BUNDABERG
REGIONAL COUNCIL

Water

A
Precious Gift

This booklet provides a guide to all aspects of water - from the catchment to the tap. In part it provides an overview of water in Australia and around the world and discusses how water is collected, treated, distributed, used and regulated.

A closer look concerning infrastructure on water for our local region and surrounding areas of concern are also provided.

The Glossary defines the terms used in this guide.

Information has been extracted from the Consumer's Guide to Drinking Water, which was prepared by the Co-operative Research Centre for Water Quality and Treatment Australia's national drinking water research centre. Collation of information from the following business and agencies has also provided valuable facts for this booklet. Sunwater - Burnett Water; Wikipedia; Wide Bay Burnett Regional Plan - Growth and Sustainability in the Wide Bay Burnett Region; Wide Bay 2020 - Water Resources; and Burnett Mary Regional Group - Country to Coast a Healthy Sustainable Future; Healthy Waterways - Best practice guidelines for the control of stormwater pollution from building sites.

If you have any queries about any of the information presented in this booklet, please telephone Bundaberg Regional Council Water & Wastewater Infrastructure Planning Technical Support on 1300 883 669 during business hours.

Some Facts About Water

More than 70% of the Earth's surface is covered by water. The oceans and seas contain 97% of all the water on the planet. Less than 3% of the Earth's water resources can be described as freshwater. About 77% of this freshwater is ice, mostly in the polar regions. Most of the rest is groundwater.

It is estimated that only 0.6% of the Earth's water is readily available as a source of water supply to its six billion people and the urban communities they form. Water is a precious resource, and for many communities, a scarce one.

Water is essential for all living things. Plants and animals are made up of between 50% and 90% water.

In its purest state, water is colourless, odourless and tasteless. However, water collected from the environment naturally contains trace quantities of dissolved and suspended materials of mineral, plant and even animal origin, which may create colour, odour and taste. Water collected from the environment is also likely to contain a diverse population of microorganisms. These may or may not be a risk to human health.

About Water in Australia

Nothing has had a greater impact on Australia than water. Water has moulded its ancient landscape and influenced the pattern of human habitation from earliest times until the present. It will continue to influence people's lifestyle, prosperity and their relationship with the land.

Australia is a continent of extremes: of geography, climate, population distribution and water resources. It is the driest inhabited continent on Earth, with highly variable rainfall patterns. This variability means that Australian communities frequently face water supply and water quality problems.

The water sources available to any Australian community may include surface water - rainfall and the resulting runoff into streams and rivers - and groundwater - water from underground sources.

Only 12% of the annual rainfall over Australia results in runoff into streams and rivers or soaks into and is retained in the ground. The rest is returned to the atmosphere directly by evaporation or from vegetation through the process of transpiration. This results in Australia having only 1% of the water carried by the world's rivers despite having 5% of the world's land area.

The long term average annual rainfall over Australia is estimated to be 455 millimetres. However, this hides the variable rainfall pattern across the continent.

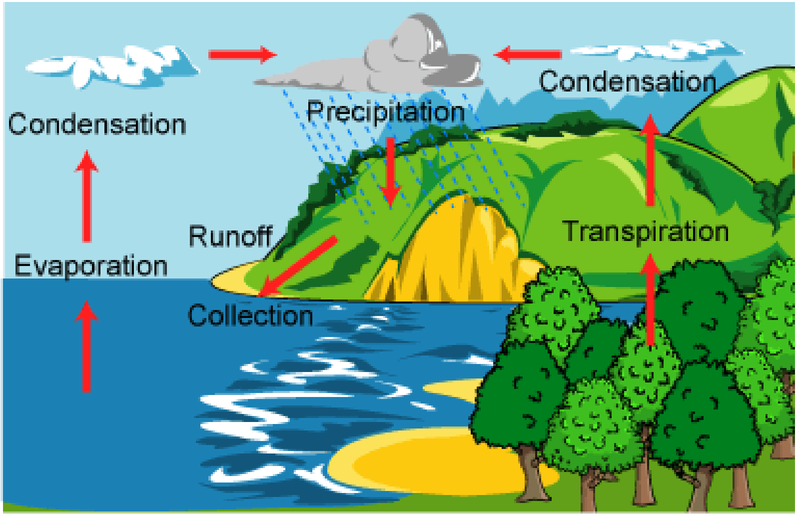
Depending on seasonal conditions, Australians use enough water every year to fill Sydney Harbour almost 50 times - between 18 and 22 million megalitres of water a year. According to the Australian Bureau of Statistics, about 70% of this water is used in agriculture for irrigation.

To ensure a reliable water supply during periods of drought, large water storages have been built in Australia. In fact, Australia stores more water per head of population then anywhere else in the world.

Water obtained from natural sources is not pure and because of conditions in catchments, variable rainfall patterns and other factors, the quality of water used in the water supply is likely to vary. Frequently it requires some form of physical and/or chemical treatment to make it safe and pleasant to drink.

The Water Cycle

When we turn on the tap, start the washing machine or take a shower, we don't necessarily think of the sun and the rain, but that is where the water comes from.



The process known as the water cycle begins with energy from the sun reaching water in oceans, seas, river and lakes. Water evaporates and becomes water vapour. As the water vapour rises, it cools and condenses into billion of droplets to from clouds.

Vegetation is another sources of water vapour. The roots of plants pump water out of the round and pass it onto the atmosphere in a process known as transpiration.

Clouds hold rainwater as long as they stay warm. If the air cools, the droplets merge until they are so heavy that they fall back to Earth as rain, hail or snow. The atmosphere is capable of holding about 10 days' supply of rain - enough to drop about 25 millimetres of freshwater over the entire surface of the planet.

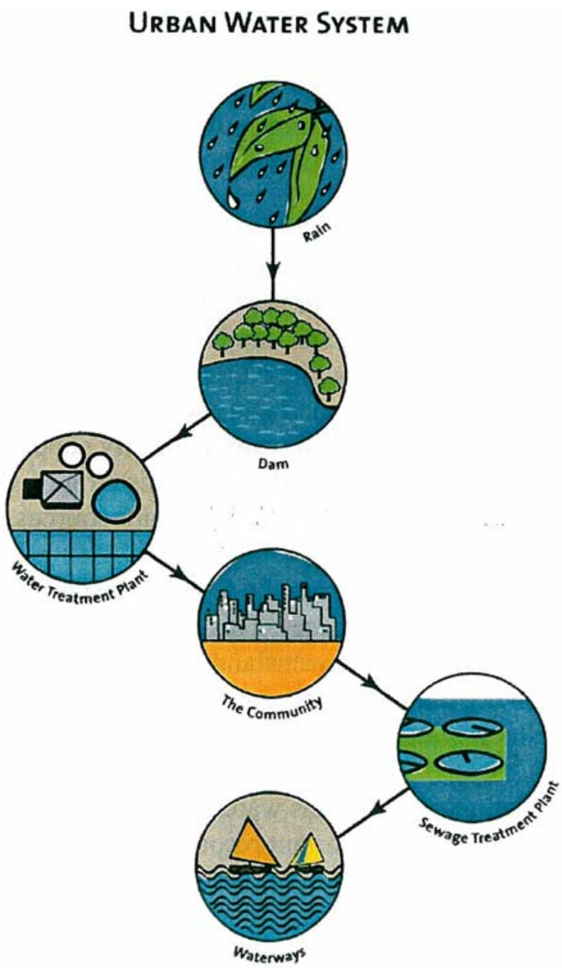
Rain and snow falling into catchments can take several routes. Some evaporates, some seeps into the ground to become groundwater and some stay on or near the surface to form streams, and ultimately rivers.

The water cycle is also referred to as the hydrological cycle. Both terms describe the solar-powered system that provides freshwater to the land-based ecosystems upon which we depend.

Urban Water Systems

When most Australians turn on the tap, they expect a continuous supply of safe and pleasant drinking water. They expect it to flow at an acceptable pressure and to be available even in the middle of a drought. They also expect their wastewater will not create a nuisance or public health hazard. Furthermore, they expect to be protected from localised or more substantial flooding.

During the 19th and particularly the 20th centuries, engineers have designed and built urban water systems to meet these expectations. This diagram demonstrates overview of the main components of an urban water system.



Collecting Water

The entire area from which a stream or river receives its water is called a catchment. A catchment is a natural drainage area, bounded by sloping ground, hills or mountains, from which water flows to a low point.

Virtually everybody lives in a catchment, which may include hundreds of sub-catchments. What happens in each of the smaller catchments will affect the main catchment.

The water comes out of a tap once flowed across a catchment - and that is why catchments are a crucial part of urban water systems.

The quality of the catchment determines the quality of the water harvested from it. Few communities have pristine water sources and the quality of water from most sources is at risk from activities occurring in the catchment.

Water resources can be classified as surface water or groundwater resources. In both cases the quality of the catchment determines the quality of the water harvested.

Groundwater is a significant source of supply in many parts of rural Australia. It is also significant ongoing sources for serval major urban centres. Approximately 60% of the water supplied to Perth, Western Australia comes from groundwater sources, while Newcastle, New South Wales draws up to 30% of its supply from groundwater when surface water sources are affected by drought.

In parts of inland Australia, water from the Great Artesian Basin is used for urban, agricultural and mining purposes. This water sources is of vital importance to outback regions of Queensland, New South Wales and South Australia and is often the only available water supply for towns and properties for the domestic and stock-watering requirements.

Storing Water

In some urban water systems, the water supply is obtained directly from a river or another body of freshwater. In others, rivers are dammed and the water supply is distributed from artificial storages, such as reservoirs.

Dams are built across rivers and streams to create reservoirs to collect water from catchments to ensure sufficient supply will be available when needed. Dams also have been built for a range of purposed beside water supply, such as agriculture and hydro-electricity generations. Water may also be released from a reservoir as an "environmental flow" to maintain the health of the ecosystem downstream of the reservoir.

In Australia, more than 400 water storages are technically defined as "large dams". A large dam is defined as one that has an embankment more than five metres high. There are also innumerable smaller water storages.

Transporting Water

Water is transported from catchments to communities by a variety of means including pipelines, aqueducts, and open channels or via natural waterways.

Treating Water

Water that is to be used in an urban supply is treated to removed sediments and contaminants and is also disinfected to kill potentially harmful microorganisms. The treatment process may use conventional technologies or apply newer, innovative approaches, to ensure the water is safe and pleasant to drink.

Supplying the Distribution System

The water mains and pipes beneath the streets of a community are described as the water supply distribution system or reticulation system. As part of this system, strategically located service reservoirs store and supply enough water to meet local peek demand at sufficient pressure. These service reservoirs are often large covered tanks in an elevated position.

Pumps and valves also form an important part of the distribution system. The end points of the system are the consumers' taps.

Managing Wastewater

Urban wastewater is known as sewage, and the pipes that transport sewage are called the sewerage system. No matter where you use water inside your home - the kitchen, bathroom, laundry or toilet - it is discharged to the sewer. From there, your wastewater begins a journey through a series of sewer pipes, pumps and mains to a sewage treatment plant.

Wastewater from industries, schools, shops and other sources is also discharged to the sewerage system.

At sewage treatment plants, wastewater is treated in a way that mimics natural biodegradation processes. After intense treatment, the treated wastewater is discharged back into the environment. Wastewater is treated to protect public health and to minimise impacts on the ecosystems of receiving waters.

Treated wastewater is increasingly being recycled or reused in agriculture, horticulture, golf courses and other businesses. A number of innovative housing developments are using dual water supply systems where recycled wastewater is supplied for some domestic purposes such as garden watering and toilet flushing, while conventional drinking water is supplied for other household uses.

Where homes and businesses are not connected to a sewage system, they will usually have some form of on-site treatment of sewage. Such on-site treatment needs to include provision of the safe discharge of the treated sewage into the local environment to protect both public health and local ecosystems. The septic tanks is a common form of domestic on-site treatment.

Managing Stormwater

Stormwater is the term used to describe the runoff from rain over an urban catchment. In cities and towns, stormwater washes across roads and streets, picking up oil, petrol, grease, sediment, industrial waste, leaf and other litter and dog droppings on roads, streets and paths. In rural areas, runoff may include agricultural and livestock waste, fertilisers and pesticides.

Stormwater can also be contaminated by landfill leachate, septic tank effluent, sewer spills and by illegal dumping. It is estimated that contaminated stormwater causes up to half the pollution in surface and groundwater sources.

Most major urban centres now use separation systems, litter traps, grates, retention basins or boom barriers to reduce the quantity of larger objects carried in stormwater before it is discharged to the environment.

What is Drinking Water?

A Definition

A commonly used definition of drinking water is water that is intended for human consumption and other domestic uses. It may be used directly from the tap, or indirectly in beverages or foods prepared with water. Bathing and showering may be among its other uses.

We expect drinking water to be safe to use and pleasant to drink. But what does safe and pleasant mean? In Australia, the key reference material is a document called "Australian Drinking Water Guidelines". These guidelines state: "drinking water should be safe to drink for people in most stages of normal life, including children over six months of age and the very old. It should contain no harmful concentrations of chemicals or pathogenic microorganisms, and ideally it should be aesthetically pleasing in regard to appearance, taste and odour.".

Water the meets all of the above criteria is also called potable water.

Why Treat Water?

Drinking water is treated to protect public health by removing microorganisms and natural or man-made chemicals that may cause illness in consumers. Water treatment may also be used to improve the water's colour, taste and odour as required.

Protection of water sources from pollution by human or animal waste can reduce the amount of microorganisms entering the water supply, but even water from the most protected wilderness environment may sometimes contain microorganisms capable of causing human disease. Illness can be easily and rapidly transmitted to large numbers of people by contaminated water supplies, therefore it is necessary to treat and/or disinfect water supplies to safeguard against disease. This provides insurance or a barrier against actual or potential contamination.

While some earlier civilisations apparently appreciated the importance of a clean and reliable water supply, the development of scientific understanding of why this was important did not occur until the second half of the 19th century. This was when the nature of infectious disease was first understood and the ability of water supplies to transmit disease such as cholera and typhoid was first demonstrated.

The approach to the provision of water services that emerged from this 19th century experience was to separate as much as possible the sources of water supply from human habitation and waste disposal. Since complete protection of water sources was often not possible, methods of treating water to kill or remove microorganisms were also developed.

The technologies used to treat water are similar worldwide. There have been a great variety of treatment process developed and the choice of treatment technology depends on the characteristics of the source water, the types of water quality problems likely to be present, and the costs of different treatment systems.

How is Water Treated?

The water treatment processes developed in the 19th century and refined during the 20th century are simple in nature. However, engineers have since developed ways of making these processes happen faster, in a smaller area and in a more controlled way at lower costs.

There are a great variety of water treatment processes, although only a few are applied in most situations. A summary of each of the main treatment processes is given below.

Coagulation, Floccculation and Sedimentation

In traditional water treatment, certain chemicals are added to raw water to remove impurities. While some particles will spontaneously settle out from water on standing (a process called sedimentation), others will not. To cause particles that are slow to settle or are non-settling, to settle out more readily, a soluble chemical or mixture of chemicals is added to the water. Such a chemical is called a coagulant and the process is called coagulation.
The coagulant reacts with the particles in the water, forming larger particles called flocs, which settle rapidly.

Flocs can also be effectively removed by passing the water through a filter. The process is controlled so that the coagulant chemicals are removed along with the contaminants.

Coagulation/flocculation processes generally use aluminium sulphate (alum) or ferric chloride as the coagulant.

A combination of coagulation/flocculation/sedimentation and filtration is the most widely applied water treatment technology around the world, used routinely for water treatment since the early part of the 20th century.

Coagulation/flocculation processes are very effective at removing fine suspended particles that attract and hold bacteria and viruses to their surface.

Research has shown that these processes alone are capable of removing up to 99.0% of the bacteria and 99% of the viruses from water supplies. These processes also remove some of the organic matter washed from soil and vegetation as water travels across the landscape, from raindrop to river. It is usually this natural organic matter that is responsible for any brown discolouration in the water. However, not all of this natural organic matter is removed by coagulation, certain taste and odour problems may remain.

Filtration

One of the oldest and simplest processes used to treat water is to pass it through a bed of fine particles, usually sand. This process is called sand filtration. In its simplest form, the water is simply passed through the filter with no other pre-treatment, such as the addition of a coagulant. Usually this type of filter will remove fine suspended solids and also some other particles such as larger microorganisms.

Sand filtration is even more efficient when the water being treated passes through the sand filter very slowly. Over time the sand particles become covered with a thin surface layer of microorganisms. Some might refer to this layer as slime but water scientists call it a biofilm. Even very small particles stick to this biofilm and are held, while water of greatly improved quality passes out through the filter.

Although very effective, they require a large area of land to achieve the sort of flows required by a large modern city. Additional process may also be needed to achieve adequate water supply.

The development of plastics has led to a new range of filter materials and methods. Process based on these new filter materials are now increasingly used to treat water for urban and industrial purposes.

In membrane filtration, water is filtered through tiny holes (usually referred to as pores) in a membrane wall rather than a bed of sand. The smaller the pore size, the greater the proportion of material the membrane retains as the water passes through.

The most common form of microfiltration membrane is a one-metre long bundle of thin, thread-like hollow fibres. A microfiltration water treatment plant would contain many such bundles.

Previously too expensive to use in many circumstances, recent advances have reduced the cost of membrane filtration to a level approaching that of conventional water treatment processes.

While membrane water treatment plants are simple and reliable in operation, especially in small to medium-sized application, there are some disadvantages. High energy costs are involved in pumping the water through the membrane. If a lot of natural organic matter is in the water, the membrane tends to block easily. This is referred to as membrane fouling. If cleaning cannot reverse the membrane fouling, the life of the membrane will be significantly shortened. This increases the cost of water treatment, since replacing membranes regularly is expensive.

Microfiltration

Microfiltration will remove most of the fine suspended solids in the water and almost all protozoa and bacteria but is not able to remove the dissolved part of the natural organic matter in the water. It is this dissolved part of the natural organic matter that is frequently the cause of colour, taste and odour problems.

Ultrafiltration

Ultrafiltration membranes have smaller pores than those in microfiltration and can therefore remove finer particles from the water. This process is capable of removing almost all the viruses (the microorganisms most difficult to remove) and improving colour.

Nanofiltration

Nauofiltration uses membranes with even smaller holes than for ultrafiltration, so requires a high operating pressure to force the water through the membrane. This results in high energy and operating costs.

However, nanofiltration is more effective than other filtration methods at improving water quality. For example, it is capable of removing all virus particles and most of the natural organic matter. However, it also removes some natural minerals from the water, which can cause pipes to corrode. To reduce corrosion in these circumstances, stabilising chemicals, such as lime, must be added to the treated water.

There are no working examples of a nanofiltration plant in Australia at present, but the process is in operation elsewhere, including Europe, where it is used to treat surface waters contaminated by herbicides and insecticides.

Additional Treatments for Unusual Circumstances

While coagulation processes and/or filtration remove most of the troublesome contaminants from water, they usually do not removal all the dissolved (or soluble) material. This includes low concentrations of dissolved organic matter that microorganisms in the water can use as a food supply and perhaps algal toxins and associated taste and odour compounds.

If water contains undesirable contaminants, additional treatment processes are required, like absorption and oxidation. Adsorption refers to the process by which chemicals are attracted to and held by a solid surface and is quite different from the similarly sounding process of absorption.

In water treatment, specialised absorbent materials are used. Examples are activated carbon and ion exchange resins. These absorbents can be used to removed purely soluble contaminants from water.

Activated carbon is the most widely used absorbent material in water treatment, because it is highly effective in removing taste and odour compounds and algal toxins.

Ion exchange resins can also remove soluble materials from water by exchanging ions (charged atoms or molecules) in the water and on the resin. This form of treatment is more often used for industrial purposes in industries that require very pure water for specialised processing, for example in computer chip manufacture. It has also found general application in the treatment of boiler feed water to reduce the problem of scaling.

Another treatment technology commonly used in Europe but only now appearing in Australia is oxidation with chemicals such as ozone or chlorine dioxide. These are strongly reactive chemicals able to oxidise a range of substances in the water.

Ozone in particular is a strong oxidising agent and is used as a disinfection agent and as a means of destroying soluble contaminants such as algal toxins, taste and odour compounds and (particularly in Europe) trace levels of insecticides. It is quite often used in combination with a column of granular activated carbon, as any soluble organics remaining after the chemical oxidation stage are biologically degraded by the film of microorganisms that develops in the activated carbon bed.

Water Stabilisation

Some raw water supplies are not stable, becoming acidic or alkaline depending on which material they are in contact with. This condition often leads to corrosion in piping systems and hot water services and can result in dissolved metals appearing in the water. For example, where copper corrosion occurs, a telltale bluish stain can appear where a tap drips on to a surface.

To prevent such corrosion problems, many waters are chemically stabilised before distribution by the addition of lime and sometimes carbon dioxide. The addition of lime (calcium carbonate) will make the water slightly harder by increasing the level of calcium in the water. Here, hardness refers to the characteristic of the water that prevents soap from lathering. In contrast, soft water will allow soap to form a lather easily.

Disinfection

Disinfection is carried out to kill harmful microorganisms that may be present in the water supply and to prevent microorganisms regrowing in the distribution systems.

Good public health owes a lot to the disinfection of water supplies. Without disinfection, waterborne disease becomes a problem, causing high infant mortality rates and low life expectancy. This remains the situation in some parts of the world.

There can be no higher priority in any water supply system than effective and safe disinfection of the water. The only possible exception to this rule occurs with secure groundwater supplies, where harmful microorganisms are prevented from entering the underground water source or contaminating the water when it is brought to the surface. Such water supplies need to be inspected and tested regularly to make sure that they remain safe.

The two most common methods to kill the microorganisms found in the water supply are oxidation with oxidising or irradiation with ultra-violet (UV) radiation.

The most widely used chemical disinfection systems are chlorination, chloramination, chlorine dioxide treatment and ozonation. Chlorination is the most widely used disinfectant for drinking water in Australia. Its introduction a century ago removed the treat of cholera and typhoid from Australian cities. It is cheap, easy to use, effective at low dose levels against a wide range of infectious microorganisms, and has a long history of safe use around the world.

Chlorine is a strongly oxidising chemical and may be added to water as chlorine gas or as a hypochlorite solution. Its main disadvantage is a tendency to react with naturally occurring dissolved organic matter to form chlorinated organic compounds.

The substances formed by the disinfectant reacting with the natural organic matter in the water are referred to as disinfection byproducts.

In 1970s, as scientific instruments capable of measuring lower and lower concentrations of substances were developed, trace quantities of chloroform and other similar chemicals were identified as disinfection byproducts in chlorinated water supplies.

Chloramines are produced when ammonia and chlorine are added to water together. They are less effective than chlorine in killing microorganisms because they are not as chemically active. However, chloramines maintain their disinfecting capability longer than chlorine and are ideal for very long distribution systems or for water supplies with long holding times in service reservoirs. For example, the disinfected water supplied to some Australian communities may travel through the distribution system for more than a week before use as drinking water from someone's tap.

Chloramines also reacts less with dissolved organic matter in the water and so produce fewer disinfection byproducts. Chloramination is a common disinfection system in Australia and many examples of its use can be found in regional Australia.

Chlorine dioxide is about 10 times more expensive than chlorine and its use in Australia is very limited. Its most significant use is by the Gold Coast City Council in Queensland.

The choice of chlorine dioxide in this application was primarily to prevent an aesthetic water quality problem caused by naturally occurring manganese compounds in the raw water. The problem is sometimes described as "black water" and can result in black stains on customers' washing.

Chlorine dioxide is a strong oxidant that can be used in low doses. It is a highly reactive, unstable gas that must be generated at the water treatment plant from sodium chlorite. Its use does not lead to the formation of chlorinated disinfection byproducts, but other possible byproducts of oxidation, such as chlorate and chlorite ions, can be a public health concern.

Ozone is the most powerful disinfectant used in water treatment. It is even effective against the difficult to treat protozoan parasites, Cryptosporidium and Giardia. Ozone, which only recently began to be used in Australia, destroys soluble contaminants such as algal toxins, taste and odour compounds and trace levels of insecticides.

Ozone is an unstable gas that must be generated at the water treatment plant. This is done by passing an electric discharge through clean, dry air or oxygen.

Because it is so reactive, ozone decays quickly in water. For this reason, it is usually used together with a small dose of chlorine or chloramine to ensure that some residual disinfection capacity is maintained in the water supply distribution system to prevent regrowth of microorganisms.

The use of ozone does not lead to chlorinated disinfection byproducts. However, other possible oxidation products, such as bromate formed from the naturally occurring bromide found in some water sources, are a potential health concern.

Ultraviolet radiation is a component of sunlight. Sunlight achieves disinfection by ultraviolet irradiation naturally. In water treatment, an appropriate level of ultraviolet irradiation, produced by mercury lamps, can kill bacteria and viruses. However, there is some uncertainty surrounding the effectiveness of ultraviolet irradiation against Crypotosporidium and Giardia.

Ultraviolet irradiation adds no chemicals to water and uses equipment that is relatively simple to operate and maintain. However, impurities in the water that cause colour and turbidity can severely reduce the effectiveness of the process because ultraviolet radiation cannot penetrate the water effectively.

Ultraviolet irradiation has no lasting effect and a further disinfectant such as chlorine or chloramine is usually added to ensure that some residual disinfection capacity is maintained in the water supply distribution system to prevent regrowth of microorganisms.

Delivering Water to the Community

The Distribution System

After water has been treated to protect public health and improve its' aesthetic properties by removing colour and taste and odour as required, it is ready to be delivered to consumers. The system of mains and pipes used to deliver the water is known as the distribution, or reticulation system.

Treated water may be held at a treatment plant or immediately discharged into the system of mains and pipes that will transport it to consumers' taps. On the way it may be held in short-term storages, usually known as service reservoirs, which are located as close as possible to where the water will be used.

An important characteristic of a drinking water distribution system is that it is closed, to prevent contamination by birds, animals or people. In contrast, irrigation water is usually delivered in open channels or aqueducts.

A significant part of the water supply lies buried underground. Out of the public eye, such infrastructure can be overlooked. It is easy to forget how valuable and essential water distribution systems are to the community.

Most distribution systems have developed and expanded as urban areas have grown. Regular cleaning (flushing and scouring), maintenance and a program to replace pipes and other equipment as they near the end of their useful lives. Water mains can be expected to have a useful life of 40 to 100 years.

Dual Pipe Systems

In future, it is possible that many Australian communities will be supplied with water of two qualities; one for drinking water quality and the other of a quality that is not safe for drinking but which is suitable for other purposes such as toilet flushing and outdoor use.

Such dual systems have been used in other parts of the world and in recent years have been trialed in Australia.

This system has the advantage of using less high quality water where lower quality water will do, but it is difficult and expensive to dig up existing suburbs and install dual pipe systems. In addition, there are public health risks if cross-connections occur between the two systems.

What About Rural and Remote Communities?

Most Australians live in cities where large investments have been made to ensure an adequate supply of water, even in times of drought.

For communities not connected to mains water supply, some provision for the supply of water is essential. This could be, for example, groundwater, stored rainwater or a combination of both.

Water and Human Health

The importance of good drinking water in maintaining human health was recognised early in human history, with water storage and treatment mentioned in historical records dating back to at least several hundred years BC.

In more recent time, studies of transmission of cholera in the mid 1800s contributed to the recognition that specific microorganisms cause specific human diseases.

By the early 1900s, better protection of water supplies from sewage pollution and simple but effective methods of water treatment greatly reduced rates of waterborne disease in developed nations. However, waterborne diseases continues to be a major cause of illness and death in the developing world, especially in children.

Since most people drink water every day, contamination of a public drinking water supply has the potential to expose nearly all members of a community to harmful chemicals or microorganisms in a very short period of time. For this reason, it is important that the protection of public health is the first consideration in managing any water supply.

Waterborne Diseases

Microorganisms that are capable of causing disease are called pathogens. The pathogens of concern in water supply are mainly those that are found in the excrement (faeces) of human or animals. If these microorganisms are present in water, and are not removed by water treatment or disinfection, then consumers may suffer infections.

Many types of pathogenic bacteria, viruses, protozoa and helminths may be transmitted by contaminated water supplies. These pathogens can also be transmitted directly from human to human, from animal to human, from swimming in contaminated water, by contaminated food, or indirectly through contact with contaminated objects. The fact that contaminated water causes an outbreak of a particular disease does not mean that the disease is only or mainly transmitted by water under normal circumstances.

Generally, faecal contamination from human sources is regarded as the greatest risk to water supplies, as some diseases such as cholera, typhoid, and gastroenteritis viruses are found only in humans. However, some pathogens from animals including mammals and birds can also cause illness in humans.

Water also plays a role in the transmission of other types of diseases. For instance, insects that breed in water, such as mosquitoes, may also spread disease to humans by sucking blood. Such diseases include typhus, dengue fever, malaria and yellow fever.

The amount of illness in a community is affected by the quantity of water that is available, as well as its microbiological quality. If there is not enough water for people to bathe themselves, or to wash cooking utensils or clothing, high rates of gastroenterities are common. In this situation, increasing the amount of water for people to use will generally produce a health benefit even if the quality of the water is not changed.

How do you know if there are Bugs in the Water?

Protection of public health depends on having multiple barriers in place to keep bugs (pathogenic organisms) out of the water supply. This includes trying to keep them out of the catchment or water source in the first place. Other barriers to these organisms are water treatment technologies, disinfection and a closed distribution system.

Measurement of pathogens in the water may appear to be the best method to determine whether the water supply is safe. However, this is an immensely difficult task, requiring expensive and sophisticated technology and taking considerable time.

It is also a very complex task due to the diversity of pathogens that exist and the different test methods required. A further problem is the inability of existing technology to continually monitor for pathogens. Because of these factors, indirect methods are used to measure microbiological water quality.

Groups of bacteria may be used by water supplies as operational indicators to assess whether water supply systems are operating normally as expected. These organisms (total coliforms and heterotrophic plate count bacteria) have no significance for assessing health risks but unusual variations in their numbers may signal a change from normal operating conditions that requires investigation.

The indicators most commonly used to measure the microbiological quality of water are E. coli, and thermotolerant (or faecal) coliforms.

Do Chemicals in Water Affect Human Health?

A wide variety of chemicals may enter a body of water used for water supply purposes via stormwater runoff. Such chemicals can be natural or manufactured substances.

Inorganic chemicals, such as mineral salts, can be leached from the natural environment. Manufactured chemicals such as pesticides, herbicides, insecticides, pharmaceuticals and industrial waste products can also be picked up from the land in the catchment or discharged into a waterway from a specific source.

Every chemical has an effect on living organism exposed to it. The study of the negative or harmful effects of chemicals on living organisms is known as toxicology.

Living organisms respond in different ways when exposed to chemicals. Some effects in organisms are immediate, that is, they show up within 24 to 48 hours. Other effects may be delayed and not show up for 10 or 20 years or more, for example, cancer in humans.

The response of a living organism exposed to a chemical depends upon the chemical dose or the exposure level. Generally, the higher the dose the more significant the effect. Simply knowing that the compound is carcinogenic is not sufficient to assess the risk to human health - it is necessary to know the harmful dose as well.

Ingestion of low levels of some chemical contaminants in drinking water over long periods of time has been associated with negative health effects, but these associations are not fully understood.

Inorganic Chemicals in Water

Inorganic chemicals may be present naturally in raw water, be derived from contamination of source water or obtained from contact with piping and plumbing materials used to transport water.

Generally a naturally occurring phenomenon, hardness is a measure of the calcium and magnesium salts dissolved in the water. Hardness levels of less than 200 milligrams per litre are described as good quality water. On the basis of taste, a concentration of total dissolved solids of less than 500 milligrams per litre is also described as good quality water.

Sometimes, domestic plumbing can be a source of elevated levels of copper or iron measured at the tap. Copper in drinking water can have health effects. Plumbing can also be a source of lead in drinking water.

Several elements are essential to human nutrition at low doses, yet can have negative effects at high doses. These include arsenic, selenium, chromium, copper, molybdenum, nickel, zinc and sodium. The elements lead, arsenic and cadmium are suspected carcinogens.

Organic Chemicals in Water

Organic chemical in water derive from;
The breakdown of naturally occurring organic materials;
Contamination of source water;
Reactions that take place during water treatment and distribution.

The breakdown of naturally occurring organic materials is the predominant source of organic chemicals in water. These chemicals are derived from vegetation, soil humus, and microbiological activity. Water scientists refer to this material as natural organic matter.

These organics are typically benign, although they can be responsible for such aesthetic problems as colour, taste and odour.

Excessive algal growth in source waters can lead to the tainting of drinking water supplies with complex and unpleasantly scented organic components such as geosmin and methylisoborneol.

The toxins produced by some blue-green algae - or cyanobacteria - are an exception to the usually benign character of natural organic matter. These toxins are harmful to human health.

A wide range of organic substances can enter the water source from human activities in the catchment. These sources include agriculture, runoff from urban settlements, wastewater discharge and leachate from contaminated soils. Most organics in water supplies that have harmful health effects are part of this group. They include pesticides and solvents.

Water in the Future

Addressing Tomorrow's Problems

Just as issues around water has moulded much of Australia's past, they will also influence the future. Several issues threaten to impact strongly on water resources and urban supplies in Australia in the future. These include climate change due to global warming, salinity and environmental degradation generally.

Increasingly, communities are asking questions about basic quality of life issued, such as their water supply. They have a right to ask these questions, and to expect answers, just as they have a right to expect the drinking water available to their children to be safe and pleasant.

The needs of the populations in the next 30 to 50 years are uncertain. Demand management programs will help to halt the previous trend of increasing per capita consumption.

Water supply, use and disposal did not undergo major technological changes in the last century: there were no paradigm shifts in relation to technology of water management. In the 21^{st} century, technology is likely to provide much more change for the water supply industry.

Increased use of water-efficient appliances by urban consumers will play a part in achieving ecologically sustainable development. A water-efficient appliance is one that has water conservation as one of its design criteria. It uses or enables the use of water more efficiently.

Water-efficient appliances generally do not rely on attitudes or behaviour of the user; rather, they impose responsible water use on the user. Savings from water-efficient appliances take time, because they are introduced slowly, replacing existing appliances. However, the water-efficient appliances being promoted at this time are expected to lead to a significant fall in per capita water use over the next couple of decades.

Climate Change

According to CSIRO's latest climate estimated, Australia will become hotter and drier in coming decades. Warmer conditions will product more extremely hot days, and fewer cold days.

CSIRO climate projections indicate that the warming won't be the same everywhere, with slightly less warming in some coastal areas and Tasmania, and slightly more warming in the north-west.

South-western Australian can expect decreases in rainfall, as can parts of south-eastern Australia and Queensland. Wetter conditions are possible in northern and eastern Australia in summer and inland Australia in autumn.

Evaporation is expected to increase over most of the country. When combined with expected changes in rainfall, there will be a clear decrease in available moisture across the country.

Environmental Degradation

Significant deforestation has occurred in Australia since British colonisation in 1788. One result of this change in vegetative cover, affecting transpiration rates from forest, has been reduction in rainfall in some catchments. Another has been salinity. A wide understanding of the need to reserve precious land management practices now exists, but in some areas it may be too late.

Across the country we need to find a meaningful balance between the competing demands of water of agriculture, urban consumption, and ecosystems.

Salinity

Changes to the Australian landscape, and in particular tree clearing, have resulted in the widespread and rapidly growing problem of salinity. While naturally occurring salinity is part of the Australian landscape, human impacts have upset the previously existing balance.

The problem has developed slowly. With the removal of the natural vegetation, the amount of water entering the water table (called the recharge) has increased and the rising groundwater level has dissolved the accumulated salt within the soil. Eventually, and perhaps more than 100 years later, the groundwater level reaches the surface, bringing the salt with it. This results in the death of all but the most salt-tolerant plants with consequential changes to other parts of the ecosystem.

While farmers were among the first to be affected, through salt-affected agricultural land, the impact on sources of freshwater has also been of growing significance.

Biodiversity, as well as regional and urban infrastructure, such as water supply, roads and buildings are now also at risk.

Just as it has taken a long time to appreciate the scale of the environmental degradation, the timeframe for these changes to be slowed or reversed will also be considerable.

Burnett River and the Regions Water Supply

The Burnett River is a river in central Queensland. The river rises close to Mt Geata, east of Monto, flowing in a general southerly direction past Eidsvold and Mundubbera. Downstream of Mundubbera, the river swings east, going through the townships of Gayndah and Wallaville before entering the city of Bundaberg. The river flows into the ocean at Burnett Heads, roughly 20km from Bundaberg.

The Burnett River also has major tributaries that include:

- ***Thee Moon Creek:*** Rises near Kroombit Tops National Park north of Monto. It flows south through Monto and Mugildie before emptying into the Burnett River south-east of Abercorn. Part of the creek is dammed near Cania Gorge to from Lake Cania.

- ***Nogo River*****:** Rises in the hills north-west of Monto. Flows south-east to join the Burnett near Ceradotus. Part of the Nogo River is dammed west of Abercorn to form Wuruma Lake, a popular fishing spot.

- ***Auburn River:*** Rises in the hills about 20km west of Cracow. Flows south before swinging to the north-east at its confluence with Johnson Creek. Passes through Auburn River National Park, a little known and untouched piece of pristine bush including Auburn Waterfall. Flows into the Burnett River west of Mundubbera.

- ***Boyne River:*** Rises in the Bunya Mountains National Park south-west of Kingaroy. Flows in a general northerly direction, emptying into the Burnett River near Mundubbera (and only 5km from the Burnett River-Auburn River confluence). Part of the Boyne River is dammed near Proston to form Lake Boondooma (which supplies water for the Tarong Power Station near Kingaroy).

- ***Barambah Creek:*** Rises in the hills between Kingaroy and the Sunshine Coast, north of Jimna. Flows in the general northerly direction before meeting the Burnett River north-east of Gayndah. Part of Barambah Creek is dammed south of Murgon to form Lake Barambah, also known as Bjelke-Petersen Dam, named after former Premier Joh Bjelke-Petersen

The Bundaberg district is one of the traditional cane growing areas of Queensland. It is the driest sugar-producing area within the state and originally relied on groundwater for those farms which had irrigation. Dry years of 1964, 1965 and 1969 together with depleted groundwater levels and increased groundwater salinity prompted the Queensland Government to adopt a scheme to provide surface water for the area.

In 1970, the Queensland Government adopted a proposal of a two-stage irrigation scheme to provide water supplies for most of the Bundaberg district. Construction began in 1970, with the second stage completed in 1993. Ned Churchward Weir was added to the scheme in 1998. Recently another phase was completed to assist the continuous water supply for the region. This was the construction of Paradise Dam, which was completed in 2005.

Water resource infrastructure associated with the scheme includes major storages, such as Fred Haigh Dam, and Paradise Dam, as well as considerable number of barrages and weirs. However there are only 6 storages sited on the Burnett River with a total capacity of 75,000 ml.

Lower Burnett Catchment
- Ben Anderson Barrage
- Ned Churchward Weir
- Paradise Dam (newly constructed)

Upper Burnett Catchment
- Kira Weir
- Jones Weir
- Claude Wharton Weir

And 3 storages sited on the Kolan River.

Kolan River Catchment
- Bucca Weir
- Fred Haigh Dam
- Kolan Barrage

The Burnett River basin has a catchment area of 32 500 km^2 in which 20 water storages have been constructed including the Walla Weir. The majority of the catchment lies outside council boundaries. The Burnett catchment is considered to consist of five sub-basins for irrigation scheme purposes:

- Auburn-Boyne River system;
- Upper Burnett River system;
- Three Moon Creek system;
- Barker Barambah Creek system; and
- Lower Burnett River system.

Portions of the Upper and Lower Burnett Region System's are involved in the Bundaberg Water Supply Scheme. The Lower Burnett Region, and the Bundaberg Water Supply Scheme in particular, draws water from Fred Haigh Dam, Bucca Weir and Kolan Barrage on the Kolan River and from Walla Weir and Ben Anderson Barrage on the Burnett River. Water is released from the Claude Wharton Weir upstream on the Burnett River for use in the Bundaberg Water Supply Scheme and also transferred from Fred Haigh Dam via the Isis Channel and Sheepstation Creek to Walla Weir to supplement supplies in the Burnett River.

The existing storages have a combined capacity to supply a nominal allocation of 198,354 ml/a through 4 major reticulation systems and 128 km of regulation stream.

Sunwater operates the Bundaberg Water Supply Scheme. This scheme supplies water to farmlands for irrigation that are located in the Bundaberg Regional Council. Communities and industrial enterprises including sugar mills are also provided by this scheme. Council treats and reticulate the water to residents.

The scheme is unique in Queensland in that it is the only large-scale irrigation area that was designed to service existing farming enterprises. Over 600 kilometres of channel and pipeline transverse the landscape distributing supplies to over 1,000 properties connected to the surface water scheme.

Channel supplies supplement or replace demand for groundwater in the district. The Department of Natural Resources and Mines manage the use of groundwater.

Information on individual irrigation systems.

Gooburrum Channel System: Gooburrum Pump Station, located 6 kilometres upstream of the Kolan Barrage, delivers water to the Gooburrum area through a balancing storage and system of open channels and pipelines. The reticulation system is controlled by automatic regulator gates, which maintain constant downstream water levels, thereby improving distribution efficiency by providing water to farms only as required.

Abbotsford Channel System: This system supplies water from the Kolan River to farms through 4 kilometres of pipelines.

Woongarra Channel System: This system supplies customers through 122 kilometres of channel and also secures groundwater supply. Woongarra Pump Station supplies water from the Ben Anderson Barrage through a balancing storage and a system of open channels and pipelines. The reticulation system is controlled by automatic regulator gate located along the earth channels.

A relift pump station, located at 23 kilometres on the Woongarra Main Channel, pumps water to a small reservoir from which the Burnett Heads and Bargara areas are served.

Givelda Channel System: This minor system originally had its own pump station from the Burnett River but is now supplied by gravity from the Isis main Channel and provides water through 10 kilometres of pipeline.

Gin Gin Channel System: This system supplies water through 68 kilometres of open channels and pipeline. The water is supplied by gravity from the Gin Gin Main Channel and by a relift pump station to the Tirroan area.

Bingera Channel System: The Bingera system supplies water through 114 kilometres of open channels and pipelines. The water is supplied by gravity from Gin Gin Main Channel through a system of open channels, pipelines, and relift pump stations. Bingera Main Channel directs water into Bullyard Creek Balancing Storage from where it is pumped to supply irrigation water. Two small relift areas are supplied at Mc Ilwraith and Bucca from the Bingera System.

Isis Channel System: Isis Pump Station, located 29 kilometres upstream of the Ben Anderson Barrage on the Burnett River, delivers water to the Isis and Givelda areas, via a reticulation system which, like previously constructed systems, is operated through a network of open channels and controlled by automatic regulator gates, a balancing storage, relift pump stations and pipelines.

The main sub-catchment of the Kolan Basin are Gin Gin Creek, Kolan River that enters the coast of Miara and the Kolan Coast that is drained by Croome and Welcome Creek entering the coast at Moore Park. Apart from the coastal townships the principal land use in the Basin is agriculture.

The Kolan River, as part of the Bundaberg Water Supply Scheme, is regulated by three structures: Fred Haigh Dam, Bucca Weir and the Kolan River Barrage. Water is also extracted directly from the river for irrigation and from Gin Gin Creek for town water and domestic use.

The Gregory River Water Supply Scheme also services Woodgate and Childers urban areas and rural residential developed along the Rising Mains between the treatment plant and those urban areas.

Urban Water Supply

The following table illustrates the source of water to urban areas. Generally surface water (from rivers) requires more extensive treatment then ground water.

Local Government Agency	Source
<u>Ex Bundaberg City Council</u> Bundaberg	 Burnett River (Branyan Treatment Plant, 190l/s) and bores
<u>Ex Burnett Shire Council</u> Burnett Heads, Bargara, Elliott Heads, Riverview Moore Park Burnett Downs River Park Rocky Point Tantitha (Zorzan)	 Burnett River via DNR Woongarra irrigation channel to Kalkie Treatment Plant and Kalkie bores 2 bores Burnett River, yard supply only Burnett River via DNR Woongarra Storage Bore supply Bore supply
<u>Ex Isis Shire Council</u> Woodgate to Childers	 Gregory River Dam and supply from BIA
<u>Ex Kolan Shire Council</u> Gin Gin Wallaville	 Gin Gin Creek and supply from Gin Gin Main Channel Burnett River

Recent agreement has been reached between the Bundaberg Regional Council and the State Government to investigate a new urban water supply source under the government's *Integrated Planning of Bulk Water Supply and Distribution Scheme* which is 50% State Government funded.

Goundwater

The region also contains significant groundwater supplies, which are used to supplement surface water supplies for irrigation and town water supply purposes. In the Bundaberg area, three main aquifers are drawn upon.

Groundwater resources face two major pressures, overuse and pollution. While a small percentage of the saline groundwater found may have already existed due to the last high sea level, recent hydrological modelling has suggested that historical over allocation of groundwater in relation to recharge rates in some coastal areas, particularly in the alluvial aquifers around Bundaberg, has resulted in saltwater intrusion from the sea, rendering bores in some areas unusable.

Small towns within our region, including Apple Tree Creek, Avondale, Cordalba, Buxton and Booyal have no town water supplies. This number will increase significantly as existing vacant allotments become occupied. Their water supply is derived by traditional country methods, including rainwater tanks, bores, creeks, dams and trucked water.

Rainwater is the most common source of drinking water. Whilst generally thought to be of excellent quality, bacteriological analysis of tank rainwater will usually show high pathogen count levels. The water collected in the washings from the roof includes bird droppings, leaves and other vegetable matter, dust and in some areas black snow during cane burning. Some reduction in the quantity of pollutants entering the tanks can be achieved by including a small catch-tank between the gutter outlet and the main tank. This catch-tank, containing the first washing, can be drained after each period of rain. Other problems occur, as tanks become older, screens become damaged and investigation of bad tasting water often reveals a dead bird or other small animals.

Sewerage and Waste

Large urban centres within the region are connected to a reticulated sewerage system that treats the wastewater before it is discharged back to the river.

On the smaller urban centres, which have on-site sewerage treatment and disposal, only Woodgate is planned to be serviced with reticulated sewerage in the future.

Effluent re-use systems are operated within Coral Cove, Avoca East and Thabeban Waste Water Treatment Plants. These areas lead Queensland in the re-use of sewerage effluent. Expressions of interest have recently been called for sale of recycled water.

With many landfill sites now not taking sewage treatment sludge, new methods of disposal need to be considered including possible re-use. In many areas the volume of septic tank and small package treatment plant sludge exceeds or will exceed the volume of sludge generated by the main sewage treatment plant. This problem needs to be addressed when upgrading all sewage treatment facilities.

All semi-urban (rural residential) areas have on-site systems with septic tanks utilising absorption/evapotranspiration trenches or on-site aerobic treatment plants with surface/sub-surface irrigation.

Many people in the Region rely on on-site sewage treatment and disposal systems. Traditionally, these systems have been septic tanks for treatment plus absorption trenches for effluent disposal. System failures are not uncommon. The section of the system which normally fails is the disposal system. The septic tank provides a low cost method of primary treatment, with great capacity for shock loads and the ability to operate with little attention. It is the preferred method of primary treatment unless there are special circumstances.

In recent years, small package treatment plants have been allowed in Queensland. These systems do not generally respond well to shock loading, require regular maintenance, are more costly to operate for the householder and have shown a high failure rate in some areas. The regular maintenance must be carried out by a license person.

Many of the soils in the Region are unsuitable for absorption trenches. Clay soils, high groundwater levels and rock close to the surface can result in flooding of the absorption systems. Sandy soils have traditionally been accepted as good for absorption trenches, but simply transfer effluent to the groundwater. Sandy soils should only be used where the soil can be modified with the addition of loamy soil to slow the passage of effluent through the root zone.

Evapotranspiration beds, with or without sand mounds, are an alternative to absorption beds and are allowed under the Sewerage and Water Supply Act. With this system, the effluent is distributed within the root zone (roots of plants) over a larger area than for absorption trenches. The systems can be designed to retain nutrient and pathogens on the site. Disposal is by evaporation and transpiration by plants growing in the disposal area. In the Region these disposal areas can be large due to the high rainfall that can occur.

All Local Government Agencies have requirements for on-site sewerage treatment and disposal systems where mains are not in place. Operation and maintenance of on-site systems is the responsibility of the owner.

Solid waste encompasses all solid produced by human activities. The majority of solid waste is presently re-used as land fill.

Because of the tightening of environmental controls on municipal refuse disposal sites, most Local Government Agencies have rationalised their disposal areas by decreasing their number and introducing transfer stations new population centres.

Bundaberg Regional Council have kerbside recycling of paper, glass and cans.

Very little chemical waste is produced in the region and that produced by industry is disposed outside the Region. Substantial quantities of agricultural waste (chemical containers, irrigation taps etc) are produced and are disposed in municipal refuse disposal sites in the area.

Medical waste is disposed in municipal refuse disposal sites and depending on the classification of the waste, Bundaberg Base Hospital's medical waste incinerated on-site.

Stormwater

Stormwater pollutants have a huge impact on the receiving environment. All urban catchments, waterways and stormwater drains end up discharging rubbish, organic matter, disturb soils and vegetation into major rivers that are then washed out into the oceans. In the local region it is impossible to filter these pollutants on a large scale but individuals can prevent most pollutants entering stormwater drains and waterways through simple practices. Washing the car on the lawn, clearing the kerb of dirt and rubbish regularly and preventing erosion and runoff from your property are just a few examples.

Urban Development

The "Integrated Planning Act 1997" provides a legislative framework for assessing developments in Queensland. This framework provides Local Councils with clear direction as to what key issues must be addressed during the planning, design, construction and operational phases of any development, such as subdivisions.

The "integrated planning' can be defined as the co-ordination planning and design of a development (or infrastructure), using a multi-disciplinary approach.

The checklist shown below can be used when considering the key water quality aspects associated with a proposed development.

Phase: Initial planning and concept design

- Form a design team that is appropriate for type and scale of development;
- Develop understanding of water quality-related planning requirements, legislation, guidelines and relevant management plans;
- Identify the type of "risk" the development is;
- Identify key water quality issues to address for the site;
- Start discussions with the relevant Council and maintain effective communications through the design stage;

- Define and agree with Council on affected receiving waters, environmental values and water quality objectives during the construction and post-construction phases;
- Identify any constraints for the development;
- Develop a preliminary concept design for the optimal combination of stormwater quality for the site to meet best practices;
- Undertake a detailed design addressing all issues of pollutant removal efficiency, safety, maintenance and aesthetics;
- Prepare a water quality monitoring program before construction commences.

Phase: Post construction (required via conditions of approval from Council)

- Stormwater quality improvement devices that will become Council's responsibility to maintain, ensure that the hand-over process is correctly followed.

Five major groups of stormwater pollutants are:

Gross pollutants: are natural or human derived substance. Typical urban sources of gross pollutants include litter, leaves, branches and lawn clippings. Due to their size, gross pollutants are usually treated by filtration.

Sediment: can be divided into three types, coarse, medium and fine. Coarse sediments are primarily responsible for the near-shore sedimentation. Medium and find sediments, however, can remain suspended in the water column, resulting in turbid water. Medium and find sediment is responsible for the unsightly discolouration.

Nutrients: excessive nutrient loads are the prime reason for excessive macroalgae and phytoplankton blooms, which can have considerable flow on effects on the aquatic environment. Nitrogen and phosphorus are the governing nutrients for primary productivity. Common urban sources of nutrients include decaying organic matter, garden fertilizers, septic tanks, sewer overflows and household detergents. Nutrients can be removed from stormwater through sedimentation as well as controlled biological uptake.

Heavy metals: have traditionally been associated with discharge from particular types of industry, however, a number of urban sources, such as sewer overflows and wear from vehicles can also contribute heavy metals in waterways. A large proportion of the heavy metals in stormwater are bound to fine sediments hence, a reduction of fine sediment will also result in reduced heavy metal loads.

***Oils and greases*:** the generic term "oils and greases" covers a range of petrochemical and other organic compounds. These compounds typically have a specific gravity of less than one which means that they generally form a slick on the surface, however, some forms can also be bound to sediments. Common urban sources of oils and greases include runoff from asphalt pavements, leaks from vehicles, car washing and industrial discharges. Treatment usually involves physical separation by utilising a barrier to trap floating oils, absorption on to oil booms, socks or pillows, or sedimentation for those oils and greases bound to sediment.

Though our local Council doesn't enforce the guidelines and state polices on stormwater pollution from individual building lots/sites, when constructing dwellings and other commercial / industrial buildings but builders should minimise environmental damage within the work site. At present the responsibility lies with the EPA.

Best practice guidelines for the control of stormwater pollution from building sites provide a practical guide to best practice techniques to minimise stormwater pollution from building sites. They are designed to help people involved in the building industry comply with environmental issues and duties. Supervisors, builders and home owners will benefit from the best practice guidelines as it ensures minimal environmental harm using cost effective measures.

What are the impacts?

Soil, sediment and litter from building sites can be a major source of stormwater pollution and can cause:

- Impacts on recreational and commercial fishing;
- Sediment build-up within waterways which can lead to weed growth;
- Loss of valuable topsoil;
- Significant public safety problems when washed onto road and intersections;
- Blocked drains creating flooding and increased maintenance costs;
- Significant harm to the environment of freshwater and marine systems through the loss of valuable marine habitats and creatures;
- Public health issued from increased algal blooms
- Reduced recreational opportunities due to increased turbidity.

Principles of effective stormwater pollution control include:

- Sensible site planning ;
- Diversion of up-slope water;
- Stabilised site entry/exit point;
- Minimisation of site disturbance and duration of disturbance;
- Installation of sediment controls along the lower edge of the site;
- Appropriate location and protection of stockpiles;
- Early connection of roofwater downpipes;
- Trap on-site runoff from tool, paint and concrete washing and brick, tile and concrete cutting;
- Compaction of backfilled trenches;
- Revegetation and stabilisation of the site.

These guidelines and checklists can be obtained through your local Council.

In the future Council, Developers and builders will maintain stormwater management programs that ensure little or no pollutants enter existing stormwater systems.

Preservation and Conservation

There are many agencies, business and volunteers within Australia that have programs to encourage sustainability for our waterways through to our oceans. In our local region we have many programs that adults and school children alike can participate in preserving water and what lives in it.

Woongarra Marine Park Monitoring and Education project off Bargara is an initiative of the Australian Marine Conservation Society - Bundaberg and District Branch, which is funded by Coastcare. This hand on program encourages volunteers and school students to participate in monitoring the beaches and creeks from Burnett Heads through to Elliott Heads. Collection of information on various ecosystems of plant life, animal and marine species in this marine park is regularly obtained for further studies on environmental issues.

Great Barrier Reef Reef Guardian Schools program is run by the Great Barrier Reef Marine Park Authority, which is funded by the Australian Government. This program encourages school children and adults to become involved in protecting the Great Barrier Reef and surrounding marine environment through projects that contribute to the preservation and best environmental practices and the importance of conserving the reef for the future.

It is vital that every person participates in the preserving of water on an individual and global basis. Clean water is becoming extremely hard to obtain and therefore we as a community needs to change our way of living to accommodate the insufficient supply of clean drinkable water.

This issue about water not only effects us now but also our future and everything that lives on this earth.

GLOSSARY OF WATER-RELATED TERMS

Absorption: The physical uptake of water and any material dissolved in it.

Acidic: Describing the chemical characteristic of acid.

Activated Carbon: Particles or granules of carbon used in water treatment because of their high capacity to selectively remove certain trace and soluble materials. Usually obtained by heating a carbon source (such as wood)

Adsorption: A process in which molecules are attracted to and retained on a surface (compare with absorption). In water treatment, the large surface area of activated carbon is used to remove low concentrations of contaminants.

Aeration: The mixing of air and water, resulting in oxygen from the air dissolving in the water.

Aerobic: As applied to water, refers to the presence of oxygen dissolved from the air.

Algae: Microscopic plants which contain chlorophyll and live floating or suspended in water. They may also be attached to structures, rocks or other submerged surfaces. Excess algal growths can give tastes and odours to drinking water. Algae produce oxygen when exposed to sunlight and use oxygen in darkness. Their biological activities significantly affect the pH and dissolved oxygen concentrations of water.

Algal Bloom: The occurrence of a high concentration of microscopic plant life, such as green or blue-green algae (cyanobacteria), in a river, lake and reservoir, usually as a result of increased nutrient content.

Alkaline: Describing the chemical characteristic that can neutralise acid. Technically, a pH valve above 7.

Anaerobic: As applied to water, refers to the absence of oxygen (also see aerobic).

Aquifer: Soil or rock below the land surface that is saturated with water. A confined aquifer has layers of impermeable material above and below it and is under pressure. When the aquifer is penetrated by a well, the water rises above the top of the aquifer. In an unconfined aquifer, the upper water surface (water table) is at atmospheric pressure and thus is able to rise and fall.

Artesian Well: A well bored down to the point, usually at great depth, at which the water pressure is so great that the water is forced out at the surface.

Backflow: A reverse flow condition, created by a difference in water pressures, which causes water to flow back into the distribution pipes of a potable water supply from any source or sources other than an intended source.

Backwashing: In water treatment, the process of reversing the flow of water back through the filter media to remove the entrapped solids.

Bacteria: Singular: bacterium. Microscopic single-celled organisms with rigid walls. Bacteria are found almost everywhere. Some bacteria in soil, water or air can cause human disease.

Blue-green Algae: See cyanobacteria.

Catchment: The areas of land which collect rainfall and contribute to surface water (streams, rivers, wetlands) or to groundwater. A catchment is a natural drainage area, bounded by sloping ground, hills or mountains, from which water flows to a low point.

Chloroform: A volatile organic compound formed as a byproduct of chlorination of natural waters. One of several compounds referred to as trihalomethanes.

Chloramines: Compounds formed by a reaction of hypochlorous acid (or aqueous chlorine) with ammonia. Used to disinfect water supplies.

Chlorination: The application of chlorine to water, generally for the purpose of disinfection.

Chlorinator: A mechanical device which is used to add chlorine to water.

Coagulant: Chemical used to coagulate - clump together - very fine particles into larger particles. Soluble salts of aluminium and ferric iron are the most commonly used coagulants in water treatment.

Coagulation: The clumping together of very fine particles into larger particles caused by the use of chemicals (coagulants). The chemicals neutralise the electrical charges of the fine particles and destabilise the particles. This clumping together makes it easier to separate the solids from the water by settling, skimming, draining, or filtering.

Coliform: A group of bacteria found in the intestines of animals (including humans) and also in soil, vegetation and water.

Colloids: Very small, finely divided solids (particles that do not dissolve) that remain dispersed in a liquid for a long time due to their small size and electrical charge. When most of the particles in water have a negative electrical charge, they tend to repel each other. This repulsion prevents the particles from clumping together, becoming heavier, and settling out.

Condensation: The process of water vapour in the air turning into liquid water. Condensation is the opposite of evaporation.

Contaminant: Any physical, chemical, biological, or radiological substance or matter that has an adverse effect.

CSIRO: Australia's Commonwealth Scientific and Industrial Research Organisation.

Cyanobacteria: A group of microorganisms with bacteria-like properties that can cause test, odour and other problems in water supplies. Also known as blue-green algae.

Dam: Is an artificial structure built to retain water for a variety of purposes, which may include human consumption, irrigation or industry needs; to reduce large discharges of floodwater; to increase water stored; or to increase the depth of water in an area.

Desalination: The removal of dissolved salts (such as sodium chloride) from water by specific water treatment processes, for example reverse osmosis.

Disinfection: The process designed to kill most microorganisms in water, including essentially all pathogens.

Disinfection Byproduct: A compound formed by the reaction of a disinfectant, such as chlorine, with organic material in the water supply.

Distribution system: A network of pipes leading from a water treatment plant to customers plumbing systems.

Effluent: Flow leaving a place or process. Sewage effluent refers to the flow leaving a sewage treatment process.

Epilimnion: The upper layer of water in a thermally stratified lake or reservoir. This layer consists of the warmest water and has a fairly uniform (constant) temperature. The layer is readily mixed by wind action.

Evaporation: The process by which water or another liquid becomes a gas. Water from land areas, bodies of water, and all other moist surfaces is absorbed into the atmosphere as a vapour.

Filtration: A process for removing particles from water by passage through porous media.

Flocculation: The gathering together of fine particles in water by gentle mixing after the addition of coagulant chemicals to form larger particles.

Fluoridation: The addition of a chemical to increase the concentration of floride ions in drinking water to a predetermined optimum limit to reduce the incidence of tooth decay in children.

Flushing: A method used to clean water distribution lines. Hydrants are opened and water with a high velocity flows through the pipes and removed deposits from them.

Great Artesian Basin: Largest artesian ground-water basin in the world. It underlies approximately one-fifth of Australia and extends beneath the arid and semi-arid parts of Queensland, New South Wales, South Australia and the Northern Territory, stretching from the Great Dividing Range to the Lake Eyre depression. The basin covers a total area of more then 1.7 million square kilometres and has an estimated water storage of 8,700 million megalitres.

Greywater: Wastewater from cloths washing machines, showers, bathtubs, hand washing, and sinks.

Groundwater: The supply of fresh water found beneath the Earth's surface, usually in aquifers.

Hard water: Alkaline water containing dissolved salts that interfere with some industrial processes and prevent soap from lathering. The hardness of water is usually expressed as the equivalent concentration of calcium carbonate in milligrams per litre.

Hazard: A biological, chemical or physical agent that has the potential to cause harm or loss.

Head loss: The pressure lost by water flowing in a pipe or channel as a result of turbulence caused by the velocity of flowing water and the roughness of the pipe, channel walls or restrictions caused by fittings.

Herbicide: A compound, usually a synthetic organic chemical, used to kill or control plant growth.

Humus: Organic portion of the soil remaining after prolonged microbial decomposition.

Hypochlorite: Chemical compounds containing available chlorine, used for disinfection. They are available as liquids (bleach) or solids (powder, granules and pellets).

Hypolimnion: The lowest layer in a thermally stratified lake or reservoir. This stagnant layer of colder, more dense water, has a constant temperature.

Inorganic: Material such as sand, salt, iron, calcium salts and other mineral materials. Inorganic substances are of mineral origin.

Ion: A atom or group of atoms which has gained or lost electrons and carries an electric charge.

Leaching: The process by which soluble materials in soil, such as salts, nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Mains: Large underground water or sewer pipes.

Metabolism: The sum of the chemical reactions occurring within a cell or a whole organism.

Microorganisms: Living organisms that can be seen individually only with the aid of a microscope.

Non-potable: Water that is considered unsafe and/or unpalatable for drinking.

Nutrient: Any substance that is assimilated (taken in) by organisms and promotes growth.

Organic: Substances that come from animal or plant sources. Organic substances always contain carbon.

Osmosis: The passage of a liquid from a weak solution to a more concentrated solution across a semipermeable membrane. The membrane allows the passage of the solvent (water) but not the dissolved solids (solutes). This process tends to equalise the conditions on either side of the membrane.

Oxidation: The addition of oxygen, removal of hydrogen, or removal of electrons from an element or compound. It is the opposite of reduction. In the environment, organic matter is oxidized to more stable substances.

Ozonation: The application of ozone to water for disinfection or for taste and odour control.

Pathogen: A disease-causing microorganism, includes various types of bacteria, viruses, fungi and protozoa.

Permeable: Can be passed through. Term used to described soil and rock and also in membrane technology.

Pesticide: Any substance or chemical designed or formulated to kill or control animal pests.

pH: A measure of the basic (alkaline) or acidic condition of a solution. A pH of less then 7 is acidic, of 7 is neutral and of more than 7 is alkaline. Natural waters usually have a pH between 6.5 and 8.5.

photosynthesis: A process in which organisms, with the aid of chlorophyll (green plant pigment), convert carbon dioxide and inorganic substances into oxygen and additional plant material, using sunlight for energy. All green plants grow by this process.

Pipeline: A length of pipe, which works in unison with other devices such as pumps, valves, and other control devices to convey a liquid or gas from one location to another.

Porosity: In relation to groundwater, the capacity of soil or rock to hold water.

Potable water: Water that is safe and satisfactory for drinking and cooking.

Pump station: A structure containing mechanical and electrical equipment to assist in the movement of water.

Quality: The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.

Raw water: Water in its natural state, before treatment, water entering the first treatment process of a water treatment plant.

Reservoir: Any natural or artificial holding area used to store, regulate, or control water.

Respiration: A process in which an organism uses oxygen for its life processes.

Runoff: That portion of catchment rainfall which does not evaporate or infiltrate into the ground but runs across the surface.

Salinity: The concentration of dissolved salts, usually sodium chloride, in water.

Sand filter: Device to remove suspended solids from water by passage through a bed of sand.

Sediment: Usually applied to material suspended in water or recently deposited from suspension. In the plural the word is applied to all kinds of deposits from the waters of streams, lakes, or seas.

Sedimentation: A water treatment process in which solid particles settle out of the water being treatment in a large clarifier or sedimentation basin.

Service pipe: A pipeline extending from the water main to the building served or to the consumers system.

Soft water: Water having a low concentration of calcium and magnesium ions.

Solvent: A substance that dissolves other substances, thus forming a solution. Water dissolves more substances than any other, and is known as the universal solvent.

Stormwater: Technically, all runoff is stormwater. However, the term "stormwater" is generally used in reference to urban runoff in constructed stormwater drainage systems.

Stream: A general term for a body of flowing water, a natural water course containing water at least part of the year.

Surface water: All water naturally open to the atmosphere (river, lakes, reservoirs, streams, impoundments, seas, estuaries, etc).

Suspended solids: Solids that float on the surface or are suspended in water, and which are largely removable by filtering.

Thermocline: The middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth. Also called the metalimnion.

Transporation: The process by which water vapour is released to the atmosphere by living plants.

Tributary: A smaller river or stream that flows into a larger river or stream. Usually, a number of smaller tributaries merge to form a river.

Valve: A device that opens and closes to regulate the flow of water or other fluids.

Water cycle: The circulation of water on Earth as it evaporates from the sea and lakes, condenses into clouds and falls again as precipitation (rain, hail, sleet, snow)

Water quality: A description of the chemical, physical and biological characteristics of water for a particular purposes.

Water supplier: The owner or operator of a public water system.

Water supply system: The collection, treatment, storage, and distribution of potable water from source to consumer.

Water table: The level of groundwater in an unconfined aquifer. This level can be very near the surface of the ground or far below it.

Weir: A control or barrier placed across the width of an open channel, bank or river to impound, control and measure water discharges. Weirs are similar to dams but tend to be smaller in size.