The Cooperative Research Centre for
Water Quality and Treatment

Drinking Water Facts

All About Australia's Drinking Water

Everyone needs clean, safe water to drink. In Australia, the world's driest inhabited continent and a land of climatic and geographical extremes, this requires special skill.

WHAT IS DRINKING WATER?

"Drinking water" – sometimes called potable water – is water that is safe for humans to drink and use for other domestic purposes, such as cooking, washing up, bathing and showering. In Australia, most water sources require some form of treatment to make them safe to drink.

According to the Australian Drinking Water Guidelines:

> *Ideally, drinking water should be clear, colourless, and well aerated, with no unpalatable taste or odour, and it should contain no suspended matter, harmful chemical substances, or pathogenic microorganisms.*

In other words, drinking water should not contain chemicals, organic substances or organisms that can make us sick. Drinking water should also be at a reasonable temperature and free of odours, tastes and colour.

The guidelines also define drinking water as water *'…which, on the current state of knowledge, is safe to drink over a lifetime: that is, it constitutes no significant risk to health'.*

When most Australians turn on the tap, we expect a continuous supply of drinking water that meets these guidelines – water that is safe and pleasant to drink.

We expect it to flow at an acceptable pressure and to be available even in the middle of a drought. We also expect that our wastewater will not create a nuisance or public health hazard. Furthermore, we expect to be protected from localised or more substantial flooding. During the nineteenth century and particularly in the twentieth, engineers designed and built urban water systems to meet these expectations.

WATER AND PUBLIC HEALTH

The importance of good drinking water in maintaining human health was recognised long ago. Water storage and treatment are mentioned in historical records dating back nearly 3,000 years.

A pivotal step towards developing safe supplies of drinking water was the understanding that specific microorganisms cause specific human diseases.

In the mid-nineteenth century, London doctor John Snow linked water supplies to the spread of disease. This was a major breakthrough. Dr Snow showed that cholera was not transmitted by 'bad air' or 'filthy conditions'; rather, it spread through polluted drinking water, or contaminated food or objects. He was the first to use chlorine as a disinfectant for water.

By the early 1900s, rates of waterborne disease were greatly reduced in developed nations through better protection of water supplies from sewage pollution and simple but effective methods of water treatment, such as sand filtration.

The widespread introduction of disinfection in the early twentieth century improved public health even further.

However, waterborne diseases continue to be a major cause of illness and death in many parts of the world, where more than one billion people drink unsafe water. The World Health Organisation (WHO) estimates that each year 2.4 million deaths are caused by unsafe water and lack of sanitation.

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Even in developed countries, contamination of drinking water still occurs occasionally.

In December 2007 in Nokia, Finland, drinking water was contaminated when sewage effluent entered the distribution system. Up to half of town's 30,000 residents may have been exposed and more than a thousand cases of gastroenteritis are estimated to have been caused by the contamination. At least 250 people sought medical care and a number were diagnosed with Campylobacter and Salmonella infections.

'BUGS' IN THE WATER

Microorganisms that are capable of causing disease are called pathogens and include bacteria, viruses, and protozoa such as *Cryptosporidium* and *Giardia*. In water supplies, the pathogens of concern are mainly those found in faeces of humans or animals.

Pathogens of human origin are generally regarded as the greatest health risk from water supplies, as many of the significant water-borne diseases, such as cholera and typhoid, are found only in humans. If present in a water supply and not removed by treatment, these pathogens can cause infection in people who drink the water.

However, some pathogens carried by animals can also cause illness in humans. When such illnesses are water-borne, their most common source is mammals in water catchments (whether native, feral, or agricultural) and birds in service reservoirs.

Other microorganisms, called Blue-Green Algae, can grow naturally in our sources of drinking water. Some of these algae produce toxins or chemicals that can affect the taste and odour of the water.

To ensure that pathogens and algal toxins do not pose a health risk to the community, water supplies are treated in various ways before distribution.

COLLECTING WATER

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

Most Australians live in a catchment, which may include hundreds of sub-catchments. What happens in each of the smaller catchments will affect the greater catchment.

Catchments are a crucial part of urban water systems, whether surface water or groundwater. The quality of the catchment determines the quality of the water that is supplied from it.

In a few highly protected areas, catchments exist in their natural state and minimal water treatment is needed. For example, most of the water supply for Melbourne and Canberra comes from natural wilderness catchments set aside solely for water collection.

Photo courtesy AWQC

Few communities, however, have pristine water sources and the quality of water from most sources is affected by conditions and activities in the catchment.

For example, most of Adelaide's water is derived from the Murray River, which has a vast catchment — the Murray Darling Basin — that is home to almost two million people and contains more than 50,000 farms.

Water is transported from catchments to communities in a variety of ways, including pipelines, aqueducts, open channels or natural waterways.

STORING WATER

In some urban water systems, the water supply is obtained directly from a river or another body of fresh water. 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 collect water from catchments in reservoirs, to ensure sufficient supply will be available when needed. Dams are also built for other purposes, such as irrigation and generating hydro-electricity.

In Australia, a large dam is defined as one with an embankment more than five metres high. Australia has more than 400 large dams, and the largest of these is Tasmania's Gordon Dam, which can hold 12,450,000 megalitres (one megalitre is one million litres).

Groundwater, from sources such as the Great Artesian Basin, is also a significant source of supply in many parts of rural Australia and for several major urban centres. Almost half of Perth's water supply is groundwater.

TREATING WATER

Before water is distributed to an urban community, it is treated to ensure it is safe and pleasant to drink. Treatment is designed to remove sediments and contaminants and to kill potentially harmful microorganisms. Of the great variety of water treatment processes, those mentioned below are by far the most commonly applied.

Coagulation, flocculation and sedimentation

While many particles will gradually settle out from water over time, (a process called sedimentation), some will not. To cause slow or non-settling particles to settle out more readily, a soluble chemical or mixture of chemicals is added to the water. Such chemicals are called coagulants and the process is called coagulation.

Coagulants react with the particles in the water, forming larger particles called flocs, which settle rapidly and can be removed as sludge. Flocs can also be effectively removed by passing the water through a filter; either directly or after sedimentation. The process is controlled so that the coagulant chemicals are removed along with the contaminants.

These processes remove some of the natural organic matter that is washed from soil and vegetation as water travels across the landscape. Natural organic matter is usually the cause of brown discolouration in water and can also cause foul tastes and odours. However, not all of this natural organic matter is removed by coagulation and it may react with disinfectants applied to the water, to form disinfection by-products.

Filtration

One of the oldest and simplest processes used to treat water is to pass it through a bed of fine particles, typically sand.

Sand filtration will usually 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, although this requires large areas of land, not normally available in cities.

A combination of coagulation/flocculation/sedimentation and sand filtration (often referred to as conventional water treatment) is the most widely applied water treatment technology around the world, used routinely for water treatment since the early part of the twentieth century.

Filtration techniques have changed with the development of modern plastics. The result is a new range of filter materials and methods to treat water for urban and industrial purposes.

Microfiltration – passing water at pressure through membranes with a small pore size – is the most widely used membrane water treatment in Australia. Microfiltration is also becoming more and more popular for water treatment plants supplying smaller rural and regional communities. Ultrafiltration and nanofiltration, which use even smaller pore membranes, are less common.

Disinfection

While coagulation, flocculation and filtration can remove quite a large amount of organic material and larger microorganisms from raw water, there are some important pathogens that are not eliminated during these treatments.

Disinfection kills harmful microorganisms that may be present in the water supply and prevents them from regrowing in the distribution systems. Without disinfection, waterborne diseases become an increased threat.

Chlorine is the most widely used disinfectant for drinking water in Australia. 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.

Removal of contaminants

In some supplies contamination or the presence of algae can result in chemicals being present in the water. Some of these chemicals may not be removed by the conventional water treatment or disinfection processes described above. In these cases the chemicals need to be chemically or physically adsorbed from the water and the best method currently is the use of activated carbon.

Activated carbon is formed by converting natural carbon-containing products, such as coal and wood, using heat and steam, into a highly porous carbon material which is extremely effective for adsorbing a wide range of compounds.

The activated carbon is available in two forms, powdered or granular. Powdered activated carbon (PAC) can be added in treatment plants at the rapid mixing stage described above, where it can adsorb chemicals and then be enmeshed with the settleable floc formed and removed with the sludge. PAC is applied where this type of contamination or algal episodes occur infrequently. Granular activated carbon (GAC) is placed in a filter as the final polishing step after the normal sand/anthracite filter and is used where contamination is on ongoing issue.

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DISTRIBUTING WATER

After water has been treated to protect public health and improve aesthetics by removing suspended matter and any compounds that colour the water or make it taste or smell unpleasant, it is ready to be delivered to consumers.

The water mains and pipes beneath the streets of a community are known as the distribution, or reticulation, system. The system also includes service reservoirs that store and supply enough water to meet local peak demand at sufficient pressure. Service reservoirs are often large, covered tanks in an elevated position. Pumps and valves also form an important part of the distribution system. The system ends at the consumers' taps.

An important characteristic of a drinking water distribution system is that it is sealed, to prevent contamination by birds, animals or people. Distribution systems require regular cleaning (flushing and scouring), maintenance and a program to replace pipes and other equipment as they near the end of their useful lives.

MANAGING DRINKING WATER

The Australian water industry is expected to provide supplies that are safe for the community at large, including infants and the elderly, who are at greater risk from water-borne infection than most.

In Australia, the states and territories are largely responsible for protecting public health and managing natural resources, including water supplies. This means that the government of each state and territory decides whether and how to implement the latest Australian Drinking Water Guidelines, WHO Guidelines for Drinking Water Quality, or some other guidelines to regulate water quality in that state.

A range of agencies can be involved in individual water supply systems. Water resource departments, natural resource and environment departments, agriculture departments, health departments, local governments, planning authorities, catchment management boards, and community-based interest groups and organisations can all have a role in ensuring water quality. Ultimately, however, the drinking water suppliers are responsible for delivering safe drinking water to consumers.

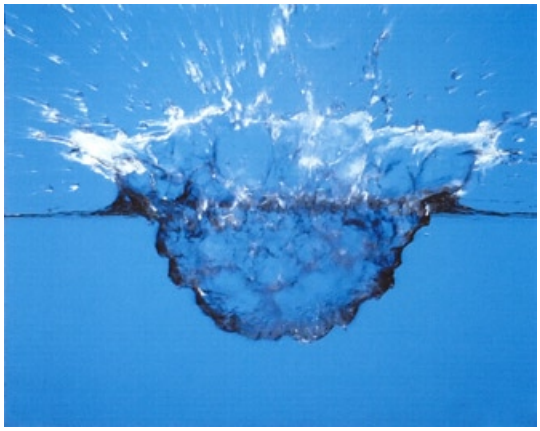
In the past, drinking water quality has not been subject to specific legislation in Australia. Instead, mechanisms such as operating licences, charters, memoranda of understanding and customer contracts have been used to implement the guidelines for water supplies. However some states are now introducing regulations based on the Australian Drinking Water Guidelines. In 2003 Victoria was the first state to pass legislation covering drinking water quality, followed by Tasmania and, in 2008 by Queensland.

AUSTRALIAN DRINKING WATER GUIDELINES

The *Australian Drinking Water Guidelines* are intended to provide the best levels of evidence-based advice to the professionals who manage water supplies, and in a way that the community can understand and use to participate in decision-making. The guidelines are based primarily on the latest World Health Organization recommendations and are used widely throughout Australia.

The guidelines are concerned with the safety of water from a health viewpoint and its aesthetic quality – that is, its taste, colour and odour. They are applicable to any water intended for drinking (except bottled or packaged water) regardless of its source (municipal supplies, rainwater tanks, bores, point-of-use treatment devices, and so on) or where it is used (at home, restaurants, camping areas and shops). They consider the spectrum of the water supply system, from collection in catchments to supply via the consumer's tap.

The guidelines are subject to rolling review to ensure that they are kept up-to-date as new knowledge develops. They are published jointly by the National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRRMC). The Australian Drinking Water Guidelines are available at http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm



FOR MORE INFORMATION

visit the Web site:
www.waterquality.crc.org.au

The Cooperative Research Centre (CRC) for Water Quality and Treatment is Australia's national drinking water research centre. An unincorporated joint venture between 30 different organisations from the Australian water industry, major universities, CSIRO, and local and state governments, the CRC combines expertise in water quality and public health.

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CRC for Water Quality and Treatment