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Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 11 HYDROLOGY

Section 6 Ground Water

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Terminology Relating to River Valley Projects Sectional Committee, had been approved by the River Valley Division Council.

A number of Indian Standards have been published covering various aspects of river valley projects and a number of similar standards are in the process of formulation. These standards include the precise definitions of technical terms which are required to avoid ambiguity in their interpretation. To achieve this end, the Bureau has brought out IS 4410 'Glossary of terms relating to river valley projects' which has been published in various parts. This part (Part 11) contains definitions of terms relating to hydrology.

The revision of this standard has been taken up in the light of experience gained during the use of this standard. In this revision certain definitions have been modified and definitions relating to field practice have been included.

This standard was first published in 1985. This revision is being taken up to update the defined terms so as to provide a more comprehensive compilation of the terms contained therein. This revision is based on the suggestions of the 'Ground water and Preliminary Investigation' Sectional Committee RVD 3.

*Indian Standard***GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS****PART 11 HYDROLOGY****Section 6 Ground Water****1 SCOPE**

1.1 This standard (Part 11/Section 6) covers definitions of terms relating to ground water.

2 GROUND WATER**2.1 Abstraction**

The removal of water from any ground water source, either permanently or temporarily.

2.2 Access Tube

A pipe inserted into a well to permit installation of instruments, and safeguarding them from touching or becoming entangled with the pump or other equipment in the well.

2.3 Adhesive Water

Water forming a film around soil particles, over adsorbed water, and held by the forces of molecular attraction, after gravity water has drained, but with less strength than absorption water and without perceptible emission of heat. Adsorbed water is entirely fixed, whereas adhesive or pellicular water may move from one particle to another.

2.4 Absorbed Water

Water held on the surface of individual soil particles by the forces of molecular attraction with emission of heat (heat of wetting).

2.5 Annual Depletion Rate

The average rate over a period of years at which withdrawals in excess of recharge deplete the storage depth in a ground water reservoir.

2.6 Aquiclude

A formation or group formations which, although porous and capable of absorbing water slowly, will not transmit it rapidly enough to furnish a sufficient supply for a well or spring, even under saturated conditions.

2.7 Aquifer

A formation or group of formations or a part of formation that contains sufficient permeable

material and is saturated to yield significant quantities of water to wells and springs.

2.8 Aquifer Loss, Formation Loss

The head loss at a pumped or overflowing well associated with groundwater flow through the aquifer to the well face.

2.9 Aquifer Properties

The properties of an aquifer that determine its hydraulic behaviour and its response to abstraction.

2.10 Aquifer Test

A test involving the withdrawal of measured quantities of water from or addition of water to, a well and measurement of resulting changes in head of the aquifer both during or after the period of discharge or addition.

2.11 Aquifuge

An impermeable formation which has no interconnected openings and hence cannot absorb or transmit water.

2.12 Aquitard

It is a saturated but poorly permeable stratum that impedes ground water movement and does not yield water to wells, but that may transmit appreciable water to and from adjacent aquifers.

2.13 Apparent Velocity of Ground Water

The apparent distance covered per unit time by ground water in the saturated zone. It is defined as the volume of water flowing per unit time divided by the cross-sectional area taken perpendicular to the streamlines.

2.14 Area of Artesian Flow

A land or water surface which lies below a piezometric surface. It is an area in which the water of some underlying aquifer is under sufficient pressure to rise above the surface.

2.15 Artesian Basin

Areal extent of a confined aquifer.

2.16 Artesian Flow

Natural flow above the ground from wells and springs in an artesian basin.

2.17 Artesian Head

The height above the bottom of the upper confining formation, to which the water in a confined aquifer would rise, if free to do so.

2.18 Artesian Pressure

The pressure exerted by a body of water confined in a waterbearing geologic formation, against a superimposed impermeable or less permeable formation, the pressure usually being due to the fact that the free water level of the sub-surface water body stands at a higher level than that of the bottom of the upper confining formation.

2.19 Artesian Spring

Water issuing under artesian pressure, generally through some fissure or other opening, in the confining bed that overlies an aquifer.

2.20 Artesian Water

Sub-surface water under sufficient pressure to cause it to rise above the bottom of the superimposed confining formation, if afforded an opportunity to do so. Flowing artesian wells are produced when the pressure is sufficient to force the water above the land surface.

2.21 Artificial Recharge

Artificial recharge is the augmentation of the natural infiltration of precipitation, or surface water, into underground formation by some method of construction, spreading of water, or by artificially changing natural conditions.

2.22 Average Velocity of Ground Water

The velocity measured as the volume of ground water passing per unit time through a unit cross-sectional area divided by the porosity of the aquifer material.

2.23 Base Flow

The sustained or dry weather flow of streams resulting from the outflow of permanent or perched ground water and from the draining of large lakes and swamps.

2.24 Borehole

A hole, usually vertical, bored to determine sub-surface conditions, for extraction of water or measurement of groundwater level.

2.25 Casing

A tube used as temporary or permanent lining for a well.

2.26 Column Pipe

That part of the rising main within the well.

2.27 Coefficient of Permeability

The rate of flow of a fluid through a unit cross-section of a porous mass under a unit hydraulic gradient at a specified temperature.

2.28 Confined Aquifer

An aquifer bounded above and below by impermeable formation where groundwater is confined under pressure greater than atmospheric pressure. Both the aquifer and water it contains are said to be confined.

2.29 Confining Bed, Confining Layer or Confining Stratum

An impervious stratum directly above or below one bearing water.

2.30 Confined Ground Water

A body of ground water overlain by material sufficiently impervious to sever free hydraulic connection with overlying ground water except at the intake. Confined ground water moves under the pressure due to difference in head between intake and discharge areas of the confined water body and is under sufficient pressure to rise above the bottom of the upper confining bed, if given an opportunity to do so.

2.31 Cone of Depression

The depression, roughly conical in shape, produced in a water table, or piezometric surface by extraction of water from a well at a given rate.

2.32 Connate Water

Water which has entered a rock formation by being entrapped in the interstices of the rock material (either sedimentary or extrusive igneous) at the time the material was deposited and has been out of contact with the atmosphere for at least an appreciable part of geologic period.

2.33 Capillary Fringe/Capillary Zone

The zone immediately above the water-table extending upto the limit of capillary rise of water. It may consist solely of capillary water or it may be combined with gravity water in transit to the water-table.

2.34 Critical Velocity of Ground Water

The maximum velocity under which laminar flow can occur in porous media.

2.35 Cavern Water

Water in large, tubular or cavernous openings.

2.36 Darcy's Law

The flow rate through porous media is proportional to the head loss and inversely proportional to the length of flow path which is primarily governed by Darcy's Law which is expressed as:

$$V = Ki$$

$$\text{or } Q = KAi$$

where

Q = quantity of water flowing in the aquifer material;

K = a constant, it depends upon porosity and permeability of the aquifer material; and is called coefficient of permeability;

i = loss of head/unit length or hydraulic gradient;

V = velocity of water in the aquifer material; and

A = cross-sectional area of aquifer material through which the water flows.

2.37 Discharge of Ground Water

The outflows of ground water from the lithosphere to the earth surface.

2.38 Drawdown

The reduction in static head within the aquifer resulting from abstraction.

2.39 Effective Porosity

It is the ratio of interconnected interstitial volume and the total volume of a water transmitting medium.

2.40 Effective Velocity, Actual Velocity, True Velocity, Field Velocity of Ground Water

The velocity measured by the volume of ground water passing per unit time through unit cross-sectional area divided by effective porosity of the water transmitting material.

2.41 Effluent Stream, Gaining Stream

A stream or a stretch of a stream which receives water from ground water in the zone of saturation. The water surface of such a stream stands at a lower level than the water table, or piezometric surface of the ground water body, from which it receives water.

2.42 Equipotential Lines

Lines connecting points having the same piezometric head.

2.43 Field Capacity, Specific Retention

The amount of water held in the soil after the excess gravitational water has drained away and after the rate of downward movement of water has materially decreased. Essentially the same as 'specific retention', it is a more general

term used in studies of ground water which covers all types of strata. Furthermore, field capacity is usually expressed as percentage of weight whilst specific retention is generally given as percentage by volume.

2.44 Field Coefficient of Permeability

Coefficient of permeability at the prevailing temperature of water.

2.45 Filter Pack

Granular material introduced into the annular space between the aquifer and screen or perforated lining, to prevent or control the movement of particles of the aquifer into the well.

2.46 Fissure Water, Fault Water

Water in open fractures, joints, faults in rock formations which is usually in abundance only near the ground surface.

2.47 Flow Lines

Lines showing the path of flow of ground water.

2.48 Flownet

A net of equipotential lines and flow lines intersecting at right angles.

2.49 Fluctuation of Water Table

The upward and downward movements of the water table due to periods of recharge and discharge of water in the zone of saturation.

2.50 Geohydrology

The study of that branch of hydrology relating to sub-surface or subterranean water in its geological context.

2.51 Geyser

A thermal spring from which hot water steam is intermittently thrown vertically to a considerable height.

2.52 Ground Water

Sub-surface water occupying the zone of saturation and which is free to move under gravity. In a strict sense the term applies only to water below the water table.

2.53 Ground Water Balance

It is a concept which states that all inputs of water in a defined space and time are equal to the sum of all outputs of water, and the changes of water storage, in the same space and time.

2.54 Ground Water Basin

Physiographic or geological unit containing at least one aquifer of significant areal extent capable of furnishing a substantial water supply.

2.55 Ground Water Budgeting

A detailed estimate of the amount of water added to the ground water reservoir of a given area (recharge) balanced against estimates of amounts of withdrawals from the ground water reservoir of the area during a specified period.

2.56 Ground Water Cascade

The descent of ground water on a steep hydraulic gradient to a lower and flatter water table slope. A cascade occurs below a ground water barrier or dam, and at the contact of less permeable material with more permeable material, downslope.

2.57 Ground Water Dam

A natural or artificial body of material which is impermeable, or has only low permeability, and which occurs below the surface in such a position that it impedes the horizontal movement of ground water and consequently causes pronounced difference in the level of the water table on its opposite sides.

2.58 Ground Water Decrement or Discharge

Water abstracted from the ground water reservoir by evaporation, transpiration, spring flow and effluent seepage, pumping wells and outflow of ground water under the area within consideration.

2.59 Ground Water Divide/Ridge

A line on a water table on each side of which the water table slopes downward in the direction away from the line.

2.60 Ground Water Hydrology

The Branch of hydrology relating to sub-surface or subterranean water.

2.61 Ground Water Increment, Ground Water Accretion

Water added to the ground water reservoir in any given time interval from all sources, influent seepage from streams, rainfall, irrigation and inflow of ground water from outside the area under consideration.

2.62 Ground Water Mound, Ground Water Ridge

A mound-shaped or ridge-shaped pattern of ground water built up by influent seepage.

2.63 Ground Water Recharge, Recharge of an Aquifer

Replenishment or addition of water to the ground water storage by natural processes or artificial methods.

2.64 Ground Water Storage

Volume of ground water available at any instance of time.

2.65 Ground Water Trench

A trench-shaped depression of the water table caused by effluent seepage into a drainage ditch, drainage pipe, or stream or by movement of ground water to the thalweg underlying a stream and by artificial pumping by battery of wells.

2.66 Ground Water Turbulent Flow

Turbulent flow which occurs in large openings in the zone of saturation under high velocities.

2.67 Hydraulic Conductivity

The volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area of cross section measured perpendicular to the direction of flow.

NOTE — This definition assumes an isotropic medium in which the pores are completely filled with water.

2.68 Hydraulic Gradient

The change in hydraulic head of the aquifer per unit distance in the direction of flow.

2.69 Hydraulic Head

It is the height of piezometric surface (for confined aquifer) or water table (for unconfined aquifer) at a particular location above a datum.

2.70 Hydrogeology

A branch of earth science dealing with the sub-surface distribution of rock formations and their ability to receive, store and transmit water.

2.71 Hydrograph (Groundwater)

Ground water graph which shows water level in a well, plotted against time.

2.72 Hydro Isopleth Map

A map showing fluctuation of water table with respect to time and space.

2.73 Hydraulic Profile of an Aquifer

A vertical section of the piezometric surface or the water table of an aquifer.

2.74 Incompetent Stratum

A rock stratum which will yield to flowage or internal shear when under stress.

2.75 Induced Recharge of an Aquifer

Discharge of water from a stream into an aquifer induced by lowering of the water table.

2.76 Infiltration Rate

The rate at which infiltration takes place expressed in depth of water per unit of time, usually in millimeters per hour.

2.77 Infiltration Rate Curve

Curve showing the actual rate of infiltration with respect to time.

2.78 Infiltrometer

A device to measure rate of infiltration in experimental observations.

2.79 Influent Percolation

Movement of water, in the zone of aeration, from the ground surface toward the water table under the force of gravity.

2.80 Influent Stream, Loosing Stream

A stream or stretch of a stream which contributes water to the zone of saturation. The water surface of such a stream stands at a higher level than the water table, or piezometric surface, of the ground water body to which it contributes water.

2.81 Impermeable Material

Material that does not permit water to move through it at a perceptible rate under the normal hydraulic gradients normally present.

2.82 Intake Area (Recharge Area) of an Aquifer System

The surface area where the water gets absorbed from perception or surface flow, which eventually reaches the zone of saturation of an aquifer.

2.83 Intermediate Vadose Water

Water in the intermediate vadose zone.

2.84 Intermediate Vadose Zone

It is the portion of the zone of aeration which lies between the lower edge of soil water zone and the upper limit of capillarism.

2.85 Isopiestic Line, Pressure Surface Contour

A line on a map connecting all points of equal elevation, to which water pressure in a water-bearing formation would rise if free to do so; a line connecting all points of equal pressure in a water-bearing formation under pressure; or a line connecting all points of equal altitude on the upper surface of an unconfined aquifer.

2.86 Leaky Aquifer

Aquifer overlain and/or underlain by a relatively thin semi-pervious layer, through which flow into or out of the aquifer can take place.

2.87 Lining

A tube or wall used to support the sides of a well, and sometimes to prevent the entry of water.

2.88 Lithosphere

The solid part of the earth as distinguished from the hydrosphere and the atmosphere. This part of the earth is predominantly composed of rocks (either coherent or incoherent, and including the disintegrated rock materials known as soil and subsoil), together with everything in this rocky crust.

2.89 Natural Recharge

It is that portion of water which gravitates to the zone of saturation under natural conditions.

2.90 Observation Well

A special well drilled, or an existing well, in a selected location for the purpose of observing parameters such as water levels and quality changes.

2.91 Overflowing Well

A well from which groundwater is discharged at the ground surface without the aid of pumping.

2.92 Perched Ground Water

Ground water occurring in a limited area in an unsaturated zone separated from the main body of the ground water by an impervious stratum.

2.93 Perched Spring

A spring whose source of water supply is a perched water body.

2.94 Perennial Spring

A spring that discharges continuously at all seasons of the year.

2.95 Permeable Material

Material that permits water to move through it at perceptible rates under the normal hydraulic gradients.

2.96 Permeability

It is defined as the characteristic of medium to transmit water.

2.97 Pellicular Water — See 2.3.**2.98 Piestic Interval**

The difference in static level between two isopiestic lines or lines of equal pressure.

2.99 Phreatic Cycle, Cycle of Fluctuation

The total time occupied by a period of rise and a succeeding period of decline of a water table. The most common kinds of cycles are daily, seasonal, annual, and secular.

2.100 Phreatic Surface

The upper boundary of an unconfined ground water body, at which the water pressure is equal to the atmospheric pressure.

2.101 Phreatic Water

Ground water occurring in the zone of saturation having a water table.

2.102 Physical Yield Limit, Potential Yield

The greatest rate of artificial withdrawal from an aquifer, which can be maintained throughout the foreseeable future without regard to cost of recovery. The physical yield limit is, therefore, equal to the present recharge, or that anticipated in the foreseeable future, less the unrecoverable natural discharge.

2.103 Piezometric Surface, Pressure Surface

It is an imaginary surface to which the water in a confined aquifer would rise if afforded an opportunity to do so.

2.104 Porosity

Porosity is an index of the void characteristics of a soil or stratum as pertaining to percolation and is the ratio, usually expressed as a percentage, of the volume of voids of a given soil mass to the total volume of soil mass.

2.105 Pore Water

Water in the interstices or voids of the formation.

2.106 Potential Yield

The maximum rate of artificial withdrawal from an aquifer, which can be maintained throughout the foreseeable future without regard to cost of recovery. The potential yield is, therefore, equal to the present recharge, or that anticipated in the foreseeable future, less the unrecoverable natural discharge.

2.107 Potentiometric Surface

The surface that represents the static head of ground water.

2.108 Profile of Water Table

The line formed by the intersection of the water table with a vertical plane. The term is also applied to a graphical representation of such a line.

2.109 Pumping Test

A test which is conducted to determine aquifer or well characteristics.

2.110 Radius of Influence

It is the radial distance from the centre of the well to the point where the cone of depression tangentially meets the static or unaffected water table.

2.111 Recuperation

Recovery of water table after cessation of pumping or withdrawal of water.

2.112 Rising Main

The pipe carrying water from within a well to a point of discharge.

2.113 Running Plot

A graph of a variable against elapsed time continually updated as measurements are taken.

2.114 Saturated Zone

That part of an aquifer, normally beneath the deepest water table, in which ideally all voids are filled with water under pressure greater than atmospheric.

2.115 Safe Yield

The maximum rate at which water can be artificially withdrawn from an aquifer throughout the foreseeable future without impairing the aquifer.

2.116 Screen

A type of lining tube, with openings designed to permit the flow of water into a well while preventing the entry of aquifer or filter pack material.

2.117 Seepage

A slow movement of water due to capillary action through pores and interstices of unsaturated close soil material into, a surface, or sub-surface, body of water reach as a river, canal, reservoirs or field.

2.118 Soil Water

The suspended water in the uppermost layer of soil of the zone of aeration and lying near enough to the surface to be discharged into the atmosphere by the transpiration of plants or by evaporation from the soil (includes hygroscopic, capillary and non-capillary water).

2.119 Soil Water Zone

Part of the zone of aeration that consists of soil and other materials near the ground surface, capable of discharging water into the atmosphere by transpiration of plants or by evaporation. The zone extends from the ground surface to major root zone and the thickness varies with the soil type and vegetation cover.

2.120 Spring

A concentrated natural discharge of ground water appearing at the surface as a current of flowing water.

2.121 Specific Capacity

The rate of discharge of water from a well divided by the drawdown within the well.

2.122 Specific Yield

The quantity of water that a unit volume of permeable rock or soil, after being saturated, will yield when drained by gravity. It may be expressed as a ratio or as a percentage by volume. The sum of specific retention and specific yield equals the porosity of the material drained. (This definition is different from that of surface water.)

2.123 Specific Retention

The ratio of the volume of water that a given body of rock or soil will hold against the pull of gravity to the total volume of the body itself.

2.124 Static Water Level

The water level in a non-pumping well outside the area of influence of any pumping well. This level registers one point on the water table in a water-table well or one point on the pressure surface in a confined water well.

2.125 Static Head

The height, relative to an arbitrary reference, level, or a column of water that can be supported by the static pressure at a given point.

2.126 Storage Coefficient of an Aquifer

A dimensionless fraction representing the volume of water released or stored from a vertical prism of the aquifer having a base of unit area and a height equal to the thickness of the aquifer, when the piezometric surface falls or rises one unit of height normal to the surface. In an unconfined aquifer the coefficient of storage is essentially equal to the specific yield.

2.127 Subterranean Stream

A body of flowing water that passes through a very large interstice, such as a cave or cavern, or a group of large communicating interstices.

2.128 Sub-Surface Water

Water that occurs beneath the surface of the earth (in the lithosphere). It may be in liquid, solid, or gaseous state. It is also called underground water or subterranean water.

2.129 Suspended Water

Water in the zone of aeration.

2.130 Transmissivity

The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the saturated aquifer under a unit hydraulic gradient.

2.131 Unconsolidated Aquifer

A loose formation which can hold and transmit water.

2.132 Vadose Water

See 2.129

2.133 Water of Compaction

Water furnished by destruction of pore space owing to compaction of sediments.

2.134 Water of Condensation

Water formed by condensation of water vapours appearing from the atmosphere or soil air in rock interstices and also of water vapours arising from the magmosphere or from the volcanic focuses of the lithosphere.

2.135 Water of Infiltration

The part of the surface water or precipitation entering the upper parts of the lithosphere through small capillary pores of the soil and interstices in the rock.

2.136 Water Logging

A phenomenon where water stands near, at, or above the land surface causing damage to plant roots.

2.137 Water Table (Phreatic Surface)

Upper surface of zone of saturation in an unconfined aquifer.

2.138 Water Table Contour

A line drawn on a map and passing through the points where the water table has the same elevation above a specified datum plane.

2.139 Water Table Spring/Depression Spring

A spring that occurs at the intersection of the water table and the surface.

2.140 Well

An artificial excavation (pit, hole, tunnel) generally cylindrical in form and often walled in sunk (drilled, dug, driven, bored or jetted) into the ground to such a depth as to penetrate water yielding rock or soil and allow the water to flow or to be pumped to the surface.

2.141 Well Development

The physical and chemical treatment of a well to achieve minimum resistance to movement of water between well and aquifer.

2.142 Well Efficiency

A measure of the performance of a production well.

2.143 Well Loss

The head loss resulting from flow of ground-water across the well face, including any part of the aquifer affected by drilling, and any filter pack or lining tube, into the well and up or down the well to the pump.

2.144 Zone of Aeration, Aeration Zone, Zone of Suspended Water, Unsaturated Zone/Vadose Zone

Zone of earth materials or rock from which the ground and capillary water has drained out, leaving the interstices filled with air and water held or suspended by molecular forces, such as cohesion, adhesion and surface tension. It extends from ground surface to water table.

2.145 Zone of Fluctuation of Water Table, Zone of Phreatic Fluctuation

The zone through which the water table fluctuates from its highest to the lowest level within the formation, in response to the discharge and recharge conditions. Depending upon the position of the water table in the zone, a part of the zone will lie in the zone of aeration and the other part will lie in the zone of saturation.

2.146 Zone of Saturation

Zone in which interstices of rock or other materials are filled with water under hydrostatic pressure.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002

Telephone

{ 331 01 31
{ 331 13 75

Eastern : 1/14 C. I. T. Scheme VIII M, V. I. P. Road, Maniktola
CALCUTTA 700054

{ 37 84 99, 37 85 61
{ 37 86 26, 37 86 62

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022

{ 60 38 43,
{ 60 20 25,

Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113

{ 235 02 16, 235 04 42
{ 235 15 19, 235 23 15

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
BOMBAY 400093

{ 632 92 95, 632 78 58
{ 632 78 91, 632 78 92

Branch : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE.
FARIDABAD. GHAZIABAD, GUWAHATI. HYDERABAD. JAIPUR. KANPUR.
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