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LAKE ERIE INTERNATIONAL JETPORT MODEL FEASIBILITY INVESTIGATION

Report 17-3

LONGSHORE WAVE ENERGY ANALYSES

by

Douglas G. Outlaw, Donald L. Durham

Hydraulics Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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Report 3 of a Series

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Prepared for Lake Erie Regional Transportation Authority
Cleveland, Ohio 44113

Under Task 17 of LERTA First-Phase
Airport Feasibility Study

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Monthly and annual direction distribution tables for significant wave heights and significant periods have been prepared for the west-southwest through the north to the northeast in 22.5-deg segments using hindcast data for Cleveland, Ohio, developed by A. H. Glenn and Associates of New Orleans, Louisiana. The significant height-significant period tables in the hindcast were used to distribute linearly the significant period over the monthly and annual percentages of occurrence of significant wave heights from each of the specified

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directions. The tables are given in Appendix A of this report. Refraction diagrams for 4-, 6-, and 8-sec waves near Cleveland are also included in this report. The initial starting point of the wave orthogonals on the refraction diagrams is approximately 3 miles offshore where the wave hindcast in the basic report is applicable. The results of the refraction analysis indicate that 4- and 6-sec waves are relatively unaffected by refractive effects except near the shoreline, but that the bottom topography may affect the direction of propagation of longer period waves from directions which are not approximately perpendicular to the lake bottom contours. Calculated monthly and annual net longshore wave energy is estimated for 15 locations along the Lake Erie shoreline near Cleveland. The longshore energy is variable along the shoreline, but a general eastwardly net longshore direction for the wave energy is indicated by the longshore wave energy data near Cleveland. Comparison of estimated and observed noncohesive longshore transport at two sites near Cleveland with results of this study indicates that shoreline composition, geometry, and protective structures have a significant effect on longshore transport near Cleveland. An estimate for the average annual total longshore energy is given.

PREFACE

The longshore wave energy analyses reported herein were sponsored by the Lake Erie Regional Transportation Authority (LERTA), Cleveland, Ohio, as a part of the model feasibility investigation being conducted at the U. S. Army Engineer Waterways Experiment Station (WES). The WES investigation, Task 17 of the LERTA investigation, is a portion of an airport feasibility study undertaken by LERTA to evaluate proposed airport sites, one of which is in Lake Erie near Cleveland.

This report was prepared by Mr. D. G. Outlaw and Dr. D. L. Durham of the Wave Dynamics Division (WDD), WES, under the general supervision of Dr. R. W. Whalin, Chief, WDD, and Mr. H. B. Simmons, Chief, Hydraulics Laboratory. Assisting in the preparation of data for this report were Messrs. Ou Yang Yu-Ching and G. M. Hopper, temporarily assigned to the WDD.

The Director of WES during the conduct of this investigation and the preparation and publication of this report was COL G. H. Hilt, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

	Page
PREFACE	1
CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT	3
PART I: INTRODUCTION	4
PART II: WAVE HINDCAST DIRECTIONAL DISTRIBUTION	6
Wave Hindcast Analysis	6
Direction Distribution Tables	7
PART III: WAVE REFRACTION ANALYSIS FOR EXISTING CONDITIONS NEAR CLEVELAND	9
Refraction Analysis Procedure	9
Selection of Refraction Grids	14
Refraction Diagrams	16
Refractive Effects on Wave Propagation	18
PART IV: LONGSHORE WAVE ENERGY	21
Wave Energy Effects on Littoral Transport	21
Wave Energy Formulation	27
Estimated Longshore Wave Energy	31
Comparison of Observed and Calculated Longshore Transport Data	38
PART V: CONCLUSIONS	39
REFERENCES	41
TABLES 1-16	
PLATES 1-20	
APPENDIX A: MONTHLY AND ANNUAL DIRECTION DISTRIBUTION TABLES FOR SIGNIFICANT WAVE HEIGHTS AND SIGNIFICANT PERIODS	A1
TABLES A1-A96	
APPENDIX B: GLOSSARY	B1
Definition of Terms	B1
Additional Sources of Information	B2
APPENDIX C: NOTATION	C1

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
cubic yards	0.7645549	cubic metres
feet per second	0.3048	metres per second
foot-pounds	1.355818	joules
degrees (angle)	0.01745329	radians

LAKE ERIE INTERNATIONAL JETPORT

MODEL FEASIBILITY INVESTIGATION

LONGSHORE WAVE ENERGY ANALYSES

PART I: INTRODUCTION

1. The Lake Erie Regional Transportation Authority (LERTA) is conducting a feasibility and site selection study for a major hub airport in the Cleveland Service Area. One of the possible sites being evaluated is an offshore site in Lake Erie near Cleveland, Ohio. As a part of the feasibility analysis of an offshore site, the U. S. Army Engineer Waterways Experiment Station (WES) is conducting a model feasibility investigation, the results of which are to be presented in a series of reports published under the general title "Lake Erie International Jetport Model Feasibility Investigation." This report, which is the third of the series, presents results of the longshore wave energy analyses. The scope of the jetport project and available data pertinent to the model feasibility study are reviewed in the first report of the series (Reference 1), and the second report (Reference 2) presents the conclusions and results based on the study of the feasibility of using physical hydraulic models to estimate the effects of the proposed jetport on lake hydrodynamics. Reference 3 presents a wave hindcast* for Cleveland that was prepared earlier in the WES investigation by A. H. Glenn and Associates of New Orleans, Louisiana, to supplement existing wave hindcasts,[4,5] which are based on shorter time histories of wind data.

2. Included in Reference 3 are average monthly and annual significant wave height-direction distribution tables and significant wave height-significant period tables for a station at latitude $41^{\circ}39.0'$ N and longitude $81^{\circ}33.5'$ W. Along with the hindcast tables, normal wind, normal (long-duration) water level, storm wind, and storm (short-duration) water level data are presented. Storm wave characteristics

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* For convenience, hydraulic terms are defined in the Glossary (Appendix B).

are included for the 30 most severe storms during the period of record used for the hindcast and for the severe storms of November 1913 and November 1950. Average monthly and annual wind speed-direction distributions are also provided for the hindcast station. The average number of years between occurrences of maximum and significant wave heights and of significant wave periods is presented for the hindcast station. The data for storm wave occurrence intervals may be applied at a second location, latitude $41^{\circ}38.2'$ N and longitude $81^{\circ}42.4'$ W, near the offshore limit of the initial jetport concept.

3. Average monthly and annual significant wave height-significant wave period tables for the west-southwest through the north to the northeast in 22.5-deg segments have been developed from the data in Reference 3 and are included in this report as Appendix A. Wave refraction diagrams and tables of refraction coefficients and orthogonal azimuths at the shoreline are also calculated for the lake shoreline near Cleveland. The data from the wave hindcast significant wave height-significant wave period direction tables and from the refraction analysis are used to estimate the longshore wave energy near Cleveland.

4. Fifteen locations near Cleveland are included in the study. The average monthly and net longshore energy and the annual total longshore wave energy are given for each location. Annual longshore littoral transport rates for noncohesive sediment are also estimated and compared with observed rates at two sites.

PART II: WAVE HINDCAST DIRECTIONAL DISTRIBUTION

Wave Hindcast Analysis

5. As indicated in Reference 3, the wave hindcast by A. H. Glenn and Associates was developed from wind data recorded over a 10-yr period at Cleveland Hopkins Airport. Correlations for wind speed based on observations from Burke Lakefront Airport, located along the Cleveland shoreline, were applied to the Cleveland Hopkins data to obtain monthly average wind speed distributions applicable to the lake hindcast location. A. H. Glenn and Associates found no significant differences in wind direction for average conditions between the Burke Lakefront and Cleveland Hopkins wind direction data, and the Cleveland Hopkins direction data were considered applicable to the hindcast location. As stated in Reference 3, the wind speed-direction distribution tables were developed for overwater wind conditions at the hindcast location and are not applicable to an overland exposure. Additional details concerning the procedures used in developing the wind speed-direction distributions are given in Reference 3.

6. The tables for wind speed were then used in developing the average monthly and annual significant wave height-direction and significant wave height-significant period distribution tables. To develop the hindcast tables, A. H. Glenn and Associates determined average fetches and depths for each of 16 compass points. Based on previous experience in the application of hindcast techniques, A. H. Glenn and Associates adopted and modified deepwater and intermediate-depth water wave hindcast techniques for specific application to Lake Erie, and these techniques were used to obtain the wave height-direction and wave height-wave period tables. In the hindcast, wave generation was assumed to be fetch- and depth-limited, but not duration-limited. As indicated in Reference 3, this assumption is occasionally conservative. Additional details concerning the development of the wave hindcast tables are given in Reference 3.

7. Monthly and annual tables for significant wave heights and

significant wave periods for each of the specified directions were not included in Reference 3. In the longshore wave energy analysis, a table of significant wave heights and significant wave periods for each of the specified wave hindcast directions from the west-southwest through the north to the northeast is needed to estimate the net monthly and annual longshore wave energy. The significant height-significant period tables for each direction during a month are developed using the following procedure:

a. Multiply each percentage of occurrence in the columns of the monthly and annual significant wave height-significant period tables (Tables 27-39 in Reference 3) by the scale factor required to normalize the sum of each column to 100 percent.

b. Multiply the normalized percentage of occurrence of a particular significant wave height-significant period by the percentage of occurrence of the significant wave height from each specified direction in Tables 14-26 in Reference 3.

The method discussed above for developing the tables was suggested by Mr. A. H. Glenn* of A. H. Glenn and Associates. The method assumes that significant wave period is not affected by wave approach direction. This assumption permits the conditional probability of significant wave period for a given approach direction to be computed by multiplying the normalized probability of significant wave period (Tables 27-39 in Reference 3), which is a function of significant wave height, by the conditional probability (Tables 14-26 in Reference 3) of significant wave height for the same given approach direction.

Direction Distribution Tables

8. The percentage of occurrence of a particular significant wave height and significant period for each of eight directions from the west-southwest through the north to the northeast is given in Tables A1-A96 of Appendix A for average monthly and annual conditions. In

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* A. H. Glenn, personal communication, June 1974.

these tables, significant wave height is the average height (wave crest to preceding trough) of the highest one-third of the waves observed passing a stationary location. The significant wave period is the average period of the waves considered in determining significant height. The ratio of expected maximum wave height H_{max}* to significant wave height H_s in a group of N waves as given in Reference 3 is as follows:

N	H_{max}/H_s
100	1.53
200	1.64
500	1.77
1000	1.86

All waves moving from an 11-1/4-deg sector either side of the specified direction are included in the percentage of occurrence for that direction.

9. The month of February is not considered in Reference 3 due to the effect of ice coverage. Wave generation is inhibited or suppressed by ice formation; and as indicated in Reference 3, ice coverage varies markedly from year to year with extremes in ice coverage near Cleveland varying from late December to late March or limited ice coverage from late January to early March.

10. Significant wave height-significant period groups occurring less than 0.05 percent monthly or annually are shown as zero in the tables. A wave height group occurring less than 0.05 percent monthly will occur, on the average, less than 0.36 hr per month (4.32 hr annually). The data in Tables A1-A96 are long-term averages; and as stated in Reference 3, possible variation in average conditions should be taken into consideration in applying the data to short-term situations, particularly in the case of evaluation of operations and construction which are not long-term phenomena.

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* For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix C).

PART III: WAVE REFRACTION ANALYSIS FOR EXISTING CONDITIONS NEAR CLEVELAND

Refraction Analysis Procedure

11. Wave refraction or bending of a wave front as the wave propagates over varying bottom topography may affect both wave height and direction near the Lake Erie shoreline. Refractive effects are insignificant in deep water where the lake depth h is greater than one-half the wavelength L but become more important in depths less than one-half the wavelength. In the refraction analysis, wave orthogonals are calculated using a procedure originally developed at Stanford University.[6] Wave height H_1 near the shoreline is given by

$$H_1 = H_o K_s K_r \tag{1}$$

where H_o is the deepwater wave height; K_s the shoaling coefficient; and K_r the refraction coefficient. The major assumption, as indicated in Reference 6, is that no energy is transmitted perpendicular to the wave orthogonal. Bottom reflection, bottom friction, and percolation influence wave height but may normally be neglected in a wave refraction analysis for small slopes.

12. The shoaling coefficent K_s is a function of depth only and is given by[6]

$$K_s = \left\{ \frac{C_o}{c[1 + (4\pi h/L)/\sinh (4\pi h/L)]} \right\}^{1/2} \tag{2}$$

where C_o is the wave celerity in deep water and c is the wave celerity at any point of interest. The refraction coefficient is defined as

$$K_r = \left(\frac{\ell_o}{\ell} \right)^{1/2} = \beta^{-1/2} \tag{3}$$

where ℓ_o is the distance between wave orthogonals in deep water, ℓ is the distance between orthogonals as measured along the wave front, and

β is the orthogonal separation coefficient ℓ/ℓ_o.

13. The governing equations used in the procedure are developed from the wave ray (orthogonal) equation derived by Munk and Arthur[7]

$$\frac{D\alpha}{Ds} = -\frac{1}{c}\frac{Dc}{Dn} \tag{4}$$

where α is the angle between the x axis and the wave orthogonal, s an arc distance along the wave orthogonal, and n an arc distance along the wave front as shown in Figure 1. The plane of the x,y coordinate system is at the mean water surface. The nonlinear differential operators D/Ds and D/Dn may be expressed in terms of the x,y coordinate as illustrated in Figure 2. Equation 4 also can be written in terms of time t rather than distance along the wave orthogonal as

$$\frac{1}{\beta}\frac{D\beta}{Dt} = c\frac{D\alpha}{Dn} \tag{5}$$

The governing equations for the curvature κ of the wave orthogonal and the orthogonal separation coefficient β as derived in References 6 and 8 are

$$\kappa = \frac{1}{c}\left(\sin\alpha\frac{\partial c}{\partial x} - \cos\alpha\frac{\partial c}{\partial y}\right) \tag{6}$$

and

$$\frac{d^2\beta}{dt^2} + p(t)\frac{d\beta}{dt} + q(t)\beta = 0 \tag{7}$$

where p(t) and q(t) are variables defined as

$$p(t) = -2\left(\cos\alpha\frac{\partial c}{\partial x} + \sin\alpha\frac{\partial c}{\partial y}\right) \tag{8a}$$

and

$$q(t) = c\left(\sin^2\alpha\frac{\partial^2 c}{\partial x^2} - 2\sin\alpha\cos\alpha\frac{\partial^2 c}{\partial x\,\partial y} + \cos^2\alpha\frac{\partial^2 c}{\partial y^2}\right) \tag{8b}$$

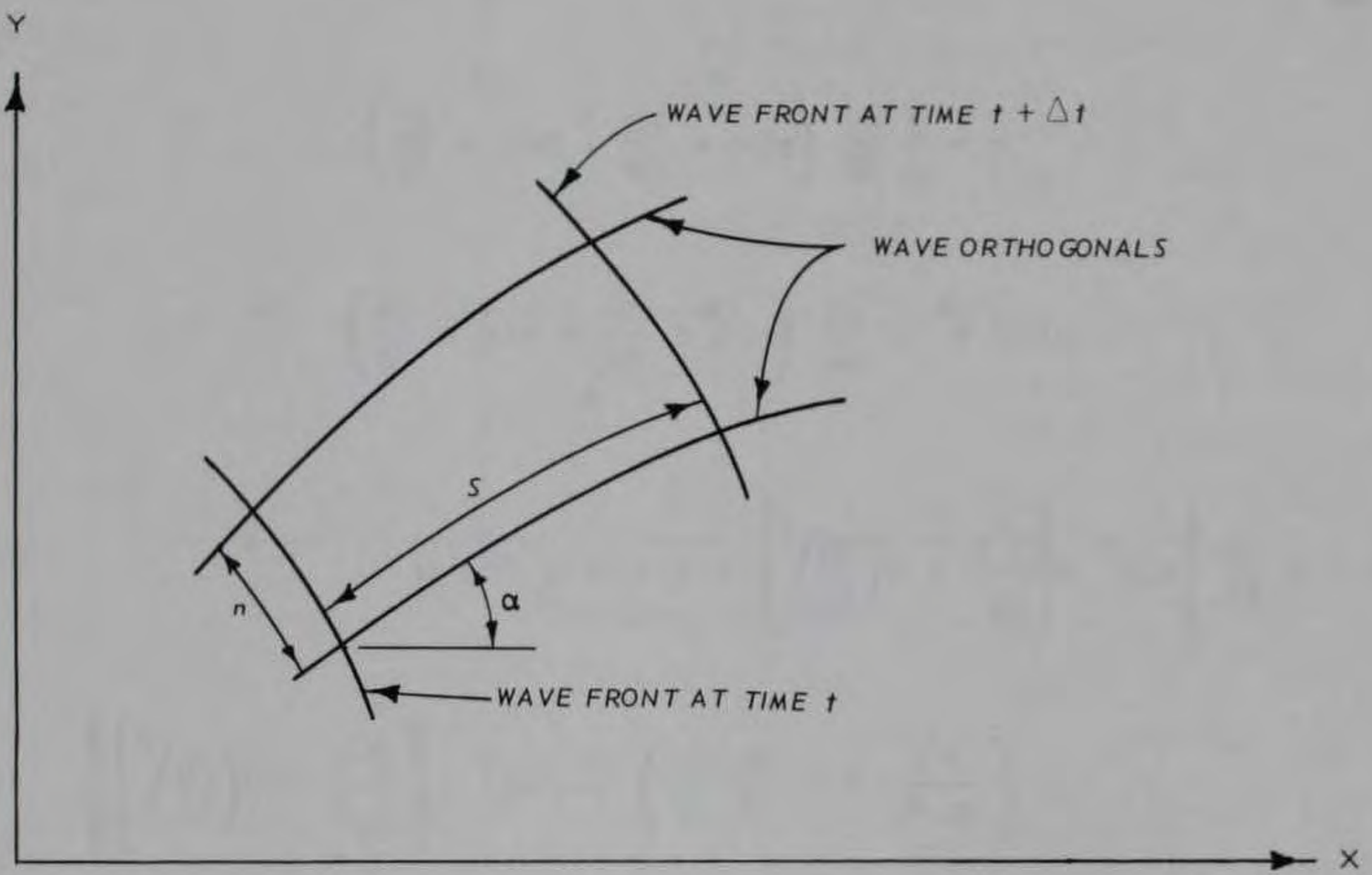

Figure 1. Wave ray coordinate system

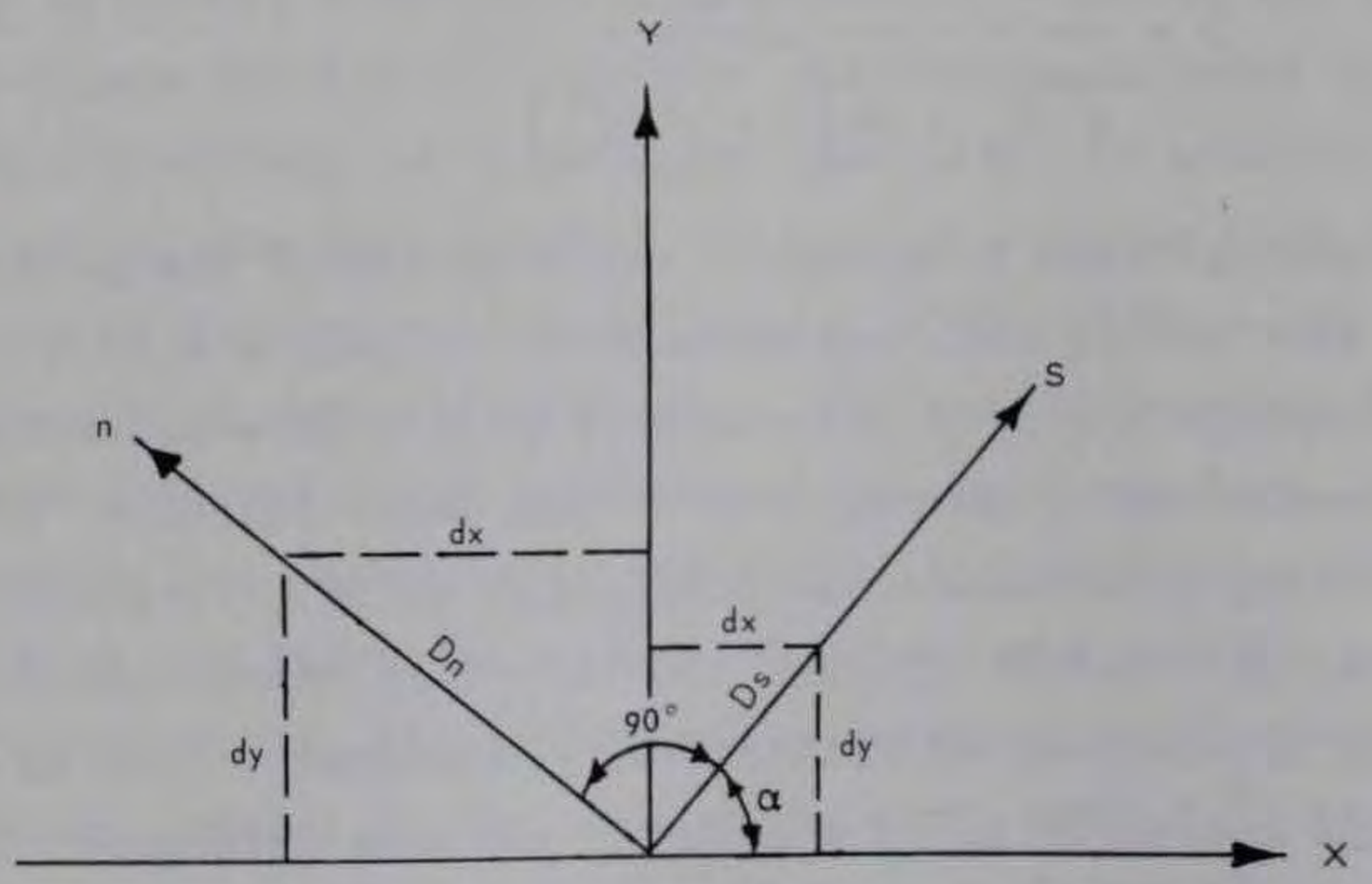

Figure 2. Differential operator definition sketch

Over variable bottom topography, the governing equations may be expressed more conveniently in terms of the water depth instead of the wave celerity as

$$\kappa = \frac{1}{c}\frac{dc}{dh}\left(\sin\alpha\frac{\partial h}{\partial x} - \cos\alpha\frac{\partial h}{\partial y}\right) \tag{9}$$

$$p(t) = -2\frac{dc}{dh}\left(\cos\alpha\frac{\partial h}{\partial x} + \sin\alpha\frac{\partial h}{\partial y}\right) \tag{10}$$

and

$$q(t) = c\frac{dc}{dh}\left\{\sin^2\alpha\left[\frac{\partial^2 h}{\partial x^2} + U\left(\frac{\partial h}{\partial x}\right)^2\right] + 2\sin\alpha\cos\alpha \times \left(\frac{\partial^2 h}{\partial x\,\partial y} + U\frac{\partial h}{\partial x}\frac{\partial h}{\partial y}\right) + \cos^2\alpha\left[\frac{\partial^2 h}{\partial y^2} + U\left(\frac{\partial h}{\partial y}\right)^2\right]\right\} \tag{11}$$

where the variable U is given by

$$U = \frac{-2\sigma c^2/C_o}{c^2/C_o + \sigma h\left(1 - c^2/C_o^2\right)^2} \tag{12}$$

and σ is the angular wave frequency. For solution of the governing equations, the wave orthogonals are assumed to propagate with a constant time step Δt through a region covered by a grid with a square mesh.

14. The second-order derivatives of the depth function $h(x,y)$ are found by fitting a second-degree polynomial to 12 grid points surrounding the area of interest (Figure 3). A better representation of local topography is obtained by fitting the polynomial to the 12 points instead of to the entire grid. The path of the wave orthogonal is computed from Equation 9 for a specified initial starting location and direction. The orthogonal is projected forward to a new approximate position using the initial curvature. A new curvature is calculated for the approximate position, and the initial and new curvatures are

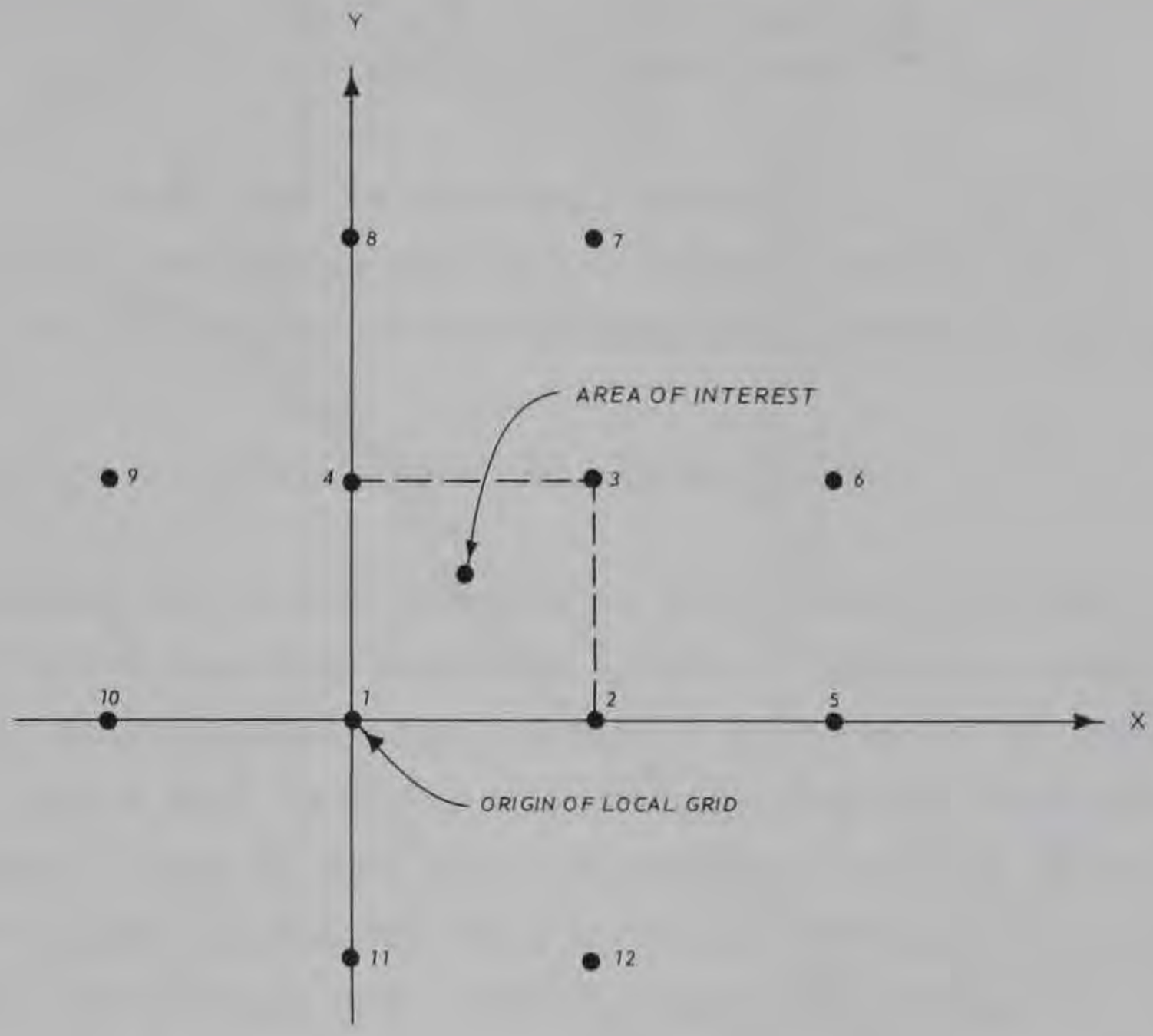

Figure 3. Location of grid points in local coordinate system for fitting of polynomial equation

averaged to obtain a better estimate of the position for the new point. The iterations for the new position are continued until the difference in curvature between two successive iterations is within specified limits. Also, the wave celerity is averaged during each iteration. The new point is then considered fixed and is used as the initial point in the following set of iterations. The wave orthogonal is continued across the grid until the lake shoreline, grid boundary, breaking wave location, or other termination conditions are attained. Equations illustrating the iterative process can be found in References 6 and 8.

15. To obtain the orthogonal separation coefficient, Equation 7 is solved by central differences using Fox's method.[9] As indicated in Reference 8, the method is well suited to an initial value type of problem where the initial and preceding values of β are known. The derivatives for β are obtained from

$$\beta_{i+1} = \frac{\left[p_i(t)\Delta t - 2\right]\beta_{i-1} - 2\left[q_i(t)\Delta t^2 - 2\right]\beta_i}{\left[p_i(t)\Delta t + 2\right]} \qquad (13)$$

where the subscript i indicates the value at time step i. The solution for β may become unstable if the wave propagates into a region of increasing depth; however, the path of the orthogonal will be correct.

Selection of Refraction Grids

16. The boundaries of the four grids used in the refraction analysis are shown in Figure 4. Grid 1 partially overlays grid 2 and covers the area west of the existing Cleveland Harbor and includes the mouth of the Rocky River and the lake shoreline east of Avon Point. The remaining three grids are contiguous, with part of grid 3 overlaid on grid 2, and cover the lake shoreline from immediately west of the Cleveland Harbor to east of the Chagrin River. The sizes of the grids were selected in order that (a) waves could be refracted into shore from appropriate directions in the wave hindcast and (b) the wave orthogonal, in most cases, could be started approximately 3 miles* offshore. The deepwater wave orthogonal azimuths vary from 270° NW to 0° N to 45° NE in 22.5-deg increments; however, all of the above directions, dependent on the orientation of the shoreline, are not included for each grid.

17. Each square in the refraction grids is 1000 ft on each side, and the size of each grid is given in the following tabulation:

Grid No.	Size, ft
1	20,000 by 65,000
2	32,000 by 38,000
3	24,000 by 63,000
4	27,000 by 51,000

Depth data for each grid point were obtained from charts L. S. 34 and L. S. 35 published by the Lake Survey Center of the U. S. Department of

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

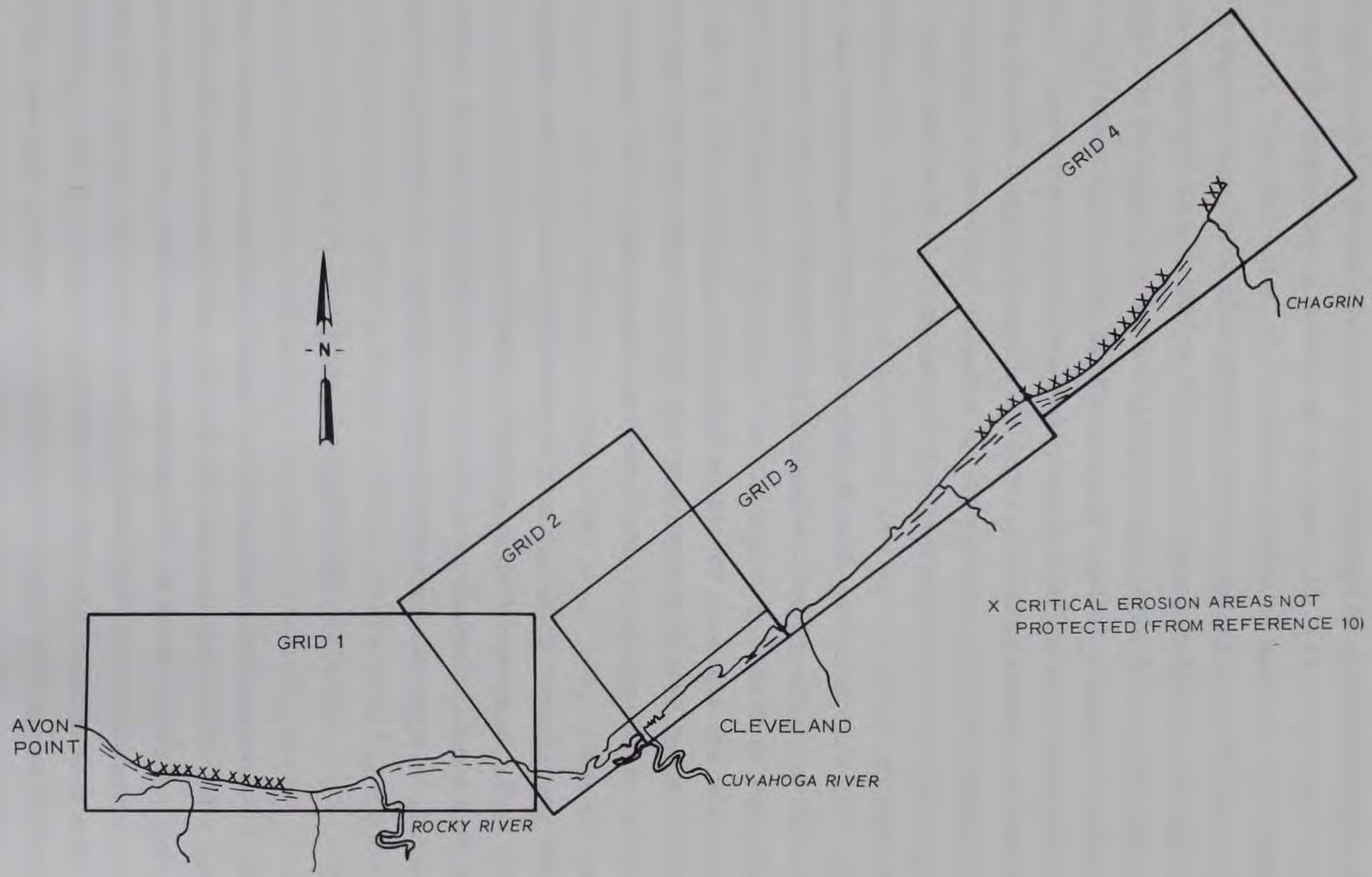


Figure 4. Grid location for refraction analysis

Commerce. The lake water level is assumed to be 2.0 ft above the mean low water datum which is slightly higher than the average lake level for Lake Erie. The time step Δt used in calculating each wave orthogonal is one-tenth of the wave period.

18. Included in the grid areas of the refraction analysis are the entrances to the existing commercial harbor at Cleveland and three shoreline reaches (Figure 4) which were identified as nonprotected critical erosion areas by the U. S. Army Engineer Division, North Central, in a cooperative study with various other Federal and State agencies.[10] Outside the shoreline reaches included in the refraction analysis grids, the two closest locations identified as areas of unprotected critical erosion are west of Cleveland near Lorain and east of Cleveland near Fairport Harbor.

19. The wave hindcast data in Reference 3 were prepared from wind data taken at Cleveland. (However, the hindcast may be used near Cleveland from east of Avon Point to the Chagrin River or farther eastward along the shoreline.) The fetch distances, particularly to the west, are affected as the hindcast is applied to areas farther west from Cleveland, with the hindcast data becoming less reliable for those shoreline reaches.

20. The area of interest in the refraction analysis was separated into four grids to reduce the total area covered in the grids. Also, using separate grids instead of a single large grid provides a finer grid point spacing without requiring large segments of computer core.

Refraction Diagrams

21. The refraction diagrams for each of the four grids are shown in Plates 1-20. The diagrams are for 4-, 6-, and 8-sec wave periods. A 1-ft wave height is used in the refraction analysis, and the wave orthogonal is terminated at the shoreline or at the Cleveland Harbor breakwater. The wave orthogonals are started approximately 3 miles offshore where refractive effects are not significant. However, the wave orthogonals do not begin from the same wave front. The azimuth shown in

each of the diagrams is the one from which the wave orthogonals propagate. An orthogonal number is shown by the initial starting point of each orthogonal.

22. Determination of the refraction coefficient K_r directly from the refraction diagrams would be very inaccurate at best. Thus, the refraction coefficients computed using Equation 13 are presented in Tables 1-4. These refraction coefficients are for the waves at their breaking locations near the shoreline or at the Cleveland Harbor breakwater, depending upon the termination point of the orthogonals. The incident wave height is taken as 1 ft, and the breaking criterion is $H_b = 0.78h_b$, where H_b is the wave height at breaking and h_b is the depth at breaking. Therefore, the refraction coefficients and consequently the breaking location are in water depths of 0.5-1.5 ft, depending upon the refraction coefficients.

23. The azimuths of the orthogonals may be measured from the refraction diagrams. However, the azimuths are difficult to determine accurately near the shoreline and therefore are given in Tables 5-8 for the termination points of the orthogonals shown in Plates 1-20. The azimuths of the orthogonals may vary rapidly near the shoreline, particularly for the 4-sec waves in regions with small bottom depths. As shown in Plates 1-20, the effect is more pronounced for orthogonals approaching the shoreline from directions not approximately perpendicular to the offshore bottom contours. The breaking location for waves with heights significantly larger than 1 ft will be farther offshore in deeper water, and the azimuths listed in Tables 5-8 may not be directly applicable. However, the azimuths may, with some decrease in accuracy, be measured directly from Plates 1-20 after the actual breaking location is determined. The horizontal distance scale for each refraction diagram is shown in Plates 1-20. The north azimuth (0.0 deg) is shown on each plate. The refraction coefficients may also be affected by the wave breaking location but not generally to the same extent as are the azimuths. The refraction coefficients listed in Tables 1-4 will usually be more accurate than those determined directly from the refraction diagrams.

Refractive Effects on Wave Propagation

24. The refraction diagrams and the refraction coefficients listed in Tables 1-4 indicate, as expected, that refractive effects are more significant for longer wave periods. The direction of propagation and the refraction coefficient of the 4-sec waves are relatively unaffected except near the shoreline. The 6-sec waves begin to refract farther offshore in deeper water; and the 8-sec waves, when started from directions not approximately perpendicular to the offshore bottom contours, begin to refract slightly immediately after being started. For example, the refraction coefficient for orthogonal 1 of the 8-sec wave for grid 4 with a deepwater azimuth of 22.5 deg has little change in magnitude at approximately 1/2 and 1 mile from the starting location, but at the shoreline the refraction coefficient is the smallest (largest separation between adjacent orthogonals) calculated for any orthogonal in the four grids. The refraction coefficients and azimuths are shown in the following tabulation. For comparison, data from the 4- and 6-sec orthogonals starting at the same location are also shown.

Wave Period sec	Refraction Coefficient at Indicated Distance			Azimuth at Indicated Distance, deg		
	1/2 Mile	1 Mile	Shoreline	1/2 Mile	1 Mile	Shoreline
4	1.00	1.00	0.62	22.5	22.5	329.0
6	1.00	0.99	0.58	21.7	21.0	321.0
8	0.99	0.98	0.53	21.3	19.9	317.4

As indicated by the preceding data, the 4- and 6-sec wave heights (with the possible exception of large storm waves) and directions are not significantly affected by offshore bottom topography except relatively near the shoreline. However, the longer period waves may be affected to some extent even at approximately 3 miles offshore for wave directions which are not approximately perpendicular to the lake bottom contours.

25. In general, Tables 1-8 indicate that refraction coefficients and changes in direction of orthogonal propagation have a similar trend along a shoreline reach, but local topography may affect the results obtained for any particular location. In the 8-sec group for grid 1,

orthogonal 1 with a 0.0-deg azimuth and orthogonal 12 with a 22.5-deg azimuth have refraction coefficients greater than 1.10, which does not follow the general trend of the refraction coefficients for other orthogonals with the same period and azimuths. The two orthogonals do, however, propagate over offshore bottom topography features, which results in the increased refraction coefficients. A similar increase is shown in the 6-sec data for the same orthogonals, but not in the 4-sec data. These increases are probably due to the effects of the depth of the offshore bottom topography on the 6- and 8-sec waves and also to the differences in the curvatures of the 4-, 6-, and 8-sec orthogonals. This difference in curvatures results in each orthogonal propagating along separate lines and over bottom topography which may vary from that over which orthogonals of waves with different periods propagate, even though the waves started at the same location. The convergence and divergence along the Cleveland Harbor breakwater indicated in the data for grids 2 and 3 are due to the dumping area lakeward of the breakwater and also to several small areas farther offshore where the depths are 10-15 ft less than the surrounding lake depths. Along the breakwater and the shoreline reaches affected by dumping area and decreased depths, no trend is apparent except for the general indication that 4-sec waves are not as strongly affected as are 6- and 8-sec waves. The azimuths of the orthogonals are also significantly affected and are dependent on the offshore topography in this region.

26. Along the shoreline sections of grids 3 and 4, the refraction coefficient data are again affected by variation in local topography, particularly near the mouth of the Chagrin River. The refraction data do not indicate any effect of lakefront structures more significant than those of other local changes in topography.

27. Areas of divergence where the refraction coefficient is 0.80 or less are limited and are generally dependent on the initial azimuth, wave period, and again, local topography. Shoreline reaches of grids 1, 3, and 4, in which two or more adjacent orthogonals are 0.80 or less, are shown in the following tabulation.

Grid Number	Period, sec	Azimuth, deg	Orthogonals
1	4,6,8	45.0	1,2
	4	315.0	10,11
3	4	22.5	1,2
	6,8	22.5	1,2,3
4	4,6,8	22.5	1,2

As would be expected, the reaches are for azimuths which are not approximately perpendicular to the offshore bottom contours. As previously discussed, the topography lakeward of the Cleveland Harbor breakwater significantly influences the refraction coefficients at the breakwater, and the coefficients are variable and do not follow any general trend.

28. The areas of increased and decreased refraction coefficients discussed in paragraphs 25-27 should not be interpreted as reaches of significantly increased or reduced wave energy based solely on the refraction analysis. The refraction data must first be considered along with the wave hindcast data to estimate the monthly and annual wave energy distribution along the shoreline.

PART IV: LONGSHORE WAVE ENERGY

Wave Energy Effects on Littoral Transport

Littoral processes

29. Generally, littoral processes[11] result from the interaction of winds, waves, currents, tides, sediments, and other phenomena in the littoral zone. In Lake Erie, astronomical tides are relatively small and their effects may be neglected when littoral processes and sediment transport are considered. The lake shoreline characteristics are described in References 1 and 12-14, and the shoreline is generally composed of bluff sections of shale or cohesive glacial till deposits. Several characteristics[1] of shore erosion near Cleveland are:

a. Shore erosion is a continuing process and is most severe during periods of high lake levels.

b. Littoral currents near Cleveland flow generally from west to east with temporary reversals of direction due to northerly and northeasterly winds.

c. Generally, the longshore net sediment transport is from west to east near Cleveland.

d. The predominant direction of littoral sediment transport west of Avon Point changes to an east-to-west pattern.

e. Limited quantities of sand for beach nourishment are provided by the Rocky, Cuyahoga, and Chagrin Rivers, and sand which is available is usually deposited in the respective harbors and navigation channels.

f. The shale and cohesive glacial till deposits in the bluffs near Cleveland are not highly resistant to erosion caused by wave attack.

g. Erosion rates vary along the shoreline, but west of Chagrin they have been observed at up to 5 ft per year with an average recession rate of 2-4 ft per year.

Beaches, generally narrow during periods of high water, are found in front of the glacial bluff deposits near Cleveland; however, they are not continuous along the shoreline and are typically found in shoreline indentions or trapped by groins.

30. Wave action is the principal[11] cause of most shoreline changes. Small-amplitude wave theory can provide estimates of water

motion, longshore force, and energy flux due to waves. However, estimates of wave-induced sediment transport for noncohesive materials rely heavily on empirical coefficients and judgment. Data for cohesive materials are very limited, and a generally accepted method of estimating transport of cohesive materials has not been developed.

Wave-induced water
motion on sand beaches

31. Along shoreline reaches with beaches, increased turbulence is generated at the wave breaking locations, and sediment suspension becomes more pronounced. In the surf zone shoreward of the breaker zone, the water motion is mostly uniform horizontal motion. A longshore component of momentum results when wave crests break at an angle to the shoreline and is the principal cause of longshore currents (currents that flow parallel to the shoreline in the surf zone). Terminology used in describing beach characteristics is shown in Figure 5.

32. As a wave approaches the breaker zone in shallow water, the water particle velocity is also approximately horizontal and constant

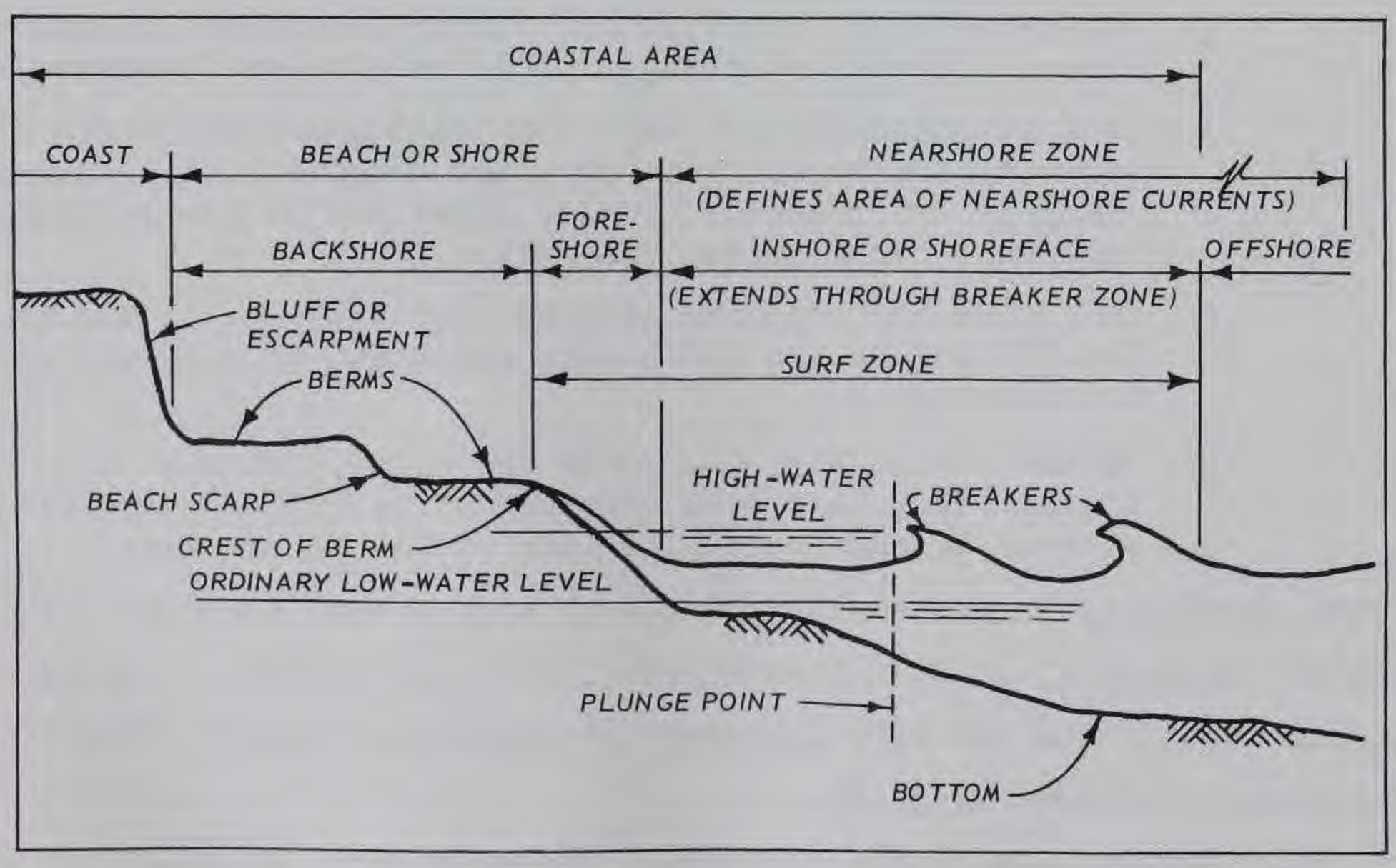


Figure 5. Beach profile terminology (from Reference 11)

over depth. The velocities are not constant with time, however, due to the oscillatory characteristics of wave-induced, water particle velocity. Significant vertical velocities do occur as the wave height increases prior to breaking. The water particle velocity and turbulence at breaking suspend sediment which may then be transported by currents into the surf zone where velocities are normally too low to suspend sediment. The most turbulence is usually produced by plunging breakers. The plunging crest of the wave at breaking can act as a free-falling jet which scours a trough into the bottom. Immediately seaward of the breaker zone, a longshore bar is frequently formed, partially by sediment transported from the trough and partially by sediment transported in bottom ripples moving from offshore. The wave-generated currents in the littoral zone may have wind-generated or river-inflow currents superimposed upon them. Nearshore currents may also be altered by changes in the geometry of the littoral zone due to fluctuations of the lake surface during wind setup.

33. Limited exchange of water takes place between the surf zone and the area seaward of the breaker line. The breaking wave is formed largely of water which is withdrawn from the surf zone as the wave forms and re-enters the surf zone and breaks. Thus, only a limited exchange of mass develops. The mass transport velocity in shoaling waves, wind-generated currents, wave-induced setup, density currents, rip currents, and currents due to the local bottom topography is responsible for the exchange of mass which does occur. The return flow from the surf zone may vary from broad diffuse flows to concentrated rip currents.

34. Wave-induced longshore currents normally have mean values of 1 fps or less. Observations of currents ranging from 3 to 5.5 fps have been reported, but the highest ranges observed are also reported to have been influenced by winds. The longshore currents generally have low speeds but are important in longshore transport of sediment suspended by breaking waves. An estimate of the longshore velocity v in the fully developed flow shoreward of the breaker line may be obtained from the modified Longuet-Higgins equation.[15]

$$v = 20.7\ m(gH_b)^{0.5} \sin 2\alpha_b \qquad (14)$$

where

m = beach slope

g = acceleration of gravity

H_b = wave height at breaking

α_b = angle between the breaking wave crest and the shoreline

The longshore velocity distribution from the shoreline through the littoral zone may be calculated from further development of the Longuet-Higgins theory,[16] but the relationship of the calculated longshore current to sediment transport over erodible sand beds has not been defined for a broad range of conditions. Longshore current velocity is most affected by changes in the angle between the breaker crest and the shoreline and by changes in wave height H at breaking H_b. The total volume of water transported in the littoral zone is more dependent on H_b since the breaking location is determined primarily by the breaking wave height.

Sediment transport characteristics in the littoral zone

35. Littoral transport is classified as either onshore-offshore transport or longshore transport, depending upon the average net direction. The onshore-offshore transport is perpendicular to the shoreline, and the longshore transport is parallel to the shoreline. Movement of sediment usually has both an onshore-offshore and a longshore component. The onshore-offshore component is normally most significant seaward of the breaker zone in the absence of strong wind-generated or tidal longshore currents. Both components are important in the surf zone. The transport occurs in two modes, bed-load transport and suspended-load transport. The bed-load transport is due to the motion of sand grains moved by shear stress from the wave-induced water particle velocity, and the suspended-load transport is the transport of sand grains by currents after the grains have been suspended by wave action. The two types of transport are usually present at the

same time and are difficult to separate. The sediment transport may also be characterized by the type of wave-induced motion initiating sediment movement. In the offshore zone seaward of the breakers, the wave motion above the sand bed increases until it exerts sufficient shear stress to move the sand particles. The sand then forms ripples with crests parallel to the wave crests. Near the breaker zone a cloud of sand rises upward from the lee side of the ripple during the passage of the wave crest and drifts seaward as the trough of the wave passes. The direction of transport of the remaining sand suspended in the cloud reverses as the next wave crest approaches. Bed-load transport also occurs in the offshore zone. The net transport is dependent on local current and wave actions.

36. Ripple formation and transport are present in the surf zone but with added suspended sediment entrained during breaking of the wave. The sediment in the suspended load and the bed load oscillates back and forth with each passing wave and moves alongshore with the longshore current. Due to the sediment suspension from the breaking wave, significant quantities of sand are suspended over most of the water depth in the surf zone. The amount of sediment suspended is usually less for a spilling wave at breaking than for a plunging wave at breaking.

37. During severe storm conditions, a typical beach profile usually develops with a concave upward curve. The sand eroded from the beach is deposited mostly as a ramp or bar in the surf zone existing at the time of the storm. After the storm, sand deposited seaward of the shoreline begins moving shoreward as a sandbar with a gently sloping seaward face and a steeper landward face. Given sufficient time before another severe storms occurs, the sand bar will migrate to the landward limit of the storm erosion. The rate of migration of the bar varies greatly and is apparently related to wave conditions, beach slope, sand grain size, and length of time waves work over the bar. The migration of a sand bar in Lake Michigan after a storm is shown in Figure 6 for a beach profile near Holland, Michigan. Depending on local conditions, beach profiles may vary markedly from the typical profile shown in Figure 6. Accretion of sediment instead of erosion may occur along a

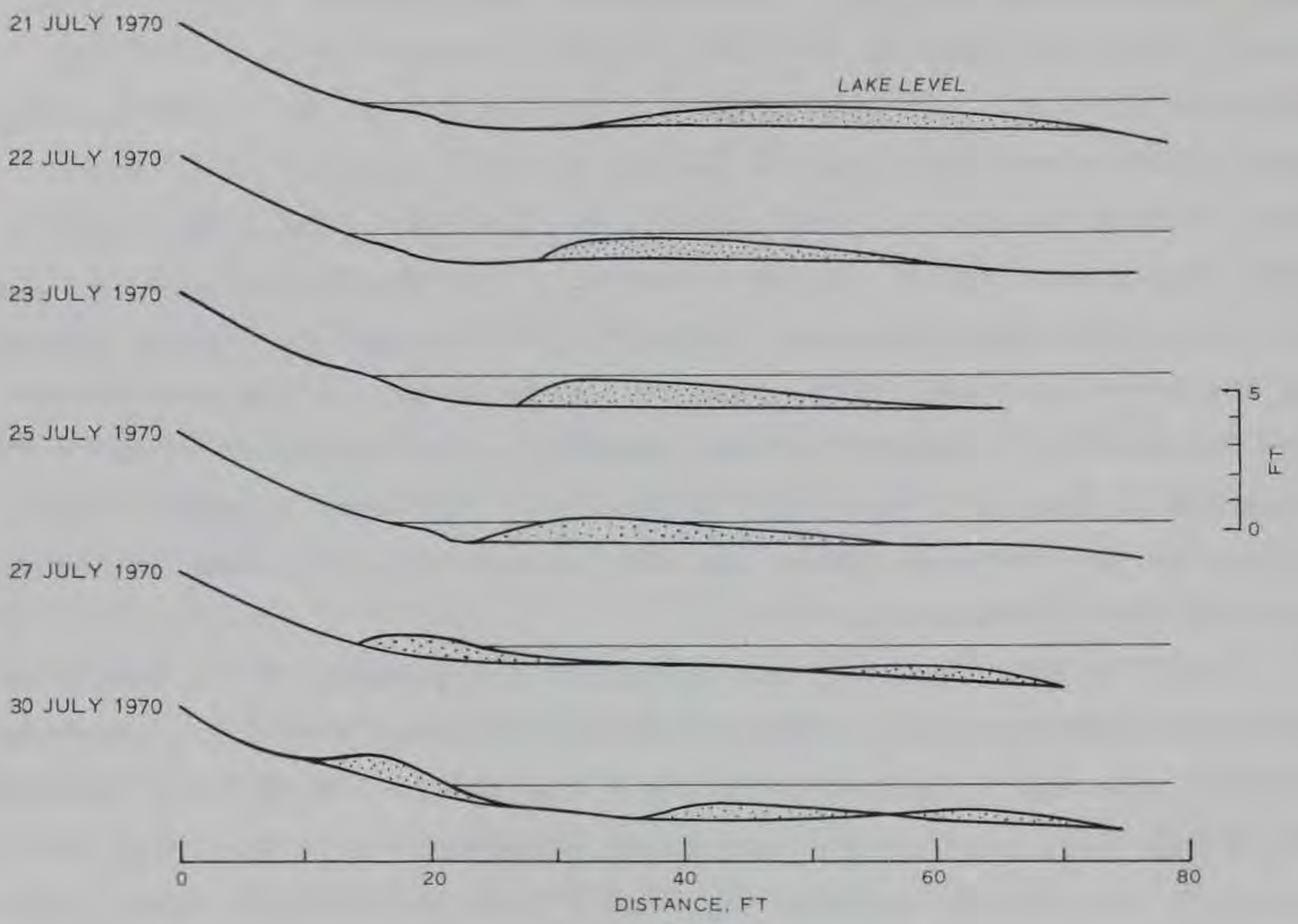


Figure 6. Shoreward migration of offshore sandbar (adapted from Reference 11)

beach during a storm. Also, accretion or erosion may be influenced by shoreline structures such as groins, jetties, breakwaters, and other types of shoreline construction.

38. The seaward limit of the zone in which significant sand transport can be expected is difficult to determine exactly, but it may be approximated as the deepest contour which is approximately parallel to the shoreline or as the depth at which the maximum wave-induced velocity first exceeds 0.5 fps, provided this depth is less than the depth of the deepest contour parallel to the shoreline.

39. The preceding summary of the effects of wave action on beaches and on noncohesive suspension and transport is intended only as a general description of the processes occurring in the littoral zone. More detailed descriptions and additional data can be found in References 11, 17, and 18, particularly with regard to the effects of

beach slope, wave height, wave steepness, and sediment grain size distribution in the littoral zone.

Wave action on shoreline bluff sections

40. Bluff sections near Cleveland are subject to erosion caused by wave attack at the surface lake level if the bluff is unprotected. Protection for the bluff may be provided by a beach, seawall, or other type of shoreline protection. Bluff recession may increase during periods of high lake levels. Beaches existing during low lake levels may become submerged, and increased wave attack against the base of the bluff results. In many cases, the wave attack undercuts the bluff, and the stability of the undercut section is endangered. Shear and tension failures may then occur, and badly jointed and fissured materials may erode as intact blocks. However, wave action may be beneficial along shoreline sections where accretion of beach sediment occurs and where the base of the bluff is protected.

41. The relationship between bluff recessions and wave energy is complex and is not well defined. Historical data must usually be used to determine bluff recession rates. The effect of wave-induced currents may vary along bluff sections, depending on the position of the breaking wave. If the wave breaks against the base of the bluff, the surf zone previously discussed is not formed and the longshore sediment transport occurs seaward of the wave breaking position. Offshore profiles[12] by the U. S. Army Engineer District, Buffalo (shown in Figure 7) are examples of profiles of shoreline sections where the waves may break directly against the bluff. As indicated by the difference between the 1947 and 1876 surveys for profile 1, net accretion of material may occur offshore over a long period of time. Profile 1 was taken approximately 2000 ft east of the mouth of the Rocky River and profile 2 approximately 2 miles west of the mouth of the Cuyahoga River.

Wave Energy Formulation

42. The total energy in a progressive wave system is the sum of

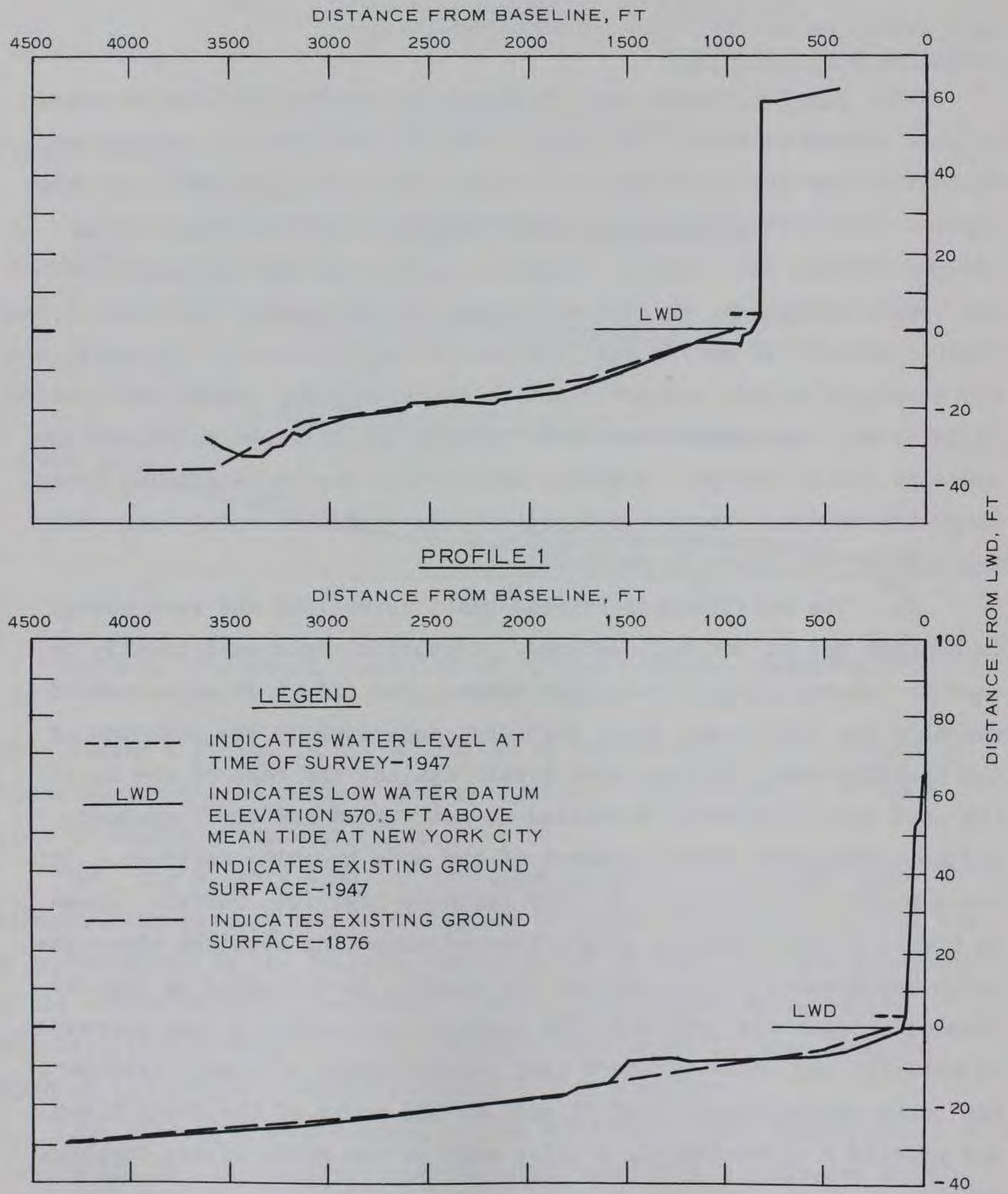


Figure 7. Lake Erie offshore profiles west of Cleveland, Ohio

the kinetic and potential energy contained in the wave system. The kinetic energy is due to the water particle velocity, and the potential energy is due to the presence of the wave form imposed on the mean water level. From small amplitude wave theory, the total wave energy E in one wavelength per unit width of wave crest is given for waves propagating from the same direction by

$$E = \frac{\rho g H^2 L}{8} \tag{15}$$

where ρ is the density of the water. The total average energy per unit surface area $\overline{E}$ is

$$\overline{E} = \frac{\rho g H^2}{8} \tag{16}$$

and is termed the specific energy or energy density.

43. The average wave energy flux $\overline{P}$ or the average rate at which energy is transmitted in the direction of wave propagation through a vertical plane parallel to the wave crest over the entire depth is given by

$$\overline{P} = \overline{E}nc = \overline{E}C_g \tag{17}$$

where n is the ratio of the wave group velocity C_g to the wave celerity c and is given by

$$n = \frac{1}{2}\left[1 + \frac{4\pi h/L}{\sinh (4\pi h/L)}\right] \tag{18}$$

The average energy flux in the direction of wave propagation per unit length of beach is

$$\overline{P} \cos \alpha_s = \frac{\rho g H^2}{8} C_g \cos \alpha_s \tag{19}$$

where α_s is the angle between the wave crest and the shoreline. The longshore component P_l of the average wave energy flux is

$$P_l = \overline{P} \cos \alpha_s \sin \alpha_s \tag{20}$$

or, alternately,

$$P_l = \frac{\overline{P}}{2} \sin 2\alpha_s$$

At breaking, the average wave energy flux P_{lb} is

$$P_{lb} = \frac{\rho g}{16} H_b^2 C_g \sin 2\alpha_b \tag{21}$$

where the subscript b indicates values at the breaker line. The wave height at breaking is

$$H_b = K_s K_r H_o \tag{22}$$

where

K_s = shoaling coefficient at breaker position, and
K_r = refraction coefficient at breaker position

The group velocity at breaking may be approximated for small-amplitude, linear wave theory as

$$C_g \approx \sqrt{gh} \tag{23}$$

Substituting for H_b and C_g, Equation 21 can be written as

$$P_{lb} = \frac{\rho g}{16} (K_s K_r H_o)^2 \sqrt{gh} \sin 2\alpha_b \tag{24}$$

The average wave energy over a specified time period is obtained from Equation 24 by multiplying P_{lb} by the duration of the wave train given in the hindcast tables.

44. Equations 15-24 assume a single wave train with one period and one height. For prototype conditions, a spectrum of wave heights and periods usually exists. The wave distribution usually follows a Rayleigh distribution, and the proper wave height to be used in

Equations 15-24 is found from the root mean square (rms) amplitude. However, most wave data are described in terms of the significant wave height, which may be used in Equations 15-24. The calculated average longshore energy flux using significant wave heights will be approximately double[11] the energy flux calculated using the rms height. The wave hindcast data from Part II are tabulated using the significant wave height, and the average longshore energy flux calculated using the significant wave height will be referred to as the longshore energy flux factor P_{lf}. The longshore transport rate Q of noncohesive sediment along beaches may be estimated from

$$Q = (7.5 \times 10^3) P_{lf} \tag{25}$$

Using U. S. customary units, the estimated longshore transport is in cubic yards per year.

45. Equation 25 is based upon empirical data and is recommended[11] for use by the U. S. Army Coastal Engineering Research Center (CERC). However, CERC cautions that judgment is required in the use of Equation 25 since the data have considerable scatter about the equation and are for noncohesive transport along an unprotected beach.

Estimated Longshore Wave Energy

Shoreline sites

46. The 15 locations selected for analysis near Cleveland are shown in Figure 8. The locations were selected to (a) include sites in the areas of critical erosion with an unprotected shoreline covered by the refraction grids, (b) consider sites near commercial harbors and river mouths, and (c) provide a reasonably even distribution of sites along the shoreline. The limits of the shoreline reach considered in the longshore energy analysis were chosen so that the lake shoreline affected by the jetport would probably be included in the analysis. A tentative jetport site, described in Reference 2, for use in the WES model feasibility study is located approximately 5-8 miles offshore at

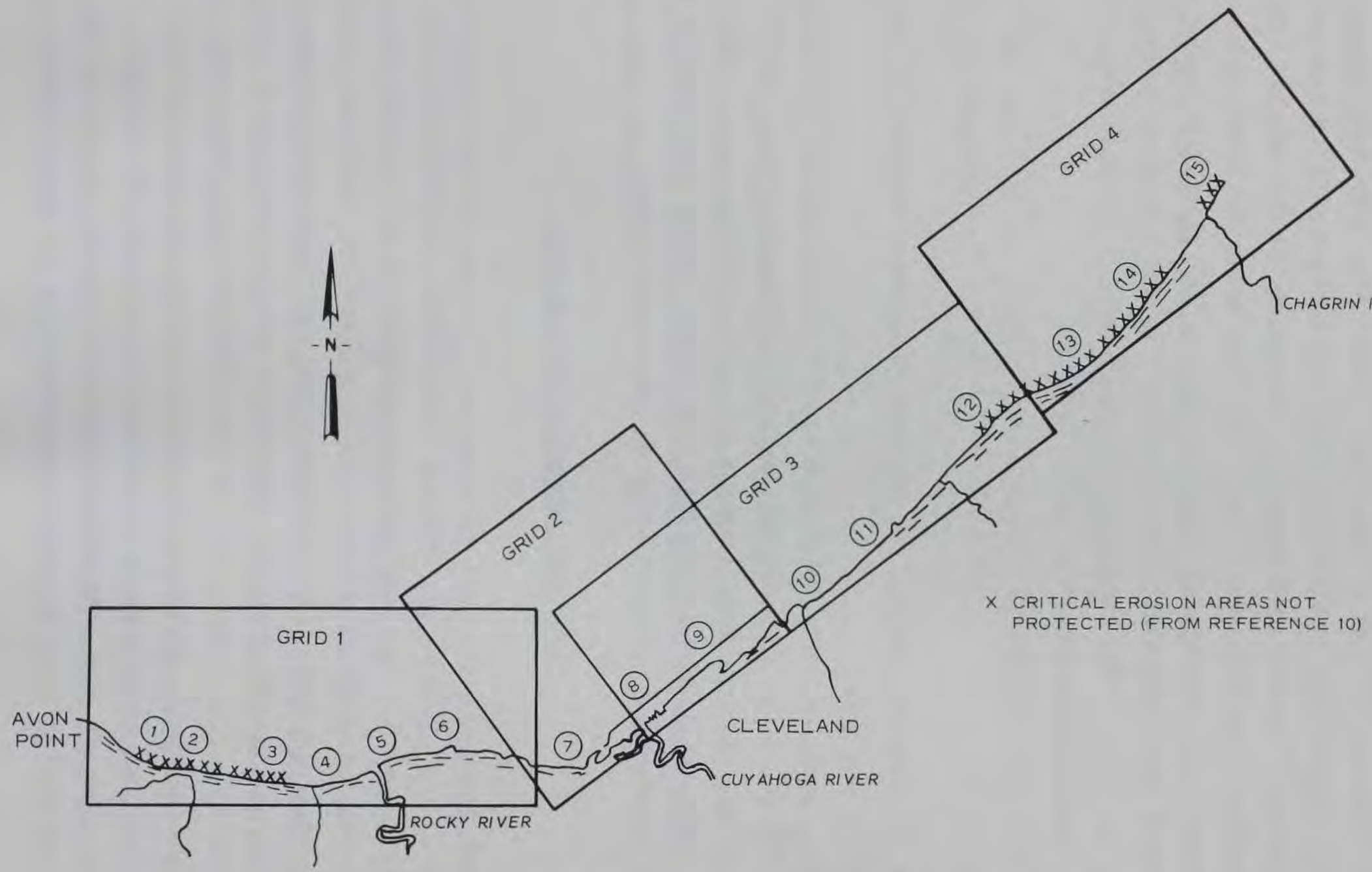


Figure 8. Location of sites used in longshore energy analysis

Cleveland; however, this site is tentative and may not be the offshore site recommended by LERTA as a result of the LERTA jetport feasibility study.

47. In the longshore energy analysis, the significant wave height used was the midpoint of each wave height range given in Tables A1-A88. For example, the wave height used with the duration given for the 6- to 7-ft significant wave height range was 6.5 ft. The wave period used was the midpoint of the period range in Tables A1-A88. For the period ranging from 0 to 3 sec, refractive effects were considered small and were neglected. For the 3- to 5-sec range, the 4-sec refraction data were used; for the 5- to 7-sec range, the 6-sec refraction data were used; and for ranges above 7 sec, the 8-sec refraction data were used. The refraction coefficients K_r and azimuths A_z used in the longshore energy analysis are given in Tables 9 and 10 for the 15 locations, but the data in these tables do not agree exactly with the refraction coefficients and azimuths in Tables 1-8. In some cases, the site fell between two of the wave orthogonals and an average value was used. Also, the data in Tables 1-8 are for a 1-ft significant wave height, and the data in Tables 9 and 10 are for an average breaking depth of the incident wave assumed to be approximately 3 ft. The incident wave was assumed to break when the ratio of the wave height to lake depth was 0.78. For sites 1-6, waves approaching from deepwater azimuths of from 315 to 45 deg were included in the analysis, and for sites 7-15, azimuths of from 270 to 22.5 deg were included. The shoreline azimuths used for each site are also given in Tables 9 and 10. For sites 7-15, the duration of waves approaching from a deepwater azimuth of 292.5 deg was divided equally between the 270- and the 315-deg azimuths and the refraction data for the two directions used. The shoaling coefficient was calculated using Equation 2.

Net longshore wave energy

48. The calculated net monthly and annual longshore energy for sites 1-15 is given in Table 11. February is not included in the monthly data to account for the effects of suppressed wave action due to ice formation over the lake. Positive values in the table indicate

a net eastwardly longshore energy, and negative values indicate a net westwardly longshore energy.

49. The monthly data in the table show a general trend toward an eastwardly net longshore energy during the winter months and either a reduced eastwardly or, for a number of sites, a change to a westwardly net longshore energy during the summer months. With the exception of sites 2, 4, 8, and 13, the calculated net longshore energy is eastwardly, thereby indicating a net eastwardly longshore sediment transport at these sites. The calculated eastward annual net longshore energy varies from 11.9(10^7) ft-lb at site 5 to 336.0(10^7) ft-lb at site 7. The annual net longshore energy was above 100(10^7) ft-lb at sites 1, 7, 11, and 15.

50. The westward annual net longshore energy is low (less than 20(10^7) ft-lb) except at sites 4 and 8. Site 8 is along the breakwater, and the refraction offshore at the breakwater is significantly influenced by the uneven topography lakeward of the breakwater. Site 9, also along the breakwater, has a net annual eastwardly longshore energy of 16.0(10^7) ft-lb compared with -62.4(10^7) ft-lb for site 8. Site 4, west of the mouth of the Rocky River, has a net westwardly annual longshore energy of -126.6(10^7) ft-lb. Site 4 might be expected to be similar to site 3; however, the shoreline azimuth at site 4 is smaller than that at site 3 and the wave orthogonal azimuths are less than those at site 3. The wave orthogonal azimuths given in Table 9 for site 4 indicate that waves with a deepwater azimuth of 315 deg contribute to eastwardly longshore energy but the 337.5-deg azimuth contributes little longshore energy, and also that waves from the 0.0-, 22.5-, and 45.0-deg deepwater azimuths all contribute to a negative or westwardly longshore energy. The azimuths for site 3 indicate that the longshore energy should be more evenly distributed about middle deepwater azimuth (0.0 deg). The difference in net longshore wave energy is due to the difference in the shoreline azimuth and wave orthogonal azimuths at breaking. Site 4 is also located along a shale bluff section of the shoreline which is resistant to erosion[19] (less than 1 ft per year) and provides little beach-building material. Due to the shale bluffs, westward annual net

longshore transport at site 4 should be minimal and has yet to be observed.

51. Site 2 also has a negative or westwardly calculated annual net longshore energy, but this net longshore energy is much lower than that for site 4. The negative longshore energy calculated at site 13 may also occur; however, a study of the shoreline reported by the U. S. Army Engineer District, Buffalo (NCB)[12] indicates that the longshore sediment transport near site 13 is generally eastwardly. At site 13, the fetch length to Pelee Island from the west is 23 percent greater than that from Pelee Island to the wave hindcast station ($41^{\circ}39.0'$ N, $81^{\circ}33.5'$ W). The increase in significant wave height that could occur over the longer fetch could well increase the eastward longshore energy sufficiently to change the direction of the calculated annual net longshore energy. Thus, the annual net longshore wave energy analysis provides a qualitative picture of an eastwardly directed net longshore wave energy throughout the area of interest. This eastwardly directed net longshore wave energy is consistent with observed eastward net longshore sediment transport[13,14,19] for the same area. For the few shoreline reaches with local westwardly directed net longshore wave energy, the local shoreline composition and topography minimize the westward contribution to the net longshore sediment transport.

52. The average annual total longshore wave energy at each of the sites is given in Tables 12 and 13 and is the sum of the absolute values of the longshore energy from each direction. The longshore energy varies from $83.2(10^7)$ ft-lb at site 2 to $572.6(10^7)$ ft-lb at site 8. In general, the sites west of the Cleveland Harbor have a lower average annual total longshore energy which is probably due to the decreased size of the sector from which waves may attack the shoreline along the reach. Refractive effects and shoreline geometry also result in a decreased annual total longshore energy near site 13. The energy is largest at the two sites along the Cleveland Harbor breakwater where the refraction coefficients are generally either slightly less than or greater than 1.

53. The longshore wave energy analysis discussed above neglects

the effect of wave generation from the hindcast location to the shoreline. Mr. A. H. Glenn* of A. H. Glenn and Associates has suggested that a conservative approach would be to assume the refraction is always equal to 1. For very conservative estimates, the refraction coefficients in Tables 9 and 10 were set equal to 1 if the coefficients were less than 1, and average monthly and annual net longshore energy and average annual total longshore energy were recalculated. The longshore energy results calculated using this approach are presented in Tables 14-16. Comparison of these results with previous estimates shows that the change in the calculated average annual net longshore energy is as follows:

Site	Net Longshore Energy Using K_r from Tables 9 and 10 ft-lb(10^7)	Net Longshore Energy Using $K_r \geq 1.0$ ft-lb(10^7)	Difference ft-lb(10^7)
1	198.1	228.9	30.8
2	-11.8	5.6	17.4
3	13.6	25.3	11.7
4	-126.6	-149.9	-23.3
5	11.9	6.6	-5.3
6	35.2	35.9	0.7
7	336.0	495.3	159.3
8	-62.4	-51.2	11.2
9	16.0	57.9	41.9
10	77.3	63.6	-14.7
11	142.0	134.4	-7.6
12	12.6	-25.7	-38.3
13	-19.3	-28.0	-8.7
14	28.9	-18.0	-46.9
15	237.4	202.0	-35.4

As might be expected when comparing the average annual net longshore energies calculated using these two methods, the change is not systematic, and for sites 2, 12, and 14, the direction of the average annual net longshore transport changes. The results of the calculations using the two methods to obtain average annual total longshore energy are compared in the following tabulation:

---

* A. H. Glenn, personal communication, December 1974.

Site	Total Longshore Energy Using K_r from Tables 9 and 10 ft-lb(10^7)	Total Longshore Energy Using $K_r \geq 1.0$ ft-lb(10^7)	Difference ft-lb(10^7)
1	198.1	228.9	30.8
2	83.2	112.6	29.4
3	112.6	137.9	25.3
4	175.3	204.6	29.3
5	134.1	143.8	9.7
6	125.1	140.5	15.4
7	336.4	495.5	159.1
8	572.6	588.6	16.0
9	467.5	520.1	52.6
10	336.0	386.7	50.7
11	280.4	322.8	42.4
12	178.8	233.4	54.6
13	143.1	215.6	72.5
14	179.4	248.0	68.6
15	379.7	424.7	45.0

A major increase occurs at site 7 where a significant portion of the longshore energy is developed from waves approaching from a deepwater azimuth of 315.0 deg. The calculated refraction coefficients for this direction at site 7 are 0.91 for 4 sec, 0.81 for 6 sec, and 0.78 for 8 sec. Since the calculated total longshore energy is strongly affected by these refraction coefficients, increasing the coefficients to 1.0 increases the longshore energy approximately 50 percent.

54. The 3-mile distance not included in the fetch length considered in the wave hindcast does not comprise a significant percentage of the total fetch length for each direction, and the use of the second approach where refraction coefficients are limited to 1.0 or greater is probably too conservative. Generally, longshore energy due to waves approaching from directions not approximately perpendicular to the shoreline is increased when the refraction coefficient is set equal to or greater than 1, and for waves with a refraction coefficient significantly less than 1, the increase in longshore energy is greater than that which would be expected due to wave generation over the longer fetch length. Thus, the longshore energy data in Tables 11-13 are recommended for use even though the effect of this 3-mile fetch length is neglected.

Comparison of Observed and Calculated Longshore Transport Data

55. Data from the NCB beach erosion control study[12] indicate that an average annual accretion of approximately 6400 cu yd/yr occurs at the existing beach in Edgewater Park. For the small beach just west of the structures at White City Park, the data indicate an average annual accretion of approximately 400 cu yd/yr. Sites 7 and 11 correspond to these two locations, and the estimated longshore noncohesive sediment transport (using Equation 25) is $8.7(10^5)$ and $3.66(10^5)$ cu yd/yr for sites 7 and 11, respectively. These estimates are several orders of magnitude higher than the observed beach accretion data. While Equation 25 is an empirically derived estimate and can be expected to vary from the observed sediment transport rates, the large difference in this case is probably due to lack of noncohesive sediment available for longshore transport. Site 7 is just east of a shale bluff section resistant to erosion, and the shoreline west of White City Park is protected by a series of seawalls.[19] The above-mentioned comparison of observed and estimated longshore transport rates indicates that numerous factors affect longshore sediment transport near Cleveland and that observed longshore transport rates must be used for reliable quantitative estimates of the longshore transport.

PART V: CONCLUSIONS

56. Based on the results of the longshore wave energy analysis reported herein, it is concluded that:

a. Average annual net longshore wave energy varies significantly along the shoreline near Cleveland and, along some reaches, may reverse direction. However, the general trend for the entire region of interest is an eastwardly directed net longshore wave energy, which is consistent with an observed eastwardly net longshore sediment transport.

b. Average annual total longshore wave energy is variable along the shoreline and is generally smaller west of Cleveland.

c. The variability of the longshore wave energy along the shoreline near Cleveland is primarily due to refractive effects on the wave height and direction of wave approach.

d. Longshore transport rates of noncohesive sediment are significantly affected by man-made structures, bluff composition, and beach formation near Cleveland.

e. Shoreline recession rates are dependent upon local conditions, including wave attack, shoreline composition, beach formation, beach slope, and mean lake level.

f. Reliable quantitative estimates of longshore sediment transport and shoreline recession rates near Cleveland should be based on observed data.

The longshore wave energy data in this report provide a basis for comparison of the effects of the proposed jetport on longshore wave energy. The data may be used as a qualitative indication of the average net longshore transport along the shoreline. Quantitative estimates of longshore transport developed from longshore wave energy data for typical beach sections near Cleveland are neither reliable nor consistent with computations based on limited observations, probably because of variations in shoreline composition and shoreline protective structures near Cleveland. The effect of the proposed jetport on longshore wave energy and, in turn, on longshore transport rates can be qualitatively estimated using procedures similar to those used in this investigation, provided the effects of the jetport on the local wave regime have been defined. To define this perturbed wave regime, physical wave model

studies[2] must be conducted and/or analytical methods developed to predict the first-order effects (diffraction patterns) of the jetport on the local wave climate.

REFERENCES

1. Durham, D. L. and Outlaw, D. G., "Lake Erie International Jetport Model Feasibility Investigation; Scope of Study and Review of Available Data," Technical Report H-74-6, Report 1, Jul 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.; Prepared as Report 17-1 for Lake Erie Regional Transportation Authority, Cleveland, Ohio.

2. Outlaw, D. G. et al., "Lake Erie International Jetport Model Feasibility Investigation; Physical Model Feasibility Study," Technical Report H-74-6, Report 17-2, Apr 1975, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.; Prepared as Report 17-2 for Lake Erie Regional Transportation Authority, Cleveland, Ohio.

3. A. H. Glenn and Associates, "Wind, Wave, Water Level, and Ice Conditions Affecting Design and Construction of the Proposed Lake Erie International Jetport, Cleveland, Ohio," Contract Report H-74-1, Mar 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

4. Saville, T., "Wave and Lake Level Statistics for Lake Erie," Technical Memorandum No. 37, 1953, U. S. Beach Erosion Board, CE, Washington, D. C.

5. Lee, C. H., "Additional Wave Statistics for Stations on Lake Michigan and Lake Erie," U. S. Beach Erosion Board Bulletin, Vol 12, Jul 1958, pp 1-8.

6. Dobson, R. S., Some Applications of a Digital Computer to Engineering Problems, M.S. Thesis, Stanford University, 1967.

7. Munk, W. H. and Arthur, R. S., "Wave Intensity Along a Refracted Ray," Gravity Waves, Circular No. 521, pp 95-108, Nov 1952, National Bureau of Standards, Washington, D. C.

8. Whalin, R. W., "The Limit of Applicability of Linear Wave Refraction Theory in a Convergence Zone," Research Report H-71-3, Dec 1971, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

9. Salvadori, M. G. and Baron, M. L., Numerical Methods in Engineering, 2d ed., Prentice-Hall, New York, 1961.

10. U. S. Army Engineer Division, North Central, "Great Lakes Region Inventory Report, National Shoreline Study," Aug 1971, Chicago, Ill.

11. U. S. Army Coastal Engineering Research Center, "Shore Protection Manual," 1973, Fort Belvoir, Va.

12. "Cleveland and Lakewood, Ohio, Beach Erosion Control Study," 81st Congress, House Document No. 502, 1950.

13. "Shore of Lake Erie in Lake County, Ohio, Beach Erosion Control Study," 81st Congress, House Document No. 596, 1950.

14. Stanley Consultants, "Shoreline Erosion Study, Lake Erie Shoreline, Lake County, Ohio," 1969, Cleveland, Ohio.

15. Galvin, C. J., Jr., and Eagleson, P. S., "Experimental Study of Longshore Currents on a Plane Beach," Technical Memorandum No. 10, Jan 1965, U. S. Army Coastal Engineering Research Center, CE, Washington, D. C.

16. Garcia, W. J. and Perry, F. C., "A Means of Predicting Littoral Sediment Transport Outside the Breaker Zone" (in preparation), U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

17. Ippen, A. T., ed., Estuary and Coastline Hydrodynamics, McGraw-Hill, New York, 1966.

18. Wiegel, R. L., Oceanographical Engineering, Prentice-Hall, New York, 1964.

19. "Preliminary Estimate of Erosion or Accretion Along the Ohio Shore of Lake Erie and Critical Erosion Areas," Technical Report No. 8, Jun 1961, State of Ohio, Department of Natural Resources, Division of Shore Erosion, Columbus, Ohio.

Table 1

Refraction Coefficients at Shoreline for Grid 1

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	45.0	0.72	0.78	0.92	0.90	0.92	0.96	0.93	0.95	0.99	0.97	0.98	1.02	0.99	--	--
	22.5	0.97	0.91	0.97	0.86	0.97	0.99	1.00	0.96	0.94	0.96	0.98	1.04	1.00	0.93	--
	0.0	1.04	1.04	1.00	0.94	0.99	0.96	1.00	1.00	0.99	0.99	0.99	0.95	0.91	0.95	0.95
	337.5	0.97	0.95	0.98	1.02	1.02	1.04	0.97	0.96	0.95	0.95	0.99	0.88	0.77	0.90	--
	315.0	0.84	0.96	0.92	0.91	1.00	1.03	0.92	0.92	0.83	0.79	0.79	--	--	--	--
6	45.0	0.80	0.75	0.86	0.89	0.88	0.88	0.85	0.87	0.97	0.96	0.98	0.89	0.92	--	--
	22.0	1.02	0.96	0.96	0.89	0.94	0.94	1.00	0.95	0.96	0.98	0.99	1.11	0.97	0.92	--
	0.0	1.10	0.97	0.98	0.92	0.98	1.01	0.98	0.99	0.99	0.96	0.99	0.94	0.96	0.91	0.98
	337.5	1.01	0.96	0.98	1.01	1.02	1.03	0.94	0.97	0.91	0.90	0.90	0.81	0.76	0.95	--
	315.0	0.92	0.93	0.92	0.94	0.98	0.99	0.87	0.82	0.78	0.82	0.61	--	--	--	--
8	45.0	0.75	0.76	0.84	0.91	0.84	0.86	0.84	0.86	0.95	0.97	1.03	0.88	0.97	--	--
	22.5	1.03	0.96	0.96	0.89	0.93	0.90	0.99	0.96	0.98	1.00	1.00	1.14	0.96	0.92	--
	0.0	1.13	0.97	0.97	0.91	0.97	1.03	0.97	0.99	0.99	0.95	1.00	0.94	0.99	0.90	0.99
	337.5	1.01	0.98	0.98	0.99	1.01	1.02	0.96	0.96	0.91	0.86	0.83	0.83	0.84	1.05	--
	315.0	0.90	0.91	0.95	1.02	0.94	0.96	0.87	0.79	0.84	0.85	0.61	--	--	--	--

Table 2

Refraction Coefficients at Shoreline and

Harbor Breakwater for Grid 2

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number 1	2	3	4	5	6	7	8
4	22.5	0.93	1.02	0.86	0.95	1.00	0.97	--	--
	0.0	1.12	1.01	1.03	1.02	0.98	0.96	0.96	--
	337.5	1.01	0.97	1.01	1.01	1.00	0.88	1.05	--
	315.0	1.00	1.01	1.08	1.00	0.99	0.99	1.00	0.90
	270.0	0.96	1.21	0.97	1.02	--	--	--	--
6	22.5	1.50	1.52	0.68	1.10	1.13	1.07	--	--
	0.0	1.25	1.16	--*	1.11	0.99	0.91	0.88	--
	337.5	0.96	0.78	1.01	1.03	1.00	0.80	0.99	--
	315.0	1.01	0.95	--*	0.95	0.95	0.97	0.91	0.76
	270.0	0.89	0.84	1.11	1.07	--	--	--	--
8	22.5	--*	1.38	0.78	1.25	1.21	1.13	--	--
	0.0	1.34	1.32	--*	1.14	1.04	0.90	0.84	--
	337.5	0.93	0.70	1.02	1.02	1.00	0.77	0.93	--
	315.0	1.03	0.92	--*	1.06	0.92	0.94	0.88	0.75
	270.0	0.94	0.72	1.12	1.19	--	--	--	--

* Unstable solution.

Table 3

Refraction Coefficients at Shoreline for Grid 3

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	22.5	0.75	0.75	0.82	0.85	0.90	1.01	0.98	1.01	1.10	--	--	--	--	--	--
	0.0	0.78	0.74	0.94	0.92	0.91	0.94	0.96	1.01	1.00	1.00	0.96	1.00	0.99	--	--
	337.5	0.97	0.98	0.98	0.98	0.87	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.03	1.07	0.99
	315.0	1.02	1.00	0.99	1.02	0.95	1.02	1.01	1.00	1.01	1.00	0.98	0.96	0.97	0.96	0.98
	270.0	0.94	0.92	0.85	0.87	0.84	0.92	0.86	--	--	--	--	--	--	--	--
6	22.5	0.73	0.71	0.74	0.81	0.89	1.09	0.98	0.99	1.08	--	--	--	--	--	--
	0.0	0.83	0.82	0.84	0.94	0.89	0.94	0.96	0.98	0.95	0.95	1.04	1.19	0.95	--	--
	337.5	0.97	0.98	0.99	0.97	0.99	1.00	0.96	1.00	0.99	0.99	0.91	0.97	1.06	--*	1.03
	315.0	1.01	0.99	0.98	1.03	0.93	1.02	1.02	1.02	1.01	0.97	0.93	1.00	0.91	--*	1.00
	270.0	0.91	0.98	0.72	0.88	0.89	1.00	0.76	--	--	--	--	--	--	--	--
8	22.5	0.64	0.74	0.69	0.87	0.95	--*	0.98	0.96	0.95	--	--	--	--	--	--
	0.0	0.86	0.86	0.79	0.92	0.90	0.95	0.97	1.00	0.93	0.94	0.94	0.94	0.92	--	--
	337.5	0.98	0.98	0.99	0.96	0.99	1.00	0.95	1.00	0.98	0.98	0.98	0.95	1.08	--*	1.06
	315.0	1.01	0.99	0.98	1.03	0.93	1.02	1.02	1.04	1.02	0.95	0.93	1.01	0.99	--*	1.05
	270.0	0.89	1.03	0.85	0.84	0.92	1.05	0.85	--	--	--	--	--	--	--	--

* Unstable solution.

Table 4

Refraction Coefficients at Shoreline for Grid 4

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number 1	2	3	4	5	6	7	8	9	10	11
4	22.5	0.62	0.72	0.81	0.91	--	--	--	--	--	--	--
	0.0	0.92	0.89	0.79	0.82	0.84	0.85	0.91	0.96	1.06	--	--
	337.5	0.99	0.99	0.98	1.01	0.98	0.93	0.92	0.94	0.95	0.98	1.03
	315.0	1.03	1.01	0.98	1.04	1.03	1.00	1.01	1.03	1.00	1.02	0.92
	270.0	0.93	0.85	0.91	0.78	0.90	0.90	0.93	--	--	--	--
6	22.5	0.58	0.62	0.84	1.07	1.06	0.85	0.91	--	--	--	--
	0.0	0.85	0.86	0.87	0.81	0.78	0.87	0.89	0.91	0.97	--	--
	337.5	0.93	1.02	0.93	1.06	1.03	0.92	0.93	0.97	0.93	0.96	1.05
	315.0	1.11	0.99	0.98	1.10	1.06	1.00	1.00	1.05	0.99	1.04	0.90
	270.0	0.88	0.92	0.89	0.89	1.06	0.99	0.96	--	--	--	--
8	22.5	0.53	0.73	0.93	0.65	0.96	1.10	--	--	--	--	--
	0.0	0.88	0.84	0.95	0.91	0.77	0.92	0.85	0.93	1.00	--	--
	337.5	0.90	1.01	0.92	1.05	1.05	0.89	0.94	1.03	0.94	0.96	1.06
	315.0	1.15	0.98	0.98	1.12	1.08	1.00	1.00	1.06	0.99	1.05	0.89
	270.0	1.06	1.16	0.91	1.14	1.26	1.15	0.96	--	--	--	--

Table 5

Wave Orthogonal Azimuths at Shoreline for Grid 1

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	45.0	355.8	21.5	28.8	23.0	19.2	20.6	25.8	31.9	40.9	38.4	38.8	33.7	37.3	--	--
	22.5	2.0	352.7	358.9	347.6	15.1	14.0	18.7	13.3	12.5	14.4	27.6	30.6	23.7	17.8	--
	0.0	8.7	3.4	356.0	353.2	346.0	343.1	359.4	3.2	7.7	7.5	9.4	13.7	25.1	19.0	9.1
	337.5	2.6	348.2	345.7	336.7	346.0	333.9	343.0	344.8	355.1	358.0	353.8	357.2	23.8	10.1	--
	315.0	350.5	339.7	338.8	327.8	332.2	326.0	327.2	329.2	345.8	354.2	346.8	--	--	--	--
6	45.0	6.0	347.8	21.1	16.5	20.9	20.3	22.7	22.9	36.8	38.8	35.7	29.8	24.2	--	--
	22.5	1.5	355.0	2.8	344.6	8.1	13.6	16.9	11.3	8.7	14.3	27.3	31.1	24.3	16.3	--
	0.0	9.9	3.2	355.1	350.2	344.9	340.8	359.2	4.3	1.1	9.0	10.8	16.9	30.4	20.0	11.9
	337.5	2.9	352.6	349.0	337.2	344.0	333.6	344.7	352.8	359.9	359.4	355.3	6.5	27.6	8.9	--
	315.0	345.2	337.1	340.9	342.7	331.0	326.8	337.0	348.1	0.5	359.4	358.7	--	--	--	--
8	45.0	6.1	348.0	15.8	15.7	22.1	17.1	16.7	19.3	34.8	40.2	32.0	26.4	21.7	--	--
	22.5	1.1	357.9	1.9	345.6	4.9	13.9	16.0	10.7	7.0	14.5	27.6	31.1	24.7	17.4	--
	0.0	8.8	3.0	344.7	349.0	344.6	339.5	359.3	2.3	9.6	9.5	10.8	18.5	30.0	20.0	12.7
	337.5	3.4	354.2	349.2	337.3	342.3	333.6	345.6	356.6	2.2	0.5	1.1	12.2	1.7	11.2	--
	315.0	347.8	337.9	336.7	345.4	331.7	328.6	339.5	355.0	0.5	353.6	11.1	--	--	--	--

Table 6

Wave Orthogonal Azimuths at Shoreline and Harbor Breakwater for Grid 2

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number 1	2	3	4	5	6	7	8
4	22.5	28.0	10.4	1.4	17.4	22.6	8.3	--	--
	0.0	0.3	0.9	356.5	359.0	355.0	5.4	0.0	--
	337.5	338.8	336.7	335.5	337.5	336.6	350.8	356.3	--
	315.0	315.5	315.7	314.8	317.6	313.9	315.4	317.7	325.1
	270.0	272.9	270.6	276.6	270.7	--	--	--	--
6	22.5	2.8	11.5	0.0	13.8	17.1	7.9	--	--
	0.0	359.6	356.2	349.1	355.3	351.4	7.0	0.6	--
	337.5	340.6	335.9	332.7	337.4	335.2	357.5	357.0	--
	315.0	317.8	318.9	315.1	322.2	313.0	317.2	320.9	345.0
	270.0	286.2	276.6	281.2	281.3	--	--	--	--
8	22.5	1.0	11.9	0.8	8.4	15.8	11.5	--	--
	0.0	358.7	352.7	347.7	354.2	349.8	8.1	0.8	--
	337.5	340.9	335.6	331.3	337.4	334.6	0.1	356.2	--
	315.0	319.2	319.3	315.2	323.5	312.7	317.6	323.7	358.8
	270.0	293.0	283.4	280.8	288.0	--	--	--	--

Table 7

Wave Orthogonal Azimuths at the Shoreline and Harbor Breakwater for Grid 3

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	22.5	339.1	351.7	3.4	4.2	342.7	21.0	21.4	22.0	18.6	--	--	--	--	--	--
	0.0	327.0	318.0	335.8	333.6	341.6	349.2	350.5	342.0	359.5	359.8	0.3	358.9	356.0		
	337.5	320.9	321.3	323.9	325.3	306.1	327.0	331.8	333.8	334.4	337.3	337.5	337.7	335.9	338.6	335.0
	315.0	316.3	314.5	316.6	318.3	310.1	319.8	318.7	317.9	316.3	316.8	319.4	315.4	316.0	315.7	317.3
	270.0	294.4	298.0	305.0	291.8	300.0	290.1	286.2	--	--	--	--	--	--	--	--
6	22.5	336.8	336.3	347.8	350.7	359.6	12.1	14.0	16.6	15.2	--	--	--	--	--	--
	0.0	319.0	317.7	344.8	331.4	333.1	342.0	343.1	348.8	356.3	358.6	356.9	353.4	351.2	--	--
	337.5	320.8	322.0	322.3	323.8	318.0	323.5	329.0	330.6	332.3	336.7	338.1	337.8	332.8	339.4	329.1
	315.0	316.3	314.7	316.2	317.8	310.7	319.7	319.0	318.3	317.3	318.2	326.5	317.8	319.9	317.5	322.4
	270.0	300.1	296.4	314.6	307.9	302.9	294.1	285.4	--	--	--	--	--	--	--	--
8	22.5	338.3	332.6	341.3	348.4	350.6	335.7	349.1	11.4	12.8	--	--	--	--	--	--
	0.0	319.9	321.9	336.6	330.9	331.3	339.7	340.1	350.2	354.2	358.4	356.2	349.4	348.7	--	--
	337.5	321.1	322.3	321.9	323.2	319.6	323.1	327.5	329.1	331.3	336.4	338.5	337.5	332.0	339.9	327.5
	315.0	316.3	314.7	315.9	317.5	311.3	319.5	318.9	318.4	317.6	318.7	330.8	319.1	321.8	317.8	325.5
	270.0	307.8	298.1	325.7	308.2	306.5	298.9	290.9	--	--	--	--	--	--	--	--

Table 8

Wave Orthogonal Azimuths at Shoreline for Grid 4

Wave Period sec	Deepwater Azimuth deg	Orthogonal Number 1	2	3	4	5	6	7	8	9	10	11
4	22.5	329.0	340.1	350.9	354.4	--	--	--	--	--	--	--
	0.0	339.3	332.3	317.7	323.6	323.4	330.1	337.6	349.0	348.5	--	--
	337.5	327.4	320.9	331.9	324.8	318.1	316.7	322.2	321.7	326.0	332.0	338.1
	315.0	319.3	312.4	323.3	317.3	312.0	308.1	307.5	313.2	317.1	319.4	328.6
	270.0	281.1*	305.7	302.3	305.1	306.7	298.4	290.8	--	--	--	--
6	22.5	321.0	325.6	328.1	339.2	350.6	344.8	--	--	--	--	--
	0.0	332.1	331.5	322.7	316.0	324.3	327.1	332.8	342.9	344.6	--	--
	337.5	326.4	320.0	330.3	324.3	319.1	312.2	316.4	314.9	322.0	330.2	339.1
	315.0	319.6	313.1	324.1	317.2	312.2	307.8	307.3	313.8	317.7	320.0	330.2
	270.0	308.8	311.2	302.2	315.2	303.2	303.5	293.2	--	--	--	--
8	22.5	317.4	316.3	324.1	333.1	348.6	349.2	--	--	--	--	--
	0.0	327.2	331.5	325.0	317.0	316.8	322.3	330.2	337.5	343.2	--	--
	337.5	326.2	319.4	329.7	324.3	317.8	312.4	313.7	313.7	321.2	329.3	339.4
	315.0	319.6	313.2	324.3	317.2	312.3	307.7	307.3	314.2	317.6	320.1	330.3
	270.0	309.2	307.3	307.4	311.2	301.1	301.9	293.8	--	--	--	--

* At east boundary of grid.

Table 9

Refraction Coefficient and Azimuth Data at the Shoreline for Sites 1-6

Site	Shoreline Azimuth deg	Wave Period sec	Wave Deepwater Azimuth, deg 315.0 K_r	315.0 A_z	337.5 K_r	337.5 A_z	0.0 K_r	0.0 A_z	22.5 K_r	22.5 A_z	45.0 K_r	45.0 A_z
1	130.0	4	1.04	1.0	0.91	1.0	0.95	12.0	1.04	30.0	0.98	39.0
		6	0.81	14.0	0.94	5.0	0.91	17.0	1.10	30.0	0.97	39.0
		8	1.01	4.0	0.85	10.0	0.90	17.0	0.96	24.0	1.04	33.0
2	100.0	4	0.82	336.0	0.90	350.0	0.96	6.0	0.98	17.0	1.05	30.0
		6	0.62	354.0	0.82	5.0	0.97	10.0	0.99	16.0	0.87	24.0
		8	0.70	359.0	0.84	20.0	0.97	11.0	1.00	17.0	0.86	20.0
3	100.0	4	0.82	340.0	0.95	351.0	1.00	6.0	1.00	19.0	0.91	25.0
		6	0.80	350.0	0.93	355.0	0.99	8.0	1.00	17.0	0.88	25.0
		8	0.85	355.0	0.91	0.0	0.98	8.0	0.99	17.0	0.84	23.0
4	76.0	4	0.92	329.0	0.96	345.0	1.00	0.0	0.97	15.0	0.83	24.0
		6	0.91	340.0	0.95	340.0	0.97	359.0	0.94	8.0	0.86	21.0
		8	0.87	340.0	0.95	350.0	0.97	359.0	0.92	5.0	0.84	16.0
5	80.0	4	1.01	323.0	1.02	336.0	0.98	350.0	0.92	5.0	0.75	10.0
		6	0.97	327.0	1.02	336.0	0.95	349.0	0.91	355.0	1.10	10.0
		8	0.94	330.0	1.00	335.0	1.00	348.0	0.90	352.0	0.77	0.0
6	90.0	4	0.93	330.0	0.98	345.0	1.00	357.0	0.98	11.0	0.89	22.0
		6	0.93	337.0	0.98	345.0	0.97	356.0	0.98	5.0	0.90	14.0
		8	0.92	337.0	1.05	348.0	0.96	355.0	0.99	0.0	0.81	18.0

Table 10

Refraction Coefficient and Azimuth Data at the Shoreline for Sites 7-15

Site	Shoreline Azimuth deg	Wave Period sec	Wave Deepwater Azimuth, deg 270.0 K_r	270.0 A_z	315.0 K_r	315.0 A_z	337.5 K_r	337.5 A_z	0.0 K_r	0.0 A_z	22.5 K_r	22.5 A_z
7	105.0	4	--*	--*	0.91	324.0	1.02	352.0	0.96	5.0	0.96	18.0
		6	--	--	0.81	342.0	0.90	356.0	0.92	355.0	1.10	14.0
		8	--	--	0.78	352.0	0.85	356.0	0.90	356.0	1.26	9.0
8	55.0	4	1.00	270.0	1.00	315.0	1.01	338.0	1.02	358.0	0.95	19.0
		6	1.07	281.0	0.96	317.0	1.03	337.0	1.11	357.0	1.50	3.0
		8	1.20	288.0	0.94	318.0	1.02	337.0	1.14	354.0	0.86	1.0
9	55.0	4	1.21	270.0	0.97	315.0	1.00	339.0	0.96	0.0	1.02	22.0
		6	0.83	276.0	1.15	316.0	0.96	341.0	1.05	359.0	0.99	17.0
		8	0.94	293.0	0.91	317.0	0.93	341.0	1.06	356.0	0.96	11.0
10	55.0	4	0.85	286.0	0.99	317.0	1.00	334.0	0.96	351.0	0.82	3.0
		6	1.00	294.0	0.97	318.0	0.99	331.0	0.96	343.0	0.81	351.0
		8	1.05	299.0	0.95	319.0	0.98	330.0	0.96	340.0	0.87	349.0
11	55.0	4	0.85	294.0	1.01	317.0	0.98	329.0	0.93	343.0	0.76	348.0
		6	0.89	301.0	1.02	315.0	1.00	324.0	0.95	336.0	0.71	340.0
		8	0.85	302.0	1.01	318.0	1.00	324.0	0.92	334.0	0.74	337.0
12	47.0	4	1.07	291.0	0.99	315.0	0.98	326.0	0.84	336.0	0.60	347.0
		6	0.93	297.0	1.01	317.0	0.97	325.0	0.86	329.0	0.73	336.0
		8	0.90	303.0	1.00	316.0	0.97	324.0	0.87	327.0	0.77	333.0
13	55.0	4	0.71	301.0	1.05	318.0	0.97	332.0	0.93	344.0	0.74	350.0
		6	0.76	308.0	1.04	319.0	0.94	328.0	0.90	337.0	0.71	345.0
		8	0.77	322.0	0.98	325.0	0.96	326.0	0.90	337.0	0.66	340.0
14	47.0	4	0.87	293.0	1.05	315.0	0.94	326.0	0.87	334.0	0.62	329.0
		6	0.96	300.0	1.04	315.0	0.94	320.0	0.79	338.0	0.63	338.0
		8	0.80	303.0	1.05	315.0	0.99	317.0	0.78	322.0	0.84	327.0
15	55.0	4	0.93	298.0	1.04	316.0	1.01	329.0	0.91	341.0	0.78	353.0
		6	1.08	294.0	1.09	19.0	1.05	325.0	0.86	337.0	0.69	344.0
		8	1.26	296.0	1.11	316.0	1.04	326.0	0.84	336.0	0.76	338.0

* Site 7 is sheltered from waves approaching from 270 deg deepwater azimuth.

Table 11

Average Monthly and Annual Net Longshore Energy (ft-lb × 10^7)

for Sites 1-15

Month	Site 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Jan	21.6	-0.1	3.4	-10.5	4.2	6.6	35.7	8.7	15.1	19.8	23.6	8.4	4.2	9.5	36.6
Mar	29.2	-6.4	-2.9	-26.0	-4.3	0.9	38.4	-18.1	-2.6	8.9	17.2	2.0	-2.2	4.0	29.3
Apr	24.0	-3.9	-1.3	-19.8	-1.7	1.6	34.0	-16.1	-4.7	4.8	12.6	0.0	-3.3	1.7	22.0
May	22.9	-2.6	0.1	-17.2	-0.1	2.6	33.3	-20.9	-8.8	0.6	9.3	-2.6	-5.2	-0.8	16.9
June	17.8	-2.3	-0.6	-14.6	-1.5	1.0	28.3	-18.8	-9.1	1.6	6.1	-3.7	-5.9	-2.2	12.5
July	15.4	-0.4	1.2	-10.4	0.4	2.3	27.9	-12.0	-6.1	-0.8	6.1	-3.5	-5.4	-1.8	12.0
Aug	13.7	-0.1	1.4	-8.8	0.4	2.0	26.1	-7.9	-3.3	0.3	6.4	-3.2	-4.9	-1.3	12.2
Sep	12.3	0.3	1.9	-6.9	1.5	2.8	25.4	-4.9	-0.1	2.8	8.3	-1.3	-3.0	0.3	14.1
Oct	13.8	0.4	2.1	-7.3	2.2	3.4	27.8	-2.5	2.6	6.6	11.7	1.2	-1.4	2.3	19.2
Nov	12.3	1.5	3.7	-3.3	4.6	5.2	27.6	12.4	13.9	15.3	18.0	6.1	2.9	7.2	27.7
Dec	15.1	1.8	4.6	-3.8	6.2	6.8	31.5	17.7	19.1	20.6	22.7	9.2	4.9	10.0	34.9
Annual	198.1	-11.8	13.6	-126.6	11.9	35.2	336.0	-62.4	16.0	77.3	142.0	12.6	-19.3	28.9	237.4

Table 12

Average Annual Total Longshore Energy (ft-lb × 10^7)

at Sites 1-6

Site	Deepwater Azimuth, deg					
	315.0	337.5	0.0	22.5	45.0	Total*
1	41.4	45.8	67.5	40.7	2.7	198.1
2	19.5	13.2	3.2	-21.1	-26.2	83.2
3	27.8	26.1	9.2	-25.2	-24.3	112.6
4	15.6	7.9	-45.5	-63.6	-42.7	175.3
5	43.3	27.2	2.6	-19.2	-41.8	134.1
6	39.9	26.8	13.4	-19.1	-25.9	125.1

* Sum of absolute values for each deepwater azimuth.

Table 13

Average Annual Total Longshore Energy (ft-lb × 10^7)

at Sites 7-15

Site	Deepwater Azimuth, deg					
	270.0	315.0	337.5	0.0	22.5	Total*
7	--	248.6	31.9	52.2	3.7	336.4
8	137.7	117.4	-24.2	-114.3	-179.0	572.6
9	108.5	133.3	-26.8	-105.1	-93.8	467.5
10	104.1	102.6	-13.1	-62.0	-54.2	336.0
11	74.5	136.7	-0.9	-40.2	-28.1	280.4
12	79.1	16.8	-15.1	-35.7	-32.1	178.8
13	40.0	21.9	-7.4	-40.6	-33.2	143.1
14	64.1	40.0	-8.2	-42.9	-24.2	179.4
15	120.2	188.3	-2.4	-35.8	-33.0	379.7

* Sum of absolute values for each deepwater azimuth.

Table 14

Average Monthly and Annual Net Longshore Energy (ft-lb × 10^7) for Sites 1-15 with a Minimum Refraction Coefficient of 1.0

Month	Site 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Jan	25.4	3.0	5.6	-12.5	4.1	7.2	52.8	10.0	21.7	19.2	25.0	5.9	6.1	6.1	33.3
Mar	33.5	-4.9	-2.1	-31.5	-5.4	0.2	55.5	-17.1	3.0	5.3	15.5	-4.4	-4.4	-3.9	22.4
Apr	27.5	-2.5	-0.5	-23.4	-2.7	1.2	49.1	-15.3	-0.3	2.0	10.8	-5.4	-5.4	-5.1	16.4
May	26.3	-1.0	1.1	-19.9	-0.9	2.6	48.2	-20.0	-5.5	-2.2	6.9	-8.3	-8.1	-7.8	11.5
June	20.2	-1.6	-0.2	-16.9	-2.2	0.7	41.3	-18.0	-6.8	-3.8	3.8	-8.5	-8.9	-8.0	8.2
July	17.7	0.5	1.8	-11.8	-0.1	2.3	41.0	-11.1	-4.1	-1.8	4.5	-7.0	-7.5	-5.9	9.0
Aug	15.6	0.9	2.0	-9.9	-0.1	2.0	38.9	-7.0	-1.4	-0.6	5.0	-6.3	-6.6	-4.6	9.7
Sep	14.3	1.5	2.6	-7.8	1.2	2.9	38.0	-3.9	2.0	2.3	7.4	-3.9	-4.1	-2.7	12.0
Oct	16.0	1.7	3.1	-8.2	1.9	3.6	41.3	-1.4	5.9	6.1	11.3	-1.3	-1.7	-1.0	16.9
Nov	14.5	3.5	5.2	-3.7	4.6	5.7	41.6	13.6	18.4	15.8	19.3	5.2	4.8	6.1	26.4
Dec	17.9	4.5	6.7	-4.3	6.2	7.5	47.6	19.0	25.0	21.3	24.9	8.3	7.8	8.8	33.5
Annual	228.9	5.6	25.3	-149.9	6.6	35.9	495.3	-51.2	57.9	63.6	134.4	-25.7	-28.0	-18.0	202.0

Table 15

Average Annual Total Longshore Energy (ft-lb × 10^7) at Sites 1-6 with a Minimum Refraction Coefficient of 1.0

Site	Deepwater Azimuth, deg					
	315.0	337.5	0.0	22.5	45.0	Total*
1	52.5	52.9	79.7	41.1	2.7	228.9
2	38.4	17.3	3.4	-21.6	-31.9	112.6
3	42.4	29.8	9.4	-25.3	-31.0	137.9
4	18.6	8.7	-47.6	-71.1	-58.6	204.6
5	45.3	27.2	2.8	-22.9	-45.6	143.8
6	46.2	27.9	14.2	-19.8	-32.4	140.5

* Sum of absolute values for each deepwater azimuth.

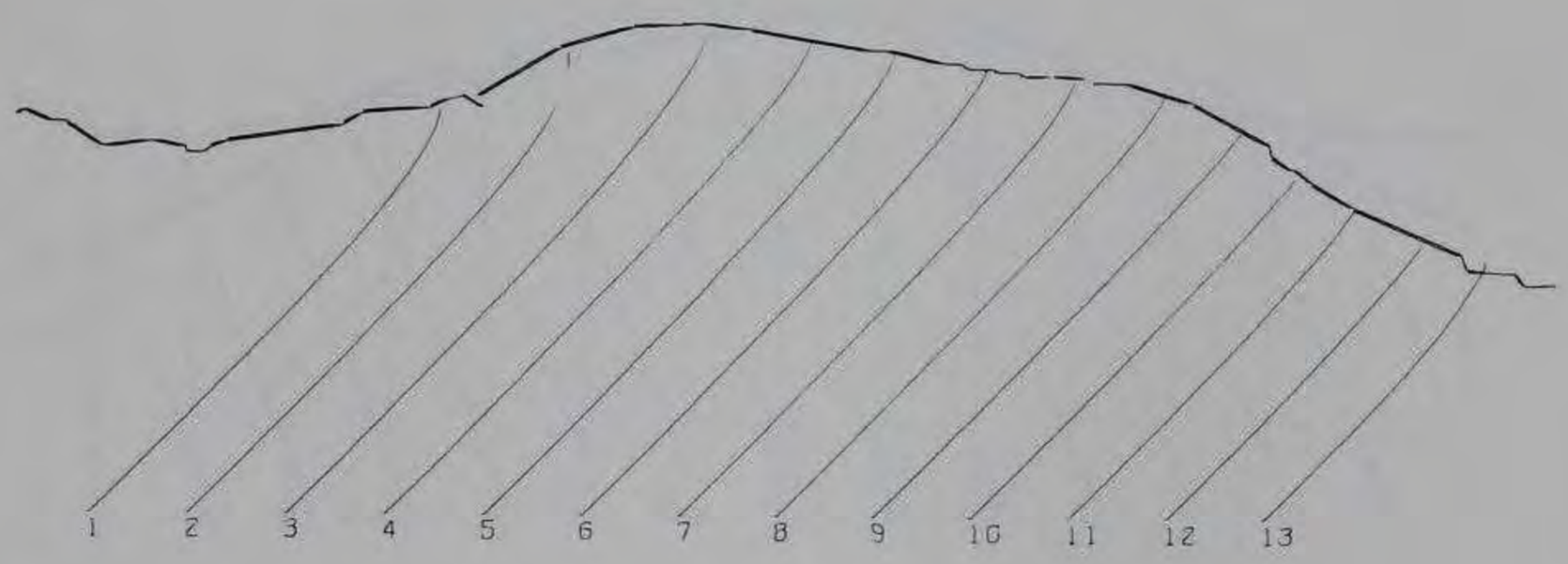
Table 16

Average Annual Total Longshore Energy (ft-lb × 10^7) at Sites 7-15 with a Minimum Refraction Coefficient of 1.0

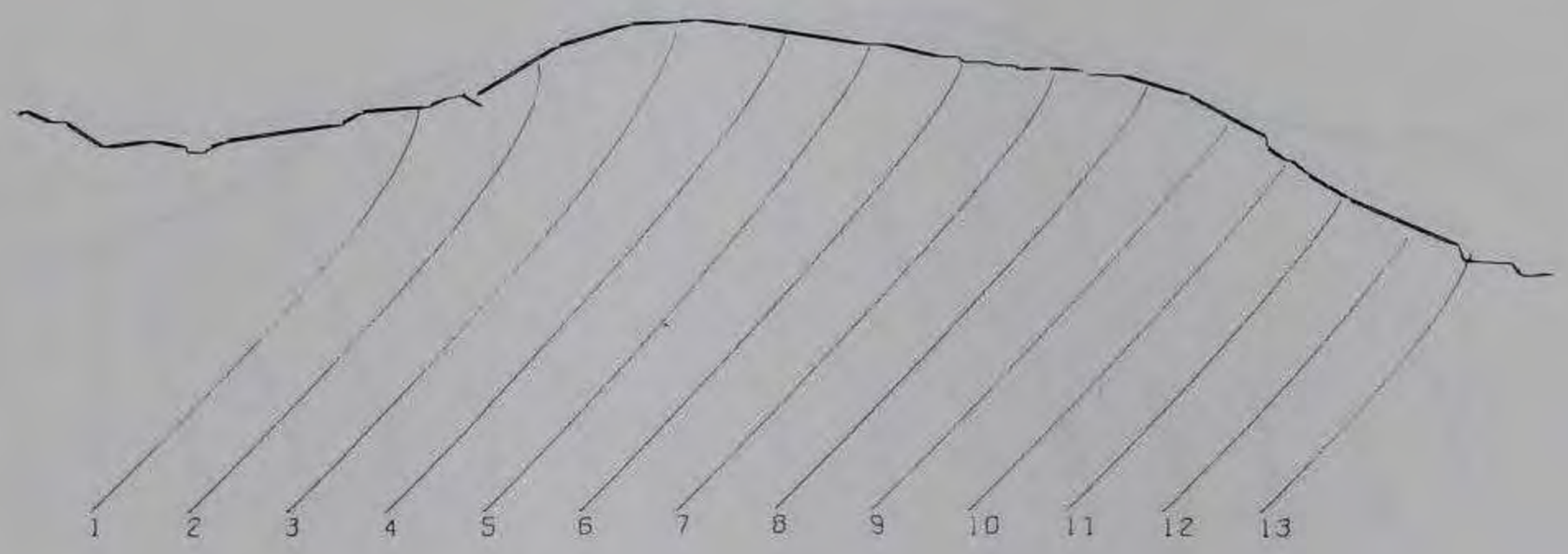
Site	Deepwater Azimuth, deg					
	270.0	315.5	337.5	0.0	22.5	Total*
7	--	394.4	36.5	61.0	3.6	495.5
8	137.7	130.9	-24.3	-114.3	-181.4	588.6
9	134.9	154.1	-28,4	-106.9	-95.8	520.1
10	112.8	112.4	-13.2	-67.2	-81.1	386.7
11	96.9	136.7	-1.0	-45.2	-53.0	322.8
12	87.1	16.8	-16.0	-48.5	-65.0	233.4
13	71.8	21.9	-8.1	-49.0	-64.8	215.6
14	75.0	40.0	-9.3	-65.3	-58.4	248.0
15	123.7	188.3	-2.4	-46.7	-63.6	424.7

* Sum of absolute values for each deepwater azimuth.

4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

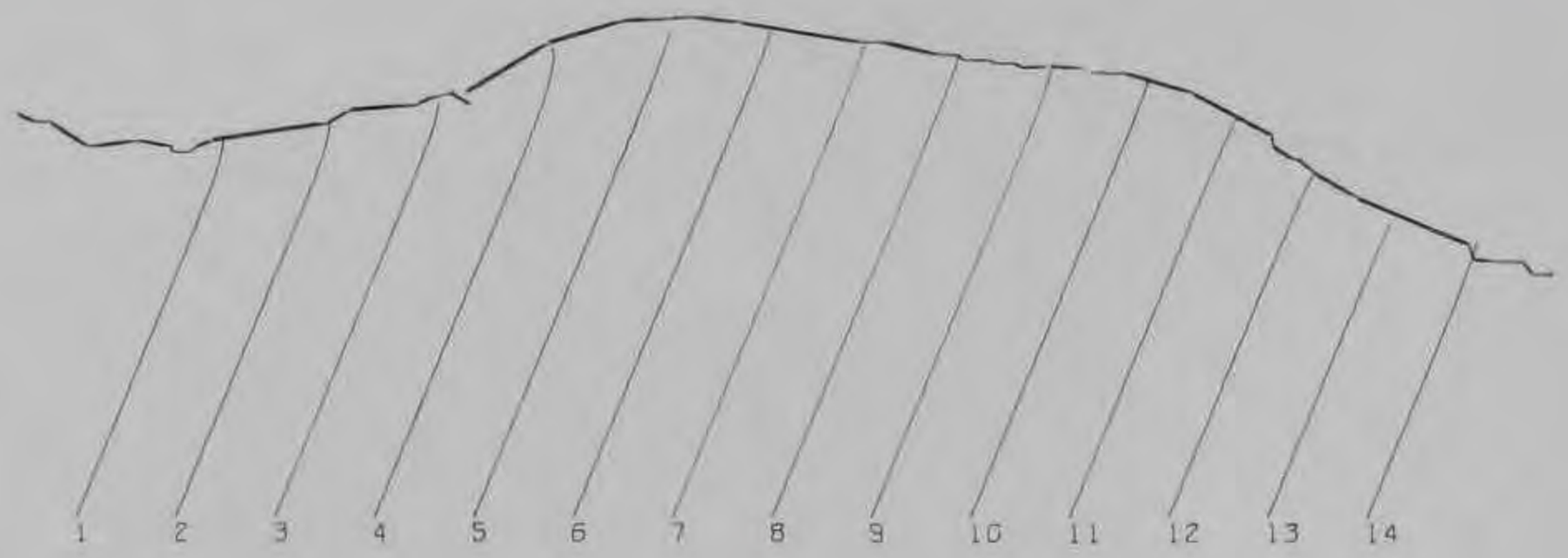
WAVE REFRACTION
WEST OF HARBOR

DEEPWATER AZIMUTH = 45.0 DEG

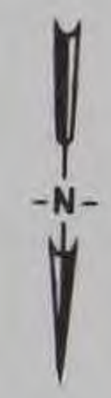
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

PLATE 1



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD

8-SEC WAVE PERIOD

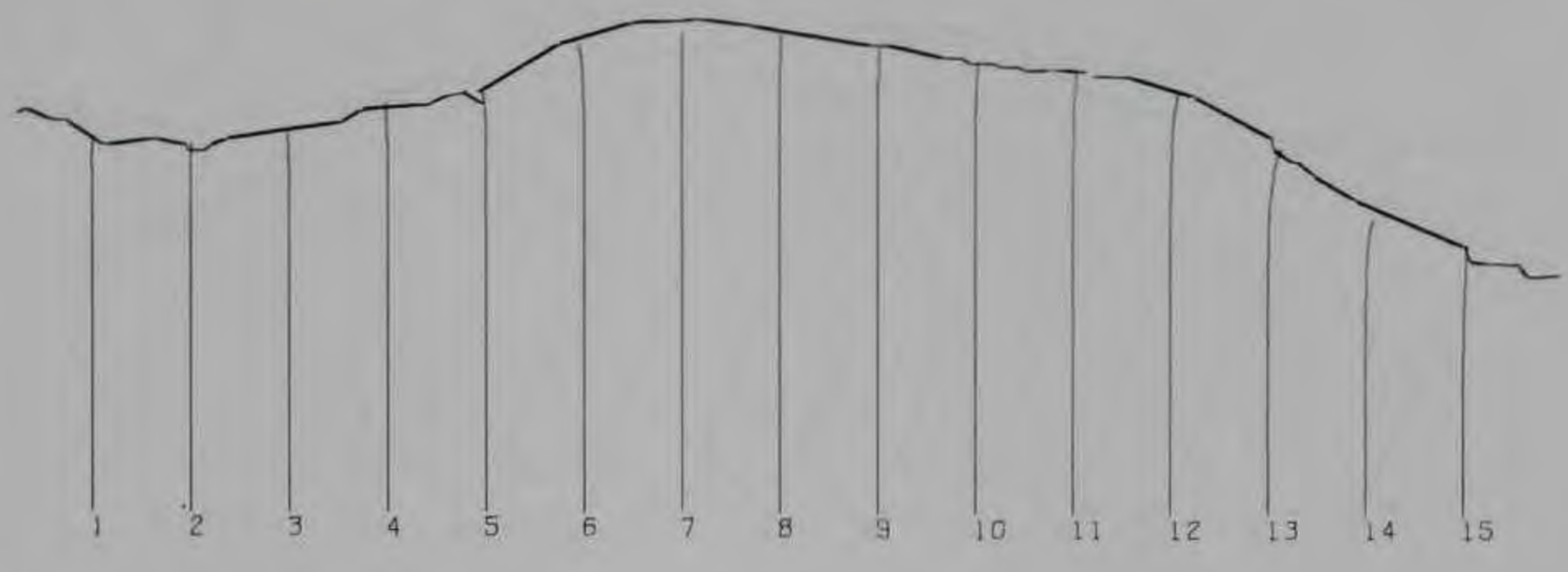
WAVE REFRACTION
WEST OF HARBOR

DEEPWATER AZIMUTH = 22.5 DEG

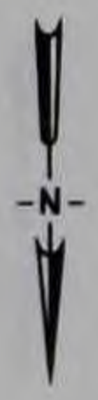
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

PLATE 2



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD

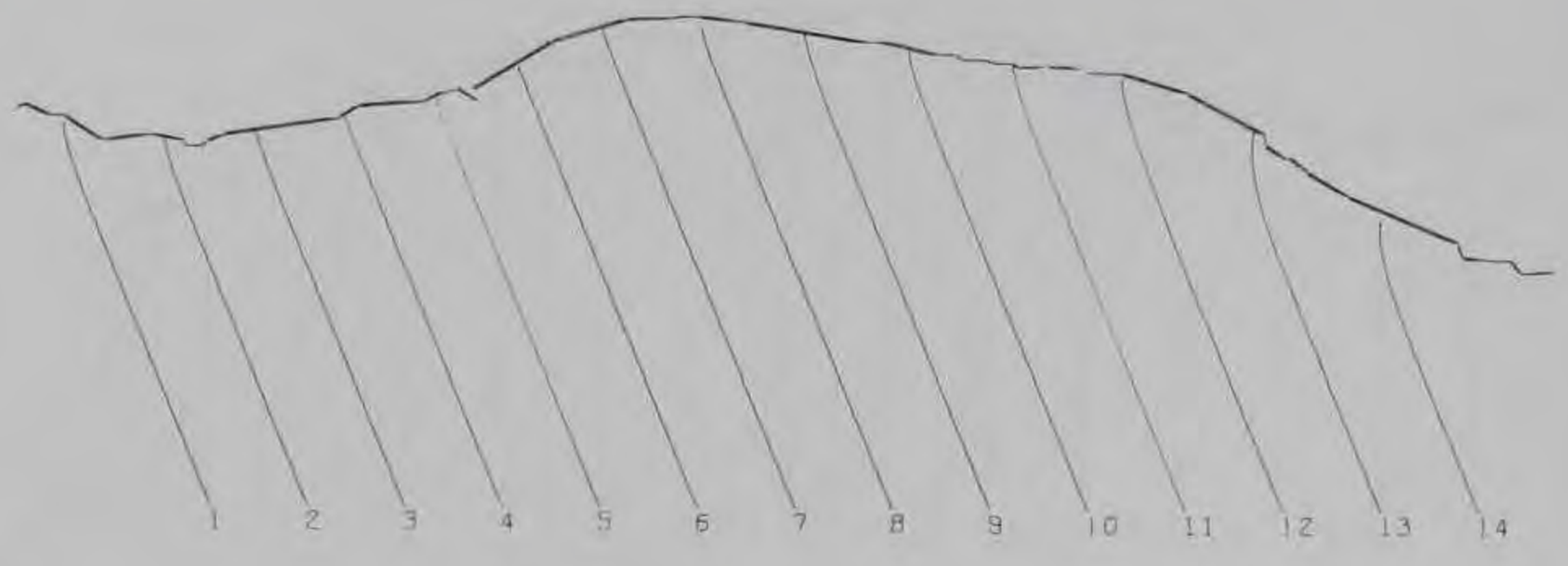
8-SEC WAVE PERIOD

WAVE REFRACTION
WEST OF HARBOR

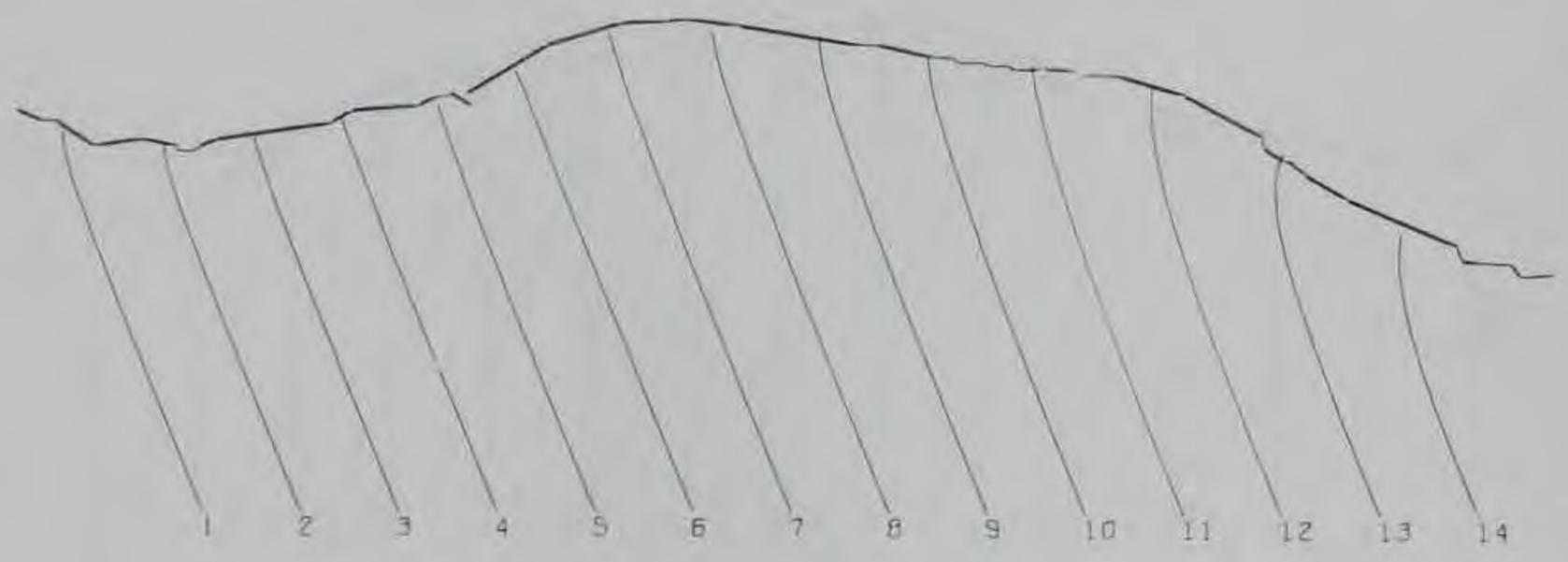
DEEPWATER AZIMUTH = 0.0 DEG

SCALE IN FEET

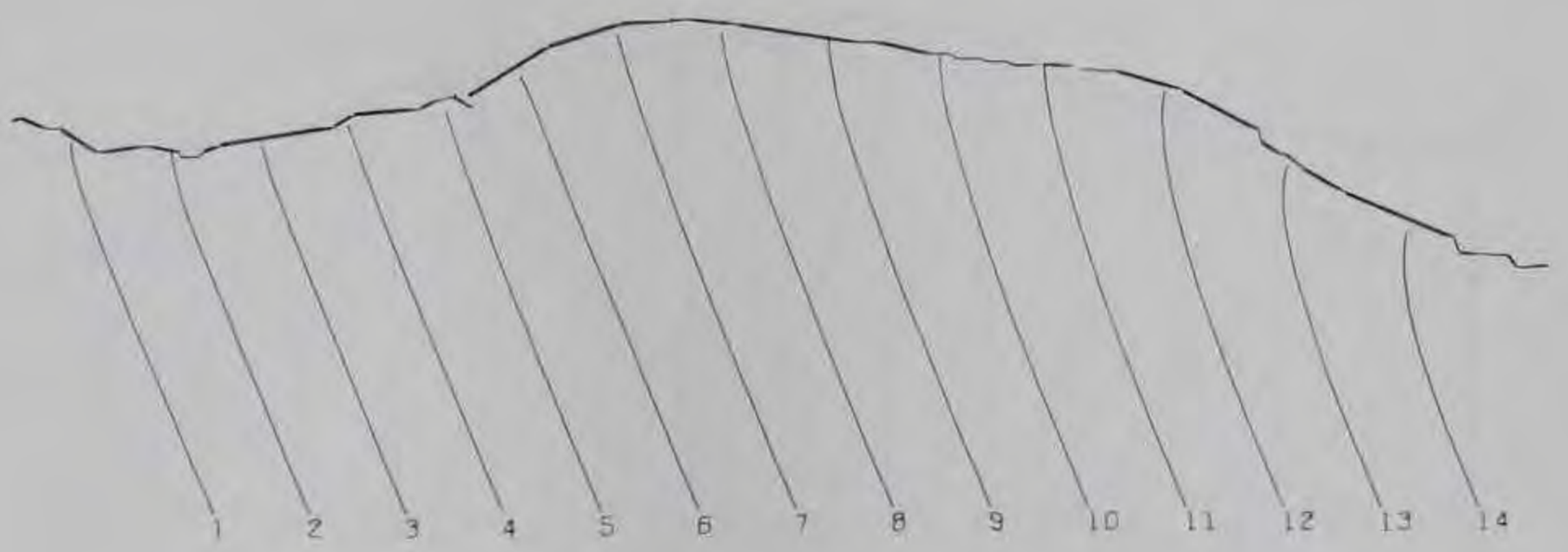
5000 0 5000 10,000 15,000 20,000



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

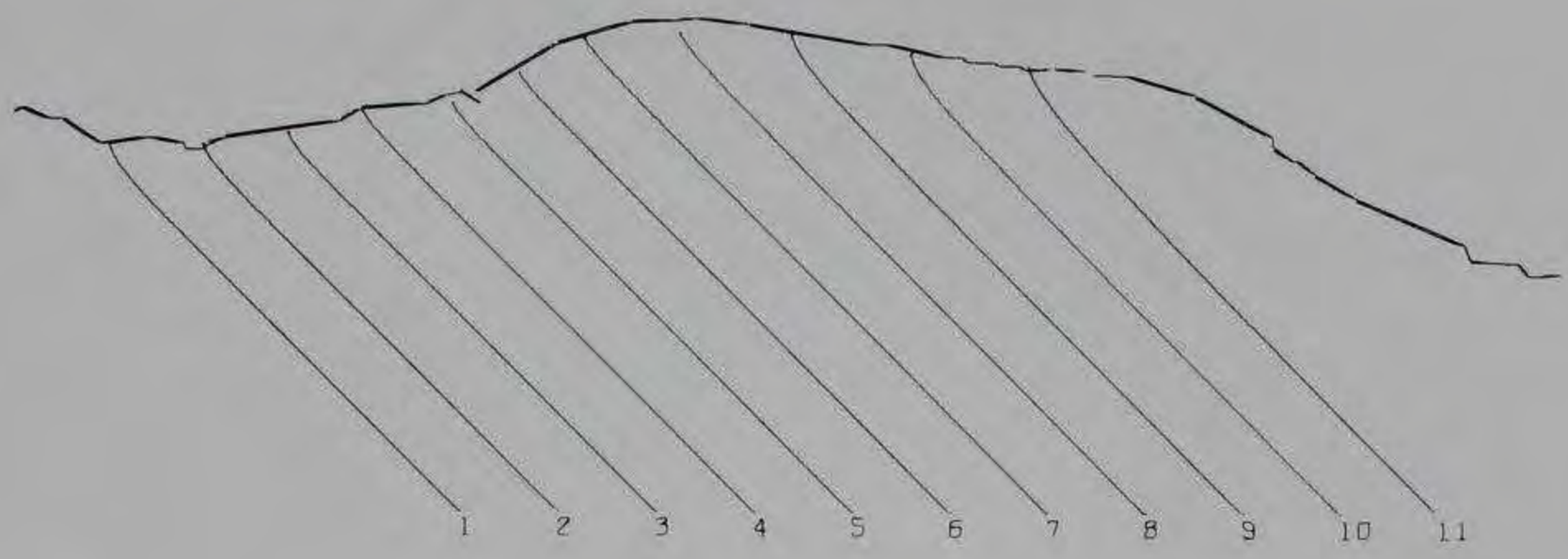
WAVE REFRACTION
WEST OF HARBOR

DEEPWATER AZIMUTH=337.5 DEG

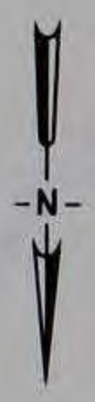
SCALE IN FEET

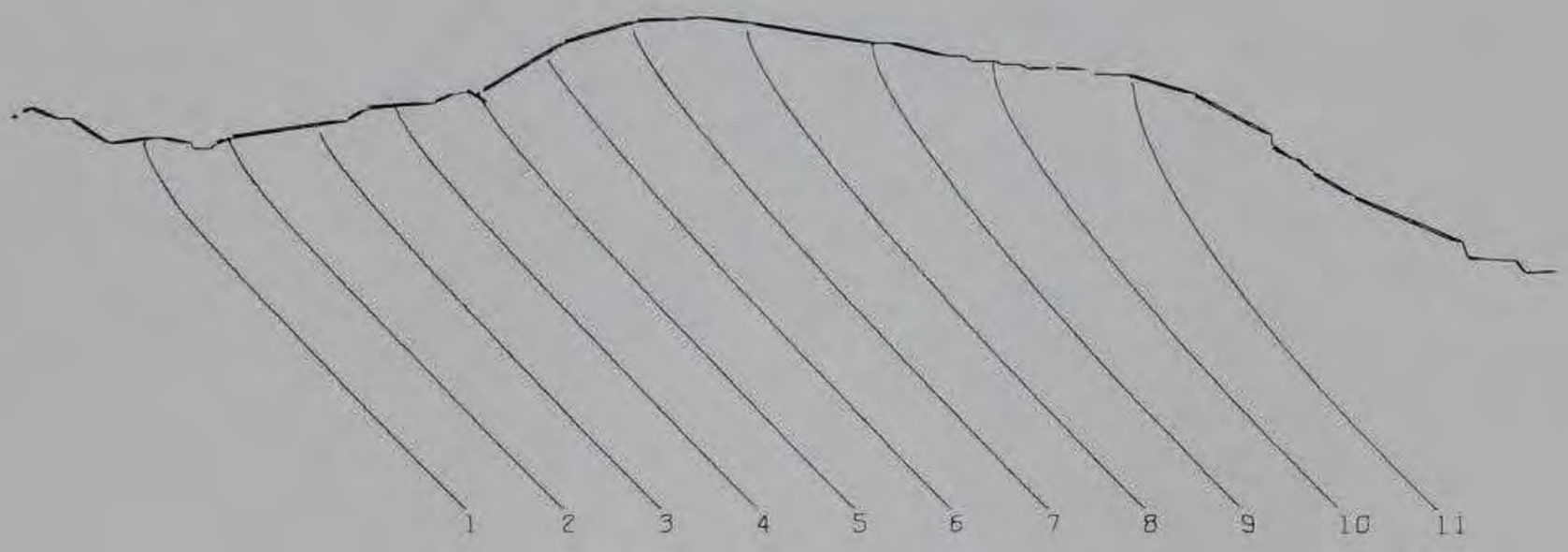
5000 0 5000 10,000 15,000 20,000

PLATE 4

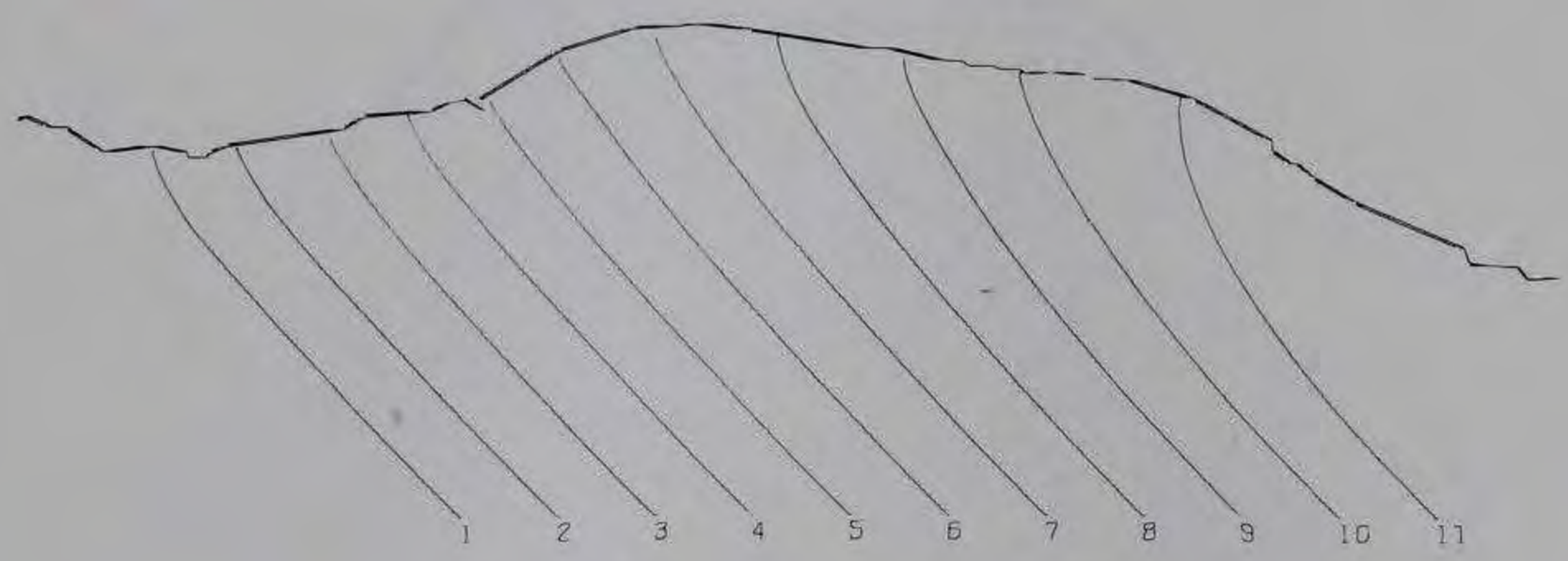


4-SEC WAVE PERIOD





6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

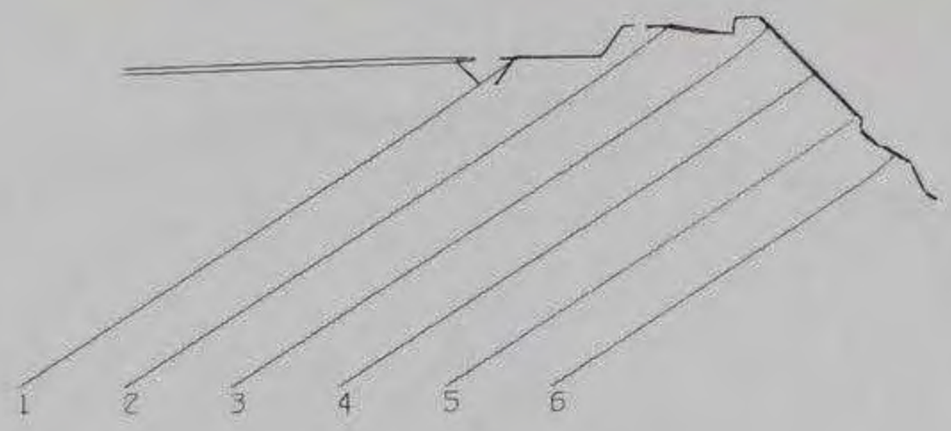
WAVE REFRACTION WEST OF HARBOR

DEEPWATER AZIMUTH = 315.0 DEG

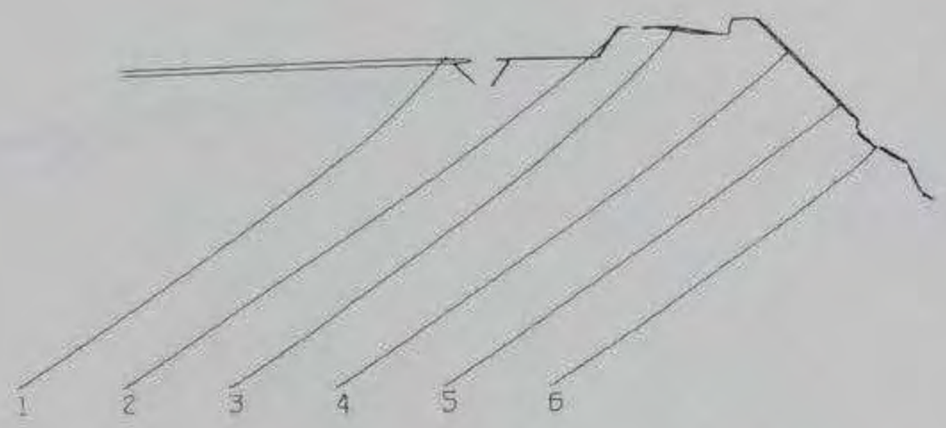
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

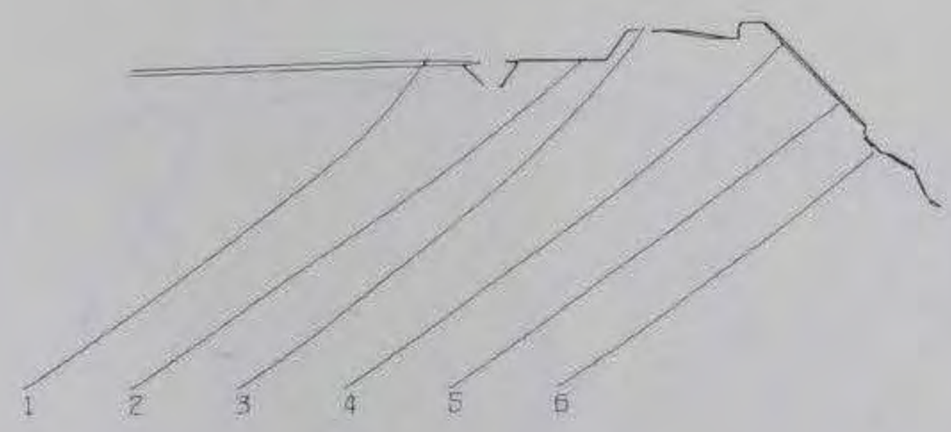
PLATE 5



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

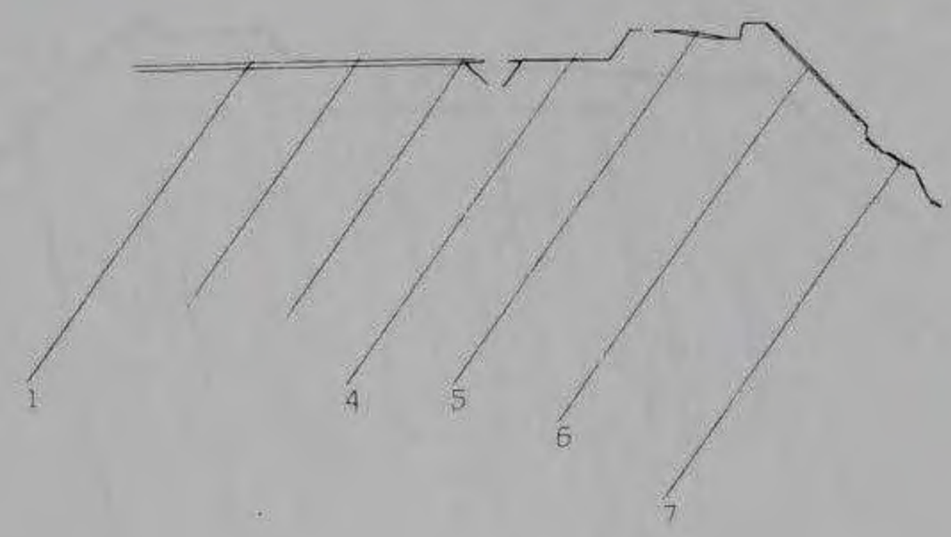
WAVE REFRACTION AT HARBOR

DEEPWATER AZIMUTH = 22.5 DEG

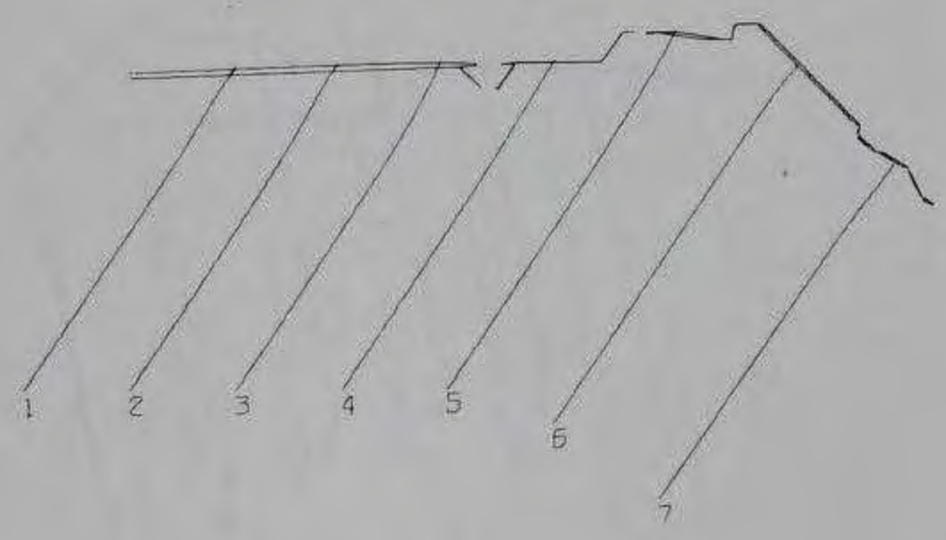
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

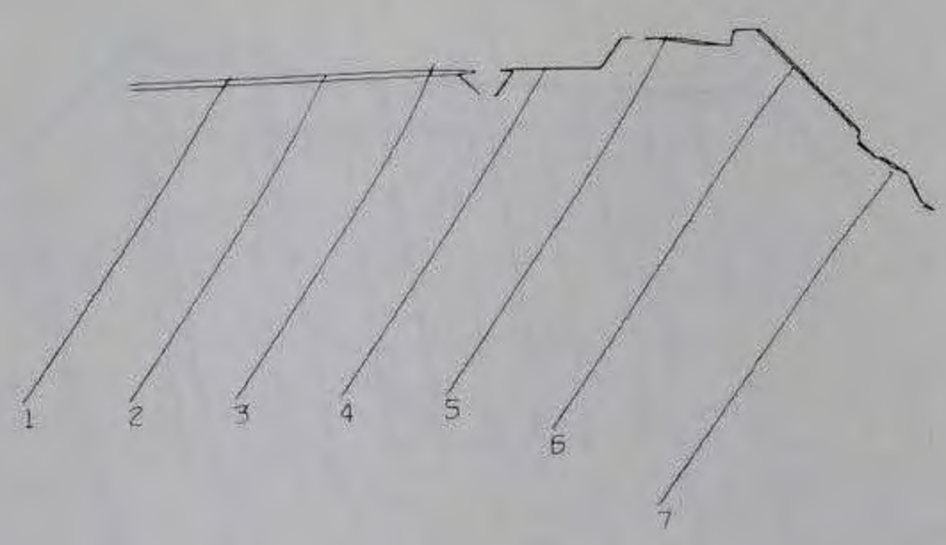
PLATE 6



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



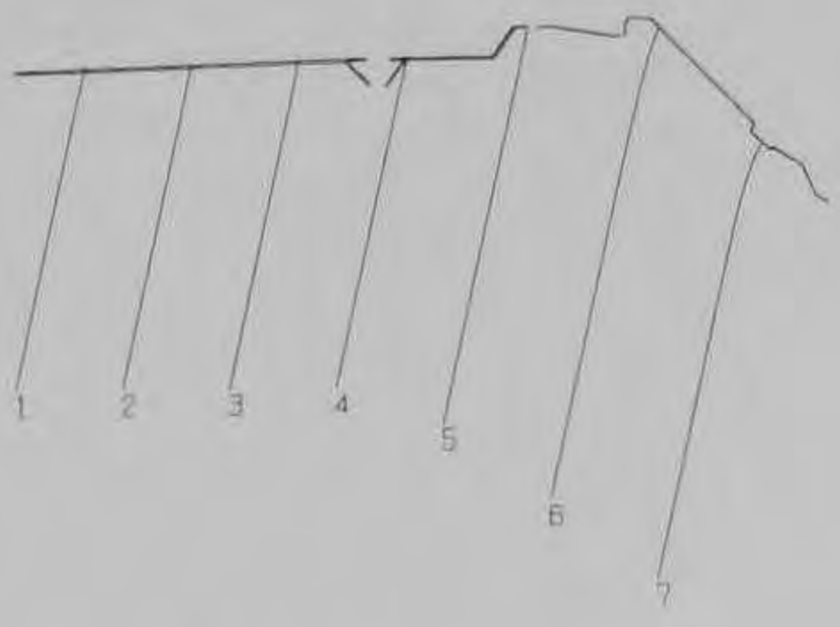
8-SEC WAVE PERIOD

WAVE REFRACTION AT HARBOR

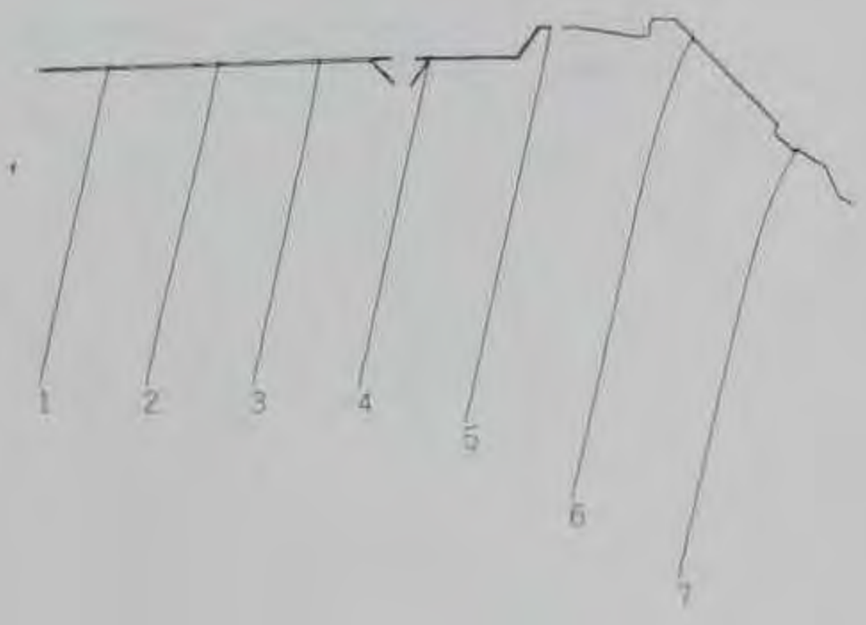
DEEPWATER AZIMUTH = 0.0 DEG

SCALE IN FEET

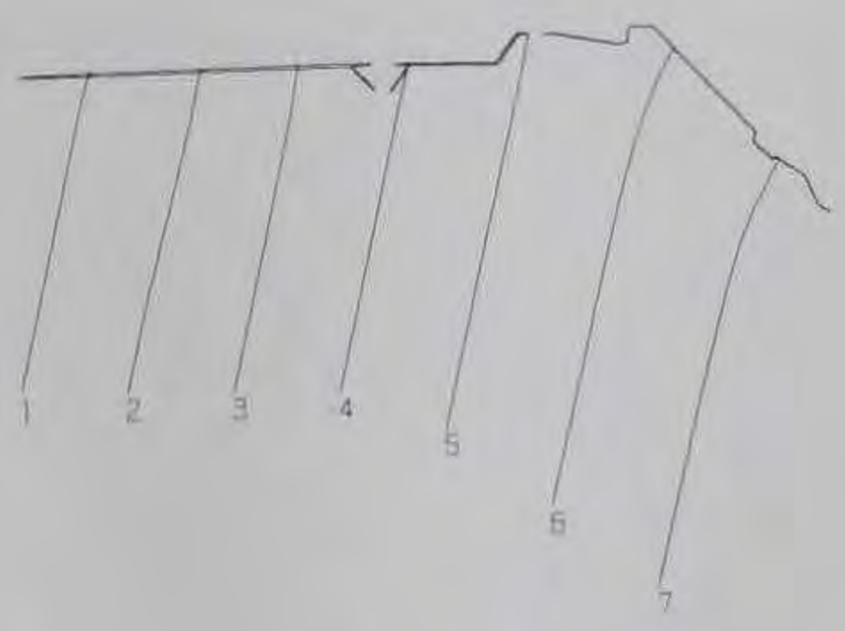
5000 0 5000 10,000 15,000 20,000



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

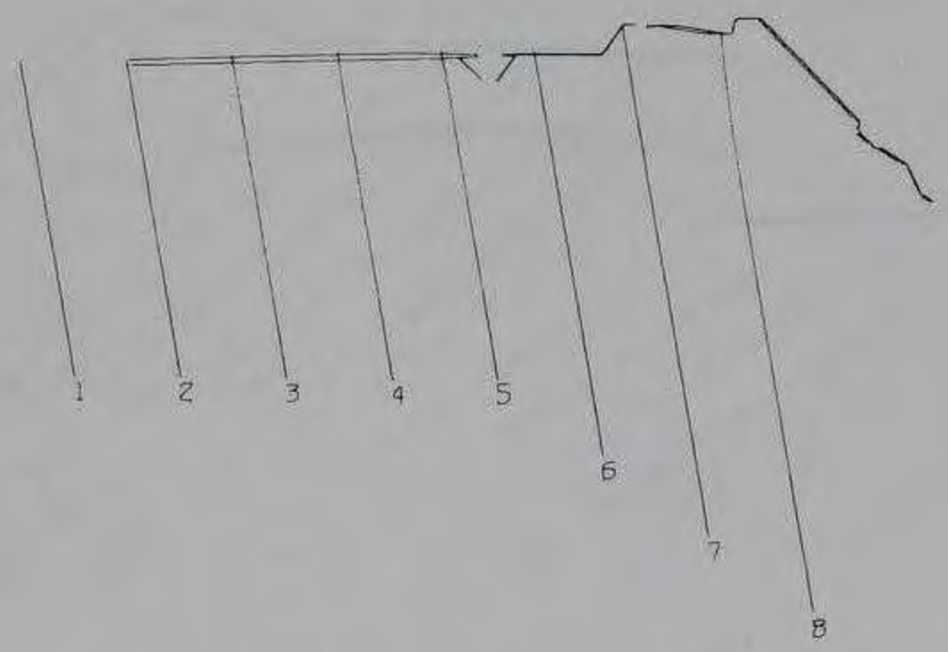
WAVE REFRACTION AT HARBOR

DEEPWATER AZIMUTH = 337.5 DEG

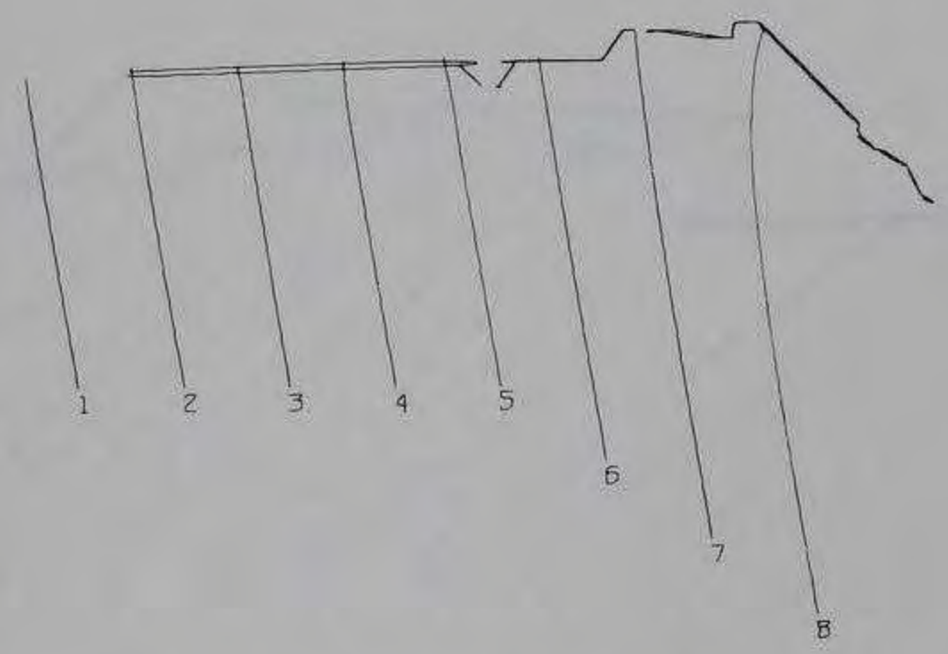
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

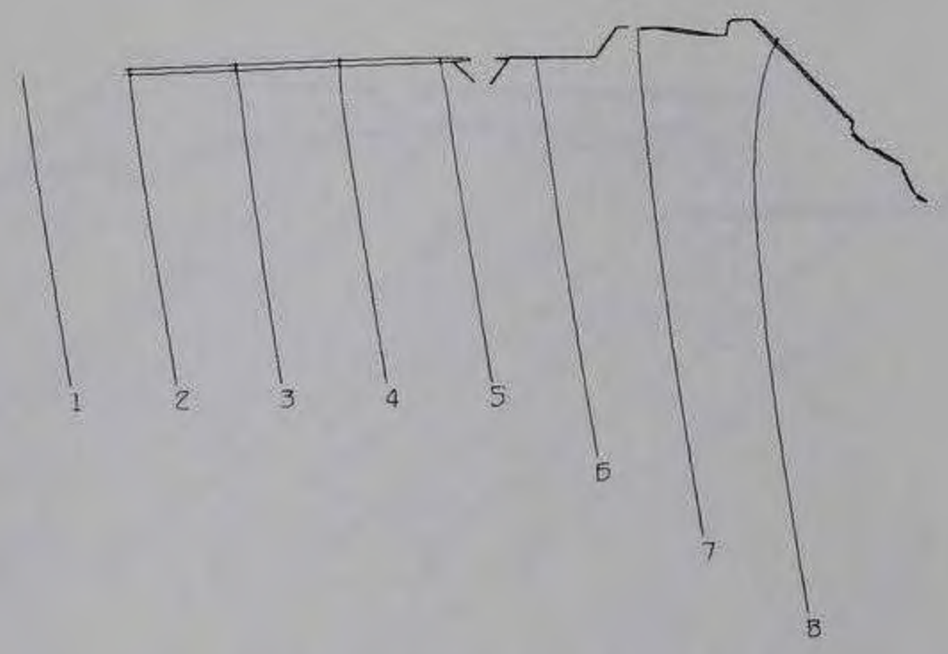
PLATE 8



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



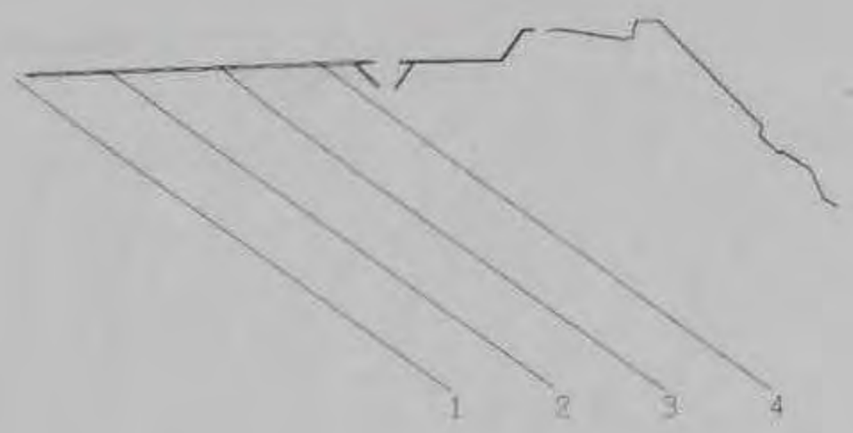
8-SEC WAVE PERIOD

WAVE REFRACTION AT HARBOR

DEEPWATER AZIMUTH = 315.0 DEG

SCALE IN FEET

5000 0 5000 10,000 15,000 20,000



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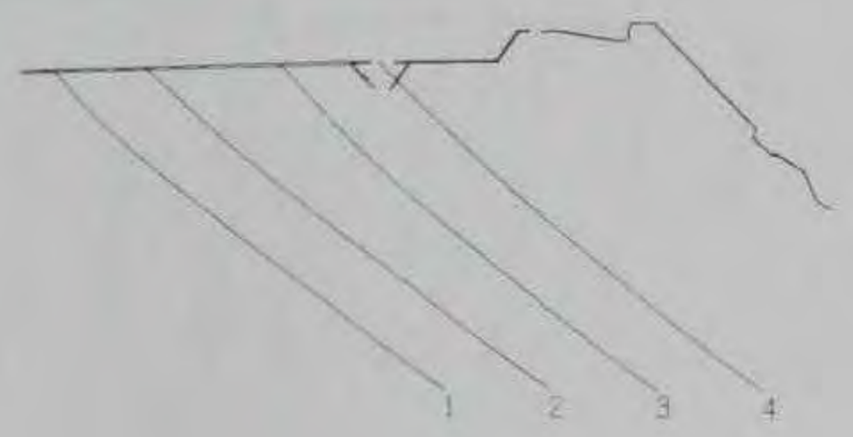
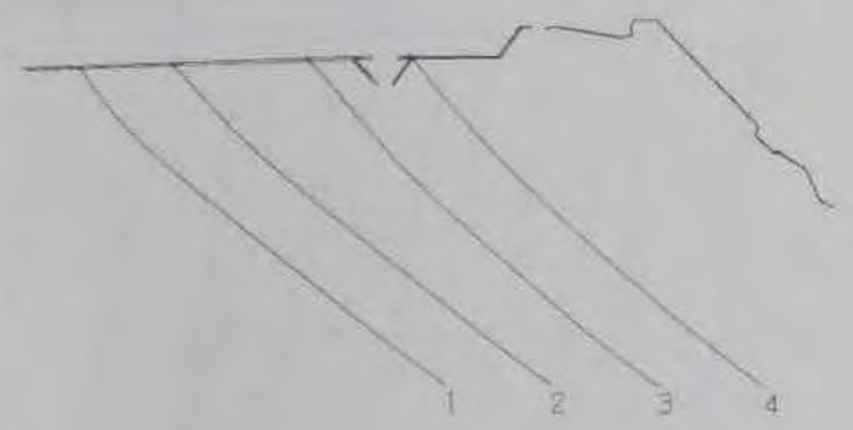
4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

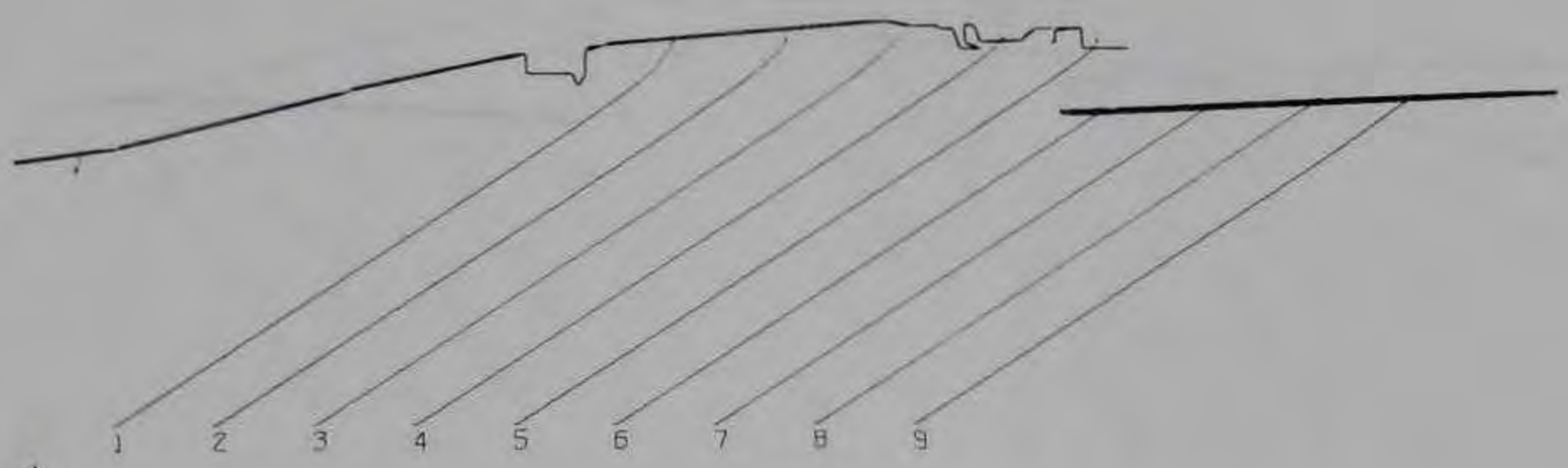
WAVE REFRACTION AT HARBOR

DEEPWATER AZIMUTH = 270.0 DEG

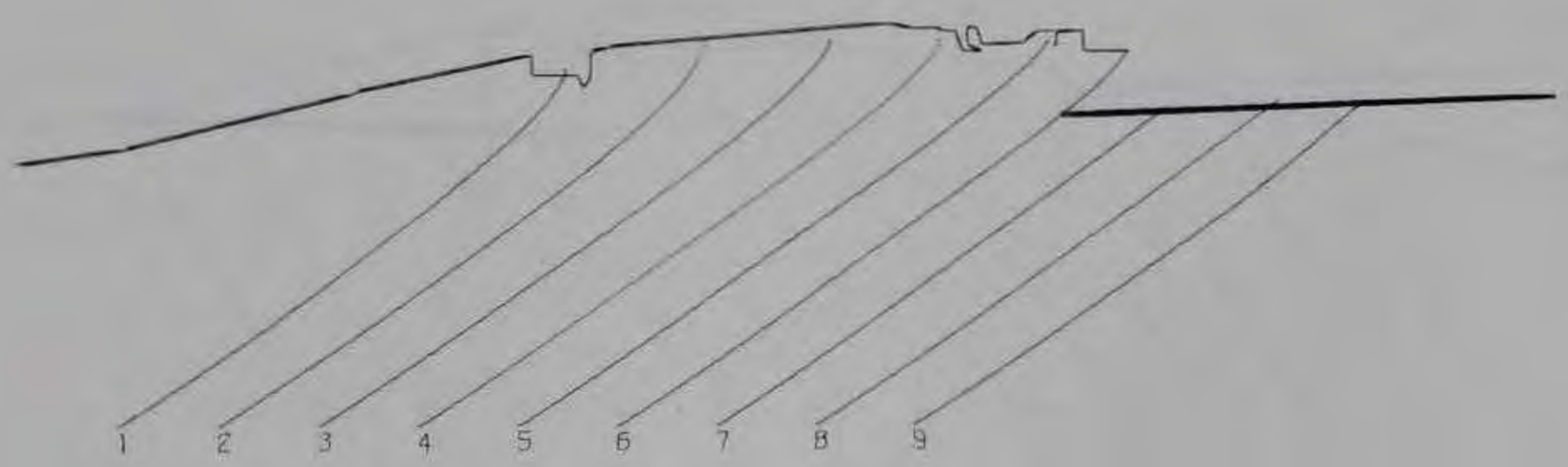
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

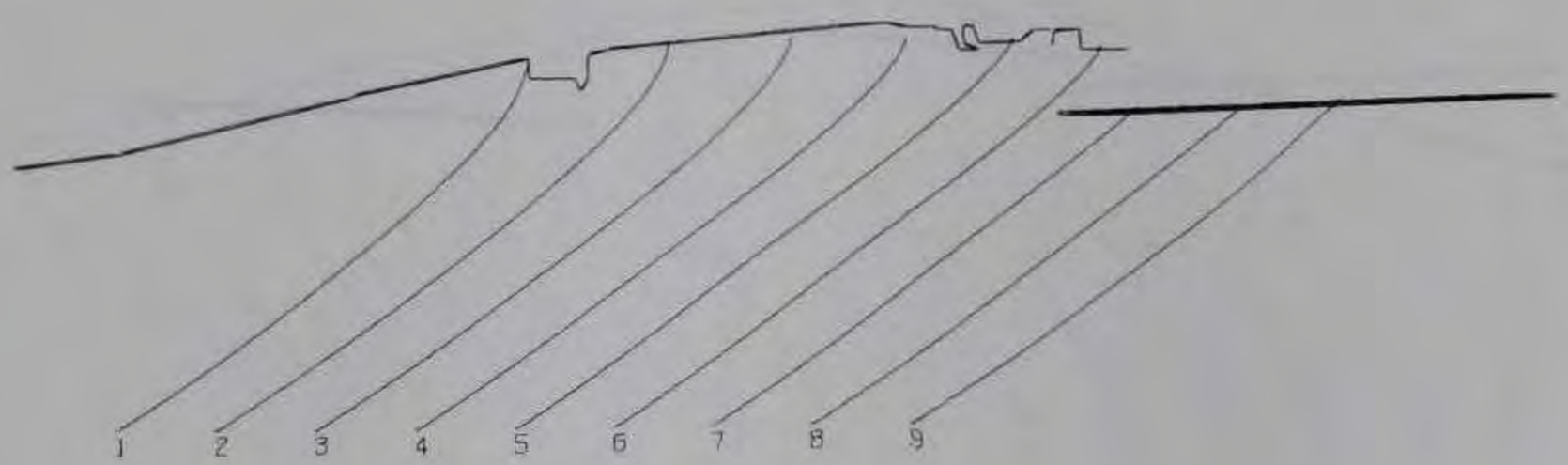
PLATE 10



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

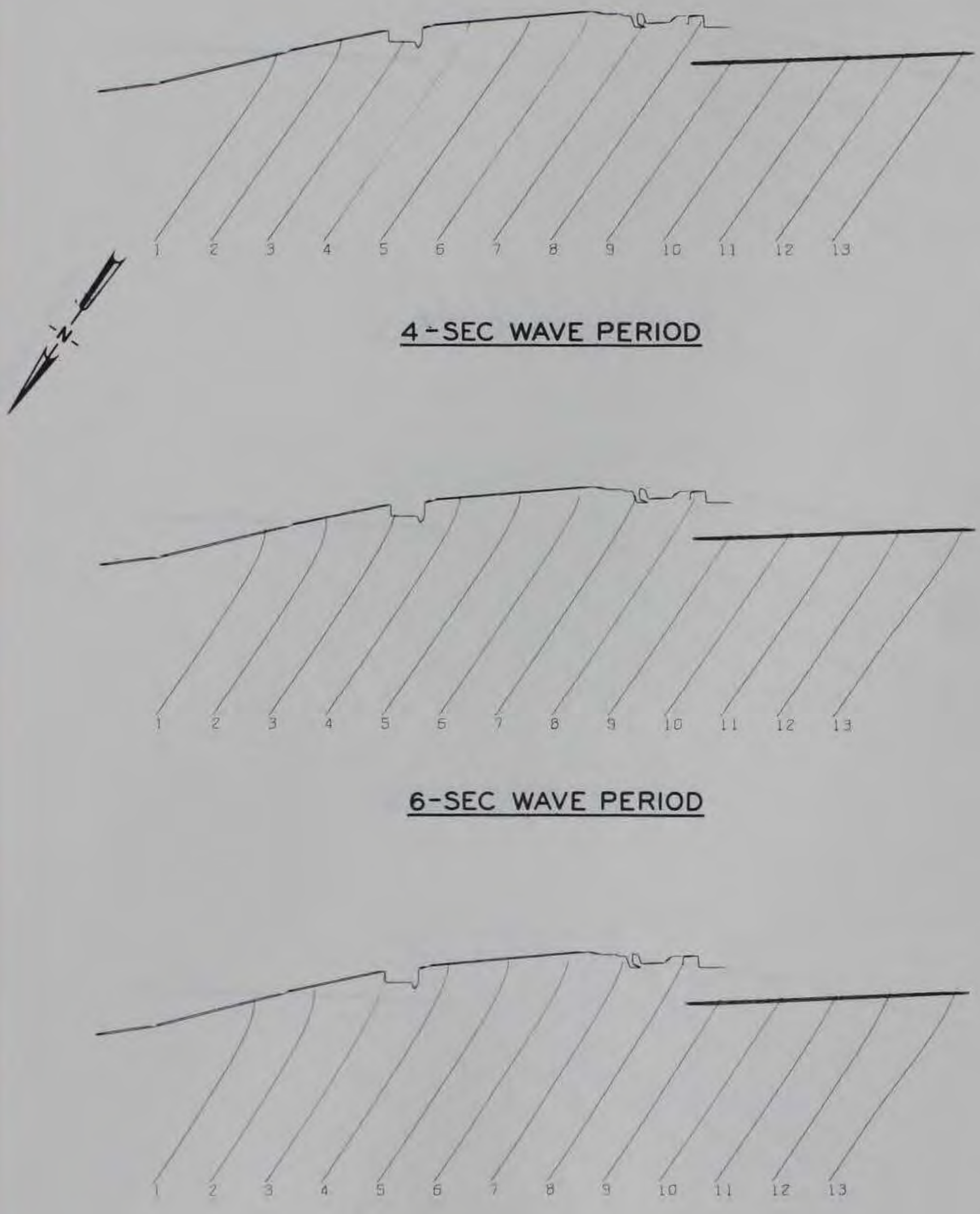
WAVE REFRACTION
EAST OF HARBOR

DEEPWATER AZIMUTH = 22.5 DEG

SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

PLATE 11



4-SEC WAVE PERIOD

6-SEC WAVE PERIOD

8-SEC WAVE PERIOD

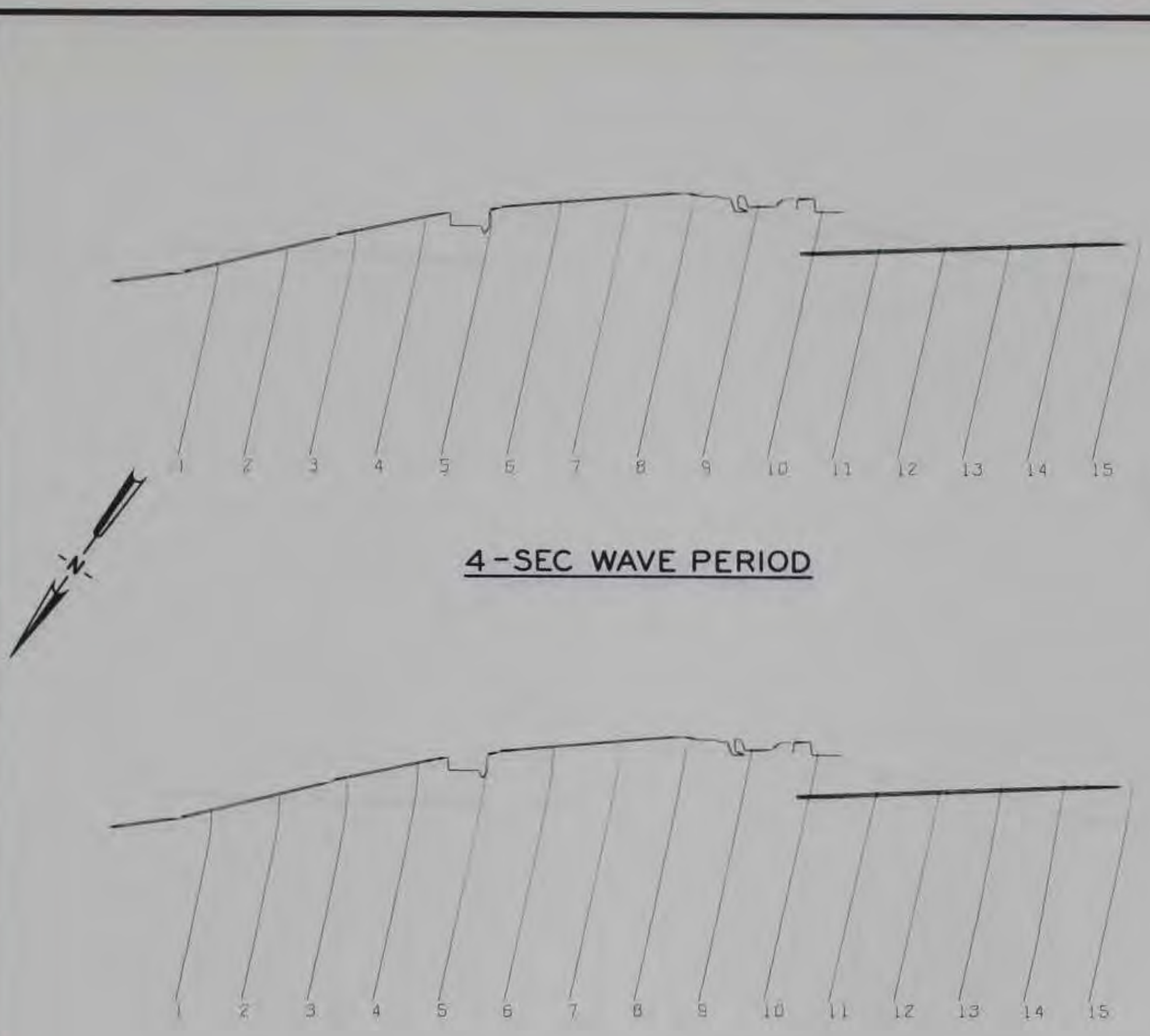
WAVE REFRACTION EAST OF HARBOR

DEEPWATER AZIMUTH = 0.0 DEG

SCALE IN FEET

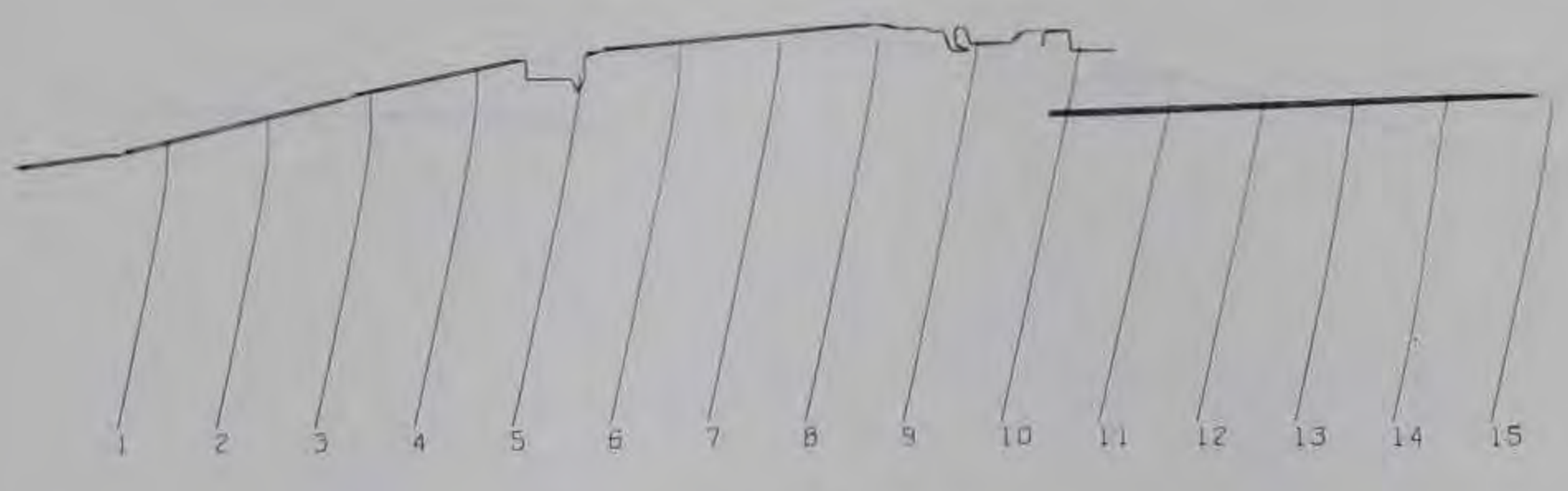
5000 0 5000 10,000 15,000 20,000

PLATE 12



4-SEC WAVE PERIOD

6-SEC WAVE PERIOD



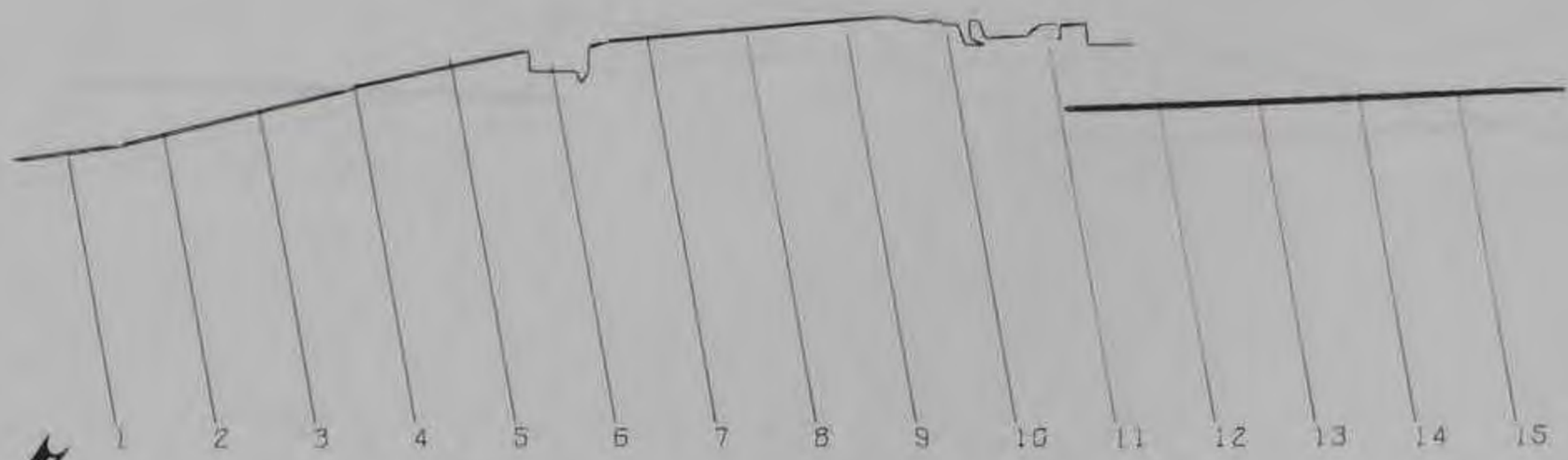
8-SEC WAVE PERIOD

WAVE REFRACTION
EAST OF HARBOR

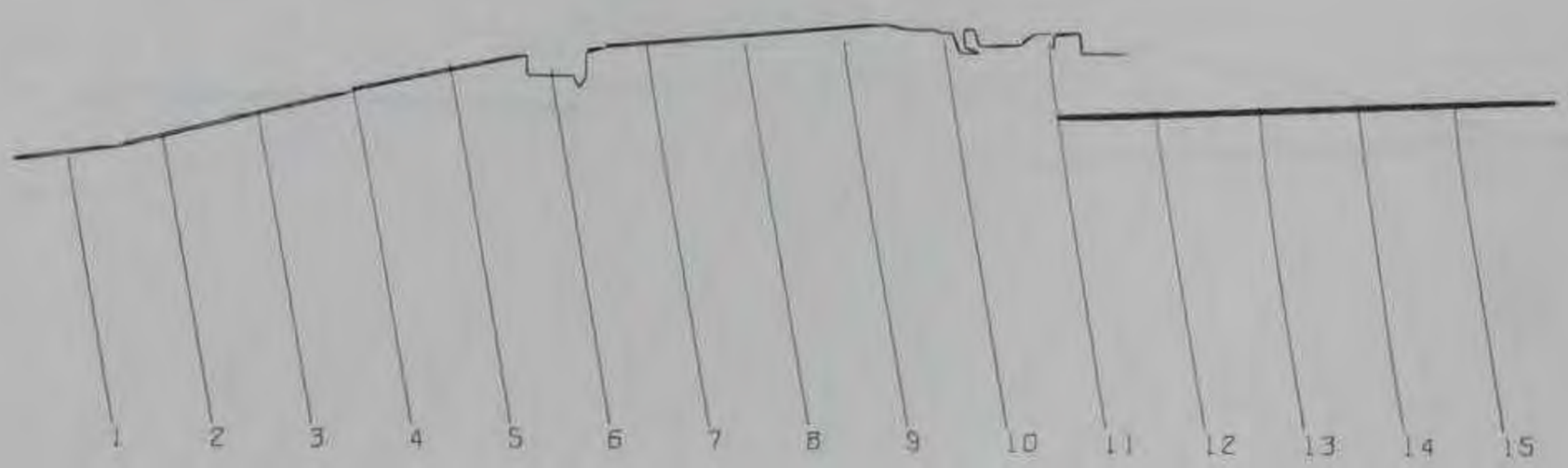
DEEPWATER AZIMUTH = 337.5 DEG

SCALE IN FEET

5000 0 5000 10,000 15,000 20,000



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD

8-SEC WAVE PERIOD

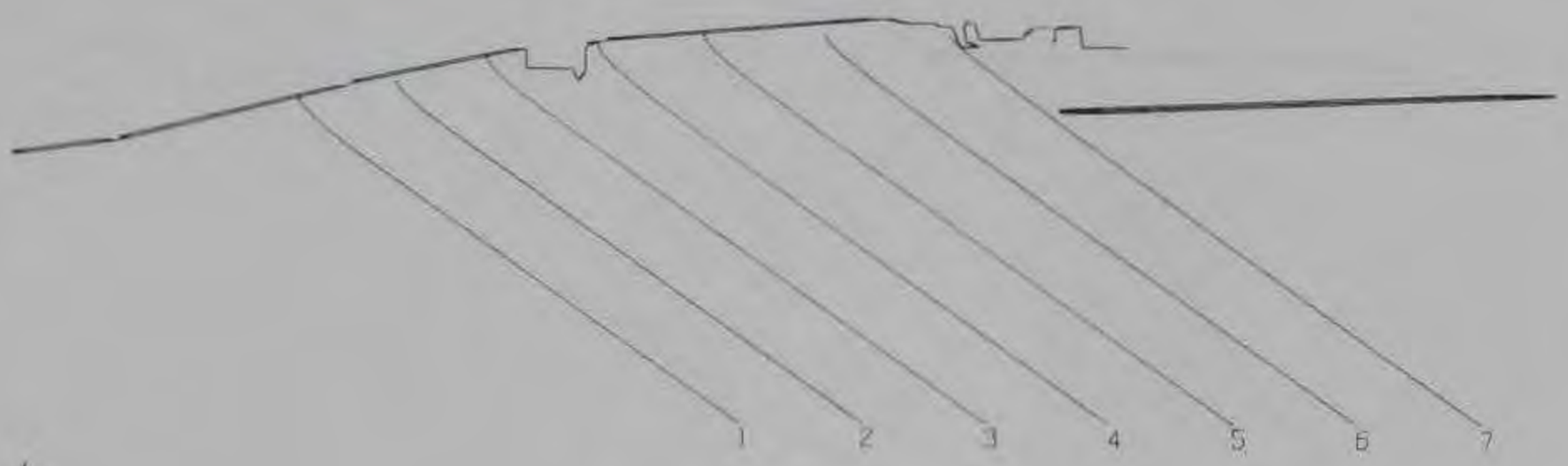
WAVE REFRACTION EAST OF HARBOR

DEEPWATER AZIMUTH = 315.0 DEG

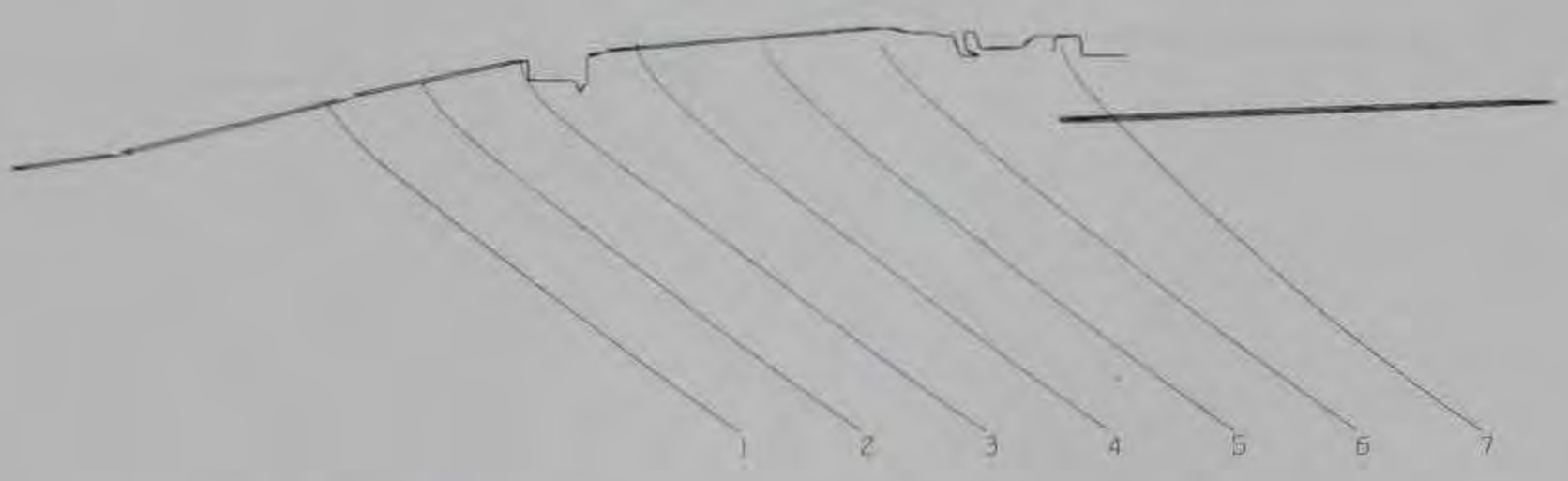
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

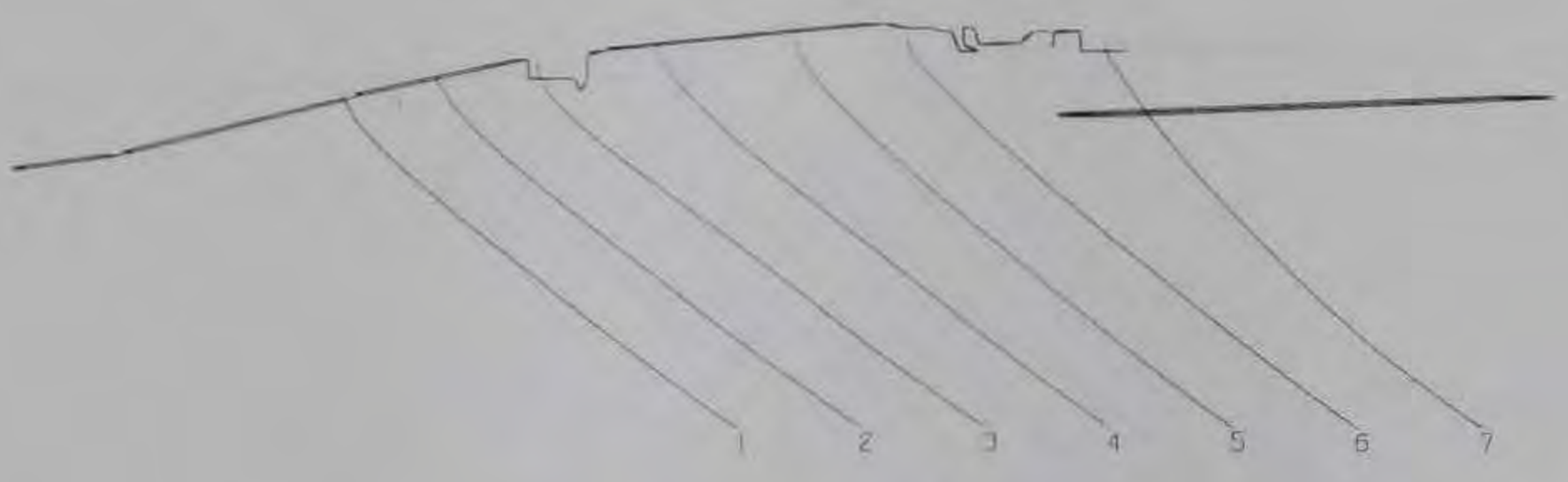
PLATE 14



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

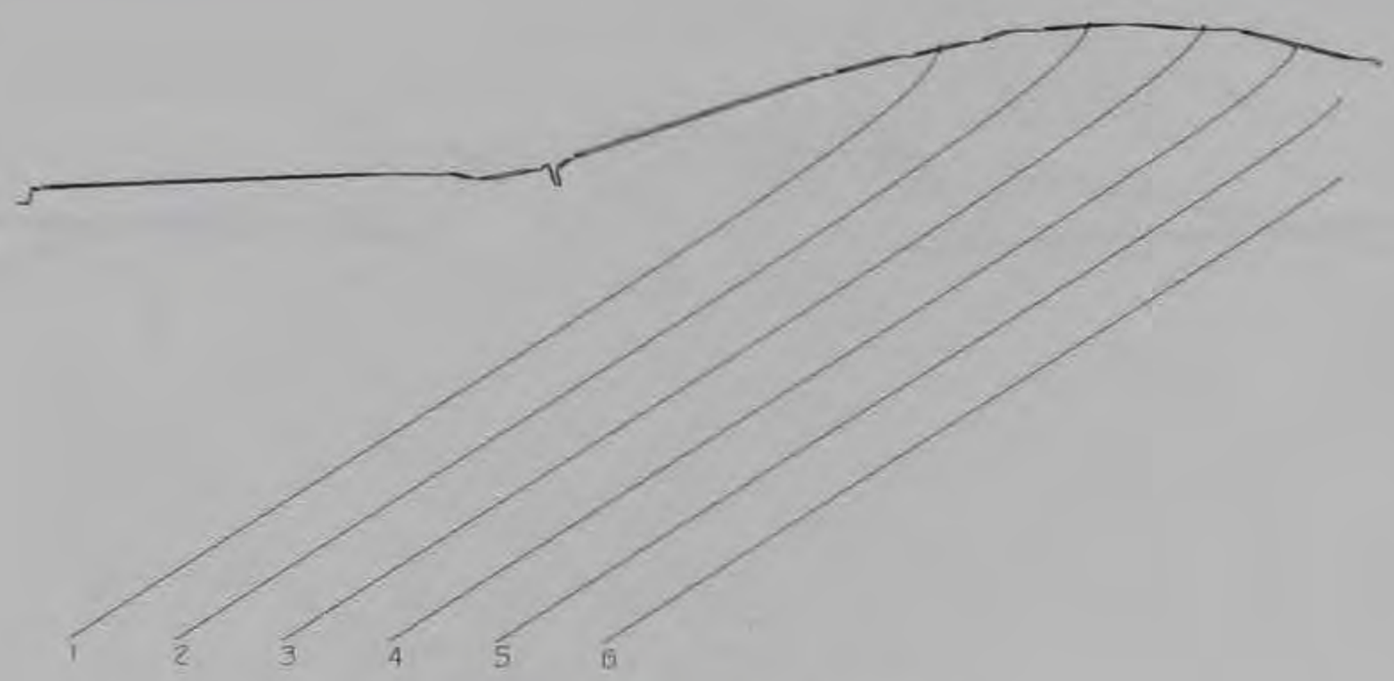
WAVE REFRACTION
EAST OF HARBOR

DEEPWATER AZIMUTH = 270.0 DEG

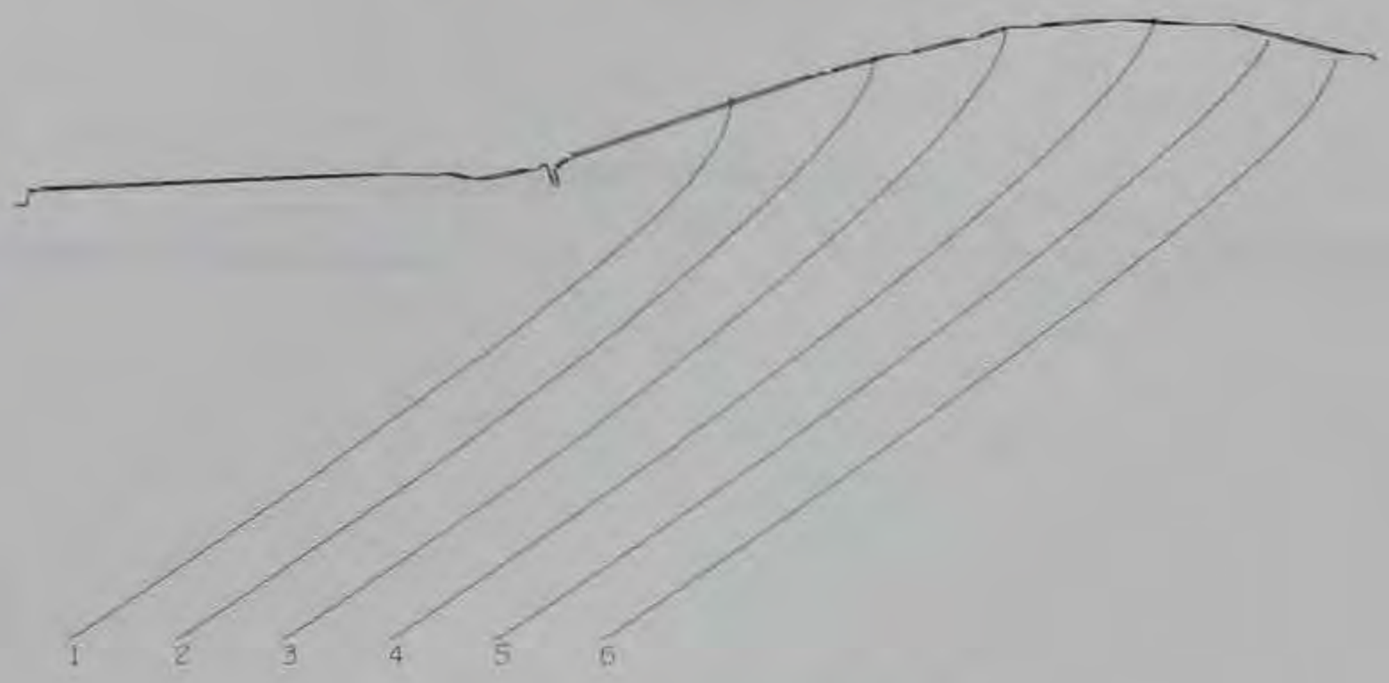
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

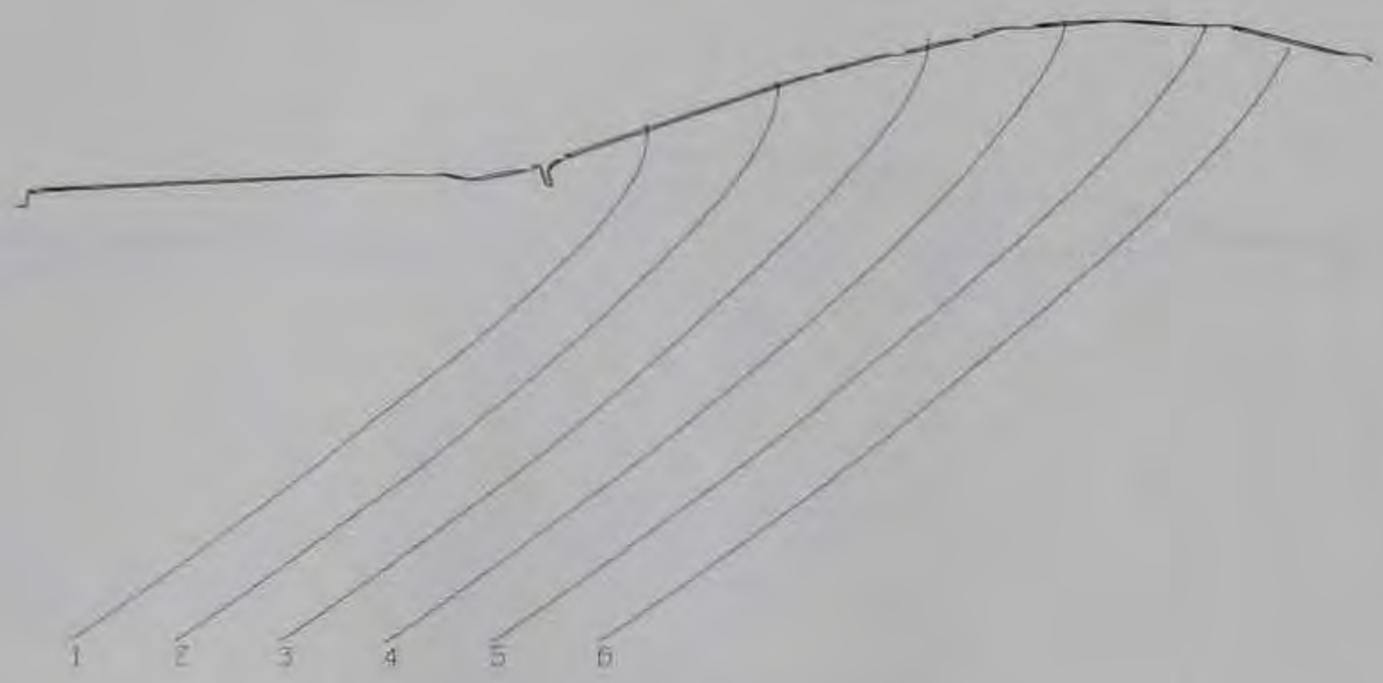
PLATE 15



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

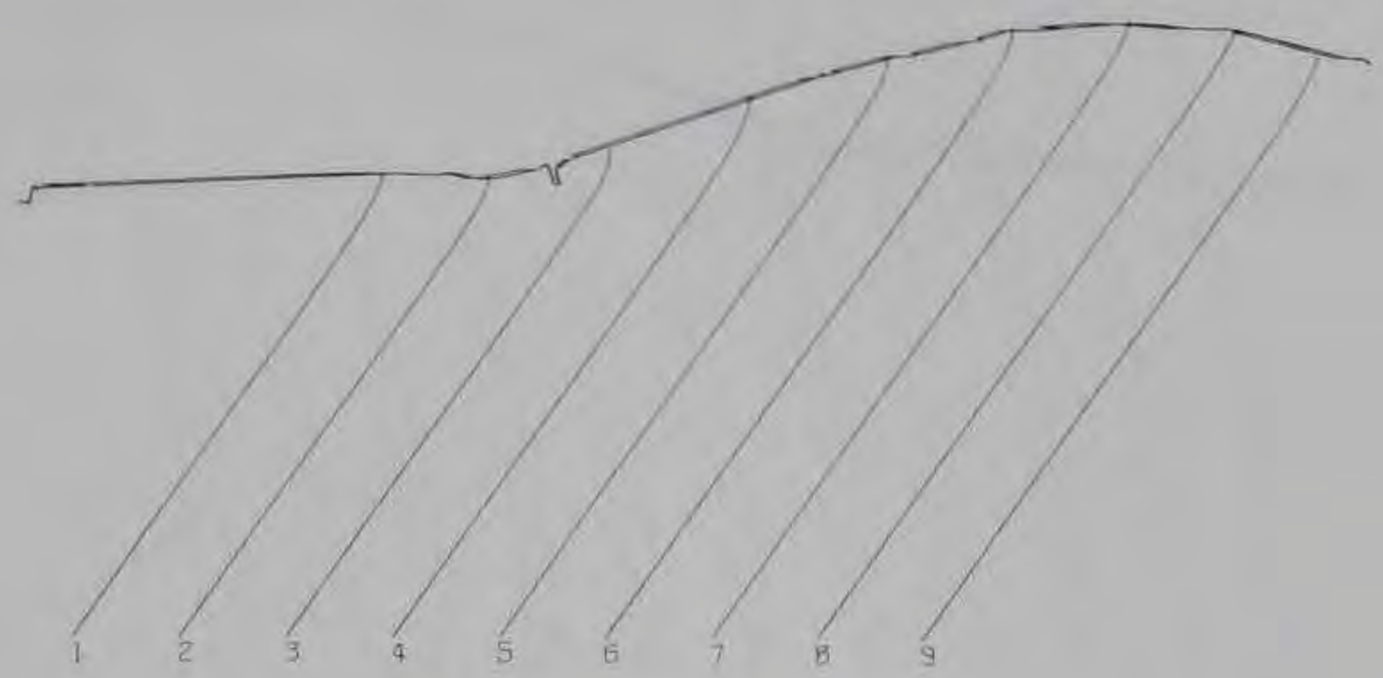
WAVE REFRACTION
CHAGRIN RIVER

DEEPWATER AZIMUTH = 22.5 DEG

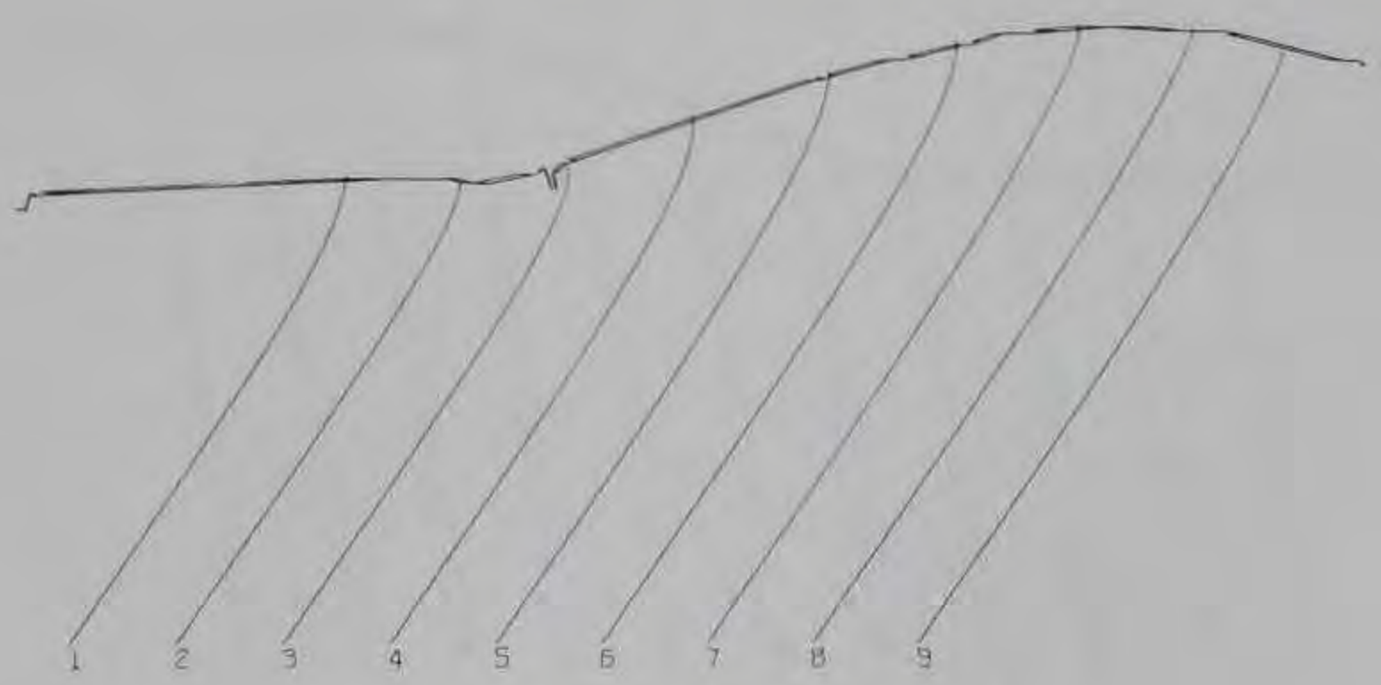
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

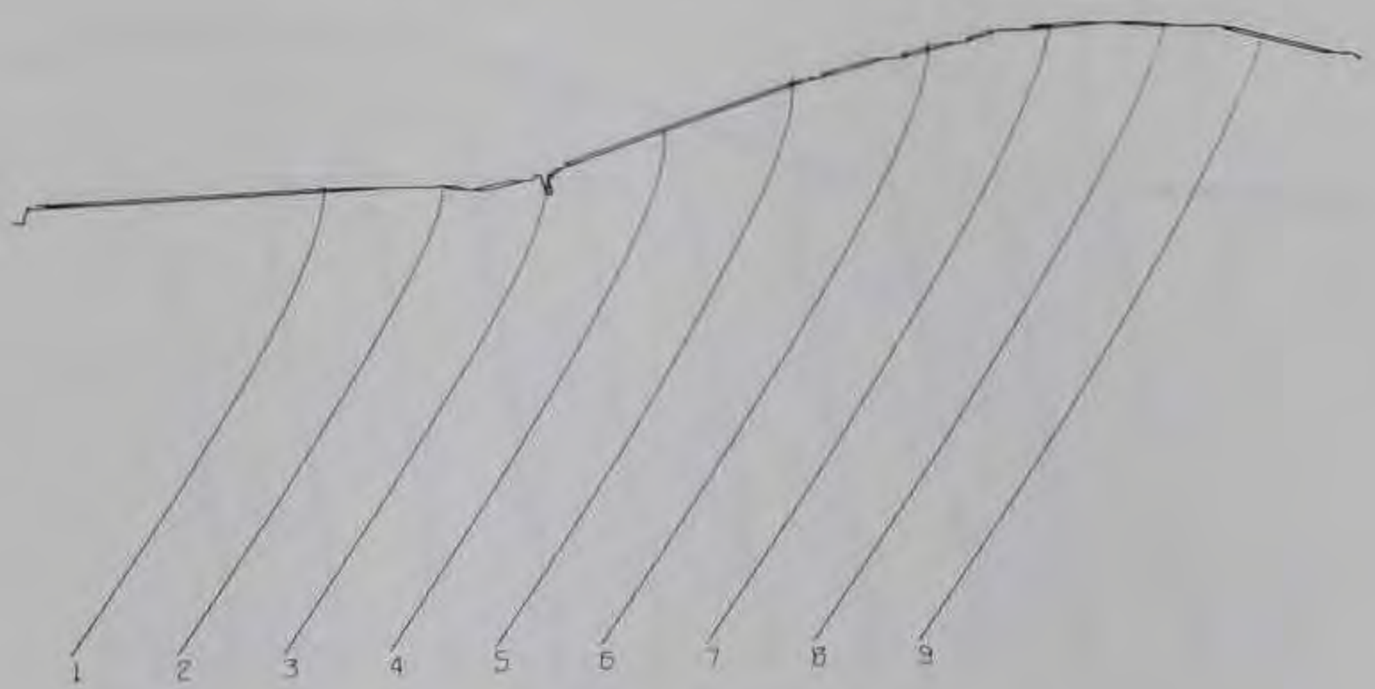
PLATE 16



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



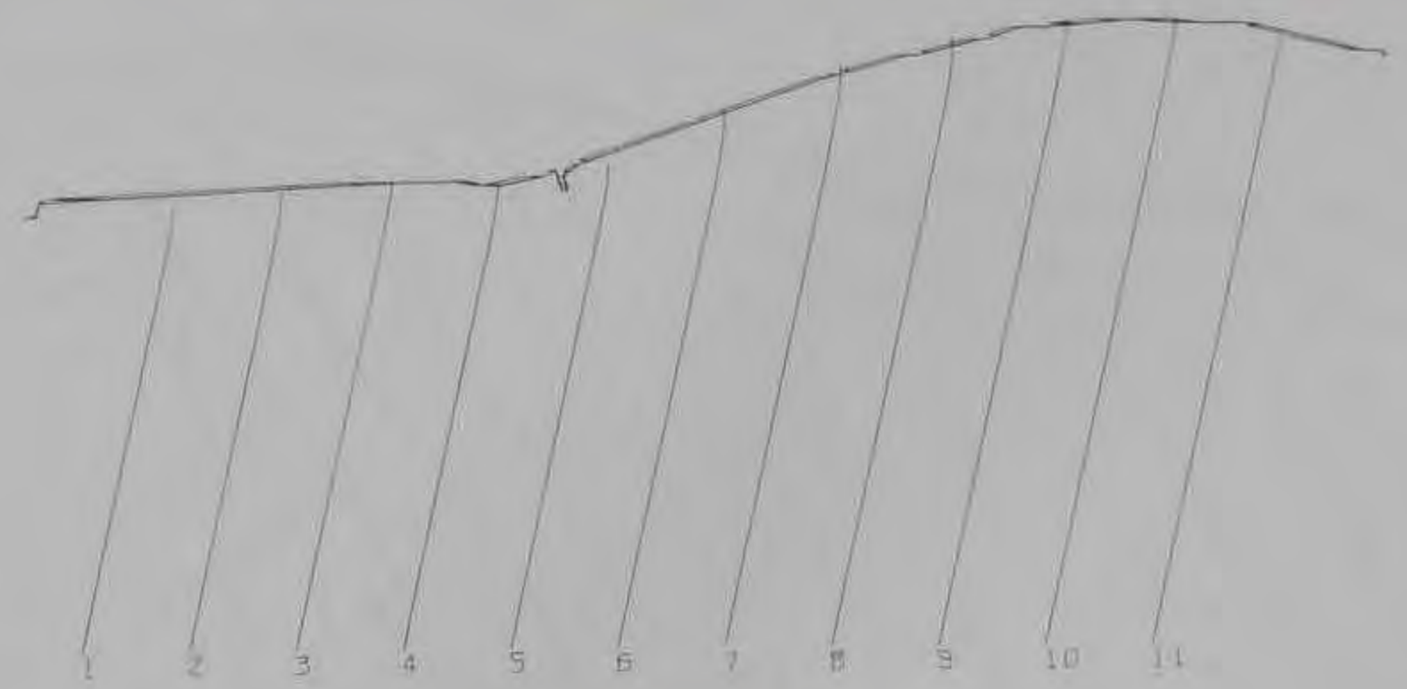
8-SEC WAVE PERIOD

WAVE REFRACTION
CHAGRIN RIVER

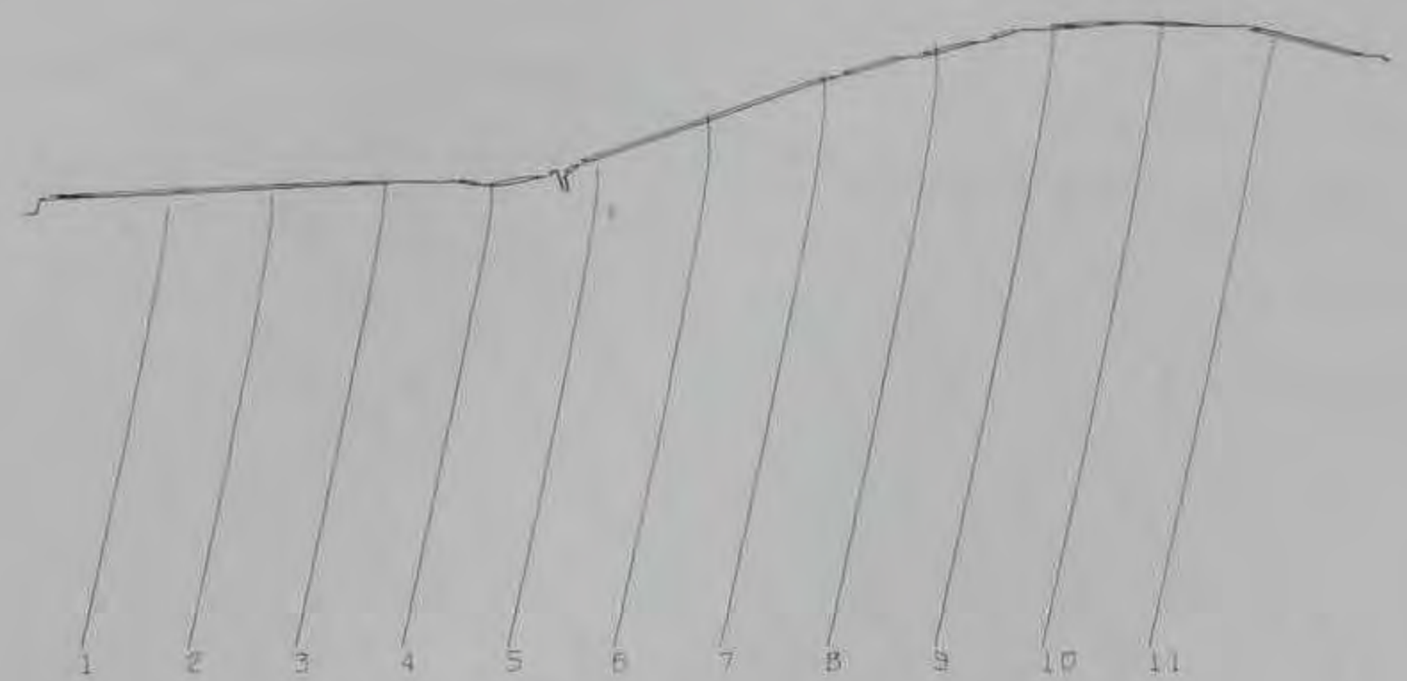
DEEPWATER AZIMUTH = 0.0 DEG

SCALE IN FEET

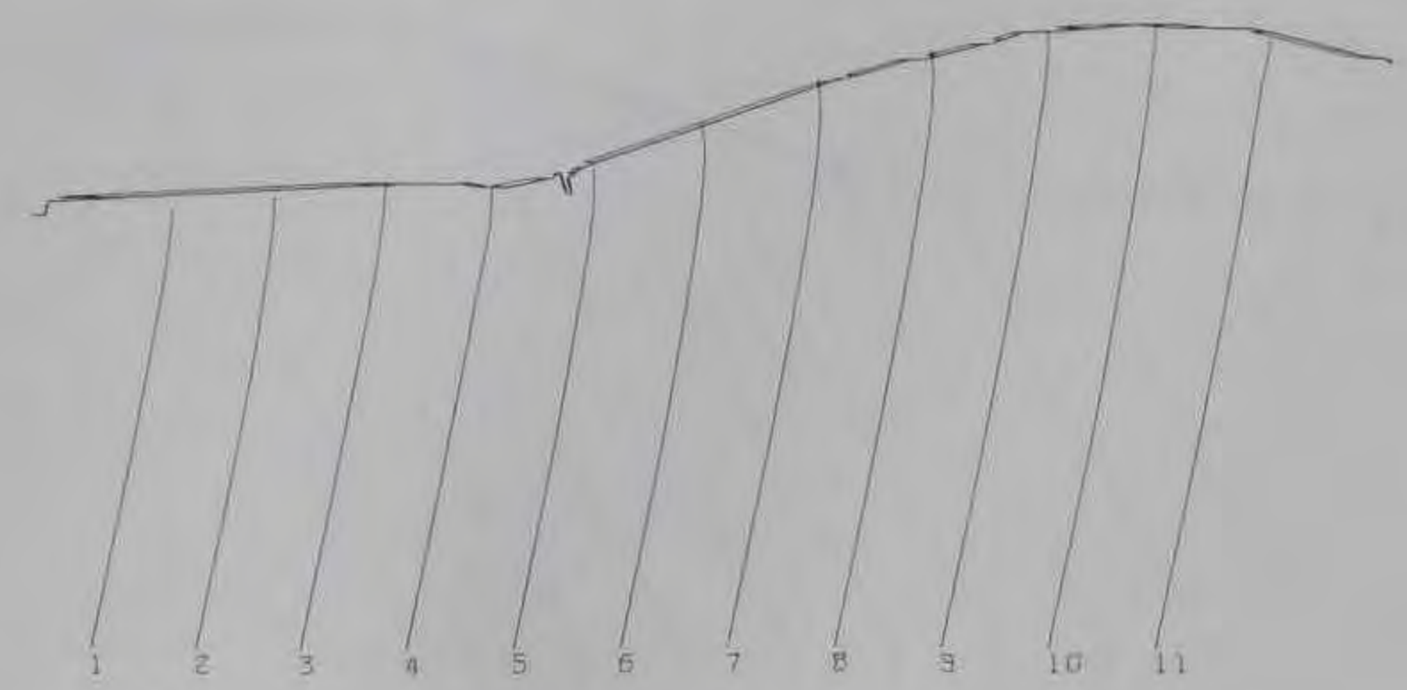
5000 0 5000 10,000 15,000 20,000



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

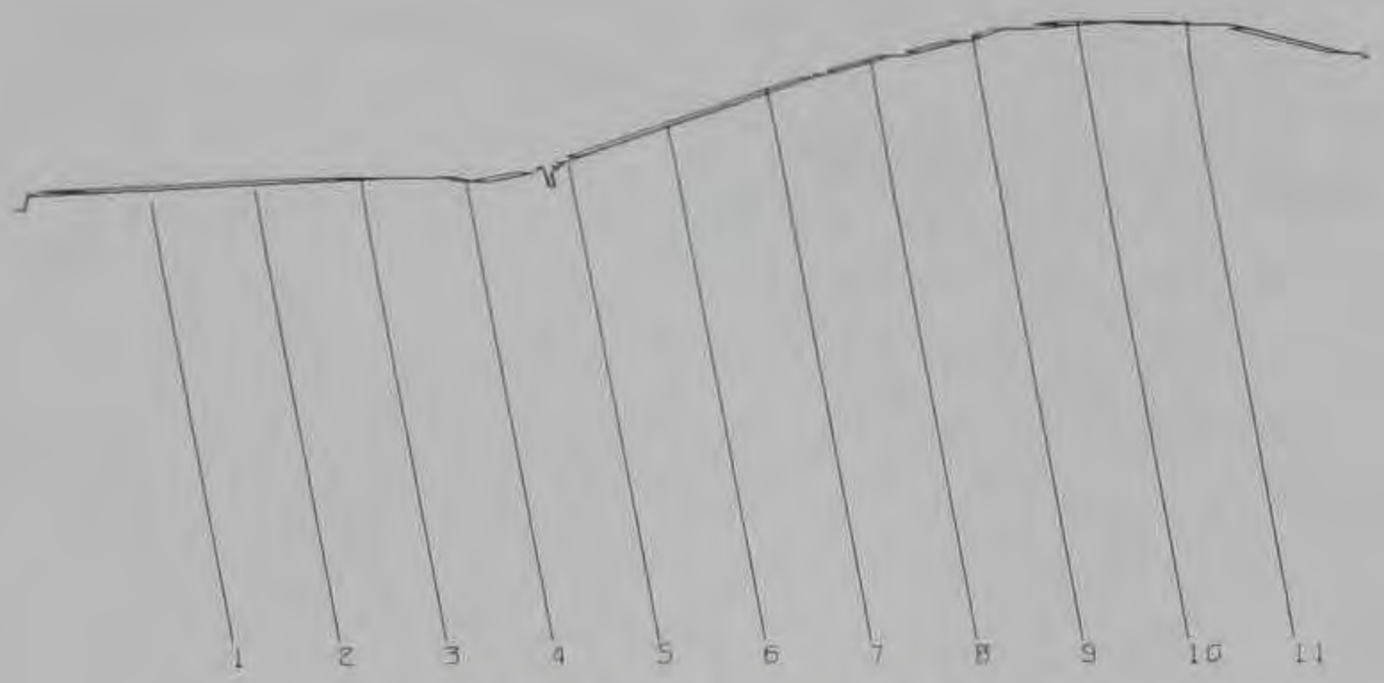
WAVE REFRACTION
CHAGRIN RIVER

DEEPWATER AZIMUTH = 337.5 DEG

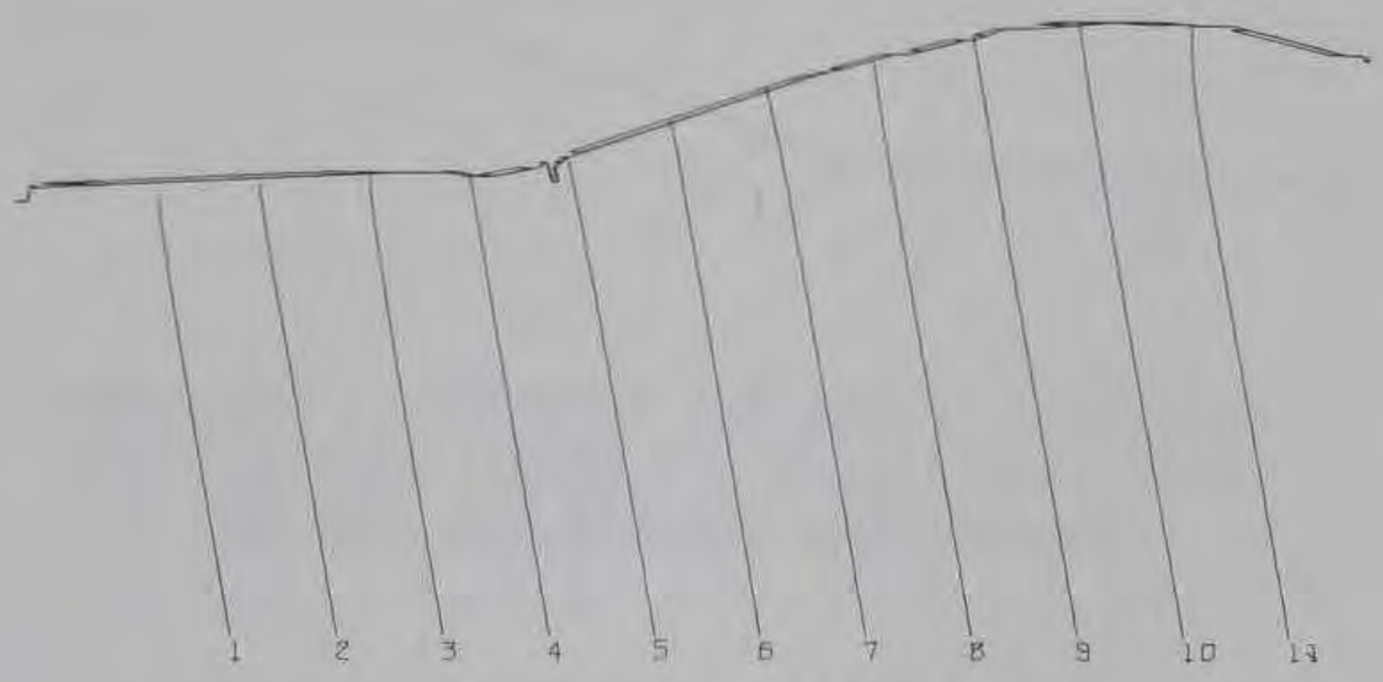
SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

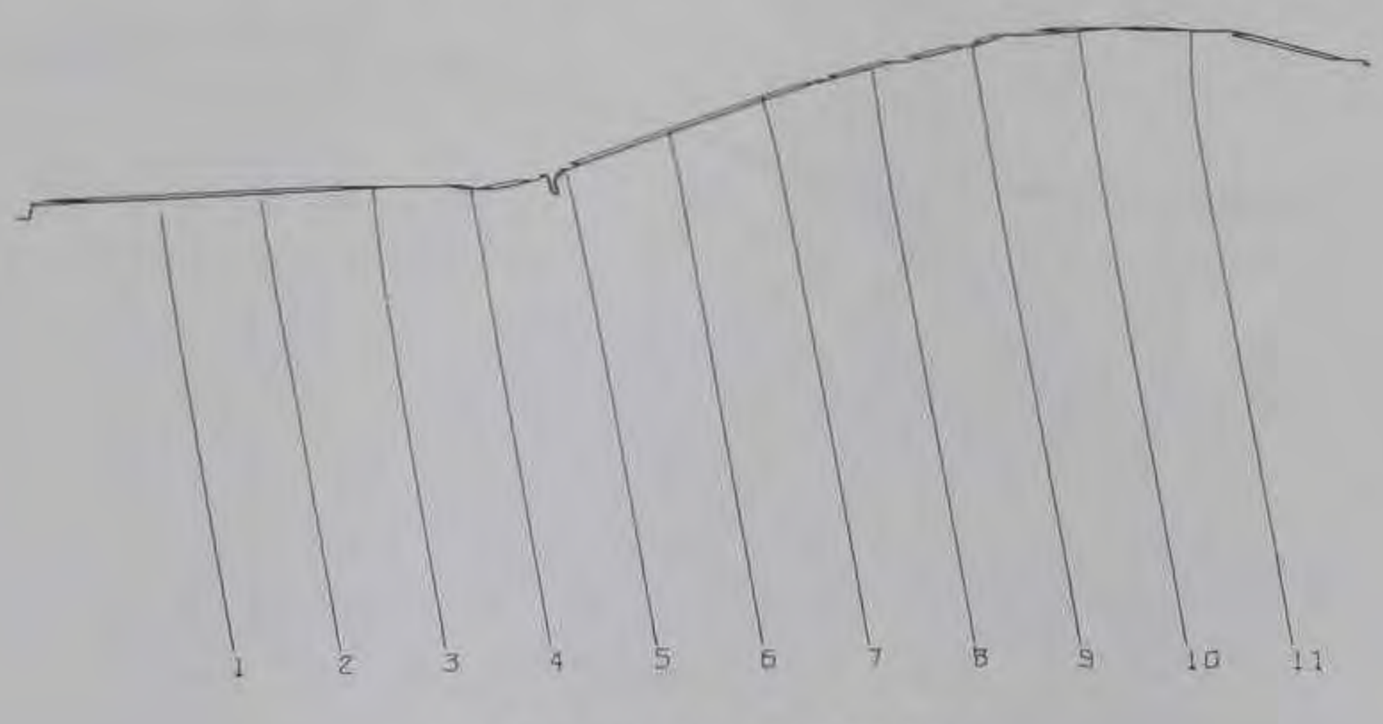
PLATE 18



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



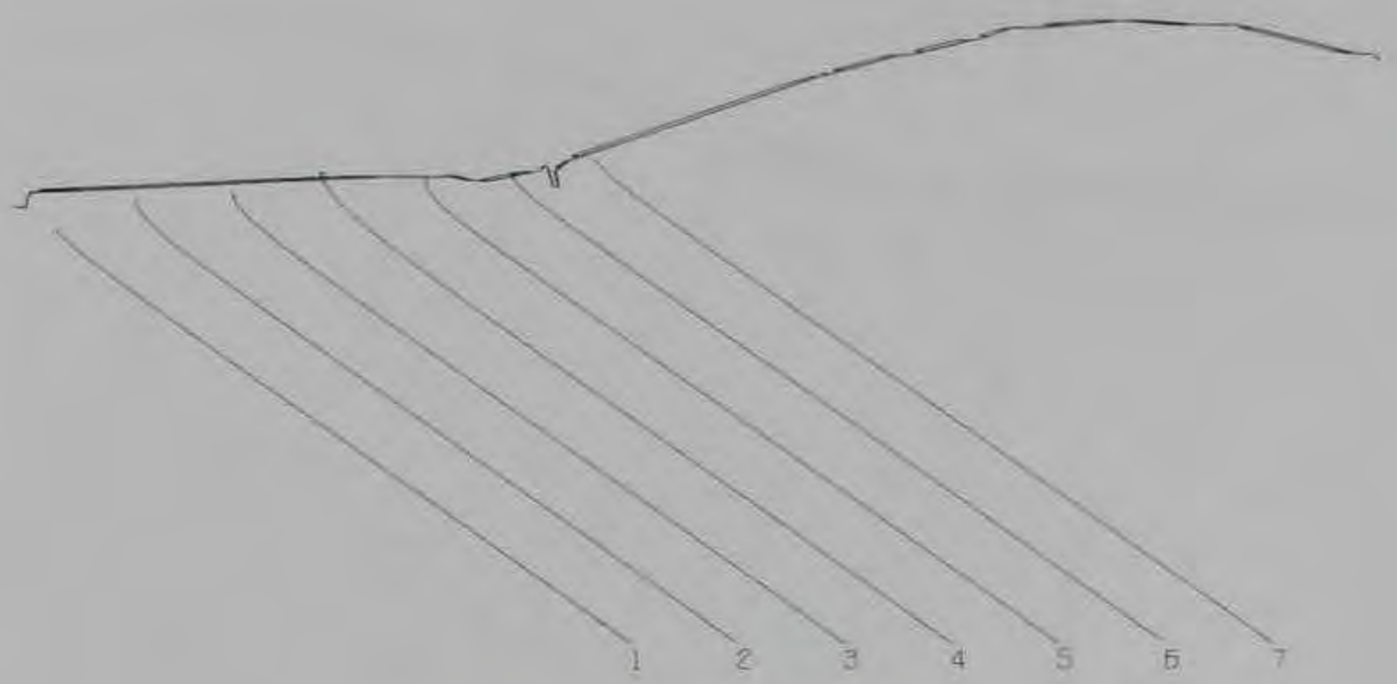
8-SEC WAVE PERIOD

WAVE REFRACTION
CHAGRIN RIVER

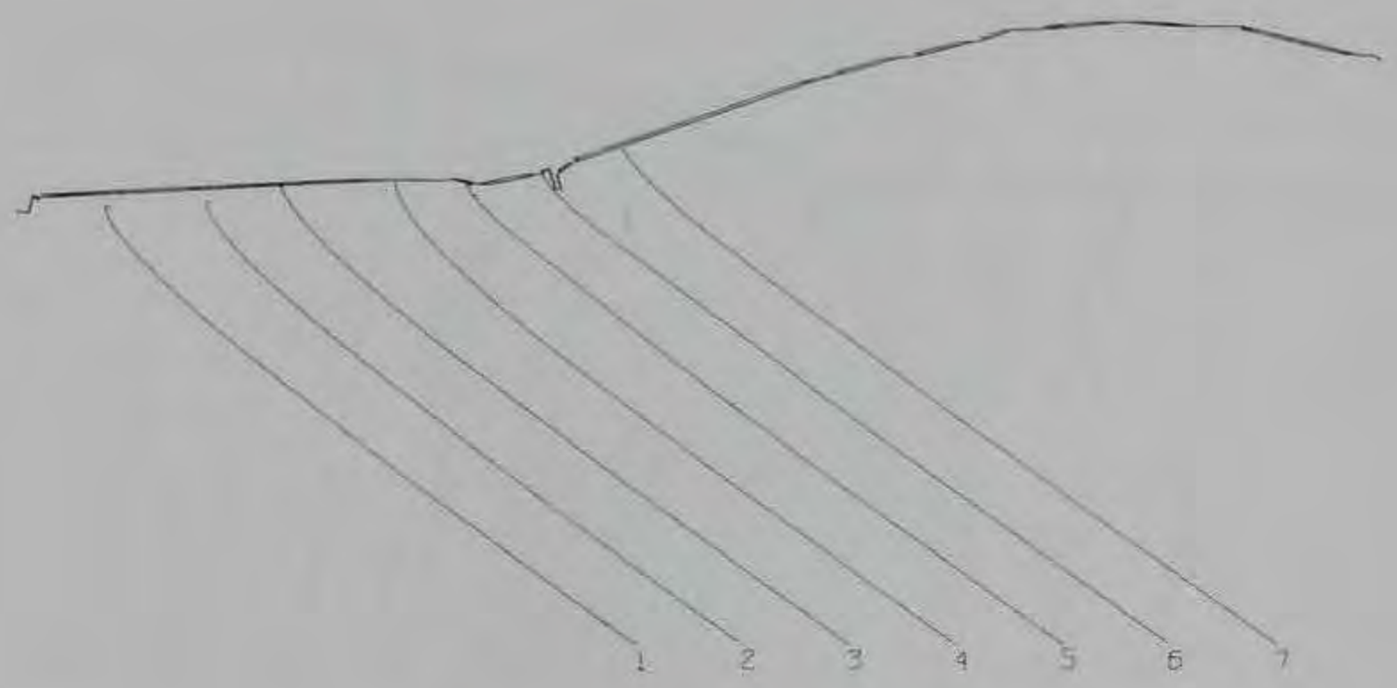
DEEPWATER AZIMUTH = 315.0 DEG

SCALE IN FEET

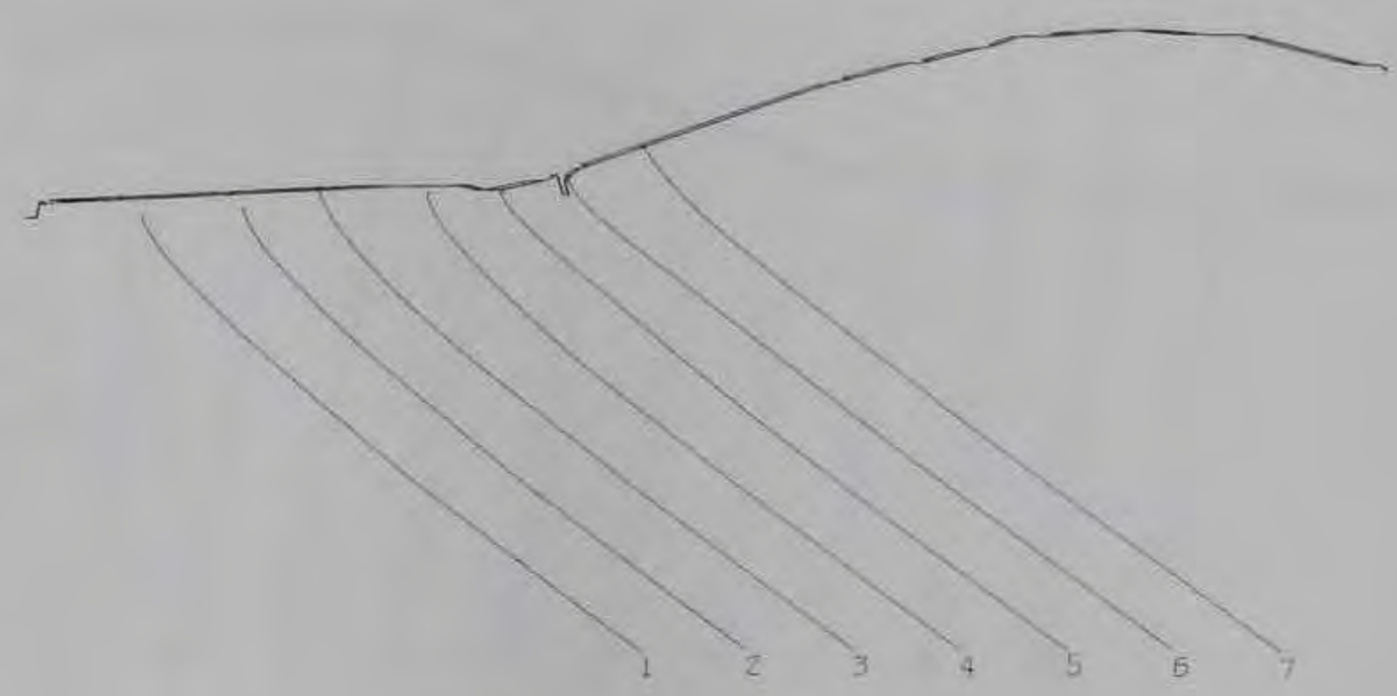
5000 0 5000 10,000 15,000 20,000



4-SEC WAVE PERIOD



6-SEC WAVE PERIOD



8-SEC WAVE PERIOD

WAVE REFRACTION
CHAGRIN RIVER

DEEPWATER AZIMUTH = 270.0 DEG

SCALE IN FEET

5000 0 5000 10,000 15,000 20,000

PLATE 20

APPENDIX A: MONTHLY AND ANNUAL DIRECTION DISTRIBUTION TABLES FOR SIGNIFICANT WAVE HEIGHTS AND SIGNIFICANT PERIODS

Table A1

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.5	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6
4	0.0	0.3	1.1	0.9	0.5	0.2	0.0	0.0	0.0	0.0	0.0	3.0
5	0.0	0.1	0.3	1.2	0.9	0.5	0.1	0.0	0.0	0.0	0.0	3.1
6	0.0	0.0	0.1	0.2	0.5	0.3	0.1	0.1	0.0	0.0	0.0	1.3
7	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.1	2.4	2.8	2.1	1.1	0.2	0.1	0.0	0.0	0.0	10.0

Table A2

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.0	0.3	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.1	0.7	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	2.3
5	0.0	0.0	0.2	0.9	0.8	0.6	0.2	0.1	0.0	0.0	0.0	2.8
6	0.0	0.0	0.1	0.2	0.4	0.4	0.2	0.1	0.0	0.0	0.0	1.4
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.5	1.6	2.0	1.9	1.3	0.5	0.3	0.0	0.0	0.0	8.1

Table A3

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7
4	0.0	0.1	0.5	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.9
5	0.0	0.0	0.1	0.7	0.7	0.5	0.2	0.0	0.0	0.0	0.0	2.2
6	0.0	0.0	0.1	0.1	0.4	0.3	0.2	0.1	0.0	0.0	0.0	1.2
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	1.0	1.6	1.7	1.1	0.5	0.1	0.0	0.0	0.0	6.4

Table A4

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.4	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	1.5
5	0.0	0.0	0.1	0.6	0.6	0.4	0.2	0.0	0.0	0.0	0.0	1.9
6	0.0	0.0	0.0	0.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.9
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.3	0.8	1.4	1.3	0.8	0.5	0.1	0.0	0.0	0.0	5.2

Table A5

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
4	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.4	0.4	0.3	0.1	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.3	0.6	0.9	0.8	0.6	0.2	0.1	0.0	0.0	0.0	3.5

Table A6

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
4	0.0	0.0	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.9
5	0.0	0.0	0.1	0.3	0.3	0.3	0.2	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.6	0.6	0.6	0.6	0.5	0.1	0.0	0.0	0.0	3.1

Table A7

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
4	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.6
5	0.0	0.0	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.1	1.1
6	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.7
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.2	0.4	0.5	0.6	0.5	0.1	0.0	0.0	0.2	2.6

Table A8

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for January

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5
5	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.8
6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.2	0.4	0.4	0.4	0.2	0.1	0.0	0.0	0.2	1.9

Table A9

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.5	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
4	0.0	0.3	0.9	0.8	0.4	0.1	0.0	0.0	0.0	0.0	0.0	2.5
5	0.0	0.1	0.3	1.0	0.7	0.3	0.1	0.0	0.0	0.0	0.0	2.5
6	0.0	0.0	0.1	0.2	0.4	0.2	0.1	0.1	0.0	0.0	0.0	1.1
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.1	2.0	2.4	1.6	0.7	0.2	0.1	0.0	0.0	0.0	8.3

Table A10

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.0	0.3	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.7	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	2.4
5	0.0	0.0	0.2	0.8	0.8	0.5	0.2	0.0	0.0	0.0	0.0	2.5
6	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	0.0	1.3
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.6	1.6	1.9	1.8	1.1	0.6	0.1	0.0	0.0	0.0	7.7

Table A11

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.0	0.3	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.6	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	2.0
5	0.0	0.0	0.2	0.7	0.7	0.4	0.2	0.0	0.0	0.0	0.0	2.2
6	0.0	0.0	0.1	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	1.1
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.5	1.4	1.6	1.5	1.0	0.6	0.1	0.0	0.0	0.0	6.7

Table A12

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
4	0.0	0.1	0.4	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.1	0.6	0.6	0.3	0.1	0.0	0.0	0.0	0.0	1.7
6	0.0	0.0	0.0	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.8
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.8	1.4	1.3	0.6	0.2	0.1	0.0	0.0	0.0	4.8

Table A13

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.3	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.0	0.1	0.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.0	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.8
7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.6	1.1	1.2	0.5	0.2	0.1	0.0	0.0	0.0	4.1

Table A14

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.3	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.5
5	0.0	0.0	0.1	0.5	0.6	0.5	0.2	0.1	0.0	0.0	0.0	2.0
6	0.0	0.0	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	1.0
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.6	1.3	1.3	1.1	0.6	0.2	0.0	0.0	0.0	5.5

Table A15

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
4	0.0	0.1	0.4	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.6
5	0.0	0.0	0.1	0.5	0.6	0.5	0.3	0.1	0.1	0.0	0.1	2.3
6	0.0	0.0	0.0	0.1	0.3	0.3	0.3	0.2	0.1	0.0	0.1	1.4
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.8	1.3	1.3	1.1	0.8	0.4	0.2	0.0	0.2	6.5

Table A16

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for March

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
4	0.0	0.1	0.3	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.3
5	0.0	0.0	0.1	0.4	0.5	0.5	0.2	0.1	0.1	0.0	0.1	2.0
6	0.0	0.0	0.0	0.1	0.3	0.3	0.2	0.1	0.1	0.0	0.1	1.2
7	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0,0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0,0	0.0
TOTAL	0.0	0.3	0.6	0.9	1.2	1.1	0.6	0,2	0.2	0.0	0.2	5.3

Table A17

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.5	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.4
4	0.0	0.3	0.9	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.3
5	0.0	0.1	0.3	0.9	0.6	0.2	0.1	0.0	0.0	0.0	0.0	2.2
6	0.0	0.0	0.1	0.2	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.9
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.1	2.0	2.1	1.4	0.4	0.2	0.1	0.0	0.0	0.0	7.5

Table A18

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
4	0.0	0.2	0.7	0.7	0.3	0.2	0.0	0.0	0.0	0.0	0.0	2.1
5	0.0	0.1	0.2	0.8	0.6	0.4	0.1	0.0	0.0	0.0	0.0	2.2
6	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.0	0.0	1.0
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.6	1.9	1.4	0.8	0.2	0.1	0.0	0.0	0.0	7.1

Table A19

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
4	0.0	0.2	0.6	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.8
5	0.0	0.1	0.2	0.7	0.6	0.2	0.1	0.0	0.0	0.0	0.0	1.9
6	0.0	0.0	0.1	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.9
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.8	1.4	1.6	1.4	0.5	0.2	0.1	0.0	0.0	0.0	6.2

Table A20

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for April

Significant Wave Period sec	Significant Wave Height Group, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.5	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.1	0.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.5	1.0	1.1	1.1	0.4	0.2	0.0	0.0	0.0	0.0	4.5

Table A21

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.6	0.9	0.8	0.4	0.2	0.0	0.0	0.0	0.0	3.3

Table A22

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.3	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.1	0.6	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1.9
5	0.0	0.0	0.2	0.7	0.7	0.4	0.2	0.0	0.1	0.0	0.0	2.3
6	0.0	0.0	0.1	0.1	0.3	0.2	0.2	0.1	0.1	0.0	0.0	1.1
7	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.5	1.4	1.6	1.6	0.8	0.5	0.1	0.2	0.0	0.0	6.9

Table A23

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.1	0.6	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1.9
5	0.0	0.0	0.2	0.7	0.7	0.4	0.2	0.1	0.0	0.0	0.0	2.3
6	0.0	0.0	0.1	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.1	1.2
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.5	1.3	1.6	1.6	1.0	0.5	0.3	0.0	0.0	0.1	7.1

Table A24

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for April

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
4	0.0	0.1	0.3	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.0	0.1	0.4	0.5	0.4	0.2	0.0	0.0	0.0	0.0	1.6
6	0.0	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.0	0.0	0.0	0.9
7	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.4	0.6	0.9	1.1	1.0	0.5	0.1	0.0	0.0	0.0	4.8

Table A25

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.7	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.4	0.8	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.0
5	0.0	0.1	0.3	0.7	0.3	0.1	0.1	0.0	0.0	0.0	0.0	1.6
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.5	2.0	1.6	0.7	0.2	0.2	0.0	0.0	0.0	0.0	6.4

Table A26

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.7
5	0.0	0.0	0.2	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.5
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.8	1.6	1.4	0.8	0.4	0.2	0.0	0.0	0.0	0.0	5.4

Table A27

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	0.0	0.2	0.6	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.7	1.4	1.3	0.7	0.4	0.2	0.0	0.0	0.0	0.0	4.9

Table A28

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.0	0.1	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	0.9	0.9	0.7	0.4	0.2	0.0	0.0	0.0	0.0	3.9

Table A29

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.1	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.7	1.0	1.1	0.7	0.4	0.2	0.0	0.0	0.0	0.0	4.3

Table A30

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.5	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
4	0.0	0.3	0.8	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	2.2
5	0.0	0.1	0.2	0.8	0.7	0.3	0.1	0.0	0.0	0.1	0.0	2.3
6	0.0	0.0	0.1	0.2	0.4	0.2	0.1	0.1	0.0	0.1	0.0	1.2
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	1.1	1.8	1.8	1.7	0.7	0.3	0.1	0.0	0.2	0.0	8.0

Table A31

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
4	0.0	0.2	0.7	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	2.0
5	0.0	0.0	0.2	0.8	0.7	0.4	0.1	0.0	0.0	0.1	0.0	2.3
6	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.0	1.1
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	0.7	1.7	1.8	1.6	0.8	0.3	0.1	0.0	0.2	0.0	7.5

Table A32

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for May

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
4	0.0	0.1	0.4	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.0	0.1	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.4	0.9	1.3	0.8	0.4	0.2	0.1	0.0	0.0	0.0	4.3

Table A33

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
3	0.2	0.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.3	0.9	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.7
5	0.0	0.1	0.3	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.6	1.3	2.0	1.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	5.6

Table A34

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.1	0.2	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	1.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	4.3

Table A35

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.1	0.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	1.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	4.0

Table A36

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.1	1.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	3.7

Table A37

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.6	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	0.1	0.2	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	1.3	0.6	0.2	0.0	0.0	0.0	0.0	0.0	4.6

Table A38

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.2	0.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
4	0.0	0.4	1.1	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.7
5	0.0	0.1	0.3	1.0	0.6	0.2	0.1	0.1	0.1	0.0	0.0	2.5
6	0.0	0.0	0.1	0.2	0.3	0.1	0.1	0.1	0.1	0.0	0.0	1.0
7	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.5	1.5	2.4	2.2	1.3	0.4	0.2	0.2	0.2	0.0	0.0	8.9

Table A39

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.1	0.6	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
4	0.0	0.3	0.7	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.0
5	0.0	0.1	0.2	0.7	0.6	0.2	0.1	0.0	0.1	0.0	0.0	2.0
6	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.0	0.1	0.0	0.0	1.0
7	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	1.3	1.6	1.6	1.3	0.6	0.3	0.0	0.2	0.0	0.0	7.2

Table A40

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for June

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.0	0.1	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.5	0.9	1.1	0.8	0.4	0.2	0.0	0.0	0.0	0.0	4.1

Table A41

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.2	0.7	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.4	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.4	1.6	1.6	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	4.9

Table A42

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.1	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.3

Table A43

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.5

Table A44

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.2	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.9
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.2	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	3.7

Table A45

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.6	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
4	0.0	0.3	0.8	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.7
5	0.0	0.1	0.2	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	1.3	1.7	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	5.1

Table A46

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
3	0.2	0.8	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
4	0.1	0.4	1.3	0.8	0.2	0.1	0.0	0.0	0.0	0.0	0.0	2.9
5	0.0	0.1	0.4	1.0	0.5	0.2	0.1	0.1	0.0	0.0	0.0	2.4
6	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.8
7	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.7	1.8	3.0	2.3	1.0	0.5	0.1	0.3	0.1	0.0	0.0	9.8

Table A47

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.2	0.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.3	0.9	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.0
5	0.0	0.1	0.3	0.7	0.5	0.1	0.0	0.0	0.0	0.0	0.0	1.7
6	0.0	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.4	1.3	2.0	1.7	1.0	0.2	0.0	0.0	0.0	0.0	0.0	6.6

Table A48

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for July

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.0	0.1	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.9
6	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	0.9	1.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	3.4

Table A49

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
3	0.2	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
4	0.1	0.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.7	1.6	1.4	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.7

Table A50

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
4	0.0	0.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
5	0.0	0.1	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.8	1.1	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.8

Table A51

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
5	0.0	0.1	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.1

Table A52

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.3	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	3.7

Table A53

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.1	0.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
4	0.0	0.3	0.8	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.7
5	0.0	0.1	0.3	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	1.4	1.9	1.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	5.3

Table A54

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
3	0.2	1.0	0.9	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.4
4	0.1	0.5	1.3	0.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0	3.2
5	0.0	0.1	0.4	1.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	2.1
6	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.7	2.1	2.9	2.6	1.2	0.3	0.0	0.1	0.0	0.0	0.0	9.9

Table A55

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.1	0.5	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
4	0.0	0.2	0.8	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1.8
5	0.0	0.1	0.2	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.3	1.0	1.8	1.7	0.6	0.3	0.0	0.0	0.0	0.0	0.0	5.7

Table A56

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for August

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
4	0.0	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.4	0.9	1.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	3.1

Table A57

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.7	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.3	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	0.1	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.5	1.9	0.9	0.4	0.2	0.0	0.0	0.0	0.0	0.0	5.1

Table A58

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.4	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	3.6

Table A59

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.1	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.1	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
6	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.0	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	3.2

Table A60

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.2	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.8	1.4	0.8	0.4	0.2	0.0	0.0	0.0	0.0	0.0	3.8

Table A61

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.5	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
4	0.0	0.3	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	0.1	0.2	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.1	1.6	1.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	4.6

Table A62

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.2	0.7	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
4	0.0	0.3	1.0	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	2.3
5	0.0	0.1	0.3	0.8	0.4	0.1	0.0	0.0	0.0	0.0	0.0	1.7
6	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.8
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.4	1.5	2.2	1.9	0.9	0.3	0.1	0.0	0.1	0.0	0.0	7.4

Table A63

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.3	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
4	0.0	0.2	0.6	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.1	0.2	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.8	1.4	1.1	0.5	0.3	0.1	0.0	0.0	0.0	0.0	4.4

Table A64

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for September

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7
5	0.0	0.0	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.7
6	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.4	0.6	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	2.4

Table A65

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.7	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
4	0.0	0.4	1.0	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	2.2
5	0.0	0.1	0.3	0.6	0.3	0.1	0.1	0.0	0.1	0.0	0.0	1.6
6	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.9
7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.6	2.1	1.5	0.7	0.3	0.2	0.1	0.2	0.0	0.0	6.9

Table A66

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.7	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.6
5	0.0	0.1	0.2	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.5	1.1	0.7	0.4	0.2	0.0	0.0	0.0	0.0	5.0

Table A67

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.1	0.2	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	1.1	1.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0	3.7

Table A68

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.1	0.1	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.9
6	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.7	0.9	1.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	3.5

Table A69

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.0	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.1
5	0.0	0.0	0.1	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.0	0.9	1.1	0.7	0.3	0.0	0.0	0.0	0.0	0.0	3.2

Table A70

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.1	0.2	0.4	0.4	0.2	0.1	0.0	0.1	0.0	0.0	1.5
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.8
7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	1.1	1.0	0.9	0.4	0.2	0.1	0.2	0.0	0.0	4.7

Table A71

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
4	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.3	0.3	0.3	0.1	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.6	0.7	0.6	0.6	0.2	0.0	0.0	0.0	0.0	3.1

Table A72

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for October

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
4	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5
5	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.6
6	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.4	0.5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1.6

Table A73

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
3	0.1	0.7	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8
4	0.0	0.3	1.1	0.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.7
5	0.0	0.1	0.4	1.1	0.7	0.3	0.1	0.0	0.0	0.0	0.0	2.7
6	0.0	0.0	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.0	0.0	1.0
7	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.5
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.4	2.5	2.7	1.5	0.7	0.3	0.1	0.0	0.0	0.0	9.4

Table A74

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.0	0.4	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
4	0.0	0.2	0.7	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.9
5	0.0	0.1	0.2	0.8	0.6	0.3	0.1	0.0	0.0	0.0	0.0	2.1
6	0.0	0.0	0.1	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.9
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.9	1.6	1.7	1.4	0.7	0.2	0.1	0.0	0.0	0.0	6.6

Table A75

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
4	0.0	0.1	0.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.2	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.5
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.5	1.1	1.3	0.9	0.4	0.3	0.1	0.0	0.0	0.0	4.6

Table A76

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
4	0.0	0.1	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.2
5	0.0	0.0	0.1	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	0.8	1.1	0.9	0.4	0.2	0.0	0.0	0.0	0.0	3.8

Table A77

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
4	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.1
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.3	0.6	0.9	0.7	0.4	0.2	0.0	0.0	0.0	0.0	3.1

Table A78

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
4	0.0	0.0	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.7
5	0.0	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.6	0.5	0.5	0.4	0.2	0.0	0.0	0.0	0.0	2.3

Table A79

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
4	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5
5	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.7
6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.2	0.4	0.4	0.4	0.2	0.0	0.0	0.0	0.0	1.7

Table A80

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for November

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
5	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
6	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.2	0.3	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1.1

Table A81

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.0	0.5	0.8	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6
4	0.0	0.3	1.2	1.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	3.2
5	0.0	0.1	0.4	1.2	0.9	0.4	0.1	0.0	0.0	0.0	0.0	3.1
6	0.0	0.0	0.1	0.2	0.4	0.2	0.1	0.1	0.0	0.0	0.0	1.1
7	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	1.2	2.7	2.9	2.0	0.9	0.2	0.1	0.0	0.0	0.0	10.0

Table A82

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.0	0.3	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4	0.0	0.2	0.7	0.7	0.4	0.2	0.1	0.0	0.0	0.0	0.0	2.3
5	0.0	0.0	0.2	0.8	0.7	0.4	0.2	0.0	0.0	0.0	0.0	2.3
6	0.0	0.0	0.1	0.1	0.4	0.3	0.2	0.1	0.0	0.0	0.0	1.2
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.6	1.6	1.8	1.7	1.0	0.6	0.1	0.0	0.0	0.0	7.4

Table A83

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
4	0.0	0.1	0.5	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0	1.7
5	0.0	0.0	0.2	0.7	0.6	0.3	0.2	0.0	0.0	0.0	0.0	2.0
6	0.0	0.0	0.1	0.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0	1.0
7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.4	1.1	1.6	1.3	0.7	0.6	0.1	0.0	0.0	0.0	5.8

Table A84

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.4	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.0	0.1	0.5	0.5	0.3	0.1	0.0	0.0	0.0	0.0	1.5
6	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.3	0.8	1.1	1.1	0.7	0.2	0.1	0.0	0.0	0.0	4.3

Table A85

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
4	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.0
5	0.0	0.0	0.1	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.2
6	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.5
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.3	0.6	0.9	0.8	0.4	0.2	0.0	0.0	0.0	0.0	3.2

Table A86

Monthly Percentage Occurrence of Significant wave Period in Selected Significant Wave Height Groups from the North for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
4	0.0	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.8
5	0.0	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.2	0.4	0.5	0.6	0.4	0.2	0.1	0.0	0.0	0.0	2.4

Table A87

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
4	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5
5	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.7
6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.2	0.2	0.3	0.4	0.4	0.2	0.1	0.0	0.0	0.0	1.8

Table A88

Monthly Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast for December

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.4
5	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
6	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.2	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.2

Table A89

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Southwest

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3	0.1	0.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
4	0.0	0.3	0.9	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.2
5	0.0	0.1	0.3	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	1.9
6	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.7
7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	1.3	2.0	1.7	1.1	0.4	0.2	0.0	0.0	0.0	0.0	6.9

Table A90

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
4	0.0	0.2	0.7	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.7
5	0.0	0.1	0.2	0.6	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.6
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.6	1.4	0.9	0.5	0.2	0.0	0.0	0.0	0.0	5.7

Table A91

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the West-Northwest

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.5	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	0.0	0.2	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	1.4
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	1.1	1.3	0.8	0.4	0.2	0.0	0.0	0.0	0.0	4.6

Table A92

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northwest

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.1	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.3
5	0.0	0.0	0.2	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.5	1.1	1.1	0.7	0.4	0.2	0.0	0.0	0.0	0.0	4.2

Table A93

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northwest

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.2	0.5	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.3
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	1.1	1.1	0.7	0.4	0.2	0.0	0.0	0.0	0.0	4.3

Table A94

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
3	0.1	0.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
4	0.0	0.2	0.7	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.8
5	0.0	0.1	0.2	0.6	0.5	0.2	0.1	0.1	0.0	0.1	0.0	1.9
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.8
7	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.9	1.6	1.4	1.1	0.5	0.2	0.2	0.0	0.2	0.0	6.3

Table A95

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the North-Northeast

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.2	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	1.4
5	0.0	0.0	0.2	0.5	0.4	0.2	0.1	0.1	0.0	0.1	0.0	1.6
6	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.8
7	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.6	1.1	1.1	0.9	0.5	0.2	0.2	0.0	0.2	0.0	5.0

Table A96

Annual Percentage Occurrence of Significant Wave Period in Selected Significant Wave Height Groups from the Northeast

Significant Wave Period sec	Significant Wave Height Groups, ft											
	0	1	2	3	4	5	6	7	8	9	10+	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
4	0.0	0.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.9
5	0.0	0.0	0.1	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.0
6	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.4
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 PLUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.2	0.4	0.6	0.6	0.6	0.4	0.2	0.0	0.0	0.0	0.0	3.0

APPENDIX B: GLOSSARY*

Definition of Terms

Azimuth - Angle measured in a clockwise direction from north.

Bar - A submerged or emerged embankment of sand, gravel, or other unconsolidated material built on the sea floor in shallow water by waves and currents.

Breaking depth - The still-water depth at the point where a wave breaks.

Duration - In wave forecasting (or hindcasting), the length of time the wind blows in essentially the same direction over the fetch.

Fetch - In wave forecasting (or hindcasting), the horizontal distance in the direction of the wind over which the wind blows, as used in this report, and is synonymous with fetch length.

Littoral zone - In beach terminology, a zone extending seaward from the shoreline to just beyond the breaker zone.

Longshore current - The littoral current in the breaker zone moving essentially parallel to the shore, usually generated by waves breaking at an angle to the shoreline.

Longshore transport rate - Rate of transport of sedimentary material parallel to the shore in the littoral zone and is usually expressed in cubic yards per year.

Orthogonal - On a refraction diagram, a line drawn perpendicular to the wave crest.

Percolation - Infiltration of the wave motion into the semifluid mass of certain finely suspended sediments of the permeable lake bottom.

Ripples (bed forms) - Small bed forms with a wavelength less than 1 ft and heights less than 0.1 ft.

Shoaling coefficient - The ratio of the height of a wave in water of any depth to its height in deep water with the effect of refraction eliminated.

Significant wave height - Average height of the one-third highest waves of a given wave group.

Significant wave period - Average period of the one-third highest waves in a given wave group.

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* Definitions used in this Glossary refer to the context in which the words are used in this report and are not intended to be general definitions.

Surf zone - The area between the outermost breaker and the limit of wave uprush.

Wave celerity - Velocity of wave propagation.

Wave diffraction - The phenomena by which energy is transmitted laterally along a wave crest. When a portion of a train of waves is interrupted by a barrier, such as a breakwater, the effect of diffraction is manifested by propagation of waves into the sheltered region within the barrier's geometric shadow.

Wave energy - Total potential and kinetic energy of the wave, usually expressed as an average energy over a complete wavelength per unit surface area.

Wave group velocity - The velocity of a wave group. In deep water, it is equal to one-half the velocity of the individual waves within the group.

Wave height - The vertical distance between a crest and the preceding trough.

Wave hindcast - The calculation from historical wind data (usually synoptic weather charts) of wave characteristics that probably occurred at some past time and could be expected to occur in the future.

Wave reflection - Reflection of an impinging wave by a very steep beach, barrier, or other reflecting surface.

Wave refraction - The process by which the direction of a wave changes as it moves in shallow water at an angle to the bottom contours.

Additional Sources of Information

The definitions used in this Glossary refer to the context in which the words are used in this report and are not intended to be general definitions.

The following references may be used for more detailed definitions or additional information about most terms:

"Shore Protection Manual," Volume III, U. S. Army Coastal Engineering Research Center, 1973.

Ippen, A. T., "Estuary and Coastline Hydrodynamics," McGraw-Hill, 1966.

Neumann, G. and Pierson, W. J. "Principles of Physical Oceanography," Prentice-Hall, 1966.

Hunt, L. M. and Groves, D. G., ed., "A Glossary of Ocean Science and Undersea Technology Terms," Compass Publications, Inc., 1965.

APPENDIX C: NOTATION

A_z	Azimuth
c	Wave celerity
C_g	Wave group velocity
C_o	Wave celerity in deep water
$D/D_n, D/D_s$	Nonlinear differential operators
E	Wave energy
$\overline{E}$	Energy density
g	Acceleration of gravity
h	Lake depth
h_b	Depth at breaking
$h(x,y)$	Depth function
H	Wave height
H_b	Wave height at breaking
H_o	Deepwater wave height
H_s	Significant wave height
H_{max}	Expected maximum wave height
H_l	Wave height near the shoreline
K_r	Refraction coefficient
K_s	Shoaling coefficient
ℓ	Distance between orthogonals as measured along the wave front
ℓ_o	Distance between wave orthogonals in deep water
L	Wavelength
m	Beach slope
n	Ratio of wave group velocity to wave celerity; also, arc distance along the wave front
N	Number of waves
$p(t)$	Variable
$\overline{P}$	Average wave energy flux
P_l	Average longshore wave energy flux
P_{lb}	Average longshore wave energy flux at breaking, calculated using the rms amplitude
P_{lf}	Average longshore wave energy flux at breaking, calculated using the significant wave height

q(t)	Variable
Q	Longshore transport rate
rms	Root mean square
s	Arc distance along the wave orthogonal
t	Time
U	Variable
v	Maximum longshore velocity
x	Horizontal distance
y	Horizontal distance (in direction perpendicular to x)
α	Angle between the x axis and the wave orthogonal
α_b	Angle between the breaking wave crest and the shoreline
α_s	Angle between the wave crest and the shoreline
β	Orthogonal separation coefficient, ℓ/ℓ_o
κ	Curvature of the wave orthogonal
ρ	Density
σ	Angular wave frequency
Δt	Constant time step

Subscripts

b	Values at breaking line
i	Value at time step i