

Glossary

Access way	A path or route that provides access to the levee from the leveed area and that must be useable also in case of flood and flood defence. See also <i>Escape route</i>
Active earth pressure	The horizontal stress exerted by a mass of soil on a retaining wall as the wall moves away from the soil.
Aeolian soil	Soil deposits that have been transported by wind.
Air-voids ratio	The ratio of the volume of air to the total volume of a mass of soil.
Alarm level	The level below crisis level. This is usually a predetermined value where the monitored levee parameter falls to within range of the crisis level, but has not resulted in systematic failure of the function being monitored. See also <i>Crisis level</i>
Allowable bearing capacity	The maximum bearing pressure that can be allowed on a foundation soil, usually in order to limit settlement.
Angle of internal friction	For a given soil, the angle on the graph of the shear stress and normal effective stresses at which shear failure occurs.
Angle of repose	The maximum angle, just before failure, of a slope composed of granular material.
Angle of shearing resistance	The ratio of effective shear and normal stresses mobilised at any state prior to failure.
Angle of wall friction	The angle of friction between soil and the surface of a retaining wall or bottom side of a foundation.
Anisotropy	A characteristic of soils which exhibit different properties such as strength, stiffness and permeability.
Annual exceedance probability (AEP)	Probability of exceeding a specified flow or level in any year (inverse of the return period for an annual maximum series).
Anthropogenic influences	General term used to describe the influence of man.
Appraisal	The process of assessing in a structured way the case for proceeding with a project or proposal. This is tied closely with Assessment.
Aquifer	A stratum of soil with relatively high permeability; a water-bearing stratum of rock or soil. See also <i>Confined aquifer</i>
Armourstone	Coarse aggregates used in hydraulic structures and other civil engineering works. A relatively large quarry stone or specially shaped concrete block that is selected to fit specified requirements of mass and shape, which is placed in a cover layer or under layer. A single stone is referred to as a piece of armour stone.
Artesian	A condition that exists when the water table piezometric surface lies above the ground level.
Asphalt	Description of all mixtures of mineral aggregates bound with bituminous materials used in the construction and maintenance of paved surfaces.
Assessment	The process of identifying, quantifying, and prioritising the condition, vulnerability, or risk associated with a system or components of a system.

Asset	Person, structure, facility, information, material, or process that has value. Generally, in this handbook, an asset is a raised defence, a structure, a watercourse, a channel, a culvert or a beach. Mainly during risk assessment, it can also indicate anything in the flood area that has value.
Asset management	Systematic and co-ordinated activities through which an organisation optimally and sustainably manages its assets and asset systems. This includes their associated performance, risks and expenditures over their life cycles for the purpose of achieving the organisations' strategic aims.
Astronomical tide	A periodic rise and fall in the level of the water in oceans and seas that are the result of gravitational effects of the earth, moon, sun and planets, without any atmospheric influences. See also <i>Tide</i>
At-rest Earth pressure (or Earth pressure at rest)	The horizontal stress developed in a mass of soil loaded in conditions of zero horizontal strain.
Atterberg limits	The water contents of a soil mass corresponding to the transition between a solid, semi-solid, plastic solid or liquid. Laboratory test used to distinguish the plasticity of clay and silt particles.
Barrage	Structure built in an estuary with the specific intention of preventing, or in some way modifying, tidal propagation. Synonym: estuary barrier (or coastal barrier) See also <i>Dam, Hydraulic control structure</i>
Base	Foundation area of a levee.
Beach	A deposit of non-cohesive material (eg sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively worked by present day hydrodynamic processes (ie waves, tides and currents) and sometimes by winds.
Bearing capacity	The ability of soils to support applied foundation loads without shear failure.
Bearing pressure	The total stress transferred by a structure to the underlying ground through the foundation.
Bed forms	Mobile features on a seabed or a river bed (eg ripples, sand waves or dunes) resulting from the movement of sediment.
Bed load	Sediment transport mode in which individual particles either roll or slide or bounce along the bed as a shallow, mobile layer a few particle diameters deep. The part of the load that is not continuously in suspension. See also <i>Suspended load, Total load</i>
Bed shear stress	Stress acting tangentially to the bed, representing wave and current energy transfer to the bed.
Bench	A name applied to ledges that are shaped like steps or terraces cut into the side of a levee during construction to ensure a good interaction between two layers. See also <i>Berm</i>
Benefit area	See <i>Leveed area</i>
Benefits	The value placed on the reduced likelihood of flooding provided by flood defence assets.
Bentonite	Colloidal clay largely made up of the mineral sodium montmorillonite, a hydrated aluminium silicate.
Berm	A horizontal step in the sloping profile of a levee. See also <i>Bench</i>

Bitumen	A hydrocarbon binder. A virtually non-volatile adhesive material derived from crude petroleum that is used to coat mineral aggregate for use in construction and maintenance of paved surfaces.
Blanket	A layer or layers of graded fine stones underlying a levee or a breakwater, rock embankment or groyne. Its purpose is to prevent the natural bed material from being washed away.
Block size distribution	Sizes of armourstone pieces represented mathematically to reflect the relative proportions of smaller and larger pieces.
Body	The main part of an earth structure, whose main function is stability. For homogenous dams or levees, it also functions as water tightness. See also <i>Core</i>
Borrow pit	A site used to supply soils for earthwork construction.
Boundary conditions	Physical conditions, eg waves, currents and drifts, used as boundary input or constraint to physical or numerical models.
Breach	Any loss of material such that water could or does pass through the structure. See also <i>Deterioration, Break, Failure, Progressive failure, Sudden failure</i>
Breaching	Process of making a breach.
Break	Partial or total destruction of a levee. See also <i>Breach, Deterioration</i>
Breaking	Reduction in wave energy and height in the surf zone due to limited water depth. See also <i>Dissipation</i>
Breakwater	Structures constructed on the coastline as part of a coastal defence system or to protect beaches and/or harbours from the effects of wave action, coastal erosion or longshore drift. They can be constructed some distance from the coast, or with one end linked to the coast. They can be either fixed or floating. A breakwater structure is designed to absorb the energy of impacting waves. This is done either by using mass (eg with caissons) or by using a revetment slope (eg with rock or concrete armour units). See also <i>Dike, Groyne, Jetty, Levee</i>
Buildability	See <i>Constructability</i>
Bund	Mound of material, such as rock, gravel, sand, clay, gabions etc.
Canal	A large artificial channel, generally of trapezoidal cross-section, designed for low velocity flow. Its purpose is to convey water for navigation, hydroelectricity, irrigation or drainage.
Capillary action (or Capillarity)	Ability of liquid to flow against gravity where liquid spontaneously rises in a narrow space such as a thin tube, or in porous materials such as paper or in some non-porous materials such as liquified carbon fibre. Synonym: Soil suction
Capillary rise	The height to which water will rise above the water table due to negative pore water pressure (suction) or capillary action of the soil.
Capillary stresses	Pore water pressures less than atmospheric values produced by surface tension.
Catchment	The area from which precipitation and groundwater will collect and contribute to the flow of a specific river.
Caving	Process of losing material from a stream or river bank caused by different types of erosion. See also <i>Internal erosion, External erosion, Scour, Outflanking</i>

Channel	<ol style="list-style-type: none"> 1 A natural or artificial waterway of perceptible extent that either periodically or continuously contains moving water or that 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 (synonym: sail line). 3 The deepest part of a stream, bay or strait through which the main volume or current of water flows. 4 A large strait, such as the English Channel.
Clay	<p>A stiff, sticky sedimentary material that is soft and pliable when wet and consists mainly of various silicates of aluminium. Clay particles are smaller than silt, having a diameter less than 0.0039 mm. They possess electromagnetic properties that bind the grains together to give a bulk strength or cohesion. See also <i>Silt, sand</i></p>
Climate change	<p>Refers to any long-term trend in mean temperature, wind speed, drift rate and its consequences on the mean sea level, wave height, rainfall etc.</p>
Closure structure	<p>A structure intended to keep water from entering a leveed area, such as stop logs, earthen closure, gate or sandbag closure. The structure may be permanent or temporary. See also <i>Stop logs, Demountable defence, Flood gate</i></p>
Coastal area models (2D and 3D)	<p>Deterministic model that simulates temporal and spatial variations of hydrodynamic related parameters over a defined horizontal area. See also <i>Two-/three-dimensional (2D or 3D) model</i></p>
Coastal defences	<p>General term used to encompass both coast protection against erosion and sea defence against flooding. Synonym: Coast protection</p>
Cofferdam	<p>A temporary structure used to enclose a construction area, and prevent soil or water from entering into it.</p>
Cohesionless soils	<p>Granular soils such as sands and gravels with values of cohesion close to zero.</p>
Cohesive sediment	<p>Sediment containing significant proportion of clays, the electromagnetic properties of which cause the sediment to bind together.</p>
Cohesive soils	<p>Clayey and silty soils that can be remoulded into balls or rolled into threads.</p>
Colluvial soils	<p>Soils deposited at the base of foothills via gravity or erosion.</p>
Compaction	<p>Volume change in soils that air, and in the case of cohesionless soils water, is expelled from the voids by mechanical action. In construction, compaction can be achieved by rolling, tamping or vibrating fill soils.</p>
Condition assessment	<p>An assessment of a coastal/fluvial flood/erosion defence structure to determine its condition from a structural, health and safety, and environmental perspective. See also <i>Assessment, Condition appraisal</i></p>
Condition monitoring	<p>Continuous or periodic inspection, assessment, measurement and interpretation of the resultant data to indicate the condition of the specific component. This will determine the need for some preventive or remedial action. See also <i>Performance monitoring</i></p>
Consequence of failure	<p>The (sum of) personal injuries, fatalities, material damage, environmental damages and other damages (eg cultural heritage) due to the failure of a structure or a flood defence system. See also <i>Damage potential</i></p>
Consolidation	<p>Volume change of a soil often leading to settlement as a result of the expulsion of air or water from a soil and the dissipation of excess pore pressure under sustained static loads.</p>

Consolidation settlement	Settlement of a foundation due to squeezing out of water from the pores as the soil comes to equilibrium with the applied loads. See also <i>Immediate settlement</i>
Constructability	The extent to which the design of the building helps ease of construction, subject to the overall requirements for the completed building. Synonym: buildability
Contact erosion	Internal erosion at the joint of two soil materials. See also <i>Joint erosion</i>
Core	1 An inner, often much less permeable, portion of a structure (eg a levee). The fines content and upper sizes may be controlled. 2 A cylindrical sample of rock or soil extracted by coring. See also <i>Coring</i>
Cost benefit analysis	Method of economic analysis that assesses both costs and benefits of an intervention, design option or management process, estimating both costs and benefits in monetary units. This analytic technique is useful to compare alternatives.
Crack	A narrow break in the continuity of the material. See also <i>Fissure, Tension crack</i>
Creep	Time dependent deformations that occur in soil at constant effective stress without changes in volume and pore water pressure.
Crest	Highest elevation of levee, breakwater, seawall, sill or dam.
Critical circle	In a slope stability analysis, the slip circle that corresponds to the lowest factor of safety.
Critical depth	The water depth at critical flow in a given section of a mono-dimensional flow.
Critical flow	Free surface flow with minimum specific energy for a given discharge and a Froude number of unity. The water depth is known as the critical depth. See also <i>Froude number, Hydraulic jump, Subcritical flow, Supercritical flow</i>
Critical hydraulic gradient	The hydraulic gradient at which effective stresses becomes zero.
Cross-section	Vertical section of the levee perpendicular to the levee course/line. It includes outside and inside sections and is measured by surveying elevations with ranges across the levee from landside to riverside. Also depicts the shape of a watercourse by surveying elevations across and perpendicular to the direction of flow. See also <i>Planform</i>
Culvert	A closed conduit carrying a watercourse beneath an obstruction such as a road, railway or canal. The term 'closed' implies that a culvert has a hard soffit and invert. The term conduit implies the conveyance of water some or all of the time, but excluding tunnels and underpasses for vehicles, pedestrians and animals.
Current	Body of water that has a steady flow in a particular direction. See also <i>Flow, Discharge</i>
Current-refraction	Process by which wave velocity is affected by a current.
Cut-off wall	A wall of impervious material usually of concrete, asphaltic concrete, or steel sheet piling constructed in the foundation to reduce seepage beneath and adjacent to the levee. See also <i>I-wall, Sheet pile</i>
Dam	An artificial barrier built in rivers or estuaries that have the ability to impound water or liquid-borne materials for storage and/or control purposes. The dam is generally a permanent impoundment structure. See also <i>Barrage, Hydraulic control structure</i>

Damage potential	Property, goods etc that would be destroyed, damaged or affected in the case of potential flooding. See also <i>Stake, Vulnerability</i>
Datum	Any permanent line, plane or surface used as a reference to which elevations are referred.
Decommissioned (retired) levee	Levee that is identified by the operating authority as having lost its flood protection function.
Degradation	An irreversible process leading to a significant change in the structure of a material, typically characterised by a loss of properties (eg integrity, molecular mass or structure, mechanical strength) and/or by fragmentation. Degradation is affected by environmental conditions and proceeds over a period of time comprising one or more steps. See also <i>Deterioration, Weathering</i>
Demountable defence	Defences built above ground and supported by in situ structural foundations as part of a flood defence system. These are not normally in place but are put in place during a flood event or another event, for example to close a gate or to raise a levee. See also <i>Closure structure</i>
Density	The ratio of the total mass to the total volume of a unit of soil. Usually expressed as a unit weight where weight is interchanged with mass (unit: kg/m ³)
Depression	Relatively shallow and localised deviations in the crown or levee toe, often caused by vehicular traffic. See also <i>Rutting</i>
Desiccation	The process of shrinkage or consolidation of the fine-grained soil produced by increase of effective stresses in the grain skeleton caused by the natural drying of near-surface soils.
Design criteria	A set of conditions agreed by the developers, planners, and regulators that the proposed system should satisfy. See also <i>Design flood, Design storm, Protection objective, Level of protection</i>
Design flood	Hydrologic event(s) that is/are used to evaluate risk of overtopping, damage, or failure in consideration of defined design criteria. See also <i>Design storm</i>
Design flood level	Water level(s) referring to the design flood corresponding to local protection objectives. See also <i>Limit states</i>
Design profile	A geometric representation of a coastal or river structure, detailing the dimensions, shape and size.
Design standard	A set of engineering and/or planning procedures, policies and methodologies that are applied in the design of a system or its components.
Design storm	A hypothetical extreme storm whose waves coastal structures will often be designed to withstand. The severity of the storm (ie annual exceedance probability) 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 duration. See also <i>Design flood</i>
Desk study	A preliminary investigation in which available information about a site is gathered and studied in order to characterise the site and identify ground related hazards in advance of any field investigations.
Deterioration	1 A gradual decline, as in quality, serviceability or strength.

	<p>2 Decline in the material properties of some or all components of an asset caused by external agents (eg freeze/thaw) leading to a reduction in its structural strength.</p> <p>See also <i>Degradation, Weathering</i></p>
Deterministic	Descriptor of method or process that adopts precise, single values for all variables and input values, giving a single value output.
Development	Change of land use. Often, it is made up of housing, industrial buildings or new infrastructure. Where it is within the flood plain, it is of particular interest.
Dewatering	The removal of groundwater/surface water to lower the water table. See also <i>Drainage</i>
Diagnosis	Identification of the possible cause(s) of a failure or deterioration of a function, based on logical reasoning founded on a set of information coming from an inspection, a control or a test. By extension, a statement or conclusion from such an analysis.
Differential settlement	The vertical displacement due to settlement of one point in a foundation with respect to another point of the foundation. See also <i>Settlement</i>
Diffraction	Process affecting wave generation, where wave energy is radiated normal to the original direction of movement when it meets an obstruction. As the waves pass the obstacle the wave bends as it moves into the shadow of the obstacle.
Digital elevation models	A digital representation of ground surface topography or terrain exclusive of features (the earth surface). Synonym: Digital terrain models See also <i>Digital surface models</i>
Digital surface models	A digital representation of the ground surface that includes buildings, vegetation, and roads, as well as natural terrain features. See also <i>Digital elevation models, Photogrammetric analysis</i>
Dike	Flood protection linear structure that can be geotechnical works (levee), masonry, or concrete structure (flood wall). Also relates to sea dikes (breakwater) or the dikes along a canal or the auxiliary structure associated with a dam that serves to retain the reservoir. Also relates to river training structures. These structures are typically constructed using rock. Synonym: Wingdam
Discharge	The ratio of total volume of water flowing to a particular unit of time, normally expressed in cubic metres per second (m ³ /s). Synonym: Flow rate (often abbreviated to flow)
Discharge section	Cross-section area of flowing water marked by the water level and the wetted perimeter perpendicular to the main flow velocity vector. Synonym: Flow section
Downstream	In the direction of or nearer to the mouth of a stream.
Drain	Part of a hydraulic structure whose function is to get water out of or across the structure. It can be made from coarse geotechnical material (or coarser than the rest of the body) or from geosynthetic materials. In a masonry or concrete structure it can consist of a boring (hole). See also <i>Filter, Slope drain, Toe drain, Drainage ditch</i>
Drainage	<p>1 Process of dewatering a soil body, a structure, or a levee.</p> <p>2 Removal of naturally occurring runoff from a watershed or basin by a waterway (canal, channel, or other conveyance mechanism).</p>
Drainage area	Measured area within a drainage divide that contributes surface runoff to a given point on a stream.

Drainage ditch	Ditch parallel to the levee on the landside toe, collecting and discharging the seepage water. See also <i>Toe drain</i>
Draw-down	In subsurface hydrogeology, it is the change in hydraulic head observed at a well or aquifer, typically due to pumping. In surface water hydrology, it is the lowering of the water level in a man-made reservoir.
Draw-down rate	Water level lowering rate (velocity), eg after the flood peak.
Drowned weir flow	See <i>Submerged weir flow, Subcritical flow</i>
Durability	The ability of a material to retain its physical and mechanical properties when exposed to actual loading during the service life.
Earth pressure	The force per unit area exerted by soil on a retaining wall.
Earthworks	Earthworks are structures created through the deposition, compaction, and shaping of quantities of soil or rock used as fill materials. See also <i>Embankment, Levee</i>
Eddy	A vortex-type motion of fluid flowing partly opposite to the main current.
Effective porosity	Drainable pore volume fluid in porous media (soils) most commonly considered representing the porosity of a rock or sediment available to contribute to fluid flow through the rock or sediment.
Effective stress	The portion of the total stress that is supported through grain-to-grain contact of the soil. It is the stress in a soil mass that is effective in causing volume changes and in mobilising the shear strength arising from friction. It is the difference between the total stress and the pore water pressure.
Elastic deformation	Deformation caused in a soil due to a change in loading, where the soil recovers completely when the load is removed.
Elevation	The vertical distance above or below a local or national datum.
Embankment	Fill material, usually earth or rock, placed with sloping sides and with a length greater than its height. See also <i>Earthworks</i>
Empirical modelling	Computational modelling using empirical relationships. See also <i>Numerical model, Hybrid model</i>
Encroachment	Any permitted, authorised, or unauthorised structure that is within the easement area of the flood risk mitigation device and is not a part of the device itself.
Energy grade line	An imaginary line showing the total head or the sum of the elevation, pressure and velocity heads, of a flow relative to a datum. The slope of the energy grade line is the energy gradient. See also <i>Energy head, Hydraulic grade line</i>
Energy head	The total energy per unit weight of fluid expressed in metres of water above a geodetic datum. Also known as 'head'. See also <i>Hydraulic head, Velocity head, Energy grade line, Specific Energy, Hydrodynamic force, Hydrodynamic pressure, Pressure head</i>
Engineered fill	Soils used as fill, such as retaining wall backfill, foundation support, dams, levees, slopes etc that are selected, deposited and compacted in accordance with engineered specifications. See also <i>Earthworks, Rockfill</i>
Engineering inspection	A detailed investigation of any asset to determine its underlying condition or performance, including any structural faults. Synonym: <i>Engineering survey</i>

Engineering properties of soil	Engineering parameters of a soil such as permeability, shear strength and consolidation (as distinct from index properties).
Engineering survey	See <i>Engineering inspection</i>
Epoch	A period of time. Used in levee management plans and other strategic documents to refer to the three time periods when considering future change: short-term (0 to 20 years), medium-term (20 to 50 years) and long-term (50 to 100 years).
Equipotential	For a flow net, lines connecting points of equal total head. Equipotential lines are usually drawn so that the interval, or equipotential drop, is constant. Equipotential lines intersect flow lines and impermeable boundaries at right angles.
Escape route	Way to leave the polder/hinterland in the case of emergency (emerging levee failure). Must also be usable during flooding of the landside area behind the levee. See also <i>Access way</i>
Estuary	A transition zone between river environments and maritime environments subject to both marine influences, such as tides, waves, and the influx of saline water; and riverine influences, such as flows of fresh water and sediment.
Event	An occurrence meeting of specified conditions (eg water level, wave height and period) in relation with the characteristics of the flood defences. By extension, the result of these conditions on the landside area (eg volume of water overtopping or overflowing, water depth, velocity of the current). See also <i>Joint probability</i>
Excess pore pressure	That increment of pore water pressure greater than hydro-static value, produced by consolidation stresses in compressible materials or by shear strain. Excess pore pressure is dissipated during consolidation. See also <i>Hydrostatic (pore) pressure</i>
Exit gradient	The hydraulic gradient near an exposed surface through which seepage is moving.
External erosion	Process by which particles are removed from a surface by the action of wind, flowing water or waves. See also <i>Internal erosion, Wear, Weathering</i>
Facing	A coating of material for architectural or protection purposes, eg stonework coating or an impervious coating on the waterside slope of the levee. See also <i>Revetment</i>
Factor of safety	The ratio of a limiting value of a quantity to the design value of that quantity.
Failure	<ol style="list-style-type: none"> 1 Gradual decline (deterioration) or sudden decline (break) of the structure of a levee or of its foundation, leading to the inability to achieve its function. See also <i>Failure modes, Deterioration, Break, Breach</i> 2 Inability to achieve a defined performance threshold for a given function, in particular for flood defence. See also <i>Limit states, Progressive failure, Sudden failure</i>
Failure envelope	For a given soil, the graph of the shear stress and normal effective stresses at which shear failure occurs.
Failure modes	Description of one of any number of ways in which a levee or flood defence system may fail to meet a particular performance indicator.
Fetch (length)	Relative to a particular point (on the water surface or the banks), the length of the area of water surface over which the wind can blow to generate waves at the point. The fetch length depends on the shape and dimensions of the fetch area and is measured parallel to the expected wind. The longer the fetch length and

the faster the wind speed, the larger and stronger the wave will be.

Filter	Layer or zone consisting of geotextile, geomembrane, sand, gravel, or other granular or fibrous material, preventing the fine materials from being washed through the voids of another layer or to avoid particle transport in the case of seepage. See also <i>Underlayer, Graded filter, Granular filter, Filter layer, Filter zone, Open layer, Slope drain, Drain</i>
Filter layer or zone	Layer or zone with certain grain size distribution or geotextile to avoid particle transport in the case of seepage. Synonym: Layered filter
Filtration	Function of preventing the migration of particles between two layers. This function can be accomplished by a special part (filter) or it can be accomplished naturally by the granular properties of the two zones.
Flap gate/valve	A top-hinged gate designed to close when downstream water level exceeds the upstream water level. Frequently used for drainage outfalls into tidal waters and rivers to prevent backflow. Synonym: Check valve
Flood	<ol style="list-style-type: none"> 1 Discharge of water beyond the mean discharge under conditions of high water level. A flood is described by its probability of not being exceeded, its hydrograph, max discharge, duration, and volume. 2 An inundation (by overflowing or overtopping) that comes from a river, a sea or other body of water and causes or threatens damage. Also, any relatively high stream flow overflowing or overtopping the natural or artificial banks in any reach of a stream. <p>See also <i>Storm event</i></p>
Flood defence asset	An asset that would by its failure increase the likelihood of flooding from any main river and/or the sea to people, property or infrastructure (eg levees, flood walls and other raised defences, closure structures, pumping stations).
Flood defence system	The system of levees and associated structures that protects a previously floodable area from floods up to certain conditions. See also <i>Benefit area</i>
Flood duration	Duration of the elevated water level and discharge above some threshold. See also <i>Persistence of storms</i>
Flood gate	<ol style="list-style-type: none"> 1 A roadway or railroad closure structure that can be of varying types, eg swing gate, trolley gate and rolling gate. See also <i>Closure structure</i> 2 A means of controlling, varying or stopping a flow in a pipeline. They can be of different sorts (eg sluice gate or flap gate) and be housed in a gatewell. See also <i>Gatewell</i>
Floodplain	Land on either side of a river or behind the coastal defences that is below the highest defined flood level.
Flood Risk Management System (FRMS)	A system consisting of those flood defence assets that relate to main river or sea flooding, upon which an entity may choose to exercise operational or direct enforcement powers, and that contributes to managing flood risk to a discrete location.
Flood wall	A hard structure (eg masonry or concrete) with purpose to contain water. It can be either associated with levees in a flood protection system (function similar to an earthen levee), or be used as a structure to protect the embankment or placed on the top of a levee.

Floodway	Path that flowing water takes during a flood. Also, a designated flowage area intended to convey discharges that exceed a certain level.
Flow duration curve	Graph showing the proportion of time during which discharges are equalled or exceeded.
Flow force	Force on completely or partially submerged bodies due to the approaching flow of water. See also <i>Hydrodynamic force</i>
Flow line	The path that water will follow when moving from an area of high pressure to an area of low pressure in a seepage analysis.
Flow net	A graphical analysis of seepage flow in a mass of soil to estimate flow quantities and pore pressures.
Flow pattern	Modelling of the flow net.
Flow quantity	The total volume of water flowing in a seepage analysis.
Flow rate	See <i>Discharge, Stream flow</i>
Flow section	See <i>Discharge section</i>
Forcing	The natural processes that activate hydro- and morpho-dynamics (eg winds, waves, tides).
Forecasting	Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. A commonplace example might be estimation of the expected value for some variable of interest at some specified future date.
Foundation	A component of an engineered structure that transmits a structure's forces into the underlying soil or rock. Related to levees, the levee generally rests directly on the ground without an engineered foundation, where the ground itself is the foundations. In some case, particularly if the soil has poor properties, then a blanket (eg Fascine mattress) can be used as foundation. See also <i>Substrate, Founding depth</i>
Founding depth	The depth below the ground surface where the base of a foundation is located. See also <i>Foundation</i>
Fragility	The likelihood of particular defence or system to fail under a given load condition. Typically expressed as a 'fragility curve' relating load to likelihood of failure. Combined with descriptors of deterioration, fragility relationships enable performance to be described over time. See also <i>Design standard</i>
Freeboard	<ol style="list-style-type: none"> 1 The height of the lowest point of a structure above still water level at the maximum level of a given event. 2 The increment of levee or flood wall height added to the design flood height to increase the likelihood of the design event being contained without the levee or flood wall overtopping.
Free surface flow	Flow with a free water surface at atmospheric pressure and exposed to the air. See also <i>Full flow, Pressure flow</i>
Friction angle	See <i>Angle of internal friction</i>
Froude number (Fr)	A dimensionless ratio between inertia and gravity forces in a fluid, or between mean velocity and wave celerity. Froude number is unity for critical flow, greater than 1 for supercritical flow and less than 1 for subcritical flow.
Full flow	Flow in a closed conduit in which the water surface just reaches soffit level, but does not flow under pressure. See also <i>Free surface flow, Pressure flow</i>

Functional analysis	Analysis of a system, environment and components, based on its/their (main) functions.
Gabion	Generic name given to a revetment system consisting of stone contained in steel or polymer mesh. Types include box gabions, gabion mattresses and sack gabions.
Geology	The science that deals with the dynamics and physical history of the earth, the rocks of which it is composed, and the physical, chemical, and biological changes that the earth has undergone or is undergoing.
Geomechanics	The geologic study of the behaviour of soil and rock. The two main disciplines of geomechanics are soil mechanics and rock mechanics. The former deals with the behaviour of soil from a small scale to a landslide scale. The latter deals with issues in geosciences related to rock mass characterisation and rock mass mechanics, such as applied to tunnel design, rock breakage, and rock drilling. Many aspects of geomechanics overlap with parts of geotechnical engineering. Modern developments relate to seismology, continuum mechanics, discontinuum mechanics, and transport phenomena.
Geomembrane	A kind of geosynthetic material, which is impermeable.
Geomorphology	Describes the characteristics of all the features on the earth, in particular the river, estuary, lake or seabed forms and systems and examines the processes sustaining them.
Geophysical survey	The systematic collection of geophysical data for spatial studies. This process produces images of features (such as archaeological and geotechnical) that are hidden below the ground surface. A great variety of sensing instruments may be used, and data may be collected from above or below the Earth's surface and from aerial or marine platforms. See also <i>Ground investigation</i>
Geophysics	Quantitative physical methods for exploring structures and properties beneath the Earth's surface. A variety of methods and instruments are available using natural or artificial sources generating, eg electromagnetic/seismic waves or static/dynamic electric/magnetic fields and corresponding sensors at the surface, on/below water or in boreholes to record the response of the subsurface.
Geosynthetics	Generally polymeric products used to solve civil engineering problems. The term is generally regarded to encompass eight main product categories: geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells (cellular confinement) and geocomposites.
Geotechnique	The branch of civil engineering that deals with the mechanical behaviour of soils, rocks and earthwork materials. It adopts the principles of soil and rock mechanics to evaluate the stability and performance of both natural soils and man-made earthen structures.
Geotechnical instrumentation	Instruments used to monitor phenomena such as deformation, pore pressures and stress within the ground.
Geotextile	Any strong synthetic fabric used in civil engineering, as to retain an embankment to stabilise soils, retain soils, prevent the mixing of dissimilar soils, provide a filtering function, pavement support, subgrade reinforcement, drainage, erosion control and silt containment.
Graded filter	Filter consisting of different layers with different grain sizes. See also <i>Filter, Granular filter</i>
Grading curve	See <i>Particle size distribution</i>
Grain size distribution	See <i>Particle size distribution</i> See also <i>Block size distribution</i>

Granular filter	A bed of granular material incorporated in a levee and graded as to allow seepage to flow across or down the filter zone without causing the migration of the material from zones adjacent to the filter. See also <i>Filter, Graded filter</i>
Ground investigation	The sub-surface part of a site investigation including sampling and field testing and with associated laboratory testing and factual reporting. See also <i>Geophysical survey</i>
Groundwater	Water that is below the surface of the ground in the saturated zone.
Grout	A material used to fill voids, and seal joints. It is usually composed of a mixture of water, cement, sand, and sometimes fine gravel. It hardens over time much like mortar.
Groyne	Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain beach material. Most groynes are made of timber, rock or concrete, and extend from a seawall, or the backshore, onto the foreshore and occasionally further offshore. See also <i>River training structure</i> Synonym: Spur-dike
Habitat	The area or environment where an organism or ecological community normally lives or occurs.
Hazard	<ol style="list-style-type: none"> 1 A situation, physical event (eg flood or storm), phenomenon or human activity with the potential to result in harm. 2 Probability for a dangerous phenomenon to occur with a given intensity.
Head loss	The difference in head between two points due to friction or other features that result in energy loss (eg a transition, step, constriction, expansion, or bend). See also <i>Energy head</i>
Headwall (of a culvert)	The retaining wall at a culvert inlet or outlet that provides support to the embankment. The headwall is normally at right angles to the culvert barrel, but may be skewed. The headwall may have wingwalls at an angle to the headwall that provide support to the channel sides and form part of the transition from channel to culvert and vice versa.
Height of levee	Vertical measured difference between the landside levee toe and the highest point of the levee crest.
Heterogeneous soil	A mass of soil with highly variable index and engineering characteristics. Antonym: Homogeneous soil
Homogenous soil	A mass of soil where the soil is of one characteristic having the same engineering and index properties. Antonym: Heterogeneous soil
Hybrid model	Model that adopts a combination of empirical and deterministic modelling approaches. See also <i>Numerical model, Empirical modelling</i>
Hydration	The introduction of water to a substance.
Hydraulic conductivity	Ratio of flow velocity to driving force (hydraulic gradient) for viscous flow under saturated conditions of a specified liquid in a porous medium.
Hydraulic control structure	Gated or fixed structure used to regulate the discharge through, over, or under a flood protection work. See also <i>Barrage, Dam, Spillway, Weir, Flood gate</i>
Hydraulic grade line	See <i>Hydraulic head, Energy grade line</i>
Hydraulic gradient	<ol style="list-style-type: none"> 1 Quotient of drop in hydraulic energy and distance of flow.

	2 In a structure or in soil: the hydraulic gradient is the difference between two or more hydraulic head measurements divided by the length of the flow path.
Hydraulic head (piezometric head)	Hydraulic head (or piezometric head) is a specific measurement of water pressure in units of length above a given geodetic datum. See also <i>Energy head, Hydraulic grade line</i>
Hydraulic jump	Abrupt rise in water level when flow changes from supercritical to subcritical, accompanied by surface disturbance and air entrainment and an associated dissipation of energy. See also <i>Critical flow</i>
Hydraulic performance	Performance of a levee (system) in terms of protection against hydraulic events (flood, storm).
Hydraulic roughness	Measure of the amount of frictional resistance water experiences when passing over land and channel features. The roughness can be expressed according to Manning (n) or Strickler (kSt). An increase in the n value will cause a decrease in the velocity of water flowing across a surface. See also <i>Manning's equation</i>
Hydraulics	The scientific study of water and other liquids, in particular their behaviour under the influence of mechanical forces and related uses in engineering.
Hydrodynamic force	Forces due to currents and waves on a completely or partially submerged body. See also <i>Hydrodynamic pressure, Flow force</i>
Hydrodynamic (or hydraulic) pressure	The pressure exerted by water (whether at rest or moving) on a surface or structure. Hydraulic pressure has the units of force per unit area and is calculated for water at rest as the product of the depth of water and its density. The pressure can differ for water in motion. See also <i>Hydrostatic pressure, Pressure head</i>
Hydrogeology	Area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust.
Hydrograph	Graph showing the variation of discharge or water level over time.
Hydrology	Science of the hydrological cycle, including precipitation, runoff and fluvial flooding.
Hydrostatic pore pressure	Pore water pressures exerted under conditions of no groundwater flow where the magnitude of pore pressure increases linearly with depth below the groundwater surface.
Hydrostatic pressure	The pressure exerted by water at rest on a surface or structure. The product of the depth of water and its density. See also <i>Hydrodynamic (hydraulic) pressure</i>
Immediate settlement	The settlement of a foundation occurring immediately upon loading. See also <i>Consolidation settlement</i>
Impermeable	Will not allow water to pass through. Synonym: Impervious
Impervious	See <i>Impermeable</i>
Incident wave	A wave moving towards land or to a structure.
Index properties	Attributes of a soil such as moisture content, void ratio, specific gravity, Atterberg limits and grain size distribution, which are unaffected by remoulding that soil (as distinct from engineering properties).
Infiltration	1 The entrance of groundwater into a structure (eg sewer, culvert or pipeline) through breaks, defective joints, or porous walls.

	2 The penetration of water through the soil from surface precipitation, stream or impoundment boundaries.
Infrastructure	Collective term for a group of assets needed for the operation of a society or enterprise or the services and facilities necessary for an economy to function. It includes physical resources, services and information technology facilities, networks and assets that, if they were disrupted or destroyed, would have a serious effect on the health, safety, security or economic well-being of citizens or the effective functioning of government. Examples include roads, railways, public services, power supplies and telecom equipment.
Internal erosion	The movement of soil particles as a result of chemical actions and/or unbalanced seepage forces produced by percolating water. See also <i>External erosion, Wear, Weathering, Piping, Joint erosion, Contact erosion, Retrogressive erosion</i>
Isotropy	A characteristic of soils that exhibit the same properties such as strength, stiffness and permeability in all directions. Isotropy is often the result of engineering approximation rather than a true soil property
I-wall	Sheet pile driven vertically into the ground. See also <i>Sheet pile, Cut-off wall</i>
Jetty	A structure extending into a body of water that protects a harbour or coastline from the effects of currents and tides. See also <i>Breakwater</i>
Joint erosion	Internal erosion in the joint between soil and concrete/masonry.
Joint probability	The probability that two or more specific outcomes will occur in an event. See also <i>Event</i>
Landside	Refers to the side of the flood defence structure opposite to the waterside. Antonym: Waterside
Layered filter	See <i>Filter layer</i>
Leakage	Unwanted discharge of fluid. See also <i>Seepage, Resurgence</i>
Leveed area	Area behind the levee that is not flooded, or in which the flooding is reduced or delayed due to the levee/flood defence system.
Levee	Raised, predominantly earth, structures (sometimes called flood defence embankments or dikes) whose primary objective is to provide protection against fluvial and coastal flood events along coasts, rivers and artificial waterways that are not reshaped under normal conditions by the action of waves and currents. Levees form part of flood defence systems that may also include flood walls, pumping stations, closure structures, natural features etc. See also <i>Dike</i>
Level of protection	For a levee: the maximum event that, with a high degree of assurance, will not result in levee failure subsequently inundating the leveed area. This maximum event can be associated with a probability of occurrence. For a flood defence system: the maximum event that, with a high degree of assurance, will not result in defence system failure subsequently inundating the flood defence area. This maximum event can be associated with a probability of occurrence. See also <i>Design criteria</i>
Levee segment	The division of a levee based on some determined parameter such as ownership, composition etc.
Life cycle cost	Total cost of managing an asset over its design life (or service life), ie the

assumed period of time after construction or refurbishment when an asset meets or exceeds its functional performance requirements with anticipated maintenance but without major repair being necessary.

See also *Whole life cost*

Limit states	<ol style="list-style-type: none"> 1 Conditions under which a structure can no longer perform its intended functions. 2 The boundary between safety and failure for a structure. The limit state function $Z=R-S$ is a function of the structure's strength (R) and loading (S) for a particular failure mode. Failure will not occur if the limit state function is positive. <p>Generally two types of limits state are distinguished: ultimate limit states (ULSs) are related to the safety of the structure and they define the limits for its total or partial collapse. Serviceability limit states (SLSs) represent those conditions that adversely affect the expected performance of the structure under normal service loads.</p> <p>See also <i>Failure</i></p>
Liquefaction	Describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid.
Liquidity index	A measure of the relationship between the current water content of a soil and its consistency limits.
Liquid limit	The water content above which the soil will flow like a liquid, but below which it will have a plastic consistency.
Lithology	Refers to rock type and composition.
Maintenance	All activities whose purposes are to maintain or restore a system in a state or in given safety or working condition, to perform a required function. It includes preventative maintenance and repairs (exclusive options). Generally it consists in repairing or replacing the components of a structure whose life is less than that of the overall structure, or of a localised area that has failed or will fail.
Maintenance area	Stripe/sector at both toes of the levee that should be kept clear for monitoring and maintenance.
Manning's equation	An empirical formula for estimating flow in open channels, or free-surface flow driven by gravity. See also <i>Hydraulic roughness</i>
Marsh	An area of low-lying wetland in which the level of water is generally shallow and often fluctuating. The water may be either standing or slow-moving. In contrast to a swamp, in which there is an abundance of woody plants, the plants in a marsh are mostly herbaceous. Reeds and rushes dominate the vegetation of marshes.
Maximum dry density	A soil property obtained in the laboratory from a compaction (Proctor) test. It is the density of compacted soil at 100 per cent compaction under the particular level of compaction applied.
Meandering	A single channel characterised by a pattern of successive deviations in alignment that results in a more or less sinusoidal course.
Mean normal stress	The mean value of the three orthogonal stresses.
Mean sea level	The average level of the sea over a period of 12 months, taking account of all tidal effects (see tides) but excluding surge generated by meteorological effects. Variation in mean sea level may well occur in the longer term.
Mean wave period	The mean period of the wave defined by zero-crossing analysis of a wave record.

Mechanism	The fundamental processes involved in or responsible for an action, reaction, or other natural phenomenon (these mechanisms can lead to breach, collapse, settlement and other failures modes).
Median annual flood	Flood with an annual exceedance probability of 50 per cent (return period two years), defined as QMED by the Institute of Hydrology (1999).
Metadata	Definitional data that provides information about or documentation of other data managed within an application or environment. It is used to document data about data elements or attributes, (name, size, data type etc) and data about records or data structures (length, fields, columns etc) and data about data (where it is located, how it is associated, ownership etc). Metadata may include descriptive information about the context, quality and condition, or characteristics of the data.
Modular flow	State of flow over crest of weir or other control structure in which the upstream water level depends on the discharge but is independent of the water level downstream of the structure. Antonym: Submerged weir flow See also <i>Supercritical flow</i>
Moisture content	The ratio between the mass of water and the mass of soil solids.
Monitoring	Systematic recording over time to establish trends in data. See also <i>Performance monitoring</i>
Monochromatic waves	See <i>Regular waves</i>
Morphology	The plan form and cross-section shape of a watercourse. See also <i>Geomorphology</i>
Mud	Wet, soft earth or earthy matter, on the ground after rain, at the bottom of a pond, or along the banks of a river.
Multi-criteria analysis	The use of more than one factor, with different units of measurement or appraisal, to judge performance. Usually analysed within a structured decision making tool.
Normal compression line	The relationship between void ratio and the normal effective stress for soil loaded beyond the current yield stress in an isotropic compression.
Normal flow	Steady, uniform flow in an open channel where the hydraulic and energy grade lines are parallel and Manning's equation applies. See also <i>Uniform flow</i>
Normally consolidated soil	Soil having a current state that lies on the normal compression line.
Numerical model	Mathematical equations that attempt to describe reality and permit prediction of the behaviour of phenomenon such as flow, sediment transport, shoreline evolution etc. See also <i>Coastal area models (2D and 3D)</i> , <i>Empirical modelling</i> , <i>Hybrid model</i> , <i>Physical model</i> , <i>Two/three-dimensional (2D or 3D) model</i> , <i>Shoreline evolution models</i>
One dimensional compression	Compression taking place with zero radial and horizontal strain.
One dimensional (1D) model	A numerical model in which all the flow parameters are assumed to be constant over the cross-section normal to the flow. There is only a velocity gradient in the flow direction.
Open layer	A layer or stratum of soil from which porewater may drain both upward and downward into overlying and underlying permeable layers, thus enabling two-way drainage. See also <i>Filter</i> , <i>Drain</i>

Operation	The day-to-day activities, associated with the flood defence management, exclusive of the maintenance itself.
Operational inspection	A regular inspection of an asset to check it is in working order and in a safe condition. See also <i>Engineering inspection, Visual asset inspection, Reach inspection</i>
Optimum moisture content	The water content at which the maximum dry density of a soil is obtained using a specific effort of compaction.
Organic soil	Earth containing a significant proportion of organic material or peat.
Outflanking	Erosion or scour behind or around the land-based end of a structure that may threaten to compromise the stability or integrity of the structure and its function. See also <i>Scour</i>
Over-consolidated soil	A clayey soil carrying a higher load in the past. Soil having a current state that lies inside the normal compression line.
Over-consolidation ratio	The ratio of maximum past pressure (pre-consolidation pressure) to the current effective stress.
Overflowing	Passing of water over the top of a structure as a result of a water level higher than the crest of the structure. See also <i>Overtopping</i>
Overflow	See <i>Spillway, Weir</i> Synonym: Levee overflow, Safety spillway
Overtopping	Passing of water over the top of a structure as a result of wave action, surge or wind. The water level in front of the structure is lower than the crest level of the structure. See also <i>Wave overtopping, Overflowing</i>
Overturning	A result of excessive lateral earth pressures with relation to retaining wall resistance thereby causing the retaining wall system to topple or rotate (overturn).
Parapet	See <i>Crown wall</i>
Particle size distribution	Soil particle sizes that are determined from a representative sample of soil, which is passed through a set of sieves of consecutively smaller openings.
Passive earth pressure	The maximum horizontal stress exerted by a mass of soil on a retaining surface as the surface moves toward the soil.
Peak	The top of a wave. Antonym: Trough
Peak period	The wave period determined by the inverse of the frequency at which the wave energy spectrum reaches a maximum.
Performance	The degree to which a system (eg a flood defence system), a structure (eg a levee) or a component succeeds when evaluated against some stated aim or objective. See also <i>Hydraulic performance</i>
Performance assessment	A comparison of present performance against performance requirements. The assessment considers the effect of condition on each performance requirement and the effect of each performance requirement on the performance of the subsystem or system. The key to performance assessment is an understanding of the link between asset (or system) condition and its response under a range of loading conditions. Outputs from this stage are the probability of failure and residual life.
Performance indicator	Specific, measurable and time-related output of a particular asset management policy or project. May be technical such as acceptable wave overtopping rates or

	conveyance capacity, or more generic such as public satisfaction. Performance indicators are designed to address the quality of the execution of a project or initiative and the degree to which the initiative meets the requirements of funders. They compare actual conditions with a specific set of reference conditions and they measure the distance(s) between the current environmental situation and the desired situation (target), ie distance to target assessment. Synonym: Performance measure
Performance monitoring	Continuous or periodic quantitative and qualitative assessments of the actual performance compared with specific objectives, targets or standards. See also <i>Condition monitoring</i>
Performance requirement	The hydraulic, structural, environmental or other criteria to which an asset or system is built and maintained.
Permeability	The property of a soil that controls the rate of flow of water through that soil. It depends on the physical properties of the medium, for example grain size, porosity, and pore shape. See also <i>Porosity, Porous</i>
Persistence of storms	The duration of sea states above some severity threshold (eg wave height). See also <i>Flood duration</i>
Phreatic surface	See <i>Piezometric surface</i>
Physical model	Simulation of a structure and/or its environment, usually in much smaller dimensions, to enable the consequences of future changes to be predicted. Synonym: Scale model See also <i>Prototype</i>
Piezometric level	An imaginary line representing the total head in an aquifer, ie it represents the height above a datum plane at which the water level stands in boreholes penetrating the aquifer. See also <i>Saturation line</i>
Piezometric surface	An imaginary or hypothetical surface of the piezometric pressure or hydraulic head throughout all or part of a confined or semi-confined aquifer; analogous to the water table of an unconfined aquifer. The piezometric surface provides an indication of the direction of groundwater flow and is used to determine hydraulic gradients. Synonym: Phreatic surface
Piping	The creation of flow channels within a levee or the underlying ground as a result of seepage and continuing internal erosion. Piping can lead to the development of boils or breaches. See also <i>Internal erosion, Retrogressive erosion</i>
Pitched stone	Squared masonry, pre-cast blocks or embedded stones laid in regular fashion with dry or filled joints (to increase friction forces). It is often placed on the waterside slope of levees as a protection against wave and ice action.
Placed rockfill, stone packing	Erosion protection surface layer of stones (set by hand or carefully set with a loader). See also <i>Pitched stone</i>
Planform	The form of a river or stream when viewed from above, for example, the term 'meandering' is a description of a sinuous planform. See also <i>Cross-section</i>
Plastic deformation	The distortion of soil resulting in a permanent and irrecoverable change in shape or volume.
Plastic limit	The moisture content in which a soil will have a plastic consistency.

Plasticity index	The difference between the liquid limit and plastic limit of a soil mass.
Ponding	<ol style="list-style-type: none"> 1 A plugging of the filter media to restrict downward movement of water causing surface accumulation. 2 A body of water that is impounded on the landside of a levee when natural drainage is severed or temporarily interrupted by the levee or operation of structures associated with the levee.
Pore pressure	The interstitial pressure of water within a mass of soil or rock.
Porosity	The ratio of the volume of voids to the total volume of soil, generally expressed as a percentage.
Porous	<ol style="list-style-type: none"> 1 Having many pores or other small spaces that can hold or transport a fluid. 2 For revetments and armour layers, the permitting of rapid through movement of water, such as during wave action. <p>See also <i>Permeability</i></p>
Pre-consolidation pressure	The maximum past pressure of a soil.
Pressure flow	<p>Flow within a closed conduit that is confined by and exerts hydraulic pressure on the conduit walls and soffit.</p> <p>Synonym: Surcharged flow</p> <p>See also <i>Free surface flow, Full flow</i></p>
Pressure head	<p>Height of a column of water required to develop a given pressure at a given point.</p> <p>See also <i>Energy head, Hydrodynamic (Hydraulic) head</i></p>
Primary consolidation	The long-term consolidation of clay or an organic soil from the loss of water in the voids due to high pressure.
Principal strains	The strains occurring in the directions of the principal axes of strain.
Principal stresses	Normal stresses acting in the direction of principal axes of stress.
Probabilistic	<p>Descriptor of method or process in which the variability of input values (eg asset loading and strength) and their sensitivity are taken into account to give results in the form of a range of probabilities for different outcomes (eg failure).</p> <p>See also <i>Deterministic</i></p>
Probabilistic design	This deals primarily with the consideration of the effects of random variability upon the performance of an engineering system during the design phase. Each variable is viewed as a probability distribution rather than a single value or number.
Probability	Measure of the chance that an event will occur. Typically defined as the relative frequency of occurrence of that event out of all possible events and expressed as a percentage with reference to a time period eg one per cent annual exceedance probability.
Process	A systematic series of actions directed to some end, eg a breaching process is composed of a succession of failure mechanisms.
Progressive failure	<p>Failure process where, once a threshold is exceeded, some residual strength enables the asset to maintain restricted performance while further progressive loss of strength takes place.</p> <p>See also <i>Failure, Sudden failure</i></p>
Protection objective	<p>Level of protection related to an event with a certain recurrence period that shall be achieved by the protection measures.</p> <p>See also <i>Design criteria</i></p>
Prototype	<p>The actual structure or condition being simulated in a model.</p> <p>See also <i>Physical model</i></p>

Pumping station	A structure used to evacuate water from interior drainage in a flood defence system. See also <i>Flood defence asset</i>
Quarry run	Materials with no fines control and including all granular material found in the quarry blast pile that can be picked up in a typical loading shovel, ie only blocks too large for easy digging and loading are left behind.
Quasi-three-dimensional (3D) model	A numerical model in which the flow parameters vary in two dimensions, but which allows determination of the flow parameter in the third dimension. See also <i>Two/three-dimensional (2D or 3D) model</i>
Raised defence	Any raised structure that protects an area from flooding. See also <i>Flood protection structure</i>
Random waves	The laboratory simulation of irregular sea-states that occur in nature.
Rating curve	A relationship between discharge/ flow and depth or water elevation at a given point.
Reach	Watercourses are divided up into measurable lengths called reaches for ease of management. See also <i>Frontage</i>
Reach inspection	An inspection measuring the probability and consequences of failure of a particular reach. This information can be used to determine the frequency of asset visual inspection.
Reflection	The process by which (part of) the energy of the wave is returned seaward.
Refraction	The process by which the direction of a wave moving in shallow water at an angle to the seabed contours is changed so that the wave crests tend to become more aligned with those contours.
Refurbishment	The process of returning an asset to its original as-designed performance. Synonym: Renovation See also <i>Rehabilitation</i>
Regular waves	Waves with a single height, period and direction. Synonym: Monochromatic waves
Rehabilitation	The process of restoring an asset for the purpose of returning that asset to design performance. See also <i>Refurbishment, Reinforcement</i>
Reinforcement	The process of improving the performance of an asset (or one of its components) against an event or a degradation mechanism. See also <i>Rehabilitation</i>
Relative compaction	A minimum density specification usually designated as a percentage of the maximum dry density.
Relative density	The density of a granular soil relative to the minimum and maximum densities achieved for that particular soil.
Relief well	A vertically installed well consisting of a well screen surrounded by a filter material designed to prevent in-wash of foundation materials into the well. Relief wells are used extensively to relieve excess hydrostatic pressures in pervious foundation strata overlain by more impervious top strata, conditions that often exist landside of levees and downstream of dams and various hydraulic structures.
Renovation	See <i>Refurbishment</i>
Repair	Restoring to operating condition after damage has occurred and a structure's functionality has been reduced. Repair can also be thought of as corrective maintenance.
Reservoir	An artificial lake, basin or tank in which a large quantity of water can be stored.

Residual risk, remaining risk	The remaining level of risk at any time before, during and after a program of risk mitigation measures has been taken.
Residual water level	The components of water level not attributable to astronomical effects. See also <i>Surge, Still water level, Tidal range</i>
Resilience	The ability to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruption.
Resurgence	<ol style="list-style-type: none"> 1 Any natural situation where water flows to the surface of the earth from underground (ie the aquifer surface meets the ground surface). 2 More specifically, in this handbook, flow of water at the surface of the landside of a levee or in the nearby natural ground. See also <i>Seepage, Leakage</i>
Retaining wall	Walls, usually constructed of concrete, rock, or sheet piles, which provide lateral stability of the earth, preventing the soil from sloughing or slope failure. Different types of retaining walls exist, eg gravity wall, counterfort wall, I-wall, T-wall.
Retrogressive erosion	Internal erosion starting on the landside progressing towards the waterside of the levee. Synonym: Backward erosion See also <i>Internal erosion, Piping</i>
Return period	For a given parameter (eg water level), the mean duration between two events where this parameter was observed. Inverse of the probability that a given event will occur in any one year. Annual exceedance probability (AEP) is the preferred term for flood risk management, one per cent AEP being equivalent to a 100-year return period. Synonym: Recurrence period, Recurrence interval
Return seepage	Seepage water on the landside of the levee that is captured by some type of collection system and evacuated. See also <i>Seepage</i>
Return seepage channel	Channel made for the purpose of collecting and evacuating seepage water. This channel can be made by digging a ditch or by building a small levee known as 'return seepage levee'.
Return seepage levee	See <i>Seep water levee</i>
Revetment	Works to protect the slopes of a levee against erosion, typically constructed from armourstone, masonry, asphalt or concrete blocks. See also <i>Facing</i>
Riparian	Of, pertaining to, situated, or dwelling on the bank of a river or other body of water. A riparian zone or riparian area is the interface between land and a river or stream. Plant habitats and communities along the river margins and banks are called riparian vegetation, characterised by hydrophilic plants.
Risk	Risk is defined as being a function of the probability that an event will occur and the consequence associated with that event. Risk = f(probability x consequence). A measure of the probability and severity of undesirable consequences or outcomes.
Risk analysis	Risk analysis is a decision-making framework that comprises three tasks – risk assessment, risk management, and risk communication.
Risk assessment	The process of identifying hazards and potential consequences, estimating the magnitude and probability of consequences, and assessing the significance of the risk(s). A tiered approach can be used with the effort in assessing each risk proportionate to its importance in relation to other risks and likely consequences.

Risk attribution	The contribution of specified assets or groups of assets to the overall risk associated with a leveed area. This helps interventions to be targeted on managing the greatest risks.
Risk control	The deliberate action taken to reduce the potential for harm or maintain it at an acceptable level.
Risk management	The systematic process of risk assessment, options appraisal and implementation of any measures to control or mitigate risk.
Risk monitoring	The definition of the measures necessary to control the risk, coupled with their use – the management of the risk. The risk management process should include the arrangements for monitoring the effectiveness of the control measures together with their review to ensure continuing relevance.
Runoff	Overland flow produced by rainfall.
Run-up, run-down	<ol style="list-style-type: none"> 1 The rush of water up a structure or beach as a result of wave action. 2 The upper and lower levels reached by a wave on a beach or coastal structure, relative to still water level, measured vertically. <p>See also <i>Swash zone</i></p>
Rutting	A long stretch of depressions in the levee crown or levee toe caused by vehicular traffic wearing away a longitudinal or vertical portion of the levee roadway. See also <i>Depression</i>
Sand	Sediment particles, mainly of quartz, with a diameter of between 0.062 mm and 2 mm, generally classified as fine, medium, coarse or very coarse. See also <i>Clay, Silt</i>
Sandbag	A sack made of hessian/burlap, polypropylene or other materials that is filled with sand or soil. Synonym: Floodbag
Saturation line	Representation of the piezometric levels on a cross-section. See also <i>Piezometric surface</i>
Scale model	See <i>Physical model</i>
Scenario	Account or synopsis of a possible course of action or events.
Scour	In a stream: erosion of the bed or banks of a watercourse by the action of moving water typically associated with channel contraction or local feature such as bridge pier. On the coast: erosion resulting from shear forces associated with flowing water and wave actions. See also <i>Caving, Outflanking</i>
Sea defences	Works to prevent or alleviate flooding by the sea. See also <i>Coastal defences</i>
Sea state	Description of the sea surface with regard to wave action.
Seepage	In soil engineering, the movement of water in soils. Seepage depends on several factors, including permeability of the soil and the pressure gradient. See also <i>Leakage, Resurgence</i>
Seepage berm	Construction of additional weight at the landside toe of the levee to counteract upward seepage forces and/or additional length required to reduce uplift pressures at the toe of the levee to tolerable values.
Seepage force	The force transmitted to a mass of soil due to the seepage of groundwater.
Seepage pressure	The seepage force per unit volume.
Seepage velocity	The average velocity at which groundwater flows through the pores of a soil. The ratio of the volume flow rate to the average area of voids in a soil cross-section.

Seep water levee	Small levee on the landside of the main levee made for the purpose of collecting and evacuating seepage water in a channel. It can also impound seeping water to reduce the hydraulic gradient. Synonym: Return seepage levee
Sensitivity analysis	Testing the potential variations in the outcome of an evaluation by altering the values of important factors that have uncertainty.
Settlement	The downward movement of the ground surface or a structure on or in the ground as a result of external stresses. See also <i>Differential settlement</i>
Settling	The process by which particulates settle to the bottom of a liquid and form sediment.
Shallow water	Commonly, water of such depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than half the surface wavelength as shallow water. Antonym: Deep water See also <i>Shoaling</i>
Shear strength	The maximum shear stress that a soil can sustain under a given set of conditions.
Shear stress	The force per unit area acting tangentially to a given plane or surface.
Sheet pile	Interlocking panels of steel that are driven into the ground to provide lateral support. See also <i>I-Wall, Cut-off wall</i>
Shoaling	Decrease in water depth resulting in the transformation of wave profile as they propagate inshore or, more specifically, a change in wave height related to the changing speed of propagation of wave energy.
Shoaling coefficient	Ratio of shoaled wave height to deep water wave height.
Shoulder	Horizontal section between levee crest and slope. See also <i>Berm</i>
Significant wave height	Average height of the highest one-third of the waves in a given sea state.
Significant wave period	Average of the periods associated with the highest one-third of wave heights in a given sea state.
Sill	1 A submerged structure across a river to control the water level upstream. See also <i>Weir</i> 2 The crest of a spillway.
Silt	A sedimentary material consisting of grains or particles of disintegrated rock, smaller than sand and larger than clay. The diameter of the particles ranges from 0.0039 mm to 0.0625 mm. Silt is often found at the bottom of bodies of water where it accumulates slowly by settling through the water. See also <i>Clay, Sand</i>
Site investigation	The process of methodically observing, sampling and testing for the purpose of characterising the ground and investigating potential hazards. Site investigation techniques can be intrusive or non-intrusive. See also <i>Geophysical survey, Ground investigation</i>
Sliding	1 Movement of a layer of materials along a slope or on a horizontal plane. Synonym: Sloughing 2 A result of excessive lateral earth pressures with relation to retaining wall resistance thereby causing the retaining wall system to move away (slide) from the soil it retains.
Slope	1 Inclined face of a cutting, bank or levee.

	2 Amount of inclination of a surface or a line to the horizontal. It is a special case of the gradient in calculus where zero indicates gravitational level. A larger number indicates higher or steeper degree of 'tilt'. Often slope is calculated as a ratio of 'rise' to 'run', or as a fraction ('rise' over 'run') in which run is the horizontal distance and rise is the vertical distance.
Slope drain	Layer of coarse soil that can be put on potential water sources on the landside slope to stabilise and dewater. See also <i>Drain, Filter</i>
Slope protection	A structure (eg rock or concrete) on the slope intended to protect the underlying material against erosion by current and/or wave action. See also <i>Bed protection, Revetment</i>
Sloughing	Movement of a mass of soil down a bank or slope into the channel usually occurring when the bank or underlying stratum is saturated. See <i>Sliding</i>
Sluice	A water channel that is controlled at its head by a gate.
Sod	1 Section cut or torn from the surface of grassland, containing the matted roots of grass. 2 Surface of the ground, especially when covered with grass or turf.
Soil classification	A standardised classification system for quantifying certain soil characteristics that is important for determining soil behaviour.
Soil suction	See <i>Capillary action (or capillarity)</i>
Specification	1 An explicit set of requirements to be satisfied by a material, product, or service. 2 Document detailing the materials, construction and/or measurement requirements for a contract, agreed by the contracted parties before they undertake the contract.
Specific energy	The energy of a fluid relative to bed level, given by the sum of pressure and velocity heads. See also <i>Energy head</i>
Spillway	A designed section of a levee with lower crest elevation, protected crest and slope, through which flow can be discharged in order to protect the levee system against failure by overflowing non-protected sections. Synonym: Safety spillway, Overflow, Levee overflow See also <i>Weir</i>
Stable	1 <i>Physics</i> : having the ability to react to a disturbing force by maintaining or re-establishing position, form, or function. A structure can be statically stable or dynamically stable. 2 <i>Chemistry</i> : not readily decomposing, as a compound; resisting molecular or chemical change.
Stake	1 A monetary or commercial interest, investment, share, or involvement in something, as in hope of gain. 2 A personal or emotional concern, interest, involvement, or share. See also <i>Damage potential, Properties at risk, Vulnerability</i>
Stakeholder	An individual or group with an interest in, or having an influence over, the success of a proposed project or other course of action.
Standard of protection (SoP)	Criteria to be achieved during analysis and design.
Standard of service (SoS)	The performance of an asset at a specific point in time expressed in terms of a physical attribute(s) of the asset or system (eg crest level, pump capacity).

Standard Penetration Resistance	The number of blows required to drive a split-spoon sampler during a standard penetration test a distance of 0.305 m after the initial penetration of 0.15 m.
Standard Penetration Test (SPT)	A field test that measures resistance of the soil to the penetration of a standard split-spoon sampler that is driven 300 mm into the ground at the base of a borehole with a 63.5 kg hammer dropped from a height of 0.76 m. The standard penetration resistance is derived from this test.
Stationary process	A process in which the mean statistical properties do not vary with time.
Steady state pore pressure	The pore water pressure at equilibrium when all excess pore pressures within a soil mass have fully dissipated.
Still water level	Average water surface elevation at any instant, excluding local variation due to waves and wave set-up, but including the effects of tides, surges and long period seiches. See also <i>Residual water level, Still water level</i>
Stochastic	Having random variation in statistics.
Stoplogs	Timber or metal beams spanning horizontally between grooves in piers or abutments of a control structure, used to isolate part of the structure or related reach for maintenance, or to raise the elevation of water retained. Synonym: Stop planks
Storm event	A storm event can be described by several sea-states, eg the increasing phase, the maximum phase and the decreasing phase. At locations under tidal influence the typical sea-state is often only two to three hours, but without tidal effects it may last six hours or longer depending on the evolution in time of wind conditions (typical timescale in the order of 12 hours to one day). See also <i>Event, Flood</i>
Storm surge	A rise of sea elevation caused by water piling up against a coast under the force of strong onshore winds such as those accompanying a hurricane or other intense storm. Reduced atmospheric pressure may contribute to rise. See also <i>Surge</i>
Strain	Deformation of a body or structure as a result of an applied force.
Strand line	An accumulation of debris (eg seaweed, driftwood and litter) cast up onto a beach, and lying along the limit of wave uprush.
Stratum	A layer of rock or soil with internally consistent characteristics that distinguish it from other layers.
Stream regime	Combinations of river discharge and water levels characteristic for a prescribed period (usually a year or a season). The stream regime determines the overall morphology of the stream. See also <i>Regime theory, Flow regime, River training structure</i>
Stress	Physical pressure, pull or other force exerted on one thing by another.
Stress history	The past history of loading and unloading of a soil mass.
Structure	A constructed component using processed materials, such as concrete, masonry, armourstone, and steel, which is part of a flood protection system.
Subcritical	Flow condition where the Froude number is less than unity. Subcritical flow describes the flow condition where upstream water level is influenced by conditions that exist downstream. See also <i>Submerged weir flow, Critical flow, Supercritical flow</i>
Submerged weir flow	Flow over crest of weir or other hydraulic structure that does not pass through critical flow, where the upstream water level depends on the water level downstream of the structure. The downstream water depth above crest level exceeds critical flow depth above crest level.

	Synonym: Drowned weir flow and Sub-modular flow See also <i>Subcritical</i>
Submergence ratio	The ratio between downstream water depth above weir crest level and the upstream water depth above weir crest level.
Subsidence	Subsidence is movement of the ground (mostly vertical) that is not caused by the application of an external load. Examples of subsidence include karst, internal erosion, the collapse of mine workings, settlement due to animal burrowing and desiccation shrinkage caused by seasonal moisture take by trees and other large vegetation.
Substrate	Material underlying or supporting a structure or another layer of material. See also <i>Foundation</i>
Sudden failure	Failure where the break process is fast. It can lead to more severe consequence than a progressive failure. See also <i>Failure</i>
Suffusion	The migration of soil particles through the soil matrix driven by flow through the soil. Suffusion is a contributor to the manifestation of internal erosion.
Supercritical	Flow condition where Froude number is greater than unity. Supercritical flow describes the flow condition where upstream water level is not influenced by conditions that exist downstream. See also <i>Modular flow, Critical flow, Subcritical flow</i>
Surcharged flow	See <i>Pressure flow</i>
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 start breaking, typically in water depths of between 5 m and 10 m.
Surge	Changes in water level because of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and that predicted using harmonic analysis, and may be positive or negative. See also <i>Storm surge, Tidal range, Still water level, Residual water level</i>
Suspended load	The material moving in suspension in a fluid, kept up by the upward components of turbulent currents or by colloidal suspension. See also <i>Bed load, Sediment load, Total load</i>
Sustainability (sustainable development)	The concept of development that meets the needs of the present without compromising the ability to meet future needs.
Swamp	An area of low-lying wet or seasonally flooded land, often having trees and dense shrubs or thickets.
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 also <i>Run-up, run-down</i>
Swell (waves)	Wind-generated waves that have travelled out of their generating area. Swell characteristically exhibits a more regular and longer period and has flatter crests than waves within their fetch. See also <i>Wind sea</i>
System	Assembly of elements, and the interconnections between them, constituting a whole and generally characterised by its behaviour (eg elements in a structure, or assets in an asset system).
Tailwater level	The water level downstream of a weir or other water regulating structure.

Tension crack	Crack appearing at the surface of a soil mass, often adjacent to a retaining wall or top of a failing slope.
Threshold of motion	The point at which the forces imposed on a sediment particle overcome its inertia and it starts to move.
Tidal cycle	Elapsed time between successive high and low waters.
Tidal range	Vertical difference in high and low water level once decoupled from the water level residuals. See also <i>Residual water level</i>
Tidal window	The window of time within a tidal cycle that permits construction or other work.
Tide	Water movements that essentially are generated by the global response of oceans to astronomic effects. On the continental shelves and in coastal waters, particularly bays and estuaries, the effect is amplified by shallow water and coastal platforms. See also <i>Astronomical tide</i>
Toe	The intersection of the landside or waterside slope of a levee with the ground surface.
Toe blanket	A revetment of resistant material placed to protect the surface of a structure (eg levee, dam, bottom of a spillway, chute) from erosion engendered by falling water, turbulent flow, or other factors. Synonym: Apron
Toe drain	A drain, ditch, or pervious pipe which has been engineered to carry seepage water away from the levee toe to control through seepage or under seepage. See also <i>Drainage ditch</i>
Tolerance	Engineering tolerance is the permissible limit of variation in a measured value or physical property of a material, manufactured object, system, or service. The tolerance may be specified as a factor or percentage of the nominal value, a maximum deviation from a nominal value, an explicit range of allowed values, be specified by a note or published standard with this information, or be implied by the numeric accuracy of the nominal value.
Top soil	The surface covering of soil which contains humus and can support vegetation.
Total load	The sum of bed load and suspended load in the river.
Total stress	Usually refers to the vertical stress, which at any point is the weight of everything above that point per unit area.
Transition points/ lines/surfaces	Locations along a flood protection system where there is a change in material (ie soil to concrete) or a change in type of structure (ie levee to gate or railroad crossing).
Trash rack	A structure built on the waterside of a structure, often a culvert, pumping station or weir, to prevent material entering the structure and causing blockages. Synonym: Trash screen See also <i>Boulder trap</i>
Trough	The part of a wave with the least magnitude; the lowest part of a wave. Antonym: Peak
Tsunami	Water waves caused by the displacement of a large body of water (ocean or large lake) with wavelengths in the order of minutes rather than seconds.
T-wall	A cantilever reinforced concrete wall consisting of a vertical concrete stem and flat or sloped base slab that form an inverted 'T'. The structural members are fully reinforced to resist applied moments and shears. See also <i>Retaining wall</i>

Two/three-dimensional (2D or 3D) model	A mathematical model in which the parameters vary in two or three dimensions. See also <i>Quasi three dimensional (2D or 3D) model</i> , <i>Coastal area model (2D and 3D)</i>
Ultimate bearing capacity	The bearing stress which would cause shear failure in the soil below a foundation; dependent upon the shear strength of the soil, applied loads and on the shape and depth of the foundation.
Uncertainty	Lack of sureness about someone or something ranging from almost complete sureness to almost complete lack of conviction about an outcome. Caused by (a) natural variability (inherent uncertainty) or (b) incomplete knowledge (epistemic uncertainty).
Underlayer	Granular or armourstone layer beneath an armour layer that serves either as a filter or to provide a consistent elevation.
Undrained shear strength	The shear strength of a saturated soil at a given water content (or voids ratio, or specific volume) under loading conditions where no drainage of pore water can take place.
Uniform flow	Flow with water surface slope parallel to the bed slope and constant depth from section to section. See also <i>Normal flow</i>
Unit weight	The ratio of the total weight of soil to the total volume of a unit of soil.
Upgrading	Improved performance against a particular criterion.
Uplift	<ol style="list-style-type: none"> 1 Upward pressure in the pores of a material (interstitial pressure) or on the base of a structure. 2 The situation in which pore water pressure within a confined or semi-confined aquifer can exceed the total weight of the overlying soil or structure and lead to a failure caused by upward movement.
Up-rush	<ol style="list-style-type: none"> 1 The landside return of water following the back-rush of a wave. 2 The flow of water up or down (down-rush) the face of a structure following wave breaking. <p>See also <i>Run-up</i>, <i>run-down</i></p>
Upstream	In the direction opposite to the flow of a stream.
Velocity head	Kinetic energy of flowing water, represented as the vertical height to which water would rise in a pitot tube. See also <i>Energy head</i>
Vertical stress	The total or effective stress acting vertically in a soil mass at a given depth caused by the soil's own weight and possible surcharge and overlying weight.
Visual inspection	A visual inspection of a flood defence asset to assess its condition in line with a fixed risk-based programme. The result of this inspection is used to report both externally and internally on the condition of the asset.
Void ratio	The ratio of the volume of voids to the volume of solids (soil grains).
Vulnerability	The susceptibility of people and assets in the leveed area to physical or emotional injury or damage during an event. See also <i>Damage potential</i> , <i>Stake</i>
Water content	The ratio between the mass of water and the mass of soil solids.
Watercourse	All rivers, streams, burns, ditches, drains, cuts, culverts, dikes, sluices, sewers and passages carrying or designed to carry water, excluding pipes or other works for the sole purpose of supplying water to a premise.
Water level	Elevation of still water level relative to a datum. See also <i>Still water level</i>
Waterside	Refers to the side of the flood protection structure towards the water. Antonym: Landside

Water table	The surface where the water pressure head is equal to the atmospheric pressure. See also <i>Piezometric surface</i>
Waterway	A navigable channel.
Wave breaking	Reduction in wave energy and height in the surf zone due to limited water depth.
Wave climate	The seasonal and annual distribution of wave height, period and direction.
Wave directional spectrum	Distribution of wave energy as a function of wave frequency and direction.
Wave field	Values of wave height, period and direction defined over a specified area at a given time.
Wave frequency	The inverse of wave period.
Wave generation	Growth of wave energy by wind.
Wave height	The vertical distance between a crest and the preceding trough.
Wavelength	The horizontal distance between two successive crests or troughs in a wave record.
Wave period	The time for a wave crest to traverse a distance equal to one wavelength.
Wave rose	Diagram showing the long-term distribution of wave height and direction.
Wave set-up	Superelevation of the water surface over the normal surge elevation attributable to onshore mass transport of the water by wave action alone.
Wave spectrum	A function that describes the distribution of wave energy over wave frequency.
Wave steepness	The ratio of wave height to wavelength.
Wear	The erosion of material from a solid surface by the action of another substance or surface or process. This superficial degradation may be induced by weathering or attrition.
Weathering	Physical, chemical and biological action that leads to deterioration in strength of the rock mass or deterioration in strength of the pieces of produced armourstone. See also <i>Degradation, External erosion, Internal erosion</i>
Weir	Low dam that is built across a river to raise the water level, divert the water, or control its flow See also <i>Hydraulic control structure, Spillway, Sill</i>
Whole life cycle	The total working life of an asset including planning, design, construction, use, operation, inspection, maintenance and refurbishment, replacement or decommission. See also <i>Life cycle cost</i>
Wind field	Values of wind speed and direction defined over a specified area at a given time.
Wind rose	Diagram showing the long-term distribution of wind speed and direction.
Wind sea	Wave conditions directly attributable to recent/local winds, as opposed to swell. Antonym: Swell (waves)
Wind set-up	Elevation of the water level over an area directly caused by wind stress on the water surface.
Wind stress	The way in which wind transfers energy to the sea surface.
Winnowing	The process of separating fine sediment from coarser sediment by fluid flow.
Works	The end products of construction as a whole.
Yield point	The point at which the soil loading behaviour changes from elastic to inelastic.

Yield stress	The stress at which yielding takes place in soils. The stress at which the swelling-recompression line joins the normal compression line.
Zero air voids curve	The curve created by plotting dry densities of soils corresponding to saturation versus water content.
Zone	Part of the levee cross-section consisting of the same soil.
Zoned levee	Levee with different soil material over the cross-section.

Abbreviations

ACM	Articulated concrete mattresses
AD	Alpine Department
ADSC	Analogue to digital signal converter
ASCE	American Society of Civil Engineers
ASTER	Advanced Spaceborne Thermal Emission And Reflection Radiometer
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BS	British Standards
CBA	Cost-benefit analysis
CETMEF	Centre d'études techniques maritimes et fluviales.
CH	High plastic clays
CL	Lean clay
CMP	Corrugated metal pipe
CRR	Cyclic resistance ration
CSM	Conceptual site model
CSR	Cyclic stress ratio
DGPS	Differential global positioning system
DT	Destructive testing
DTM	Digital terrain model
EA	Environment Agency
EAD	Expected annual damage
EIA	Environmental impact assessment
EMS	Environmental Management System
EOC	Emergency operations centre
EST	Equilibrium sediment transport
EWS	Early warning system
FEM	Finite element method
FEMA	Federal Emergency Management Agency
FRMS	Flood risk management structure
GEOTECH	Geotechnical
GFR	Glass-fibre reinforced
GIS	Geographical information system
GPS	Global positioning system
HAT	Highest astronomical tide
HDPE	High density polyethylene
HSE	Health and Safety Executive
ICE	Institute of Civil Engineers
ICOLD	International Commission on Large Dams
ILH	International Levee Handbook
IRSTEA	Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture

ISO	International Organization for Standardization
LAT	Lowest astronomical tide
LiDAR	Light detection and ranging
LMS	Levee management system
LSAC	Levee safety action classification
LSM	Life safety model
MCA	Multi-criteria analysis
MEMS	Mechanical-Electro-Mechanical
MHHW	Mean higher high water
ML–CL	Low compressible silt with some low compressible clay
MLLW	Mean lower low water
MSL	Mean sea level
MWL	Mean water level
OHSAS	Occupational Health and Safety Management System
O&M	Operation and maintenance
PDCA	Plan-do-check-act
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIANC	Permanent International Association of Navigation Congresses (now called International Navigation Association)
POC	Point of contact
POT	Peak over threshold
PVC	Polyvinyl chloride
QMS	Quality management system
SAA	ShapeAccelArray
SAR	Synthetic Aperture Radar
SBCA	Societal benefit cost analysis
SLS	Service limit state – related to the failure of levees
SPR	Source-pathway-receptor
SSI	Soil-structure interaction
STOWA	Foundation for Applied Water Research
SWL	Still water level
SYMADREM	Syndicat mixte interrégional d'aménagement des digues du Rhône et de la mer
TAW	Technical Advisory committee on Water defence
ULS	Ultimate limit state – related to the failure of levees
USACE	US Army Corps of Engineers

Notation

$\bar{\eta}$	Still water line mean water surface elevation or wave set-up	(m)
$\bar{\eta}_{max}$	Maximum mean wave set-up	(m)
$\bar{\eta}_w$	Wind set-up	(m)
$\bar{\eta}_b$	Wave set-up	(m)
A	Catchment area	(m ²)
A	Cross-sectional flow area, or sub-section of cross-sectional flow area if subscripted.	(m ²)
a	Coriolis coefficient	(-)
a	Slope angle of structure (coastal revetment or breakwater)	(°)
A_c	Cross-sectional area of waterway	(m ²)
A_m	Submerged cross section of vessel	(m ²)
A_n	Sub-element of cross-sectional area of flow in channel. Suscript n denotes sub-element number within cross-section divided into n elements	(m ²)
B	Channel width	(m)
b	Width of vertical slice (in slope stability calculation)	(m)
b	Weir width in direction of flow	(m)
b_i	Width of vertical slice i (in slope stability calculation)	(m)
B_J	Width of overtopping jet at impact with armour protection	(m)
C	Chezy coefficient	(m ^{1/2} /s)
C	Expansion or contraction coefficient	(-)
C	Weir flow coefficient	(-)
C	Wave velocity	(m/s)
c	Propagation celerity of waves	(m/s)
c'	Effective cohesion of soil	(kN/m ²)
C_o	Weir discharge coefficient, function of weir shape	(-)
C_c	Compression index	(-)
C_d	Discharge coefficient	(-)
c'_d	Design value of effective cohesion of soil	(kN/m ²)
c_g or C_g	Group velocity	(m/s)
c_h	Coefficient of horizontal consolidation	(m ² /s)
c'_k	Characteristic value of effective cohesion of soil	(kN/m ²)
C_r	Coefficient of wave reflection	(-)
CR	Compression ratio	(%)
C_u	Undrained shear strength of soil	(kN/m ²)
C_U	Coefficient of uniformity	(-)
c_u	Undrained cohesion	(kN/m ²)
C_{ud}	Design value of undrained shear strength of soil	(kN/m ²)
C_{uk}	Characteristic value of undrained shear strength of soil	(kN/m ²)
c_{ur}	Undrained residual cohesion	(kN/m ²)
c_v	Coefficient of vertical consolidation	(cm ² /s)

C_α	Coefficient of secondary compression	(cm ² /s)
$C_{\alpha\epsilon}$	Modified secondary compression index	(-)
d	Structure (crest) height relative to bed level (breakwaters, dams)	(m)
D_{10}	Effective grain size for 10 per cent passing	(m)
D_{50}	Sieve diameter, diameter of stone that exceeds the 50 per cent value of sieve curve	(m)
D_{60}	Effective grain size for 60 per cent passing	(m)
D_{90}	Grains size not exceeded by 90 per cent value of mass of the sieve curve	(m)
D_b	Average bedform height	(m)
d_b	Wave break point water depth	(m)
d_c	Critical depth of flow	(m)
d_n	Normal depth of flow	(m)
E	Total energy of flow at a cross-section	(m)
e	Voids ratio	(-)
E_d	Design value of the effect of actions	Unit of the parameter
e_o	Initial voids ratio	(-)
e_p	Voids ratio at the end of primary consolidation	(-)
E_u	Undrained elastic modulus	(kN/m ²)
F	Factor of safety (geotechnical), defined as ultimate resistance/required resistance	(-)
f	Laceys silt factor	(-)
F_j	Total force of overtopping jet on scour protection per unit length of wall	(N/m)
f_p	'Peak' frequency of wave spectrum	(1/s)
Fr	Froude number, $Fr = U/(gh)^{1/2}$	(-)
g	(Submerged weight)	(m/s ²)
$G'_{sub,d}$	Design value of the stabilising permanent vertical actions for heave verification	Unit of the parameter
G_s	Specific gravity/particle density	(-)
H	Wave height, from trough to crest	(m)
H	Water level upstream of lateral diversion weir or sill; head differential between upstream and downstream water levels at a weir	(m)
H	Energy grade line elevation	(m)
h	Water depth; height of floodwall; depth of water above lateral weir crest	(m)
H^*	Equivalent head above lateral diversion weir crest	(m)
h_1	Height of average wave surge level above or below floodwall crest; height of water level above floodwall crest	(m) + or -
$H_{1/3}$	Significant wave height based on time domain analysis, average of highest 1/3 of all wave heights	(m)
H_a	Velocity head on approach to weir	(m)
H_b	Wave height	(m)
h_D	Hydraulic depth of flow in river	(m)
H_E	Mean energy wave height	(m)
h_f	Energy loss term between two cross-section locations	(m)
H_i	Incident wave height	(m)
H_{m0}	Significant wave height calculated from the spectrum, $H_{m0} = 4\sqrt{m_0}$	(m)
H_o	Offshore or deep water wave height	(m)
h_p	Water depth perpendicular to river bottom	(m)

H_r	Reflected wave height	(m)
H_{rms}	Root mean square wave height	(m)
H_s	Significant wave height, Breaking wave height	(m)
h_s	Water depth at a distance of $1/2L$ or $5H_{max}$ seaward of structure toe	(m)
H_{so} or H'_{os}	Deep water significant wave height	(m)
h_t	Depth of tailwater; Water depth downstream of weir discharge	(m)
h_w	Height of wave crest above toe of floodwall	(m)
i	Hydraulic gradient of (phreatic) water level	(-)
i_b	Gradient of river bed	(-)
I_l	Liquidity index	(%)
I_p	Plasticity index	(-%)
I_s	Channel sinuosity (L_s/L_v)	(m/m)
K	Conveyance	(m ³ /s)
k_h	Coefficient of horizontal permeability	(m/s)
k_s	Bed roughness, hydraulic roughness	(m)
k_{sg}	Grain roughness	(m)
k_{sD}	Bedform roughness	(m)
L	Wave length, in the direction of propagation	(m)
L	Length of lateral diversion weir crest	(m)
L	Length along channel between two cross-sections, weighted reach length	(m)
L	Length of levee ring	(m)
l	Length of slip failure	(m)
L_b	Average bedform length	(m)
L_{ch}	Length between adjacent cross-sections for channel	(m)
L_{jump}	Length of hydraulic jump	(m)
L_{lob}	Length between adjacent cross-sections for left overbank	(m)
L_o	Offshore or deep water wave length, $L_o = gT^2/2\pi$	(m)
L_{rob}	Length between adjacent cross-sections for right overbank	(m)
L_s	Ship length	(m)
L_s	Channel length	(m)
L_v	Valley length	(m)
M	Total soil mass	Mg
m_0	Zeroth moment of wave spectrum	(m ² s)
m_5	Coefficient for degree of sinuosity in Cowan's method	(-)
MDD	Maximum dry density	(Mg/m ³)
M_{ed}	The design overturning moment (in slope stability analysis)	Unit of the parameter
M_{rd}	The design restoring moment (in slope stability analysis)	Unit of the parameter
m_v	Coefficient of volume compressibility	(m ² /N)
n	Manning's coefficient of bed roughness	(s/m ^{1/3})
N	Standard penetration test blow count	blows/ 0.3048 m
n_{irr}	Irregularity component of unit roughness for Manning's coefficient	(s/m ^{1/3})

n_l	Unit roughness for Manning's coefficient, comprised of three components	(s/m ^{1/3})
n_{sur}	Surface material component of unit roughness for Manning's coefficient	(s/m ^{1/3})
n_{veg}	Vegetation component of unit roughness for Manning's coefficient	(s/m ^{1/3})
n_x	Component of Manning's coefficient for Cowan's method	(s/m ^{1/3})
OMC	Optimum moisture content	(%)
P	Wetted perimeter, height of lateral weir crest above toe of levee	(m)
p	Probability	(%)
p'	Effective pressure	(kN/m ²)
$P_{f,loc,req}$	Local probability of macro-instability	(1/year)
$P_{f,inst}$	Probability of breaching as a result of slope instability of the inner slope	(1/year)
p'_o	<i>In situ</i> effective pressure	(kN/m ²)
Q	Imposed vertical surface load per metre run (in slope stability calculation)	(kN/m)
q	Specific discharge; unit discharge per meter length of weir crest	(m ³ /s/m)
Q'	Spatially varied discharge over lateral weir	(m ³ /s)
Q, Q_w	Water discharge	(m ³ /s)
Q_{am}	Stream discharge upstream of lateral diversion	(m ³ /s)
Q_{dv}	Stream discharge downstream of lateral diversion	(m ³ /s)
Q_{ch}	Water discharge within channel only	(m ³ /s)
Q_d	Design value of imposed vertical surface load per metre run (in slope stability calculation)	(kN/m)
Q_i	Imposed vertical surface load on slice i per metre run (in slope stability calculation)	(kN/m)
Q_k	Characteristic value of imposed vertical surface load per metre run (in slope stability calculation)	(kN/m)
Q_{tot}	Total discharge over lateral weir	(m ³ /s)
Q_{ob}	Water discharge within left overbank of cross-section	(m ³ /s)
Q_{ob}	Water discharge with right overban of cross-section	(m ³ /s)
Q_s	Sediment discharge	(m ³ /s or T/day)
R	Hydraulic radius	(m)
r	Relative intensity of turbulence	(-)
r	Weir crest radius, ogee crest	(m)
r, r_c	Centre-line radius of river bend	(m)
R_c	Crest freeboard, level of crest relative to still water level	(m)
R_d	Run-down level, relative to still water level	(m)
R_d	Design value of the resistance to an action	Unit of the parameter
R_u	Run-up level, relative to still water level	(m)
$R_{u2\%}$	Run-up level exceed by only two per cent of run-up tongues	(m)
$R_{up\%}$	Run-up level exceed by only p of run-up tongues; p is a probability of occurrence in (%)	(m)
S	Energy slope, slope of energy gradeline	(m/m)
s, s_o	Wave steepness, $s = H/L_o$	(-)
S_o	Gradient of river bed	(Radians)
$S_{dst,cl}$	Design value of the destabilising seepage force in the ground	Unit of the parameter
S_f	Friction slope in open channels	(m/m)
s_m	Wave steepness for mean period wave, $s_m = 2\pi H_s / (gT_m^2)$	(-)

s_{om}	Offshore (deep water) wave steepness for mean period wave, $s_{om} = H_{so}/L_{om} = 2\pi H_{so}/(gT_m^2)$	(-)
s_{op}	Offshore (deep water) wave steepness for peak period wave, $s_{op} = H_{so}/L_{op} \text{Lop} = 2\pi H_{so}/(gT_p^2)$	(-)
SWL	Still water level	(m)
T	Wave period	(s)
t_f	Fall time for water particle at wave crest to fall to ground for floodwall overtopping	(s)
T_m	Mean wave period	(s)
T_p	Wave period corresponding to the maximum frequency value	(s)
U	Horizontal depth-mean current velocity	(m/s)
u	Pore pressure	kN/m ²
u^*	Shear velocity, $u^* = \sqrt{\tau_b/\rho_w}$	(m/s)
u'	Fluctuating velocity component	(m/s)
U_{10}	Wind speed 10 m above sea surface	(m/s)
u_d	Design value of pore pressure	kN/m ²
$u_{dst;d}$	Design value of the destabilising total pore water pressure	Unit of the parameter
u_k	Characteristic value of pore pressure	kN/m ²
u_{max}	Maximum velocity at the surface for vertical velocity profile	(m/s)
$u_o \text{ or } u_{bmax}$	Maximum wave-induced orbital velocity near the bed	(m/s)
U_z	Wind speed at a height of z (m) above sea surface	(m/s)
v	Average flow velocity	(m/s)
V	Total soil volume	(m ³)
Va	Approach velocity at weir	(m/s)
V_J	Jet entry velocity for weir overflow	(m/s)
V_{mid}	Mid surf zone longshore current	(m/s)
V_w	Horizontal wave velocity	(m/s)
W	Stream top width	(m)
W	Self weight of slice per meter run (in slope stability calculation)	(kN/m)
w	Moisture content	(%)
W_d	Design value of self weight of slice per metre run (in slope stability calculation)	(kN/m)
W_i	Self weight of slice i per metre run (in slope stability calculation)	(kN/m)
W_k	Characteristic value of self weight of slice per metre run (in slope stability calculation)	(kN/m)
w_l	Liquid limit	(%)
w_p	Plastic limit	(%)
x, y, z	Distances along orthogonal axes	(m)
X_b	Horizontal distance from shoreline to breakpoint	(m)
x_c	Horizontal distance for jet trajectory	(m)
x_L	Horizontal distance for jet trajectory	(m)
X_{Ru}	Horizontal distance of wave runup	(m)
x_U	Horizontal distance for jet trajectory	(m)
y	Flow depth	(m)
y_j	Flow depth at location 1 (2, 3, etc as indicated by subscript number)	(m)
y_{bs}	Depth of flow due to bend scour	(m)
y_{es}	peak depth of flow due to confluence scour	(m)

y_{me}	Depth of scour due to plunging jet	(m)
y_n	Normal flow depth in open channel	(m)
y_s	Scour depth relative to the original bed	(m)
y_{ws}	Peak depth of flow due to sediment wave migration	(m)
Z	Stage or water level relative to a stream gauge	(m)
z	Level of riverbed compared with reference level, distance above channel bed for vertical flow distribution within flow depth; elevation at which wide speed is measured for fetch limited wave growth	(m)
z_0	Reference level of vertical velocity profile, also called: bed roughness length	(m)
α	Strength parameter correlation	(-)
α	Inclination of the base of a slice to the horizontal (in slope stability analysis)	(°)
α_i	Inclination of the base of slice i to the horizontal (in slope stability analysis)	(°)
Δu	Increase in pore water pressure	(kN/m ²)
$\Delta \sigma_v$	Increase in total vertical stress	(kN/m ²)
Λ_{GEO}	Degree of utilisation of the available design resistances by the design actions or the effects of the design actions	(-)
ρ	Bulk density	(Mg/m ³)
ρ_d	Dry density	(Mg/m ³)
ρ_s	Density of soil particles	(Mg/m ³)
ρ_w	Density of water	(kN/m ³)
$\sigma_{stab,d}$	Design value of the stabilising total vertical stress	Unit of the parameter
σ'_{vo}	<i>In situ</i> vertical effective stress	(kN/m ²)
σ'_y or p'_y	Yield stress or preconsolidation pressure	(kN/m ²)
φ'	Effective angle of shearing resistance	(°)
φ'_d	Design value of effective angle of shearing resistance	(°)
φ'_k	Characteristic value of effective angle of shearing resistance	(°)
Φ	The standard normal function	(-)
Ω	Stream power index	(m ³ /s)
Ω_{lim}	Stream power index threshold value	(m ³ /s)
β	Shore slope	(m/m)
β	Main channel contraction angle	(Radians)
β_{req}	Reliability index	(1/year)
ϕ'	Effective friction angle	(°)
ϕ'_{cv}	Effective critical state or constant volume friction angle.	(°)
ϕ'_p	Effective peak (maximum) friction angle	(°)
ϕ'_r	Effective residual friction angle	(°)
γ_u	Undrained friction angle	(°)
γ	Bazin representative bed roughness	(m ^{0.5})
γ	Specific weight of water	(N/m ³)
γ_b	Wave breaker depth index	(-)
$\gamma_b, \gamma_f, \gamma_b$	Factors reflecting influence of berms, slope roughness and wave obliquity, respectively	(-)
γ_{bulk}	Bulk unit weight of soil	kN/m ³
γ_c	Partial factor applied to effective cohesion	(-)

γ_d	Partial model factor	(-)
γ_G	Partial factor applied to permanent actions (including self-weight)	(-)
$\gamma_{G:dst}$	Partial factor for a permanent destabilising action	(-)
$\gamma_{G:fav}$	Partial factor for a permanent favourable action	(-)
$\gamma_{G:inf}$	Partial factor for permanent action (including self-weight) in calculating lower design values	(-)
$\gamma_{G:stb}$	Partial factor for a permanent stabilising action	(-)
$\gamma_{G:sup}$	Partial factor for permanent action (including self-weight) in calculating upper design values	(-)
γ_n	Consequence factor	(1/year)
γ_Q	Partial factor applied to variable actions (including applied surface loads)	(-)
$\gamma_{Q:dst}$	Partial factor for a destabilising action causing hydraulic failure	(-)
γ_{Re}	Partial factor applied to earth resistances	(-)
γ_ϕ	Partial factor applied to ϕ	(-)
κ	Von Karman coefficient	(-)
μ	Vane shear strength correction factor	(-)
ν	Kinematic viscosity	(m ² /s)
θ	Angle between the bottom contour and the wave crest	(°)
θ	Angle of jet trajectory to horizontal plan for floodwall overtopping	(°)
θ_b	Breaking wave angle relative to shore normal	(°)
θ_J	Average angle of jet trajectory	(°)
θ_L	Jet trangle of upper nappe	(°)
θ_m	Mean wave direction calculated form directional wave spectrum	(°)
θ_p	Peak wave direction	(°)
θ_U	Jet angle of lower nappe	(°)
τ	Shear stress	(kN/m ²)
τ_0	Shear stress at the bed	(N/m ²)
ξ	Surf similarity parameter	(-)
$\xi_{g \text{ safety standard}}$	Correlation factor for safety standard	(-)
ξ_m	Mean surf similarity parameter	(-)
ξ_p	Peak surf similarity parameter	(-)