

Teachers' Support Water

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Introduction

Australia is a dry continent and our water resources are increasingly under significant pressure from our growing population and climate change. See 'Water and Climate Change' below.

Student Activities

For additional student activities click on:

[Curriculum Links, Explanations, Answers and Extension](#)

[Student Activities](#) and [Teacher Notes for Student Activities](#)

[Labels for Land Use Activity](#)

[Waterwise Detective](#)

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For an example of a lesson plan integrating three learning areas and values click on: [Integrated Lesson Plan](#) This lesson plan is for *Mission Turn Off*.

Water and Catchments

Water has some remarkable features:

- Water is known as the universal solvent because it can dissolve many substances, both solid and gaseous, that come into contact with it.
- Water is the only natural substance that exists as solid, liquid and gas within normal earth temperatures.
- The temperature of water affects how quickly substances dissolve in it and, in some cases, the quantity that can be dissolved: for example, warm water holds less dissolved oxygen than colder water, but it holds more of most solids.
- Temperature also has a major effect on living things within the water. Compared to air or soil, bodies of water change temperature slowly, so aquatic life is generally not exposed to sudden fluctuations of temperature.
- Water containing salts is a good conductor of electricity – the basis of the technique for measuring the level of salt in the water (salinity).
- Moving water and ice are powerful agents of erosion – removing particles from unprotected soil surfaces, stream banks and rock faces, resulting in cloudy or turbid water.

- Water has a surface tension, which causes it to form drops and to have a 'skin' strong enough to support the weight of some aquatic insects.
- Water also sticks to other surfaces, enabling the capillary action of water in fine tubes, such as soil pores.

The properties of water vary naturally depending on the surrounding environment, so data collected about water quality must be interpreted in the context of that particular environment and position in the catchment.

This information has come from the following sources:

Crook, Thelma. *Understanding Water Quality and Peel Ribbons of Blue*

Catchments

Simple definition

A catchment is an area of land which catches water and drains that water to one point.

Background notes

A catchment is land which is bound by natural features such as hills or mountains from which water flows to a low point – that low point could be a dam, a river, an estuary or the ocean.

Catchment areas vary in size and make-up. The catchment of a whole river system can cover a large area, such as the Avon River with a catchment area of approximately 120 000 square kilometres. This larger catchment can be divided into sub-catchments for tributaries, including small creeks.

For details of your particular catchment, contact your local Ribbons of Blue Coordinator, or the Ribbons of Blue State Team or check on the website:

(www.ribbonsofblue.wa.gov.au) .

The history, climate, vegetation, soil types, fauna, land use, issues and management may be different for different parts of the same catchment.

What is in a Catchment Area?

A catchment area is made up of natural and introduced features and resources. These will vary from catchment to catchment and even within sections of a catchment.

Some examples of natural and introduced features:

Natural	Introduced
Land / soils	Mining
Natural vegetation	Crops and pastures
Native animals	Homes
Climate and water cycle	Dams
Waterways	Domestic animals and plants
Transport routes such as roads and rail	

Land Use

When we look at a map of Australia, it is easy to imagine that there is a lot of land. However, although Australia is a big country, the land available is required for many purposes. Not all the land in Australia is available for the purpose we would like. In fact, in some cases, land is short, and choices have to be made.

The land in Australia can be categorised into six major land uses:

• Urban areas

Australia is often associated with "the bush", but actually 85% of Australians live in urban environments (cities and towns). Here land is used for a range of uses such as

housing, shopping centres, industry, parks, roads, transport facilities and recreation facilities.

- Farming

Almost two-thirds of Australia is used for farming—either as agriculture (growing crops such as wheat) or pastoralism (raising animals like cows and sheep). This land use provides Australia and other countries with primary products such as food and wool. As with other land uses though, farming changes the land. This might be by clearing for crops, or by building structures such as sheds, fences, houses or roads.

- Mining

Mining is the largest single industry in Western Australia. We use many minerals every day or the products made from these minerals (such as aluminium cans, motor vehicles and petroleum). Australia has large deposits of coal, iron ore, gold, uranium, oil and natural gas and many minerals. In order to use these, they must be removed from the earth.

- Industry

Industry is another activity which uses and changes the land in Australia. Light industry is small scale (like fashion clothing or computers) while heavy industry includes larger scale operations (like the production of steel or cars).

- Tourism and Recreation

Tourism is an important land use and Australia is popular with international visitors who come to see our amazing land forms and parks like Uluru and Kakadu, go to the beaches or see our unique native flora and fauna.

- National Parks and Nature Reserves

National Parks (and other reserves) are another important land use. They are areas set aside because of their outstanding scenic beauty or unique landscape or plants and animals. National Parks are protected by law and Government permission is needed to alter the land in any way. Australia is a world leader in the development of national parks. The first was set up in NSW in 1879 – only 101 years after European settlement first began and only seven years after the first park of this type was created anywhere in the world in the USA (Yellowstone National Park).

Monitoring Water Quality

Australia is a dry continent and our water resources are increasingly under significant pressure from our growing population.

We have waterways and wetlands which are ecologically diverse and support a large variety of wildlife and vegetation.

If the quality of these assets is degraded, it can have ecological, economic and social consequences. Therefore it is critical that communities, businesses and government all work to maintain them.

Water quality monitoring refers to the investigation of the physical, chemical and biological characteristics of water and observing how these factors change over time and over different sites along a water body.

There may be a variety of reasons that a group, school or individual may wish to monitor water quality. It may be to identify a possible pollution source, observe seasonal changes in water quality, monitor the benefits of a restoration project or to use the data for awareness or education purposes.

The length of a monitoring program will depend upon the objectives but all monitoring programs should be run for an extended period to accurately determine the health of the water resource.

One-off monitoring only provides a snapshot of water quality and provides limited educational benefit to students.

Your data may be useful to other groups in your local area. For this reason, it is best to make your data available on a centralised database, such as the WIN Database. You can do this by forwarding your data to your Ribbons of Blue/Waterwatch Regional Coordinator.

What Should I Monitor?

Physical Parameters

These are the non-living aspects, including pH, temperature, turbidity, electrical conductivity, and dissolved oxygen.

Biological Parameters

These are the living parameters, including macroinvertebrates, frogs, vegetation, birds, and fish.

The biological parameters of a water body are influenced by the physical and chemical parameters and vice versa.

Ribbons of Blue commonly monitors for aquatic macroinvertebrates and vegetation. Your local coordinator can assist you or provide the contacts for assistance if you wish to monitor other biological parameters.

Chemical parameters

These include nutrients. Those most commonly monitored are nitrogen and phosphorus. Both nutrients are naturally occurring and are required by the ecosystem to function. However, human land use and development has resulted in excess nutrients entering our water bodies.

Eutrophication is the term used to describe nutrient enriched water. A eutrophic water body that receives adequate sunlight and has low flow will often experience a surge in plant growth, especially algae, resulting in an algal bloom.

Stormwater

“Stormwater” is rainfall collected from runoff and other waste water from domestic hoses or sprinklers that enters drains in the ground and is disposed of into groundwater or waterways.

In an undeveloped catchment, there is generally no runoff from small rainfall events. The rainwater is either infiltrated (soaks into the ground), evaporated or transpired (by vegetation). Water from moderate to large rainfall events generally follows natural drainage paths to creeks, wetlands or streams (receiving water bodies).

When rain falls on undeveloped land in a temperate climate, most of the water will soak into the topsoil and slowly make its way to the nearest receiving water body (via subsurface flow). These have little impact on the flow rates of the water body, because the water is received through sub surface flow. A small portion of the rainfall will become direct surface runoff (mostly from a few intense rainfall events each year). Runoff moves slowly through the catchment because the ground surface is rough due to rocks, vegetation and soil.

The features of undeveloped catchments that result in the above processes are:

- The large proportion of pervious surfaces like sand, loam and leaf litter which allows the water to soak into the top soil.
- The native vegetation cover, which increases water capture and use (evapotranspiration).
- The occurrence of natural water conveyance and storage areas (creeks, wetlands, low points in the landscape like swales or floodplains).
- The existence of natural water movement processes, intermittent flooding in floodplains and meandering water courses (water doesn't flow naturally in straight lines).

In a developed catchment, the humus, topsoil, understorey and trees that soak up water have been mostly replaced by hard, impervious, surfaces such as roads, paving and rooves. Because of the risk of flooding, drainage systems traditionally

have been built to quickly get rid of as much water as possible. Unfortunately for our rivers, these systems also carry pollutants into their waters very easily. In a developed catchment, as little as 1 mm of rainfall can generate surface runoff, whereas in an undeveloped catchment, surface run-off only occurs after heavy rainfall events.

Water Sensitive Urban Developments

Modern urban land developments are increasingly being planned to be water sensitive, and therefore more sustainable. To do this, the natural hydrologic processes and features should be incorporated wherever possible. Natural catchment features can be achieved by:

- Maintaining their natural or pre-development hydrologic regime as much as possible. This means retaining and detaining small rainfall events at site and managing large events in road reserves, public open space and water bodies (as above).
- Retaining pervious surfaces (water can pass through) and/or installing pervious surfaces and infiltration devices (such as permeable paving).
- Retaining natural vegetation where possible.
- Retaining natural drainage systems –waterways, wetlands and their floodplains and buffers
- Replicating natural drainage features in constructed drainage systems (not pipes or concrete drains)
- Not discharging stormwater directly (from pipes and drains) into waterways, wetlands or coastal waters.

Refer to the diagrams which follow on the next two pages to illustrate the differences between undeveloped, traditionally developed and water sensitive developments. In some water sensitive developments, water may be piped a short distance before vented pipes or soak wells allow a slow discharge into the subsoil. Therefore, the lessons on litter and the non pollution of the stormwater remain relevant. We don't want litter carried onto public areas or blocking vented pipes anymore than we want litter in the water bodies.

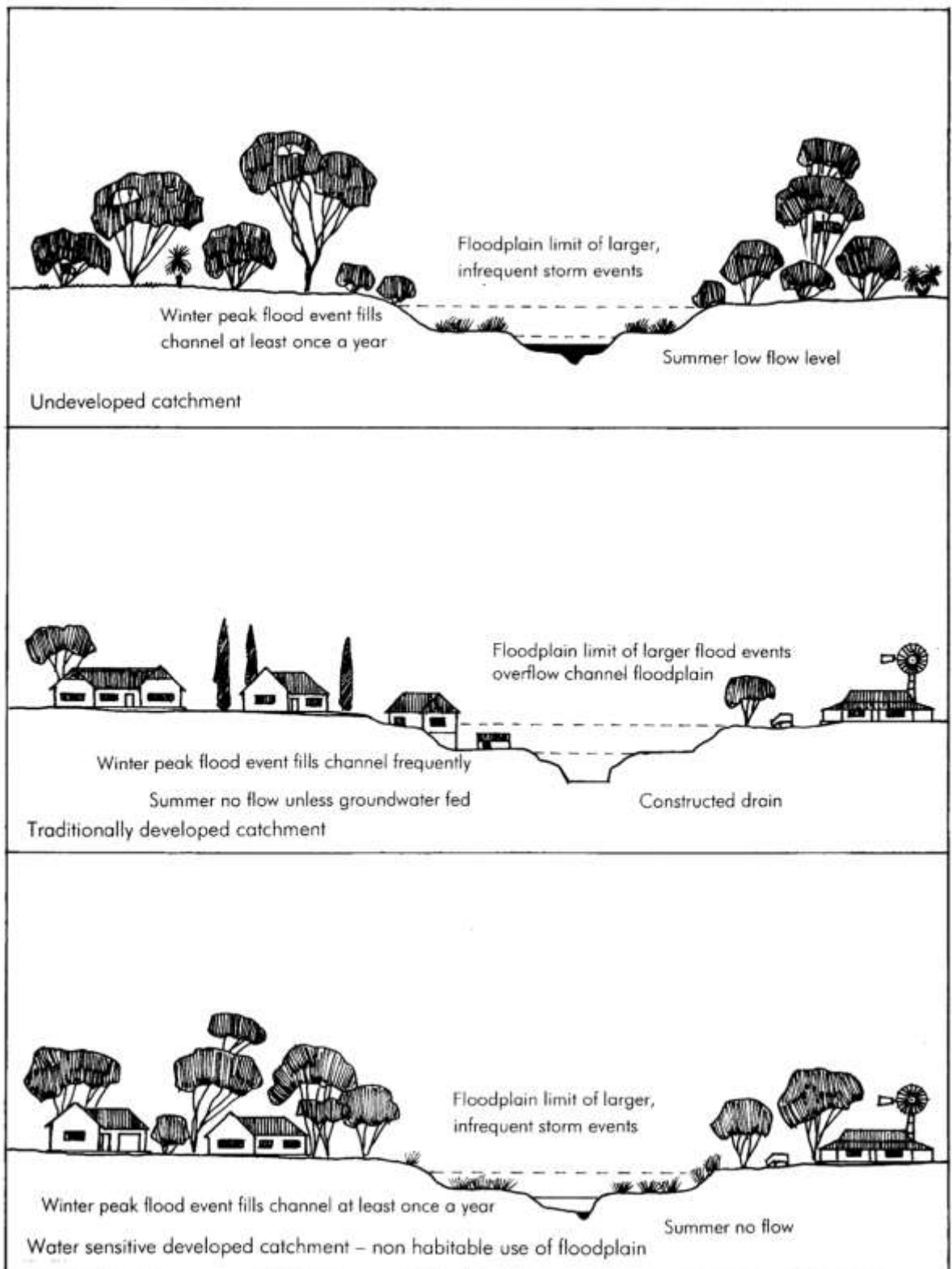
Most schools and students will still live in traditionally developed areas, but it is important for them to know that design of future areas will be more environmentally sensitive.

NOTE:

In Western Australia, new houses will be required, where suitable, to install soak wells to dispose of water from the roof. Many older homes and those in areas of impermeable soils, such as clay, will have their roof runoff directed to the street drains or directly onto the ground.

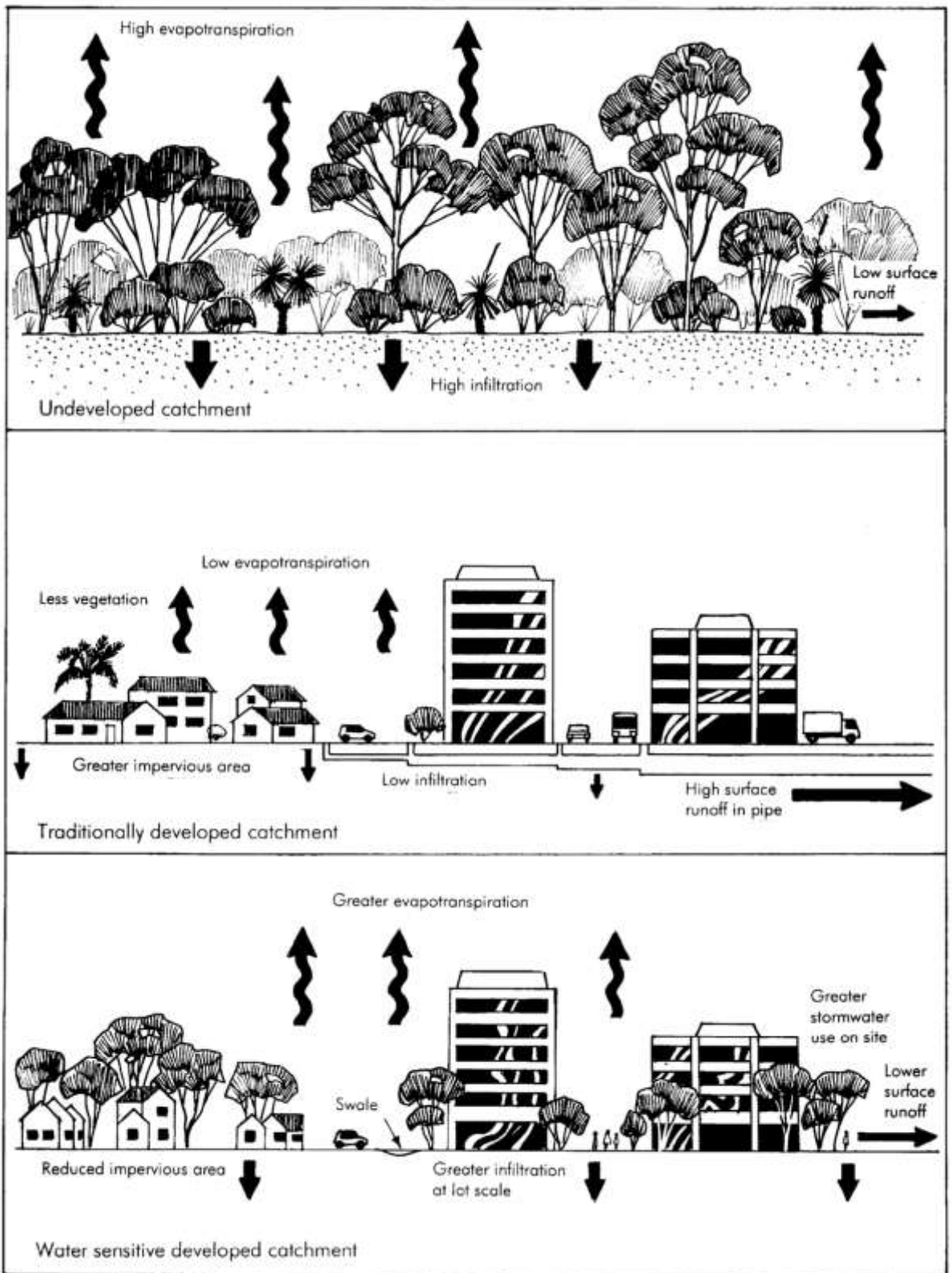
The installation of rainwater tanks to collect and use this water for such purposes as watering gardens is encouraged, but not compulsory.

In the eastern states of Australia, roof runoff is all piped directly to the street entry points of the stormwater system.



* Response of stream geometry to traditional land development and water sensitive development.

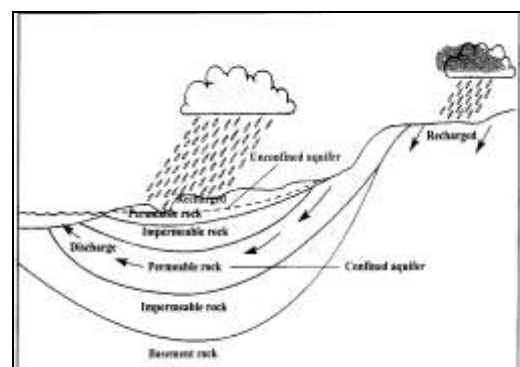
* Diagrams from the "Stormwater Management Manual" - Department of Water.



The effect of different types of development on the catchment hydrology, for low intensity (small) rainfall events (i.e. not a big rainstorm).

Groundwater

There is a great deal of water held under ground. Except in the limestone cave system, this water is very



rarely found in under ground lakes or rivers. The water is found in the tiny spaces between sand grains and pebbles or in the cracks and fractures in the rocks. This groundwater is moving, very slowly, towards the rivers, lakes or the ocean.
Ref: Understanding Groundwater. Swan River Trust

Aquifers

An aquifer is a layer of broken rock or sand that holds a usable amount of water and allows water to pass through it in usable quantities. Water pressure and gravity cause water to move in the aquifer.

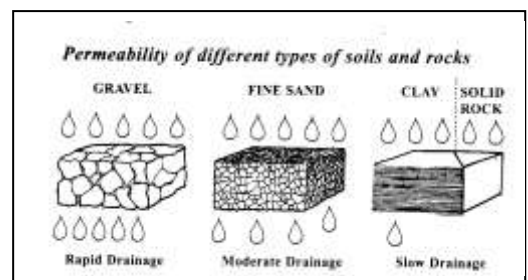
A *confined aquifer* is an area of groundwater covered by a layer of intact rock, clay or silt material through which water cannot pass. This is known as an *impermeable layer*. The water in a confined aquifer is held under pressure and when a bore is drilled through the *confining* (impermeable) *layer*, the water may rise in the bore hole and flow out the top of the bore hole. These bores are called *artesian bores*.

Unconfined aquifers have their upper boundary at the surface and contain water at the same pressure as surface water (at atmospheric pressure). These do not have impervious layers of soil above them and are *recharged* (topped up) by rainfall which filters through the soil from the surface (*seepage*).

Permeability & Porosity

The permeability of a soil or rock refers to the rate at which it allows water to move. Loose sandy soils are more permeable than tightly packed fine-grained soils like clay or silt.

Porosity refers to the amount of space in a rock or soil that can store water. Loose grained rocks like sandstone are more porous and more like a sponge than compact, hard rocks like granite. Fractures in granite and other hard rocks also store water.



The permeability and porosity of rocks determine the rate of flow in an aquifer and the amount of water it can store.

Most of the Swan Coastal Plain is made up of loose, sandy soils and limestone – ideal for unconfined aquifers. These supply most of the Metropolitan area's drinking water. There are also deeper confined aquifers which will supply more of the area's drinking water in the future

Salinity

Salinity is the problem which occurs when the watertable rises close to the surface and the concentration of soluble salts in the groundwater is sufficient to affect plant growth. These soluble salts can reach rivers and other waterways through surface and groundwater flow and render the water undrinkable, kill vegetation and destroy ecosystems and built infrastructure.

Two types of salinity are recognised in WA – dryland salinity and irrigation salinity.

Dryland salinity refers to the salinisation of the land that occurs solely from rainfall or local runoff. It does not mean that the land is dry; these areas are often damp or waterlogged. It occurs where native vegetation has been replaced with a land use that does not use all the rainfall and this causes the groundwater level to rise and bring the soluble salts with it towards the surface of the ground. This is a major issue in WA with approximately 1.8 million hectares (10%) of the cleared area affected so far. Over 80% of waterways in the south west are salt affected.

Irrigation salinity occurs where excess irrigation water raises the watertable or where the irrigated soils are poorly drained thus allowing naturally occurring soluble salts to rise and affect plant growth. In the south west, reservoirs containing saline water may also contribute. This affects a much smaller area than does dryland salinity, but is most advanced in the south west. It is also a potential threat to parts of the Ord River Irrigation District and parts of the Swan Coastal Plain south of Gingin.

Salinity is not unique to Australia – it is actually thought to be a contributing factor for the demise of the world’s first urban society (The Sumerians) in the third millennium BCE (Before the Common Era).

In WA observations of increasing land and stream salinity were first suspected of being related to land clearing in early in the twentieth century. Railway engineer W.E. Wood recognised and reported the link between land clearing and salinity in 1924.

There are three main sources of salt in any landscape:

- Salt deposited over tens of thousands of years by rainfall. This is called “cyclic salt”
- Salts derived from the weathering of minerals. This is a very slow process.
- Salts derived from marine sediments. This only occurs in discrete parts of Australia and not for most of the agricultural areas of WA.

Rainfall is by the far the greatest contributor of salt in WA. Salt enters the water cycle from the sea spray during evaporation. When salty water evaporates, minute particles of salt come out of solution and are blown high into the atmosphere with the water vapour. In south-west W A, salt has been deposited at a rate of 20 to 200 kilograms per hectare per year (with higher levels closer to the coast). Depending on the soil type and location, soils now store between 300 and 10,000 tonnes of salt per hectare deep in the soil profile.

The natural ecosystems were in balance with the amount of salt entering and leaving the system roughly

The clearing of native vegetation has changed this balance.

References:

“Salinity in the Classroom: A Resource for Western Australian Schools”, Department of Agriculture, Water and Rivers Commission

Water facts 15, Water and Rivers Commission

National Dryland Salinity Program website: www.ndsp.gov.au

Water Supply and Conservation

Meeting Western Australia’s future water needs calls for everyone to take conservation measures, every day! With our water supplies stressed by growing populations and other factors such as less recharge to groundwater and global warming, the Water Corporation and the Department of Water are looking to stretch this precious resource.

Water Use at Home

The average Perth metropolitan house uses about 303 kilolitres of scheme water a year with about 50% of that used inside the home. (prior to the 2001 introduction of the 2 day watering system homes used an average of 350 kilolitres with about 58% of it used outside the home. In many country regions the average is much higher.

Water consumption is greater during the summer period, mainly due to water use on gardens. In the metropolitan area on one day in winter, we could use 400 megalitres (or 400,000 kilolitres) of water. On a hot day in summer we could use 1,000 megalitres (or one million kilolitres).

Seventy per cent of all metropolitan scheme water is used in homes and 30 per cent is used for industrial, commercial and institutional purposes.

For today's water use, use over the past seven days and other up to the minute information, go to <http://www.water.com.au/S/supply.cfm>

One stumbling block to efficient water use is that many people don't realise just how much water they really use. When surveyed some people thought their daily use was as little as 4-5 litres and few believed it was more than 280 litres. In fact, the actual average use for a four people household is between 700 and 1100 litres per day.

Three areas, on average, account for 80% of all water used inside the home. - 33% is used in the shower (about 51 litres per person per day), 27% in the washing machine (about 42 litres per person per day) and 21% in the toilet (about 33 litres per person per day). The remaining 19% accounts for all other use inside the home, including the kitchen.

Water Conservation

Ways to save water inside the home:

- Using water efficient shower heads
- Taking shorter showers
- Installing dual-flush toilets
- Using a water efficient washing machine or dishwasher
- Operating washing machines and dishwashers only when they are fully loaded
- Checking for leaky taps and replacing worn washers
- As well as changes in water use behaviour, the use of water-efficient appliances around the home can save a substantial amount of water.

The new Water Efficiency Labelling Scheme (WELS) was introduced in 2005 and is now mandatory on all washing machines, dishwashers, showers, toilets and taps.

The WELS scheme has two features:

- A star rating which gives a quick comparison of the various brands' water efficiency; and
- A water consumption figure.

This scheme is similar in principle to the 'energy efficient' scheme which also uses stars and is required also on washing machines and dishwashers.

The more stars (1 - 6), the more water efficient the product. This system replaces the "A" labels previously used.

Water Facts

Showers

Long showers make the bathroom the greediest user of domestic water inside the home. An average shower can use more than 11 litres a minute, meaning a ten-minute shower can use more than 150 litres of heated water. Shorter showers save water and energy. An efficient low-flow shower head will use only 7 - 9 litres a minute, saving water and power.

Baths

A standard bath holds 120 litres when half full: that's just over 13 x 9-litre buckets.

Toilets

Single-flush toilets use 11 - 20 litres of water per flush.

If you have a dual-flush toilet installed, you will save between half and two-thirds of normal use. In the average home, this is about 17 to 20 kilolitres a year.

Some dual-flush toilets use 9 litres (full flush) and 4.5 litres (half-flush). New homes or renovated houses must now incorporate toilets using just 6 litres (full-flush) or 3 litres (half-flush).

Note: a silent leak in a toilet can waste 225 litres or more, daily.

Leaking Taps

A dripping tap can waste up to 10,000 litres (more than 1,100 9-litre buckets) in a year.

Teeth Cleaning

Five litres can be wasted if the tap is left running; only 1 litre is used if it is turned on and off.

Washing

Face and hand washing uses about 4 litres.

Dishwashing

Older dishwashers use about 50 litres per cycle, while modern ones (from 1990 onwards) use 18-32 litres per cycle. Note: if you wash dishes by hand, you use about 9 litres in an average kitchen sink.

Saving Water in the Garden

Much water can be saved in the garden by using the correct sprinklers and timers, watering less frequently and at the right time, and using wise garden design.

The Smart Approved WaterMark is Australia's water-saving labelling programme for outdoor products and services that help to reduce water use around the home. The aim of the programme is to raise awareness of and engagement in water conservation. It promotes products (e.g. pool blankets, wetting agents) and services (bin cleaning, car washing) that help conserve water and assist consumers to understand water conservation issues. Any product bearing the label has been rigorously investigated to ensure that it will save water.

Prior to the introduction of the 2 day sprinkler roster in 2001, about 56% of the scheme water used by single-residence households without a bore went on gardens and lawns. In-house water use had been stable since about 1981, but the volume of water used outside had increased.

The current watering roster and other initiatives has saved about 45 gigalitres of scheme water every year, but water restrictions do not necessarily reflect efficiency gains. As from October 2007, bore owners have a 3 day watering roster.

How Much, and When?

Garden needs vary with climate and soil type. Perth's sandy soils should get about 10 millimetres depth of water. This is sufficient to replenish the water needs of the top 15-20 centimetres of soil, where most roots are. You can measure 10 mm depth of water with a straight sided container such as an ice cream container under your sprinklers.

Avoid watering lawns every day except in very hot weather. Watering every second day is plenty, even during summer, and every third, fourth or fifth day is sufficient in spring and autumn.

This schedule is right for most garden plants also. Drought-proof plants such as local natives need no watering other than rainfall. Exotic plants need watering more often.

If you water in this way, lawn and plant roots are encouraged to grow deeper and are able to better withstand hot weather.

It is best to water early in the morning. Plants are solar pumps driven by the sun. They do not absorb water at night, and if irrigated after dark some water will drain away before it can be used. Night watering also allows fungi to attack wet plants.

Never water in the heat of the day or when the wind is strong. In these circumstances, water evaporates from the air and soil and very little is left for the garden.

Efficient garden planning is very important in achieving efficient water use.

Garden Planning for Water Efficiency

Water use can be reduced by:

- Retaining natural bush, trees and wildflower patches if you are building a new house
- Growing local plants from the region
- Using trees, pergolas, lattice or shade cloth to shelter plants and minimise evaporation
- Including areas of paving or mulch which don't require watering
- Using alternatives to lawn, such as ground covers
- Keeping planted areas dense and consolidated
- Choosing plants with low water needs and grouping them accordingly
- Getting expert advice on reticulation to minimise wastage and ensure efficiency.

Saving Water at School

At school we can save water by ensuring taps are turned off after drinking, brushing our teeth or washing paintbrushes. The gardener can play his/her part by watering

early in the morning rather than in the heat of the day, using reticulation wisely and planning gardens with water conservation in mind.

Water-efficient appliances (e.g. in toilets and showers) can be used to complement behavioural measures.

To become a waterwise school etc

Sources of Perth's Water:

Water in the metropolitan area comes from three sources:

- Surface water is obtained from dams (storage reservoirs) on rivers in the Darling Range. Surface water sources supply approximately 27% of the Perth region's water.
The dams supplying water to Perth, Mandurah, Pinjarra and the Goldfields and Agricultural regions are Canning, Serpentine, Serpentine Pipehead, Conjurunup Pipehead, Victoria, Mundaring Weir, South Dandalup, North Dandalup, Wungong, Stirling and Churchman's Brook. Note that Mundaring Weir normally only supplies water to the Goldfields and Agricultural Region.
- Groundwater, supplying approximately 56% through the integrated system, is obtained from huge natural reservoirs in the deep sands of the coastal plain. Groundwater is treated at groundwater treatment plants at Jandakot, Mirrabooka, Wanneroo, Neerabup, Lexia and Gwelup.
- The Perth Seawater Desalination Plant in Kwinana, opened by the Premier Mr Alan Carpenter on 18 April 2007, is now Perth's largest single source of water, supplying approximately 17% of the city's water needs.

To view graph of Perth rainfall, click on:

Rainfall Graph

Units Used to Specify Water Supply

Water Supply is quoted in Megalitres (ML)

One Megalitre = one thousand kilolitres

One Megalitre = one million litres

One kilolitre = one thousand litres

One kilolitre of water = one thousand kilograms = one tonne

There are no simple solutions or quick fixes when it comes to planning Western Australia's water supplies. The Water Corporation puts great deal of effort into planning for our future needs and there are many aspects to consider.

These include:

- Climate change that has seen the water running into Perth's dams drop by two thirds in the last seven years

- 20% increase in 20 years in the amount of water we each use at home
- Population growth of 1.7% a year by 2031,

By 2031, Perth is expected to need an extra 150 gigalitres (thousand million litres) of water (equivalent to four Serpentine Dams).

This will be met by an integrated water cycle approach including new sources, efficiency measures, water recycling, water trading and catchment management. That said, any major new water sources will be more expensive than our traditional reliance on the dams in the Darling Range and groundwater sources close to Perth.

The need for water restrictions following the severe drought of 2001 and 2002 has led to a growing public focus on climate variability and impact on our water supplies.

The Water Corporation had sought to restore the balance in the system by 2002 with completion of the Harvey Dam. However, the drought has emphasised the continuing need for increased supply sources and the 2007 desalination plant is the latest alternative source to come on line.

This rapid expansion of water supply sources was only possible because of the long term plans that have always guided the Water Corporation and its predecessors. Without them total sprinkler bans through the drought would have been unavoidable for Perth and the towns and communities supplied from the Goldfields pipeline.

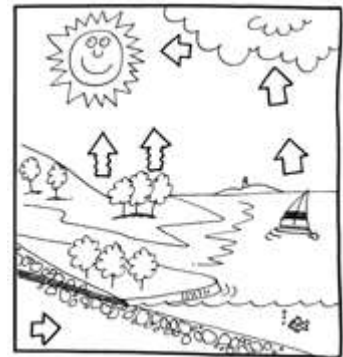
Desalination

What is desalination?

Desalination is the process of removing salt from salty water to make it suitable for drinking or for use by industries that require very pure water.

Desalination happens in nature as part of the water cycle.

When water evaporates from the sea, rivers or lakes, it leaves the salt behind and becomes water vapour. In the right conditions, clouds form from this water vapour and fresh water falls as rain.



Why do we need a desalination plant?

http://www.watercorporation.com.au/graphics/education/desal_why_1.gif Our climate is becoming drier. Due to very low rainfall, the volume of water now entering our metropolitan dams is only a third of the long-term average. Groundwater resources have also been affected by low rainfall in the last 25 years. The construction of a desalination plant will ensure that part of our water supply is guaranteed, whether it rains or not. It will also relieve the pressure on existing water sources.

The Water Corporation has built a seawater desalination plant on the coast near Kwinana to the south of Perth. The plant will use water from the ocean and will produce fresh water to supplement our existing water supply and a salty concentrate that will be returned to the ocean.

The plant is now supplying water to Perth and the Integrated Water Supply System and is the largest single source for the Integrated Water Supply System.

The plant will operate by taking seawater and processing about half the volume of water into high quality scheme water. The salt remains in the other half of the water, which will be diluted about 45- fold as it is returned to the ocean (this happens because seawater concentrate is jetted out under high pressure and mixes rapidly with the surrounding waters).

Strict conditions set by the Environmental Protection Authority will be met to ensure there is minimal impact on the environment. Environmentally friendly wind power will be used to meet the total energy requirement of the plant.

The plant will supply one-sixth of Perth's water needs independent of rainfall.

Interesting Facts about desalination

- Aristotle experimented with desalination around 350 BC.
- Sailors had small desalination plants on their sailing ships around 200 AD.
- During Western Australia's gold rush of the 1890s, fresh water was very hard to find. People built desalination plants (called 'condensers') at Coolgardie, and on the roads to the goldfields. Water was very expensive: sometimes one gallon (4.5 litres) sold for a third of the unskilled weekly wage..

http://www.watercorporation.com.au/graphics/education/desal_sale_1.gif **How salty is the sea?**

- Perth seawater contains 37,000 parts per million of salt.
- Fresh water has less than 500 parts per million of salt.
- Water described as 'marginal' has 500–1000 parts per million of salt.
- Water described as 'brackish' has 1000–15000 parts per million of salt

Ways to desalinate Water

Most desalination processes extract fresh water, rather than salt, from salty water.

Thermal desalination (distillation)

Thermal desalination is a process in which salty water is heated to produce steam. The steam then condenses on a cold surface to produce water with a low salt concentration.

Electrodialysis

Most salts dissolved in water are ionic, which means they are positively or negatively charged. When an electric charge is passed through water, the salt ions are attracted to the electrode of opposite charge. A membrane is used to separate the purified water from the salty water.

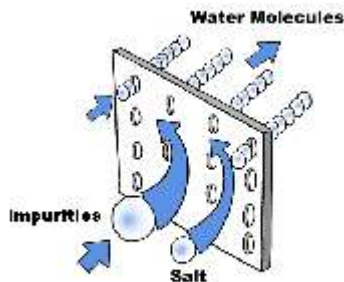
Freezing

http://www.watercorporation.com.au/graphics/education/desal_freeze_1.gif When icebergs form in arctic regions some of



the salt freezes also but over time this salt is removed from the icebergs by a natural process. Because icebergs are pure water they are less dense than sea water and they float on the surface. Although this happens naturally in nature it is difficult to produce on a large scale.

Reverse osmosis



http://www.watercorporation.com.au/graphics/education/desal_reverse_1.gif The reverse osmosis process uses very high pressure and a very fine membrane to extract fresh water from salty water. The membrane acts like a strainer. The small balls in this diagram represent water molecules, which the membrane allows to pass through. The larger balls represent salt and other impurities, which are not able to pass through the membrane.

Small desalination plants on fishing boats, yachts, large cruise ships and in some households use the reverse osmosis process

Reverse osmosis has been used for many years to provide fresh drinking water to the remote towns of Denham and Ravensthorpe in Western Australia. Large-scale reverse osmosis plants are found in dry countries such as Saudi Arabia, the United Arab Emirates, the United States of America, Spain and Trinidad.

Reverse osmosis technology is developing rapidly and has become much more affordable in the last few years.

Reverse osmosis technology has been chosen for Perth's desalination plant because it is the most economical and environmentally friendly process.

Water and Climate Change

Population and Climate:

Western Australia covers one third of the continent of Australia. Despite its size, the state only has four main climactic types: Mediterranean, Semi-Arid Grassland, Hot Desert and Monsoonal (check your atlas to see these areas shown).

Over half the state receives rainfall that is so low and unreliable that the land is useless when it comes to food production. WA therefore has a very low population density (1996) of 0.7 people per square kilometre. Like other countries in this situation, the land cannot support many people and those people living here are crowded into a small part of the total area. Most people live where they can earn an income and for most of Western Australia's population, this means in or close to *Perth*.

1) The *South-west* of WA has a *Mediterranean* type climate, similar to that of countries bordering the Mediterranean Sea (like Greece and Italy). The summers are hot and dry, and the winters are cool and rainy. Most of the rain falls between May and August. Because this is in winter, the rainfall is not lost to evaporation and so is available for use by native plants and people's crops. This rainfall is fairly reliable. WA has more rainfall than most Mediterranean countries, and in the heaviest rainfall areas south of Perth, forests of jarrah and karri are found. Cleared areas are used for

intensive farming such as dairy, orchards and vineyards, because the soil is fertile and reliable rainfall and irrigation ensure water supplies. Tourism is also a major source of employment in this area.

Inland, it is drier and the rainfall is less reliable. Farmers can't rely on receiving the same quantity and at the same time each year, so this area is largely used for wheat and sheep (extensive farming).

The South-West of the state has 90% of the population, and even here the population is not spread evenly but tends to be concentrated in *Perth* and the main large towns such as *Bunbury*, *Mandurah* and *Geraldton*. Perth became the largest WA centre for many reasons, mostly historical.

Governor Stirling declared Perth the capital in 1820, so most government workers were (and are) situated there. In the early days, Perth attracted more farming settlers than anywhere else. The port was close (Fremantle), so shipping and trade was concentrated in Perth also. Most main roads, and later railways, led to Perth and *Fremantle*.

Western Australia's manufacturing industry began in Perth and is still there.

Manufacturing provides employment for 8% of all WA workers.

The tertiary (service) industry employs the most people in WA. This includes the education, health, financial, commercial and hospitality industries as well as the public service.

2) The *semi-arid grasslands* are a half-way climate type between the hot desert and wetter coastal areas. Rainfall is lower and less reliable and droughts are common. In the southern parts it rains in winter and wheat and sheep are farmed. In the northern parts it rains in summer, so much of the rain which falls is evaporated and so can't be used. Crops can't be grown without irrigation. Most people here live on the coast or in mining towns.

3) *Hot Desert* areas have a rainfall of less than 250 millimetres per year and that is unreliable. The whole year's rain may come in one tropical cyclone. Huge cattle stations on the edges of the deserts need vast areas to support their herds as the natural vegetation is low in nutritional value. Most people living here earn a living in the mining towns or ports.

4) Monsoonal climate typically experiences hot, wet summers and warm dry winters. A small area of the state along the Kimberley coast is monsoonal. The area is not useful for grazing as it is so rugged and the soil is poor.

The Hot Desert and Monsoonal areas are thinly populated. The rainfall while often heavy in the Monsoonal areas is unreliable and often comes in the form of tropical cyclones which cause flooding and erosion. Most of the water drains away quickly or soaks in and what is left is quickly evaporated.

In the dry outback, mining, irrigation (*Kununurra* and *Carnarvon*), tourism and ports have led to scattered pockets of population inland and around the coast. The main towns in these areas (such as *Port Hedland*, *Broome*, *Carnarvon*, *Kununurra* and *Karratha*) are connected to these industries.

Perth has a Mediterranean climate with hot, dry summers and mild, wet winters. However, climate is not a constant and cannot be taken for granted.

Perth's long-term average rainfall is 880mm, but for the period from 1975 -2001, it was only 790mm.

The decrease in Perth's rainfall could be attributed to natural variations. However, a number of other factors might also have contributed to the decrease. A similar reduction might be expected as a result of global warming, while other research is

looking at links to El Nino, sea surface temperatures and pressures, Southern Ocean currents and North West cloud bands.

Changes in land use and pollution are not considered to be factors as a similar decrease was recorded at the Rottnest Island Lighthouse. Of course, climate change doesn't just affect Perth; there have been similar changes documented around the world.

In the South West of Western Australia, we have generally experienced later winter rains – ie a significant decrease in rainfall between May and July and a small increase between August and October. Overall, there has been a 12% drop in rainfall. World climate models suggest that, compared to the rest of Australia, the South West of Western Australia is more certain to become drier. The actual drop in rainfall since 1975 is similar to the drop which was predicted to occur, due to climate change, by 2030. This means that even if our variable climate were to become wetter, it is unlikely to be as wet as it was before 1975.

The inflow to Perth's dams has halved in recent years; from 338 gigalitres on average between 1911 and 1974, to an average of only 120 gigalitres between 1997 and 2003.

Making sustainable use of our water resources means balancing the needs of the environment, society and the economy.

Climate plays a key role as it is a major influence on the environment, which in turn affects society and the economy. Energy-intensive societies like ours also affect the climate through the production of greenhouse gases and changes in land use. (Refer to the operation on climate change and energy.)