SMART

IRRIGATION NEW ZEALAND

Irrigation Glossary

BOOK 2

Contents

This book is part of a series providing a comprehensive training resource for irrigation industry participants in New Zealand.

It is a comprehensive catalogue of the common terminology, acronyms, conversions, and other useful information used in the irrigation industry.

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General irrigation terminology

Irrigation

The action of applying water to land in order to supply plants with necessary water replacing moisture lost through evapo-transpiration.

Annual cost	The operating costs (energy, labour, maintenance) plus the cost of capital (exclusive of GST).
Aquifer	Underground layer of water bearing rock or unconsolidated material such as gravel or sands.
Average annual precipitation	Long-term historic yearly average (generally 30 years or more) of precipitation (rain, snow, dew) received by an area.
Back flow preventer	Device designed to prevent water from flowing in reverse through the system. Commonly used to prevent added nutrients, chemicals or effluent from mixing with clean water sources.
Bore	A drilled hole accessing underground water.
Capital cost	The overall system purchase and installation cost.
Cavitation	The formation and then immediate collapse of vacuum cavities in a liquid. Usually occurring when the liquid is subjected to rapid changes of pressure.
Chemigation	Application of chemicals to crops through an irrigation system. This is done by mixing them with the irrigation water.
Deficit irrigation	Irrigation water management option where the soil in the plant root zone is not refilled to field capacity in all or part of the field.
Design specification	A document that defines site-specific performance targets that a proposed irrigation system must be able to achieve. A designer prepares the final design to meet these requirements. A design specification includes such factors as: • System capacity • Application depth range • Maximum application intensity • Minimum distribution uniformity • Return interval.
Distribution efficiency	A measure of how much of the water supplied to the property reaches the application system. It is a function of losses in the conveyance or distribution system, from the point of water abstraction or entry to the property (in the case of irrigation schemes) to the application system.

Figure 1. Headworks.

Effective root depth
The depth of soil profile that has enough rooting density for extraction of available water. Roots may be found at depths greater than this value but do not contribute significantly to water extraction.

Equivalent applied depth
In drip-micro irrigation, determined from the volume applied to a plant, adjusted for the allocated ground area per plant.

Fertigation
Application of nutrients through an irrigation system. This is done by injecting them into the irrigation water.

Flow (flow rate)
Measurement of the volume of water passing a point in a given time. E.g. litres per second, cubic metres per hour.

Friction loss (head loss)
Amount of pressure lost through pipes due to water movement and turbulence.

Head (pressure)
Commonly used as a term for pressure. Often reported as the equivalent height of a water column measured in metres. Conversion to pressure units accounts for the specific gravity of water (about 9.81 m/s) so 10 m head is equivalent to about 98.1 kPa. For many purposes, an approximation of 10 m = 100 kPa or 1 bar is used.

Head (flow)
Historic term for flow related to mining rights.
[1 head = 1 cubic foot per second = 28.32 litres per second]

Headworks
Describes the start of the irrigation distribution system. It contains exposed mainlines, pumps, valves, filters, meters, monitoring and telemetry equipment necessary to run the system.

Headworks efficiency
A measure of the hydraulic performance of the intake structure, pump and headworks (excluding pump pressure and elevation differences) to indicate the extent of pressure loss in the water supply system between the water supply point and the mainline entry.

Hydraulic efficiency
A measure of the system hydraulic performance; measuring pressure lost between the delivery (mainline entry) and discharge points (machine entry, hydrant, or take-off in drip-micro systems), excluding variations in elevation.

Infiltration gallery
A coarse filtration system at point of take from water source. May be constructed of a rock or gravel barrier with or without embedded steel mesh drums to aid the passage of water. Surface water passes through into a channel, pond or pipe.

Infiltrometer
Device used to measure the infiltration rate/intake rate of water into soil. A ring infiltrometer consists of metal rings that are inserted (driven) into the soil surface and filled with water. The rate at which water enters the soil is observed.

Irrigation schedule
Procedure of establishing and implementing the time and amount of irrigation water to apply. Determining when to irrigate and how much water to apply, based upon measurements or estimates of soil moisture or crop water used by a plant. Set of specifications identifying times to turn on and off water to various zones of an irrigation system.

Lysimeter Device for measuring deep percolation from a soil profile. Consists of an enclosed volume of undisturbed soil with some means of collecting drainage water. It may also include some method to measure changes in the volume of stored soil water.

Mainline A pipeline that carries water from system headworks to off-takes supplying a series of blocks.

Management zone A discrete area with a particular set of irrigation management needs relating to specific factors, such as topography, soil, crop, system or management differences.

Non-point source pollution (Diffuse pollution) Pollution originating from diffuse areas (land surface or atmosphere) having no well-defined source.

Performance curve Graph showing the capability of a product with varying inputs. i.e. the dynamic head of a pump as it varies with discharge.

Pressure loss Amount of pressure lost as water flows through a system.

Pressure rating Estimated maximum internal pressure that can be continuously exerted in a pipe or container with a high degree of certainty that it will not fail.

Pressure regulator Device which maintains constant operating pressure (immediately downstream) which is lower than the upstream pressure.

Pressure tank An airtight container with a pressurised air pocket or bladder attached to a water system so that it behaves as a temporary pressurised water supply.

Return on water use The marginal change in returns resulting from the irrigation system. It is generally based on mean annual irrigation demand, and incorporates cost and productivity elements. Values can be expressed as returns per unit area or volume of water ($/ha or $/m^3). Values can be positive or negative, dependent on system costs, productivity and crop returns.

Soil bulk density The mass of dry soil per unit of bulk soil – the mass of soil in a known volume as extracted from the ground. The bulk density of soil depends on its mineral make up and the degree of compaction.

Soil horizon Layer of soil or soil material approximately parallel to the land surface and differing from adjacent layers. Differences can be physical, chemical, and biological properties or characteristics such as colour, structure, texture, kinds and number of organisms present, degree of acidity, etc.

Soil profile A vertical section through the soil from surface to below the root zone. A soil profile is comprised of one or more soil horizons.

Soil structure Combination or arrangement of primary soil particles into secondary units or peds. The secondary units are characterized on the basis of size, shape, and grade (degree of distinctness).

Soil texture Relative proportions of sand, silt and clay in a soil.

Figure 2. Pressure gauge.

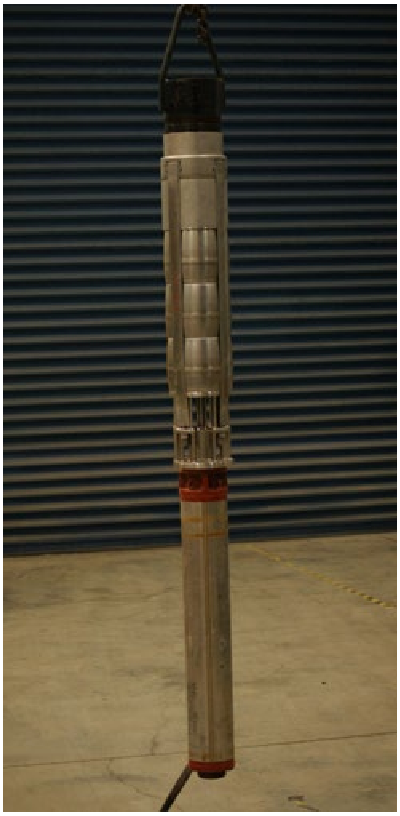

Figure 3. Submersible pump and motor.

Submersible pump	A pump that operates while submerged in a column of water down a bore or well.
Surface water body	Any significant accumulation of fresh water that is visible on the surface of the earth. Surface water bodies include lakes, rivers, streams, wetlands, water races, watercourses, and drains.
System capacity	The flow of water per unit of irrigated area normally expressed as litres per second per hectare (L/s/ha) or mm per day (mm/d) calculated on the basis of the system operating 24 hours per day.
Operating system capacity	The flow of water per unit of irrigated area that can be supplied in the time that the system is operating.
Potential system capacity	The mean daily flow of water per unit of irrigated area the system is able to provide in the time available for irrigation.
Pumping rate	The volume of water per unit time (l/s or m^3/hr) that a pump is designed to deliver at the design pressure.
Required system capacity	The flow of water per unit of irrigated area required to replace water used by the crop (plus any additional amounts for other purposes) in the time available.
System specification	A system specification is a document that describes what the final irrigation system will comprise of, and what it will be capable of achieving. A system specification: • lists components of the system, e.g., pipes and pumps • shows their locations, and • describes their key specifications, e.g., diameters, speeds, pressures.
Tensiometer	Instrument to measure the moisture content of soil. Consisting of a porous cup filled with water and connected to a manometer, vacuum gauge, or pressure transducer used for measuring the soil-water matric potential or vacuum tension.
Thrust block	Concrete or solid blocks placed in piping systems at changes in direction of water flow (tees, corners) to prevent movement of the pipe.
Water hammer	Shock wave created when the flow of water in a piping system suddenly stops (or changes speed), usually the result of a fast-closing (or opening) valve.
Water table	Upper surface of a saturated zone below the soil surface where the water is at atmospheric pressure.
Weir	Flow measuring device for open-channel flow. Weirs can be either sharp-crested or broad-crested. Flow opening may be rectangular, triangular, trapezoidal, or specially shaped to make the discharge linear with flow depth.
Yield	Flow rate that is achievable from an aquifer. This is dependent on the hydraulic conductivity of the aquifer material.

Soil water terminology

Soil water storage

A number of terms are used to describe the status of soil moisture or soil water content. Many have been used interchangeably, or in conflicting ways by different authors.

Irrigation New Zealand recommends that the following terms and associated calculations are used to describe the amount of water in soil.

KEY TERMS

Content	The volumetric water content of soil as measured at a point in time (m^3 water/m^3 soil, mm water/mm soil).
Capacity	The potential of soil to hold water, described as a ratio of volumetric water content integrated over a depth of soil (m^3 water/m^3 soil). The depth will be specified as centimetres soil depth.
Depth	The rainfall depth equivalent of water in a defined depth of soil (mm).
Water holding capacity (WHC)	The volumetric ratio of all water contained in a layer or depth of soil at field capacity, including that held too tightly for plants to access.
Total available water (TAW)	All the water that is extractable by plants (plant type may be specified); taken as the difference between soil water at field capacity and at permanent wilting point.
Readily available water (RAW)	The water that is extractable by plants (plant type may be specified) without growth limitation taken as the difference between soil water at field capacity and at stress point.
Stress available water (SAW)	The water that is extractable by plants (plant type may be specified) but with growth limitation taken as the difference between soil water at stress point and at permanent wilting point.

Soil moisture status

Saturation	Soil is said to be saturated when all its pores are full of water and no air is left. Most plants do not tolerate saturated soils for long as oxygen in the root zone is essential.
Field capacity (FC)	The soil moisture content after gravitational drainage slows from a saturated condition to a rate that is insignificant (i.e. drainage rate less than 1 mm/day). This is usually estimated in the field by measuring the soil water content 2–3 days after heavy rainfall, or by measuring the water content of soil cores in the laboratory after they have been equilibrated at a soil matric potential. In New Zealand the laboratory estimation of field capacity is measured at the nominal -10 kPa soil matric potential, but direct field measurements show that it can vary between -2 kPa to -30 kPa depending on soil texture.
Stress point (SP)	The soil moisture content, below which plant growth begins to slow. This point is different for different plants. Moisture stress is strongly related to soil matric potential, and generally occurs at approximately -50 kPa. However lab measurements commonly use -100 kPa so it is important to find out the correct value for particular soils in the field It is often related to water content for irrigation management purposes. As a rule of thumb most plants will become stressed when about 50% of the 'total available water' has been used.
Permanent wilting point (WP)	The soil moisture content where plant growth stops. This is the lower limit of available water below which plant growth ceases completely. The soil matric potential at this point corresponds to about -1,500 kPa (-15 bar). The 'permanent wilting point' is generally governed by the amount of clay in the soil – the greater the amount of clay, the higher (% soil moisture) the 'permanent wilting point'.
Oven dry	Some water is so tightly held by the soil, it is unavailable for plants. This "hygroscopic" water can only be removed by sun-baking, or in a lab by oven drying soil at 105° celsius to constant weight.

Combined terms

Profile available water (depth) (PAW_D)

The rainfall equivalent depth of 'total available water' within a specified depth in the soil.

The soil depth in centimetres is shown as a subscript following the acronym; e.g. PAW60 is the 'profile available water' in a given soil to a depth of 60 cm. It is soil specific and independent of plant type or root depth.

Profile readily available water (depth) ($PRAW_D$)

The rainfall equivalent depth of 'readily available water' within a specified depth of soil.

The soil depth in centimetres is shown as a subscript following the acronym; e.g. PRAW40 is the 'readily available water' in a given soil to a depth of 40 cm. It is soil specific and independent of plant type or root depth.

Crop available water (depth) (CAW_D)

The rainfall equivalent depth of 'total available water' by a specified crop from its root zone.

The root zone depth in centimetres is shown as a subscript following the acronym; e.g. CAW40 is the 'crop available water' in the 40 cm deep root zone in a given soil.

Readily available water (depth) (RAW_D)

The rainfall equivalent depth of 'readily available water' by a specified crop from its root zone.

The root zone depth in centimetres is shown as a subscript following the acronym; e.g. RAW40 is the 'readily available water' in the 40 cm deep root zone in a given soil.

Soil moisture deficit (depth) (SMD_D)

The rainfall equivalent depth of water required to return the soil water content in the root zone from its current status to 'field capacity'.

The root zone depth in centimetres is shown as a subscript following the acronym; e.g. SMD40 is the 'soil moisture deficit' in the 40 cm deep root zone in a given soil.

Non-limiting water range (NLWR)

Represents the range of water content in the soil where limitations to plant growth (such as water potential, air-filled porosity, or soil strength) are minimal.

- The upper limit (wet end) of non-limiting water range is determined by water content at 'field capacity', and adequate aeration for plant roots (usually taken as a minimum air filled porosity of 10%).
- The lower limit (dry end) is determined by 'permanent wilting point' and the ability of root penetration. Root penetration is measured as soil mechanical resistance taken at an arbitrary value, often penetration resistance of 3 MPa.

Figure 4. Crop and irrigator.

Soil water movement

Bypass flow (Preferential flow)	Water moving down through large pores or cracks in the soil profile without being absorbed into it.
Drainage	The loss by downward flow of excess water from saturated pore spaces in soil. It can be reduced or stopped by slowly or impermeable layers within the profile, or by high water tables.
Groundwater recharge	Includes all drainage, whether from irrigation or precipitation. It is estimated from the balance of water not retained in the root zone, calculated after any surface losses have been accounted for.
Infiltration rate	The movement of water into the soil profile. Measured as the rate (mm/hour, mm/day) at which a soil absorbs water. It varies with soil type, soil surface condition and moisture content.
Leaching	The loss of soluble material, chemical or mineral, through drainage. Measured as a concentration (mg/litre) or as a loading or a rate (kg/ha/year). Loading is determined by integrating concentration and drainage. The term can also cover the loss of other minerals and substances that are transported but not dissolved for example Ecoli and phosphorous.
Percolation	The downward movement of water through the soil. Measured as a rate (mm/hour, mm/day).
Permeability	The ability of air and water movement through the soil. It affects the supply of root-zone air, moisture, and nutrients available for plant uptake. A soil's permeability is determined by the relative rate of moisture and air movement through the most restrictive layer. It is often measured as a rate (mm/hour, mm/day).
Surface ponding	Water that does not immediately infiltrate into the soil but collects at the low points in the micro-topography of the soils surface. The implications of surface ponding are complex, depending on both time and extent of ponding.
Surface runoff	Water that does not immediately infiltrate into the soil and instead leaves the target zone by running off across the soil surface under gravity.

Soil water potential

The amount of water that is stored and is available to plants, and how freely water drains, are processes governed by potential energy. Potential energy differences determine storage and redistribution within soil. A potential energy gradient dictates soil moisture redistribution and losses, as water moves from areas of high- to low-potential energy.

Critical concepts are soil water potential and soil water content.

Soil water potential	Water potential is the potential energy of water per unit volume relative to pure water in reference conditions. It quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure, or matrix effects such as surface tension. Water potential integrates different potential drivers of water movement, which may operate in the same or different directions.
Gravity potential	The force gravity has on water; the greater the height of water, the greater the gravitational potential. Gravitational potential is measured as the height above a reference point. If the reference is the soil surface and there are 100 mm of water sitting on the soil surface, the gravitational potential is equal to 100 mm. Gravitational potential is a key driver of rapid soil drainage.
Matric potential (Matrix potential)	The surface attraction soil particles have for water. If a dry soil is adjacent to a pool of water, the soil will absorb the water. “Free” or standing water has an energy level of zero. The matric potential of unsaturated soil is less than zero so is written as a negative value. The magnitude of matric potential depends largely on soil porosity and chemical make-up. As a soil dries, the matric potential becomes more negative as the soil water becomes more tightly held by the soil in smaller pores, and is harder for plants to extract. Matric potential can be measured with a tensiometer. Electrical resistance blocks may be used in drier soils where tensiometers may not work.

Soil water content

Soil water content is the amount of water present in the soil. It can be measured as relative weight or relative volume. Both can be described as fractions or percentages (weight for weight, volume for volume) but are actually quite different.

Gravimetric water content The weight of water in a given weight of soil (g/g or kg/kg). Weighing of both soil and water is easy, but differing soil bulk densities makes interpretation for irrigation management difficult.

To determine gravimetric water content, a soil sample is weighed, then dried and re-weighed. Gravimetric water content is the weight of water removed from the soil divided by the weight of dry soil.

The standard laboratory method involves placing a field moist soil sample in an oven at 105° celsius until weight is constant. Calculating the difference in weight between the wet soil and the dry soil determines the weight of water removed. The dry soil weight is the weight of soil used in the calculation.

Volumetric water content The volume of water in a volume of soil. It is the gravimetric water content adjusted by the soil bulk density.

To determine volumetric water content, a known volume of soil is weighed, dried and re-weighed. The volumetric water content is the volume of water removed (1 ml of water weighs 1 gm) divided by the volume of soil.

Volumetric water can be described as depth of rainfall and/or irrigation equivalent in a certain depth of soil (e.g. the root zone). This is very useful for determining the supply available for plants, when irrigation is needed and how much should be applied.

Plant water use

Evaporation — The loss of water into the atmosphere from soil, water and plant surfaces.

Transpiration — The loss of water through stomata (pores) of leaf surfaces which allow gas exchange for photosynthesis and respiration. Transpiration helps cool the plant and draw up nutrients.

Evapo-transpiration (ET) — The combined processes of evaporation and transpiration.

Potential evapo-transpiration (PET) — The amount of water that would be lost through evaporation by a healthy short, uniform, actively growing indicator crop that fully covers an area and is never short of water.

Crop evapo-transpiration (ET_{crop}) — The actual water use by a crop of interest. It may be measured or calculated from PET and a crop factor.

Crop factor — The adjustment used to relate the loss of water by evapo-transpiration by an actual crop, to that of a theoretical indicator crop, (normally full cover, uniform pasture). It is influenced by species, growth stage, ground cover or canopy area effects.

Crop irrigation demand (CID) — The amount of water potentially consumed by the irrigated crop in one week during peak evapo-transpiration conditions (mm or m^3/ha/week)

Moisture stress — Occurs when the water in a plant's cells is reduced to less than normal levels. Reasons for this include a lack of water in the plant's root zone, higher rates of transpiration than the rate of moisture uptake by the roots, or loss of roots due to transplantation. Moisture stress is more strongly related to water potential than it is to water content.

Matric potentials are very important for plant water relations. Strong (very negative) matric potentials bind water to soil particles within very dry soils. Plants then create even more negative matric potentials within tiny pores in the cell walls of their leaves to extract water from the soil and allow physiological activity to continue through dry periods.

Potential soil moisture deficit (PSMD) — A measure of moisture stress experienced by a crop. Seasonal 'potential soil moisture deficit' is calculated from soil moisture budgets by summing all deficits below the critical deficit (or MAD) during the growing season for the crop.

Root zone — The part of the soil profile in which active roots are present, and from which water and nutrients can be extracted by the plant.

Figure 5. Emerging crop.

Irrigation application

Figure 6. Micro sprinkler.

Application depth	The rainfall equivalent depth of water applied to the soil surface during a single irrigation event. It is the depth of water that would be caught in a rain gauge, *not* the depth of soil that is wetted.
Application intensity	The rate (mm/hour) at which irrigation is applied. It compares "gentle showers" with "heavy rain". (See specific calculations below). **Instantaneous application intensity (Ri)** The rate (mm/hr) at which irrigation is applied by an individual stream, from an individual outlet or nozzle, to a very small area. For example, for a rotating boom it is the flow from a single outlet divided by the area being wetted at any instant by that outlet. **Average application intensity (Ra)** The rate of application (mm/hr), averaged over the individual applicator's wetted footprint. For example, for a rotating boom it is the applicator's flow rate divided by the area wetted by one full rotation of the boom.
Application rate	The commonly used term for the more correct term application intensity (ie. heavy thunderstorm vs light drizzle). Note: It does *not* mean applied depth per event (see Application depth) or applied depth per day (see System capacity).
Application efficiency	The percentage of applied water that is retained in the root zone, or in the target area, after an irrigation event.
Application uniformity	The spatial variability (measure of the evenness of coverage) of the application by irrigation. It can be defined in a variety of ways. Common examples are: • Distribution Uniformity (DU) • Coefficient of Uniformity (CU) • Coefficient of Variation (CV)

Distribution uniformity (DU)

One measure of application uniformity. It is common to use low quartile distribution uniformity (DU_{LQ}), which compares the average of the lowest quarter of (measured) applied depths with the average depth of all (measured) applied depths.

Low quarter irrigation adequacy

The ratio of the mean low quarter depth applied, to the mean target depth required across the field as a whole.

Mean field application depth

Mean application depth collected along transverse lines after adjustment for evaporation and overlap from adjacent strips.

Irrigation scheduling

Figure 7. Scheduling.

Irrigation requirement
The crop water requirement plus any additional beneficial water requirement less received precipitation and stored soil moisture.

Management allowed depletion (MAD)
The proportion of the Crop Available Water that is allowed to be removed before irrigation is applied. The level is a management decision dependent on crop type, stage of crop development, seasonal water demand and other management factors and constraints.

Note: this term is not to be confused with *maximum allowable deficit* which is another term for the trigger point see below.

Return interval (Return period)
The typical period between one irrigation event and the next. It is usually calculated for the most demanding period so that the irrigation system can meet water demand most of the time.

Scheduling co-efficient
Used to determine how much extra irrigation should be applied to ensure that most of the crop gets sufficient water. It accounts for variances and inefficiencies of application systems.

It is common to use the reciprocal of the low quartile Distribution Uniformity to calculate the extra required. Multiplying irrigation need by the scheduling coefficient determines a target application depth that ensures that 7/8th of the crop will receive at least the required depth of irrigation (some will get considerably more).

Scheduling coefficient for effluent
When applying effluent to the soil, there is a need to avoid over-application, rather than under-application as is the case with normal irrigation. The scheduling coefficient can be used to determine how much to reduce average effluent application to ensure 7/8th gets less than the target nutrient of water dose.

Shoulder periods
The beginning and end of the irrigation season (typically early/mid spring and autumn) when demand is not as great because of the lower ET and increased likelihood of rainfall.

Soil moisture deficit
The difference between the soil water content at field capacity and the current soil water content. It is measured in millimetres of rainfall equivalent in the root zone.

Target depth
The mean applied depth chosen to be applied.

It will normally be less than the soil moisture deficit at the time of application to allow space for any subsequent rainfall. It may be increased to account for non-uniform application.

Trigger Point (Irrigation point, Critical deficit, Maximum allowable deficit)
The soil moisture content (mm) or matric potential (kPa) at which irrigation is deemed necessary to avoid plant stress.

Regulatory terms[1]

Abatement notice	Requires compliance with the RMA within the time specified in the notice. Only councils can issue these to get someone to stop or to start doing something.
Applicant	A person, group or organisation who applied for a resource consent.
Assessment of environmental effects	A report that must be given to the council with your resource consent application. It outlines the effects that the proposed activity might have on the environment.
City or District councils	Are primarily responsible for managing the environmental effects of activities on land.
Department of Conservation (DoC)	Administers land under the Conservation and National Parks Acts and has a role under the RMA overseeing the management of the coastal environment.
Designations	Provisions in a district plan which provide notice to the community of an intention by the council or a requiring authority to use land in the future for a particular work or project.
District plans	Prepared by city or district councils to help them carry out their functions under the RMA.
Enforcement order	A way of getting someone to comply with the RMA. It differs from an abatement notice in that anybody (not just the council) can apply for an enforcement order against somebody else. These are issued by the Environment Court rather than the council.
Environment	Includes: a. ecosystems and their constituent parts, including people and communities, and b. natural and physical resources, and c. amenity values, and d. the social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters.
Environment Court	Specialist court where people can go to appeal decisions made by councils on either a policy statement or plan, or on a resource consent application, or apply for an enforcement order.

1. www.mfe.govt.nz/rma/public/rma-terms.html

Further submission	Provides an opportunity for people to comment on other people's original submissions on a proposed plan, plan change or variation either by supporting or opposing those submissions.
Infringement notice	An instant fine that is issued for relatively minor environmental offences.
Ministry for the Environment (MfE)	Provides advice to the government on policies, laws and other means to improve environmental management in New Zealand.
National environmental standards (NES)	Tools used to set nationwide standards for the state of a natural resource.
National policy statement (NPS)	National policy guidance for matters that are considered to be of environmental importance.
Plan change	The process that councils use to prepare changes to an operative plan.
Private plan change	A plan change initiated by any person to an operative council plan.
Project information memorandum	Issued by the city or district council and contains information relating to the location of the building and whether it will need a resource consent or not.
Public notification	Means a notice published in a newspaper or notice sent to every person the council thinks may be affected by a proposed plan, plan change or variation.
Publicly notified resource consent	Means that any person can make a submission on the consent application.
Regional councils	Primarily manage resources like the air, water, soils and the coastal marine area.
Regional plans	Prepared by regional councils if they want to use them to help manage the resources for which they are responsible.
Regional policy statements (RPS)	Must be prepared by all regional councils and help set the direction for the management of all resources across the region.
Resource consent	Is permission from the local council for an activity that might affect the environment, and that isn't allowed 'as of right' in the district or regional plan.
Resource Management Act 1991 (RMA)	New Zealand's main piece of environmental legislation and provides a framework for managing the effects of activities on the environment.

Submission	Outlines your written comments, opinions, concerns, support, opposition or neutral stance about a proposed development, a notice of requirement for a designation, or a proposed policy statement or plan.
Sustainable management	Means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economical and cultural wellbeing and for their health and safety while: a. sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations, and b. safeguarding the life-supporting capacity of air, water, soil and ecosystems, and c. avoiding, remedying or mitigating any adverse effects of activities on the environment.
Unitary authorities	Carry out the roles of both regional and district councils.

Calculations

APPLICATION INTENSITY

Application intensity is calculated by dividing the flow rate by the wetted area, and adjusting to mm applied depth, using the formula:

$R_{app} = 3{,}600 \times Q_{app} / A_{app}$

where:

R_{app} = Average application intensity (mm/hr)

Q_{app} = Flow rate to the applicator (l/s)

A_{app} = Wetted area of the applicator (m^2)

The wetted area of the applicator must be determined according to the wetting pattern of the specific irrigator. In general it is the area that is wetted at a given instant, or in one swing or rotation of a turning sprinkler, gun or boom.

Individual sprinklers

For individual FDE sprinklers, A_{app} is the total area wetted by the sprinkler, and Q_{app} is the flow rate to the sprinkler. This applies to all individual sprinklers, e.g. long laterals, or separate effluent sprinklers attached to pivot spans.

Multi-sprinkler lines

For stationary applicators with multiple sprinklers, A_{app} is the total area wetted by all of the sprinklers on the individual line, and Q_{app} is the flow rate to that line.

Rotating booms

For a rotating boom irrigator, A_{app} is the area wetted by one full rotation of the boom, and Q_{app} is the flow rate to that machine.

Gun irrigators

For gun irrigators, A_{app} is the area wetted by one swing of the gun across its operating arc, and Q_{app} is the flow rate to that machine. This applies to all gun irrigators, e.g., a travelling gun, or effluent gun attached to a centre-pivot.

Travelling boom or linear move

For travelling linear system, A_{app} is the total area wetted by all of the sprinklers on all spans when the machine is stationary, and Q_{app} is the flow rate to the machine.

Separate systems attached to centre-pivots

For systems where a separate FDE applicator is attached to a centre-pivot, the application intensity is calculated as if the FDE applicator were operating as a separate unit, e.g. a stationary sprinkler, or a gun irrigator (as above).

Conversions

ONLINE CONVERTERS

There are free converters available either on-line or downloaded to computers or smart devices. They make life very easy. The application “Convert” by Joshua Madison is one example: http://joshmadison.com/convert-for-windows/

VOLUMES

1 cubic metre = 1,000 litres (1 m^3 = 1,000 L)

1 megalitre = 1,000 cubic metres (1 ML = 1,000 m^3)

1 litre is 100 mm x 100 mm x 100 mm or 0.1 m x 0.1 m x 0.1 m

1 litre spread over 1 square metre is 1 millimetre deep (1 L = 1 m^2 x 1 mm)

AREAS

1 hectare = 10,000 square metres (1 ha – 10,000 m^2)

Area of circle = Pi x radius x radius (A = πr^2) and Pi or π = 3.1416

FLOW

1 litre per second = 3.6 cubic metres per hour (1 L/s = 3.6 m^3/h)

1 head = 1 cubic foot per second = 28.32 litres per second (1 head = 28.32 L/s)

1 litre per second per hectare = 86.4 m^3 per day per hectare = 8.64 millimetres per day (1 L/s/ha = 8.64 mm/d) or 5 mm/d = 0.5787 L/s/ha

PRESSURE

The standard pressure unit is the Pascal. In irrigation it is common to use the kilopascal or in some cases MegaPascal for measurements.

1 kiloPascal = 1,000 Pascals (1 kPa = 1,000 Pa)

1 MegaPascal = 1000 kiloPascals = 1,000,000 Pascals (1 MPa = 1,000 kPa = 1,000,000 Pa)

1 metre of water head = about 9.81 kiloPascals (depending on actual specific gravity of water)

ALTERNATIVE PRESSURE UNITS

1 pound per square inch = about 7 kiloPascals (1 psi = 6.8948 kPa)

1 atmosphere = about 101 kiloPascals (1 atm = 101.325 kPa)

1 bar = 100 kiloPascals or about 1 atmosphere (1 bar = 100 kPa = 0.98692 atm)

WATER POTENTIAL

Approx soil status	Kilopascals (kPa)	Megapascals (MPa)	Bars	Centibars
	–1	–0.001	–0.01	–1
Field Capacity	–10	–0.01	–0.1	–10
	–33	–0.033	–0.33	–33
Stress Point	–100	–0.1	–1	–100
	–1000	–1.0	–10	–1000
Permanent Wilting Point	–1500	–1.5	–15	–1500

NOTES

NOTES

REFERENCES

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