Glossary of Coastal Terminology

Prepared by Brian Voigt
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Preface

This coastal glossary includes terminology used in coastal science, engineering, geology, management, nearshore oceanography and the technologies that characterize, measure, describe or quantify the physical properties, processes and changes of the coastal zone. Numerous potential selections were omitted at the discretion of the compilers. Correspondence noting errors, omissions or containing suggestions are welcomed in anticipation of future editions of this glossary. Please send all comments to Brian Voigt, Coastal Monitoring & Analysis Program, Department of Ecology, PO Box 47600, Olympia, WA 98504-7600, 360.407.6568, email bvoi461@ecy.wa.gov.

Definitions are listed in alphabetical order and consist of the definition and descriptive terms. Many words feature multiple definitions. These definitions are listed in numerical order (1), (2), (3), etc. Terms defined by the Washington State Department of Ecology's Shoreline Master Program (SMP) Handbook 1994 edition are prefaced by the (SMP) designation. In addition, some SMP definitions reference RCW numbers, the Revised Code of Washington. Cross-referencing of terms included in the glossary is denoted by words typed in all capitals. For example, abrasion is defined as the frictional EROSION by material transported by wind and WAVES. Cross-referencing of both EROSION and WAVES is found within this definition.

The text also includes figures that reference defined terms. These figures are located in Appendix A.

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A

ABRASION: Frictional EROSION by material transported by wind and WAVES.

ACCELEROMETER: A device used in WAVE buoys for measuring acceleration.

ACCRETION: The accumulation of (beach) SEDIMENT, deposited by natural fluid flow processes.

ACTIVE MARGIN: A margin consisting of a CONTINENTAL SHELF, a CONTINENTAL SLOPE, and an oceanic TRENCH.

AEOLIAN DEPOSITS: Wind-deposited SEDIMENTS, such as SAND DUNES. See Figure 8.

AGGRADATION: The geologic process by which various parts of the surface of the earth are raised in ELEVATION or built up by the deposition of material transported by water or wind.

ALLOCHTONOUS: A term applied shelves that presently experience DEPOSITION of river-derived SEDIMENTS. See also DETRITUS.

ALONGSHORE: Parallel to and near the SHORELINE; same as LONGSHORE.

ALLUVIAL DEPOSITS: Detrital material which is transported by a RIVER and deposited – usually temporarily – at points along the FLOODPLAIN of a RIVER. Commonly composed of SANDS and GRAVELS.

ALTIMETER: An instrument that determines its distance above a particular surface.

ALTIMETER, LASER: An instrument that determines altitude by measuring the length of time needed for a pulse of coherent light to travel from the instrument to the surface and back, and multiplies half this time by the speed of light to get the straight-line distance to the surface.

ALTIMETER, LIDAR: See ALTIMETER, LASER, and lidar.

AMPLITUDE: Half of the peak-to-trough range (or height) of a WAVE. See Figure13.

ANGLE OF REPOSE: The maximum SLOPE (measured from the HORIZON) at which SOILS and loose materials on the banks of CANALS, RIVERS or EMBANKMENTS stay stable.

AQUIFER: A geologic formation that is water-bearing, and which transmits water from one point to another.

ASEISMIC RIDGE: A submarine ridge with which no earthquakes are associated.

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: The loss or dissipation of WAVE energy, resulting in a reduction of WAVE HEIGHT (AMPLITUDE).

AUTOCHTHONOUS: A term applied to shelves on which older shelf sediments are primarily being reworked by modern shelf processes.

AUTOMATIC TIDE GAGE: An instrument that automatically registers the rise and fall of the TIDE. In some instruments, the registration is accomplished by printing the heights at regular intervals, in others by a continuous graph in which the height of the TIDE is represented by the ordinates of the curve and the corresponding time by the abscissae.

AVULSION: (1) Rapid EROSION of the shoreland by WAVES during a storm. (2) A sudden cutting off of land by flood, currents or change in course of a body of water.

B

BACKSHORE: (1) The upper part of the active BEACH above the normal REACH of the TIDES (high water), but affected by large WAVES occurring during a high. (2) (SMP) The accretion or erosion zone, located landward of ordinary high tide, which is normally wetted only by storm tides.

BACKWASH: (1) The seaward return of the water following the UPRUSH of the WAVES. Also called backrush or run down. (2) Water of WAVES thrown back by an obstruction such as a ship, BREAKWATER, CLIFF, etc.

BACKWASH RIPPLES: Low amplitude RIPPLE MARKS formed on fine SAND beaches by the BACKWASH of the WAVES.

BANK: The rising ground bordering a lake, RIVER or SEA.

BAR: An OFFSHORE ridge or mound of SAND, GRAVEL, or other UNCONSOLIDATED material which is submerged (at least at high tide), especially at the mouth of a RIVER or ESTUARY, or lying parallel to, and a short distance from, the BEACH. See Figure 2.

BARRIER BEACH: A BAR essentially parallel to the SHORE, which has been built up so that its crest rises above the normal HIGH WATER level. Also called BARRIER ISLAND and OFFSHORE BARRIER.

BARRIER ISLAND: A detached portion of a BARRIER BEACH between two INLETS. See Figure6.

BARRIER SPIT: Similar to a BARRIER ISLAND, only connected to the mainland.

BASIN: A large submarine DEPRESSION of a generally circular, elliptical or oval shape.

BATHYMETRY: The measurement of DEPTHS of water in OCEANS, SEAS and lakes; also the information derived from such measurements.

BAY: A recess or INLET in the SHORE of a SEA or lake between two capes or HEADLANDS, not as large as a GULF but larger than a COVE. See also BIGHT, EMBAYMENT. See Figure 5.

BAYMOUTH BAR: A BAR extending partly or entirely across the mouth of a bay.

BEACH: (1) A deposit of non-cohesive material (e.g. SAND, GRAVEL) situated on the interface between dry land and the SEA (or other large expanse of water) and actively "worked" by present-day hydrodynamics processes (i.e. WAVES, TIDES and CURRENTS) and sometimes by winds. (2) 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. The seaward limit of a BEACH – unless otherwise specified – is the MEAN LOW WATER LINE. A BEACH includes FORESHORE and BACKSHORE. (3) (SMP) The zone of unconsolidated material that is moved by WAVES, wind and TIDAL CURRENTS, extending landward to the COASTLINE.

BEACH CREST: The point representing the limit of high tide storm WAVE RUN-UP.

BEACH EROSION: The carrying away of beach materials by WAVE action, TIDAL CURRENTS, LITTORAL CURRENTS or wind.

BEACH FACE: The section of the BEACH normally exposed to the action of WAVE UPRUSH. The FORESHORE of the BEACH.

BEACH HEAD: The CLIFF, dune or sea wall looming the landward limit of the active BEACH.

BEACH NOURISHMENT: The process of replenishing a BEACH by artificial means; e.g., by the deposition of dredged materials, also called beach replenishment or beach feeding.

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

BEACH RIDGE: A low extensive ridge of beach material piled up by storm waves landward of the BERM. Usually consists of very coarse SAND, GRAVEL or shells. Occurs singly or as a series of more or less parallel ridges.

BEACH SCARP: (1) An almost perpendicular SLOPE along the beach FORESHORE; an erosional feature due to WAVE action, it may vary in height from a few centimeters to several meters, depending on WAVE action and the nature and composition of the BEACH. See ESCARPMENT. See ESCARPMENT. (2) (SMP) A steep slope produced by wave erosion.

BEACH WIDTH: The horizontal dimension of the BEACH measured normal to the SHORELINE.

BEAUFORT SCALE: The relationship between sea state and wind speed. The *Beaufort Scale* can be used to estimate wind speed at SEA, but is valid only for WAVES generated within the local weather system, and assumes that there has been sufficient time for a fully developed SEA to have become established.

BED: The bottom of a watercourse, or any body of water.

BEDDING PLANE: A surface parallel to the surface of deposition, which may or may not have a physical expression. The original attitude of a *bedding plane* should not be assumed to have been horizontal. See also CROSS-BEDDING, SEDIMENTARY STRUCTURES.

BED LOAD: Heavy or large SEDIMENT particles that travel near or on the BED.

BENCH: (1) A level or gently sloping erosion plane inclined seaward. (2) A nearly horizontal area at about the level of maximum HIGH WATER on the sea side of a DIKE.

BENCH MARK: A mark affixed to a permanent object in tidal observations, or in a survey, to furnish a DATUM level.

BENCH MARK, TIDAL: A BENCH MARK whose ELEVATION has been determined with respect to MEAN SEA LEVEL at a nearby tide gauge; the *tidal bench mark* is used as reference for that tide gauge.

BENEFITS: The economic value of a scheme, usually measured in terms of the cost of damages avoided by the scheme, or the valuation of perceived amenity or environmental improvements.

BENTHOS: Those animals who live on the SEDIMENTS of the sea floor, including both mobile and non-mobile forms.

BENTHIC: Pertaining to the sub-aquatic bottom.

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 RECHARGE scheme. (2) On a

structure: a nearly horizontal area, often built to support or key-in an armour layer. (3) (SMP) A linear mound or series of mounds of SAND and/or GRAVEL generally paralleling the water at or landward of the line of ordinary high tide. See Figure 2.

BERM BREAKWATER: Rubble mound with horizontal BERM of armour STONES at about sea-side WATER LEVEL, which is allowed to be (re)shaped by the WAVES.

BERM CREST: The seaward limit of the BERM, or the minimum DEPTH of a submerged BERM; also called berm edge.

BIFURCATION: Location where a RIVER separates in two or more reaches or branches (the opposite of a CONFLUENCE).

BIGHT: A slight indentation in a COAST forming an open BAY, usually crescent shaped.

BLOWOUT: A DEPRESSION on the land surface caused by wind EROSION.

BLUFF: A high, steep BANK or CLIFF.

BOG: (SMP) A wet, spongy, poorly drained area which is usually rich in very specialized plants, contains a high percentage of organic remnants and residues and frequently is associated with a spring, seepage area, or other subsurface water source. A *bog* sometimes represents the final stage of the natural processes of eutrophication by which lakes and other bodies of water are very slowly transformed into land areas.

BOIL: An upward flow of water in a sandy formation due to an unbalanced hydrostatic pressure resulting from a rise in a nearby STREAM, or from removing the overburden in making excavations.

BOTTOM BOUNDARY LAYER: The lower portion of the water flow that experiences frictional retardation based on its proximity to the BED. See also VELOCITY PROFILE.

BOULDER: A rounded rock on a BEACH, greater than 256 mm in diameter, larger than a cobble. See also GRAVEL, SHINGLE.

BOX GAGE: A TIDE GAGE that is operated by a float in a long vertical box to which the TIDE is admitted through an opening

in the bottom. In the original type of *box gage* the float supported a graduated rod which rose and fell with the TIDE.

BREACHING: Failure of the BEACH HEAD or a DIKE allowing flooding by tidal action.

BREAKER: A WAVE that has become so steep that the crest of the WAVE topples forward, moving faster than the main body of the WAVE. *Breakers* may be roughly classified into four kinds, although there is much overlap (see Figure 2):

Spilling – bubbles and turbulent water spill down the front face of WAVE. The upper 25 percent of the front face may become vertical before breaking. Breaking generally across over quite a distance.

Plunging – a crest curls over air pocket; breaking is usually with a crash. Smooth splash-up usually follows.

Collapsing – breaking occurs over lower half of WAVE. Minimal air pocket and usually no splash-up. Bubbles and foam present.

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 BACKWASH.

BREAKER INDEX: Maximum ratio of WAVE HEIGHT to WATER DEPTH in the SURF ZONE, typically 0.78 for SPILLING WAVES, ranging from about 0.6 to 1.5.

BREAKER ZONE: The zone within which WAVES approaching the COASTLINE commence breaking, typically in WATER DEPTHS of between 5 m and 10 m.

BREAKING DEPTH: The still-water DEPTH at the point where the WAVE breaks.

BREAKWATER: (1) A structure protecting a HARBOR, anchorage, or BASIN from WAVES. (2) (SMP) Offshore structure aligned parallel to the SHORE, sometimes shore-connected, that provides protection from waves.

BUFFER AREA: A parcel or strip of land that is designed and designated to permanently remain vegetated in an undisturbed and natural condition to protect an adjacent aquatic or wetland

site from upland impacts, to provide habitat for wildlife and to afford limited public access.

BULKHEAD: (1) A structure separating land and water areas, primarily designed to resist earth pressures. (2) 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 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 as well as movement caused by man.

BUOY: A float; especially a floating object moored to the bottom, to mark a CHANNEL, anchor, SHOAL rock, etc. Some common types include: a *nun* or *nut* buoy is conical in shape; a *can* buoy is squat and cylindrical above water and conical below water; a *spar* buoy is a vertical, slender spar anchored at one end; a *bell* buoy, bearing a bell, runs mechanically or by the action of WAVES, usually marks SHOALS or ROCKS; a *whistling* buoy, similarly operated, marks SHOALS or channel entrances; a *dan* buoy carries a pole with a flag or light on it.

C

CALIFORNIA CURRENT: A deep-ocean boundary current that flows south-southeasterly along the U.S. west coast. The current is shallow, broad and slow moving carrying cold, nutrient poor waters toward the equator.

CALM: The condition of the water surface when there is no WIND WAVES or SWELL.

CAMERA, AERIAL: A camera especially designed for photographing the Earth's surface from above the ground; usually carried in aircraft and Earth-orbiting satellites.

CAMERA, METRIC: A camera designed particularly for PHOTOGRAMMETRY, constructed so that the image is distorted geometrically as little as possible and the camera characteristics do not change from photograph to photograph.

CANAL: An artificial watercourse cut through a land area for such uses as navigation and irrigation.

CAPE: A relatively extensive land area jutting seaward from a continent or large island which prominently marks a change in, or interrupts notably, the coastal trend; a prominent feature.

CAPILLARY WAVE: A WAVE whose velocity or propagation is controlled primarily by the surface tension of the liquid in which the WAVE is travelling. A water WAVE in which the WAVE LENGTH is less than 2.5 cm is considered to be a *capillary wave*, while WAVES longer than 2.5 cm and shorter than 5cm are in an indeterminate zone between CAPILLARY and GRAVITY WAVES. See also RIPPLE. See Figure 10.

CARRYING CAPACITY: The maximum number of species that any particular area can support over an extended period of time.

CARTOGRAPHY: The science and art of making maps.

CELERITY: The magnitude of WAVE VELOCITY.

CHANGE OF TIDE: The change of one TIDE condition (rising or falling) for the other (falling or rising), or of one TIDAL CURRENT direction flow for the other.

CHANNEL: (1) A natural or artificial waterway of perceptible extent which either periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. (2) The part of a body of water deep enough to be used for navigation through an area otherwise too shallow for navigation. (3) The deepest portion of a STREAM, BAY, or STRAIT through which the main volume of CURRENT of water flows. (4) (SMP) An open conduit for water either naturally or artificially created, but does not include artificially created irrigation, return flow or stockwatering channels (WAC 173-14-030 (8b)).

CHART DATUM: The plane or level to which SOUNDINGS, tidal levels or WATER DEPTHS are referenced, usually LOW WATER DATUM. See also DATUM PLANE and REFERENCE PLANE.

CHOPPY SEA: Short, rough WAVES tumbling with a short and quick motion. SHORT-CRESTED WAVES that may spring up quickly in a moderate breeze, and break easily at the crest.

CLASTIC ROCKS: Rocks built up of fragments which have been produced by the processes of weathering and EROSION, and in general transported to a point of deposition.

CLAY: A fine grained SEDIMENT with a typical grain size less than 0.004 mm. Possesses electromagnetic properties which bind the grains together to give a bulk strength or cohesion.

CLIFF: A high steep face of rock.

CLIMATE CHANGE: Refers to any long-term trend in MEAN SEA LEVEL, WAVE HEIGHT, wind speed, drift rate etc.

COAST: A strip of land of indefinite length and width (may be tens of kilometers) that extends from the SEASHORE inland to the first major change in terrain features.

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 that drive coastal hydro- and morphodynamics (e.g. winds, WAVES, TIDES, etc).

COASTAL MANAGEMENT: The development of a strategic, long-term and sustainable land use policy, sometimes also called SHORELINE MANAGEMENT.

COASTAL PLAIN: The plain composed of horizontal or gently sloping strata of CLASTIC material fronting the COAST and generally representing a strip of recently emerged sea bottom that has emerged from the SEA in RECENT geologic times. Also formed by AGGRADATION.

COASTAL PROCESSES: Collective term covering the action of natural forces on the SHORELINE, and the NEARSHORE seabed.

COASTAL ZONE: The land-sea-air interface zone around continents and islands extending from the landward edge of a BARRIER BEACH or SHORELINE of coastal bay to the outer extent of the CONTINENTAL SHELF.

COASTLINE: (1) Technically, the line that forms the boundary between the COAST and the SHORE. (2) Commonly, the line that forms the boundary between land and the water. (3) (SMP) The line where terrestrial processes give way to marine processes, TIDAL CURRENTS, wind waves, etc.

COBBLE: Rounded rocks ranging in diameter from approximately 64 to 256 mm.

COLLOID: As a size term refers to particles smaller than 0.00024 mm, smaller than CLAY size.

COMBER: (1) A deepwater WAVE whose crest is pushed forward by a strong wind; much larger than a WHITECAP. (2) A long-period BREAKER.

COMPASS, SURVEYOR'S: A compass for determining the magnetic azimuth of a line of sight by means of a sighting device, a graduated horizontal circle, and a pivoted magnetic needle.

CONFLUENCE: The junction of two or more RIVER reaches or branches (the opposite of a BIFURCATION).

CONSERVATION: The protection of an area, or particular element within an area, accepting the dynamic nature of the environment and therefore allowing change.

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. (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 declivity from the OFFSHORE border of the CONTINENTAL SHELF to oceanic depths. It is characterized by a marked increase in SLOPE.

CONTOUR CURRENT: A bottom current that flows parallel to the slopes of the continental margin (along the contour rather than down the SLOPE).

CONTOUR LINE: A line connecting points, on a land surface or sea bottom, which have equal ELEVATION. It is called an ISOBATH when connecting points of equal DEPTH below a DATUM.

CONTROLLING DEPTH: The least DEPTH in the navigable parts of a waterway, governing the maximum draft of vessels that can enter.

CONTROL NETWORK: GEODETIC CONTROL together with the measured or adjusted values of the distances, angels, directions, or heights used in determining the coordinates of the control.

CONTROL, GEODETIC: A set of control stations established by geodetic methods.

CONTROL, GROUND: A point or set of points, the coordinates of which have been determined by survey, used for fixing the scale and position of a photogrammetrically determined NETWORK.

CONTROL, HORIZONTAL: The geometric data relating to the horizontal coordinates of a control station.

CONTROL, PHOTOGRAMMETRIC: Geodetic or other control established to provide scale, location, and orientation for photogrammetric NETWORK.

CONTROL, VERTICAL: The ELEVATIONS (or approximations thereto) associated with control points.

COORDINATE SYSTEM: A set of rules for specifying how coordinates are to be assigned to points.

CORE: (1) A cylindrical sample extracted from a BEACH or seabed to investigate the types and DEPTHS of SEDIMENT layers. (2) An inner, often much less permeable portion of a BREAKWATER, or BARRIER BEACH.

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.

COSET: A group of units of CROSS-BEDDING which shows a uniform direction of current flow.

CO-TIDAL LINES: Lines which link all the points where the TIDE is at the same stage (or phase) of its cycle.

COUNTERCURRENT: A secondary current usually setting in a direction opposite to that of a main current.

COVE: A small sheltered recess in a SHORE or COAST, generally inside a larger EMBAYMENT.

CREEK: (1) A STREAM, less predominant than a RIVER, and generally tributary to a RIVER. (2) A small tidal CHANNEL through a coastal MARSH.

CREEP: Very slow, continuous downslope movement of SOIL or debris.

CRENULATE: An indented or wavy SHORELINE beach form, with the regular seaward- pointing parts rounded rather than sharp, as in the CUSPATE type.

CROSS-BEDDING: An arrangement of relatively thin layers of rock inclined at an angle to the more nearly horizontal BEDDING PLANES of the larger rock unit. Also referred to as cross-stratification.

CROSS SEA: Confused, irregular state of the sea due to different groups of WAVES from different directions raised by local winds.

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:

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

Temporary - due to seasonal winds

P*ermanent* 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

N*earshore* - caused principally by WAVES breaking along a SHORE.

Also, COASTAL CURRENTS such as CALIFORNIA and DAVIDSON CURRENTS that run parallel to the COAST.

CURRENT METER: An instrument for measuring the velocity of a CURRENT. It is traditionally operated by a wheel equipped with vanes of cups which is rotated by the action of the impinging CURRENT. A recording device is provided to indicate the speed of rotation which is correlated with the velocity of the CURRENT.

CUSP: One of a series of short ridges on the FORESHORE separated by crescent-shaped TROUGHS spaced at more or less regular intervals. Between these *cusps* are hollows. The *cusps* are spaced at somewhat uniform distances along beaches. They represent a combination of constructive and destructive processes.

CUSPATE: Form of BEACH SHORELINE involving sharp seaward-pointing CUSPS (normally at regular intervals) between which the SHORELINE follows a smooth arc.

CUSPATE FORELAND: A large, sandy cusp-shaped projection of the COAST. See Figure 5.

CUSPATE SANDKEY: A cusp-shaped SAND island.

CUSPATE SPIT: A sandy cusp-shaped projection of the SHORELINE, found on both sides of some LAGOONS.

D

DAILY RETARDATION OF TIDES: The amount of time by which corresponding tidal phases grow later day by day (about 50 minutes).

DAM: Structure built in RIVERS or estuaries, basically to separate water at both sides and/or to retain water at one side.

DATUM: Any position or element in relation to which others are determined, as datum point, datum line, DATUM PLANE. See Figure 11.

DATUM PLANE: A horizontal plane used as a reference from which to determine heights or DEPTHS. The plane is called a TIDAL DATUM when defined by a certain phase of the TIDE. *Datum planes* are referenced to fixed points known as BENCH MARKS, so that they can be recovered when needed. See also REFERENCE PLANE.

DAVIDSON CURRENT: Deep-ocean boundary current off the west coast of the U.S. which brings warmer, saltier, low oxygen, high phosphate equatorial type water from low to high latitudes.

DEBRIS LINE: A line near the limit of storm WAVE UPRUSH marking the landward limit of debris deposits.

DECAY AREA: Area of relative CALM through which WAVES travel after emerging from the GENERATING AREA.

DECAY DISTANCE: The distance through which WAVES travel after leaving the GENERATING AREA.

DECAY OF WAVES: The change which occurs in WAVES when they leave a GENERATING AREA and pass through a CALM (or region of lighter winds). In the process of decay the significant WAVE LENGTH increases and the SIGNIFICANT WAVE HEIGHT decreases.

DEEP WATER: In regard to WAVES, where DEPTH is greater than one-half the WAVE LENGTH. Deep-water conditions are said to exist when the surf waves are not affected by conditions on the bottom.

DEEP WATER WAVES: A WAVE in water the DEPTH of which is greater than one-half the WAVE LENGTH.

DEFLATION: The removal of loose material from a beach or other land surface by wind action.

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.

DELTA: (1) An ALLUVIAL DEPOSIT, usually triangular, at the mouth of a RIVER of other STREAM. It is normally built up only where there is no tidal or CURRENT action capable of removing the SEDIMENT as fast as it is deposited, and hence the DELTA builds forward from the COASTLINE. (2) A TIDAL DELTA is a similar deposit at the mouth of a tidal INLET, put there by TIDAL CURRENTS. (3) A WAVE DELTA is a deposit made by large WAVES which run over the top of a SPIT or BAR BEACH and down the landward side.

DENSITY STRATIFICATION: The lateral expansion of a SEDIMENT plume as it moves out of the distributary mouth, where salt and fresh water mix. This is most likely to occur where the speed of the RIVER flow is moderate to low and the distributary mouth is relatively deep.

DENSITY-DRIVEN CIRCULATION: Variations in SALINITY create variations in density in estuaries. These variations in density create horizontal pressure gradients, which drive estuarine circulation.

DEPRESSION: A general term signifying any depressed or lower area in the ocean floor.

DEPTH: Vertical distance from still-water level (or DATUM as specified) to the bottom.

DEPTH, CONTROLLING: See CONTROLLING DEPTH.

DESIGN STORM: Coastal protection structures will often be designed to withstand WAVE attack by the extreme DESIGN STORM. The severity of the storm (i.e. RETURN PERIOD) is chosen in view of the acceptable level of risk of damage or failure. A DESIGN STORM consists of a DESIGN WAVE condition, a design WATER LEVEL and a DURATION.

DESIGN WAVE: In the design of HARBORS, harbor works, etc., the type or types of WAVES selected as having the characteristics against which protection is desired.

DETRITUS: Small fragments of rock which have been worn or broken away from a mass by the action of water or WAVES.

DETACHED BREAKWATER: A BREAKWATER without any constructed connection to the SHORE.

DIAPOSITIVE: A positive photograph on a transparent medium.

DIFFERENTIAL EROSION / WEATHERING: These features develop in ROCKS which have varying resistance to the agencies of EROSION and/or weathering so that parts of the rock are removed at greater rates than others. A typical example is the removal of soft beds from between harder beds in a series of sedimentary ROCKS. The term may be applied to any size of feature, from small-scale 'etching' to the regional development of hills and VALLEYS controlled by hard and soft ROCKS.

DIFFRACTION: The phenomenon occurring when water WAVES are propagated into a sheltered region formed by a BREAKWATER or similar barrier that interrupts a portion of the otherwise regular train of WAVES, resulting in the multi-directional spreading of the WAVES.

DIKE: Sometimes written as dyke; earth structure along a SEA or RIVER in order to protect LITTORAL lands from flooding by high water; DIKES along RIVERS are sometimes called LEVEES.

DIRECTION OF CURRENT: Direction *toward* which CURRENT is flowing.

DIRECTION OF WAVES: Direction *from* which WAVES are coming.

DIRECTION OF WIND: Direction *from* which wind is blowing.

DISPERSE: (1) To spread or distribute from a fixed or constant source. (2) To cause to become widely separated.

DISPERSION: (1) Act of dispersing, or state of being DISPERSED. (2) The separation of WAVES by virtue of their differing rates of travel.

DIURNAL: Literally of the day, but here meaning having a period or a TIDAL DAY, i.e. about 24.84 hours. See Figure 11.

DIURNAL CURRENT: The type of TIDAL CURRENT having only one flood and one EBB period in the TIDAL DAY. A ROTARY CURRENT is DIURNAL if it changes its direction through all points of the compass once each TIDAL DAY. See Figure 11.

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. See Figure 11.

DOCK: The slip or waterway between two PIERS, or cut into the land, for the reception of ships.

DOUBLE EBB (TIDAL): An EBB CURRENT having two maxima of velocity separated by a smaller EBB velocity.

DOUBLE FLOOD (TIDAL): A flood CURRENT having two maxima of velocity separated by a smaller flood velocity.

DOUBLE TIDE: A double-headed TIDE; that is, a HIGH WATER consisting of two maxima of nearly the same height separated by a relatively small DEPRESSION, or a LOW WATER consisting of two minima separated by a relatively small ELEVATION.

DOWNDRIFT: The direction of predominant movement of littoral materials.

DOWNWELLING: A downward movement (sinking) of surface water caused by ONSHORE Ekman transport, converging CURRENTS or when a water mass becomes more dense than the surrounding water.

DRAINAGE BASIN: Total area drained by a STREAM and its tributaries.

DREDGING: (SMP) Excavation or displacement of the bottom or SHORELINE of a water body. *Dredging* can be accomplished with mechanical or hydraulic machines. Most is done to maintain channel depths or berths for navigational purposes; other *dredging* is for shellfish harvesting or for cleanup of polluted sediments.

DRIFT CURRENT: A broad, shallow, slow-moving OCEAN or lake CURRENT. Opposite of STREAM CURRENT.

DRIFT SECTOR: (SMP) A particular reach of marine shore in which LITTORAL DRIFT may occur without significant interruption, and which contais any and all natural sources of such drift, and also any accretion shoreforms accreted by such drift.

DRYING BEACH: That part of the BEACH uncovered by water (e.g. at LOW TIDE). Sometimes referred to as subaerial beach.

DUNES: (1) Accumulations of windblown SAND on the BACKSHORE, usually in the form of small hills or ridges, stabilized by vegetation or control structures. (2) A type of bed form indicating significant SEDIMENT transport over a sandy seabed.

DURATION: In forecasting WAVES, the length of time the wind blows in essentially the same direction over the FETCH (GENERATING AREA).

DURATION, MINIMUM: The time necessary for steady-state WAVE conditions to develop for a given wind velocity over a FETCH.

DURATION OF EBB: The interval of time in which a TIDAL CURRENT is ebbing, determined from the middle of the slack waters.

DURATION OF FALL: The interval from HIGH WATER to low water.

DURATION OF FLOOD: The interval of time in which a TIDAL CURRENT is flooding, determined from the middle of slack waters.

DURATION OF RISE: The interval from LOW WATER to high water.

DYNAMIC EQUILIBRIUM: Short term morphological changes that do not affect the MORPHOLOGY over a long period.

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 INTERVAL: The interval between the transit of the moon over the meridian of a place and the time of the following strength of EBB.

EBB STRENGTH: The EBB CURRENT at the time of maximum 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: A nontechnical term used for falling tide or EBB CURRENT. The portion of the tidal cycle between HIGH WATER and the following low water. See Figure 11.

ECHO SOUNDER: An instrument for determining the DEPTH of water by measuring the time of travel of a sound-pulse from the surface of a body of water to the bottom and back.

ECOSYSTEM: The living organisms and the nonliving environment interacting in a given area.

EDDY: A current of air, water, or any fluid, forming on the side of the main current, especially one moving in a circle; in extreme cases a whirlpool.

EDGE WAVE: An ocean WAVE parallel to the COAST, with crests normal to the SHORELINE. An EDGE WAVE may be standing or progressive. Its height diminishes rapidly seaward and is negligible at a distance of one WAVE LENGTH OFFSHORE.

EELGRASS: A submerged marine plant with very long narrow leaves.

EKAMAN TRANSPORT: Resultant flow at right angles to and to the right of the wind direction (in the northern hemisphere) referred to as UPWELLING and DOWNWELLING.

ELEVATION: The distance of a point above a specified surface of constant potential; the distance is measured along the direction of gravity between the point and the surface.

ELUTRIATION: The process by which a granular material can be sorted into its constituent PARTICLE SIZES by means of a moving STREAM of fluid (usually air or water). *Elutriators* are extensively used in studies of SEDIMENTS for determining PARTICLE SIZE distribution. Under certain circumstances wind, RIVERS and STREAMS may act as natural elutriating agents.

EMBANKMENT: An artificial BANK, mound, DIKE, or the like, built to hold back water or to carry a roadway.

EMBAYED: Formed into a BAY or bays; as an *embayed* SHORE.

EMBAYMENT: (1) An indentation in a SHORELINE forming an open BAY. (2) The formation of a BAY.

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

ENDEMIC: Native to a specific geographic area.

ENTRANCE: The *entrance* to a navigable BAY, HARBOR or CHANNEL, INLET or mouth separating the OCEAN from an inland water body.

EQUATORIAL CURRENTS: (1) OCEAN CURRENTS flowing westerly near the equator. There are two such currents in both the Atlantic and Pacific Oceans. The one to the north of the equator is called the North Equatorial Current and the one to

the south is called the South Equatorial Current. Between these two currents there is an easterly flowing STREAM known as the Equatorial Countercurrent. (2) TIDAL CURRENTS occurring semimonthly as a result of the moon being over the equator. At these times the tendency of the moon to produce DIURNAL INEQUALITY in the current is at a minimum.

EQUATORIAL TIDES: TIDES occurring semimonthly as the result of the moon being over the equator. At these times the tendency of the moon to produce a DIURNAL INEQUALITY in the TIDE is at a minimum.

EROSION: Wearing away of the land by natural forces. On a BEACH, the carrying away of beach material by WAVE action, TIDAL CURRENTS or by DEFLATION. (2) (SMP) The wearing away of land by the action of natural forces.

ESCARPMENT: A more or less continuous line of CLIFFS or steep SLOPES facing in one general direction which are caused by EROSION or faulting, also called SCARP.

ESTUARY: (1) A semi-enclosed coastal body of water which has a free connection with the OPEN SEA. The seawater is usually measurably diluted with freshwater. (2) The part of the RIVER that is affected by TIDES. (3) (SMP) The zone or area of water in which freshwater and saltwater mingle and water is usually brackish due to daily mixing and layering of fresh and salt water.

EULITTORAL: That part of the LITTORAL ZONE less than 50 m in DEPTH.

EVENT: An occurrence meeting specified conditions, e.g. damage, a threshold WAVE HEIGHT or a threshold WATER LEVEL.

F

FACIES: The sum total of features such as sedimentary rock type, MINERAL content, SEDIMENTARY STRUCTURES, BEDDING characteristics, fossil content, etc. which characterise a SEDIMENT as having been deposited in a given environment.

FAIRWAY: The parts of a waterway kept open, and unobstructed, for navigation.

FATHOM: A measure of WATER DEPTH equal to 1.83 m (6 feet).

FAULT: A fracture in rock along which there has been an observable amount of displacement. Faults are rarely single planar units; normally they occur as parallel to sub-parallel sets of planes along which movement has taken place to a greater or lesser extent. Such sets are called fault or fracture-zones.

FAUNA: The entire group of animals found in an area.

FEEDER BEACH: An artificially widened beach serving to nourish DOWNDRIFT beaches by natural LITTORAL CURRENTS or other forces.

FEEDER CURRENT: The currents which flow parallel to SHORE before converging and forming the NECK of a RIP CURRENT. See Figure 7.

FETCH: The length of unobstructed OPEN SEA surface across which the wind can generate WAVES (GENERATING AREA).

FETCH LENGTH: (1) The horizontal distance (in the direction of the wind) over which a wind generates SEAS or creates WIND SETUP. (2) The horizontal distance along open water over which the wind blows and generates waves.

FJORD: A long, narrow arm of the SEA, usually formed by entrance of the SEA into a deep glacial trough.

FLOATING BOG: A grass or moss growth floating on a pool of water with high content of decayed vegetation, grass and moss roots.

FLOCCULATION: The change which takes place when the DISPERSED phase of a COLLOID forms a series of discrete particles which are capable of settling out from the DISPERSION medium. In geological processes, *flocculation* is almost inevitably a result of a COLLOIDAL solution mixing with a solution containing electrolytes, e.g., sea water.

FLOOD: (1) Period when TIDE level is rising; often taken to mean the flood current which occurs during this period. (2) A flow above the CARRYING CAPACITY of a CHANNEL.

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 INTERVAL: The interval between the transit of the moon over the meridian of a place and the time of the following flood.

FLOOD MARK: Proof of any kind on the SHORELINE used to determine the highest level attained by the water surface during the flood (note: the height of the flood mark usually includes the WAVE RUN-UP).

FLOODPLAIN: (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) (SMP) Synonymous with 100-year *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. The limits of this area are based on flood regulation ordinance maps or reasonable method that meets the objectives of the SMP (WAC 173-22-030(2)).

FLOOD ROUTING: The attenuating effect of storage on a river-flood passing through a VALLEY by reason of a feature acting as control (e.g. a reservoir with a spillway capacity less than the flood inflow, or the widening or narrowing of a VALLEY).

FLOOD STRENGTH: The FLOOD CURRENT at time of maximum velocity.

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

FLOOD TIDE: A nontechnical term used for rising TIDE or flood current. In technical language flood refers to current. The portion of the tidal cycle between LOW WATER and the following high water. See Figure12.

FLORA: The entire group of plants found in an area.

FLUSHING TIME: The time required to replace all the water in an ESTUARY, HARBOR, etc., by action of current and tide.

FOAM: The light-colored substance which is made up of an aggregation of bubbles, formed on the surface of liquids by violent agitation.

FOAM LINE: (1) The front of a WAVE as it advances shoreward, after it has broken. (2) Lines of foam such as those which move around the HEAD of a RIP.

FOG: Vapor condensed to fine particles of water and obscuring vision near the ground.

FOLLOWING WIND: A wind blowing in the same direction as the WAVES are travelling.

FORESHORE: (1) The part of the SHORE, lying between the BERM CREST and the ordinary LOW WATER mark, which is ordinarily traversed by the UPRUSH and BACKRUSH of the WAVES as the TIDES rise and fall. (2) The same as the BEACH FACE where UNCONSOLIDATED material is present. (3) (SMP) In general terms, the BEACH between MEAN HIGHER HIGH WATER and MEAN LOWER LOW WATER.

FREEBOARD: The additional height of a structure above design HIGH WATER level to prevent overflow. Also, at a given time, the vertical distance between the WATER LEVEL and the top of the structure.

FRONTAGER: Person or persons owning, and often living in, property immediately landward of the beach.

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 wind speed, 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) (SMP) 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.

GALE: A wind between a strong breeze and a storm. A continuous wind blowing in degrees of moderate, fresh, strong, or whole *gale* and varying in velocity from 28 to 30 NAUTICAL MILES per hour.

GAUGE: A device for measuring the WATER LEVEL relative to a DATUM.

GENERATING AREA: In WAVE forecasting, a continuous area of the water surface over which the wind blows in essentially the same direction. Sometimes used synonymously with FETCH LENGTH.

GENERATION OF WAVES: (1) The creation of WAVES by natural or mechanical means. (2) The creation of and growth of WAVES by a wind blowing over a water surface for a certain length of time. The area involved is called the GENERATING AREA or FETCH.

GEODESY (OR GEODETICS): The science of dealing with the investigation of scientific questions connected with the shape and dimensions of the Earth.

GEOGRAPHIC INFORMATION SYSTEM (GIS): A system of spatially referenced information, including computer programs that acquire, store, manipulate, analyze, and display spatial data.

GEOID: The equipotential surface of the Earth's gravity field which best fits, in the least squares sense, MEAN SEA LEVEL.

GEOLOGY: The science which treats of the origin, history and structure of the Earth, as recorded in ROCKS; together with the forces and processes now operating to modify ROCKS.

GEOMORPHOLOGY: (1) That branch of physical geography which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc. (2) The investigation of the history of geologic changes through the interpretation of topographic forms.

GEOPHYSICS: The study of the physical characteristics and properties of the Earth.

GLOBAL POSITIONING SYSTEM (GPS): A navigational and positioning system developed by the U.S. Department of Defense, by which the location of a position on or above the Earth can be determined by a special receiver at that point interpreting signals received simultaneously from several of a constellation of special satellites.

GRADED BEDDING: An arrangement of PARTICLE SIZES within a single bed, with coarse grains at the bottom of the bed and progressively finer grains toward the top of the bed.

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.

GRAVEL: (1) Loose, rounded fragments of rock, larger than SAND, but smaller than cobbles. (2) Small STONES and PEBBLES, or a mixture of these with SAND.

GRAVITY WAVE: A WAVE whose velocity of propagation is controlled primarily by gravity. Water WAVES more than 5 cm long are considered *gravity waves*. WAVES longer than 2.5 cm and shorter than 5 cm are in an indeterminate zone between CAPILLARY and GRAVITY WAVES. See RIPPLE. See Figure 10.

GREAT DIURNAL RANGE: The difference in height between MEAN HIGHER HIGH WATER and MEAN LOWER LOW WATER. The expression may also be used in the contracted form diurnal range.

GROIN: (1) A shore-protection structure (built usually to trap LITTORAL DRIFT or retard EROSION of the SHORE). It is narrow in width (measured parallel to the SHORE) and its length may vary from tens to hundreds of meters (extending from a point landward of the SHORELINE out into the water). GROINS may be classified as *permeable* (with openings through them) or *impermeable* (a solid or nearly solid structure). (2) (SMP) A barrier-type structure extending from the BACKSHORE or stream bank into a water body for the purpose of the protection of a SHORELINE and adjacent upland by influencing the movement of water and/or deposition of materials.

GROIN BAY: The BEACH compartment between two groins.

GROIN SYSTEM: A series of GROINS acting together to protect a section of BEACH. Commonly called a GROIN field.

GROUND PENETRATING RADAR (GPR): A geophysical technology that uses radio waves to detect buried objects and the internal structure of landforms.

GROUND SWELL: (1) Long high SWELL in DEEP WATER. (2) Also, this SWELL as if rises to prominent height in SHOAL water.

GROUND WATER: Subsurface water occupying the zone of saturation. In a strict sense the term applied only to water below the WATER TABLE.

GROUP VELOCITY: The velocity at which a WAVE GROUP travels. In DEEP WATER, it is equal to one-half the individual WAVE VELOCITY.

GULF: A relatively large portion of SEA, partly enclosed by land.

GUT: (1) A narrow passage such as a STRAIT or INLET. (2) A CHANNEL in otherwise SHALLOW WATER, generally formed by water in motion.

GUYOT: Flat-topped SEAMOUNT.

H

HABITAT: The place where an organism lives.

HALF-TIDE LEVEL: A plane midway between MEAN HIGH WATER and MEAN LOW WATER, also called MEAN TIDE LEVEL.

HALOCLINE: A zone in which SALINITY changes rapidly.

HARBOR: A water area nearly surrounded by land, sea walls, BREAKWATERS or artificial DIKES, forming a safe anchorage for ships.

HARD DEFENSES: A general term applied to impermeable COASTAL DEFENSE structures of concrete, timber, steel, masonry, etc, which reflect a high proportion of INCIDENT WAVE energy.

HEAD: (1) A comparatively high PROMONTORY with either a CLIFF or steep face. It extends into a large body of water, such as a SEA or lake. An unnamed HEAD is usually called a *headland*. (2) The section of RIP CURRENT which has widened out seaward of the BREAKERS, also called *head of rip*.

HEADLAND: A land mass having a considerable ELEVATION. See Figure 13.

HEAVE: (1) The vertical rise or fall of the WAVES or the SEA. (2) The translational movement of a craft parallel to its vertical axis. (3) The net transport of a floating body resulting from WAVE action.

HEAVY SEA: A SEA in which the WAVES run high.

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 HIGHER HIGH WATER. See Figure 11.

HIGHER LOW WATER (HLW): The higher of the two low waters of any TIDAL DAY. See Figure 11.

HIGH SEAS: This term, in municipal and international law, denotes all that continuous body of salt water in the world that is navigable in its character and that lies outside territorial waters and maritime belts of the various countries, also called OPEN SEA.

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. Nontechnically, also called the HIGH TIDE.

HIGH WATER LINE: The intersection of MEAN HIGH WATER with the SHORE. The SHORELINE delineated on the nautical charts of the U.S. Coast and Geodetic Survey is an approximation of the mean high water line.

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

HINDCASTING: In WAVE prediction, the retrospective forecasting of WAVES using measured wind information. See also WAVE HINDCASTING.

HINTERLAND: The region lying inland from the COAST.

HISTORIC EVENT ANALYSIS: Extreme analysis based on HINDCASTING typically ten EVENTS over a period of 100 years.

HOOK: A SPIT or narrow CAPE, turned landward at the outer end, resembling a hook in form.

HORIZON: (1) The line or circle which forms the apparent boundary between Earth and sky. (2) (*Geological*) A plane in rock strata characterized by particular features, as occurrence of distinctive fossil species. One of the series of distinctive layers found in a vertical cross-section of any well-developed SOIL.

HURRICANE: A cyclonic storm, usually of tropic origin, covering an extensive area, and containing winds in excess of 75 miles per hour.

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.

I

IMPERMEABLE GROIN: A GROIN through which SAND can not pass.

INCIDENT WAVE: WAVE moving landward.

INFRAGRAVITY WAVES: WAVES with periods above about 30 seconds generated by WAVE GROUPS breaking in the SURF ZONE. See LONG WAVES.

INLET: (1) A narrow strip of water running into the land or between islands. (2) An arm of the SEA (or other body of water) that is long compared to its width, and that may extend a considerable distance inland.

INLET GORGE: Generally, the deepest region of an INLET.

INSHORE: (1) The region where WAVES are transformed by interaction with the sea bed. (2) In beach terminology, the zone of variable width extending from the LOW WATER LINE through the BREAKER ZONE.

INSHORE CURRENT: Any current inside the SURF ZONE.

INTERTIDAL: The zone between the high and LOW WATER marks.

IRREGULAR WAVES: WAVES with random WAVE PERIODS (and in practice, also heights), which are typical for natural wind-induced WAVES.

ISOBATH: Line connecting points of equal WATER DEPTH on a chart; a seabed contour.

ISOSTASY: The tendency of the Earth's crust to maintain a state of near equilibrium, i.e., if anything occurs to modify the existing state, a compensation change will occur to maintain a balance.

ISOTOPE: An atom with a specified number of protons and a specified number of neutrons.

J

JETTY: (1) On open SEACOASTS, a structure extending into a body of water to direct and confine the STREAM or tidal flow to a selected CHANNEL, or to prevent shoaling. Jetties are built at the mouth of a RIVER or ENTRANCE to a BAY to help deepen and stabilize a CHANNEL and facilitate navigation. (2) (SMP) A structure usually projecting out into the SEA at the mouth of a river for the purpose of protecting a navigational channel, a harbor or to influence water currents.

K

KEY: A low, insular BANK of SAND, coral, etc., as one of the islets off the southern coast of Florida.

KNOT: The unit of speed used in navigation. It is equal to one NAUTICAL MILE (6076.115 feet or 1852 meters) per hour.

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. See DAILY RETARDATION OF TIDES.

LAGOON: A shallow body of water, as a pond or lake, which usually has a shallow restricted INLET from the SEA. See Figure 5.

LAMINAR FLOW: Slow, smooth flow, with each drop of water traveling a smooth path parallel to its neighboring drops. *Laminar flow* is characteristic of low velocities, and particles of

SEDIMENT in the flow zones are moved by rolling or SALTATION.

LANDLOCKED: Enclosed by land, or nearly enclosed, as a HARBOR.

LANDMARK: A conspicious object, natural or man-made, located near or on land, which aids in fixing the position of an observer.

LEADLINE: A line, wire or cord used in SOUNDING. It is weighted at one end with a plummet (sounding lead). See also SOUNDING LINE.

LEDGE: A rocky formation continuous with and fringing the SHORE.

LEEWARD: The direction *toward* which the prevailing wind is blowing; the direction *toward* which WAVES are travelling.

LEVEE: (1) An EMBANKMENT to prevent inundation. (2) (SMP) A large DIKE or EMBANKMENT, often having an access road along the top, which is designed as part of a system to protect land from floods.

LIGHT BREEZE: A wind with velocity from 4 to 6 NAUTICAL MILES per hour.

LIMIT OF BACKWASH: The seaward limit of the BACKWASH at any given TIDE stage.

LIMIT OF UPRUSH: The landward limit of UPRUSH at any given TIDE stage.

LITTORAL: (1) Of, or pertaining to, a SHORE, especially a SEASHORE. (2) (SMP) Living on, or occurring on, the SHORE.

LITTORAL CURRENTS: A current running parallel to the BEACH and generally caused by WAVES striking the SHORE at an angle.

LITTORAL DEPOSITS: Deposits of LITTORAL DRIFT.

LITTORAL DRIFT: (1) The sedimentary *material* moved in the LITTORAL ZONE under the influence of WAVES and

currents. (2) (SMP) The mud, SAND, or GRAVEL material moved parallel to the SHORELINE in the NEARSHORE ZONE by waves and CURRENTS.

LITTORAL TRANSPORT: The movement of LITTORAL DRIFT 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: The rate of transport of sedimentary material parallel to or perpendicular to the SHORE in the LITTORAL ZONE. Usually expressed in cubic meters (yards) per year. Commonly used as synonymous with LONGSHORE TRANSPORT RATE.

LITTORAL ZONE: An indefinite zone extending seaward from the SHORELINE to just beyond the BREAKER ZONE.

LOAD: The quantity of SEDIMENT transported by a current. It includes the SUSPENDED LOAD of small particles in the water, and the bedload of large particles that move along the bottom.

LOCALLY GENERATED WAVES: WAVES generated within the immediate vicinity, within approximately 50 km, of the point of interest.

LONGCRESTED WAVES: A WAVE, the crest length of which is long compared to the WAVE LENGTH.

LONGSHORE: Parallel and close to the COASTLINE.

LONGSHORE BAR: A SAND ridge or ridges, 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 CURRENT: A current located in the SURF ZONE, moving generally parallel to the SHORELINE, generated by WAVES breaking at an angle with the SHORELINE, also called the ALONGSHORE CURRENT. See also NEARSHORE CURRENT SYSTEM). See Figure 6.

LONGSHORE DRIFT: Movement of SEDIMENTS approximately parallel to the COASTLINE.

LONGSHORE TRANSPORT RATE: Rate of transport of sedimentary material parallel to the SHORE. Usually expressed in cubic meters (yards) per year. Commonly used as synonymous with LITTORAL TRANSPORT RATE.

LONGSHORE TROUGH: An elongate DEPRESSION or series of depressions extending along the lower BEACH or in the OFFSHORE zone inside the BREAKERS.

LONG WAVES: WAVES with periods above about 30 seconds; can be generated by WAVE GROUPS breaking in the SURF ZONE. See also INFRAGRAVITY WAVES.

LOOP: That part of a STANDING WAVE where the vertical motion is greatest and the horizontal velocities are least.

LOWER HIGH WATER (LHW): The lower of the two high waters of any TIDAL DAY. See Figure 11.

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 LLW. See Figure 11.

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. See Figure 11.

LOW TIDE: See LOW WATER

LOW TIDE TERRACE: A flat zone of the BEACH near the LOW WATER level.

LOW WATER (LW): The minimum height reached by each falling TIDE. Nontechnically, also called LOW TIDE.

LOW WATER LINE: The line where the established LOW WATER DATUM intersects the SHORE. The plane of reference that constitutes the LOW WATER DATUM differs in different regions.

LUNAR DAY: The time of 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. The mean *lunar day* is approximately 24.84 solar hours in length, or 1.035 times as great as the mean solar day. Also called TIDAL DAY.

LUNAR TIDE: The portion of the TIDE that can be attributed directly to attraction to the Moon.

M

MACRO-TIDAL: TIDAL RANGE greater than 4 m.

MANAGED RETREAT: The deliberate setting back of the existing line of defense in order to obtain engineering and/or environmental advantages.

MARGIN, CONTINENTAL: A zone separating a continent from the deep-sea bottom.

MARKER, SURVEY: An object placed at the site of a station to identify the surveyed location of that station.

MARKER, REFERENCE: A mark of permanent character close to a survey station, to which it is related by an accurately measured distance and azimuth (or bearing).

MARIGRAM: A graphic record of the rise and fall of the TIDE. The record is in the form of a curve in which time is represented by abscissas and the height of the TIDE by ordinates.

MARSH: (1) A tract of soft, wet land, usually vegetated by reeds, grasses and occasionally small shrubs. (2) (SMP) Soft, wet area periodically or continuously flooded to a shallow depth, usually characterized by a particular subclass of grasses, cattails and other low plants.

MARSH, DIKED: A former SALT MARSH which has been protected by a DIKE.

MARSH, SALT: A MARSH periodically flooded by salt water.

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 CURRENT SYSTEM. See Figure 7.

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 HIGHER HIGH WATER (MHHW): The arithmetic average of the ELEVATIONS of the HIGHER HIGH WATERS of a MIXED TIDE over a specific 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 interval.

MEAN HIGH WATER (MHW): The average ELEVATION of all high waters recorded at a particular point or station over a considerable period of time, usually 19 years. 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. 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 HIGH WATER SPRINGS (MHWS): The average height of the HIGH WATER occurring at the time of SPRING TIDES.

MEAN LOWER LOW WATER (MLLW): The average height of the lower low 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 observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value.

MEAN LOW WATER SPRINGS (MLWS): The average height of the low waters occurring at the time of the SPRING TIDES.

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

MEAN RISE OF THE TIDE: The height of MEAN HIGH WATER above the plane of reference or DATUM of chart.

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 (see sea level datums).

MEAN STEEPNESS: The ratio of the MEAN DEPTH to the horizontal distance over which the MEAN DEPTH was determined.

MEAN TIDE LEVEL: Same as HALF-TIDE LEVEL.

MEAN WATER LEVEL: The mean surface level as determined by averaging the heights of the water at equal intervals of time, usually at hourly intervals.

MEAN WAVE PERIOD: The mean of all individual WAVES in an observation interval of approximately half an hour.

MESO-TIDAL: TIDAL RANGE between 2 m and 4 m.

METEOROLOGICAL TIDES: Tidal constituents having their origin in the daily or seasonal variation in weather conditions which may occur with some degree of periodicity.

MICRO-TIDAL: TIDAL RANGE less than 2 m.

MIDDLEGROUND SHOAL: A SHOAL formed by EBB and flood TIDES in the middle of the CHANNEL of the LAGOON or ESTUARY end of an INLET.

MID-EXTREME TIDE: A plane midway between the extreme HIGH WATER and the extreme LOW WATER occurring in any locality.

MINERAL: A naturally occurring, inorganic, crystalline solid that has a definite chemical composition and possesses characteristic physical properties.

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.

MIST: Water vapor suspended in the air in very small drops finer than rain, larger than FOG.

MIXED CURRENT: Type of TIDAL CURRENT characterized by a conspicious velocity difference between the two FLOODS or two EBBS usually occurring each TIDAL DAY. See also MIXED TIDE.

MIXED TIDE: Type of TIDE which the presence of a DIURNAL WAVE is conspicious 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.

MOLE: In coastal terminology, a massive solid-filled structure (generally revetted) of earth, masonry or large STONE.

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

MORAINE: An accumulation of earth, STONES, etc., deposited by a glacier, usually in the form of a mound, ridge or other prominence on the terrain.

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.

MUD FLAT: A muddy, low-lying strip of ground by the SHORE, or an island, usually submerged more or less completely by the rise of the TIDE.

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.

NAUTICAL MILE: Also known as GEOGRAPHICAL MILE, its length is 1852 meters (6076.115 feet), approximately 1.15 times as long as the statute mile of 5280 feet.

NEAP HIGH WATER: See NEAP TIDE.

NEAP LOW WATER: See NEAP TIDE.

NEAP RANGE: See NEAP TIDE.

NEAP TIDAL CURRENT: TIDAL CURRENT of decreased velocity occurring semimonthly as the result of the moon being in quadrature.

NEAP TIDE: TIDE of decreased range occurring semimonthly as the result of the moon being in quadrature. The NEAP RANGE of the TIDE is the average SEMIDIURNAL range occurring at the time of NEAP TIDES 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. The average height of the high waters of the NEAP TIDE is called NEAP HIGH WATER or HIGH WATER NEAPS (MHWN), and the average height of the corresponding LOW WATER is called NEAP LOW WATER or LOW WATER NEAPS (MLWN).

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 CURRENT: The current system caused by WAVE action in and near the BREAKER ZONE, and which consists of four parts: the SHOREWARD MASS TRANSPORT of water; LONGSHORE CURRENTS; RIP CURRENTS; and the LONGSHORE movement of the expanding heads of RIP CURRENTS.

NECK: (1) The narrow strip of land which connects a PENINSULA with the mainland, or connects two ridges. (2) The narrow band (rip) of water flowing seaward through the SURF. See also RIP CURRENT. See Figure 7.

NESS: Roughly triangular PROMONTORY of land jutting into the SEA, often consisting of mobile material, i.e. a beach form.

NETWORK: A set consisting of: (a) stations for which geometric relationships have been determined and which are so related that removal of one station from the set will affect the relationships (distances, directions, coordinates, etc.) between the other stations; and (b) lines connecting the stations to show this interdependence.

NIP: The cut made by WAVES in a SHORELINE of emergence.

NODAL ZONE: An area in which the predominant direction of the LONGSHORE TRANSPORT changes.

NOURISHMENT: The process of replenishing a BEACH. It may be brought about naturally, by LONGSHORE TRANSPORT, or artificially by the deposition of dredged materials.

O

OCEAN: The great body of salt water which occupies two-thirds of the surface of the Earth, or one of its major subdivisions.

OCEAN CURRENT: A nontidal current constituting a part of the general oceanic circulation.

OCEANOGRAPHY: That science treating of the OCEANS, their forms, physical features and phenomena.

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 BREAKWATER: A BREAKWATER built towards the seaward limit of the LITTORAL ZONE, parallel (or nearly parallel) to the SHORE.

OFFSHORE CURRENTS: (1) Currents outside the SURF ZONE. (2) Any current flowing away from the SHORE. See Figure 7.

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

ONSHORE: A direction landward *from* the SEA.

ONSHORE CURRENT: Any current flowing *towards* the shore.

ONSHORE WIND: A wind blowing landward *from* the SEA.

OPEN SEA: Same as HIGH SEAS.

OPPOSING WINDS: A wind blowing in the opposite direction to that in which the WAVES are travelling.

ORDINARY HIGH WATER MARK (OHWM): (SMP) That mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegitation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department.

ORDINARY TIDE: This expression is not used in a technical sense by the U.S. Coast and Geodetic Survey, but the word "ordinary" when applied to TIDES, may be taken as the equivalent of the word "mean". Thus "ordinary HIGH WATER LINE" may be assumed to be the same as "mean high water line".

ORTHOPHOTOGRAPH: A photograph prepared from a perspective photograph by removing distortions and displacements of points caused by tilt, relief, and perspective.

ORTHOPHOTOMAP: A map made by assembling a number of ORTHOPHOTOGRAPHS into a single, composite picture.

OSCILLATION: A periodic motion backward and forward. To vibrate or vary above and below a mean value.

OUTCROP: A surface exposure of bare rock, not covered by SOIL or vegetation.

OUTFALL: (1) The vent of a RIVER, drain, etc. (2) A structure extending into a body of water for the purpose of discharging sewage, storm runoff or cooling water.

OUTFLANKING: EROSION behind or around the inner end of a GROIN or BULKHEAD, usually causing failure of the structure.

OVERFALLS: Breaking WAVES caused by a conflict of currents, or by the wind moving against the current.

OVERSPLASH: The water that splashes over the top of a BREAKWATER, SEAWALL, etc.

OVERTOPPING: Water carried over the top of a COASTAL DEFENSE due to WAVE RUN-UP or SURGE action exceeding the crest height.

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

PARTIALLY MIXED ESTUARY: An ESTUARY that shows a small to moderate SALINITY change with DEPTH.

PARTICLE SIZE: in dealing with SEDIMENTS and sedimentary ROCKS it is necessary that precise dimensions should be applied to such terms as CLAY, SAND, pebble, etc. Numerous scales have been suggested, but in this work, the Wentworth-Udden scale is used, as it is widely accepted as an international standard. In the table which follows, *particle size* limits are shown, but within most groups further subdivision is possible; for example, SAND may be described as very fine, medium,

coarse, very coarse. *particle size* is normally determined by hand measurement of PEBBLES, cobbles, and BOULDERS, sieving of GRAVEL, SAND and SILT and ELUTRIATION of SILT and CLAY (7).

SIZE RANGE	*PARTICLE*
>256 mm.	BOULDER
64 – 256 mm.	COBBLE
4 – 64 mm.	PEBBLE
2 – 4 mm.	'Granule', GRAVEL
1/16 – 2 mm.	SAND
1/256 – 1/16 mm.	SILT
<1/256 mm.	CLAY

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

PEBBLES: Beach material usually well-rounded and between about 4 mm to 64 mm diameter.

PENINSULA: An elongated portion of land nearly surrounded by water and connected to a larger body of land, usually by a NECK or an ISTHMUS.

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 perigree (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 perigree.

PERIODIC CURRENT: A current caused by the tide-producing forces of the Moon and the Sun, a part of the same general movement of the SEA that is manifested in the vertical rise and fall of the TIDES. See FLOOD CURRENT and EBB CURRENT.

PERMANENT CURRENT: A current that runs continuously independent of the TIDES and temporary cause. PERMANENT CURRENTS include the fresh water discharge of a RIVER and the currents that form the general circulatory systems of the OCEAN.

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 large enough to permit passage of appreciable quantities of LITTORAL DRIFT.

PETROLOGY: That branch of GEOLOGY which treats of the scientific study of ROCKS.

PHOTIC ZONE: The zone extending downward from the OCEAN surface within which the light is sufficient to sustain photosynthesis. The DEPTH of this layer varies with water clarity, time of year and cloud cover, but is about 100 m in the open OCEAN. It may be considered the DEPTH to which all light is filtered out except for about one percent and may be calculated as about two and one-half times the DEPTH of a SECCHI DISK reading.

PHOTOGRAMMETRY: The science of deducing the physical dimensions of objects from measurements on images (usually photographs) of the objects.

PHOTOMOSAIC: An assemblage of photographs, each of which shows part of a region, put together in such a way that each point in the region appears once and only once in the assemblage, and scale variation is minimized.

PHYSICAL GEOLOGY: A large division of GEOLOGY concerned with earth materials, changes of the surface and interior of the earth, and the forces that cause those changes.

PIER: A structure, usually of open construction, extending out into the water from the SHORE, to serve as a landing place, recreational facility, etc., rather than to afford coastal protection.

PILE: A long substantial pole of wood, concrete or metal, driven into the earth or sea bed to serve as a support or protection.

PILING, SHEET: Interlocking member of wood, steel, concrete, etc., subject to lateral pressure, driven individually to form an obstruction to percolation, to prevent movement of material for SEAWALLS, stabilization of foundations, etc.

PIPING: EROSION of closed flow CHANNELS (tunnels) by the passage of water through SOIL; flow underneath structures, carrying subsoil particles, may endanger the stability of the structure.

PIXEL: An element of surface resulting from subdividing an image into the smallest identically shaped figures that give information about the location, intensity and perhaps color of the source, but such that no smaller subdivision will provide more information.

PLACER DEPOSITS: MINERAL deposits consisting of dense, resistant and often economically valuable MINERALS which have been weathered from TERRIGENOUS ROCKS, transported to the SEA and concentrated in marine sediments by WAVE or current action.

PLACER MINE: Surface mines in which valuable MINERAL grains are extracted from STREAM bar or beach deposits.

PLANFORM: The outline or shape of a body of water as determined by the stillwater line.

PLATEAU: (1) (Geographical) an elevated plain, tableland or flat-topped region of considerable extent. (2) (Oceanographical) an ELEVATION from the bottom of the OCEAN with a more or less flat top and steep sides.

PLEISTOCENE: An epoch of the QUATERNARY Period characterized by several glacial ages.

PLUNGE POINT: (1) For a PLUNGING WAVE, the point at which the WAVE curls over and breaks. (2) The final breaking point of the WAVES just before the water rushes up the BEACH.

POCKET BEACH: A BEACH, usually small, between two HEADLANDS.

POINT: (1) The extreme end of a CAPE, or the outer end of any land area protruding into the water, usually less prominent than a CAPE. (2) (SMP) A low profile SHORELINE

PROMONTORY of more or less triangular shape, the top of which extends SEAWARD.

POINT BAR: A STREAM bar deposited on the inside of a curve in the STREAM, where the water velocity is low.

PORT: A place where vessels may discharge or receive cargo.

PRESERVATION: Static protection of an area or element, attempting to perpetuate the existence of a given 'state'.

PROFILE, BEACH: See BEACH PROFILE

PROGRESSIVE WAVE: A WAVE which is manifested by the progressive movement of the WAVE form.

PROMONTORY: A high point of land extending into a body of water; a HEADLAND.

Q

QUATERNARY: (1) The youngest geologic period; includes the present time. (2) The latest period of time in the stratigraphic column, 0 – 2 million years, represented by local accumulations of glacial (Pleistocene) and post-glacial (Holocene) deposits which continue, without change of fauna, from the top of the Pliocene (Tertiary). The QUATERNARY appears to be an artificial division of time to separate pre-human from post-human sedimentation. As thus defined, the QUATERNARY is increasing in duration as man's ancestry becomes longer.

R

RADAR: An instrument for determining the distance and direction to an object by measuring the time needed for radio signals to travel from the instrument to the object and back, and by measuring the angle through which the instrument's antenna has traveled.

RADIOACTIVE DATING (RADIOMETRIC DATING): the most reliable method of obtaining a 'date' for a rock depends upon the

observation that the rate of decay of a radioactive element is a constant. The earliest methods, using uranium and thorium MINERALS as the starting material, yielded evidence that the extent of geological time was at least 2 million years. The development of knowledge concerning radioactive processes since 1939 has made available a number of refined techniques for RADIOACTIVE DATING which are nowadays routine processes.

RAISED BEACH: A WAVE-CUT PLATFORM, with or without a covering of beach materials, which is now raised above the present sea-level. See also REJUVENATION.

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

RANGE OF TIDE: The difference in height between consecutive high and low waters. The MEAN RANGE is the difference between MEAN HIGH WATER and MEAN LOW WATER. The GREAT DIURNAL RANGE or DIURNAL RANGE is the difference in height between MEAN HIGHER HIGH WATER (MHHW) and MEAN LOWER LOW WATER (MLLW). Where the type of TIDE is DIURNAL, the mean range is the same as the DIURNAL range. See Figure 11.

RAVINEMENT: UNCONFORMITIES in a transgressional sequence of deposits which take on a variety of forms based on wave energy and sediment supply.

REACH: (1) An arm of the OCEAN extending into the land. (2) A straight section of restricted waterway of considerable extent; may be similar to a NARROWS, except much longer in extent.

RECENT: (Geological) A synonym of Holocene. See also QUATERNARY.

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

RECTIFICATION: The process of producing, from a tilted or oblique photograph, a photograph from which displacement caused by tilt has been removed.

RECHARGE: The addition of new water to an AQUIFER or to the zone of saturation.

RED TIDE: Discoloration of surface waters, most frequently in COASTAL ZONES, caused by large concentrations of microorganisms.

REEF: A ridge of rock or other material lying just below the surface of the SEA.

REEF BREAKWATER: Rubble mound of single-sized STONES with a crest at or below sea level which is allowed to be (re)shaped by the WAVES.

REFERENCE PLANE: The plane to which SOUNDING and tidal data are referred.

REFERENCE POINT: (1) A specified location (in plan elevation) to which measurements are referred. (2) In beach material studies, a specified point within the REFERENCE ZONE.

REFERENCE STATION: A TIDE or current station for which tidal or TIDAL CURRENT 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 ZONE: In regard to beach measuring procedure, the part of the FORESHORE subject to WAVE action (between the LIMIT OF UPRUSH and the LIMIT OF BACKWASH) at mid-tide stage. In areas of great TIDAL RANGE a more complex definition is needed.

REFLECTED WAVE: That part of an INCIDENT WAVE that is returned (reflected) seaward when a WAVE impinges on a BEACH, SEAWALL or other reflecting surface.

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

REFLECTION, SEISMIC: See SEISMIC REFLECTION.

REFRACTION: The process by which the direction of a WAVE moving in SHALLOW WATER at an angle to the bottom contours is changed. The part of the WAVE moving shoreward in shallower water travels more slowly than that portion in

deeper water, causing the WAVE to turn or bend to become parallel to the contours. See Figure 13.

REFLECTOR: A surface, usually a rock or SEDIMENT layer, that strongly reflects seismic (sound) waves.

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

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

RESOLUTION: (1) In general, a measure of the finest detail distinguishable in an object or phenomenon. (2) In particular, a measure of the finest detail distinguishable in an image.

RETARDATION: The amount of time by which corresponding tidal phases grow later day by day (about 50 minutes).

RETURN PERIOD: Average period of time between occurrences of a given EVENT.

REVERSING TIDAL CURRENT: A TIDAL CURRENT that flows alternately in approximately opposite directions with a SLACK WATER at each reversal of direction. Currents of this type usually occur in RIVERS and STRAITS where the direction of flow is more or less restricted to certain CHANNELS. When the movement is towards the SHORE, the current is said to be flooding, and when in the opposite direction it is said to be ebbing.

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) (SMP) Facing of stone, concrete, etc., built to protect a SCARP, EMBANKMENT or shore structure against erosion by waves of CURRENTS.

RILL MARKS: Small drainage CHANNELS forming in the lower portion of a BEACH at LOW TIDE.

RIPARIAN: (1) Pertaining to the banks of a body of water. (2) (SMP) Of, on or pertaining to the banks of a river.

RIP CHANNEL: A CHANNEL cut by seaward flow of RIP CURRENT, usually crosses a LONGSHORE BAR.

RIP CURRENT: A strong surface current of short duration flowing seaward from the SHORE. It usually appears as a visible band of agitated water and is the return movement of water piled up on the SHORE by incoming WAVES and wind. A RIP CURRENT consists of three parts: the FEEDER CURRENT flowing parallel to the shore inside the BREAKERS; the NECK, where the FEEDER CURRENTS converge and flow through the breakers in a narrow band or "rip"; and the HEAD, where the current widens and slackens outside the breaker line. See Figure 7.

RIPPLE: (1) The light fretting or ruffling on the surface of the water caused by a breeze. (2) The smallest class of WAVES and one in which the force of restoration is, to a significant degree, both surface tension and gravity.

RIPPLE-DRIFT BEDDING (RIPPLE-DRIFT CROSS-BEDDING): See CROSS-BEDDING.

RIPPLE MARKS: Undulations produced by fluid movement over SEDIMENTS. Oscillatory currents produce symmetric RIPPLES whereas a well-defined current direction produces asymmetrical RIPPLES. The crest line of RIPPLES may be straight or sinuous. The characteristic features of *ripples* depend upon current velocity, PARTICLE SIZE, persistence of current direction and whether the fluid is air or water. SAND DUNES may be regarded as a special kind of 'super'-ripple.

RIPRAP: (1) Broken STONES used for REVETMENT, TOE protection for BLUFFS, or structures exposed to wave action, foundations, etc. (2) Foundation of wall or STONES placed together irregularly. (3) (SMP) A layer, facing or protective mound of stones placed to prevent EROSION, scour or sloughing of a structure or EMBANKMENT; also the stone so used.

RIPS: Agitation of water caused by the meeting of currents or by rapid current setting over an irregular bottom.

RISK ANALYSIS: Assessment of the total risk due to all possible environmental inputs and all possible mechanisms.

RIVER: A natural STREAM of water larger than a brook or CREEK.

ROCKS: An aggregate of one or more MINERALS rather large in area. The three classes of *rocks* are the following: (1) Igneous rock – crystalline rocks formed from molten material. Examples are granite and basalt. (2) Sedimentary rock – A rock resulting from the consolidatrion of loose SEDIMENT that has accumulated in layers. Examples are sandstone, shale and limestone. (3) Metamorphic rock – Rock that has formed from preexisting rock as a result of heat or pressure.

ROLLER: (1) An indefinite term, sometimes considered to denote one of a series of long-crested WAVES which roll in upon a COAST, as after a storm. (2) Long, high SWELL, also called a GROUND SWELL.

ROTARY CURRENT, TIDAL: A TIDAL CURRENT that flows continually with the direction of flow changing through all points of the compass during the TIDAL PERIOD. ROTARY CURRENTS are usually found OFFSHORE where the direction of flow is not restricted by any barriers. The tendency for the rotation in direction has its origin in the deflecting force of the earth's rotation and, unless modified by local conditions, the change is clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. The velocity of the current usually varies throughout the tidal cycle, passing through two maxima in approximately opposite directions and two minima with the direction of the current at approximately ninety degrees from the direction at the time of maximum velocity.

RUNNEL: A corrugation or TROUGH formed in the foreshore or in the bottom just OFFSHORE by WAVES or TIDAL CURRENTS.

RUN-UP: the rush of water up a structure or BEACH on the breaking of a WAVE. The amount of *run-up* is the vertical height above STILLWATER LEVEL that the rush of water reaches (2)

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SALIENT: Coastal formation of beach material developed by WAVE REFRACTION and DIFFRACTION and LONGSHORE drift comprising of a bulge in the COASTLINE

towards an OFFSHORE island or BREAKWATER, but not connected to it as in the case of a TOMBOLO. See also NESS, CUSP.

SALINITY: Number of grams of salt per thousand grams of sea water, usually expressed in parts per thousand.

SALINITY GRADIENT: Change in SALINITY with DEPTH, expressed in parts per thousand per foot.

SALTATION: A term used to describe the movement of a particle being transported by wind or water which is too heavy to remain in suspension. The particle is rolled forward by the current, generates lift and rises, loses the forward momentum supplying the lift and settles to the floor, where the process is repeated. The size of the particles which can be saltated depends upon the velocity of the current and its density, e.g., water will saltate larger particles than air at the same velocity.

SALT-WEDGE ESTUARY: In this circulation type, the density-driven component dominates and two well-mixed layers are separated by a sharp HALOCLINE. The seawater entering the CHANNEL appears as a TONGUE or wedge.

SAND: An UNCONSOLIDATED (geologically) mixture of inorganic SOIL (that may include disintegrated shells and coral) consisting of small but easily distinguishable grains ranging in size from about .062 mm to 2.0 mm.

SAND BAR: (1) See BAR. (2) In a RIVER, a ridge of SAND built to or near the surface by RIVER currents.

SAND DUNE: A DUNE formed of SAND.

SAND SPIT: A narrow SAND EMBANKMENT, created by an excess of deposition at its seaward terminus, with its distal end (the end away from the point of origin) terminating in open water.

SAND WAVES: (1) Longshore sand waves are large-scale features that maintain form while migrating along the shore with speeds on the order of kilometers per year. (2) Large-scale asymmetrical bedforms in sandy river beds having high length to height ratios and continuous crestlines.

SCARP: See ESCARPMENT.

SCOUR PROTECTION: Protection against EROSION of the seabed in front of the TOE.

SEA: (1) See OCEAN. (2) A large body of salt water, second in rank to an OCEAN, more or less LANDLOCKED and generally part of, or connected with, an OCEAN or a larger *sea*. (3) WAVES caused by wind at the place and time of observation. (4) State of the OCEAN or lake surface, in regard to WAVES.

SEA BREEZE: A breeze that blows *from* the SEA toward the land caused by unequal heating of land and water masses.

SEA CLIFF: A CLIFF situated at the seaward edge of the coast. See Figure 2.

SEACOAST: The coast adjacent to the SEA or OCEAN.

SEA DEFENSES: Works to prevent or alleviate flooding by the SEA.

SEA GRASS: Members of marine seed plants that grow chiefly on SAND or sand-mud bottom. They are most abundant in water less than 9 m deep. The common types are: Eel grass (Zostera), Turtle grass (Thallasia) and Manatee grass (Syringodium).

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

SEA PUSS: A dangerous LONGSHORE CURRENT; a RIP CURRENT caused by return flow; loosely, the submerged CHANNEL or INLET through a BAR caused by those currents.

SEAMOUNT: Conical mountain rising 1000 m or more above the sea floor.

SEASHORE: (1) (Law) All ground between the ordinary high-water and low-water mark. (2) The SHORE of the SEA or OCEAN.

SEAWALL: (1) A structure built along a portion of a coast primarily to prevent EROSION and other damage by WAVE action. It retains earth against its shoreward face. (2) (SMP) A structure separating land and water areas primarily to prevent EROSION and other damage by wave action. Generally more massive and capable of resisting greater wave forces than a BULKHEAD.

SECHHI DISK: Visibility disk used to measure the transparency of the water column.

SEDIMENT: (1) Loose, fragments of ROCKS, MINERALS or organic material which are transported from their source for varying distances and deposited by air, wind, ice and water. Other *sediments* are precipitated from the overlying water or form chemically, in place. *Sediment* includes all the UNCONSOLIDATED materials on the sea floor. (2) (SMP) The fine grained material deposited by water or wind.

SEDIMENT CELL: In the context of a strategic approach to COASTAL MANAGEMENT, a length of COASTLINE in which interruptions to the movement of SAND or SHINGLE along the beaches or NEARSHORE sea bed do not significantly affect beaches in the adjacent lengths of COASTLINE. See LITTORAL CELL.

SEDIMENT SINK: A point or area at which beach material is irretrievably lost from a coastal cell, such as an ESTUARY, or a deep CHANNEL in the seabed. See Figure 8.

SEDIMENT SOURCE: A point or area on a COAST from which beach material arises, such as an eroding CLIFF, or RIVER mouth. See Figure 8.

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. See Figure 8.

SEDIMENT TRANSPORT PATHS: The routes along which net SEDIMENT movement occurs.

SEISMIC REFLECTION: The return of part of the energy of SEISMIC WAVES to the earth's surface after the WAVES bounce off a rock boundary.

SEISMIC REFRACTION: The bending of SEISMIC WAVES as they pass from one material to another.

SEISMIC WAVES: A long-period wave caused by an underwater seismic disturbance or volcanic eruption.

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. See Figure 11.

SEMIDIURNAL TIDE: TIDES occurring twice daily. There are two high and two lows per TIDAL DAY. See Figure12.

SENSING, REMOTE: The response of an instrument or organism to stimuli from a distant source.

SET (OF CURRENT): The direction *towards* which a current flows.

SETBACK: (SMP) A required open space, specified in shoreline master programs, measured horizontally upland from an perpendicualr to the ordinary high water mark.

SHALLOW WATER: Water of such DEPTH that surface WAVES are noticeably affected by bottom TOPOGRAPHY. Typically this implies a WATER DEPTH equivalent to less than half the WAVE LENGTH.

SHALLOW WATER WAVE: A PROGRESSIVE GRAVITY WAVE which is in water less than 1/25 the WAVE LENGTH in DEPTH.

SHEET EROSION: The removal of a thin layer of surface material, usually topsoil, by a flowing sheet of water.

SHEET FLOW: Sediment grains under high sheer stress moving as a layer that extends from the bed surface to some distance below (on the order of a few cm). Grains are transported in the direction of fluid flow.

SHEET, SMOOTH: A sheet on which field control and hydrographic data such as SOUNDINGS, depth curves, and regions surveyed with a wire drag are finally plotted before being used in making a final chart.

SHELF, CONTINENTAL: See CONTINENTAL SHELF.

SHINGLE: A loose term for coarse beach material, a mixture of GRAVEL, PEBBLES and larger material, often well-rounded and of hard rock, e.g. chert, flint etc.

SHOAL: (1) (*noun*) A detached area of any material except rock or coral. The DEPTHS over it are a danger to surface navigation. Similar continental or insular shelf features of greater DEPTHS are usually termed BANKS. (2) (*verb*) To *become* shallow gradually. (3) To *cause* to become shallow. (4) To *proceed* from a greater to a lesser DEPTH of water.

SHORE: That strip of ground bordering any body of water which is alternately exposed, or covered by TIDES and/or WAVES. A SHORE of UNCONSOLIDATED material is usually called a BEACH.

SHOREFACE: The narrow zone seaward from the LOW TIDE SHORELINE permanently covered by water, over which the beach sands and GRAVELS actively oscillate with changing WAVE conditions.

SHORELINE: (1) The intersection of a specified plane of water with the SHORE. (2) (SMP) All of the water areas of the state, including reservoirs and their associated uplands, together with the lands underlying them, except those areas excluded under RCW 90.58.030(2)(d).

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.

SHORE TERRACE: A TERRACE made along a COAST by the action of WAVES and shore currents; it may become land by the uplifting of the SHORE or the lowering of the water.

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.

SIGNIFICANT WAVE HEIGHT: Average height of the highest one-third of the WAVES for a stated interval of time.

SIGNIFICANT WAVE PERIOD: Average period of the highest one-third of the WAVES for a stated interval of time.

SILT: SEDIMENT particles with a grain size between 0.004 mm and 0.062 mm, i.e. coarser than CLAY particles but finer than SAND.

SLACK WATER (SLACK TIDE): The state of a TIDAL CURRENT when its velocity is near zero, especially the moment when a reversing current changes its direction and its velocity is zero. The term is also applied to the entire period of low velocity near the time of turning of the current when it is too weak to be of any practical importance in navigation. The relation of the time of SLACK WATER to the tidal phases varies in different localities. In some places SLACK WATER occurs near the times of high and low water, while in other localities the SLACK WATER may occur midway between high and LOW WATER.

SLIDE: In mass wasting, movement of a descending mass along a plane approximately parallel to the SLOPE of the surface.

SLIP FACE: The steep, downwind SLOPE of a dune; formed from loose, cascading SAND that generally keeps the SLOPE at the ANGLE OF REPOSE (about 34 degrees).

SLOPE: The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25, indicating one unit rise in 25 units of horizontal distance; or in a decimal fraction (0.04). also called GRADIENT.

SLOUGH: A small muddy marshland or tidal waterway which usually connects other tidal areas.

SLUMP: In mass wasting, movement along a curved surface in which the upper part moves vertically downward while the lower part moves outward.

SMALL DIURNAL RANGE: Difference in height between MEAN LOWER LOW WATER (MLLW) and MEAN HIGHER HIGH WATER (MHHW). Applicable only when the type of TIDE is either SEMIDIURNAL or MIXED.

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.

SOIL: A layer of weathered, UNCONSOLIDATED material on top of bed rock; often also defined as containing organic matter and being capable of supporting plant growth.

SOIL HORIZONS: Layers of SOIL that are distinguishable by characteristic physical or chemical properties.

SOLITARY WAVE: A WAVE consisting of a single ELEVATION (above the water surface) of height not necessarily small compared to the DEPTH, and neither followed or preceded by another ELEVATION or DEPRESSION of the water surface.

SORTING: Process of selection and separation of SEDIMENT grains according to their grain size (or grain shape or specific gravity).

SOUND: (1) (*noun*) a relatively long arm of the SEA or OCEAN forming a CHANNEL between an island and a mainland or connecting two larger bodies, as a SEA and the OCEAN, or two parts of the same body; usually wider and more extensive than a STRAIT. (2) (*verb*) To measure the DEPTH of the water.

SOUNDING: A measured DEPTH of water. On hydrographic charts the SOUNDINGS are adjusted to a specific plane of reference (SOUNDING DATUM).

SOUNDING DATUM: The plane to which SOUNDINGS are referred. See CHART DATUM.

SOUNDING LINE: A line, wire or cord used in SOUNDING. It is weighted at one end with a plummet.

SPIT: (1) A long narrow accumulation of SAND or SHINGLE, lying generally in line with the COAST, with one end attached to the land the other projecting into the SEA or across the mouth of an ESTUARY. See also NESS. (2) (SMP) An accretion shoreform which extends seaward from and parallel to the SHORELINE. See Figure 5.

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.

SPRING TIDAL CURRENTS: TIDAL CURRENTS of increased velocity occurring semi-monthly 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 (MSL).

STAND OF TIDE: An interval at high or LOW WATER when there is no discernable change in the height of the TIDE. The WATER LEVEL is stationary at high and LOW WATER for only an instant, but the change in level near these times is so slow that it is not usually perceptible. See SLACK TIDE.

STANDING WAVE: (1) A type of WAVE in which the surface of the water oscillates vertically between fixed nodes without progressing. (2) A WAVE of essentially stable form which does not move with respect to a selected REFERENCE POINT.

STATION, CONTROL: A point on the ground whose horizontal or vertical location is used as a basis for obtaining locations of other points.

STEP: The nearly horizontal section which more or less divides the BEACH from the SHOREFACE. See Figure 3.

STILLWATER LEVEL (SWL): The surface of the water if all WAVE and wind action were to cease. In DEEP WATER this level approximates the midpoint of the WAVE HEIGHT. In SHALLOW WATER it is nearer to the TROUGH than the crest. Also called the UNDISTURBED WATER LEVEL.

STONE: Quarried or artificially broken rock for use in construction.

STORM SURGE: A rise or piling-up of water against SHORE, produced by strong winds blowing ONSHORE. A *storm surge* is most severe when it occurs in conjunction with a high TIDE. See Figure 10.

STRAIT: A relatively narrow waterway between two larger bodies of water. See SOUND.

STRAND: The SHORE or BEACH of the OCEAN or a large lake. The land bordering any large body of water, especially a SEA or an arm of the OCEAN.

STRAND LINE: An accumulation of debris (e.g. seaweed, driftwood and litter) cast up onto a BEACH, and lying along the limit of WAVE up rush.

STRATIGRAPHY: (1) The study of stratified ROCKS (SEDIMENTS and volcanics) especially their sequence in time. (2) The character of the ROCKS and the correlation of beds in different localities.

STREAM: (1) Any flow of water; a current. (2) A course of water flowing along a bed in the earth.

STREAM CURRENT: A narrow, deep and swift OCEAN CURRENT, such as the Gulf Stream. Opposite of DRIFT CURRENT.

STRUCTURAL GEOLOGY: The branch of GEOLOGY concerned with the internal structure of bed rock and the shapes, arrangement, and interrelationships of rock units.

SUB-AERIAL BEACH: That part of the BEACH which is uncovered by water (e.g. at LOW TIDE sometimes referred to as DRYING BEACH).

SUBDUCTION ZONE: Elongate region in which the sea floor slides beneath a continent or island arc.

SUBMARINE CANYON: V-shaped VALLEYS that run across the CONTINENTAL SHELF and down the CONTINENTAL SLOPE. See Figure 8.

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

SUBORDINATE STATION: A TIDE or current station at which a short series of observations has been obtained, which is to be reduced by comparison with simultaneous observations at another station having well-determined tidal or current constants.

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

SUB-TIDAL BEACH: The part or the BEACH (where it exists) which extends from LOW WATER out to the approximate limit of storm EROSION. The latter is typically located at a maximum WATER DEPTH of 8 to 10 m for moderate wave environments and is often identifiable on surveys by a break in the SLOPE of the BED.

SURF: (1) Collective term for BREAKERS. (2) The WAVE activity in the area between the SHORELINE and the outermost limit of breakers. (3) The term *surf* in literature usually refers to the breaking WAVES on SHORE and on REEFS when accompanied by a roaring noise caused by the larger WAVES breaking.

SURF ZONE: The NEARSHORE zone along which the WAVES become BREAKERS as they approach the SHORE. See Figure 6.

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. See Figure 10.

SURFACE WATER WAVE: see SURFACE GRAVITY WAVE (PROGRESSIVE).

SURFACE WAVE: see SURFACE GRAVITY WAVE (PROGRESSIVE). See Figure 10.

SURF BEAT: irregular OSCILLATIONS of WATER LEVEL within the SURF ZONE with periods in 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, typically in WATER DEPTHS of between 5 m and 10 m. See Figure 6.

SURGE: (1) Long-interval variations in velocity and pressure in fluid flow, not necessarily periodic, perhaps even transient in nature. (2) The name applied to WAVE motion with a period intermediate between that of an ordinary wind WAVE and that of the TIDE. (3) Changes in WATER LEVEL as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded WATER LEVEL and that predicted using harmonic analysis, may be positive or negative.

SURVEY, CONTROL: A survey that provides coordinates (horizontal or vertical) of points to which supplementary surveys are adjusted.

SURVEY, HYDROGRAPHIC: A survey that has as its principal purpose the determination of geometric and dynamic characteristics of bodies of water.

SURVEY, PHOTOGRAMMETRIC: A survey in which monuments are placed at points that have been determined photogrammetrically.

SURVEY, TOPOGRAPHIC: A survey which has, for its major purpose, the determination of the configuration (relief) of the surface of the land and the location of natural and artificial objects thereon.

SUSPENDED LOAD: The finest of the beach SEDIMENTS, light enough in weight to remain lifted indefinitely above the bottom by water turbulence.

SWASH: (1) Same as UPRUSH. (2) A body of dashing, splashing water. (3) A BAR over which the OCEAN washes.

SWASH BARS: Low broad sandy BARS formed by SEDIMENT in the surf and SWASH ZONES, separated by linear depressions, or RUNNELS, running parallel to the SHORE.

SWASH CHANNEL: A narrow sound or CHANNEL of water lying within a sandbank, or between a sandbank and a SHORE.

SWASH MARK: The thin wavy line of fine SAND left by the UPRUSH when it recedes from its upward limit of movement on the BEACH FACE.

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. See Figure 6.

SWELL: WAVES that have traveled a long distance from their GENERATING AREA and have been sorted out by travel into LONG WAVES of the same approximate period.

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TECTONIC FORCES: Forces generated from within the earth that result in uplift, movement, or deformation of part of the earth's crust.

TECTONICS: The study of the major structural features of the Earth's crust or the broad structure of a region.

TERRIGENOUS SEDIMENTS: Literally 'land-formed' SEDIMENT that has found its way to the sea floor. The term is applied (a) to SEDIMENTS formed and deposited on land (e.g., SOILS, SAND DUNES) and (b) to material derived from the land when mixed in with purely marine material (e.g., SAND or CLAY in a shelly limestone).

TERRACE: A horizontal or nearly horizontal natural or artificial topographic feature interrupting a steeper slop, sometimes occurring in a series.

THALWEG: The line down the center of the main CHANNEL of a STREAM.

THRESHOLD VELOCITY: The maximum orbital velocity at which the SEDIMENT on the BED begins to move as WAVES approach SHALLOW WATER.

TIDAL CURRENT: The alternating horizontal movement of water associated with the rise and fall of the TIDE caused by ASTRONOMICAL TIDE-producing forces.

TIDAL DATUM: See REFERENCE PLANE.

TIDAL DAY: See LUNAR DAY.

TIDAL DELTA: See DELTA.

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

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.

TIDAL MARSH: Same as TIDAL FLATS.

TIDAL PERIOD: The interval of time between two consecutive like phases of the TIDE or TIDAL CURRENT. See Figure 11.

TIDAL POOL: A pool of water remaining on a BEACH or REEF after recession 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) (SMP) The volume of water present between MEAN LOW and MEAN HIGH TIDE.

TIDAL RANGE: See RANGE OF TIDE.

TIDAL RISE: The height of TIDE as referred to the DATUM of a chart. See Figure 11.

TIDAL STAND: An interval at high or LOW WATER when there is no observable change in the height of the TIDE. The WATER LEVEL is stationary at high and LOW WATER for only an instant, but the change in level near these times is so slow that it is not usually perceptible.

TIDAL WAVE: (1) A WAVE, in the OCEANS and seas, produced by TIDES and TIDAL CURRENTS. (2) Non-technical term in popular usage for an unusually high and destructive WATER LEVEL along a SHORE. It usually refers to STORM SURGE or TSUNAMI.

TIDE: The periodic rising and falling of the water that results from gravitational attraction of the moon and sun 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. See Figure 11.

TIDE, ASTRONOMIC: The periodic change in magnitude and direction of gravity as caused by attraction of the Sun, Moon, and other members of the Solar system.

TIDE, DIURNAL: See DIURNAL.

TIDE, EBB: See EBB TIDE.

TIDE, FLOOD: See FLOOD TIDE.

TIDE GAGE: A device for measuring the rise and fall, and the current height of the TIDE.

TIDE LEVEL: The height of the TIDE above a specified level.

TIDE, MIXED: See MIXED TIDES.

TIDE, NEAP: See NEAP TIDES.

TIDES, RIP: See RIP.

TIDE, SEMIDIURNAL: See SEMIDIURNAL, SEMIDIURNAL TIDE.

TIDE, SLACK: See SLACK WATER.

TIDE, SPRING: See SPRING TIDES.

TIDE STAFF: A TIDE GAGE consisting of a vertical graduated staff from which the height of the TIDE can be read directly. It is called a *fixed* staff when it is secured in place so that it cannot be easily removed. A *portable* staff is one that is designed for removal from the water when not in use.

TIDE STATION: The geographic location at which tidal observations are made. 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.

TIDES, TYPES OF: The characteristic form of the TIDE with special reference to the relation of the DIURNAL and SEMIDIURNAL waves. TIDES are sometimes classified as DIURNAL, SEMIDIURNAL and MIXED, but there are no sharply defined limits separating the groups. The TIDE is said to be DIURNAL when the diurnal wave predominated and only a single high and single LOW WATER occur each day during the greater part of the month. The TIDE is SEMIDIURNAL when the semidiurnal wave predominates and two high and two low waters occur each TIDAL DAY with a relatively small inequality in the high and LOW WATER heights. In the MIXED type of TIDE the DIURNAL and semidiurnal waves are both important factors and the TIDE is characterized by large inequality in the high or LOW WATER heights or in both. There will usually be two high and two low waters each day, but occasionally the TIDE will become DIURNAL. See Figure 11.

TIDE, WIND: See WIND TIDE.

TOE: (1) Lowest part of sea- and portside breakwater slope, generally forming the transition to the seabed. (2) The point of break in slope between a dune and a BEACH FACE.

TOMBOLO: (1) Coastal formation of beach material developed by REFRACTION, DIFFRACTION and LONGSHORE DRIFT to form a 'NECK' connecting a COAST to an OFFSHORE island or BREAKWATER (see also SALIENT). (2) (SMP) A causeway-like ACCRETION SPIT that connects an offshore rock or island to the main shore, or to another island. See Figure 5.

TONGUE: A long narrow strip of land, projecting into a body of water.

TOPOGRAPHIC MAP: A map on which ELEVATIONS are shown by means of CONTOUR LINES.

TOPOGRAPHY: The form of the features of the actual surface of the Earth in a particular region considered collectively.

TRAINING WALL: A wall or JETTY to direct current flow.

TRANSGRESSION, MARINE: The invasion of a large area of land by the SEA in a relatively short space of time (geologically speaking). Although the observable result of a marine transgression may suggest an almost 'instantaneous' process, it is probable that the time taken is in reality to be measured in millions of years. The plane of *marine transgression* is a plane of UNCONFORMITY. The reverse of a transgression is a REGRESSION.

TRANSITIONAL WATER (ZONE): In regard to PROGRESSIVE GRAVITY WAVES, water whose DEPTH is less than one-half, but more than 1/25, the WAVE LENGTH, also called a SHALLOW WATER WAVE.

TRANSVERSE BAR: A BAR which extends approximately right angles to SHORELINES.

TRAVEL TIME: The time necessary for WAVES to travel a given distance from the GENERATING AREA.

TRENCH: A long narrow submarine DEPRESSION with relatively steep sides.

TROUGH: A long and broad submarine DEPRESSION with gently sloping sides.

TROUGH, WAVE: See WAVE TROUGH.

TRUNCATED LANDFORM: A landform cut off, especially by EROSION, and forming a steep side or CLIFF.

TSUNAMI: A large, high-velocity WAVE generated by displacement of the sea floor (such as sudden faulting, landsliding, or volcanic activity); also called seismic sea wave. Commonly misnamed TIDAL WAVE. See Figure 10.

TURBIDITY: (1) A condition of a liquid due to fine visible material in suspension, which may not be of sufficient size to be seen as individual particles by the naked eye but which prevents the passage of light through the liquid. (2) A measure of fine suspended matter in liquids.

TURBIDITY CURRENT: A flowing mass of sediment-laden water that is heavier than clear water and therefore flows downslope along the bottom of the SEA or a lake.

TURBULENT FLOW: Any flow which is not LAMINAR, i.e., the stream lines of the fluid, instead of remaining parallel, become confused and intermingled.

TYPE OF TIDE: See TIDE, TYPE OF.

U

UNCONFORMITY: A surface that represents a break in the geologic record, with the rock unit immediately above it being considerably younger than the rock beneath. There are three major aspects to consider: (1) Time. An *unconformity* develops during a period of time in which no SEDIMENT is deposited. This concept equates deposition and time, and an *unconformity* represents unrecorded time. (2) Deposition. Any interruption of deposition, whether large or small in extent, is an *unconformity*. This aspect of *unconformity* pre-supposes a standard 'scale' of deposition which is complete. Major breaks in sedimentation can usually be demonstrated easily, but minor breaks may go unrecorded until highly detailed investigations are made. (3) Structure. Structurally, *unconformity* may be regarded as planar structures separating older ROCKS below from younger ROCKS above, representing the 'break' as defined in (1) and (2) above. A plane of *unconformity* may be a surface of weathering, EROSION or denudation, or a surface of non-deposition, or possibly some combination of these factors. It may be parallel to the upper strata, make an angle with the upper strata, or be irregular. Subsequent Earth movements may have folded or faulted it.

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.

UNDERTOW: (1) A current below water surface flowing seaward; the receding water below the surface from WAVES breaking on a shelving beach. (2) Actually *undertow* is largely mythical. As the BACKWASH of each WAVE flows down the BEACH, a current is formed which flows seaward. However, it is a

periodic phenomenon. The most common phenomena expressed as *undertow* are actually RIP CURRENTS.

UNDERWATER GRADIENT: The SLOPE of the sea bottom. See SLOPE.

UNDISTURBED WATER LEVEL: Same as STILL WATER LEVEL.

UPDRIFT: The direction to which the predominant LONGSHORE movement of beach material approaches.

UPLAND: (SMP) Generally described as the dry land area above and landward of the ORDINARY HIGH WATER MARK (OHWM).

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

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. See Figure5.

V

VALLEY: An elongated DEPRESSION, usually with an outlet, between BLUFFS or between ranges of hills or mountains.

VARIABILITY OF WAVES: (1) The variation of heights and periods between individual WAVES within a WAVE TRAIN. (2) The variation in direction of propagation of WAVES leaving the GENERATING AREA. (3) The variation in height along the crest, usually called "variation along the WAVE".

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. See Figure 14.

VISCOSITY: Resistance to flow.

W

WATER DEPTH: Distance between the seabed and the still WATER LEVEL.

WATER LEVEL: The ELEVATION of a particular point or small patch on the surface of a body of water above a specific point or surface, averaged over a period of time sufficiently long to remove the effects of short period disturbances.

WATER LINE: (1) The juncture of land and SEA. This line migrates, changing with the TIDE or other variation of the WATER LEVEL. Where WAVES are present on the BEACH, this line is also known as the limit of BACKRUSH. (2) The common boundary between the water surface and any immersed structure.

WATER MARK: A line or mark left on the SHORES of a body of water by the water as an indication of the water's former ELEVATION.

WATER, NAVIGABLE: The waters which are or can be used as water highways for commerce.

WATER TABLE: The upper surface of a zone of saturation, where the body of groundwater is not confined by an overlying impermeable formation. Where an overlying confining formation exists, the AQUIFER in question has no WATER TABLE.

WATER TYPE: A water having well-defined temperature, SALINITY and nutrient characteristics.

WAVE: (1) An oscillatory movement in a body of water manifested by an alternate rise and fall of the surface. (2) A disturbance of the surface of a liquid body, as the OCEAN, in the form of a ridge, SWELL or hump. (3) The term *wave* by itself usually refers to the term SURFACE GRAVITY WAVE (PROGRESSIVE). See also CAPILLARY WAVE, GRAVITY WAVE, PROGRESSIVE WAVE, STANDING WAVE, TIDE WAVE, TSUNAMI. See Figure 10.

WAVE AGE: The ratio of WAVE VELOCITY to wind velocity.

WAVE BASE: The plane or DEPTH to which WAVES may erode the bottom in SHALLOW WATER.

WAVE CLIMATE: Average condition of the WAVES at a place, over a period of years, as shown by height, period, direction, etc.

WAVE CLIMATE ATLAS: Series of maps showing the variability of WAVE conditions over a long COASTLINE.

WAVE CREST: (1) The highest part of the WAVE. (2) That part of the WAVE above still water level.

WAVE CREST LENGTH: See CREST LENGTH.

WAVE-CUT PLATFORM: A horizontal BENCH of rock formed beneath the SURF ZONE as a COAST retreats because of WAVE EROSION.

WAVE DELTA: See DELTA.

WAVE DIRECTION: The direction *from which* the WAVES are coming.

WAVE DRIFT: The small net forward displacement of water in the direction of the WAVE travel, particularly in WAVES of large AMPLITUDE, so that the orbits are not quite closed, and the water, while in the crests, moves slightly further forward than it moves backward while in the TROUGHS. See also MASS TRANSPORT, SHOREWARD.

WAVE GENERATION: Growth of WAVE energy by wind.

WAVE GROUP: A series of WAVES in which the distance between crests, and the AMPLITUDE, vary only slightly.

WAVE HEIGHT: The vertical distance between the crest (the high point of a WAVE) and the TROUGH (the low point). See Figure 12.

WAVE HINDCAST: The calculation from historic synoptic weather charts of the WAVE characteristics that probably occurred at some past time.

WAVE HOLLOW: See WAVE TROUGH.

WAVE LENGTH: The distance, in meters, between equivalent points (CRESTS or TROUGHS) on WAVES. See Figure 12.

WAVE PERIOD: (1) The time required for two successive WAVE CRESTS to pass a fixed point. (2) The time, in seconds, required for a WAVE CREST to traverse a distance equal to one WAVE LENGTH.

WAVE PROPAGATION: The transmission of WAVES through water.

WAVE RECORDER: A meter which records either the surface time history of GRAVITY WAVES, or the subsurface pressure time history due to these WAVES.

WAVE REFRACTION: See REFRACTION.

WAVE ROSE: Diagram showing the long-term distribution of WAVE HEIGHT and direction.

WAVE SET-UP: ELEVATION of the still-water level due to breaking WAVES.

WAVE STAFF: An instrument consisting of a graduated vertical pole for measuring WAVE HEIGHTS, and, by introducing a timing device, WAVE PERIODS. The staff may support a strip or series of electrical contacts for activating a recorder.

WAVE STEEPNESS: The ratio of WAVE HEIGHT to its length. Not the same thing as the SLOPE between a WAVE CREST and its adjacent TROUGH. See Figure 12.

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 the WAVE form between crests. Also that part of a WAVE below STILL WATER LEVEL. See Figure 12.

WAVE VARIABILITY: (1) The variation of heights and periods between individual WAVES within a WAVE TRAIN. WAVE TRAINS are not composed of WAVES of equal heights and periods, but rather of heights and periods which vary in a statistical manner. (2) The variability in direction of WAVE

travel when leaving the GENERATING AREA. (3) The variation in height along the crest.

WAVE VELOCITY: Speed at which the individual WAVE form advances, defined as the WAVE LENGTH divided by the WAVE PERIOD (in meters per second). See CELERITY. See Figure 14.

WAVE WASH: The erosive action on SHORES or EMBANKMENTS caused by the lapping or breaking of WAVES.

WEATHER SHORE: The land lying in the direction *from which* the wind is coming. The WINDWARD side.

WEIR: A low DAM or wall across a STREAM to raise the upstream WATER LEVEL. Termed fixed crest WEIR when uncontrolled.

WELL: A hole, generally cylindrical and usually walled or lined with pipe, that is dug or drilled into the ground to penetrate an AQUIFER below the zone of saturation.

WELL MIXED ESTUARY: In this circulation type, tidal fluctuations dominate, and the water column is mixed vertically.

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).

WHITECAP: The white froth on crests of WAVES in a wind (caused by the wind blowing the crest forward and over).

WIND CURRENT: A current created by the action of the wind. From theoretical considerations, currents produced by winds in the OPEN SEA will set to the right of the direction towards which the wind is blowing if in the Northern Hemisphere and to the left of this direction if in the Southern Hemisphere.

WIND RIPPLE: Small, low ridge of SAND produced by the SALTATION of windblown SAND.

WIND ROSE: Diagram showing the long-term distribution of wind speed and direction.

WIND SEA: WAVE conditions directly attributable to recent winds, as opposed to SWELL.

WIND SETUP: (1) The vertical rise in the STILLWATER LEVEL on the LEEWARD side of a body of water caused by WIND STRESSES on the surface of the water. (2) The difference in stillwater levels on the WINDWARD and the LEEWARD sides of a body of water caused by WIND STRESSES on the surface of the water. (3) synonymous with WIND TIDE and STORM SURGE. STORM SURGE is usually reserved for use on the OCEAN and large bodies of water. *Wind setup* is usually reserved for use on reservoirs and smaller bodies of water.

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

WIND TIDE: The deviation from a still-water level surface ELEVATION caused by the transport of surface water by winds.

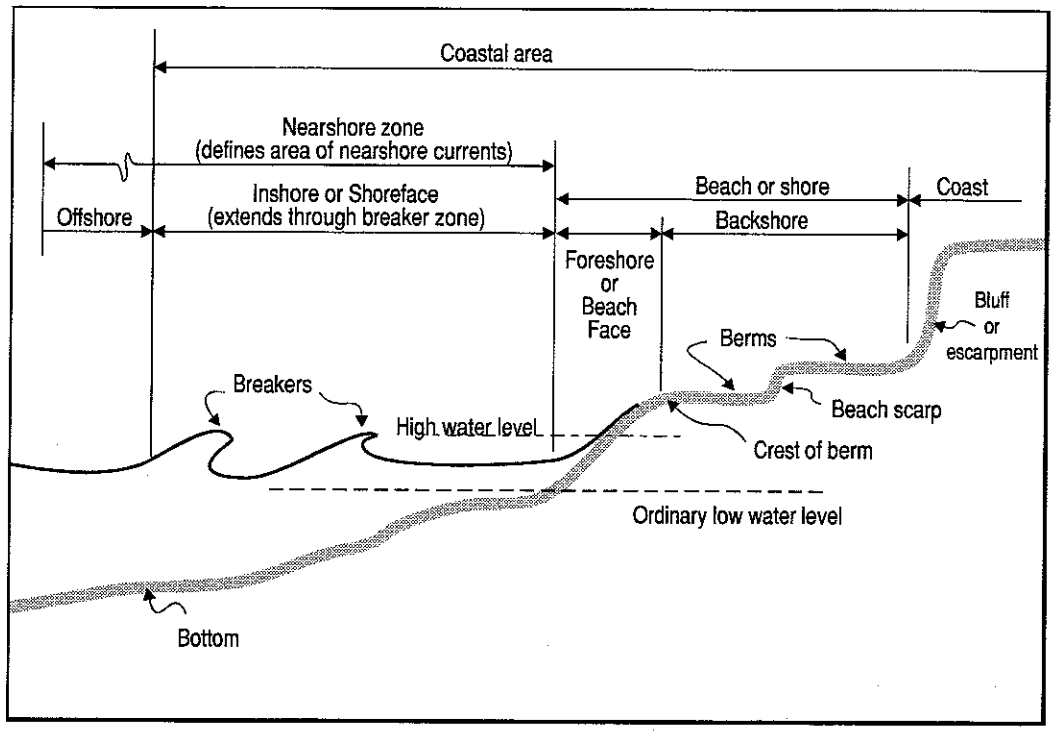
WINDWARD: The direction *from which* the wind is blowing.

WIND WAVES: (1) WAVES formed and growing in height under the influence of wind. (2) Loosely, any WAVE generated by wind. See Figure 10.

WITNESS MARK: A material mark placed at a known distance and direction from a property corner, an instrument station or a survey station, as an aid in its recovery and identification.

WITNESS POST: See WITNESS MARK.

Appendix A



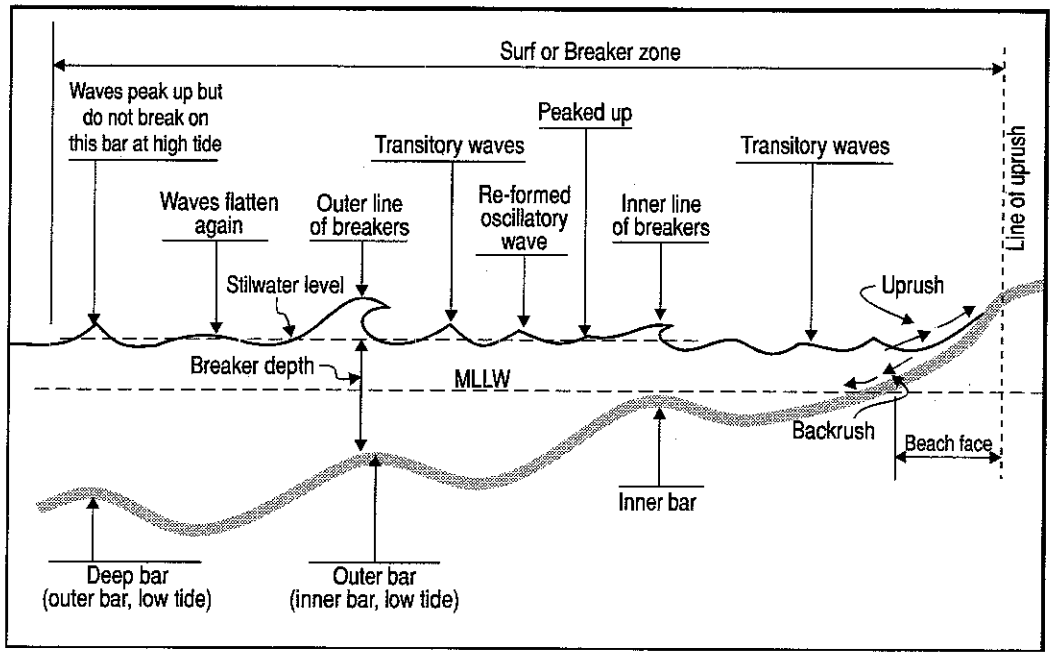


Figure 1: (a) The coastal zone and (b) the surf or breaker zone (Modified after USACE, 1972)

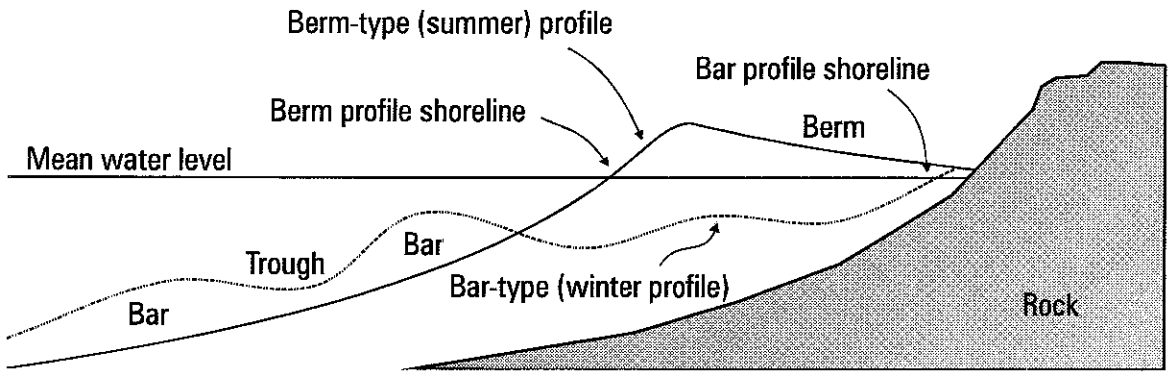


Figure 2: Seasonal cycle of a beach caused by differing wave conditions (Modified from Komar, 1998).

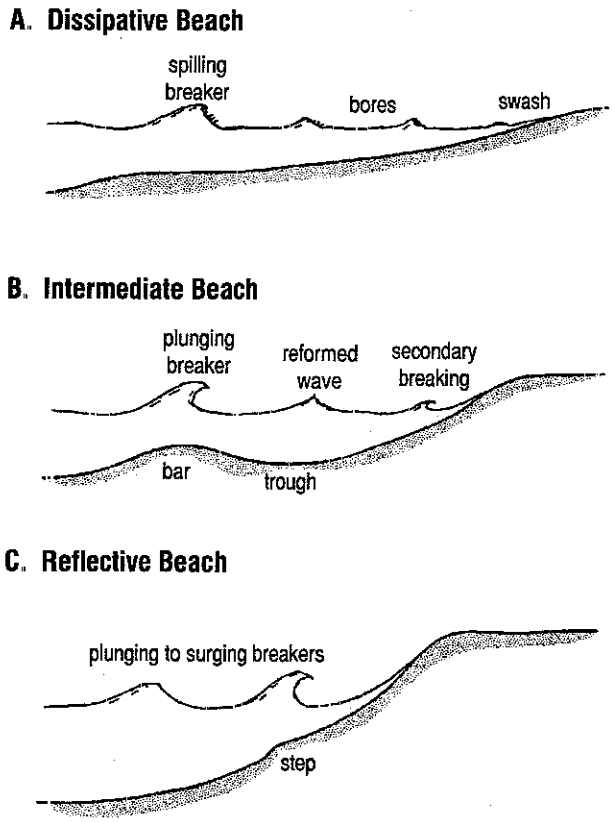


Figure 3: (a) Dissipative mild sloping beach with spilling breakers, (b) intermediate beach with plunging and secondary breakers, and (c) steep sloping reflective beaches (From Komar, 1998).

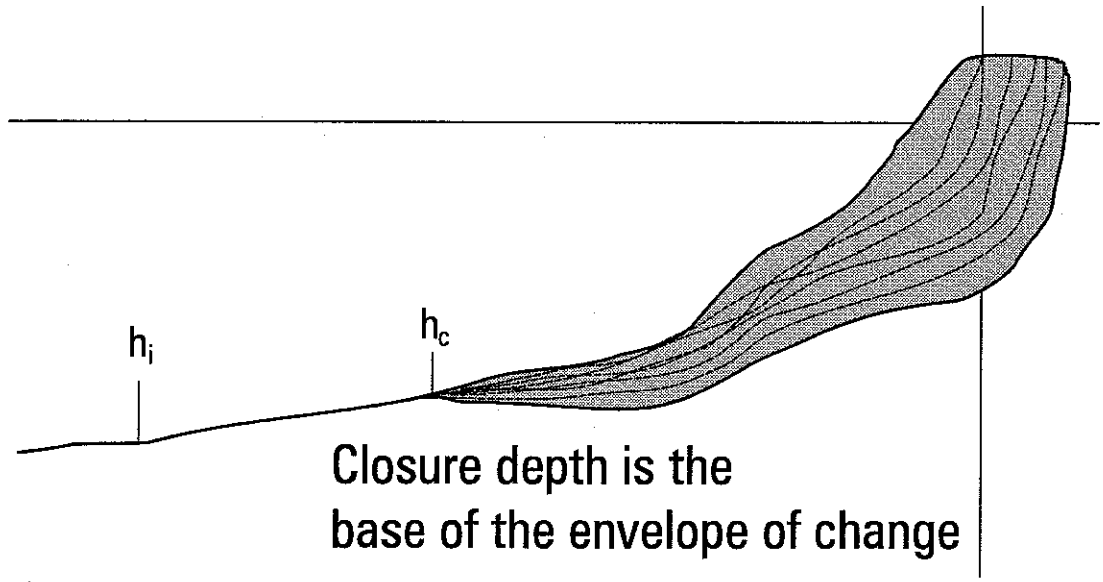


Figure 4: The depth of closure of an upper shoreface cross-shore profile. The shaded area indicates the total envelope of change for a time-series of profiles (Modified after Wright, 1995).

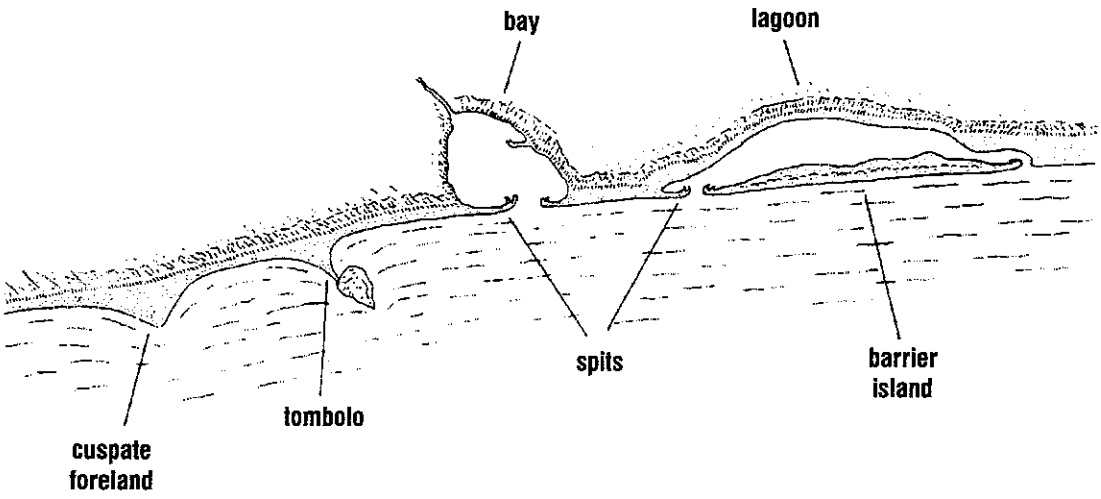


FIGURE 5: Features associated with accreting coasts (From Komar, 1998).

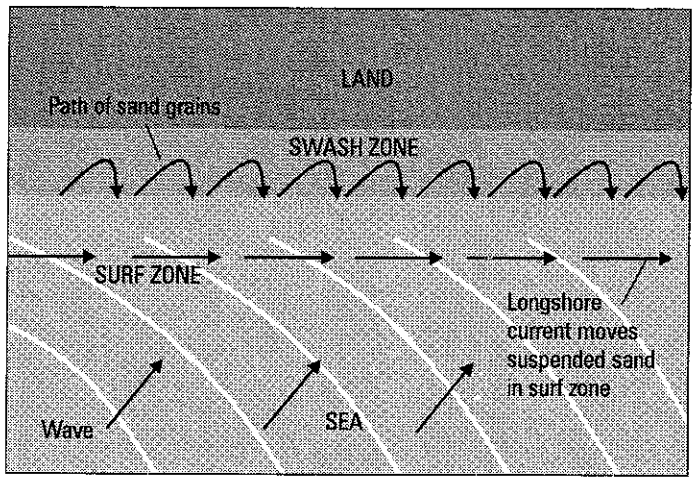


FIGURE 6: Longshore drift of sand on the beach face and by a longshore current within the surf zone (Modified after Plummer, et al., 1985).

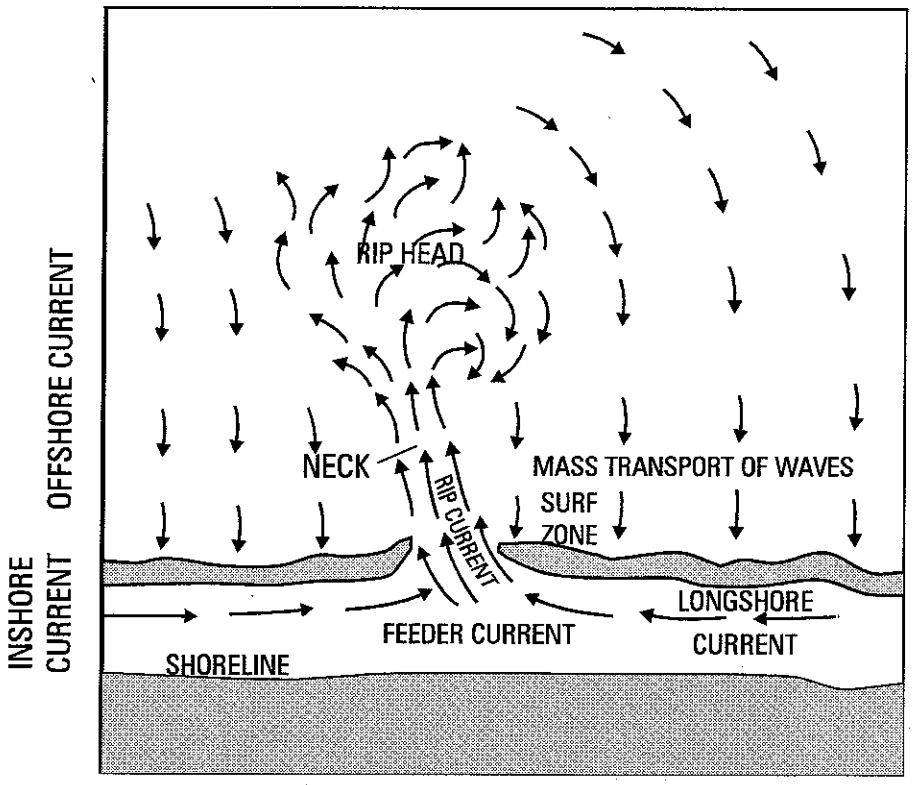


FIGURE 7: The elements of a rip current embayment (From USACE, 1972).

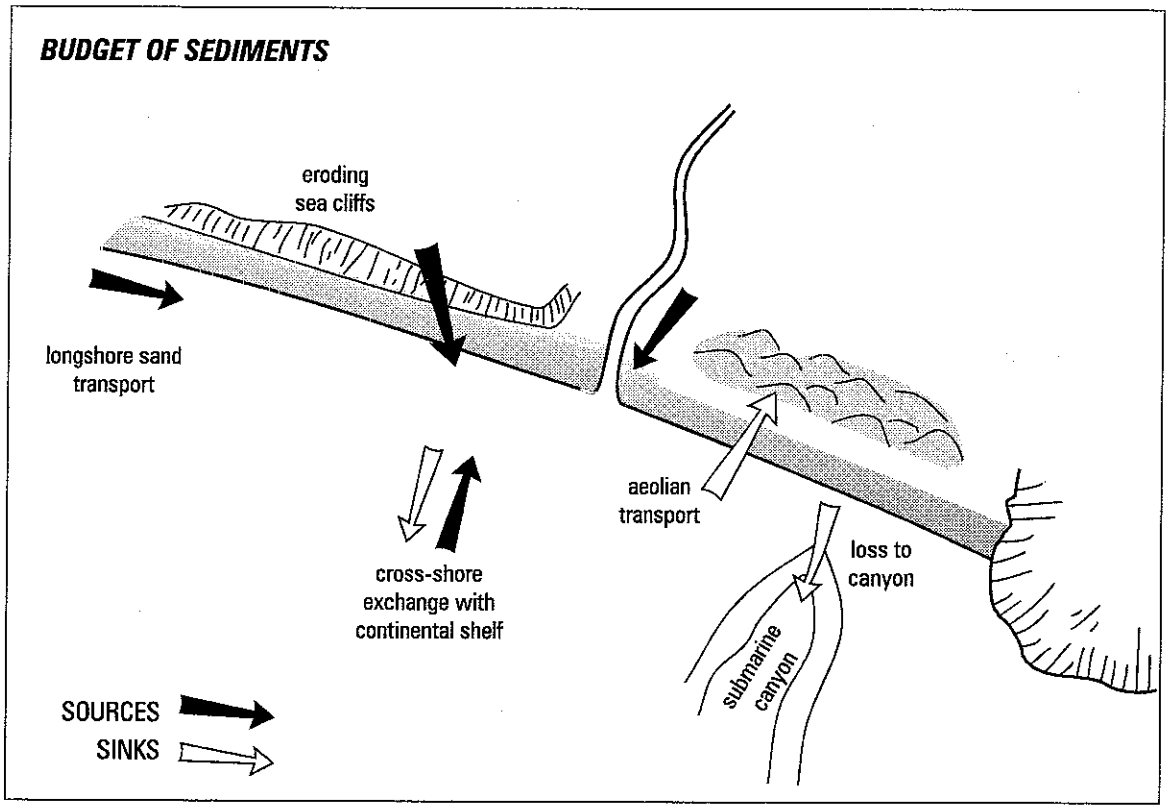


FIGURE 8: Schematic of the principal components involved in the development of a littoral cell sediment budget (From Komar, 1996).

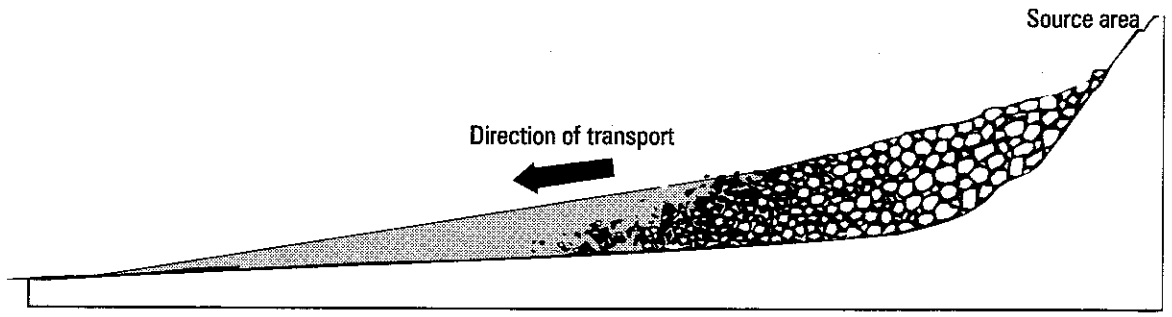


FIGURE 9: Sediment deposits usually become thinner away from the source area, and sediment grains become finer and more rounded (From Plummer, et al., 1985).

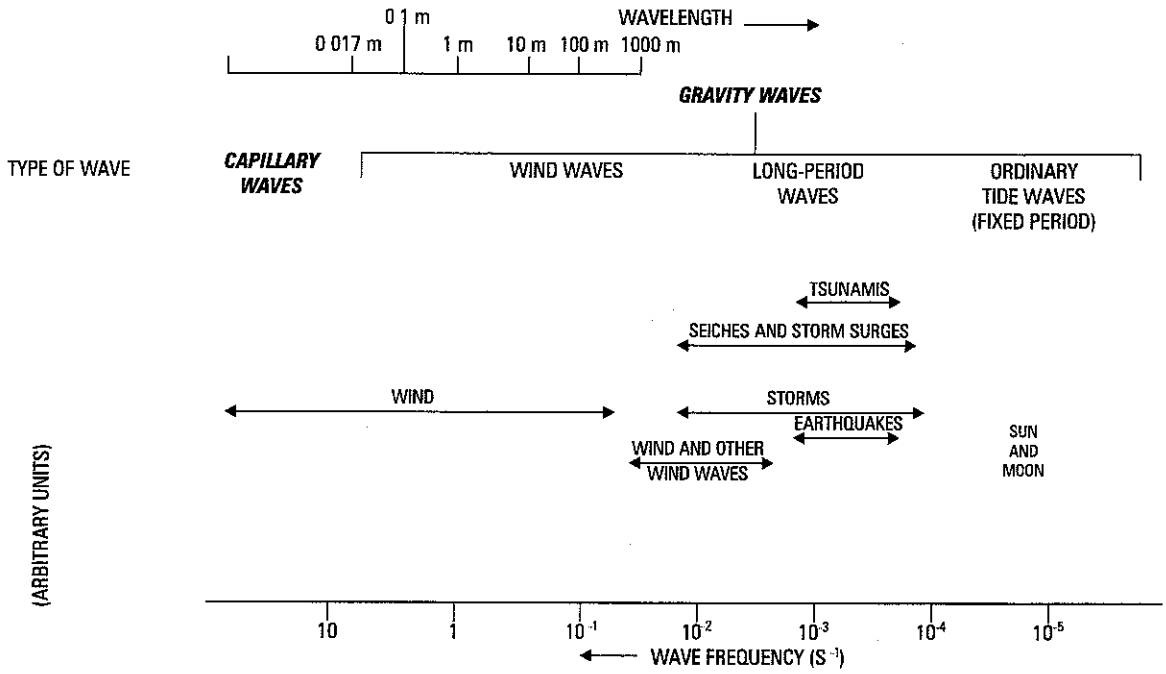


FIGURE 10: Types of surface waves, showing the relationships between wave length, wave frequency, the nature of the displacing forces and the relative amounts of energy in each type of wave (From Brown, et al., 1989).

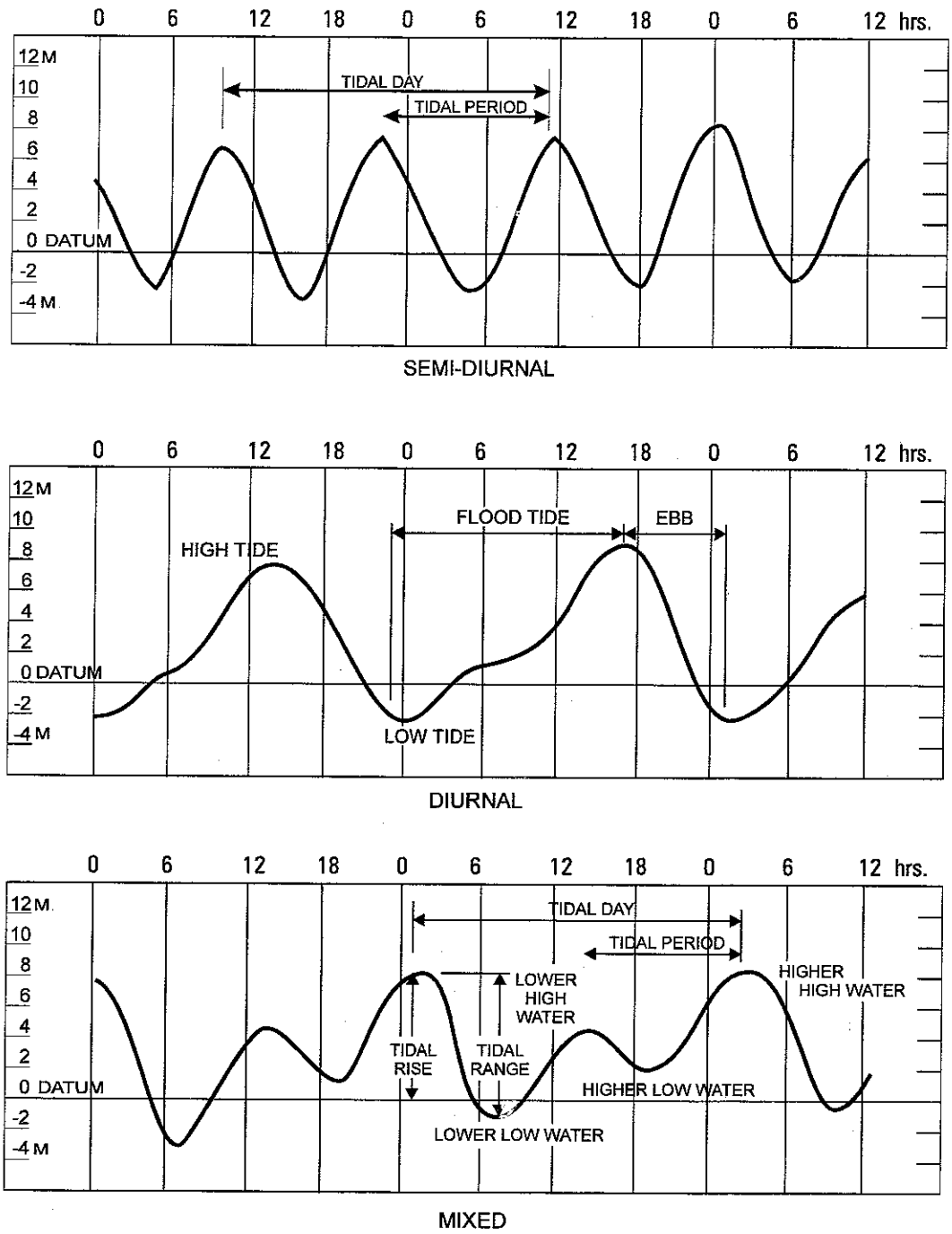


FIGURE 11: Types of tides: (a) Semi-diurnal, (b) Diurnal and (c) Mixed (From Wiegel, 1953).

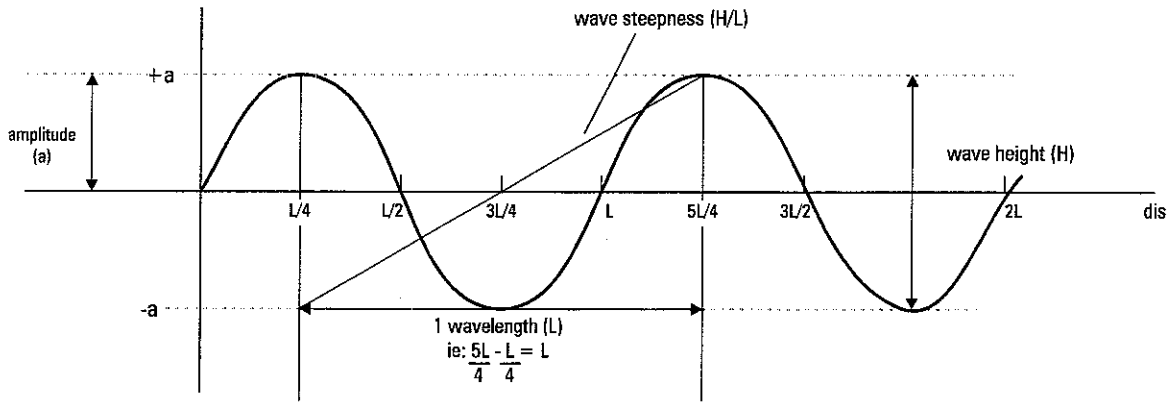


FIGURE 12: A vertical profile, showing the linear dimensions, of two successive idealized ocean waves (From Brown, et al., 1989).

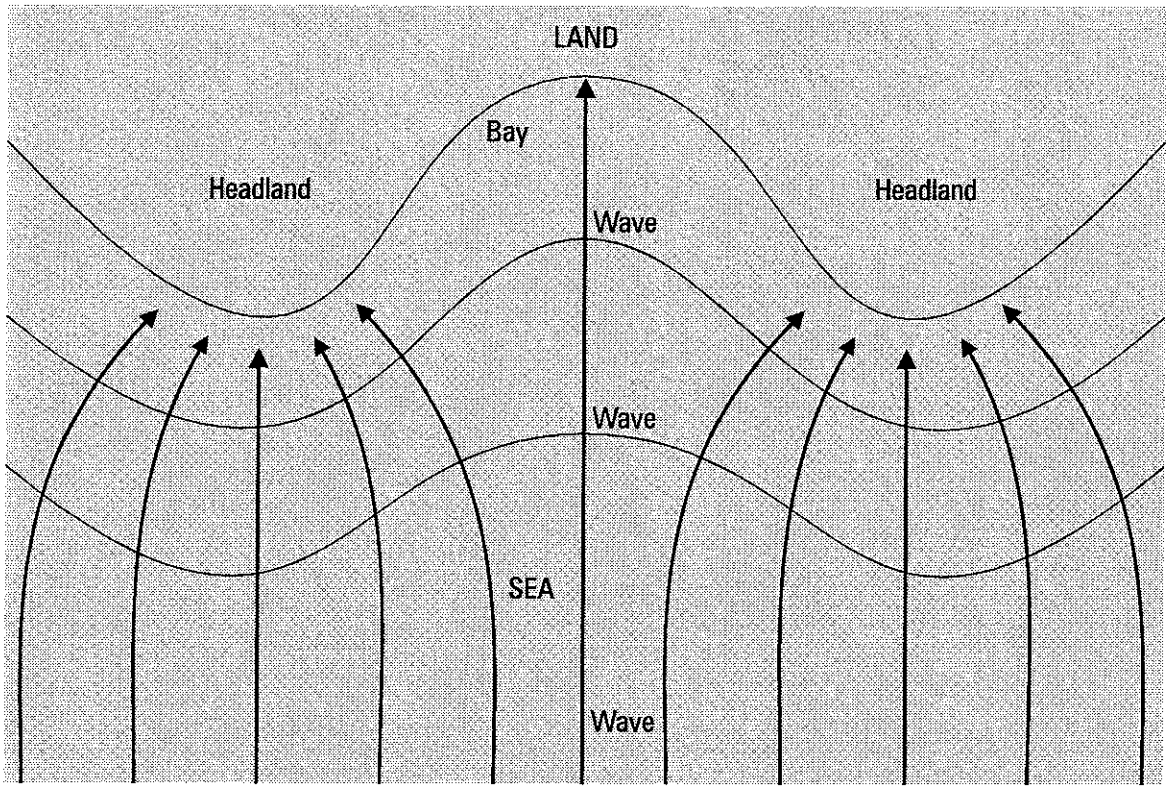


FIGURE 13: Wave refraction on an irregular coast. Shallow water slows waves off headlands while the same waves move faster through deep bays. Arrows show energy concentrated on headlands, spread out in bays (From Plummer, et al., 1985).

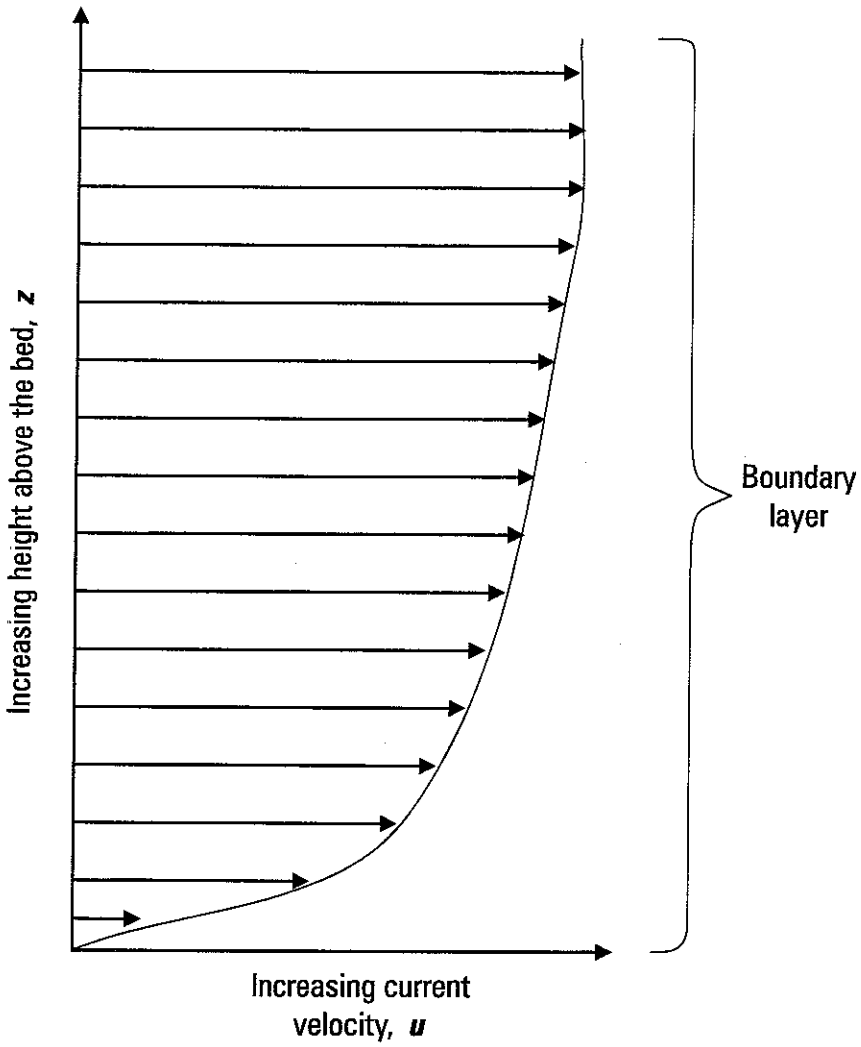


FIGURE 14: The velocity profile for a steady current flow over a bed. The arrows indicate the direction of flow and the length of each arrow is proportional to the current velocity at the height above the bed (From Brown, et al., 1989).