

## 7. Supply and use of recycled water

### 7.1 PROTECTION AND MAINTENANCE OF DISTRIBUTION SYSTEMS AND STORAGEES

Most recycled water delivery systems require some form of storage to provide a buffer during periods of lower demand or for temporary detention in the event of system malfunction. The two principal issues that arise with regard to storage of recycled water are storage capacity and microbial and algal growth.

#### 7.1.1 Sizing of recycled water storages

Recycled water that is supplied for irrigation, whether for crops, landscape irrigation or garden watering, is subject to large fluctuations in demand owing to seasonal variation in plant growth and precipitation.

As irrigation of recycled water should not take place during rain events or when the soil is saturated, either the supplier or the user will sometimes need to have the capability to store the excess supply of recycled water or to discharge it to the environment.

Where the water recycling project receives water from an STP operating under an existing development approval, the sizing of the storage and any consequent requirement for discharge to the environment resulting from overtopping or bypassing of the storage should be discussed with the relevant local office of the EPA. The sizing of storage should also be addressed in the project's Recycled Water Management Plan.

The Model for Effluent Disposal using Land Irrigation (MEDLI, see section 7.3.5 of these guidelines) can be used to compare the effect of different capacities of recycled water storage on the performance of a scheme using a given size of irrigation area. The size of the storage will influence the likelihood of releases of recycled water from the storage during wet weather. From this, a combination of storage size and irrigation area can be selected so that the magnitude and frequency of overtopping is such as not to cause environmental harm or adversely affect the environmental values of any receiving water body. For large scale recycled water irrigation schemes, any relevant provisions of Chapter 3 (Part 6, Referable Dams and Flood Mitigation) of the Water Act should be followed. These include the need for licensing of what are called 'referable' dams (classified by height and storage).

#### 7.1.2 Maintenance of water quality during storage of recycled water

Whenever recycled water is stored, as well as during its residence time within the recycled water pipe system, there will be potential for microbial or algal growth that could lead to a reduction in water quality. Also, open

storages are susceptible to contamination with animal and bird faecal matter and re-suspension of sediments. Where there is potential for degradation of water quality during storage or distribution, appropriate disinfection, further treatment or other preventive measures may need to be applied, depending on the planned final use of the recycled water.

Storage of recycled water in open storages at any stage of treatment or distribution has the potential to promote the growth of cyanobacteria and algae, which can significantly reduce water quality for many applications. The risk of algal blooms is increased when nutrient levels are elevated (particularly phosphorus) and when water temperature is high.

If an algal bloom occurs in a recycled water storage, supply of recycled water for stock watering, irrigation or other purposes that could involve inhalation of aerosols should be discontinued. As the identification of the specific cyanobacteria that may contain toxins can only be done by specialists, supply should not be reconnected until a laboratory (with accreditation by NATA for the appropriate testing method) has confirmed the absence of toxins.

If the risk of algal blooms in stored recycled water has been determined as being high or very high, control measures should be considered. These could include increased nutrient removal during treatment, establishment of aquatic plants within the storage so that excess nutrients can be taken up or some form of chemical or physical treatment to reduce algal growth in the storage. Destratification of water storages has been found to reduce the tendency for algal blooms, especially some toxic forms of cyanobacteria. Further advice on prevention of algal blooms in water storages can be obtained from the Department of Natural Resources and Mines (see Appendix D for contact details) or see the DNRM fact sheets: *Blue-green algae: General information* and *Managing blue-green algae blooms in farm dams*.

#### 7.1.3 Disposal of below specification recycled water

When recycled water has been produced that does not meet specifications, or beneficial use is not possible, the recycled water supplier and/or user should ensure that alternative methods of either storage or disposal are available to avoid contamination of already treated water. If the supplier needs to dispose of below specification recycled water, this should be done in accordance with their existing development approval. If there is no development approval covering the use of recycled water, advice should

be sought from the local EPA office before disposal to the natural environment is undertaken as any such release may cause environmental harm or adversely affect the environmental values of the receiving water body.

#### 7.1.4 Mosquito control in storages

In Queensland, mosquitoes are vectors of Ross River virus disease, Barmah Forest virus disease, dengue, malaria, Japanese encephalitis virus disease and Murray Valley encephalitis virus disease. Breeding sites include fresh, brackish and polluted water in natural and constructed ground sites as well as artificial containers such as water storage tanks, constructed drains, tyres and discarded tins and bottles.

It is essential that the implementation of water recycling does not enhance mosquito breeding and the transmission of disease. The Local Government Association of Queensland has produced a *Mosquito Management Code of Practice* (LGAQ 2002) that contains detailed advice on mosquito control in Queensland. Some key preventative measures are discussed below:

- Consideration should be given to potential mosquito breeding in the design stage of recycling projects. Queensland Health (2002) has published *Guidelines to minimise mosquito and biting midge problems in new development areas*. This document provides advice on how to prevent or minimise the impact of mosquitoes and other biting insects in new development areas.
- Constructed wetlands, water impoundments, grass swales and open earth drains can all be designed so as to minimise mosquito breeding. The *Australian Mosquito Control Manual* (Mosquito Control Association of Australia 2002) has helpful advice on mosquito control. This manual can be purchased through the Association's website.
- Regular maintenance of all structures associated with storage or treatment of recycled water is necessary to minimise mosquito breeding. For example, if mosquitoes are present in an open water storage, water plants should be cleared away from the edge of the storage to reduce habitat for larvae. In particular, recent research suggests that dense mats of surface vegetation or fallen decaying material can encourage mosquito breeding (Dale et al. 2001).
- When recycled water is used for irrigation, surface ponding should be prevented by appropriate irrigation scheduling.
- Construction and installation of water storages should

be carried out in accordance with Part 8, Mosquito Prevention and Destruction of the Health Regulation 1996. Where a risk assessment process has identified that there is a significant risk of mosquito borne disease, holding tanks for recycled water should be designed so as to prevent entry of mosquitoes.

- Open recycled water storages should be monitored regularly to identify presence of mosquito larvae.
- Where recycled water is used or treated in a constructed wetland, the cells of the wetland and the inlets/outlets should be designed so that there is no stagnant water. Also, aligning the cells parallel to the dominant wind direction so that wind ripples disturb the surface of the water appears to inhibit mosquito larval survival (Dale et al. 2001).
- If a potential health risk from mosquito breeding has been identified, biological control using natural predators, such as aquatic invertebrates or native fish known to prey upon mosquito larvae, may be considered.
- Chemical controls range from relatively benign "natural" larvicides such as those based on *Bacillus thuringiensis israelensis* (Bti) through to more toxic chemicals. Only chemicals registered for mosquito control should be used. If chemicals are used, this must not contaminate the recycled water so that it is no longer fit for its intended purpose.

Further information on mosquito control may be obtained from Queensland Health. Information on use of fish in mosquito control maybe obtained from the Department of Primary Industries and Fisheries (see Appendix D).

## 7.2 DUAL WATER SUPPLY SYSTEMS

Class A+ recycled water supplied through a dual water supply system to residences and industry can take the place of a broad range of current uses of drinking water. These uses include garden watering, washing of cars, boats and external surfaces of buildings, toilet flushing, and fountains and water features (not used for bathing).

Water supply systems in Queensland are generally owned and controlled by the water service provider up to the point of connection to the premises' supply pipe and after that by the property owner. Responsibility for ensuring the integrity of the recycled water system up to the point of supply therefore lies with the water service provider and thus works can only be undertaken by employees or contractors employed by the water service provider.

In some cases, for example, community title developments or resort islands, the water supply infrastructure is provided largely or entirely by the body corporate or leaseholder. In this case the responsibility for infrastructure lies with the owner of the infrastructure.

Work done on pipes or fittings located within the property boundary of the owner of the property is the responsibility of the property owner and must only be done by a licensed plumber in accordance with the Plumbing and Drainage Act.

### 7.2.1 Systems under the control of the water service provider

The Department of Natural Resources and Mines has published *Planning Guidelines for Water Supply and Sewerage* (NRM 2005). In these Planning Guidelines, the Queensland Government has adopted the following Water Services Association of Australia (WSAA) codes as suitable standards for the collection/reticulation component of sewerage and water supply schemes, including recycled water:

*WSA 02 – 2002 Sewerage Code of Australia*

*WSA 03 – 2002 Water Supply Code of Australia*

*WSA 04 – 2001 Sewage Pumping Station Code of Australia*

The Water Services Association of Australia Supplement to its *Water Supply Code 2002 (Version 2.3)* entitled *Dual Water Supply Systems (Version 1.1)*, covers the design and construction of dual supply systems for servicing new developments that provide both drinking water and non-drinking water via reticulation. The supplement contains advice relating to:

- differentiation of drinking water and non-drinking water pipe systems via colour coding and other markings
- design considerations for dual supply systems, including system configuration, sizing of mains, pressure, main depths, fittings and flushing points
- construction and installation of property services
- standard drawings for prevention of cross-connections between drinking and non-drinking water supply systems.

While the WSAA codes are not mandated, they are suggested as suitable for installation and maintenance of dual pipe systems in Queensland.

### 7.2.2 Integrity testing for dual reticulation systems

The provider of dual reticulation water services should set up and undertake a systematic inspection procedure for all properties connected with the recycled water system. Integrity testing should be done in accordance with the AS/NZS 3500.1:2003, section 9: *Non-drinking water services*. The inspection should test operation of the non-return valves by pressure testing and check for cross-connections between potable and recycled water supplies.

Each provider of recycled water services should determine the frequency of inspection necessary to detect any cross-connections. The minimum inspection frequency should be:

- all new services at installation
- all services on change of ownership
- all services following completion of property extensions or plumbing modifications.

The provider should periodically audit recycled water services. If the audit indicates any cross-connections are occurring in the system, inspection frequency and practices should be reviewed and appropriate measures taken.

### 7.2.3 Cross-connection control and backflow prevention

It is fundamental to the design of recycled water distribution systems to maintain separation of the recycled water and potable water systems to avoid potential health risks from inadvertent cross-connection and possible direct ingestion of the recycled water. It is therefore essential that no direct connection of the recycled water system into any potable supply system take place.

All recycled water pipes should be installed in accordance with the Standard Plumbing and Drainage Regulation. If potable water is supplied into the recycled water system as make-up water, an approved air gap or other backflow prevention device must be installed at the point of delivery of the potable water supply in accordance with the Standard Plumbing and Drainage Regulation. If this device is a critical control point in any risk assessment process for a dual reticulation scheme, it should be regularly inspected and tested, with records kept of such inspections and tests, as part of the Recycled Water Management Plan.

Where the recycled water system does not have to provide the high flows or pressure required for fire fighting, the

potable supply can be protected from the risk of backflow by operating the recycled water system at a lower pressure than the potable water system.

#### 7.2.4 Differentiation of pipe systems

Recycled water distribution systems should be clearly and uniquely identified so they cannot be mistaken for any system used to convey potable water. All above ground and buried pipes for domestic and residential buildings should be distinctively and permanently colour-coded (deep purple or lilac) in accordance with AS/NZS 3500.1:2003, section 9: *Non-drinking water services*. Where practical, they should be laid below the depth of the potable water supply. For above ground installations, recycled water pipes should not be installed within 100 mm of potable water pipes and for below ground installations they should not be laid closer than 300 mm from potable water pipes.

In buildings other than dwellings or apartment buildings, all pipes installed in ducts, accessible ceilings or exposed in basements or plant rooms should be clearly identified in accordance with AS 1345-1995 *Identification of the Contents of Pipes, Conduits and Ducts*.

Recycled water pipes installed as part of an irrigation system should comply with AS 2698.2-2000 *Plastics Pipes and Fittings for Irrigation and Rural Applications*.

#### 7.2.5 Skills and competencies of plumbers

In order for the additional requirements of dual reticulation systems discussed above to be implemented safely and consistently, it is essential for all plumbing work done on recycled water systems to be completed by a plumber holding an appropriate licence under the Plumbing and Drainage Act.

#### 7.2.6 Domestic use of recycled water

Hazard control at the point of use of Class A+ recycled water in residential situations must be limited to those actions that can be readily communicated to the community and easily complied with. The specific requirements for hazard control should be developed as part of the Recycled Water Management Plan and specified in the terms of use document supplied to customers. Hazard controls for this form of use may include:

- prohibition of the performance of any regulated plumbing works by anyone other than a licensed plumber
- maintenance of appropriate signs over any recycled water taps

- provision of advisory information to customers recommending approved and non-approved uses of recycled water.

#### 7.2.7 Validation and verification for dual reticulation schemes

All of the above control measures, as well as any others identified during the risk assessment phase during development of the Recycled Water Management Plan, must be checked during both validation and verification of Class A+ schemes supplying recycled water for dual reticulation.

### 7.3 IRRIGATION WITH RECYCLED WATER

Appropriately treated recycled water may be used for irrigation of public open spaces such as parks, road verges, sports grounds, schoolyards, golf courses, racecourses and cemeteries as well as pasture, agricultural, horticultural and silvicultural crops. Appropriate classes of recycled water for all of these applications are shown in Table 6.3 of these guidelines.

Many of the management controls that should be developed for general irrigation purposes (i.e. regardless of source water used) also apply to irrigation with recycled water. This would include, for example, calculation of hydraulic loading rates, erosion control, prevention of runoff and nutrient monitoring. Therefore, an existing irrigation management plan could be readily adapted to apply to recycled water following completion of a properly conducted risk assessment.

Recommended hazard controls for irrigation with recycled water are discussed further below.

#### 7.3.1 Site assessment

One of the first steps in developing an irrigation scheme using recycled water is to conduct a comprehensive site assessment. Appendix E shows some of the key factors that should be considered. The site assessment may be undertaken during the planning phase of project development, or later during development of the Recycled Water Management Plan, but any findings from the assessment, in terms of monitoring requirements or control measures, should become part of the Recycled Water Management Plan.

### 7.3.2 Signs

Wherever recycled water is used, erect prominent warning signs indicating, in English and any other appropriate community language:

“RECYCLED WATER BEING USED — DO NOT DRINK”

Alternative wording may be required, depending on the possible exposure route for humans. For example, a recycled water storage on a golf course may need a sign warning golfers not to enter the water to retrieve golf balls. Location, sizing and wording of signs should be determined after consideration of factors such as public accessibility, visibility from likely points of access and the nature of the sub-community targetted (e.g. children or non-English speakers). All recycled water signs should comply with AS 1319-1994 *Safety Signs for the Occupational Environment*.

### 7.3.3 Controlled access

*Controlled access* means that the recycled water user can maintain effective control over public access to an area being irrigated or being affected by spray drift from irrigation. This can be achieved by fences and lockable gates or clear demarcation of land that may be affected by irrigation, combined with prominent warning signs. Controlled access in public areas is not guaranteed simply by night-time irrigation. Additional mechanisms, such as those mentioned above or even temporary fencing erected for the duration of irrigation, should be used.

No restriction of public access is required when Class A or A+ recycled water is used, but the recycled water user should ensure the risk of inadvertent consumption or inhalation of aerosols is minimised via appropriate controls. Spray irrigation of Class B, C or D recycled water always requires controlled access. The precise nature of the controls used should be determined according to the risk assessment conducted during formulation of the Recycled Water Management Plan. Where subsurface drip irrigation is used, Class B or C recycled water may be used with uncontrolled access. However, it is essential that the drip irrigation does not lead to surface ponding of water. Subsurface irrigation should be installed below the soil surface and not just below surface mulch.

Class B or C recycled water may be used for spray irrigation in areas where public access can be prevented during irrigation and for long enough after irrigation that wetted surfaces have dried. No simple time limit can be placed on drying of surfaces, as this will depend on the season and atmospheric conditions. Use of this quality of recycled water may also necessitate measures to reduce

spray drift from the reuse site (see below). All of these issues should be addressed during the scheme risk assessment and in the Recycled Water Management Plan.

Recycled water storages in areas open to public access should be either fenced off or clearly signposted to warn against swimming, wading, boating or misuse.

### 7.3.4 Irrigation buffer zones

Whenever using recycled water in areas where public access is uncontrolled, it is advisable to use irrigation delivery systems that minimise aerosols. This is important in both minimising contact with recycled water as well as the possibility of creating an adverse public reaction to recycled water use in public spaces.

No specific buffer zone is required for spraying of Class A recycled water. If no other information on risk factors dictates a need for a specific width of buffer zone, the following could be used as a starting point for the other classes of recycled water:

- 30 metres for Class B recycled water
- 50 metres for Class C recycled water
- 100 metres for Class D recycled water.

However, if a risk assessment completed as part of a Recycled Water Management Plan shows that these buffer zones do not accurately reflect the risks, alternative buffer zone distances can be used that more accurately reflect the risks of the particular site and usage proposed. When using Class B or C recycled water, spray-drift into residential areas and areas of public access can be reduced by use of screening trees (especially those with small leaf area such as casuarinas), which reduce wind speed and thus reduce transmission of water droplets. Other methods to reduce the impact of spray drift include use of anemometer switching systems, which shut off irrigation when wind speed is above a certain level, low rise sprinklers, which have a limited ‘throw’, and sprinklers with a large droplet size to reduce production of water vapour. Recycled water should not come into contact with picnic tables, barbecue facilities and drinking fountains.

Buffer distances should be measured from the edge of the spray zone to the point at which contact with recycled water could present a risk. For example, for irrigation of recycled water at a golf course, neighbouring residents could be expected to use every part of their yard so the buffer distance should be measured to the property boundary, not the house.

### 7.3.5 Use of mass balance approach for recycled water irrigation

The theory behind the mass balance approach in irrigation is that the application rate of any component of recycled water, whether it be hydraulic loading, salts, nitrogen or phosphorus, should not exceed:

- the rate at which it is taken up by the plants and removed from the site
- the safe storage of the element in the soil
- allowable losses into the environment.

Recycled water users who wish to irrigate crops, pasture or public open space should therefore undertake a comprehensive water, nutrient and salt budget for their proposed reuse. There are a variety of tools available for this purpose. One that is particularly suitable for Queensland conditions is MEDLI. This is a computer-based mathematical model that was developed jointly by the Queensland Department of Primary Industries and the Co-operative Research Centre for Waste Management and Pollution Control. It is designed to simulate the operation of a recycled water irrigation scheme over a long period, typically many decades.

MEDLI simulates the natural processes that take place from day to day, by performing material balance calculations using the volume of incoming water, its constituents (nitrogen, phosphorus, dissolved salts), data about the physical system itself, plus climatic data for the particular site covering a prescribed period. Either historical or synthesised climatic data can be used. The model is suitable for a range of different sources of recycled water, including municipal effluent and wastewater from intensive livestock industries. For further information, contact the Department of Natural Resources and Mines or the *Department of Primary Industries and Fisheries* (see Appendix D).

Salt management is a critical issue when using recycled water for irrigation. While a certain amount of salt build-up in soil irrigated with recycled water may be unavoidable, the salt must be prevented from damaging the productive capacity of the land, or significantly degrading ground water.

The accumulation of sodium in the soil can cause a decline in soil physical properties, especially in porosity and permeability to water. If salt builds up in the soil root zone, the growth rate of plants and their capacity to take up water and nutrients will be reduced. Some species cope better than others, and highly salt-sensitive crops should be

avoided. Unless the accumulated salt is washed out of the root zone regularly damage will occur.

The amount of leaching required to achieve this ‘washing’ of the root zone can be estimated from the salt content of the recycled water, the presence of other contaminants and the crop’s water-use rate. In many locations, rainfall will provide enough leaching in most years to protect the root zone. When this is not the case, and extra irrigation is needed to achieve the required leaching, provision may have to be made to use water with a lower salt content for this purpose.

Another point to remember is that the long-term sustainability of irrigation with recycled water is determined not so much by the concentration of salts in the recycled water as the actual loads applied to the soil. Thus, if implementation of water use efficiency measures can reduce the amount of water applied, this will bring about a commensurate reduction in the loads of salt and other contaminants. For example, if a golf course is using 1 ML of recycled water per day with a TDS concentration of 1200 mg/L, they could reduce their TDS load from 12 tonnes per day to 8 tonnes by reducing their water use by one-third.

Where an irrigator is concerned that salt levels in the recycled water they are using may affect the salinity or sodicity of their soil, they may wish to use the SALF (Salt and Leaching Fraction) computer program (DNR 2000c). SALF may be used to determine the long-term steady state effect of irrigation with recycled water on the salt leaching fraction from the soil, soil salinity level and effect on crop yield.

While hydrological, nutrient and salt modelling can provide a valuable input into the planning of recycled water irrigation schemes, ongoing monitoring of scheme performance will also be necessary to ensure scheme sustainability. A monitoring program should be designed as part of the Recycled Water Management Plan (see Chapter 4 of these guidelines). The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARM CANZ 2000a) contain trigger values for a wide range of potential contaminants and water quality characteristics in irrigation water used for primary production.

If the risk assessment shows that the quality of the recycled water is not appropriate to ensure the long-term sustainability of the project, further treatment of the recycled water or appropriate risk management strategies will have to be implemented to ensure sustainability.

The Queensland Government's *Planning Guidelines: Separating Agricultural and Residential Land Uses* (DNR 1997b) provide useful information on planning issues affecting agricultural land uses that may involve water recycling, including conflict assessment, buffer area design, control of odours and sediment and stormwater runoff.

### 7.3.6 Irrigating food crops

Regardless of the standard of recycled water used, irrigation of food crops using recycled water should only take place after a Recycled Water Management Plan has been completed that includes a HACCP or equivalent food industry risk assessment. HACCP assessments for irrigation of food crops must also take account of risks associated with post-harvest handling. For example, while an irrigated vegetable crop may have post-harvest processing or cooking, or a thick removable rind, irrigation with lower classes of recycled water could expose other harvested crops to cross-contamination risks during post-harvest handling (particularly during washing of produce), especially if the other crops are consumed raw.

The risks associated with food crops irrigated with recycled water vary with quality of the recycled water used, the irrigation delivery system, the type of crop, the nature of post-harvest handling and the extent of post-harvest processing.

As noted in section 2.1.6, food sold in Queensland must comply with the requirements of the *Queensland Food Act 1981*, the *Food Standards Regulation 1994* and the *Australia New Zealand Food Standards Code*. In particular, Standard 1.4.2 of Part 1.4 (Contaminants and Residues) of the code sets out maximum residue limits (MRLs) for a wide range of contaminants that can enter the food chain during food production. If a chemical is detected in food that is above the MRL for that chemical, or is detected *at any level* for a chemical for which there is no MRL, then that food would be considered 'unsuitable' under the *Queensland Food Act*.

This has clear implications for the recycled water producer's trade waste management. If the risk assessment for the Recycled Water Management Plan identifies potentially hazardous chemicals in raw sewage, there may be a need for specific monitoring to ensure that treatment processes are consistently removing these contaminants.

Although uptake of chemical contaminants by food crops is not well understood, contaminant levels in food are unlikely to be affected by the generally low levels of chemical residues typically found in those classes of

recycled water that are suitable for irrigation of food crops.

Any food crops that are likely to be consumed raw should only be irrigated with Class A+ recycled water. Crops that receive intensive, obligatory post-harvest processing, such as sugarcane or wine grapes, can be irrigated with Class C recycled water. Above ground food crops with subsurface irrigation delivery systems can also use Class C recycled water. Above ground food crops watered via spray irrigation and all root crops should use Class A+ recycled water but if a Recycled Water Management Plan has been completed and risk management strategies adopted that can guarantee the safety of the crop being irrigated, an alternative class of recycled water could be used.

The Commonwealth Department of Agriculture, Fisheries and Forestry has produced *Guidelines for On-farm Food Safety for Fresh Produce* (AFFA 2001) that provide a single consolidated source of information relating to on-farm food safety for fresh produce crops. They are designed to help assess the risks to food safety during on-farm production of fresh crops and provide information on good practices to prevent, reduce or eliminate the hazards, including the risk of contaminating produce when using water.

Many retail nurseries supply food plants that may be eaten shortly after sale (e.g. herbs and some vegetables). These should only be irrigated with Class A+ recycled water. Retail nurseries may also have a very high level of contact between customers (or workers) and wetted surfaces including plants. Therefore Class A recycled water should be used for irrigation in retail nurseries. If a Recycled Water Management Plan incorporating HACCP is prepared that can demonstrate that health risks can be managed, a lower class of recycled water could be used. For wholesale nurseries see section 7.3.8 of these guidelines.

### 7.3.7 Pasture irrigation, stock watering, and agricultural washdown

Recycled water can be used for irrigation of pasture and fodder for grazing animals, for stock water and for washdown of facilities:

- Class B recycled water can be used for irrigation of pasture and fodder for dairy animals where there is no withholding period between irrigation and feeding.
- Class C recycled water can be used for pasture and fodder for dairy animals if there is a withholding period of five days and for other grazing animals (except pigs) with a withholding period of four hours.

- Recycled water supplied for stock drinking water should meet the requirements of Class B, with the exceptions noted below. Stock should not drink recycled water sourced from the same or similar species of animals as this increases the hazard from pathogens.
- Stock should not be exposed to recycled water that may contain helminth (tapeworm) eggs. If the source water may contain helminth eggs, it should not be used for stock, or further treatment must be undertaken to achieve helminth removal. Helminth removal can be achieved by a minimum of 25 days pondage detention or filtration via sand or membranes. Where cattle may come into contact with recycled water, the Recycled Water Management Plan should include appropriate assessment of risks as well as specific control measures to prevent infection.
- Class B water can be used for washdown of facilities in dairies, stockyards and feedlots but should not come into contact with milking machinery.

Owing to the need to prevent the pig tapeworm, *Taenia solium*, from establishing a life cycle in Australia, pigs should not come into contact with recycled water sourced from municipal STPs.

Additional advice regarding water quality for stock animals can be found in Chapter 4 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMICANZ 2000a).

### 7.3.8 Irrigating non-food crops, including trees, turf and plant nurseries

Typical uses include irrigation of non-food crops such as cotton, trees, woodlots, turf farms and wholesale plant nurseries (for retail nurseries see section 7.3.6 of these guidelines). Production of these crops will generally take place in areas where public access can be excluded, and thus a lower quality of recycled water may be used. Where the risk assessment undertaken as part of the Recycled Water Management Plan has indicated that public access can be controlled, and off-site impacts prevented, Class D recycled water can be used to irrigate these crops. If a wholesale nursery is supplying fresh herbs or vegetables to a retail outlet, the Recycled Water Management Plan should ensure that any health risks are appropriately managed.

Parties wishing to supply or use recycled water to irrigate hardwood plantations in Queensland should refer to *Using Recycled Water to Irrigate Hardwood Plantations in Queensland* (DPI 2003).

## 7.4 USING RECYCLED WATER FOR INDUSTRIAL PURPOSES

Industrial use includes washdown, dust control on construction sites and quarries, boiler feed, process water, industrial cooling and mining as well as a broad range of other uses. Generally, the water quality requirements for industrial purposes will be determined by the needs of the process being supplied. Where the recycled water is used within an open system, for example for dust suppression on construction sites where workers or passing cars may be subject to intermittent spray drift, Class A recycled water, or better, should be used. For industrial uses of recycled water within closed systems, for example for industrial cooling or boiler feed, Class C recycled water could be used, subject to the need for additional treatment to prevent fouling, scaling, corrosion, foaming or biological growth within recycled water pipes. Where recycled water is used for above ground irrigation of landscaping where there is no public access, Class C recycled water may be used.

Where an industrial facility has a development approval from the EPA or other approval body, any discharge of recycled water from the site to stormwater or the natural environment (including ground water) should be covered by the conditions attaching to the development approval. If the facility or site is not covered by an existing development approval, discharges of recycled water will be subject to the user's general environmental duty not to cause environmental harm. In this case, further advice should be sought from the local office of the EPA.

## 7.5 USING RECYCLED WATER FOR FIRE FIGHTING AND FIRE PROTECTION

### 7.5.1 Fire fighting

Where possible, fire fighters need to have access to high quality water because the water they use to fight fires often saturates them, they ingest aerosols fighting a fire and water from fire hoses is sometimes used in first aid treatment of burns victims at the scene of the fire. In urban areas the highest quality water is supplied through the reticulated potable water system.

However, the need to provide fire flows via the potable water system can have some undesirable effects on this system. Fire fighting requires water pressure and volumes above those required for most domestic and commercial situations. This means that potable water mains that have a dual role as fire fighting mains often have to be of larger diameter than

they would otherwise be. This leads to water spending more time in the mains, thus increasing the opportunity for microbial biofilms to grow within the pipe system. This can reduce water quality for customers, shield pathogens from disinfection and give rise to more frequent mains flushing. In turn this can lead to wastage of potable water, increased use of chlorine and possibly increased levels of disinfection by-products in the potable water system.

For this reason, when dual reticulation systems are being planned, it may be found that it is not practical to provide fire flows through both the potable and recycled water mains. It can be therefore be advantageous to move the requirement for fire flows out of the potable water mains and into the recycled water mains.

Use of Class A+ recycled water for fire fighting represents a negligible health risk for fire fighters (WSAA 2004). This is because the high level of treatment of Class A+ recycled water removes pathogens to such an extent that the likelihood of any health impact on fire fighters, given their infrequent exposure, would be negligible. Also, although there can be trace chemical residues in Class A+ recycled water (unpublished EPA data), the levels are so low that occasional exposure from fire fighting would not be expected to present a health hazard to fire fighters.

Where fire fighters have to treat burns at the scene of a fire that is being fought with Class A+ recycled water, it is essential that immediate measures be taken to rapidly cool the burn with copious amounts of cool water. The need to cool the affected tissue and alleviate pain is of far greater importance than the small differences in the quality of Class A+ recycled water compared with drinking water. First aid treatment for burns victims always involves infection control regardless of the quality of the water used to cool the burn.

However, in providing first aid to persons with burns or scalds in areas where there is a readily accessible reticulated drinking water supply, preference would normally be given to the drinking water supply, provided this does not delay the immediate treatment of the burn.

In accordance with the requirements of the Workplace Health and Safety Act, described in section 2.1.7 of these guidelines, whenever recycled water is proposed to be used for fire fighting, the employer of the fire fighters has an obligation to ensure the workplace health and safety of their employees. The employer's responsibilities under this Act are summarised in section 2.1.7.1 of these guidelines. A recommendation in these guidelines does not take the place of the employer's responsibilities under the Workplace Health and Safety Act.

### **7.5.2 Fire protection through automatic fire sprinkler systems**

Water used in automatic fire sprinkler systems needs to be high quality because it may sit in the pipe system for extended periods, leading to the possibility of microbial regrowth within the system. As long as it complies with the requirements of Australian Standard AS2118.1-1999 *Automatic Fire Sprinkler Systems*, recycled water that has been treated to the Class A+ standard may be suitable for this purpose. However, if it has higher nutrient levels than potable water, there may be a need for additional management (e.g. regular flushing or disinfection) to reduce growth of biofilms. As the use of recycled water in automatic sprinkler systems is not likely to generate significant potable water savings, and may involve higher management overheads, this use may not be practical in most cases.

## **7.6 USING RECYCLED WATER TO SUPPLEMENT DRINKING WATER SUPPLIES**

The Australian Drinking Water Guidelines (NHMRC & NRMCC 2004) recommend that drinking water should always be derived from the best available source of water. In most parts of Australia, during normal climatic conditions, this would include the freshwater reaches of a river, lake or aquifer or an impoundment formed to store water from one of these sources. Wherever possible, this storage should be minimally impacted by human activities, including disposal of waste. However, there are parts of Queensland where, due to long-term drought, these 'natural' water sources will not be adequate either to support planned growth beyond a certain population or, in more extreme cases, to meet the water needs of current population levels. In these cases highly treated recycled water may actually become the 'best' available source of water.

Recycled water may be added to a river, aquifer, dam or other water body where it mixes with the existing source for drinking water. When this is done in a planned way, the recycled water will usually be treated to a standard that is even higher than potable water, before being blended with raw water, re-treated, and supplied to customers.

The treatment required to ensure safe indirect potable reuse of effluent would have to be determined on a case by case basis. This is because there are many man-made chemicals that potentially may be found in sewage and it is not possible at this time to set safe concentrations for all of these chemicals. Also, it is not feasible to monitor

for all known chemicals that could occur in recycled water sourced from STPs, as most chemical contaminants require specific analytical tests that, if undertaken on a regular basis, would not be economically feasible.

For these reasons, the best method of ensuring the safety of planned, indirect potable reuse is to undertake a comprehensive HACCP-based risk assessment of the entire system for collection, treatment and use of recycled water for indirect potable purposes. This should involve the following steps:

- a human health risk assessment of the extent of contaminant removal required to guarantee that drinking water quality can be consistently achieved
- a systematic characterisation of the catchment of the sewerage system supplying the raw sewage
- identification of the sources for all contaminants of concern in the source sewage
- negotiation of strict trade waste controls specifying the concentration and loads of all contaminants of concern discharged to sewer (this may need to include domestic discharges if these are suspected to be the source of identified contaminants)
- specification of monitoring requirements for all high risk contaminants of concern at their source (for commercial customers only). Consideration should be given to automated systems (e.g. telemetered alarms back to the treatment plant) to alert operators about any out of specification wastewater that enters the sewerage system
- design of a treatment process that specifically removes all contaminants of concern that have been identified in the risk assessment. The treatment process will also have to guarantee a sufficiently high log removal of pathogens to ensure that none enters the drinking water system. This is likely to exceed the five to six-log removal discussed for dual reticulation quality recycled water, but will depend on the outcome of the health risk assessment
- where possible, online monitoring of treated water for all contaminants or indicators that the Recycled Water Management Plan has identified as representing a hazard to human health. Currently, online monitoring is limited to a small range of contaminants, but this field of science is rapidly advancing and so treatment plant operators must ensure that they make use of new online monitoring technologies as soon as they become sufficiently reliable and affordable. Over time this will include DNA-based biosensors that are

capable of detecting specified pathogens

- a final recycled water quality monitoring program targeting all known contaminants of concern in the final treated water.

It should be borne in mind that, as noted in section 3.1 of these guidelines, the Queensland Government will not recognise STP effluent in water allocation and management frameworks established under a Water Resource Plan.

### 7.6.1 Aquifer storage and recovery

Aquifer storage and recovery involves recharge of aquifers with water for storage and later use. This aquifer recharge can be achieved either by surface spreading of water with percolation to ground water or direct injection of water into aquifers. Recycled water can be used for this purpose to achieve augmentation of potable or non-potable water supplies, to renew depleted aquifers or to prevent seawater intrusion into aquifers in coastal areas.

The overriding consideration when investigating the introduction of recycled water into aquifers is that there should be no resulting deterioration of ground water quality. Where recycled water sourced from STPs is introduced into an aquifer that may be used for extraction of potable water, the same site-specific assessment and management processes should be used as discussed above. Where recycled water is introduced into an aquifer that has no drinking water extraction, Class A+ recycled water should be used. Further information on aquifer storage and recovery using stormwater can be found in the South Australian EPA *Code of Practice for Aquifer Storage and Recovery*.

## 7.7 USING RECYCLED WATER FOR WATER FEATURES AND HABITAT PURPOSES

Determination of the appropriate class of recycled water for fountains and ornamental water bodies should only take place after an appropriate assessment of the risks of human contact has been undertaken. Amongst the factors that should be considered are the likelihood and frequency of human exposure to recycled water, the effectiveness of disinfection, the extent of aerosol generation and the prominence and wording of signage. For example, if the person responsible for the water quality in the fountain or water feature is aware that there is a likelihood of human contact with the water (e.g. wading on hot days or occasional accidental ingestion of water) it may be appropriate to use only class A+ recycled

water. If human contact can be appropriately controlled, class A recycled water could be used. If there is certainty about no human contact (e.g. no physical access or no aerosol generation) class B or C recycled water could be used. Use of any class of recycled water other than Class A+ must involve appropriate consideration of control measures during development of the Recycled Water Management Plan.

Highly treated recycled water may be used to create artificial wetlands or to restore natural wetlands degraded by drought or over-extraction of water. However, the continuous discharge of treated effluent should not be used to create environmental flows within rivers, as this will not replicate the highly variable nature of natural flows. As noted in section 3.1 of these guidelines, the Department of Natural Resources and Mines will not include releases of recycled water to a waterway as comprising part of the allocatable flow from that waterway.

Where recycled water is used for environmental purposes, it is essential that the environmental qualities and water quality objectives of the receiving waterway are considered before this takes place. The EPA is currently working with stakeholders to establish these values in accordance with the Environmental Protection (Water) Policy. For more information see the *EPA website*.

Where recycled water is being supplied by a facility that is subject to a development approval from the EPA, such as an STP, the holder of the approval will have to demonstrate to the EPA both the need for environmental releases of recycled water as well as a clear net benefit to the environment from the release.

