Card for Humanity - Water filters

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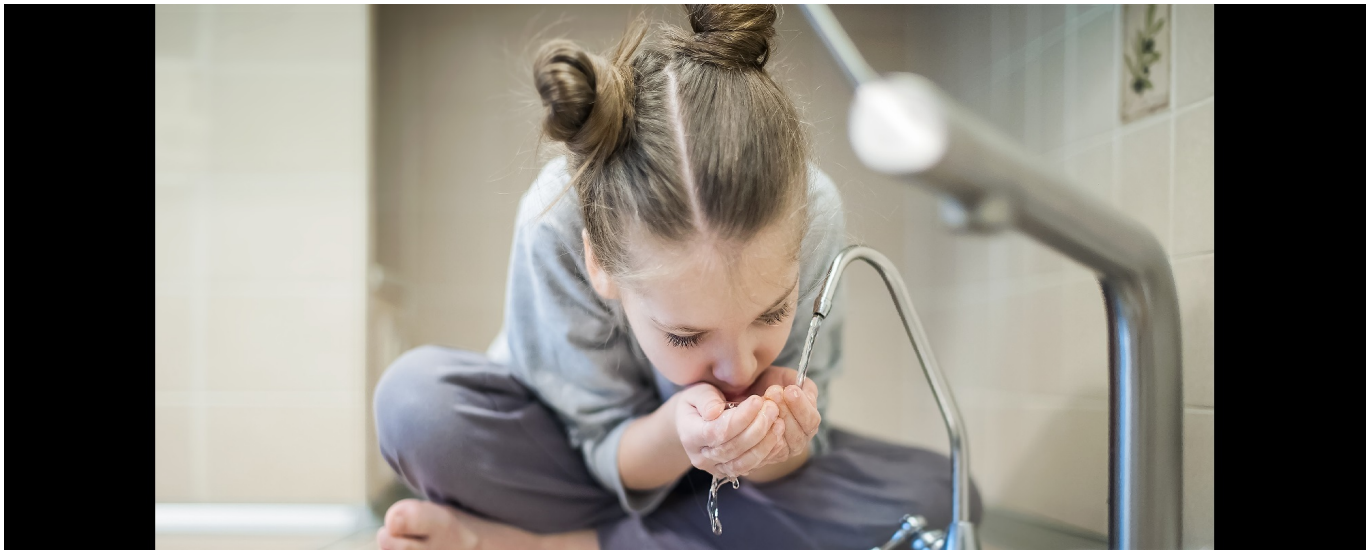

Do we need to filter our drinking water?

In Australia, water is readily treated and available for drinking, food production, domestic use, and recreational purposes. However, depending on your drinking water source, a water filter may be beneficial for your health.

Australian tap water has been found to contain chemicals including aluminium, chlorine, fluoride, and nitrate, as well as heavy metals, disinfection by-products, microorganisms and pesticides that may have adverse health effects (Table 1).

Tank water may contain other contaminants such as sediment, atmospheric pollution, and insects. In addition, groundwater may contain high salt levels, iron, and other heavy metals and agricultural contaminants such as pesticides and nitrates from fertilisers.

Table 1 Common contaminants in domestic tap water

Contaminant	Details
Aluminium	• Aluminium may naturally be present in drinking water due to the drinking water catchment geology and the presence of clay-based soils. • Aluminium salts are also commonly added as coagulants during water treatment to remove turbidity, organic matter, and microorganisms. • Fluoride additives used in water fluoridation may also contain aluminium ([1]). • Aluminium in drinking water has been linked to Parkinson's disease, amyotrophic lateral sclerosis ([2]), and Alzheimer's disease ([3]).

Asbestos	• Half of the pipelines in Australia contain asbestos cement ([4]). These pipes are not dangerous in their original condition. However, asbestos fibres can contaminate water supplies as these pipes degrade over time. • Asbestos pipes have a recommended usable lifespan of 70 years; however, many of these pipes in Australia were installed more than 100 years ago ([5]). • Asbestos is a known human carcinogen by the inhalation route. • Asbestos fibres in drinking water have been linked with gastrointestinal cancers; however, its use for pipes is not regulated in several countries, including Australia, due to conflicting evidence ([6]). • It is not clear whether asbestos fibres ingested in drinking water can pass through the gastrointestinal tract walls in sufficient numbers to cause adverse effects ([7]).
Chlorine and chlorine by-products	• Chlorine and hypochlorites are toxic to microorganisms and are used extensively as disinfectants for drinking water supplies. • Chlorine reacts with natural organic matter in water to form carcinogenic by-products, such as trihalomethanes (THMs) ([8]). • Epidemiological studies suggest associations between consumption of chlorinated tap water with elevated THM concentrations and adverse health outcomes, including bladder cancer ([9]), children born small for gestational age ([10]), and miscarriages ([11]). • Chlorine is also a skin and lung irritant ([12]).
Copper	• Copper is used throughout Australia in some domestic water supply pipes and fittings, and corrosion of copper plumbing can cause elevated levels in drinking water. • A low level of copper (• Consumption of high levels of copper can cause acute symptoms, including nausea, vomiting, diarrhoea, gastric (stomach) complaints and headaches ([7]). • Long-term exposure is linked to diabetes, Parkinson's disease, and Alzheimer's disease ([13]).
Fluoride	• The National Health and Medical Research Council (NHMRC) supports Australian states and territories fluoridating their drinking water supplies within the range of 0.6 -1.1 mg/L ([14]). • However, fluoridation is controversial, and growing evidence links artificial fluoridation and developmental neurotoxicity ([15]). • Exposure to fluoride in drinking water has been linked with adverse health effects, including dental fluorosis ([16]), skeletal fluorosis ([17]), arthritis, hypothyroidism ([18]), diabetes ([19]) and neurodevelopmental disorders in children ([20], [21]).
Lead	• Lead is still used to manufacture a range of plumbing products, including brass fittings, which are widely used in drinking water systems in homes, buildings, and water supply points, such as drinking water fountains. Lead can leach from these plumbing products into drinking water ([22]). • Lead pipes were commonly used between the 1900s and 1930s, and some older homes and buildings may still have old copper pipes with lead-based solder. • Even low lead levels in children can cause behaviour and learning problems, lower IQ and hyperactivity, hearing problems and anaemia. Cardiovascular, renal, and reproductive health effects are believed to occur at blood lead levels as low as 1–2 µg/dL ([23]).

Organic chemicals and pesticides	• More than 20,000 human-made industrial and household chemicals are used routinely in Australia ([24]). • These can enter drinking water supply catchments as runoff, deposition from the air, or the direct discharge of treated wastewaters from sewerage plants and industry. • Due to the sheer number of chemicals, very few are tested for routinely in drinking water. • Many of these chemicals are linked to adverse health effects; for example, per- and poly-fluoroalkyl substances, also known as PFAS, are known to disrupt immunological, metabolic, and endocrine pathways and are potentially carcinogenic ([25]).

Choosing a water filter - what is the best water filter?

There is no single water filter that outweighs the rest, and apart from cost, there are several factors to consider when selecting a water filter.

Identify the contaminants in your drinking water you wish to remove

To identify the contaminants present in your water, you can obtain water quality information from your local water utility/authority. For example, you can obtain water quality results for Sydney drinking water from Sydney Water. Your local Public Health Unit can also provide information on water quality and health, e.g. NSW Public Health.

If you cannot get a water quality report or have a private water supply such as a rainwater tank or groundwater bore, you may want to consider having your water independently tested at a NATA accredited laboratory. Examples of NATA accredited laboratories equipped to analyse drinking water include Australian Laboratory Services (ALS) and Envirolab.

After identifying the contaminants in your drinking water, you can select a water filter that is certified to address your water quality concerns.

It is important to recognise that no filter eliminates all contaminants, so understanding what filters do and do not do is important.

Compare options for water filtration

Several water filtration solutions are available, ranging from whole of house (point of entry systems) to filters for specific areas (point of use systems) such as kitchen taps.

Point of Use (POU) systems (tap mounted or under sink)

- Used to filter water directly where it is sourced and is installed at a single water connection, typically under the sink, or to kitchen taps and showerheads.

- Have a low volume production so are best suited for light household applications such as drinking water and bathing.
- Will last 3-12 months depending on the size of the unit.

Point of Entry (POE) systems

- Installed at the main water line where water first enters the home before it reaches any outlet points such as sinks, washing machines, bathroom, and toilets.
- Most commonly placed in front of the water heater to deliver purified hot and cold water to every tap in the home.
- Offer high-capacity filtration and can treat up to several thousand litres of water per day.
- Can use a variety of different filter cartridges and media beds to remove many water contaminants.
- Produce high-quality general-purpose water, but additional water filtration systems such as reverse osmosis units may be required for drinking water.
- Incur significant cost because large filters are required to cope with large volumes of water, and the cartridges need to be replaced on a regular basis.

When choosing a filtration system, you need to decide whether you want to treat just the drinking water at your kitchen tap or would like to treat sources from where water enters your home.

Often an effective solution is whole of house treatment, with further treatment for drinking water.

Factors to consider include the total number of bathrooms in your home, the number of residents, amount of bench or under sink space (e.g. reverse osmosis systems require significant space) and water pressure, as more water pressure is required for filtration systems that incorporate multiple filtration units.

Verify certification of your water filter

Before purchasing a water filter, verify the filter meets performance standards by reviewing a certificate of analysis. This certificate should be certified by a NATA accredited laboratory or the National Sanitation Foundation International (NSF). NSF certification includes:

- NSF 42 covers aesthetic effects such as chlorine, taste, odour, and particles.
- NSF 53 covers health effects such as cysts (giardia, cryptosporidium), a range of organic chemicals (such as trimethylamine and pesticides) and heavy metals.

The Australian Standard AS/NZS4348 covers a wide range of contaminants, such as taste, odour, and microbiological and chemical impurities.

Replacing your filter

You will need to consider the cost and frequency of replacing filters. Point of entry filters are likely to incur great costs than point of use filters because of the large volume of water they are required to treat.

Common types of water filters

Each water filter medium can remove specific contaminants (Table 2). Your choice of filter will depend on price, bench/under sink space and contaminants present. Reverse osmosis filters are most effective at removing contaminants but are expensive. Most households rely on a dual cartridge system, such as a sediment pre-filter combined with an activated carbon block filter impregnated with kinetic degradation fluxion (KDF).

Table 2 Common drinking water filter mediums ([26],[27],[28])

Filter type	Description	Benefits	Limitations
Activated Carbon Filter (includes mixed media that removes heavy metals)	• Carbon filters have deep beds of activated carbon manufactured from a variety of organic substances such as coal, coconut, and lignite. • The carbon is heated to very high temperatures in the absence of oxygen to form millions of microscopic holes, enhancing the removal of chemicals from water.	• Absorbs organic contaminants that cause taste, colour, and odour problems. • Some designs remove chlorination by-products such as trihalomethane. • Effectively remove sediment, pesticides, petrochemicals, and chlorine. • Easy to install and inexpensive. • Can be used in many styles ranging from portable bottles, jug filters, benchtop units, tap filters, under sink plumbed in and the whole of house systems.	• Efficiency at removing contaminants will vary depending on pore size and source material. • Need to be replaced regularly as the adsorption sites get used. • Prone to biofilm formation. • Only partially remove fluoride and heavy metals such as copper and lead.
Ion exchange resin filters	• The ion exchange process percolates water through bead-like spherical resin materials (ion-exchange resins). Ions in the water are exchanged for other ions fixed to the beads. • A variety of resins have been used including aluminosilicates, heavy metals, and synthetic resins like acrylic.	• Removes minerals, particularly calcium and magnesium, that make water “hard”. • Some designs remove radium and barium. • Removes some heavy metals and fluoride.	• Do not remove sediment, pesticides, microbes, or chlorine. • If water has oxidised iron or iron bacteria, the ion-exchange resin will become clogged.

Ceramic filters	• Uses a natural ceramic media, often referred to as a ceramic filter candle, which processes the water and removes contaminants through a network of pores. • Many commercially produced ceramic filters are impregnated with silver to act as a bacteriostatic agent and prevent biofilm formation on the filter surface.	• Removes pathogenic bacteria including *E. coli*, shigella, and salmonella, sediment, and turbidity. • Most ceramic filters come with a carbon cartridge to remove chlorine and organic contaminants such as pesticides and volatile organic compounds. • If the ceramic element contains an ion exchange resin, heavy metals like lead, mercury, copper, and zinc are greatly reduced in the water. • Can be used in a benchtop or under sink system.	• Require regular maintenance to remove biofilms. • Slow to filter. • Require more maintenance than carbon filters and can be more expensive.
Sediment filters	• Can be made from a variety of materials, including polypropylene, polyester, cotton, cellulose, ceramic, and glass fibre and come in a variety of pore sizes. • Often works in conjunction with other filtration methods, like reverse osmosis or ultraviolet purification, to ensure other filters and water filtration equipment can operate efficiently.	• Designed to collect solid debris and particulate matter from the water.	• Needs to be used with other filters to remove other contaminants such as organics, pathogens, and heavy metals.
Reverse osmosis (RO)	• Removes contaminants from unfiltered water when pressure forces it through a semipermeable membrane. • Water flows from the more concentrated side (more contaminants) of the RO membrane to the less concentrated side (fewer contaminants) to provide clean drinking water.	• Removes fluoride, chlorine, nitrates, sodium, other dissolved inorganics, and organic compounds. • Removes foul tastes, smells, or colours. • May also reduce the level of some pesticides, dioxins, chloroform, and petrochemicals.	• Expensive to buy, install and maintain. • Needs to be plumbed in and they produce large volumes of wastewater which will need to be diverted.

kinetic degradation fluxion (KDF) filters	• High-purity copper-zinc granules that reduce contaminants in water using an oxidation/reduction (redox) reaction.	• Removes chlorine, iron, hydrogen sulfide, lead, mercury, calcium carbonate, magnesium, chromium, bacteria, algae, and fungi.	• Does not remove organic chemicals (pesticides, disinfection by products such as THMs) or parasitic cysts. • If water has high sediment content/turbidity, it should be combined with a sediment pre-filter. • Need to be periodically backwashed with hot water to remove the insoluble contaminants.

Table 3 Other drinking water treatment options ([26],[28])

Treatment method	Description	Benefits	Limitations
UV sterilisers	• A UV water purifier exposes bacteria, viruses, or cysts (like Cryptosporidium and Giardia) to a germicidal ultraviolet wavelength that disrupts the DNA in pathogenic microorganisms so they cannot reproduce.	• UV systems are beneficial where the possibility of a serious illness occurring from localised water is high, especially from organic matter and excrement in the water. • Inactivates most of the microorganisms present in drinking water.	• Does not remove particles from water, additive chemicals, or remove bad tastes and odours. • Not commonly used for water filtration in homes that rely on tap water as chlorinated water will effectively kill bacteria in the distribution system.
Distillation	• Separates a solution by adjusting the boiling temperature, and capturing the steam that is made. The pure water is collected on one side of the water distiller and any other contaminants are left behind.	• Removes nitrates, bacteria, sodium, hardness, dissolved solids, most organic compounds, heavy metals, and radionuclides. • Kills bacteria.	• Does not remove some volatile organic contaminants, certain pesticides, and volatile solvents. • Bacteria may recolonise on the cooling coils during inactive periods. • Minerals that are required for health are removed in the distillation process such as calcium, magnesium, and fluoride.

Boiling	• Water boils at 100°C , whereas most microorganisms cannot survive in water above 70 °C for more than 30 minutes.	• Effective in destroying all classes of waterborne pathogens and can be effectively applied to all waters, including those high in turbidity.	• Does not remove chlorine or contaminants such as lead.

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