
AVE.
BM POINT OF PINES
N. 525,500
N
HYDROGRAPHY CONTOURS 500 FT. EAST AND 100 WEST OF BRIDGE AREA FROM SURVEYS TAKEN 14 OCT. 1987.
SAUGUS RIVER NAVIGATION PROJECT
RECOMMENDED
ENTRANCE CHANNEL
-8 FEET AT M.L.W. 150 FEET WIDE
(WIDENED AT BENDS)
(-8 FEET M.L.W. = -12.6 FEET N.G.V.D.)
HYDROGRAPHY CONTOURS FROM SURVEY OF 20 FEB 1986 ARE SHOWN AT N.G.V.D. DATUM FROM EL. -6 TO -22 FEET N.G.V.D.
CONTOURS FROM 2 TO -4 ARE FROM 1974 TOPOGRAPHY
500 FOOT GRID BASED ON MASSACHUSETTS RECTANGULAR GRID SYSTEM. NATIONAL GEODETIC VERTICAL DATUM OF 1929
CONTOUR INTERVAL 2 FT.
CITY OF REVERE
DATE OF PHOTOGRAPHY 2-7-81
AERIAL DATA PRODUCTION ASSOCIATES, INC. PENNSAUKEN, N.J.
PEACE DALE, R.I.
100 0 100 200 300 FEET
SCALE 1" = 100'
CITY OF LYNN
DATE OF PHOTOGRAPHY 4-23-83
COMPILED AND CONTROLLED BY JAMES W. SEWALL COMPANY, OLD TOWN, MAINE THROUGH PHOTOGRAMMETRIC METHODS.
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SAUGUS RIVER AND TRIBUTARIES
FLOOD DAMAGE REDUCTION STUDY
SAUGUS RIVER
FLOODGATES
GENERAL PLAN

Figure 1

ATTACHMENT A

LISTING OF WAVE HEIGHT, PERIOD AND
WATER DEPTH FROM OCTOBER 28, 1991
AT 3:00 P.M. TO APRIL 30, 1992 AT 9:00 P.M.

Wave Height - Hmo = Four times the square root of the wave energy in a record (Shore Protection Manual (SPM) Volume II, Page 5)

Wave Period - Tp = The inverse of the value of the frequency band with the highest energy (SPM, Volume II, Page 814)

Water Depth = Depth to sea floor at sensor location

Date/Time (GMT)	Hm0 (m)	depth (m)	period (sec)
10 28 91 1500	0.01	5.38	3.8
10 28 91 1800	0.03	7.42	10.0
10 28 91 2100	0.03	7.51	9.1
10 29 91 0	0.01	5.49	3.8
10 29 91 300	0.01	5.04	4.3
10 29 91 600	0.02	6.91	10.0
10 29 91 900	0.05	7.69	9.1
10 29 91 1200	0.01	6.18	4.0
10 29 91 1500	0.01	5.71	4.2
10 29 91 1800	0.04	7.29	10.0
10 29 91 2100	0.06	8.08	14.3
10 30 91 0	0.04	6.62	20.0
10 30 91 300	0.01	5.42	4.8
10 30 91 600	0.03	6.50	20.0
10 30 91 900	0.11	7.96	14.3
10 30 91 1200	0.09	7.20	16.7
10 30 91 1500	0.02	5.97	20.0
10 30 91 1800	0.07	7.01	20.0
10 30 91 2100	0.17	8.54	14.3
10 31 91 0	0.15	7.78	4.8
10 31 91 300	0.02	5.83	3.8
10 31 91 600	0.02	5.79	20.0
10 31 91 900	0.10	7.27	20.0
10 31 91 1200	0.08	7.14	11.1
10 31 91 1500	0.01	5.45	4.2
10 31 91 1800	0.01	5.58	3.8
10 31 91 2100	0.08	7.29	12.5
11 1 91 0	0.07	7.44	9.1
11 1 91 300	0.01	5.59	4.5
11 1 91 900	0.04	6.85	4.8
11 1 91 1200	0.06	7.66	11.1
11 1 91 1500	0.02	5.98	11.1
11 1 91 1800	0.01	4.88	4.2
11 1 91 2100	0.03	6.49	3.8
11 2 91 0	0.07	7.73	11.1
11 2 91 300	0.02	6.11	5.3
11 2 91 600	0.01	4.56	5.0
11 2 91 900	0.02	5.98	12.5
11 2 91 1200	0.05	7.66	11.1
11 2 91 1500	0.07	6.52	4.0
11 2 91 1800	0.01	4.52	20.0
11 2 91 2100	0.01	5.51	20.0
11 3 91 0	0.03	7.48	11.1
11 3 91 300	0.02	6.74	11.1
11 3 91 600	0.01	4.59	3.8
11 3 91 900	0.01	5.23	3.8
11 3 91 1800	0.01	4.91	3.8
11 3 91 2100	0.01	4.89	14.3
11 4 91 0	0.02	7.02	9.1
11 4 91 300	0.03	7.22	10.0
11 4 91 600	0.01	5.18	20.0
11 4 91 1200	0.02	6.93	9.1
11 4 91 1500	0.03	7.63	10.0
11 4 91 1800	0.01	5.50	5.3
11 4 91 2100	0.01	4.41	3.8
11 5 91 0	0.01	6.36	12.5
11 5 91 300	0.04	7.58	12.5
11 5 91 600	0.01	5.87	4.5
11 5 91 900	0.01	4.48	3.8
11 5 91 1200	0.02	6.39	3.8
11 5 91 1500	0.03	7.90	12.5
11 5 91 1800	0.02	6.15	3.8
11 5 91 2100	0.01	4.22	16.7
11 6 91 0	0.01	5.73	4.0
11 6 91 300	0.02	7.58	9.1

Date/Time (GMT)	Hm0 (m)	depth (m)	period (sec)
11 6 91 600	0.02	6.43	14.3
11 6 91 900	0.01	4.54	4.0
11 6 91 1200	0.01	5.88	4.0
11 6 91 1500	0.03	7.83	10.0
11 6 91 1800	0.02	6.75	6.3
11 6 91 2100	0.01	4.41	5.0
11 7 91 0	0.01	5.13	4.5
11 7 91 300	0.02	7.33	14.3
11 7 91 600	0.02	6.93	14.3
11 7 91 1200	0.02	5.44	3.8
11 7 91 1500	0.03	7.54	5.6
11 7 91 1800	0.03	7.18	14.3
11 7 91 2100	0.03	4.86	4.0
11 8 91 0	0.01	4.66	3.8
11 8 91 300	0.02	6.83	4.0
11 8 91 600	0.02	7.22	14.3
11 8 91 900	0.01	5.31	4.2
11 8 91 1800	0.02	7.57	12.5
11 8 91 2100	0.02	5.44	3.8
11 9 91 0	0.01	4.51	5.9
11 9 91 300	0.01	6.27	5.6
11 9 91 900	0.01	5.93	4.3
11 9 91 1500	0.03	6.75	3.8
11 9 91 1800	0.05	7.81	8.3
11 9 91 2100	0.02	6.16	4.3
11 10 91 0	0.01	4.64	3.8
11 10 91 300	0.01	5.81	3.8
11 10 91 600	0.04	7.34	9.1
11 10 91 900	0.02	6.36	9.1
11 10 91 1200	0.01	4.94	4.2
11 10 91 1500	0.02	6.14	9.1
11 10 91 1800	0.06	7.67	9.1
11 10 91 2100	0.04	6.69	8.3
11 11 91 300	0.01	5.44	3.8
11 11 91 600	0.06	7.15	9.1
11 11 91 900	0.05	6.70	9.1
11 11 91 1200	0.01	5.15	3.8
11 11 91 1800	0.07	7.40	9.1
11 11 91 2100	0.06	6.94	10.0
11 12 91 0	0.01	5.05	3.8
11 12 91 300	0.01	5.09	4.2
11 12 91 600	0.02	6.69	10.0
11 12 91 900	0.03	6.94	9.1
11 12 91 1200	0.01	5.47	4.0
11 12 91 1500	0.01	5.30	3.8
11 12 91 1800	0.02	6.73	9.1
11 13 91 0	0.01	5.58	3.8
11 13 91 300	0.01	4.90	4.0
11 13 91 600	0.01	6.11	10.0
11 13 91 900	0.02	6.95	9.1
11 13 91 1200	0.01	5.76	4.8
11 13 91 1800	0.01	6.20	8.3
11 13 91 2100	0.02	7.12	10.0
11 14 91 300	0.01	4.89	3.8
11 14 91 600	0.01	5.86	4.3
11 14 91 900	0.01	6.99	3.8
11 14 91 1200	0.01	6.26	4.2
11 14 91 1500	0.01	5.03	4.0
11 14 91 1800	0.01	5.74	3.8
11 14 91 2100	0.01	7.01	9.1
11 15 91 0	0.01	6.46	4.2
11 15 91 300	0.01	5.07	20.0

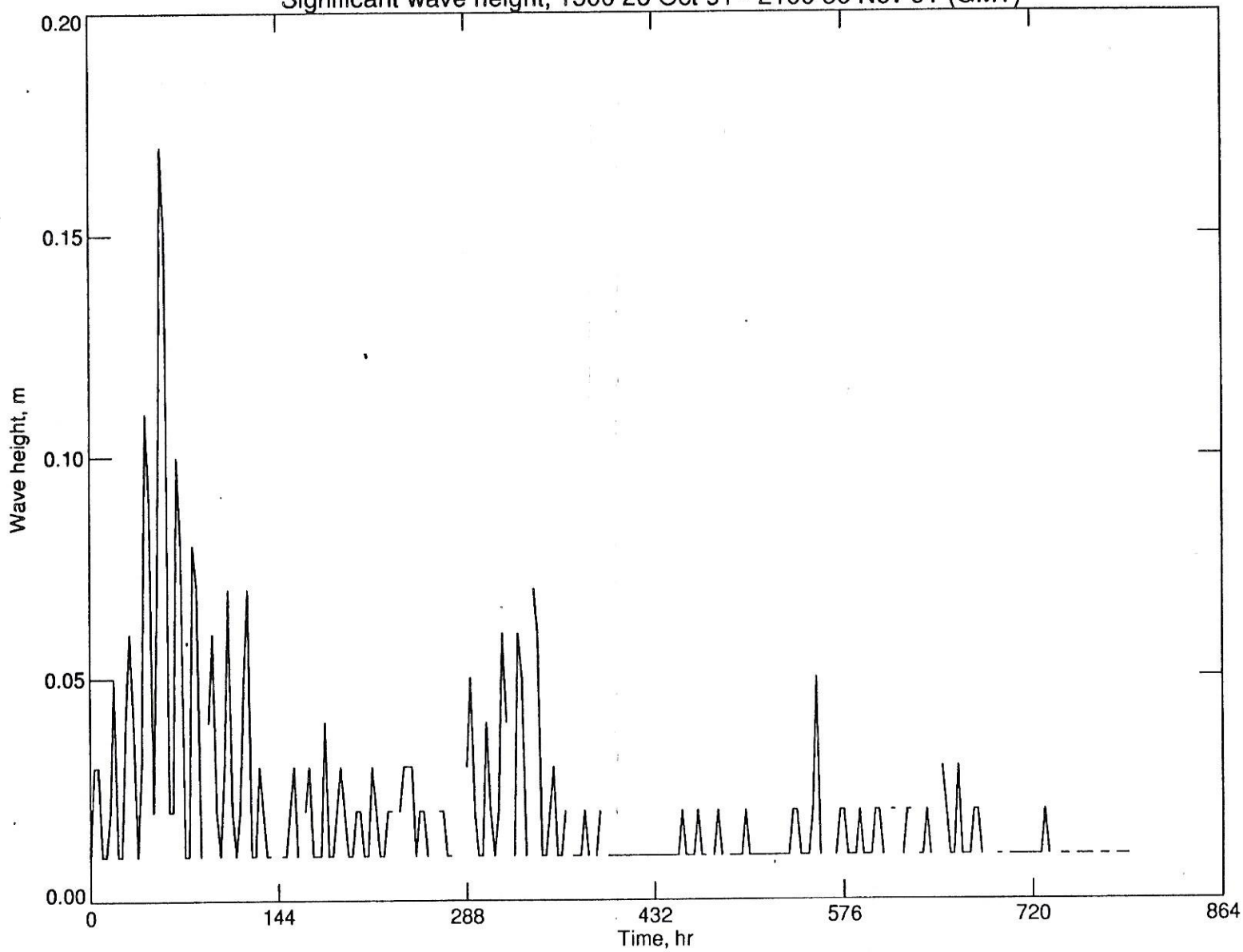
sample

ATTACHMENT B

TIME-SERIES PLOTS OF SIGNIFICANT
WAVE HEIGHTS FROM OCTOBER 28, 1991
TO APRIL 30, 1992

SAUGUS RIVER, MA, 42.44 N, 70.96 W

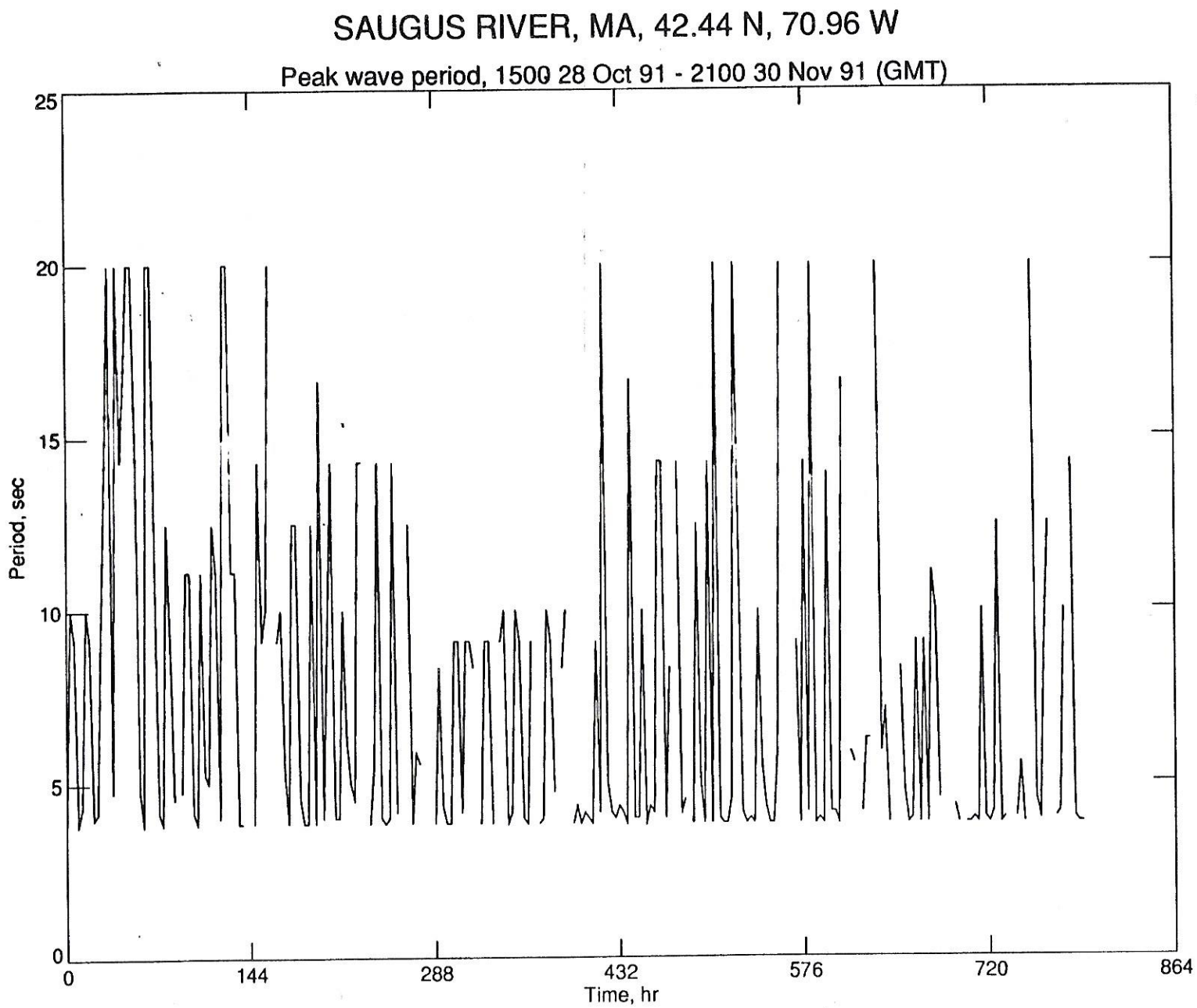
Significant wave height, 1500 28 Oct 91 - 2100 30 Nov 91 (GMT)



Sample

ATTACHMENT C

TIME-SERIES PLOTS OF PEAK WAVE PERIODS
FROM OCTOBER 28, 1991 to APRIL 30, 1992


SAUGUS RIVER, MA, 42.44 N, 70.96 W
Peak wave period, 1500 28 Oct 91 - 2100 30 Nov 91 (GMT)
Period, sec
25
20
15
10
5
0
0
144
288
432
576
720
864
Time, hr

Sample