Water Recycling in Australia

For those seeking more detailed information on recycled water use in Australia, particularly for agricultural and amenity uses.

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NATIONAL PROGRAM FOR Sustainable Irrigation

HAL Know-how for Horticulture™

contents

How much water do we use?

Australia's total annual water use adds up to about 26 000 gigalitres (GL). This is about 1.3 million litres per person per year (1.3 megalitres or ML).

Daily domestic water use averages about 320 litres per person (about two bathtubs full, one for the house and one for the garden).

Why recycle our water?

Recycling our water can offer substantial benefits to our society including:

- Reduction of nutrient and contaminant loads into oceans and rivers
- Providing more drinking quality water for domestic uses by substituting drinking quality water with recycled water for irrigation of agricultural crops and amenity horticulture
- Reduced stress on the groundwater and rivers by providing alternative water supplies

There may also be benefits to agricultural and amenity enterprises through:

- Guaranteed water supply and water quality
- Security for investment in agricultural enterprises
- Recycling of valuable nutrients

What is recycled water?

Water recycling is a generic term for water reclamation and reuse, where the resulting water is referred to as recycled water. This term will be used throughout this document, but you might also find a number of other terms used in the water industry. These include:

- Water reclamation
- Water recycling
- Water reuse
- Wastewater
- Sewage effluent
- Reclaimed water
- Grey water

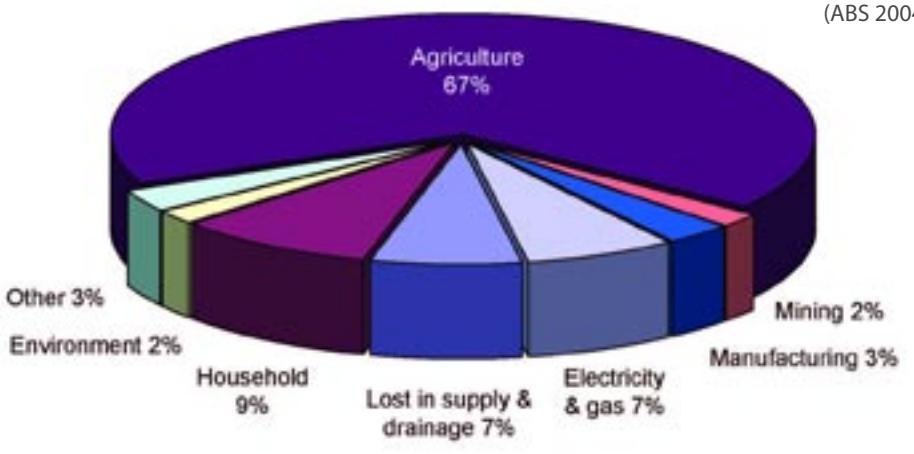
Definitions for these and other terms can be found in the glossary (page 15).

Water recycling can include:

- Recycling of wastewater from previous uses. This generally means the reclamation of water from domestic sewage effluent or municipal wastewater. These waters may be recycled from bathroom and laundry effluents (grey water), from the entire domestic sewage stream (black water) or from municipal wastewater
- Recycling of water from agricultural and industry wastewater

Recycled water can be either or both of the above waters. This document refers specifically to the recycling of water from treated sewage effluents.

Figure 1
How Australia's water resources are used (ABS 2004)



Australia's water resources

Water resource management poses significant ongoing challenges in Australia. Our annual water use is approximately 1.3 million litres per person, the third highest consumption rate in the world. The largest two uses of water in Australia are agriculture (67% or 16 700 GL, 2001-02) and domestic (i.e. households - 9% or 2 200 GL, 2001-02). Increasing strain on our water resources has resulted in a greater focus on the efficient management of all water sources in Australia.

Many capital cities in Australia estimate that in the future they will not have sufficient water supplies to meet their growing populations.

One water resource that has been under-utilised in Australia is 'treated' sewage effluent (commonly known as wastewater, recycled water or reclaimed water). Currently, less than 10% of this water resource is treated and utilised with the remainder being discharged at various points in the environment. However, there is growth in the use of recycled water for a variety of purposes. Recycled water provides benefits for the community and the environment by increasing available water resources and decreasing nutrient and contaminant loads to surface and coastal waters.

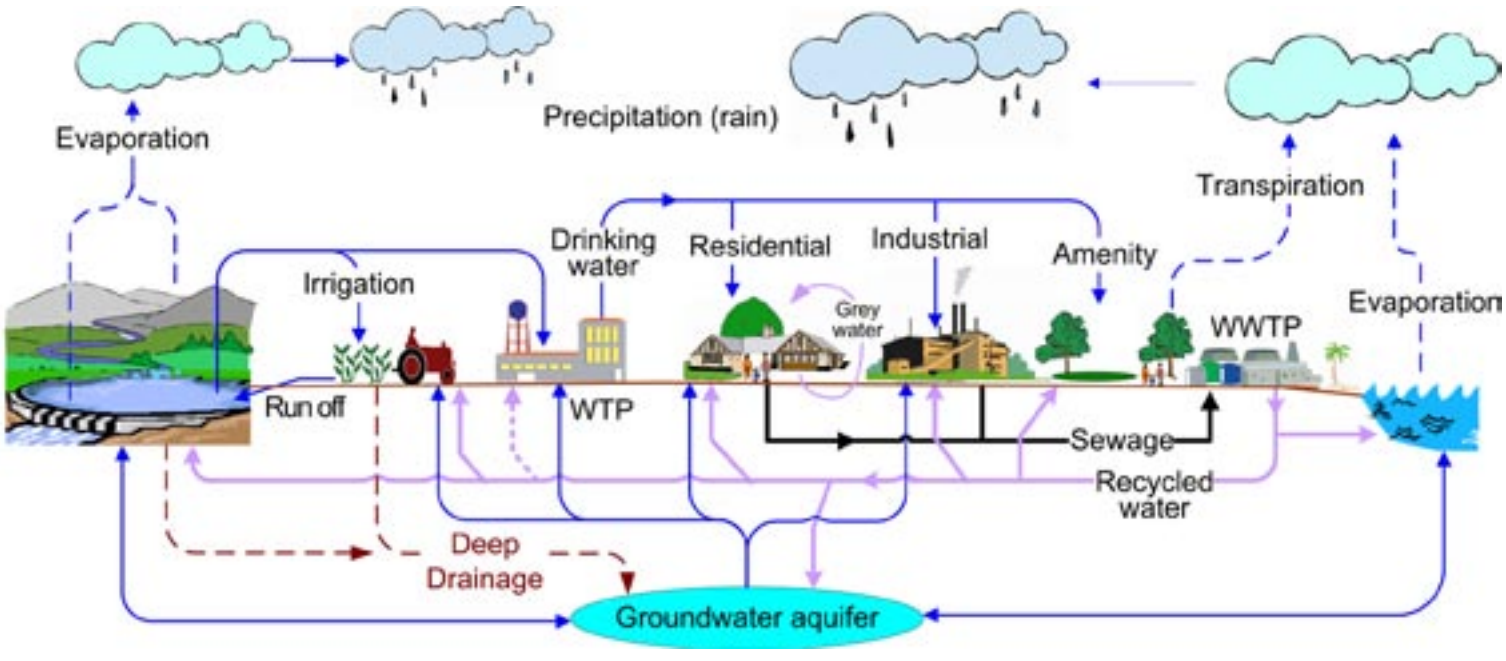
We must also remember that all water we use or reuse returns to the environment to become part of the natural water cycle through run off or drainage and ends up in the atmosphere, creeks, rivers, oceans, lakes, groundwater and other water reserves (Figure 2). A lot of water also evaporates and ends up as clouds, returning to the land as rain, snow or ice (Figure 2).

Australia's recycled water resources

About 12% of Australia's water is used for household and manufacturing purposes (Figure 1) with a large percentage ending in the reticulated wastewater stream. In total, some 2 000 GL of this water is thought to be recoverable, but in 2002 less than 10% (167 GL) of the total output from sewage treatment plants was recycled. There are significant differences in reuse between states, with South Australia recycling greater than 15% of its wastewater, but Victoria, Australian Capital Territory and Northern Territory recycling less than 10%. The cities of Perth, Melbourne and Canberra have targets of achieving 20% water recycling within the next ten years.

Some of the highest rates of recycling water occur in regional Australia, but volumes are relatively small. In many arid areas of Australia the reliable supply of wastewater is very attractive to irrigators. Many inland towns have been supplying water to farmers for years, either formally through reticulated systems, or informally via downstream extractions. For example, nearly all small towns in WA and many throughout Australia recycle 100% of their wastewater.

Figure 2
Typical water cycle (blue) including recycled water (lilac) and sewage (black)
WTP = Drinking Water Treatment Plant
WWTP = Wastewater Treatment Plant



Annual water reuse from sewage treatment plants in Australia 2001-02

State	%	GL
NT	5.5	1.1
ACT	5.6	1.7
Tas	9.5	6.2
WA	10.0	12.7
SA	15.1	15.2
Vic	6.7	30.1
Qld	11.2	38.0
NSW	8.9	61.5
AUST	**9.1**	**166.5**

(Radcliffe 2004)

What can recycled water be used for?

Recycled water can be used for just about anything, as long as it is treated to a level to make it fit for the intended purpose, from a health and environmental perspective (Figure 3) . However, the cost of treatment may make reclamation uneconomical for some uses.

Australia now has more than 580 different recycled water schemes operating, which use approximately 167 GL/year. The bulk of these schemes involve:

Urban environments
: Households, golf courses and recreational parks.

Industry
: Washing and cooling in power stations and mills.

Agriculture
: Horticulture, forestry, pasture, flowers, viticulture and sugar cane.

Other possible uses include:

- Fire fighting
- Groundwater recharge
- Municipal landscapes
- 'Dual pipe' urban uses
- Environmental flows and wetlands

It is now also possible for advanced treatment technology to produce safe drinking (potable) water. In several countries wastewater is recycled for potable reuse via groundwater injection (e.g. Factory 21, Orange County, California, USA) or where it is added directly to surface reservoirs (e.g. NeWater, Singapore). Such planned indirect or direct potable reuse is not currently practiced in Australia, although it is being considered by some councils with severe water shortages.

Recycled water for agriculture and amenity horticulture

Approximately 230 recycled water schemes use recycled water in urban environments, while some 270 schemes are in agriculture. Agriculture uses the largest volume of recycled water accounting for 82% (423 GL) of all recycled water used. Most recycled water in agriculture is used for pastures, dairy farming and horticulture (fruit, grapes and vegetables). Golf courses, sporting grounds and parks are also a significant user of recycled water, using approximately 33 GL. Urban gardens are a relatively small user of recycled water.

The required quality of the recycled water will differ depending on the crop being irrigated or the use of the amenities.

The reclamation or treatment process

Recycled water can be produced using different degrees of treatment to produce a defined quality of water which will be fit for the intended purpose (Figure 3).

Australia's water industry is one of the world leaders in water recycling. They use some of the most developed and robust treatment technology and have a strong commitment to water recycling.

Class A is usually the best quality recycled water as it must meet stringent microbiological health standards before it is fit for the purpose of irrigating all crops, even fresh vegetables (Class A+ is used in Queensland and refers to the same very high quality recycled water described as Class A in other states). It is generally produced using tertiary and/or advanced treatment processes (Figure 3) and includes a disinfection process. There are also lower classes of recycled water (B, C and D), which for health reasons have restrictions placed on them. For example, restrictions include: crops that can be grown (fresh versus produced peel or processed); the extent of direct human contact with the water; and the method of irrigation (spray versus subsurface drip).

The treatment processes are carefully controlled and monitored using food safety systems (e.g. Hazard Analysis and Critical Control Points – HACCP), ensuring consistent water quality and compliance with State, Territory and Commonwealth guidelines (see 'Guidelines and risk management', page 5).

Recycled water must also be fit for the intended purpose from an environmental perspective. Treatment processes focus primarily on pathogen reduction (human health) in recycled water (Figure 3). However, part of the recycled water treatment process can also substantially reduce nutrient and other contaminant levels, making it safer in aquatic systems (e.g. environmental flows). Advanced treatments can also remove salts resulting in more environmentally sustainable irrigation systems. However, the more water is treated, the greater the cost. A balance between economic and environmental sustainability and safety is often sought by government and industry.

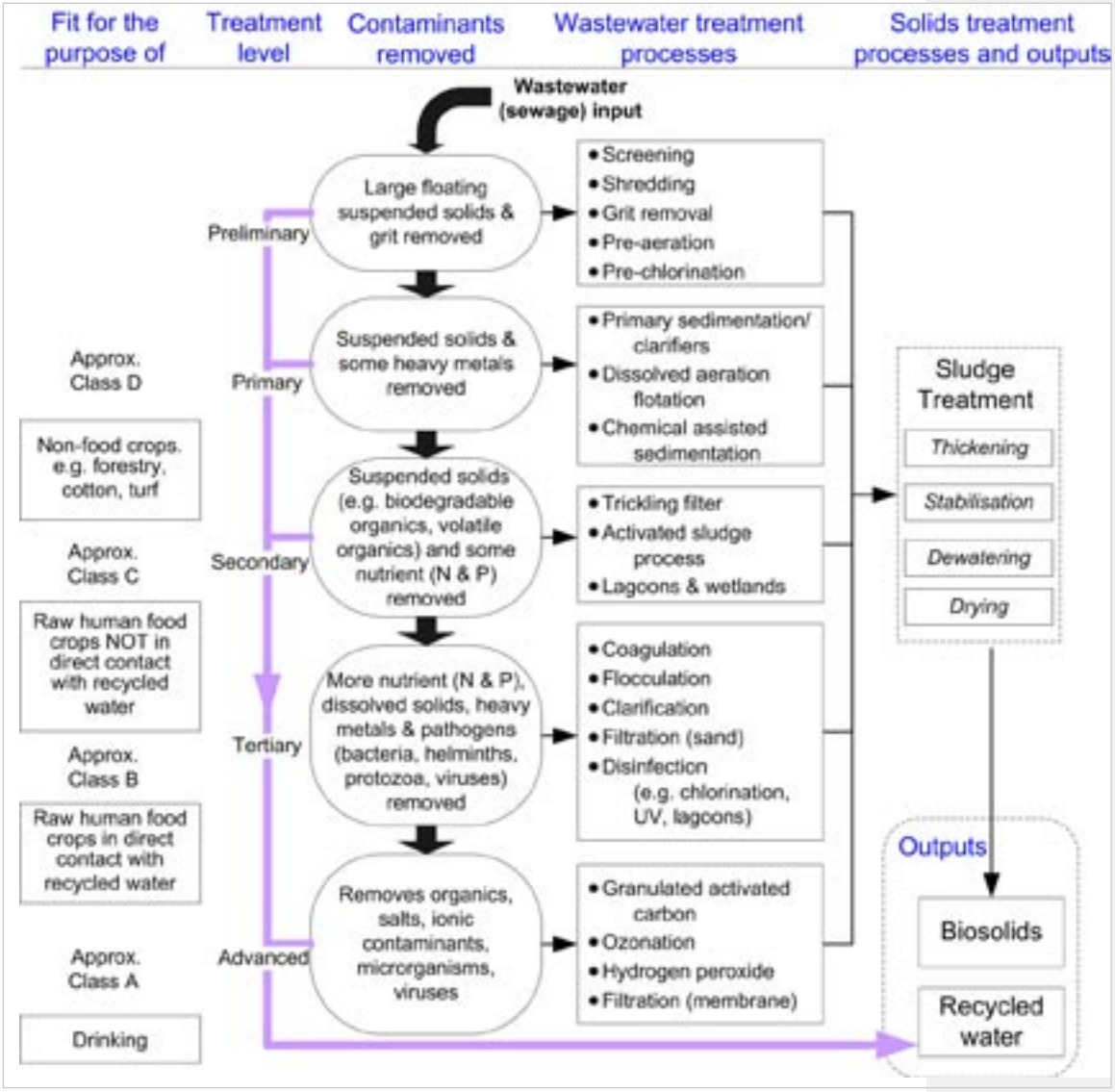


Figure 3
Treatment levels and processes typically used to treat wastewater. This diagram gives a general indication of parameters; it is not a substitute for specific guidelines and verification processes

Figure 4
Example of lilac colouring of pipe and tap required for recycled water use in agricultural and urban areas

Guidelines and risk management

Australia is drafting a new national guideline for recycled water which refers to water being fit for the intended purpose. However, state guidelines still refer to classes of water and people generally understand what these mean in their state.

Recycled water can be produced using different degrees of treatment to produce a defined quality of water (Figure 3). In Australia, these qualities are commonly classified into Classes A, B, C or D, depending on the state/territory or federal guidelines followed. Different guidelines have specific standards that vary from state to state (e.g. all states have Class D recycled water except Tasmania). Most states in Australia (SA, Tas, Vic, NSW, Qld) have guidelines for irrigation of crops and pastures with recycled water. These have been developed from extensive research in Australia and around the world and from risk management principles. Scheme operators, managers and practitioners need to comply with state and national guidelines. See your state guidelines for detailed information regarding appropriate water qualities required for a specific reuse scheme.

The new draft Australian National Guidelines for Water Recycling use 'fit for purpose' in place of the Class A to D system. The draft Guidelines (Feb 2006) have adopted a standard risk assessment (www.ephc.gov.au/ephc/water_recycling.html) and Hazard Analysis and Critical Control Point (HACCP) system.

The standard risk assessment approach has 7 main steps:

1. Communicate and consult
2. Establish the context
3. Identify the hazards/risk
4. Analyse the risks
5. Evaluate the risks
6. Treat the risks
7. Monitor and review the hazards/risks
8. Record the risk management process

HACCP is now the international standard for food safety. When guidelines and best practice principles are followed, users and consumers can be confident that it is safe to work with recycled water, the food grown with recycled water is safe, and that the environment is not adversely affected by the use of recycled water.

How do I know where recycled water is used?

In Australia, recycled water plumbing and taps are identified by their colour. Generally, Australian design standards (AS/NZS 3500.5:2000) require all plumbing outlets, and in most cases pipes, to be marked with the colour lilac (Figure 4) and the words:

"RECYCLED WATER — CAUTION NOT FOR DRINKING" or similar as approved by the relevant state authority.

Common units

1 kilolitre (KL) = 1 000 litres (L) = 1 cubic metre = 1 tonne of water

1 000 KL = 1 megalitre (ML) = 1 million litres = 100 mm of water over 1 hectare

An Olympic swimming pool = 2.5 ML

1 Gigalitre (GL) = one thousand million litres (1 000 ML)

What are the potential risks associated with recycled water?

The risks associated with recycled water must be minimised to acceptable levels before recycled water can be used in any specific situation (i.e. the water must be fit for purpose). In most cases, these environmental and health risks can be managed through the level of wastewater treatment or by the carefully managed use of recycled water (Figure 5). However, in some cases these risks are too costly to manage and the reuse scheme may not be economically viable.

Individual state environment and/or health related authorities are generally responsible for ensuring the water recycled is fit for the intended use.

Key potential health risks

Microbial pathogens in wastewater from sewage effluent are the major concern for human health when recycling water. The major groups of pathogens are:

- Bacteria (e.g. Escherichia coli, Salmonella spp)
- Viruses (e.g. Enteroviruses, Rotavirus, Hepatitis A)
- Protozoa (e.g. Giardia Lamblia, Cryptosporidium parvum)
- Helminths (e.g. Taenia spp (Tapeworm), Ancylostoma spp (Hookworm))

Not all infections make you sick. To become infected by a pathogen you must be exposed to a sufficient number of pathogens. If recycled water is fit for the intended purpose, exposure will be low and infection unlikely as it is related to the concentrations of pathogens in the recycled water and the amount of water ingested.

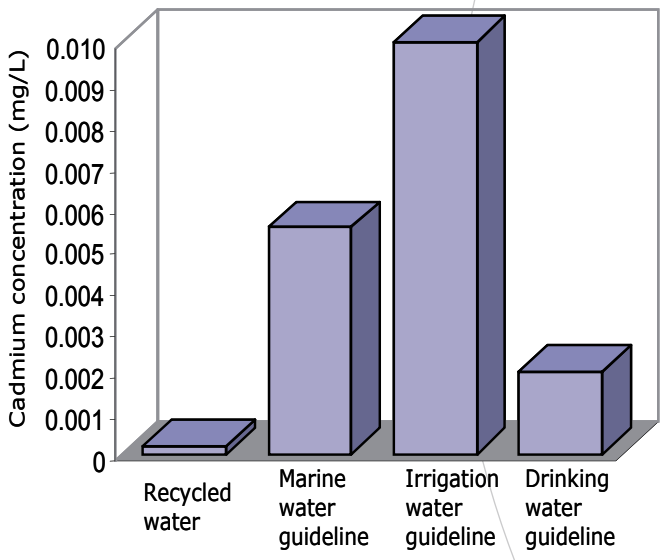


Figure 5 Comparison of cadmium (a heavy metal) concentration measured in recycled water (Class A) with other water guidelines limits in Australia

Key potential environmental risks

Some of the common environmental risks from recycled water include:

Salinity
Chronic problem which needs to be managed in all irrigation systems. Can result in reduced plant growth and plant damage and can impact on freshwater plants and invertebrates in natural ecosystems if discharged directly with little dilution. Most common salts are sodium chloride.

Sodicity
Excess sodium in recycled water can cause soil dispersion/swelling, reducing water infiltration on heavier textured soils. This can be difficult to remedy.

Sodium
Can be toxic to some plants if it accumulates in soils from ongoing irrigation. More important as a component of salinity and sodicity.

Chloride
Can be toxic to plants if sprayed directly on leaves, and if it accumulates in soils from ongoing irrigation, but is usually more important as a component of salinity.

Nitrogen
Mostly of benefit to cultivated plants, but can cause eutrophication (excessive nutrient levels) in land and aquatic ecosystems.

Phosphorus
Mostly of benefit to cultivated plants, but can cause eutrophication (excessive nutrient levels) in land and aquatic ecosystems.

Chlorine residuals
By-products of disinfection processes may be harmful to aquatic or marine ecosystems if discharged directly with little dilution.

Hydraulic loading
Too much water applied to land can result in excess groundwater recharge, water logging and secondary salinity.

Boron
Plant toxicity may arise in some plants in some soils if it accumulates from ongoing irrigation.

Surfactants
Some organic and inorganic surface active agents from detergents can remain in recycled water and be harmful to some aquatic organisms.

Other risks which require monitoring

A broad range of chemicals have been identified as having the potential to alter normal endocrine function in animals, i.e. endocrine disrupting chemicals (EDCs). At this stage, there is no evidence that environmental exposure to low levels of potential EDCs (potentially present in recycled water) affects human health because of the relatively low exposure. However, ongoing monitoring is required to ensure good risk management.

Pharmaceutical chemicals and their metabolites, potentially found in recycled water, raise similar issues to EDCs (above). Health impacts from pharmaceuticals should also be minimal because of the relatively low exposure. However, ongoing monitoring is required to ensure good risk management.

All of these risks are manageable if guidelines and appropriate risk management principles are followed

How safe is recycled water?

Recycled water is very safe when guidelines are followed and it is used for the intended purpose. Recycled water schemes are approved by the designated regulatory authorities in each state of Australia. This is usually the departments responsible for health and/or the environment. These departments assess the level of risk to humans or the environment to determine if a recycled water scheme will be approved. The level of risk which is considered acceptable is the same, if not better, as that used for drinking water treatment and reticulation schemes in Australia. In many cases, recycled water more than meets many other water quality guidelines used in Australia (Figure 5).

Is recycled water safe for use in agriculture?

Yes. In Australia, Class A is the highest rating for recycled water used for irrigation and is equal to the most stringent guidelines anywhere in the world. It also exceeds standards recommended by the World Health Organisation for irrigation of food crops. State Departments of Health and Environmental Protection Authorities (or equivalent) set these strict guidelines to ensure the safety of farmers irrigating with recycled water, the public and consumers. Every reuse scheme requires the approval of these departments and must show that appropriate control measures are in place (before the reuse scheme is commissioned) to guarantee a particular water quality to the user, which is fit for purpose. These extensive safeguards ensure the microbiological and chemical safety of recycled water from a health and environmental perspective, and also the quality of food crops produced by irrigating with recycled water.

From a health and pathogen perspective, Class A recycled water is considered suitable for unrestricted irrigation of all crops, including food crops. Lower classes can be restricted to certain agricultural crops depending on the irrigation method, crop and post harvest process involved. Separate labelling for produce is not needed as the produce is required to meet the same food safety standards as crops irrigated with traditional water sources.

Is recycled water safe for use around the home?

Health and environmental risks from Class A recycled water provided to households through reticulated recycled water pipes (lilac) are very low as it has been treated specifically for use around the house and garden. Recycled water use inside the house is usually restricted to the toilet and laundry.

There is also an increasing trend towards grey water use around the home. On-site use of water from the laundry and bathroom (grey water) is not as safe as treated 'dual pipe' recycled water because it is likely to contain high numbers of micro-organisms, some of which may cause disease. Kitchen sink waste may pose more health and environmental risk and is best disposed of via sewerage systems.

National guidelines for grey water use suggest that grey water can be used for garden irrigation, but only via drip or subsurface emitters and not for vegetable crops. Fruit trees can be irrigated if subsurface or drip irrigation is used, provided that fruit is not allowed to fall on to the ground where bacteria and other pathogens from grey water may reside.

Yes

Water recycling is safe if appropriate guidelines are followed

Figure 6
Birdlife on a wetland where recycled water is the sole water source

Is the person using recycled water safe?

Class A recycled water is of similar or higher quality compared with many of the alternative water sources currently used for fire fighting, irrigating and road making. Considering the quality of recycled water (Class A) and the degree of exposure to these users, their health will not be compromised if good personal hygiene is practised.

However, if lower classes of recycled water are used, more detailed occupational health and safety procedures may be required to minimise the user's direct exposure to the recycled water.

Environmental allocation

Beneficial environmental allocation is the planned addition of recycled water to surface waters. This can lead to: improved environmental outcomes for biota, habitats and ecological processes; improved cultural values, contact recreation activities and aesthetic uses; and approved water extractions for irrigation. By default, some rivers in Australia already receive considerable benefit from the stream flow generated from sewage treatment plants. For example, recycled water from the city of Canberra discharges into the Molonglo River and provides up to 100% of the river flow at times. Removing this flow could impact significantly on environmental and social processes that are sustained by the current 'discharge', as flow will decrease significantly.

There is substantial opportunity to increase the quality and quantity of water flowing down our rivers and streams by using specifically tailored recycled water.

Acceptance of recycled water use in agriculture and amenity horticulture

A number of surveys have shown that acceptance of recycled water use varies across communities. Generally, there is widespread support for recycling water but the closer the water comes to personal contact, the less acceptable the reuse option. Factors that might influence this are: **source of recycled water; degree of contact; trust; emotion**; risk perceptions; choice; knowledge; environmental attitudes; environmental justice issues; cost and socio-demographic factors. Recent studies in Australia have shown the first four factors above (bolded) were most important in influencing our acceptance of recycled water.

The major predictors of how people will behave toward recycled water and irrigation of food crops are thought to be:

- Attitudes, which are influenced by emotion and trust
- Subjective norms (i.e. what those people we relate to think or would do)
- Emotions, which are influenced by trust and subjective norms

Other research in Australia and other parts of the world have shown that consumers generally accept produce irrigated with recycled water if it is of the same standard as produce grown with other water sources. Trust in government regulation is very important.

It is critical that users of recycled water and people who purchase produce grown with it have ready access to information when they seek it. This information should focus on issues and concerns that are important to the particular communities and might influence their decisions to use the recycled water or buy the produce.

Research has shown that where recycled water has been used for some time in horticulture:

- Growers and their markets (including major retailers) have accepted the use of recycled water to grow food crops
- Growers trust in the quality control of recycled water has been strengthened by the fact that produce has always been accepted by the markets and there have been no detrimental health impacts
- Farmers value the water
- Quality assurance advisors and wholesalers have confirmed there is no difference between crops grown with recycled water and traditional sources

Some important issues for the future

Who owns recycled water and how much is it worth?

Currently, there is some confusion regarding the ownership of recycled water, probably since the recycled water was previously considered part of sewage treatment waste. Often recycled water is sold to a company for distribution to the users. However, legal difficulties arise where recycled water is discharged to water bodies and then used beneficially downstream. The discharge of recycled water could then potentially be withdrawn by the water treatment body impacting on the user of this water source. Such problems will need to be resolved in the near future if the industry is to develop smoothly. Research into access to recycled water and determining responsibilities for recycled water is currently underway.

Supply of recycled water to the end user

Reclamation of water from sources such as sewage is now an established component of sustainable water resource management in Australia. This provides increased water security and reduces direct discharge of nutrients and other contaminants to our rivers and oceans.

Although demand for recycled water is likely to increase in the future, a major constraint to more widespread use of water from the large city wastewater treatment plants is the cost of pumping recycled water back to the users. Most capital city sewerage systems have made effective use of gravity to pipe sewage to the coast where sewage treatment plants and the ocean outfalls are located. The direct and indirect (greenhouse) cost of pumping back uphill may be prohibitive.

Selected large industrial reuse projects and urban landscaping projects which are located close to wastewater reclamation plants are cheaper to establish than dual reticulation residential schemes from large centralised reclamation plants. However, for new residential subdivisions the cost of a second pipe adds only a relatively small amount to the price of each block. There may be more economic benefit to build smaller scale local reclamation systems, rather than to install large mains and incur the substantial energy costs of pumping over long distances and challenging topography. Establishing recycling systems during development of regions is almost always more cost effective than retro-fitting.

Summary

Recycled water has become an integral part of Australia's water resources. If guidelines are followed and recycled water is used for the purpose intended, risks to human and environmental health are insignificant. However, the benefits are significant. For example: recycling of nutrients; replacement of water to be used for irrigation that can be now used for drinking; beneficial allocation to the environment; reduced nutrient and contaminant loads into water bodies; reduced stress on traditional water sources; and guaranteed water supply to recycled water users.

Some examples of recycled water schemes in Australia

Virginia Water Recycling Scheme, SA (horticulture)

The Virginia Water Recycling Scheme is one of the largest recycled water schemes in Australia. A $30 million filtration/disinfection plant was built to treat effluent from the Bolivar sewage treatment plant, producing Class A recycled water which is used without restriction for irrigation of horticultural and agricultural produce (e.g. carrot, broccoli and pasture).

The 100 km pipeline recycled water distribution network is owned and operated by Earth Tech, a private engineering company. The scheme has grown rapidly from using 1 600 ML in 1998 to 12 100 ML in 2005 (20 000 ML has been contracted to growers). This quantity of water, treated to a lower standard, would otherwise have been discharged to the Gulf of St Vincent and diminishing groundwater reserves in the region used for irrigation instead.

The water is used by more than 240 growers to irrigate a range of food and non-food crops sold to local, national and international markets.

Eastern Irrigation Scheme South East Melbourne, Vic (horticulture, sports grounds and households)

The Eastern Irrigation Scheme delivers 5 000 ML of Class A recycled water each year for irrigating market gardens, golf courses, racetracks and residential developments. The scheme was officially launched in May 2005 and is a partnership between Melbourne Water and Earth Tech, a private engineering company.

Earth Tech designed and built an ultrafiltration plant, the largest of its kind in Australia, to process treated wastewater from Melbourne Water's Eastern Treatment Plant to Class A standard. Earth Tech also designed and built the 50km pipeline network to distribute the recycled water.

It will also supply a residential third pipe development for toilet flushing and garden watering in the Cranbourne-Five Ways area. Approximately 2 000 homes at Sandhurst and two 18-hole golf courses in Carrum Downs are already connected under this scheme, ultimately using 1 200 ML of recycled water a year for the golf courses and recreational areas, as well as for residential garden watering and toilet flushing.

Figure 7 Membrane filtration bank for recycling water at South East Melbourne

Northern Territory (forestry, sports grounds and public landscapes)

Recycled water is used on a limited basis in Darwin, Pine Creek, Katherine, and Alice Springs. However, the demand for recycled water from large irrigation customers is increasing. Benefits include the potential to reduce watering costs and potable water use, and extend watering during dry periods.

Kwinana, WA (industrial)

There have been few water reuse schemes in the Perth metropolitan area to date due to the availability of groundwater and concerns about the possible contamination of groundwater from recycled water. However, a major reuse project is underway at Kwinana, producing 5 000 ML/year for mining, power, chemical, fertiliser and petroleum industries in the area.

Rouse Hill, NSW (households)

More than 15 000 households at Rouse Hill, in the north west of Sydney, are currently connected in a third pipe recycled water scheme run by Sydney Water. The homes have two water supplies: recycled water and drinking water. The recycled water taps, pipe work and plumbing fittings are coloured lilac to ensure that recycled water is not confused with drinking water. Drinking water is used for drinking, cooking and showering. The recycled water is used for garden watering, washing cars, toilet flushing, park and golf course irrigation and for local industrial purposes.

Hervey Bay, Qld (recreational and horticulture)

Wide Bay Water at Hervey Bay is providing recycled water from its sewage treatment plant for use on sugar cane, a turf farm, a golf courses, sports fields and other uses. They currently recycle greater than 90% of their wastewater.

Australia Trade Coast, Qld (industry and green-field)

Australia Trade Coast (ATC) was launched in May 1999 as an initiative to transform Brisbane's 8 000 hectare 'ports' precinct into a major global trade and industry hub on the East Coast of Australia. The predicted growth will outstrip drinking water supply infrastructure into the future. A Water Master Plan for the area will make available both Class A and demineralised water from local wastewater treatment plants to specific zones in the ATC. Stage 1 was completed in 2000 and supplies 10 ML/d of demineralised water to an oil refinery. Stage 2, soon to be implemented, will supply other existing large water using customers in the area from other local treatment plants. Stage 3 will be constructed in line with market development of green-field space in the area. The total scheme is expected to supply approximately 50 ML/d of recycled water, offsetting a similar amount of drinking water.

Glossary

Beneficial allocations
Planned allocations of recycled water to surface waters. They may provide improved environmental outcomes for biota, habitats and ecological processes, improved cultural values (contact recreation and aesthetic use), as well as approved water extractions for irrigation.

Biosolids
Organic material which comes from micro-organisms used in sewage treatment and water from this process.

Black water
Toilet waste.

Direct recycling for drinking
This encompasses water that has been highly treated to make it suitable for human drinking water use and is conveyed directly from the treatment plant to the water supply system. The best-known example is in Windhoek, Namibia.

Drinking water (potable water)
Water suitable for human consumption without health risks.

'Dual pipe' systems
Provision of recycled water to households via a centralised reticulated mains system. Typical uses are garden watering, toilet flushing and car washing.

Effluent
Out-flow of water or wastewater from any water processing system or device.

Environmental flows
Beneficial allocation of water specifically for environmental gains.

Fit for purpose
Safe for the intended use.

Grey water
Wastewater from the hand basin, shower, bath, spa bath, washing machine, laundry tub. It is not the water from the toilet, kitchen sink or dishwasher. Water from the kitchen is generally too high in grease and oil to be reused successfully without significant treatment.

Indirect recycling
The beneficial use of water after it has been discharged from a treatment plant into a natural surface water or groundwater body, from which water is extracted often without consideration of the origin of the water.

Non-potable water
Water that does not meet drinking water standards, but may be fit for other specifically defined purposes.

Pathogen
Disease-causing micro-organism.

Recycled water
Water that has been through a reclamation process and used for another purpose. Reclaimed and recycled water are commonly used to mean the same thing.

Reclaimed water
Water delivered from wastewater and treated to a level appropriate for its intended use.

Sewage
Used water and waste substance produced by human bodies and industries, transported in sewerage systems.

Stormwater
Water which runs off urban and semi-urban developments following rainfall on roads, the ground, roofs, footpaths etc, usually carried away by drains. Contaminants are picked up from the surfaces stormwater runs over.

Unplanned or incidental recycling for drinking
Use of recycled water after it has been treated and then discharged into surface or groundwaters from which further water is taken for human 'drinking water' supplies. For example, Adelaide takes up to 85% of its water from the River Murray, downstream from many towns discharging treated effluent into the Murrumbidgee/Murray river system.

Wastewater
Water which is being disposed after it has been used.

Water reclamation
Treatment of wastewater to make it reusable for one or more applications. The process produces recycled water.

Water reuse
Beneficial and planned use of recycled or treated water for specific purposes such as irrigation, industrial or environmental uses especially on-site (e.g. reuse household 'grey water' for garden irrigation).

Water recycling
Reclamation of wastewater generated by a given user for on-site use by the same user, such as in industry (e.g. systems for washing and cooling, which use the same water several times, with or without treatment between uses). However, it is now commonly used as a generic term for water reclamation and reuse in Australia.

Further information

National guidelines

NRMMC, EPHC (2005) National Guidelines for Water Recycling. Managing Health and Environmental Risks. Draft for public consultation.
www.ephc.gov.au/ephc/water_recycling.html

ANZECC & ARMCANZ, NHMRC (2000) Guidelines for sewerage systems: Use of reclaimed water. NWQMS Australian and New Zealand Guidelines for Fresh and Marine Water Quality
www.mincos.gov.au/pub_anzwq.html

DAFF (2005) Guidelines for developing recycled water schemes in horticulture
www.daff.gov.au/waterguidelines_hort

State recycled water use guidelines available online

NSW	www.environment.nsw.gov.au/water/effluent.htm
Qld	www.epa.qld.gov.au/register/p01212aa.doc
SA	www.environment.sa.gov.au/epa/pdfs/recycled.pdf
Tas	www.dpiwe.tas.gov.au/inter.nsf/WebPages/CDAT-5JV3TW?open
Vic	http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/PubDocsLU/464.2?OpenDocument

State agencies

EPA New South Wales	www.environment.nsw.gov.au/water/index.htm
EPA Queensland	www.epa.qld.gov.au/environmental_management/water/
EPA South Australia	www.environment.sa.gov.au/epa/water.html
Primary Industries, Water & Environment (Tas)	www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/DREN-4VH8C4
EPA Victoria	www.epa.vic.gov.au/Water/
EPA Western Australia	www.epa.wa.gov.au/

Websites for more information on recycled water

Australia

Australian Heritage Commission	www.ahc.gov.au
Agriculture Fisheries and Forestry – Australia	www.affa.gov.au
ATSE Water Recycling Report (Radcliffe 2004)	www.atse.org.au/index.php?sectionid=597
CRC for Water Quality and Treatment	www.waterquality.crc.org.au
Department of Environment and Heritage	www.deh.gov.au
National Program for Sustainable Irrigation	www.npsi.gov.au
Murray Darling Basin Commission	www.mdbc.gov.au
National Coordinator Reclaimed Water Development in Horticulture	www.recycledwater.com.au
National Environmental Protection Council	www.ephc.gov.au

International

United States EPA	www.epa.gov
FAO HACCP	www.fao.org/docrep/W8088E/w8088e00.htm#Contents
World Water Council	www.worldwatercouncil.org

Other useful reference materials

ABS (2004) 'Water accounts Australia 2000-01.' (Australian Bureau of Statistics: Canberra, Australia).

Hamilton AJ, Boland A, Stevens D, Kelly J, Radcliffe J, A. Z, Dillon P, Paulin B (2005) Position of the Australian horticultural industry with respect to the use of reclaimed water. Agricultural Water Management 71, 181-209.

Radcliffe J (2004) 'Water recycling in Australia.' (Australian Academy of Technological Sciences and Engineering, Parkville, Victoria).

Stevens D (Ed) (2006) Growing Crops with Reclaimed Wastewater. CSIRO Publishing, Melbourne.