Guidance for Flood Risk Analysis and Mapping

Coastal Notations, Acronyms, and Glossary of Terms

May 2016

FEMA

Requirements for the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) Program are specified separately by statute, regulation, or FEMA policy (primarily the Standards for Flood Risk Analysis and Mapping). This document provides guidance to support the requirements and recommends approaches for effective and efficient implementation. Alternate approaches that comply with all requirements are acceptable.

For more information, please visit the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage (www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping). Copies of the Standards for Flood Risk Analysis and Mapping policy, related guidance, technical references, and other information about the guidelines and standards development process are all available here. You can also search directly by document title at www.fema.gov/library.

Document History

Affected Section or Subsection	Date	Description
First Publication	May 2016	Initial version of new transformed guidance. The content was derived from the Guidelines and Specifications for Flood Hazard Mapping Partners, Procedure Memoranda, and/or Operating Guidance documents. It has been reorganized and is being published separately from the standards.

Table of Contents

1.0 Notation

Symbol	Description	Units	Typical Units, English	Typical Units, SI
A	Equilibrium beach profile coefficient	$L^{⅓}$	$ft^{⅓}$	$m^{⅓}$
B	Berm height	L	ft	m
C	Wave phase velocity or celerity	L/T	ft/s	m/s
C_G	Wave group velocity	L/T	ft/s	m/s
C_k	Sample kurtosis	--	--	--
C_p	Plant drag coefficient	--	--	--
C_s	Sample skewness	--	--	--
C_0	Deepwater wave celerity, $gT / 2\pi$	L/T	ft/s	m/s
D	Quarrystone diameter	L	ft	m
	Dune height	L	ft	m
D_{50}	Size of 50th percentile of sediment	L	mm	mm
d_h	Depth over berm	L	ft	m
d_s	Local still water depth	L	ft	m
E	Wave energy	LF/L	ft-lb/ft	N-m/m
	Crest elevation of structure	L	ft	m
E_B	Computed erosion estimate	L^2	ft^2	m^2
$E_{HotSpot}$	Extra profile lowering at a hot spot	L	ft	m
E_j	Beach-dune juncture elevation	L	ft	m
E_{jMLWP}	Beach-dune juncture elevation for the MLWP	L	ft	m
E_{jStorm}	Beach dune juncture elevation during a storm	L	ft	m
E_T	Total still water elevation	L	ft	m

Symbol	Description	Units	Typical Units, English	Typical Units, SI
E_{WH}	Estimated eroded area for the recurrence interval of the wave height	L^2	ft^2	m^2
E_{WL}	Estimated eroded area for the recurrence interval of the water level	L^2	ft^2	m^2
e	Base of natural logarithms (=2.718)	--	--	--
F	Cumulative probability function	--	--	--
F_c	Freeboard	L	ft	m
F'	Dimensionless freeboard	--	--	--
F_n	Discrete spectral wave frequency	1/T	hz	hz
F_R	Wind wave runup coefficient	--	--	--
f	Wave frequency	1/T	hz	hz
	Darcy-Weisbach resistance coefficient	--	--	--
	Probability density function	--	--	--
f_e	Coriolis coefficient	1/T	1/S	1/S
f_p	Spectral peak frequency, $1/T_p$	1/T	hz	hz
g	Gravitational acceleration	L/T^2	ft/s^2	m/s^2
H	Wave height	L	ft	m
$\overline{H}$	Mean, average over all waves			
H'_o	Unrefracted deep water wave height	L	ft	m
H_b	Breaking wave height	L	ft	m
H_c	Controlling wave height	L	ft	m
H_{m0}	Spectral significant wave height	L	ft	m
H_o	Deep water wave height	L	ft	m

Symbol	Description	Units	Typical Units, English	Typical Units, SI
H_s	Significant wave height	L	Ft	m
H_x	Wave height at *x* location in surf zone	L	ft	m
h_*	Wave structure parameter	--	--	--
h	Water depth	L	ft	m
h_b	Breaker depth	L	ft	m
h_c	Depth over crest	L	ft	m
h_m	Height of the land barrier	L	ft	m
h_o	Depth over crest	L	ft	m
K_s	Shoaling coefficient	--	--	--
k	Wave number, $2\pi / L$	rad/T	rad/ft	rad/m
	Bluff erosion parameter	--	--	--
L	Likelihood	--	--	--
LL	Log-likelihood	--	--	--
L_{berm}	Berm width	L	ft	m
L_{om}	Spectral deep water wave length	L	ft	m
L_0	Deep water wave length, $gT^2 / 2\pi$	L	ft	m
$M(n)$	Number of direction components in spectrum at f_n	--	--	--
m	Beach slope (rise/run)	L/L	--	--
P	Average porosity of rubble structure cover layer	--	--	--
	Precipitation rate	L/T	in./hr	mm/hr
	Probability	--	--	--

Symbol	Description	Units	Typical Units, English	Typical Units, SI
Q	Dimensionless overtopping	--	--	--
q	Mean overtopping rate per unit length	L^2/T	ft^2/s	m^2/s
R	Total wave runup	L	ft	m
R_a	Adjusted runup elevation	L	ft	m
R_{inc}	2-percent incident wave runup on natural beaches	L	ft	m
R_{Total}	Total runup (static setup plus dynamic setup plus incident wave runup.)	--	--	--
$R_{2\%}$	Runup exceeded by 2% of the runup crest	L	ft	m
R_∞	Maximum potential profile recession	L	ft	m
$R_{\infty HotSpot}$	Potential recession at a hot spot	L	ft	m
$R_{\infty storm}$	Potential recession for storm	L	ft	m
r	Linear correlation coefficient			
S	Water level change	L	ft	m
S_c	Compressive strength of bluff material	F/L^2	lb/ft^2	N/m^2
$S(f)$	Spectral density	L^2-T^2	ft^2/hz	m^2/hz
$S(f,\theta)$	Directional spectral density	L^2T/deg	$(ft^2/hz)/deg$	$(m^2/hz)/deg$
S_0 $(fn, \theta_{o,n,m})$	Discrete directional spectrum in deep water	L^2-T^2	ft^2/hz	m^2/hz
S_{ns} $(fn, \theta_{o,n,m})$	Discrete directional spectrum in nearshore	L^2-T^2	ft^2/hz	m^2/hz
s	Sample standard deviation	--	--	--
$S(f)$	Continuous spectrum	L^2T	ft^2/hz	m^2/hz
T	Wave period	T	s	s

Symbol	Description	Units	Typical Units, English	Typical Units, SI
$\bar{T}$	Mean, average over all waves	T	s	s
$T_{m-1.0}$	Spectral wave period	T	s	s
T_D	Storm duration	T	hr	hr
T_p	Spectral peak period, $1/f_p$	T	s	s
T_s	Significant wave period	T	S	S
	Time scale for beach profile response	--	--	--
t	Time	T	s	s
V_c	Velocity at crest	L/T	ft/s	m/s
V_f	Fall velocity	L/T	ft/s	m/s
V_{max}	Maximum overtopping volume per wave per unit length	L^2/wave	ft^2/wave	m^2/wave
v	Horizontal (y) component of local fluid velocity (water particle velocity)	L/T	ft/s	m/s
W	Wind speed	L/T	mi/hr	m/s
W_b	Surf zone width to breaker line	L	ft	m
W_c	Wind stress coefficient term	L/T	mph	kph
W_x	x component of wind speed	L/T	mi/hr	m/s
W_y	y component of wind speed	L/T	mi/hr	m/s
X	Accumulated bluff to erosion	L	ft	m
$\bar{x}$	Sample mean	--	--	--
x,y,z	Right-handed Cartesian coordinates	L	ft	m
γ	Runup reduction coefficients			
γ_r	Roughness reduction factor	--	--	--

Symbol	Description	Units	Typical Units, English	Typical Units, SI
γ_b	Berm section in breakwater			
γ_β	Wave direction factor			
γ_P	Porosity factor			
$y_{G,inner}$	Seaward extent of overtopping	L	ft	m
$y_{G,outer}$	Landward extent of overtopping	L	ft	m
y_0	Cross-shore location of structure crest	L	ft	m
z_c	Structure crest elevation	L	ft	m
z_G	Elevation behind crest	L	ft	m
$( )_b$	Term evaluated at the breaker line	--	--	--
$( )o$	Term evaluated in deep water	--	--	--
tan α	Structure slope	--	--	--
α	Storm duration recession reduction factor	--	--	--
	JONSWAP Spectrum term	L^2T	ft^2/hz	m^2/hz
α_c	Structure crest slope	--	--	--
β	Storm profile response coefficient	--	--	--
	Wave angle at structure	deg	deg	deg
γ	Specific gravity of a fluid	F/L^3	lb/ft^3	N/m^3
	Peak enhancement factor used in the JONSWAP spectrum	--	--	--
γ_b	Breaker depth index	--	--	--
	Runup berm coefficient	--	--	--
Δf	Frequency increment	1/T	hz	Hz

Symbol	Description	Units	Typical Units, English	Typical Units, SI
ΔR	Potential excess runup	L	ft	M
E	Energy dissipation rate	F/LT	lb/s-ft	n/m-s
$\hat{\eta}$	Dynamic or oscillating setup	L	ft	M
$\bar{\eta}$	Mean or static wave setup	L	ft	M
$\bar{\eta}_b$	Static setdown at the breaker point	L	ft	M
$\bar{\eta}_{max}$	Maximum static wave setup	L	ft	M
$\bar{\eta}_{min}$	Minimum static wave setup	L	ft	M
$\bar{\eta}_o$	Static setup at the shoreline	L	ft	m
$\eta(x,t)$	Displacement of water surface relative to SWL	L	ft	m
$\overline{\eta^2}$	Mean square of water surface fluctuations	L^2	ft^2	m^2
η_3	Coefficient of skewness	--	--	--
η_4	Coefficient of kurtosis	--	--	--
η_i	Water surface displacement by incident wave	L	ft	m
η_{rms}	rms value of free surface elevation	L	ft	m
$\bar{\theta}$	Overall mean wave direction	deg	deg	deg
Θ	Direction of wave propagation	deg	deg	deg
θ_{main}	Main wave direction in a directional spectrum	deg	deg	deg
θ_m	Discrete wave direction	deg	deg	deg

Symbol	Description	Units	Typical Units, English	Typical Units, SI
$\theta_m(f)$	Mean wave direction as a function of frequency.	deg	deg	deg
K	Breaker index	--	--	--
	Wind stress factor	--	--	--
M	Population Mean	--	--	--
N	Spectral narrowness parameter	--	--	--
ξ	Surf similarity parameter or Iribarren number	--	--	--
ξ_{om}	Spectral deep water ξ	--	--	--
ξ_0	Deep water ξ	--	--	--
Π	Constant = 3.14159	--	--	--
P	Mass density of water	M/L^3	$slug/ft^3$	kg/m^3
ρ_a	Mass density of air	M/L^3	$slug/ft^3$	kg/m^3
ρ_{fw}	Mass density of fresh water	M/L^3	$slug/ft^3$	kg/m^3
ρ_s	Mass density of sediment	M/L^3	$slug/ft^3$	kg/m^3
Ω	Rotational speed of the earth	rad/T	rad/S	rad/S
Φ	Latitude	deg	deg	deg
τ_x, τ_y	Wind stress	F/L^2	lb/ft2	N/m^2
σ	Population standard deviation	L	ft	m

2.0 Acronyms

FEMA has an extensive list of acronyms posted on their website at www.fema.gov/pdf/plan/prepare/faatlist07_09.pdf. The acronyms below are used in many of the coastal guidance documents and include some of the acronyms given in the FEMA list.

Acronym	Definition
1-D	One-Dimensional
2-D	Two-Dimensional
ACES	Automated Coastal Engineering System
ADCIRC	Advanced Circulation Model
BFE	Base Flood Elevation
BST	Bathystrophic Storm Tide
CDF	Cumulative Distribution Function
CDIP	Coastal Data Information Program
CEM	Coastal Engineering Manual
CERC	Coastal Engineering Research Center or Community Engagement & Risk Communication
CFR	Code of Federal Regulations
CHAMP	Coastal Hazard Analysis Modeling Program
CZM	Coastal Zone Management
CHL	Coastal and Hydraulics Laboratory
DHL	Delft Hydraulics Laboratory of the Netherlands
DIM	Direct Integration Method
ERDC	Engineer Research and Development Center
DWLX%	Dynamic Water Level X%
ENSO	El Niño, Southern Oscillation
EST	Empirical Simulation Technique
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FNMOC	Fleet Numerical Meteorology and Oceanography Center
G&S	FEMA Guidelines and Standards

Acronym	Definition
GEV	Generalized Extreme Value
GIS	Geographic Information Systems
GLERL	Great Lakes Environmental Research Laboratory
IF	Inland Fetch
IGLD85	International Great Lakes Datum of 1985
GROW	Global Reanalysis of Ocean Waves
JONSWAP	Joint North Sea Wave Project
JPM	Joint Probability Method
LiDAR	Light Detection and Ranging (System)
LiMWA	Limit of Moderate Wave Action
LWD	Low Water Datum
MIP	Mapping Information Platform
MAS	Mapping Activity Statement
MHHW	Mean Higher High Water
MHLW	Mean Higher Low Water
MHW	Mean High Water
MII	Meteorology International Inc.
MLHW	Mean Lower High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MLWP	Most Likely Winter Profile
MSL	Mean Sea Level
MTL	Mean Tide Level
MWD	Main Wave Direction
MWL	Mean Water Level
NAVD88	North American Vertical Datum of 1988
NDBC	National Data Buoy Center
NFIP	National Flood Insurance Program
NGDC	National Geophysical Data Center

Acronym	Definition
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey
NWS	National Weather Service
NWLON	National Water Level Observation Network
OF	Overwater Fetch
PDF	Probability Density Function
PFD	Primary Frontal Dune
POT	Peak-Over-threshold
RMS	Root Mean Square
RWL	Reference Water Level
SOEN	Southern Oscillation El Niño
SPM	Shore Protection Manual
SPR	Special Problem Report
STWL	Static Water Level
SWEL	Stillwater Elevation
SWL	Stillwater Level
TAW	Technical Advisory Committee for Water Retaining Structures
TSDN	Technical Support Data Notebook
TSWL	Total Still Water Level
TWEL	Total Water Elevation
TWG	Technical Working Group
TWL	Total Water Level
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WHAFIS	Wave Height Analysis for Flood Insurance Studies
WIS	Wave Information Studies

3.0 Glossary

Many of the coastal engineering terms in this glossary are from the Shore Protection Manual (SPM) (USACE, 1984) and Coastal Engineering Manual (CEM) (USACE, 2002). These two archives have the most comprehensive glossary of terms and should be used if the term is not included in this glossary. The SPM and CEM coastal engineering terms are supplemented with additional commonly used terms relevant to coastal hazard analysis and mapping. FEMA has various other glossaries posted on the FEMA website at www.fema.gov.

---------- A ----------

ACCRETION May be either natural or artificial. Natural accretion is the buildup of land, solely by the action of the forces of nature, on a beach by deposition of water- or airborne material. Artificial accretion is a similar buildup of land by reason of an act of man, such as the accretion formed by a GROIN, BREAKWATER, or beach fill deposited by mechanical means.

AEOLIAN See EOLIAN.

ALONGSHORE Parallel to and near the shoreline; LONGSHORE.

AMPLITUDE, WAVE (1) The magnitude of the displacement of a wave from a mean value. An ocean wave has an amplitude equal to the vertical distance from still-water level to wave crest. For a sinusoidal wave, the amplitude is one-half the wave height. (2) The semirange of a constituent tide.

APRON Layer of stone, concrete or other material to protect the toe of a structure.

ARMOR LAYER Protective layer on a BREAKWATER or SEAWALL composed of armor units.

ARMOR UNIT A relatively large quarrystone or concrete shape that is selected to fit specified geometric characteristics and density. It is usually of nearly uniform size and usually large enough to require individual placement. In normal cases it is used as primary wave protection and is placed in thicknesses of at least two units.

ASTRONOMICAL TIDE The tidal levels and character which would result from gravitational effects, e.g. of the Earth, Sun, and Moon, without any atmospheric influences.

ATTENUATION (1) A lessening of the amplitude of a wave with distance from the origin. (2) The decrease of water-particle motion with increasing depth. Particle motion resulting from surface oscillatory waves attenuates rapidly with depth, and practically disappears at a depth equal to a surface wavelength.

---------- B ----------

BACKSHORE That zone of the shore or beach lying behind the upper swash zone.

BASE FLOOD The flood that has a 1-percent chance of being equaled or exceeded in any given year.

BASE FLOOD ELEVATION Elevation of the base flood in relation to a specified datum, such as the NAVD. The base flood elevation is the basis of the insurance and floodplain management requirements of the NFIP.

BATHYMETRY The measurement of depths of water in oceans, seas, and lakes; also information derived from such measurements.

BEACH The zone of unconsolidated material that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves). The seaward limit of a beach—unless otherwise specified—is the mean low water line. A beach includes foreshore and backshore..

BEACH EROSION The carrying away of beach materials by wave action, tidal currents, littoral currents, or wind.

BEACH FILL Material placed on a beach to renourish eroding shores.

BEACH PROFILE A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or seawall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.

BEACH WIDTH The horizontal dimension of the beach measured normal to the shoreline and landward of the higher-high tide line (on oceanic coasts) or from the still water level (on lake coasts).

BENCHMARK A permanently fixed point of known elevation. A primary bench mark is one close to a tide station to which the tide staff and tidal datum originally are referenced.

BENCHMARK, TIDAL A bench mark whose elevation has been determined with respect to mean sea level at a nearby tide gage; the tidal bench mark is used as reference for that tide gage.

BERM (1) On a beach, a nearly horizontal plateau on the beach face or backshore, formed by the deposition of beach material by wave action or by means of a mechanical plant as part of a beach renourishment scheme. Some natural beaches have no berm, others have several. (2) On a structure: a nearly horizontal area, often built to support or key-in an armor layer.

BERM CREST The seaward limit of a BERM.

BLANKET (FOUNDATION or BEDDING) A layer or layers of graded fine stones underlying a BREAKWATER, GROIN or rock embankment to prevent the natural bed material from being washed away.

BLUFF A relatively steep vertical land barrier composed of consolidated material and sediments. The heights and capacities of coastal bluffs to withstand erosion can vary greatly. Coastal bluffs erode due to wave action and terrestrial processes including weathering.

BORE A very rapid rise of the tide in which the advancing water presents an abrupt front of considerable height. Bores can also form during wave runup on beach that exceeds dune or structure crest resulting in a wave overtopping bore.

BOUNDARY CONDITIONS Environmental conditions, e.g. waves, currents, drifts, etc. used as boundary input to physical or numerical models.

BREACHING Failure of the beach head or a dike allowing flooding by tidal action.

BREAKER A wave breaking on a shore, over a REEF, etc. Breakers may be classified into four types: Collapsing--breaking occurs over lower half of wave, with minimal air pocket and usually no splash-up. Bubbles and foam present. Plunging--crest curls over air pocket; breaking is usually with a crash. Smooth splash-up usually follows. Spilling--bubbles and turbulent water spill down front face of wave. The upper 25 percent of the front face may become vertical before breaking. Breaking generally occurs over quite a distance. Surging--wave peaks up, but bottom rushes forward from under wave, and wave slides up beach face with little or no bubble production. Water surface remains almost plane except where ripples may be produced on the beachface during runback.

BREAKER DEPTH The still-water depth at the point where a wave breaks. Also called DEPTH OF BREAKING.

BREAKER INDEX Ratio of breaking wave height to deepwater wave height.

BREAKER ZONE The zone within which waves approaching the coastline commence breaking, typically in water depths of between 5 and 10 meters.

BREAKING Reduction in wave energy and height in the surf zone due to limited water depth.

BREAKWATER A structure protecting a shore area, harbor, anchorage, or basin from waves.

BULKHEAD A structure or partition to retain or prevent sliding of the land. A secondary purpose is to protect the upland against damage from wave action.

BUOYANCY The resultant of upward forces, exerted by the water on a submerged or floating body, equal to the weight of the water displaced by this body.

BYPASSING, SAND Hydraulic or mechanical movement of sand from the accreting updrift side to the eroding downdrift side of an inlet or harbor entrance. The hydraulic movement may include natural movement as well as movement caused by man.

---------- C ----------

CAISSON Concrete box-type structure.

CELERITY Wave speed.

CENTRAL PRESURE DEFICIT The difference between the actual central pressure and the atmospheric pressure outside the radius of the storm where pressure is closer to normal. Most

influential factor in storm surge generation, controlling the intensity of the hurricane, i.e., wind velocity and stress over the ocean surface and inverse barometric effects.

CLOSURE DEPTH The water depth beyond which repetitive profile surveys (collected over several years) do not detect vertical sea bed changes, generally considered the seaward limit of littoral transport. The depth can be determined from repeated cross-shore profile surveys or estimated using formulas based on wave statistics. Note that this does not imply the lack of sediment motion beyond this depth.

CNOIDAL WAVE A type of wave in shallow water (i.e., where the depth of water is less than 1/8 to 1/10 the wavelength). The surface profile is expressed in terms of the Jacobian elliptic function cn u; hence the term cnoidal.

COASTAL CURRENTS (1) Those currents which flow roughly parallel to the shore and constitute a relatively uniform drift in the deeper water adjacent to the surf zone. These currents may be tidal currents, transient, wind-driven currents, or currents associated with the distribution of mass in local waters. (2) For navigational purposes, the term is used to designate a current in coastwise shipping lanes where the tidal current is frequently rotary.

COASTAL DEFENSE General term used to encompass both coast protection against erosion and sea defense against flooding.

COASTAL FORCING The natural processes which drive coastal hydro- and morphodynamics (e.g. winds, waves, tides, etc).

COASTAL PLAIN The plain composed of horizontal or gently sloping strata of clastic materials, generally representing a strip of sea bottom that has emerged from the sea in recent geologic time.

COASTAL PROCESSES Collective term covering the action of natural forces on the shoreline, and near shore seabed.

COASTAL ZONE The transition zone where the land meets water, the region that is directly influenced by marine and lacustrine hydrodynamic processes. Extends offshore to the continental shelf break and onshore to the first major change in topography above the reach of major storm waves. On barrier coasts, includes the bays and lagoons between the barrier and the mainland.

COASTLINE (1) Technically, the line that forms the boundary between the coast and the shore. (2) Commonly, the line that forms the boundary between the land and the water, esp. the water of a sea or ocean.

COHESIVE SEDIMENT Sediment containing significant proportion of clays, the electromagnetic properties of which cause the sediment to bind together.

CONSOLIDATION The gradual, slow compression of a cohesive soil due to weight acting on it, which occurs as water is driven out of the voids in the soil. Consolidation only occurs in clays or other soils of low permeability.

CONTINENTAL SHELF (1) The zone bordering a continent extending from the line of permanent immersion to the depth, usually about 100 m to 200 m, where there is a marked or rather steep descent toward the great depths of the ocean. (2) The area under active littoral processes during the Holocene period. (3) The region of the oceanic bottom that extends outward from the shoreline with an average slope of less than 1:100, to a line where the gradient begins to exceed 1:40 (the CONTINENTAL SLOPE).

CONTINENTAL SLOPE The downward slope from the offshore border of the CONTINENTAL SHELF to oceanic depths. It is characterized by a marked increase in slope.

CONTROLLING WAVE HEIGHT Approximately, the average height of the highest 1 percent of waves during storm conditions. For NFIP purposes, the controlling wave height is taken to be 1.6 times the SIGNIFICANT WAVE HEIGHT.

CONVERGENCE (1) In refraction phenomena, the decreasing of the distance between orthogonals in the direction of wave travel. Denotes an area of increasing wave height and energy concentration. (2) In wind-setup phenomena, the increase in setup observed over that which would occur in an equivalent rectangular basin of uniform depth, caused by changes in planform or depth; also the decrease in basin width or depth causing such increase in setup.

CORIOLIS EFFECT Force due to the Earth's rotation, capable of generating currents. It causes moving bodies to be deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The "force" is proportional to the speed and latitude of the moving object. It is zero at the equator and maximum at the poles.

CREST LENGTH, WAVE The length of a wave along its crest. Sometimes called crest width.

CREST OF WAVE (1) the highest part of a wave. (2) That part of the wave above still-water level.

CROSS-SHORE Perpendicular to the shoreline.

CURRENT (1) The flowing of water, or other liquid or gas. (2) That portion of a stream of water which is moving with a velocity much greater than the average or in which the progress of the water is principally concentrated. (3) Ocean currents can be classified in a number of different ways. Some important types include the following: (1) Periodic - due to the effect of the tides; such Currents may be rotating rather than having a simple back and forth motion. The currents accompanying tides are known as tidal currents; (2) Temporary - due to seasonal winds; (3) Permanent or ocean - constitute a part of the general ocean circulation. The term drift current is often applied to a slow broad movement of the oceanic water; (4) Nearshore - caused principally by waves breaking along a shore.

CURRENT, FEEDER Any of the parts of the nearshore current system that flow parallel to shore before converging and forming the neck of the RIP CURRENT.

CURRENT, FLOOD The tidal current toward shore or up a tidal stream. Usually associated with the increase in the height of the tide.

CURRENT, LITTORAL Any current in the littoral zone caused primarily by wave action; e.g., .

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

CURRENT, TIDAL The alternating horizontal movement of water associated with the rise and fall of the tide caused by the astronomical tide-producing forces.

CURRENT-REFRACTION Process by which wave velocity, height, and direction are affected by a current.

---------- D ----------

DATUM Any permanent line, plane or surface used as a reference datum to which elevations are referred.

DECAY AREA Area of relative calm through which waves travel after emerging from the generating area.

DECAY DISTANCE The distance waves travel after leaving the generating area (FETCH).

DECAY OF WAVES The change waves undergo after they leave a generating area (FETCH) and pass through a calm, or region of lighter winds. In the process of decay, the significant wave height decreases and the significant wavelength increases.

DEEP WATER Water so deep that surface waves are little affected by the ocean bottom. Generally, water deeper than one-half the surface wavelength is considered deep water. Compare SHALLOW WATER.

DEEP WATER WAVES A wave in water the depth of which is greater than one-half the WAVELENGTH.

DEGRADATION The geologic process by means of which various parts of the surface of the earth are worn away and their general level lowered, by the action of wind and water.

DEPTH The vertical distance from a specified datum to the sea floor.

DEPTH OF BREAKING The stillwater depth at the point where the wave breaks. Also BREAKER DEPTH.

DEPTH LIMITED WAVE The depth of water which causes waves to break. See DEPTH OF BREAKING or BREAKER DEPTH.

DIFFRACTION (of water waves) The phenomenon by which energy is transmitted laterally along a wave crest. When a part 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.

DIFFRACTION COEFFICIENT Ratio of diffracted wave height to deep water wave height.

DIURNAL INEQUALITY The difference in height of the two high waters or of the two low waters of each day. Also, the difference in velocity between the two daily flood or ebb currents of each day.

DIURNAL TIDE A tide with one high water and one low water in a tidal day.

DIVERGENCE (1) In refraction phenomena, the increasing of distance between orthogonals in the direction of wave travel. Denotes an area of decreasing wave height and energy concentration. (2) In wind-setup phenomena, the decrease in setup observed under that which would occur in an equivalent rectangular basin of uniform depth, caused by changes in planform or depth. Also the increase in basin width or depth causing such decrease in setup.

DOWNDRIFT The direction of predominant movement of littoral materials.

DUNES Ridges or mounds of loose, wind-blown material, usually sand.

DUNE HEEL The inland limit of the FRONTAL DUNE at point where there is a distinct change from a relatively steep slope to a relatively mild slope.

DUNE TOE Junction of the gentle slope seaward of the dune and the dune face.

DURATION In wave forecasting, the length of time the wind blows in nearly the same direction over the FETCH (generating area).

DYNAMIC WATER LEVEL The combination of SWL (TIDE and STORM SURGE) plus dynamic and static WAVE SETUP. Also known as the reference water level, which is determined before calculating WAVE RUNUP.

---------- E ----------

EBB Period when tide level is falling; often taken to mean the ebb current which occurs during this period.

EBB CURRENT The movement of a tidal current away from shore or down a tidal stream. In the semidiurnal type of reversing current, the terms greater ebb and lesser ebb are applied respectively to the ebb currents of greater and lesser velocity of each day. The terms of maximum ebb and minimum ebb are applied to the maximum and minimum velocities of a continuously running ebb current, the velocity alternately increasing and decreasing without coming to a slack or reversing. The expression maximum ebb is also applicable to any ebb current at the time of greatest velocity.

EBB TIDAL DELTA The bulge of sand formed at the seaward mouth of TIDAL INLETS as a result of interaction between tidal currents and waves. Also called inlet-associated bars and estuary entrance shoals.

EBB TIDE The period of tide between high water and the succeeding low water; a falling tide.

ELEVATION The vertical distance from a particular feature of interest to a fixed vertical datum, such as NAVD88, MSL, MHHW, etc..

EL NIÑO Warm equatorial water which flows southward along the coast of Peru and Ecuador during February and March of certain years. It is caused by poleward motions of air and unusual water temperature patterns in the Pacific Ocean, which cause coastal downwelling, leading to the reversal in the normal north-flowing cold coastal currents. During many El Niño years, storms, rainfall, and other meteorological phenomena in the Western Hemisphere are measurably different than during non-El Niño years.

EMERGENT COAST A coast in which land formerly under water has recently been exposed above sea level, either by uplift of the land or by a drop in sea level.

EMPRICAL SIMULTAION TECHNIQUE Empirical estimation of the cumulative distribution using nonparametric plotting position methods. Assumption is that future events will be statistically similar in magnitude and frequency to those particular storms that constitute the database.

ENERGY COEFFICIENT The ratio of the energy in a wave per unit crest length transmitted forward with the wave at a point in shallow water to the energy in a wave per unit crest length transmitted forward with the wave in deep water. On refraction diagrams this is equal to the ratio of the distance between a pair of orthogonals at a selected shallow-water point to the distance between the same pair of orthogonals in deep water. Also the square of the REFRACTION COEFFICIENT.

EOLIAN (also AEOLIAN) Pertaining to the wind, esp. used with deposits such as loess and dune sand, and sedimentary structures like wind-formed ripple marks.

EOLIAN SANDS Sediments of sand size or smaller which have been transported by winds. They may be recognized in marine deposits off desert coasts by the greater angularity of the grains compared with waterborne particles.

EROSION The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

ESTUARY (1) The part of a river that is affected by tides. (2) The region near a river mouth in which the fresh water of the river mixes with the salt water of the sea and which received both fluvial and littoral sediment influx.

EUSTATIC SEA LEVEL CHANGE Change in the relative volume of the world's ocean basins and the total amount of ocean water.

EVENT-BASED ANALYSIS A method to determine BFEs for the 1-percent-annual-chance flood in a study area with forcing comes from a single source such as a hurricane or synthetic storm event. Typically, the elevated water levels and wave conditions are coincident for an EVENT-BASED ANALYSIS.

EYE In meteorology, usually the "eye of the storm" (hurricane): the roughly circular area of comparatively light winds and fair weather found at the center of a severe tropical cyclone.

---------- F ----------

FETCH Distance over which wind acts on the water surface to generate waves. Sometimes used synonymously with FETCH LENGTH. Also GENERATING AREA.

FETCH LENGTH The horizontal distance (in the direction of the wind) over which a wind generates seas or creates a WIND SETUP.

FETCH-LIMITED Situation in which wave growth (or wave height) is limited by the size of the wave generation area (fetch).

FLOOD CHANNEL Channel located on ebb-tidal shoal that carries the flood tide over the tidal flat into the back bay or lagoon.

FLOOD CURRENT The movement of a tidal current toward the shore or up a tidal stream. In the semidiurnal type of reversing current, the terms greater flood and lesser flood are applied respectively to the flood currents of greater and lesser velocity each day. The terms maximum flood and minimum flood are applied to the maximum and minimum velocities of a flood current the velocity of which alternately increases and decreases without coming to slack or reversing. The expression maximum flood is also applicable to any flood current at the time of greatest velocity.

FLOOD ELEVATION Height of the water surface above an established elevation datum such as the NGVD29, NAVD88 or mean sea level.

FLOOD GATE A gravity outlet fitted with vertically-hinged doors, opening if the inner water level is higher than the outer water level, so that drainage takes place during low water.

FLOOD PLAIN (1) A flat tract of land bordering a river, mainly in its lower reaches, and consisting of alluvium deposited by the river. It is formed by the sweeping of the meander belts downstream, thus widening the valley, the sides of which may become some kilometers apart. In time of flood, when the river overflows its banks, sediment is deposited along the valley banks and plains. (2) Synonymous with 1%-annual-chance floodplain. The land area susceptible to being inundated by stream derived waters with a 1 percent chance of being equaled or exceeded in any given year.

FLOOD TIDAL DELTA The bulge of sand formed at the landward mouth of TIDAL INLETS as a result of flow expansion.

FLOODWALL A long, narrow concrete or masonry wall built to protect land from flooding.

FOREDUNE The front DUNE immediately behind the backshore.

FORERUNNER Low, long-period ocean SWELL which commonly precedes the main swell from a distant storm, especially a tropical cyclone.

FORESHORE The part of the shore, lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low-water mark, that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall.

FORWARD SPEED Rate of movement (propagation) of the hurricane eye in meters per second, knots, or miles per hour.

FREEBOARD Under the NFIP, a factor of safety, usually expressed in feet above flood level, that is applied for the purposes of floodplain management. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than those calculated for a selected flood, such as the base flood.

FRONTAL DUNE Ridge or mound of unconsolidated sandy soil extending continuously alongshore landward of the sand beach and defined by relatively steep slopes abutting markedly flatter and lower regions on each side.

FULLY-DEVELOPED SEA The waves that form when wind blows for a sufficient period of time across the open ocean. The waves of a fully developed sea have the maximum height possible for a given windspeed, FETCH and duration of wind.

---------- G ----------

GABION (1) Steel wire-mesh basket to hold stones or crushed rock to protect a bank or bottom from erosion. (2) Structures composed of masses of rocks, rubble or masonry held tightly together usually by wire mesh so as to form blocks or walls. Sometimes used on heavy erosion areas to retard wave action or as a foundation for BREAKWATERS or JETTIES.

GAGE (GAUGE) Instrument for measuring the water level relative to a datum.

GENERATING AREA In wave forecasting, the continuous area of water surface over which the wind blows in nearly a constant direction. Sometimes used synonymously with FETCH LENGTH. Also FETCH.

GEOGRAPHICAL INFORMATION SYSTEM (GIS) Database of information which is geographically referenced, usually with an associated visualization system.

GEOMETRIC SHADOW In wave diffraction theory, the area outlined by drawing straight lines paralleling the direction of wave approach through the extremities of a protective structure. It differs from the actual protected area to the extent that the diffraction and refraction effects modify the wave pattern.

GLACIER A large body of ice moving slowly down a slope of valley or spreading outward on a land surface (e.g., Greenland, Antarctica) and surviving from year to year.

GRADIENT (1) A measure of slope (soil- or water-surface) in meters of rise or fall per meter of horizontal distance. (2) More general, a change of a value per unit of distance, e.g. the gradient in longshore transport causes erosion or accretion. (3) With reference to winds or currents, the rate of increase or decrease in speed, usually in the vertical; or the curve that represents this rate.

GROIN (British, GROYNE) Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain littoral material. Most groins are of timber or rock and extend from a SEAWALL, or the backshore, well onto the foreshore and rarely even further offshore.

GROIN SYSTEM A series of groins acting together to protect a section of beach. Commonly called a GROIN field.

---------- H ----------

HARBOR OSCILLATION (HARBOR SURGING) The nontidal vertical water movement in a harbor or bay. Usually the vertical motions are low; but when oscillations are excited by a tsunami or storm surge, they may be quite large. Variable winds, air oscillations, or surf beat also may cause oscillations.

HARD DEFENSES General term applied to impermeable coastal defense structures of concrete, timber, steel, masonry, etc, which reflect a high proportion of incident wave energy.

HIGH TIDE, HIGH WATER (HW) The maximum elevation reached by each rising tide. See TIDE.

HIGH WATER (HW) Maximum height reached by a rising tide. The height may be solely due to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions.

HIGH WATER LINE In strictness, the intersection of the plane of mean high water with the shore. The shoreline delineated on the nautical charts of the National Ocean Service is an approximation of the high water line. For specific occurrences, the highest elevation on the shore reached during a storm or rising tide, including meteorological effects.

HIGH-WATER MARK A reference mark on a structure or natural object, indicating the maximum stage of tide or flood.

HIGHER HIGH WATER (HHW) The higher of the two high waters of any tidal day. The single high water occurring daily during periods when the tide is diurnal is considered to be a higher high water.

HIGHER LOW WATER (HLW) The higher of two low waters of any tidal day.

HIGH-VELOCITY WAVE ACTION Condition in which wave heights or wave runup depths are greater than or equal to 3 feet.

HINDCASTING In wave prediction, the retrospective forecasting of waves using measured wind information. In storm surge prediction, forecasting of storm surge using measured water levels.

HYDROGRAPHY (1) The description and study of seas, lakes, rivers and other waters. (2) The science of locating aids and dangers to navigation. (3) The description of physical properties of the waters of a region.

HYDROSTATIC PRESSURE The pressure exerted by water at any given point in a body of water at rest.

---------- I ----------

IMPERMEABLE GROIN A GROIN constructed such that sand cannot pass through the structure (but sand may still move over or around it).

INCIDENT WAVE Wave moving landward.

INFRAGRAVITY WAVE Long waves with periods of 30 seconds to several minutes.

INLET (1) A short, narrow waterway connecting a bay, lagoon, or similar body of water with a large parent body of water. (2) An arm of the sea (or other body of water) that is long compared to its width and may extend a considerable distance inland. See also TIDAL INLET.

INTERTIDAL The zone between the high and low water tides.

IRREGULAR WAVES Waves with random wave periods (and in practice, also heights), which are typical for natural wind-induced waves.

ISOBATH A contour line connecting points of equal water depths on a chart.

---------- J ----------

JETTY On open seacoasts, a structure extending into a body of water, which is designed to prevent shoaling of a channel by littoral materials and to direct and confine the stream or tidal flow. Jetties are built at the mouths of rivers or tidal inlets to help deepen and stabilize a channel.

JOINT PROBABILITY The probability of two (or more) things occurring together.

JOINT PROBABILITY DENSITY Function specifying the joint probability distribution of two (or more) variables.

JOINT RETURN PERIOD Average period of time between occurrences of a given joint probability event.

JONSWAP SPECTRUM Wave spectrum typical of growing deep water waves developed from field experiments and measurements of waves and wave spectra in the Joint North Sea Wave Project

---------- K ----------

KINEMATIC VISCOSITY The dynamic viscosity divided by the fluid density.

KINETIC ENERGY (of WAVES) In a progressive oscillatory wave, a summation of the energy of motion of the particles within the wave.

---------- L ----------

LAGGING OF TIDE The periodic retardation in the time of occurrence of high and low water due to changes in the relative positions of the moon and sun.

LITTORAL Of or pertaining to a shore, especially of the sea.

LITTORAL CELL A reach of the coast that is isolated sedimentologically from adjacent coastal reaches and that features its own sources and sinks. Isolation is typically caused by protruding headlands, submarine canyons, inlets, and some river mouths that prevent littoral sediment from one cell to pass into the next. Cells may range in size from a multi-hundred meter POCKET BEACH in a rocky coast to a BARRIER ISLAND many tens of kilometers long.

LITTORAL DRIFT, LITTORAL TRANSPORT The movement of beach material in the littoral zone by waves and currents. Includes movement parallel (long shore drift) and sometimes also perpendicular (cross-shore transport) to the shore.

LITTORAL TRANSPORT RATE Rate of transport of sedimentary material parallel or perpendicular to the shore in the littoral zone. Usually expressed in cubic meters (cubic yards) per year. Commonly synonymous with LONGSHORE TRANSPORT RATE.

LITTORAL ZONE In beach terminology, an indefinite zone extending seaward from the shoreline to just beyond the breaker zone.

LONG WAVES Waves with periods above about 30 seconds; can be generated by wave groups breaking in the surf zone. See also INFRAGRAVITY WAVES.

LONGSHORE Parallel to and near the shoreline; ALONGSHORE.

LONGSHORE BAR A sand ridge or ridges, running roughly parallel to the shoreline and extending along the shore outside the trough, that may be exposed at low tide or may occur below the water level in the offshore.

LONGSHORE DRIFT Movement of (beach) sediments approximately parallel to the coastline.

LONG-TERM EROSION The amount of beach and shoreline erosion that occurs over a period of time lasting days to decades, to tens of decades.

LOW TIDE (LOW WATER, LW) The minimum elevation reached by each falling tide. See TIDE.

LOW WATER (LW) The minimum height reached by each falling tide.

LOW WATER DATUM An approximation to the plane of mean low water that has been adopted as a standard reference plane. See also DATUM, PLANE and CHART DATUM.

LOWER HIGH WATER (LHW) The lower of the two high waters of any tidal day.

LOWER LOW WATER DATUM An approximation to the plane of MEAN LOWER LOW WATER that has been adopted as a standard reference plane for a limited area and is retained for an

indefinite period regardless of the fact that it may differ slightly from a better determination of MEAN LOWER LOW WATER from a subsequent series of observations.

LOWER LOW WATER (LLW) The lower of the two low waters of any tidal day. The single low water occurring daily during periods when the tide is diurnal is considered to be a lower low water.

LUNAR TIDE The portion of the tide that can be attributed directly to attraction to the moon.

---------- M ----------

MANAGED RETREAT The deliberate setting back (moving landward) of the existing line of sea defense in order to obtain engineering or environmental advantages - also referred to as managed landward realignment. Sometimes refers to moving roads and utilities landward in the face of shore retreat.

MARGINAL PROBABILITY The probability of a single variable in the context of a joint probability analysis.

MARGINAL RETURN PERIOD The return period of a single variable in the context of a joint probability analysis.

MASS TRANSPORT, SHOREWARD The movement of water due to wave motion, which carries water through the BREAKER ZONE in the direction of wave propagation. Part of the NEARSHORE CURRENTS.

MEAN DEPTH The average DEPTH of the water area between the still water level and the SHOREFACE profile from the waterline to any chosen distance seaward.

MEAN HIGH WATER SPRINGS (MHWS) The average height of the high water occurring at the time of spring tides.

MEAN HIGH WATER (MHW) The average height of the high waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semidiurnal or mixed. Only the higher high water heights are included in the average where the type of tide is diurnal. So determined, mean high water in the latter case is the same as mean higher high water.

MEAN HIGHER HIGH WATER (MHHW) The average height of the higher high waters over a 19-year period. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value.

MEAN LOW WATER (MLW) The average height of the low waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. All low water heights are included in the average where the type of tide is either semidiurnal or mixed. Only lower low water heights are included in the average where the type of tide is diurnal. So determined, mean low water in the latter case is the same as mean lower low water.

MEAN LOWER LOW WATER (MLLW) The average height of the lower low waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. Frequently abbreviated to LOWER LOW WATER.

MEAN RANGE OF TIDE The difference in height between MEAN HIGH WATER and MEAN LOW WATER.

MEAN SEA LEVEL The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings. Not necessarily equal to MEAN TIDE LEVEL.

MEAN TIDE LEVEL A plane midway between MEAN HIGH WATER and MEAN LOW WATER. Not necessarily equal to MEAN SEA LEVEL.

MEAN WATER LEVEL The mean water surface level as determined by averaging the heights of the water at equal intervals of time, usually at hourly intervals. The mean water level includes all components contributing to the stillwater level, including astronomical tides, storm surge, wave setup and freshwater input. See TOTAL STILLWATER LEVEL.

MEAN WAVE HEIGHT The mean of all individual waves in an observation interval of approximately half an hour. In case of a Rayleigh distribution 63 percent of the significant wave height.

MINIMUM FETCH The least distance in which steady-state wave conditions will develop for a wind of given speed blowing a given duration of time.

MIXED TIDE A type of tide in which the presence of a diurnal wave is conspicuous by a large inequality in either the high or low water heights, with two high waters and two low waters usually occurring each tidal day. In strictness, all tides are mixed, but the name is usually applied without definite limits to the tide intermediate to those predominantly semidiurnal and those predominantly diurnal.

MONOCHROMATIC WAVES A series of waves generated in a laboratory, each of which has the same length and period.

MORPHODYNAMICS (1) The mutual interaction and adjustment of the seafloor topography and fluid dynamics involving the motion of sediment. (2) The coupled suite of mutually interdependent hydrodynamic processes, seafloor morphologies, and sequences of change.

MORPHOLOGY River/estuary/lake/seabed form and its change with time.

---------- N ----------

NATIONAL TIDAL DATUM EPOCH (NTDE) A period of 19 years adopted by the National Ocean Service as the period over which observations of tides are to be taken and reduced to average values for tidal datums.

NEAP TIDE Tide of decreased range occurring semimonthly as the result of the moon being in quadrature.

NEAP RANGE The NEAP RANGE is the average semidiurnal range of the tide occurring at the time of neap tide and is most conveniently computed from the harmonic constants. The NEAP RANGE is typically 10 to 30 percent smaller than the mean range where the type of tide is either semidiurnal or mixed and is of no practical significance where the type of tide is DIURNAL TIDE.

NEARSHORE (1) In beach terminology an indefinite zone extending seaward from the SHORELINE well beyond the BREAKER ZONE. (2) The zone which extends from the swash zone to the position marking the start of the offshore zone, typically at water depths of the order of 20 m.

NEARSHORE CIRCULATION The ocean circulation pattern composed of the NEARSHORE CURRENTS and the COASTAL CURRENTS.

NEARSHORE CURRENTS The current system caused primarily by wave action in and near the breaker zone, and which consists of four parts: the shoreward mass transport of water; longshore currents; seaward return flow, including rip currents; and the longshore movement of the expanding heads of rip currents.

NOURISHMENT The process of replenishing a beach. It may occur naturally by longshore transport, or be brought about artificially by the deposition of dredged materials or of materials trucked in from upland sites.

NUMERICAL MODELING Refers to analysis of coastal processes using computational models.

---------- O ----------

OFFSHORE (1) In beach terminology, the comparatively flat zone of variable width, extending from the SHOREFACE to the edge of the CONTINENTAL SHELF. It is continually submerged. (2) The direction seaward from the shore. (3) The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the sea bed on wave action is small in comparison with the effect of wind. (4) The breaker zone directly seaward of the low tide line.

OFFSHORE CURRENT (1) Any current in the offshore zone. (2) Any current flowing away from shore.

OFFSHORE WIND A wind blowing seaward from the land in the coastal area.

ONSHORE A direction landward from the sea.

OPTIMAL SAMPLING Choosing storms for simulation in such a way as to accurately cover the entire storm parameter space through optimal parameter section associated with weighting and interpolation methods.

ORTHOGONAL On a wave-refraction diagram, a line drawn perpendicularly to the wave crests.

OSCILLATION (1) A periodic motion backward and forward. (2) Vibration or variance above and below a mean value.

OVERTOPPING Passing of water over the top of a structure as a result of wave runup or surge action.

OVERWASH (1) The part of the UPRUSH that runs over the crest of a BERM or structure and does not flow directly back to the ocean or lake. (2) The effect of waves overtopping a COASTAL DEFENSE, often carrying sediment landwards which is then lost to the beach system.

---------- P ----------

PEAK PERIOD The wave period determined by the inverse of the frequency at which the wave energy spectrum reaches its maximum.

PERIGEAN RANGE The average semidiurnal range occurring at the time of the PERIGEAN TIDES and most conveniently computed from the harmonic constants. It is larger than the mean range where the type of tide is either semidiurnal or mixed and is of no practical significance where the type of tide is diurnal.

PERIGEAN TIDAL CURRENTS Tidal currents of increased velocity occurring monthly as the result of the moon being in perigee (i.e., at the point in its orbit nearest the Earth).

PERIGEAN TIDES Tides of increased range occurring monthly as the result of the moon being in perigee.

PERMEABILITY The property of bulk material (sand, crushed rock, soft rock in situ) which permit movement of water through its pores.

PERMEABLE GROIN A GROIN with openings or voids large enough to permit passage of appreciable quantities of LITTORAL DRIFT through the structure.

PHASE In surface wave motion, a point in the period to which the wave motion has advanced with respect to a given initial reference point.

PHASE INEQUALITY Variations in the tides or tidal currents associated with changes in the phase of the Moon in relation to the Sun.

PHASE VELOCITY Propagation velocity of an individual wave as opposed to the velocity of a wave group.

PHYSICAL MODELING Refers to the investigation of coastal or riverine processes using a scaled model.

PIERSON-MOSKOWITZ SPECTRUM Wave spectrum typical of fully-developed deep water waves.

PILE A long, heavy timber or section of concrete or metal that is driven or jetted into the earth or seabed to serve as a support or protection.

PLANFORM The outline or shape of a body of water as determined by the still-water line.

POROSITY Percentage of the total volume of a soil not occupied by solid particles but by air and water.

POTENTIAL ENERGY OF WAVES In a progressive oscillatory wave, the energy resulting from the elevation or depression of the water surface from the undisturbed level.

PRIMARY FRONTAL DUNE Under the NFIP, a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

PROBABILITY The chance that a prescribed event will occur, represented by a number (p) in the range 0 - 1. It can be estimated empirically from the relative frequency (i.e. the number of times the particular event occurs, divided by the total count of all events in the class considered).

PROBABILITY DENSITY Function specifying the distribution of a variable.

PROFILE, BEACH The intersection of the ground surface with a vertical plane; may extend from the behind the DUNE line or the top of a bluff to well seaward of the breaker zone.

PROGRESSIVE WAVE A wave that moves relative to a fixed coordinate system in a fluid. The direction in which it moves is termed the direction of wave propagation.

PROPAGATION OF WAVES The transmission of waves through water.

---------- Q ----------

---------- R ----------

RADIUS OF MAXIMUM WINDS Distance from the eye of a hurricane, where surface and wind velocities are zero, to the place where surface wind speeds are maximum.

RANDOM WAVES The laboratory simulation of irregular sea states that occur in nature.

RAYLEIGH DISTRIBUTION A model probability distribution, commonly used in analysis of waves.

RECESSION (1) A continuing landward movement of the shoreline. (2) A net landward movement of the shoreline over a specified time.

REFERENCE STATION A place for which tidal constants have previously been determined and which is used as a standard for the comparison of simultaneous observations at a second station. Also, a station for which independent daily predictions are given in the tide or current tables from which corresponding predictions are obtained for other stations by means of differences or factors.

REFERENCE WATER LEVEL General terminology to refer to the water level that is appropriate for the particular application being discussed.

REFLECTED WAVE That part of an incident wave that is returned seaward when a wave impinges on a steep beach, barrier, or other reflecting surface.

REFLECTION The process by which the energy of the wave is returned seaward.

REFRACTION (of water waves) (1) The process by which the direction of a wave moving in shallow water at an angle to the contours is changed: the part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) The bending of wave crests by currents.

REFRACTION COEFFICIENT The square root of the ratio of the distance between adjacent orthogonals in deep water to their distance apart in shallow water at a selected point. When multiplied by the SHOALING FACTOR and a factor for friction and percolation, this becomes the WAVE HEIGHT COEFFICIENT or the ratio of the refracted wave height at any point to the deepwater wave height. Also, the square root of the ENERGY COEFFICIENT.

REFRACTION DIAGRAM A drawing showing positions of wave crests and/or orthogonals in a given area for a specific deepwater wave period and direction.

REGULAR WAVES Waves with a single height, period, and direction.

RESIDUAL SURGE see RESIDUAL (WATER LEVEL)

RESIDUAL (WATER LEVEL) The components of water level not attributable to astronomical effects.

RESONANCE The phenomenon of amplification of a free wave or oscillation of a system by a forced wave or oscillation of exactly equal period. The forced wave may arise from an impressed force upon the system or from a boundary condition.

RESPONSE-BASED ANALYSIS In a RESPONSE-BASED ANALYSIS, the analysis attempts to simulate the full complexity of the physical and various processes forcing the flooding (e.g.,seas and swells), and to derive flood statistics from the results (the local response) of that complex simulation. In this approach, the elevated water levels and wave conditions are not coincident.

RETURN PERIOD Average period of time between occurrences of a given event.

REVETMENT (1) A facing of stone, concrete, etc., to protect an EMBANKMENT, or shore structure, against erosion by wave action or currents. (2) A retaining wall. (3) Facing of stone, concrete, etc., built to protect a SCARP, EMBANKMENT or shore structure against erosion by waves of currents.

REYNOLDS NUMBER The dimensionless ratio of the inertial force to the viscous force in fluid motion, Re = VL/v where L is a characteristic length, v the kinematic viscosity, and V a characteristic velocity. The Reynolds number is of importance in the theory of hydrodynamic stability and the origin of turbulence.

RUN-UP, RUN-DOWN The upper and lower levels reached by a wave on a beach or coastal structure, relative to stillwater level.

---------- S ----------

SCARP, BEACH An almost vertical slope along the beach caused by erosion by wave action. It may vary in height from a few cm to a meter or so, depending on wave action and the nature and composition of the beach.

SCOUR Removal of underwater material by waves and currents, especially at the base or toe of a shore structure.

SCOUR PROTECTION Protection against erosion of the seabed in front of the toe.

SEA LEVEL RISE The long-term trend in MEAN SEA LEVEL.

SEA STATE Description of the sea surface with regard to wave action. Also called state of sea.

SEAWALL (1) A structure, often concrete or stone, built along a portion of a coast to prevent erosion and other damage by wave action. Often it retains earth against its shoreward face. (2) A structure separating land and water areas to alleviate the risk of flooding by the sea. Generally shore-parallel, although some reclamation SEAWALLS may include lengths that are normal or oblique to the (original) shoreline. A SEAWALL is typically more massive and capable of resisting greater wave forces than a BULKHEAD.

SEDIMENT TRANSPORT The main agencies by which sedimentary materials are moved are: gravity (gravity transport); running water (rivers and streams); ice (glaciers); wind; the sea (currents and LONGSHORE DRIFT). Running water and wind are the most widespread transporting agents. In both cases, three mechanisms operate, although the particle size of the transported material involved is very different, owing to the differences in density and viscosity of air and water. The three processes are: rolling or traction, in which the particle moves along the bed but is too heavy to be lifted from it; saltation; and suspension, in which particles remain permanently above the bed, sustained there by the turbulent flow of the air or water.

SEEPAGE The movement of water through small cracks, pores, interstices, out of a body of surface of subsurface water. The loss of water by infiltration from a canal, reservoir or other body of water or from a field. It is generally expressed as flow volume per unit of time.

SEICHE (1) A standing wave oscillation of an enclosed waterbody that continues, pendulum fashion, after the cessation of the originating force, which may have been either seismic or atmospheric. (2) An oscillation of a fluid body in response to a disturbing force having the same frequency as the natural frequency of the fluid system. Tides are now considered to be seiches induced primarily by the periodic forces caused by the Sun and Moon. (3) In the Great Lakes area, any sudden rise in the water of a harbor or a lake whether or not it is oscillatory (although inaccurate in a strict sense, this usage is well established in the Great Lakes area).

SEISMIC REFLECTION The return of part of the energy of seismic waves to the earth's surface after the waves bounce off an acoustic boundary (typically rock or material of different density).

SEISMIC REFRACTION The bending of seismic waves as they pass from one material to another.

SEISMIC SEA WAVE See TSUNAMI.

SEMIDIURNAL Having a period or cycle of approximately one-half of a tidal day (12.4 hours). The predominating type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day. The tidal current is said to be semidiurnal when there are two flood and two ebb periods each day.

SETBACK A required open space, specified in shoreline master programs, measured horizontally upland from an perpendicular to the ordinary high-water mark.

SHALLOW WATER (1) Commonly, water of such a depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than one-half the surface wavelength as shallow water. See TRANSITIONAL ZONE and DEEP WATER. (2) More strictly, in hydrodynamics with regard to progressive gravity waves, water in which the depth is less than 1/25 the wavelength.

SHALLOW WATER WAVE A PROGRESSIVE WAVE which is in water less than 1/25 the wave length in depth.

SHEET FLOW In coastal areas, it is shallow water flooding with depths 1 to 3 foot. SHEET FLOW in coastal flooding will either merge into another flood source, pond in a lowlying area, or deteriorate due to ground friction and energy losses.

SHOALING (1) Decrease in water depth. (2) The transformation of wave profile as they propagate inshore.

SHOALING COEFFICIENT The ratio of the height of a wave in water of any depth to its height in deep water with the effects of refraction, friction, and percolation eliminated. Sometimes SHOALING FACTOR or DEPTH FACTOR.

SHORE NORMAL A line at a right-angle to the contours in the SURF ZONE.

SHORELINE The intersection of a specified plane of water with the shore or beach (e.g., the high water shoreline would be the intersection of the plane of mean high water with the shore or beach). The line delineating the shoreline on National Ocean Service nautical charts and surveys approximates the mean high water line.

SHORELINE MANAGEMENT The development of strategic, long-term and sustainable Coastal defense and land-use policy within a sediment cell.

SHORT-CRESTED WAVE A wave, the crest length of which is of the same order of magnitude as the wave length. A system of short-crested waves has the appearance of hills being separated by troughs.

SIGNIFICANT WAVE A statistical term relating to the one-third highest waves of a given wave group and defined by the average of their heights and periods. The composition of the higher

waves depends upon the extent to which the lower waves are considered. Experience indicates that a careful observer who attempts to establish the character of the higher waves will record values which approximately fit the definition of the significant wave.

SIGNIFICANT WAVE HEIGHT The average height of the one-third highest waves of a given wave group. Note that the composition of the highest waves depends upon the extent to which the lower waves are considered. In wave record analysis, the average height of the highest one-third of a selected number of waves, this number being determined by dividing the time of record by the significant period.

SIGNIFICANT WAVE PERIOD An arbitrary period generally taken as the period of the one-third highest waves within a given group. Note that the composition of the highest waves depends upon the extent to which the lower waves are considered. In wave record analysis, this is determined as the average period of the most frequently recurring of the larger well-defined waves in the record under study.

SOFT DEFENSES Usually refers to beaches (natural or designed) but may also relate to energy-absorbing beach-control structures, including those constructed of rock, where these are used to control or redirect coastal processes rather than opposing or preventing them.

SOLITARY WAVE A wave consisting of a single elevation (above the original water surface), whose height is not necessarily small compared to the depth, and neither followed nor preceded by another elevation or depression of the water surfaces.

SPRING RANGE The average SEMIDIURNAL range occurring at the time of SPRING TIDES and most conveniently computed from the harmonic constants. It is larger than the MEAN RANGE where the type of tide is either SEMIDIURNAL or MIXED, and is of no practical significance where the type of tide is DIURNAL TIDE.

SPRING TIDAL CURRENTS Tidal currents of increased velocity occurring semimonthly as the result of the moon being new or full.

SPRING TIDE A tide that occurs at or near the time of new or full moon and which rises highest and falls lowest from the mean sea level.

STANDING WAVE A type of wave in which the surface of the water oscillates vertically between fixed points, called nodes, without progression. The points of maximum vertical rise and fall are called antinodes or loops. At the nodes, the underlying water particles exhibit no vertical motion, but maximum horizontal motion. At the antinodes, the underlying water particles have no horizontal motion, but maximum vertical motion. They may be the result of two equal progressive wave trains traveling through each other in opposite directions.

STATIONARY WAVE A wave of essentially stable form which does not move with respect to a selected reference point; a fixed swelling. Sometimes called STANDING WAVE.

STILLWATER ELEVATION (SWEL) – The stillwater elevation (SWEL) is the statistical elevation of the SWL relative to a specified datum.

STILLWATER LEVEL (SWL) Coastal water surface resulting from astronomical TIDES, SEICHE, STORM SURGE, and freshwater inputs, but excluding all wave effects.

STOCHASTIC Having random variation in statistics.

STORM INDUCED EROSION The beach and shoreline erosion that occurs during the storm or flood event, and is considered to be a short-term or event driven phenomenon.

STORM SURGE A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes that rise in level due to atmospheric pressure reduction as well as that due to wind stress. See WIND SETUP.

SUBMERGENT COAST A COAST in which formerly dry land has been recently drowned, either by land subsidence or a rise in seal level.

SUBSIDENCE Sinking or downwarping of a part of the earth's surface.

SUBTIDAL Below the low-water datum; thus permanently.

SURF (1) Collective term for BREAKERS. (2) The wave activity in the area between the shoreline and the outermost limit of breakers. (3) In literature, the term surf usually refers to the breaking waves on shore and on reefs when accompanied by a roaring noise caused by the larger waves breaking.

SURF BEAT Irregular oscillations of the nearshore water level with periods on the order of several minutes.

SURF ZONE The zone of wave action extending from the water line (which varies with tide, surge, set-up, etc.) out to the most seaward point of the zone (breaker zone) at which waves approaching the coastline commence breaking.

SURFACE GRAVITY WAVE (PROGRESSIVE) (1) this is the term which applies to the WIND WAVES and SWELL of lakes and oceans, also called SURFACE WATER WAVE, SURFACE WAVE or DEEP WATER WAVE, (2) a progressive GRAVITY WAVE in which the disturbance is confined to the upper limits of a body of water. Strictly speaking this term applies to those progressive GRAVITY WAVES whose celerity depends only upon the wave length.

SWALE The depression between two beach ridges.

SWASH The rush of water up onto the beach face following the breaking of a wave. Also UPRUSH, RUNUP.

SWASH ZONE The zone of wave action on the beach, which moves as water levels vary, extending from the limit of run-down to the limit of run-up.

SWELL Wind-generated waves that have traveled out of their generating area. Swell characteristically exhibits a more regular and longer period and has flatter crests than waves within their fetch (SEAS).

SYNOPTIC CHART A chart showing the distribution of meteorological conditions over a given area at a given time. Popularly called a weather map.

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TIDAL DAY The time of the rotation of the Earth with respect to the Moon, or the interval between two successive upper transits of the Moon over the meridian of a place, approximately 24.84 solar hours (24 hours and 50 minutes) or 1.035 times the mean solar day. Also called lunar day.

TIDAL FLATS (1) Marshy or muddy areas covered and uncovered by the rise and fall of the tide. A TIDAL MARSH. (2) Marshy or muddy areas of the seabed which are covered and uncovered by the rise and fall of tidal water.

TIDAL INLET A natural INLET or opening along a barrier island or coast maintained by tidal flow. TIDAL INLETSs control the movement of water between the open coast and adjacent sheltered waters. Inlets may be broadly classified as unimproved (natural) or improved (maintained). The physical opening of a TIDAL INLET, whether natural or maintained, has a direct and often significant effect on the propagation of tides, surge, and waves into sheltered waters and on subsequent coastal flood conditions.

TIDAL PERIOD The interval of time between two consecutive, like phases of the tide.

TIDAL PRISM (1) The total amount of water that flows into a harbor or out again with movement of the tide, excluding any fresh water flow. (2) The volume of water present between MEAN LOW and MEAN HIGH TIDE.

TIDAL RANGE The difference in height between consecutive high and low (or higher high and lower low) waters.

TIDAL SHOALS Shoals that accumulate near inlets due to the transport of sediments by tidal currents associated with the inlet.

TIDAL WAVE (1) The wave motion of the tides. (2) In popular usage, any unusually high and destructive water level along a shore. It usually refers to STORM SURGE or TSUNAMI.

TIDALLY DRIVEN CIRCULATION The movement of fresh water and seawater that are mixed by the sloshing back and forth of the ESTUARY in response to ocean tides.

TIDE The periodic rising and falling of the water that results from gravitational attraction of the Moon and Sun and other astronomical bodies acting upon the rotating Earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as TIDAL CURRENT, reserving the name TIDE for the vertical movement.

TIDE STATION A place at which tide observations are being taken. It is called a primary tide station when continuous observations are to be taken over a number of years to obtain basic tidal data for the locality. A secondary tide station is one operated over a short period of time to obtain data for a specific purpose.

TIDE TABLES Tables which give daily predictions of the times and heights of the tide. These predictions are usually supplemented by tidal differences and constants by means of which additional predictions can be obtained for numerous other places.

TOE Lowest part of sea- and portside BREAKWATER slope, generally forming the transition to the seabed. Also, see DUNE TOE.

TOTAL STILLWATER LEVEL The water level defined as the STILLWATER LEVEL plus WAVE SETUP. See MEAN WATER LEVEL.

TOTAL WATER ELEVATION The coastal water surface elevation of combined SWL plus wave effects referenced to the NGV29, NAVD88, or other datum.

TOTAL WATER LEVEL The coastal water surface elevation due to all processes (TIDES, STORM SURGE, and WAVES). The SWL plus wave effects including DYNAMIC WAVE SETUP, STATIC WAVE SETUP, AND WAVE RUNUP.

TRANSECT Cross section taken perpendicular to the shoreline to represent a segment of coast with similar characteristics.

TRANSITIONAL ZONE (TRANSITIONAL WATER) In regard to progressive gravity waves, water whose depth is less than 2 but more than 1/25 the wavelength. Often called shallow water.

TROPICAL STORM A tropical cyclone with maximum winds less than 34 m/sec (75 mile per hour).

TROUGH OF WAVE The lowest part of a waveform between successive crests. Also, that part of a wave below still-water level.

TSUNAMI A long-period wave caused by an underwater disturbance such as a volcanic eruption or earthquake. Also SEISMIC SEA WAVE. Commonly miscalled "tidal wave."

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UNCONSOLIDATED In referring to sediment grains, loose, separate, or unattached to one another.

UNDERCUTTING Erosion of material at the foot of a Cliff or bank, e.g., a sea cliff, or river bank on the outside of a meander. Ultimately, the overhang collapses, and the process is repeated.

UPDRIFT The direction opposite that of the predominant movement of littoral materials.

UPLIFT The upward water pressure on the base of a structure or pavement.

UPRUSH The rush of water up the FORESHORE following the breaking of a wave, also called SWASH or RUNUP.

UPSTREAM Along coasts with obliquely approaching waves there is a longshore (wave-driven) current. For this current one can define an upstream and a DOWNSTREAM direction. For

example, on a beach with an orientation west-east with the sea to the north, the waves come from NW. Then the current flows from West to East. Here, upstream is West of the observer, and East is DOWNSTREAM of the observer.

UPWELLING The process by which water rises from a deeper to a shallower depth, usually as a result of offshore surface water flow. It is most prominent where persistent wind blows parallel to a coastline so that the resultant Ekman transport moves surface water away from the coast.

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VELOCITY OF WAVES The speed at which an individual wave advances. See WAVE CELERITY.

VELOCITY PROFILE The velocity gradient within the BOTTOM BOUNDARY LAYER, displayed as a graph of height above the bed against the velocity of the flow.

VISCOSITY (or internal friction) That molecular property of a fluid that enables it to support tangential stresses for a finite time and thus to resist deformation. Resistance to flow.

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WASHOVER Sediment deposited inland of a beach by overwash processes.

WATER DEPTH Distance between the seabed and the water level.

WAVE A ridge, deformation, or undulation of the surface of a liquid.

WAVE CELERITY The speed of wave propagation.

WAVE CLIMATE The seasonal and annual distribution of wave height, period and direction.

WAVE CREST ELEVATION The elevation of the crest of a wave, referenced to the NGVD or other datum.

WAVE DIRECTION The direction from which a wave approaches.

WAVE DIRECTIONAL SPECTRUM Distribution of wave energy as a function of wave frequency and direction.

WAVE FORECASTING The theoretical determination of future wave characteristics, usually from observed or predicted meteorological phenomena.

WAVE FREQUENCY The inverse of wave period.

WAVE FREQUENCY SPECTRUM Distribution of wave energy as a function of frequency.

WAVE GROUP A series of waves in which the wave direction, wavelength, and wave height vary only slightly. See also GROUP VELOCITY.

WAVE HEIGHT The vertical distance between a wave crest and the preceding trough. See also SIGNIFICANT WAVE HEIGHT.

WAVE HEIGHT COEFFICIENT The ratio of the wave height at a selected point to the deepwater wave height. The REFRACTION COEFFICIENT multiplied by the shoaling factor.

WAVE PEAK FREQUENCY The inverse of wave peak period.

WAVE PERIOD The time for a wave crest to traverse a distance equal to one wavelength. The time for two successive wave crests to pass a fixed point. See also SIGNIFICANT WAVE PERIOD.

WAVE PROPAGATION The transmission of waves through water.

WAVE REFRACTION See REFRACTION (of water waves).

WAVE ROSE Diagram showing the long-term distribution of wave height and direction.

WAVE RUNUP The rush of wave water up a slope or structure. Wave runup occurs as wave break and run up beaches, sloping surfaces, and vertical surfaces.

WAVE RUNUP DEPTH Wave runup depth at any point is equal to the wave runup elevation minus the lowest eroded ground elevation at that point.

WAVE RUNUP ELEVATION The elevation reached by wave runup, referenced to the NGVD29, NAVD88, or other datum.

WAVE SETDOWN Drop in water level outside of the breaker zone to conserve momentum as wave particle velocities and pressures change prior to wave breaking.

WAVE SETUP An increase in the stillwater surface near the shoreline, caused by the presence of breaking waves.

WAVE, SINUSOIDAL An oscillatory wave having the form of a sinusoid.

WAVE SPECTRUM In ocean wave studies, a graph, table, or mathematical equation showing the distribution of wave energy as a function of wave frequency. The spectrum may be based on observations or theoretical considerations. Several forms of graphical display are widely used.

WAVE STEEPNESS The ratio or wave height to wavelength also known as sea steepness.

WAVE TRAIN A series of waves from the same direction.

WAVE TRANSFORMATION Change in wave energy due to the action of physical processes.

WAVE TROUGH The lowest part of a wave form between successive crests. Also that part of a wave below still-water level.

WAVE VELOCITY The speed at which an individual wave advances.

WAVELENGTH The horizontal distance between similar points on two successive waves measured perpendicular to the crest.

WEIBULL DISTRIBUTION A model probability distribution, commonly used in wave analysis.

WEIR A low dam or wall across a stream to raise the upstream water level. Termed fixed crest weir when uncontrolled.

WEIR JETTY A jetty with a low section or weir over which littoral drift moves into a pre-dredged deposition basin which is then dredged periodically.

WETLANDS Lands whose saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities that live in the soil and on its surface (e.g. Mangrove forests).

WIND ROSE Diagram showing the long-term distribution of windspeed and direction.

WIND SEA Wave conditions directly attributable to recent winds, as opposed to swell.

WIND SETUP On reservoirs and smaller bodies of water (1) the vertical rise in the still-water level on the leeward side of a body of water caused by wind stresses on the surface of the water; (2) the difference in still-water levels on the windward and the leeward sides of a body of water caused by wind stresses on the surface of the water. STORM SURGE (usually reserved for use on the ocean and large bodies of water).

WIND STRESS The way in which wind transfers energy to the sea surface.

WIND WAVES (1) Waves being formed and built up by the wind. (2) Loosely, any wave generated by wind.

WINDWARD The direction from which the wind is blowing.

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---------- Y ----------

---------- Z ----------