Government of **Western Australia**
Department of **Health**

Guidelines for the non-potable uses of recycled water in Western Australia

health.wa.gov.au

Foreword

It is widely recognised that Western Australia has and is experiencing a change in climate. In particular rainfall in the South West of Western Australia has become more unreliable. This combined with population growth has placed a great deal of pressure on existing traditional sources of water for domestic, industrial, and agricultural use.

The Department of Health is keen to ensure that the best use of all forms of water is made to both protect public health and to encourage development in a sustainable manner.

Wastewater can no longer be considered a ‘waste’ product to be discarded but a resource that can have potential value if used in a ‘fit for purpose’ manner. Using recycled wastewater that is ‘fit for purpose’ means it can be safely used for a wide range of non-potable uses such as domestic, public open space and agricultural irrigation, industrial applications and aquifer recharge, storage and pressurisation. More importantly if wastewater is reused it can replace drinking water for other specialised higher value uses and can reduce the environmental costs associated with pumping water long distances over land.

The Guidelines for the Non-potable Uses of Recycled Water in Western Australia, brings Western Australia into line with the nationally recognised risk management approach. The Guidelines are designed to assist planners, designers, developers and engineers in the areas of development, construction, installation, approval, operation, monitoring and auditing with the ultimate aim of establishing the safe and sustainable reuse of this valuable resource.

I take this opportunity to thank everyone who contributed to the development of the Guidelines. I would like to acknowledge the contribution from other government agencies, water service providers, key stakeholders and members of the Water Unit.

I strongly support these Guidelines as I believe that all Western Australians will benefit through the appropriate use of our recycled water resources.

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CHIEF HEALTH OFFICER

Contents

List of Tables

List of Figures

Acknowledgements

The *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (guidelines) draw heavily on the work previously completed by other agencies and organisations.

Particularly worthy of note are:

- The National Resource Management Ministerial Council
- Environmental Protection and Heritage Council
- Australian Health Ministers Conference
- NSW Department of Water and Energy
- NSW Health
- Victoria EPA
- Victoria Department of Human Services, and;
- previous work by the Water Unit, Department of Health, Western Australia (DOHWA)

These guidelines also draw heavily on the feedback received through its draft phases from industry, community, academics and government.

Thank you for all your work that has made these guidelines possible.

1. Introduction

Water is becoming an increasingly scarce and precious resource for drinking, irrigation, manufacture, cleaning, and the maintenance of hygiene. Sustainable water uses to ensure that water resources are available into the future requires not only the conservative use of water supplies, but the need to explore and utilise alternate water sources and, where possible, recycle water. Recycled water for non-potable uses is supported by the Department of Health, Western Australia (DOH) as a way to help alleviate the pressure on our scarce water resources as long as public health is protected. Whilst the main scheme water supply is a potable source, some uses of water such as public open spaces irrigation, industrial cooling and toilet flushing to name a few do not require a drinkable (potable) water quality. The distribution of non-potable water through third pipe water supplies, for example, can serve these purposes.

These guidelines are designed to provide a planning and implementation framework that is in line with the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006 (National Guidelines).

Recycled water is defined as water generated from sewage (including greywater, yellow water, black water) or from industry that is treated to provide fit-for-purpose water quality for its intended beneficial use. Treated recycled water can be used by either the recycled water service provider itself, a business supplied by the recycled water service provider, or supplied through a third pipe scheme for urban reuse.

Recycled water can be provided for onsite reuse, agriculture, irrigation, industry, potable or other use external to the treatment process" (National Water Commission, 2009).

In Western Australia, recycled water is obtained from sewage, sewer mining, separation at source (grey, yellow and black water) and industrial wastewater.

1.1. Objectives

The Guidelines for the Non-potable Uses of Recycled Water in Western Australia are designed to bring Western Australian recycled water practices and schemes in line with the National Guidelines. They seek to encourage beneficial and sustainable use of recycled water and provide guidance for planning, design, approval, operation and monitoring of recycled water supplies in regard to safeguarding public health and the environment.

The objectives of these guidelines are to maximise the reuse of recycled water through minimising and managing any risks associated with its use.

These guidelines provide information for the planners, designers, installers, operators, managers, users and regulators of recycled water systems, with the objectives of:

- Encouraging the beneficial use of recycled water and providing guidance on how this might be accomplished without negatively impacting on public health or the environment;
- Providing guidance for the planning, design, operation and monitoring of recycled water schemes through the implementation of a risk management framework; and
- Outlining the statutory approvals required for a recycled water scheme.

These guidelines replace the Draft Guidelines for the Use of Recycled Water in Western Australia 2009 which were first released in 2005.

1.2. Scope

These guidelines are designed to cover the non-potable uses of recycled water in Western Australia. Water sources covered include sewage (grey, yellow and black), treated wastewater and industrial wastewater. These guidelines primarily deal with effluent from municipal wastewater treatment plants treating mainly domestic, hospitals and some industrial waste, as well as systems serving individual commercial premises that may generate large wastewater flows (for example hotels, motels, mining camps, schools, caravan parks etc).

These guidelines do not deal with recycled water from individual household systems, for example sullage, greywater or effluent from septic tanks. Greywater obtained from single-dwellings, multiple dwellings and commercial premises producing up to 5000 L/day can be reused in accordance with the Code of Practice for the Reuse of Greywater in Western Australia (2010).

These guidelines present a generic framework for managing health and environmental risk for non-potable water recycling schemes.

Where the volume of recycled water exceeds 20 kL/day, additional requirements and approvals may be required from the Department of Water and Environmental Regulation (DWER). If the volume of recycled water is more than 20 kL/day and less than 100 kL/day, works approval from DWER to construct the facility followed by a registration to operate as Category 85 Sewage facility is required. If the volume of recycled water exceeds 100 kL/day such premises are designated as Category 54 Sewage facility and a licence is required to operate after works approval (Environmental Protection Regulations 1987). In particular, where the recycled water is from a municipal wastewater treatment plant (premises) in which sewage is treated, or from which treated sewage is to be recycled onto land or into waters), DWER may also require a nutrient and irrigation management plan (NIMP).

The use of recycled water for irrigation purposes within Public Drinking Water Source Areas to augment drinking water supplies is outside the scope of these guidelines (and Phase 1 National Guidelines).

1.3. Structure of guidelines

These guidelines are based on the implementation of the 12 elements of the risk management framework of the National Guidelines. Sections 1 to 3 of these guidelines provide an overview about the legislative framework and common uses of recycled water. Section 4 addresses aspects of the feasibility stage and planning for a recycling scheme, while sections 5 to 9 provide information on aspects that must be covered for the implementation of a Recycled Water Quality Management Plan (RWQMP). Section 11 explains the process to get DOH approval. It contains the application form and RWQMP template that should be submitted to DOH for the approval of a recycling scheme. The template has been prepared by DOH to assist applicants and scheme managers in the design and implementation of the recycling management plan. The template can be found on the DOH website at Recycled water in WA (health.wa.gov.au)

1.4. The approval process

The DOH approval process is presented in Figure 1. Details of the broader across-agency approval process are presented in Section 11.

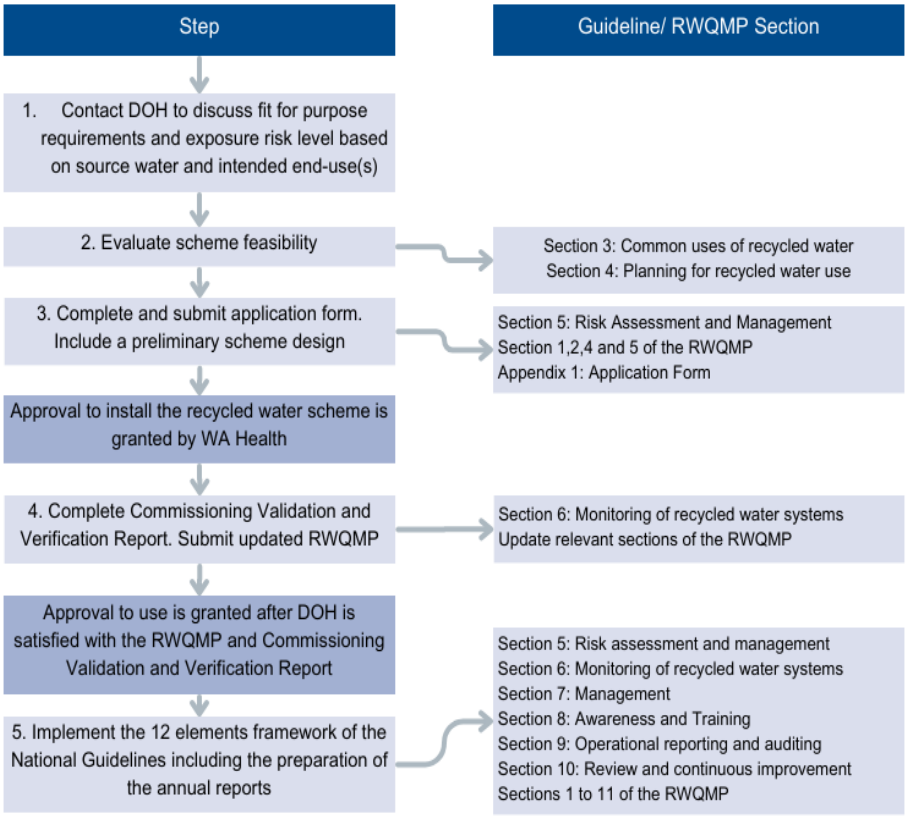

Figure 1: Schematic representation of the DOH approval process

2. Legislation and guidelines

DOH is concerned with the protection and enhancement of the health and wellbeing of the WA community. DOH regulates the design, construction, connection, operation and maintenance of sewage in accordance with the *Health (Miscellaneous Provisions) Act 1911*. For the purposes of these guidelines recycled water is considered to be sewage in accordance with Section 3 of the *Health (MP)Act* 1911. DOH sets conditions of approval for recycling water schemes and the use of recycled water in Western Australia.

2.1 Head of power for Department of Health approval of recycling schemes

The *Health (MP) Act* 1911 contains a number of provisions that regulate the use of recycled water:

- Section 98 – prohibits sewage being put anywhere unless it is authorised.
- Section 107 – prohibits the use of any apparatus for the treatment of sewage unless approved by the Chief Health Officer.
- Section 129 – prohibits the pollution of any water supply.
- The *Health (MP)Act* 1911 also contains a number of provisions that regulate the use of recycled water supplies:
- Section 94 - prohibits chemical refuse or any waste that is injurious to health to be disposed in sewers or drains.
- Section 98 – prohibits sewage being put anywhere unless it is authorised.
- Section 107 – prohibits the use of any apparatus for the treatment of sewage unless approved by the Chief Health Officer.
- Section 129 – prohibits the pollution of any water supply.

- Section 130 – Riparian rights - Power to prevent water pollution and prosecute people responsible for water pollution.
- Section 131 - The power to close off a water supply that is considered polluted or unfit for human consumption.

2.2 Relevant legislation and codes

- The *Metropolitan Water Supply and Sewerage Act* 1909 contains a number of provisions that regulate the use of alternative water sources:
- Section 54 – Only approved fittings may be used fit-for-purpose for the water supplied.
- Section 55 – People supplied with water are required to keep their fittings in good repair.
- The Metropolitan Water Supply, Sewerage and Drainage By-laws 1981 contain details on several provisions for the supply of alternate water:
- Section 3 - Protection of water against pollution.
- Section 4 - Protection of catchment areas and water reserve.
- Section 5 - Protection of public water supply areas and underground water pollution control areas.
- The *Water Services Act 2012* contains a number of provisions that regulate the use of recycling water sources:
- Section 5 – Requirement for licenses from the Economic Regulation Authority (ERA) to supply water.
- Section 7 – Power to exempt people/incorporated bodies from licensing requirements.
- The Code of Practice for the Reuse of Greywater in WA 2010 sets out the minimum requirements for the reuse of greywater in WA on:
- Single residential domestic premises
- Multiple dwellings producing up to 5000 L/day of greywater
- Commercial premises reusing up to 5000 L/day

2.3 Other agencies

There are other government and non-government agencies aside from DOH that may have an interest or regulatory role in recycled water schemes. These can include (but are not limited to) the local government, the Department of Water and Environmental Regulation, the Department of Planning, Lands and Heritage, the Environmental Protection Agency and the Economic Regulation Authority. Table 1 provides a summary of other agencies that may be involved in recycling schemes and their corresponding roles. A summary of the broader across-agency approval process is presented in Section 11.

An initial consultation with the relevant local government as to the scope of the recycled water project will indicate which of the above organisations may need to become involved. Recycling schemes in urban developments should contact the Department of Water and Environmental Regulation as the coordinating agency for the use of non-drinking water in the State. The Guidelines for the approval of non-drinking water systems in WA (2013) guides proponents step by step through the approval requirements for establishing a recycling scheme. This document can be obtained from: Guideline for the approval of non-drinking water systems in Western Australia (www.wa.gov.au)

Where a non-drinking water scheme has the potential to impact on existing water service infrastructure, including potential for cross-connection with drinking water supplies, proponents are required to consult with the water service provider (e.g. the Water Corporation, Aqwest, Busselton Water, or local government authority).

- The Department of Water and Environmental Regulation has some policies/documents relevant to recycling water schemes listed below:

- Water Quality Protection Note (WQPN11 areas Assessing and managing risks in public drinking water source areas (2021)
- Water Quality Protection Note (WQPN 33) Nutrient and Irrigation Management Plans (2010)
- Water Quality Protection Note (WQPN 50) Soil amendment using industrial by-products (2015)
- Water Quality Protection Note (WQPN 22) Irrigation with nutrient rich wastewater (2008)
- Water Quality Protection Note (WQPN 25) Land use compatibility in Public Drinking Water Source Areas (2021)
- Managed Aquifer Recharge in Western Australia (2021).

Table 1: Role and regulatory responsibilities of other state agencies in water recycling

Agency	Role in recycling schemes
Department of Water and Environment Regulation	Regulation of wastewater from prescribed industries as determined under Part V of the *Environmental Protection Act 1986* Managing the state's water resources; assessment of water management strategies under better Urban Water Management (WAPC, 2008); provides advice to the Minister for Water on requests for exemptions from the need to hold a water service provider licence.
Economic Regulation Authority	Assessment of technical and financial capability in the licensing of water service providers under the *Water Services Act 2012.*
Environmental Protection Authority (EPA)	Assessment of proposals under Part IV of the *Environmental Protection Act 1986*
Western Australian Planning Commission/ Department of Planning, Lands and Heritage	Considers non-drinking water proposal through the land planning process
Local Government	Manager of local assets, may be a water service provider, administration of the *Health Act (MP)* 1911, administration of the Building Code of Australia, granting of approvals through the land planning process.

2.4. National guidelines

The National Guidelines have been produced by the Environment Protection and Heritage Council, Natural Resources Management Ministerial Council and the Australian Health Ministers Conference to provide guidance on best practices for water recycling.

The National Guidelines provide a risk assessment framework that is applicable to the recycling of water from wastewater treatment plants, greywater and raw sewage sources. The National Guidelines are not mandatory but are designed to provide an authoritative reference that can be used to support beneficial and sustainable water recycling practises. The National Guidelines are intended to be used by anyone involved in the collection, treatment, distribution, supply, use and regulation of recycled water schemes. The *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* bring WA up to the standard of the National Guidelines and utilise its risk management-based framework.

2.5. Risk management framework

The National Guidelines set out a structure for the assessment and administration of water recycling systems following a '12 Element' risk management process. Figure 2 presents the 12 elements, of which commitment to responsible use and management of recycled water quality corresponds to Element 1. Elements 2 to 6 are the requirements for understanding the recycled water scheme, the hazards and hazardous events that can compromise the safety of the scheme and the measures in place to minimise risk to ensure reliable and safe use of recycled water. Elements 7 to 10 correspond to supporting requirements that demonstrate the competency and commitment for the implementation of best practices. Elements 11 and 12 ensure adequate management systems are implemented and provide a basis for evaluation, review and continuous improvement.

The 12 Elements Framework

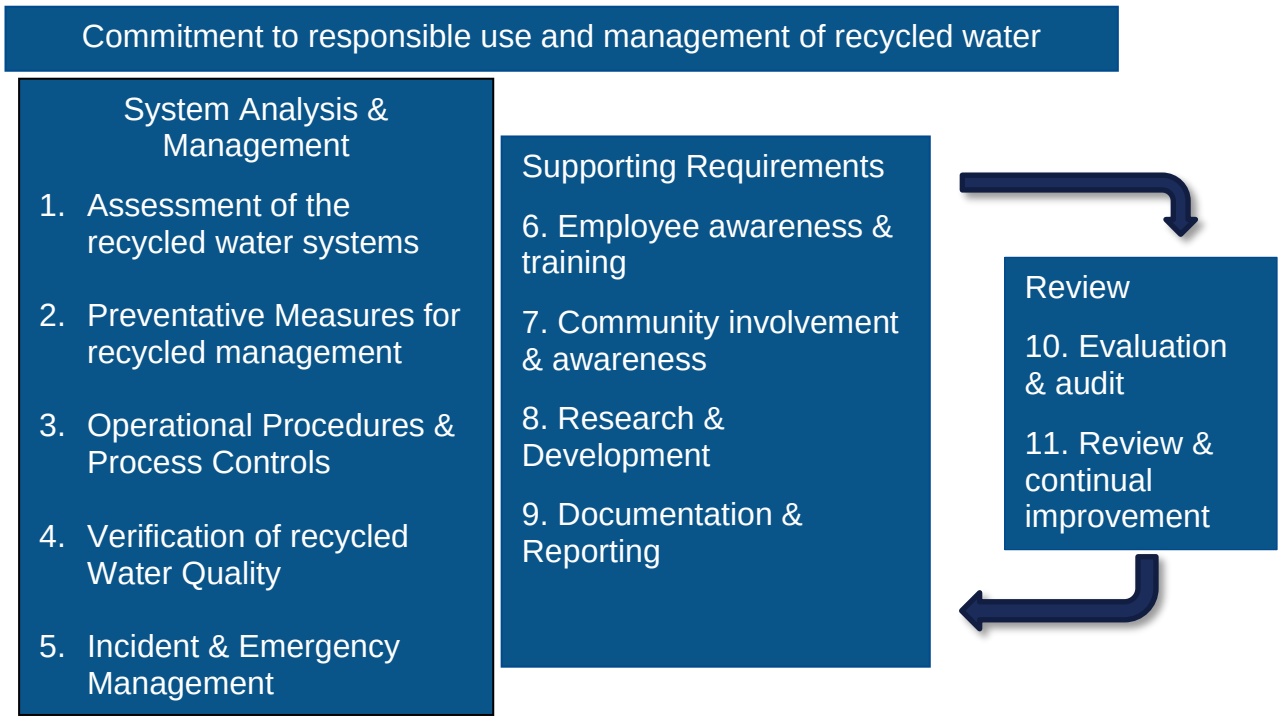

Figure 2: The 12 Elements of the risk management framework from the National Guidelines

The *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* are designed to ensure that all relevant aspects of recycled water use are covered in regard to protecting public health. By ensuring that all 12 elements are covered within a Recycled Water Quality Management Plan (RWQMP) (see approval process, Section 11), recycled water schemes can be established and utilised in the safest way possible. A list of the 12 elements of the risk management framework is depicted in Table 2. Section(s) of the guidelines and section(s) of the RWQMP addressing each element are presented in the second and third columns on Table 2.

Table 2: Guidelines for the Non-potable Uses of Recycled Water in WA and the elements of the framework covered in each section

Elements	Section of Guidelines	Section of RWQMP
Commitment to responsible use and management of recycled water quality (element 1)	*4.1: 4.3: 4.5*	*2: 3* *Appendices M*
Assessment of the recycled water system (Element 2)	*4.4; 5.1; 5.2*	*1; 4* *Appendices A; B; C; T; Y*
Preventive measures for recycled water management (Element 3)	*5.3*	*4; 5* *Appendices D; N; O; P; Q*
Operational procedures and process control (Element 4)	*5.3; 7.3; 7.6; 7.9*	*5* *Appendices D; N; O P; Q*
Verification of recycled water quality and environmental performance (Element 5)	*6; 7.10; 7.11; 7.12*	*6* *Appendices F; H; K*
Management of incidents and emergencies (Element 6)	*7.4*	*8* *Appendices K;L;R;S*
Operator, contractor and end user awareness and training (Element 7)	*8*	*7* *Appendices G; J*
Community involvement and awareness (Element 8)	*4.2; 8.3*	*9*
Validation, research and development (Element 9)	*6*	*11* *Appendices F; Q*
Documentation and reporting (Element 10)	*9.1*	*10* *Appendices K; L*
Evaluation and audit (Element 11)	*9.2*	*11* *Appendices K: Z*
Review and continuous improvement (Element 12)	*11*	*11* *Appendices K; Z*

3. Common uses for recycled water

This section presents common end-uses of recycled water. If your purposes fall outside of these suggested uses, please contact the DOH's Water Unit for clarification.

3.1 Quality and treatment

Water can be a vector for pathogens, and chemicals that are harmful to human health or the environment. In order to ensure that water is not hazardous it must undergo treatment to remove harmful substances. The level of treatment required (through biological treatment, filtration, chlorination dosing or reverse osmosis), depends on the initial water quality and the proposed end use.

3.2 Common end uses of recycled water

Recycled water must be treated to a level that is **'fit for purpose'**, that is, recycled water must be treated to a level that is suitable for its end use.

The level of treatment and monitoring that is required depends on the final application of the recycled water. End uses have been split into 4 levels of 'Exposure Risk' (see tables 7 and 8 for a list of the associated end uses):

- High – requires the highest quality of end use water and rigorous barriers, safeguards and monitoring regimes.
- Medium – has moderate risk, usually reduced from a high risk category through barriers and safeguards
- Low – presents a low risk to human health (minimal contact)
- Extra Low – negligible risk

These guidelines cover the following end uses for recycled water:

- Agricultural uses: irrigation for agriculture and horticulture
- Fire control uses: fire protection and fire fighting systems
- Municipal Uses: irrigation for urban recreational and open space
- Residential and commercial properties: irrigation, water features, utility washing, car washing, toilet flushing and dedicated cold water taps for clothes washing
- Industrial and commercial uses: dust suppression, industrial cooling water
- Woodlots: forestry
- Greywater reuse on multiple dwellings, office buildings or commercial premises reusing more than 5000 L/day
- Environmental benefits such as enhancement of environmental flows or bioremediation of contaminated soils
- Mine site uses: industrial processes, irrigation of camp premises, dust suppression

3.2.1 Agricultural uses

Agricultural uses for recycled water are diverse, and the number of agricultural enterprises utilising this water source is increasing. Some current agricultural uses include:

- Horticulture
- Trees/wood (extra low risk)
- Pasture/fodder
- Dairy pasture
- Lucerne
- Cotton
- Flowers (low risk)
- Orchard
- Nursery
- Vegetables (medium to high risk)
- Viticulture
- Hydroponics
- Turf farm
- Cane fields
- Grain cropping

Yellow water (urine) is rich in nitrogen and phosphorous and may be used as a fertiliser in gardening and agriculture to help reduce the use of artificial mineral fertilisers. Yellow water can be collected by waterless urinals or urine diversion toilets (either with or without flush water). The urine is then piped and stored in the storage tank or a rubberised "bladder" for a minimum of six months to ensure pathogen die-off/inactivation occurs. The tanks have a lid and are closed to prevent odour and loss of nitrogen via ammonia gas. After the retention time, the tank is pumped out and transported by and authorised wastewater carrier to the point of agricultural reuse.

3.2.2 Fire control uses

Recycled water can be used by fire-fighters, volunteer fire-fighters and state emergency services for:

- controlling fires
- testing and maintenance of fire control systems
- training facilities for fire fighting

There are many occupational health and safety considerations to look at when proposing to utilise medium risk exposure level recycled water for fire fighting activities. It is important to ensure that protocols are implemented to minimise incidental exposure, either by accidental splashing, aerosol inhalation or ingestion. The Australasian Fire Authority Council Background Paper (2007) lists some of the risk management measures required to minimise risk to fire-fighters when recycled water is used.

3.2.3 Municipal uses

Municipal uses for recycled water are diverse, and there are several schemes in WA that have been operating for more than 20 years. Schemes where municipal use is practiced across WA are expected to grow considerably given the increased population growth and the dry climate conditions. The municipal uses covered by these Guidelines include:

- irrigation of public parks and gardens, roadsides, sporting facilities (including golf courses and school ovals)
- road making and dust control
- street cleaning
- water features

3.2.4 Residential and commercial property uses

These Guidelines make provision for the use of recycled water for internal use, dual-reticulation supplies for residential developments and commercial property uses, including:

- in-building toilet flushing and dedicated cold water laundry taps (high risk)
- garden watering
- water features and systems, ponds, fountains, cascades (low to medium risk)
- utility washing (paths, vehicles, fences etc)

Please note that if you wish to undertake these activities in a single, domestic dwelling these guidelines do not apply. These guidelines are for communal and/or public properties as stated in the Scope (section.1.2).

3.2.5. Industrial and commercial uses

Industrial uses include:

- cooling water
- process water
- washdown water
- dust suppression

Due to the variety of inputs and the occupational health and safety consideration of industry, the use of recycled water for industrial purposes currently requires a project-by-project assessment to allocate a risk exposure level by the DOH. In future, issues relating to safe recycled water supplies in an industrial context will be covered by a technical code (Water Recycling for Industrial Purposes) as a complimentary document to work in tandem with these Guidelines.

3.2.6 Environmental uses

Recycled water can be used for environmental uses, provided that it meets site specific environmental standards. Some environmental uses include:

- bioremediation of contaminated soils
- recharge of wetlands and surface water bodies (replacing/enhancement of environmental flows)

The corresponding DWER regional office should be contacted for those recycling schemes seeking approval for environmental benefits. Contact details located at:
Water and Environmental Regulation regional offices (www.wa.gov.au)

4. Planning for recycled water use

4.1. Recycled water policy

Scheme managers must ensure that a recycled water policy is in place. A recycled water policy is important in formalising the commitment to responsible, safe and sustainable use of recycled water. The policy should provide a basis for developing more detailed guiding principles and implementation strategies. As such, it should be clear and succinct, and should address broad issues and requirements, such as:

- commitment to responsible use of recycled water, and the application of a risk management approach
- recognition and compliance with relevant regulations and other requirements
- communication and partnership arrangements with agencies with relevant expertise, and with users of recycled water
- communication and engagement with employees, contractors, stakeholders and the public
- intention to adopt best-practice management and a multiple-barrier approach
- continuous improvement in managing the treatment and use of recycled water
- the opinions and requirements of all partner agencies, employees, users of recycled water, other stakeholders and the wider community; and
- a regular review for ongoing suitability and compliance

The National Guidelines provide an example of a recycled water supply policy (section 2.1.4, page 24) for further information.

4.2 Communication planning

4.2.1 Define communication protocols with the involvement of relevant agencies

Effective communication is vital in managing the day-to-day running of a system and incidents and emergencies. Clearly defined protocols for both internal and external communications should be established with the involvement of relevant agencies including health, environment and other regulatory agencies.

These protocols should include a contact list of key people, agencies and businesses, detailed notification forms, procedures for internal and external notification, and definitions of responsibilities and authorities. Contact lists should be updated regularly (e.g. six-monthly) to ensure they are accurate.

4.2.2 Develop a public and media communications strategy

User confidence and trust during and after an incident or emergency are essential, and are largely affected by how incidents and emergencies are handled. A public and media communication strategy should be developed before any incident or emergency situation

occurs. Draft public and media notifications should be prepared in advance of any incident and should be designed for the target audience. An appropriately trained and authoritative contact should be designated to handle all communications in the event of an incident or emergency. All employees should be kept informed during any incident for their own requirements and because they provide informal points of contact for the community.

Users of recycled water should be told when an incident has ended, and should be provided with information on the cause of the incident and actions taken to minimise future occurrences. This type of communication helps to allay community concerns and restore confidence in the water supply. Post-incident surveys of the community are valuable to establish the perceptions of users of recycled water relating to events and how they were managed.

4.2.3 Community consultation

The recycled water scheme proponent should decide on the level of community engagement in the planning stages of the project. Proponents should undertake community involvement early in the planning stage, as part of a strategic and planned aspect of the recycling scheme.

As part of the process the proponent should identify the primary audience for community engagement to maximise the opportunity for participation and feedback on the recycling scheme. The primary audience would normally consist of those community members that will benefit/use the recycled water and/or those community members that will be directly impacted by the scheme.

If there are other audiences within the community that will be targeted by the program they should also be identified and listed. Once the proponent has identified the community engagement audience, there are many possible techniques that can be applied. The Guide to Best Practice Planning Engagement in Western Australia (DPLH) promotes best-practice engagement and consultation and foster good planning outcomes and can be found: Guide to Best Practice Planning Engagement in Western Australia (www.wa.gov.au)

The Public health consultation: A guide for developers (DOH) provides the principles and tools on how to design and appropriate, sound, fair and transparent community involvement process and can be found at:

Public-Health-Consultation-Guide.pdf

4.2.4 Stakeholder engagement

In addition to the identified community that may be affected by, or have an interest in the water recycling scheme, the proponent of the recycled water scheme should also communicate with other parties such as local and state government agencies.

The primary contact for recycled water schemes will be DOH, or the DWER for urban developments planning a recycling scheme. The proponent of the scheme should discuss the proposal/plans, including the statutory requirements, with the relevant authority as early as possible in the project to ensure that all relevant issues are addressed during the planning stage and prior to the commencement of the design and operation phases.

4.3 Financial planning

Financial assessment is required to determine the long-term viability and sustainability of a recycled water scheme and is particularly important where the scheme plans to provide essential services to end-users (such as toilet flushing).

Financial assessment considers whether the projected revenues will be sufficient to cover expenditures and whether the financial return is sufficient to make the project commercially viable. Proponents should be aware that the market and pricing for recycled water is in its infancy, but that it has clearly become a resource rather than a waste product.

When essential services are involved, applicants are required to receive their own legal advice to determine whether a licence from the Economic Regulation Authority (ERA) is required under the *Water Services Act 2012*. If a licence is required a financial plan should be submitted with the licensing application to the ERA for assessment.

4.4 Site selection

Selecting a suitable site is critical to the successful establishment of a recycled water scheme. The criteria for site selection will be dependant on the proposed end use of the recycled water but there are some criteria common to all recycled water treatment processes.

In selecting a suitable site for the construction of a recycled water scheme, particular attention should be paid to:

- Land use conflicts. The surrounding uses of land should be consistent with the recycled water scheme. Where the scheme is located in close proximity to residential premises, planning consideration should be given to minimise odour and noise nuisance, providing a buffer distance and managing the visual amenity of the site. Special attention should be placed on potential land use conflicts between the recycled water scheme and Public Drinking Water Source Areas or specific environmental requirements in environmentally sensitive areas. For the location of sensitive water resources, contact the DWER local regional office or go to ttps://www.wa.gov.au/service/natural-resources/water-resources/interactive-water-science-maps
- Proximity to the end-use. A site that is located sufficiently close to the proposed end-use is preferred to minimise the environmental impacts from constructing pipelines and potentially pumping the recycled water, as well as to improve the financial viability of the project. Some environments may be so sensitive as to preclude the operation of a recycled water scheme or the use of recycled water in the vicinity of the environment, e.g. a project that requires pipework through sensitive wetlands, etc.

4.5 Roles and responsibilities

4.5.1 Providers

Providers of recycled water are required to complete the relevant sections of the Recycled Water Quality Management Plan (RWQMP) related to the treatment, validation, verification and water quality monitoring.

Providers must also have a ‘Recycled Water Supply Agreement’ (see Section 7.5) with their end-users outlining what the water is supplied for, what are its possible end-uses and what quality of water is being provided. It should also include the commitment for continuous supply for essential services and contingencies for supply loss.

4.5.2 Scheme managers

Single entity schemes are schemes in which the recycled water provider and scheme manager is the same entity (i.e. the same entity is responsible from source to end-use). Scheme managers are required to complete all relevant sections of the Recycled Water Quality Management Plan (RWQMP) and are responsible for their implementation.

Multiple entity schemes are schemes with at least two entities: a recycled water provider and an end-user. Scheme managers are required to complete all sections of the RWQMP with relevant input from their suppliers (see section 4.5.1). The scheme manager is responsible for the submission to DOH and the implementation of the RWQMP. Whenever a recycled water producer supplies another entity with recycled water, the two parties should negotiate an agreement.

The agreement should specify the quality and quantity of recycled water as well as the obligations and responsibilities with respect to the supply and use of the recycled water (see Appendix M: Recycled Water Supply Agreement of the RWQMP template).

Preliminary discussions between the proposed user(s) and the proponent of the recycled water scheme should commence at the beginning of the project to provide some certainty regarding the demand for the recycled water.

4.5.3 End-users

End-users are the people who utilise the recycled water for an approved and anticipated activity such as irrigation or toilet flushing. Users should have a basic knowledge of how the recycled water supply works and what the associated risks and controls are involved in maintaining a safe recycled water supply. It is the responsibility of the scheme manager to inform end-users of the conditions of use and their responsibilities. Managers shall provide an effective communication plan with end-users including contact details of people responsible in case of incidents and emergencies (see section 3.3. of the RWQMP template).

5. Risk assessment and management

Health risk assessment is the overall process used for risk identification, risk analysis and risk evaluation. Therefore, it is used to identify the most serious threats of recycled water based on likelihood of occurrence and severity of consequences. Health risk assessment evaluates the hazards and events that can compromise recycled water quality and safety and enables decisions to be made about priorities and about measures required to control or minimise hazards or hazardous events.

5.1 Risk identification

In order to effectively manage and assess the risks involved in a recycled water supply system, hazards and possible hazardous events must be identified before the system is put in place so that they can be mitigated.

It is important that people involved in identifying risk have an understanding of the risks associated with the recycled water scheme being undertaken.

The National Guidelines, provide the following definitions for:

Hazard: a hazard is a biological, chemical, physical or radiological agent that has the potential to cause harm to people, animals, crops or plants, other terrestrial biota, aquatic biota, soils or the general environment; for example: the protozoan parasite Cryptosporidium parvum is a hazard to human health.

Hazardous Event: a hazardous event is an incident or situation that can lead to the presence of a hazard — that is, what can happen and how; for example: failure at a recycled water treatment plant leading to C. parvum passing into the distribution system of a dual-reticulation system is a hazardous event.

In order to identify risks the following questions must be answered:

- What can happen?
- When and where?
- How and why?

5.2 Risk analysis

The risk associated with identified hazards and possible hazardous events are then analysed based on the likelihood of human exposure to the hazard or the likelihood of the hazardous event occurring, combined with the potential consequence (impact) of the exposure.

Formula: Level of risk = likelihood x consequence of an event

Where appropriate, the confidence placed on estimates of levels of risk should be included and assumptions made in the analysis should be stated. Specifically for recycled water supply systems, the information required to assess the associated risks are:

- the source of recycled water and its quality
- potential hazards
- preventative measures, including treatment trains in place
- quality of treated/processed water
- intended end-uses
- preventative measures to be applied at the site of use of the recycled water
- the potential impacts being assessed.

The risk management process for recycled water schemes follows the Hazard Analysis Critical Control Point (HACCP) system. The HACCP is a systematic approach to the identification of hazards and their prevention with a focus on process control to ensure that prevention measures are operating effectively. The first step in a HACCP process is to identify the hazards and assess the risks. Having identified the possible hazards and hazardous events, the risk can be assessed or evaluated against the following risk criteria:

5.2.1 Estimate the level of risk (qualitative)

Qualitative analysis uses words to describe the magnitude of potential consequences and the likelihood that those consequences will occur. Not all hazards and hazardous events are created equal. Events that seem more likely and/or have a higher impact must be prioritised for mitigation or prevention. The following tables from the National Guidelines outline a risk matrix for qualitative risk estimation.

Table 3: Qualitative measures of likelihood

Level	Descriptor	Example description
A	Rare	May occur only in exceptional circumstances. May occur once in 100 years
B	Unlikely	Could occur within 20 years or in unusual circumstances
C	Possible	Might occur or should be expected to occur within a 5 to 10-year period
D	Likely	Will probably occur within a 1- to 5-year period
E	Very likely	Is expected to occur with a probability of multiple occurrences within a year

Table 4: Qualitative measures of consequence or impact

Level	Descriptor	Example description
1	Insignificant	Insignificant impact or not detectable
2	Minor	Health — Minor impact for small population Environment — Potentially harmful to local ecosystem with local impacts contained to site
3	Moderate	Health — Minor impact for large population Environment — Potentially harmful to regional ecosystem with local impacts primarily contained to on-site
4	Major	Health — Major impact for small population Environment — Potentially lethal to local ecosystem; predominantly local, but potential for off-site impacts
5	Catastrophic	Health — Major impact for large population Environment — Potentially lethal to regional ecosystem or threatened species; widespread on-site and off-site impacts

Table 5: Qualitative level of risk estimation

Likelihood	Consequences				
	1- Insignificant	2- Minor	3- Moderate	4- Major	5- Catastroph
A Rare	Low	Low	Low	High	Hi
B Unlikely	Low	Low	Medium	High	Very high
C Possible	Low	Medium	High	Very high	Very high
D Likely	Low	Medium	High	Very high	Very high
E Almost certain	Low	Medium	High	Very high	Very high

A more in-depth, quantitative risk assessment is recommended for schemes where the implications of an incident are higher (e.g. exposure to a large number of people or a throughput of a large volume of water or potential major health impacts). Quantitative risk calculations can be found in Appendix 2 of the Phase 1 National Guidelines.

5.2.2 Exposure risk levels

When determining the level of risk, the expected end use should be taken into account to determine the potential level of exposure that end users will have to the recycled water. Common end uses for recycled water are presented in Table 6.

Table 6: Exposure risk levels

Exposure Risk Levels	End Uses
High	• Multi dwellings; internal reuse (toilet flushing and dedicated cold water taps for washing machines) or external surface irrigation • Agricultural irrigation of food crops consumed raw or unprocessed (hydroponics, salad crops, etc) • Urban surface irrigation with unrestricted access and application*
Medium	• Urban surface irrigation with some restricted access and application* • Fountains and water features • Stock watering, dairy cattle, grazing • Industrial use with potential human exposure • Dust suppression • Wash down water • Cooling towers • Commercial food crops • Urban irrigation with enhanced restricted access and application*
Low	• Communal residential irrigation (sub-surface for fruit trees) • Agricultural irrigation; non-edible crops, fodder livestock • Subsoil irrigation
Extra Low	• Environmental benefits with unlikely human exposure • Non-food crops such as woodlots, flowers

*Criteria for different levels of restricted access and application are listed in Section 6.5

The monitoring and safeguard requirements for these levels of exposure risks are described in section 6.4.

5.3. Risk management and critical control points

Once risks have been identified, the next step is to put systems in place to manage/mitigate the risks. Risk management involves identifying a range of options for treating risks, evaluating those options, preparing treatment plans and implementing them. For recycled water supply systems the Hazard Analysis and Critical Control Points (HACCP) process is a sound method for devising a risk management system and it is summarised in Figure 3.

The HACCP process requires the identification of Critical Control Points (CCPs). CCPs are “a point, step or procedure at which control is essential to prevent or eliminate a hazard or reduce it to an acceptable level.” This may relate to a barrier or a step in the treatment process. Other control measures outside the CCPs are also important to minimise risk and are considered on a case by case basis.

A HACCP team is expected to draft a HACCP plan up for a recycled water supply system and submit it as part of the submission for approval to the Water Unit, DOH.

5.3.1 Preliminary Steps (i-v)

Preliminary step i- Assemble HACCP team

The HACCP team should be a multidisciplinary team knowledgeable of the process and product, with a broad range of expertise and skill in all aspects of the recycled water system. The team plans, develops, verifies and implements the HACCP plan.

- Assemble a team with the appropriate expertise and knowledge on the recycled water scheme. The team will have the collective responsibility for identifying the hazards that can occur in the recycled water production and delivery process. The team members should have the skills required to identify hazards and the barriers necessary for their control as well as have the authority to ensure that barrier management is developed, and will be selected depending on the focus of the hazards being identified and the intended recycled water end-uses.
- The team members should come from a range of backgrounds (health, engineering, planning, environment, wastewater treatment plant designers and operators, etc.). In some instances this stage will necessitate the proponent of the recycled water scheme going to tender to identify the appropriate expertise for the design and implementation of the project, where the knowledge is not available "in house."
- In situations where required skills are unavailable locally, the team leader should explore opportunities for external support, including benchmarking or partnering arrangements with other organisations, agencies, national or international assistance programs and internet resources.
- A list of team members, their positions, responsibilities and contact details should be compiled for reference. This list should be updated on a regular basis so the details remain current. Once all details are inserted into the table, the table should be signed off as an accurate record of that information and the details changed as required. Failure to update the list, due to restructuring of organisations, change of jobs etc., could cause a significant risk in terms of communication.

Preliminary Step ii - Describe product

A full description of the recycled water is documented. This description includes: water source; treatment processes; storage and distribution; and any special considerations to maintain recycled water safety.

Preliminary Step iii - Identify intended use

The expected use of the recycled water is documented including: how the recycled water is to be used; consumer instructions for recycled water use; and who the recycled water is intended for.

Preliminary Step iv - Construct flow diagram

The flow diagram must clearly indicate all process steps in the operation. The flow chart must state when the scheme manager responsibility starts (partially treated water, raw source water) and ends (at the meter box, at consumer tap). Steps prior to and after the organisation's direct responsibility should also be included.

Preliminary Step v - Confirmation of flow diagram

The HACCP team confirms that the flow diagram is both complete and accurate as it is used in the hazard analysis. The best validation is to go through the flowchart step-by-step and verify the set up of the system and processes. If this is not possible, those with operational knowledge of the system can validate the flow diagram.

5.3.2 Principles

Step 1 – Conduct a hazard analysis

A hazard is one that must be prevented, eliminated or reduced to an acceptable level to produce safe recycled water. Hazards may be biological, chemical, radiological or physical. Generally the hazards of greatest concern for the recycled water are those that are biological (pathogens), however, it may be appropriate to consider chemical and physical hazards depending on your catchment and/or source water.

The hazard analysis consists of three steps, which should be documented:

- Identify hazardous events at each step in the process that may impact on recycled water quality.
- Determine the risk and significance of each hazardous event. This is the product of how frequently the hazardous event is expected to occur and what the consequences of that event occurring are.
- Identify control measures for each hazardous event. These include system input management, physical barriers (such as treatment steps), monitoring, standard operating procedures and personnel training.

More than one control measure may be required to control a particular hazard, and more than one hazard may be controlled by a particular measure.

Step 2 – Determine Critical Control Points (CCPs)

A CCP is a point, step or procedure at which control can be applied and a hazard can be prevented, eliminated, or reduced to acceptable levels. Some systems have several CCPs and some may have multiple CCPs for the same hazard. Figure 4 illustrates the four questions that are required to identify a CCP.

A CCP can be identified as having the following characteristics:

- Limits for operational acceptability can be defined (the efficacy of the treatment train at these points is measurable).
- These limits can be monitored, directly or indirectly, through surrogate organisms or the presence of physical or chemical parameters.
- A pre-determined response can be enacted when deviations or ultimately a breach in quality requirements is detected by monitoring.
- The response will protect recycled water safety by bringing the control measure back into specification or by enhancing or implementing additional control points.
- The process of detection of the deviation and completion of the response can be completed in a timeframe adequate to maintain water safety.

The HACCP Process

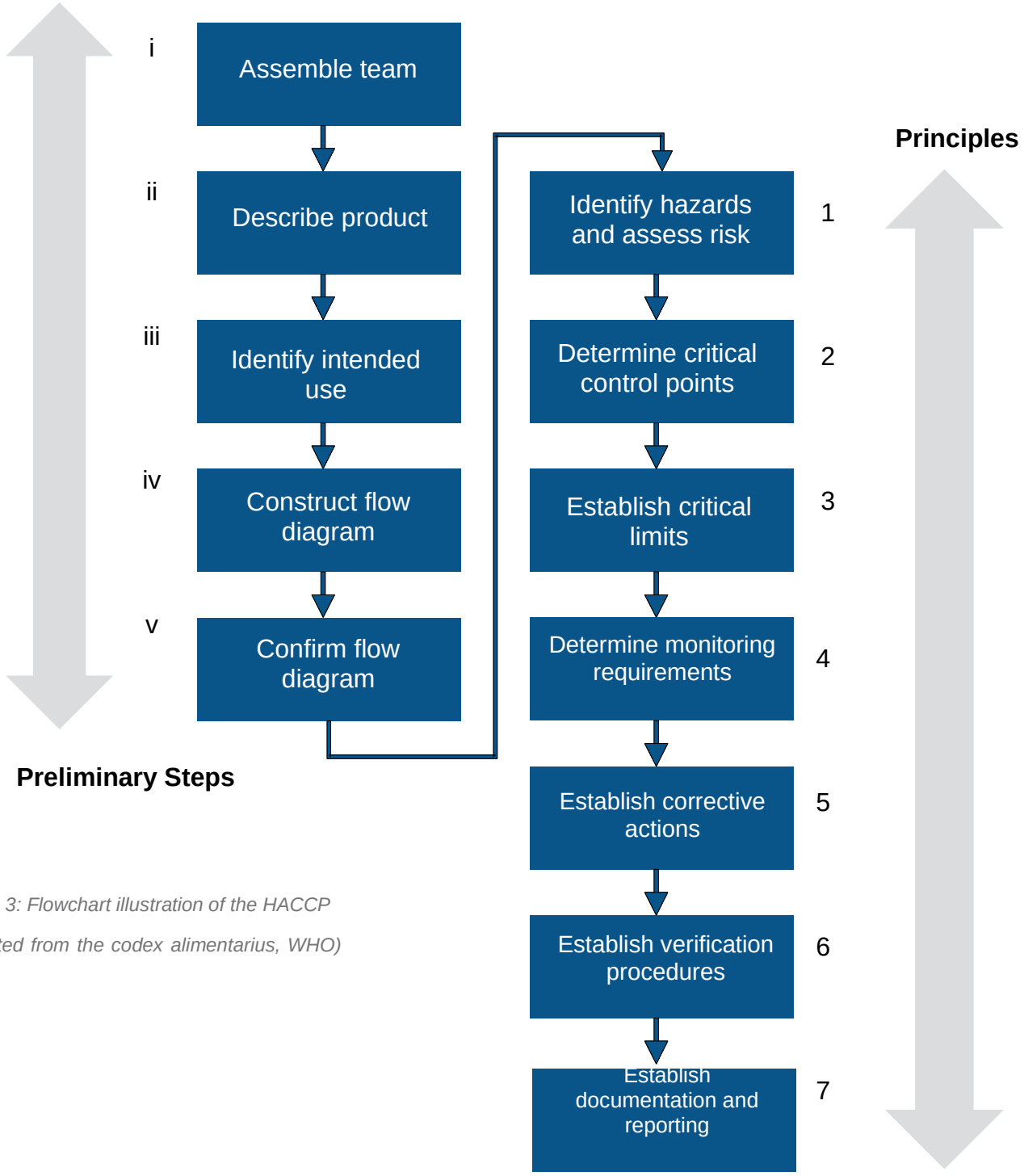

Figure 3: Flowchart illustration of the HACCP

(Adapted from the codex alimentarius, WHO)

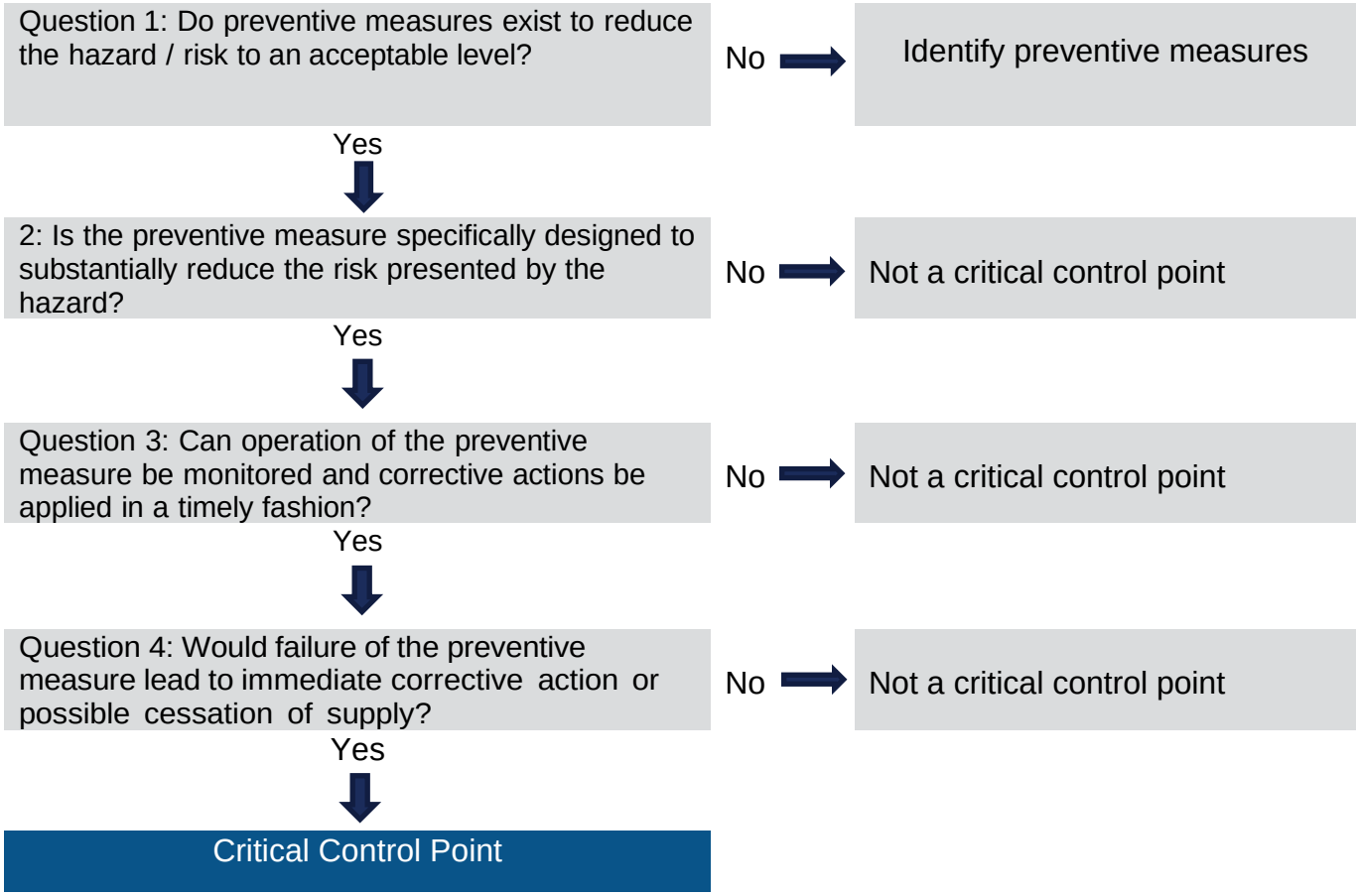

Figure 4: Critical control points (CCP) decision tree

(From National Guidelines Phase 1, 2006)

Step 3 - Establish critical limits

Critical limits are assigned to each control measure at a CCP. All CCPs must have limits for their operational parameters that are defined and validated. A critical limit distinguishes between acceptable and unacceptable performance (see Figure 5). When a critical limit is not met, corrective actions should be immediately instituted to resume control of the process. If a violation limit occurs, recycled water shall be diverted or the system shall be shut down.

Step 4 - Monitoring

Monitoring is planned observations or measurements to provide a record. All critical limits have associated monitoring activity to ensure that the critical limit is met. A monitoring regime that identifies the location and frequency of monitoring, and a description of the method or procedure of monitoring must be established. If monitoring indicates that the critical limit has not been met, then corrective action must be taken.

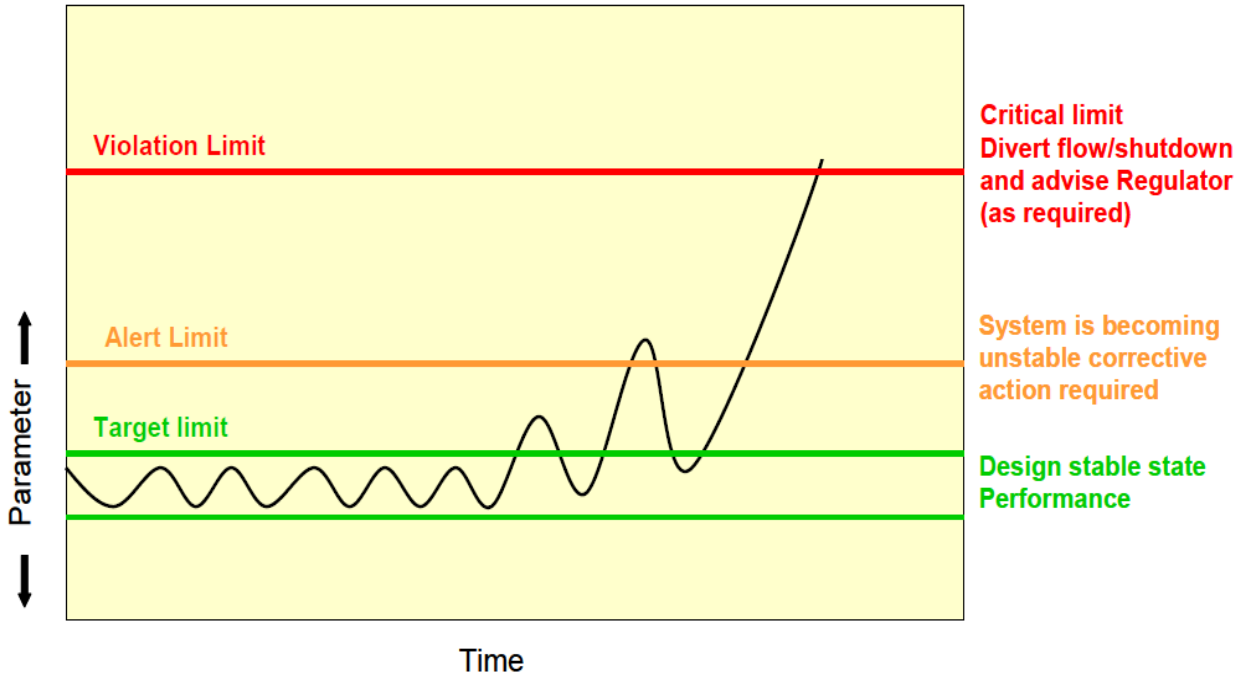

Figure 5: Representation of target, alert and violation limits for CCPs

Step 5 - Establish corrective actions

Corrective actions are taken when a critical limit is not met. If a critical limit is indicative of the treatment process providing sufficient pathogen removal, then the corrective action for not meeting that limit might be to stop recycled water delivery to end users. Corrective actions ensure that the CCP is brought under control. Corrective actions can include: immediate action, responsibility for corrective action, disposition of recycled water and the root cause of the problem. The documentation of corrective actions must include what immediate action is required to resolve the problem, who is responsible for undertaking the corrective action, and who must be notified. If a violation limit occurs, recycled water shall be diverted, or the system shall be shut down.

Step 6 - Establish verification procedures

Verification procedures are used to determine whether the control measures are effective and whether the water quality management plan is being implemented appropriately.

Verification includes:

- testing the monitoring and procedures identified in the HACCP plan during commissioning of the treatment process,
- validation of critical limits,
- equipment calibration,
- cleaning and maintenance programs,
- HACCP plan reviews and internal/external audits; and
- ongoing evaluation of monitoring data to assess the overall performance of the treatment process and HACCP plan.

Step 7 - Establish documentation and record keeping

Documentation is required as proof of compliance to the HACCP plan and to provide a legal defence for due diligence. HACCP records should be dated and signed. Records should

provide recycled water traceability. Appropriate documentation provides the foundation for establishing and maintaining an effective HACCP plan. Documentation should include:

- information used to develop the HACCP plan,
- CCPs, critical limits, monitoring and corrective actions,
- standard operating procedures relied upon or specifically developed for the HACCP plan,
- verification activities, including the validation of critical limits,
- records generated from monitoring; and
- reviews and modifications to the HACCP plan.

A HACCP team is expected to draft a HACCP plan up for a recycled water supply system and include it as part of the submission for approval to the Water Unit, DOH.

6. Monitoring of recycled water systems

Monitoring of the recycled water quality at CCPs is essential to determine the efficacy of the treatment train and ensure a safe recycled water supply. Emphasis should be placed in operational monitoring. Operational monitoring instils confidence in the water quality, gives an indication of system malfunctions and allows for a timely response to problems.

Monitoring is an essential and integral part of managing risk and it takes place at different stages in the process for different purposes. The different components of monitoring and their functions are summarised in Figure 6 and are described below.

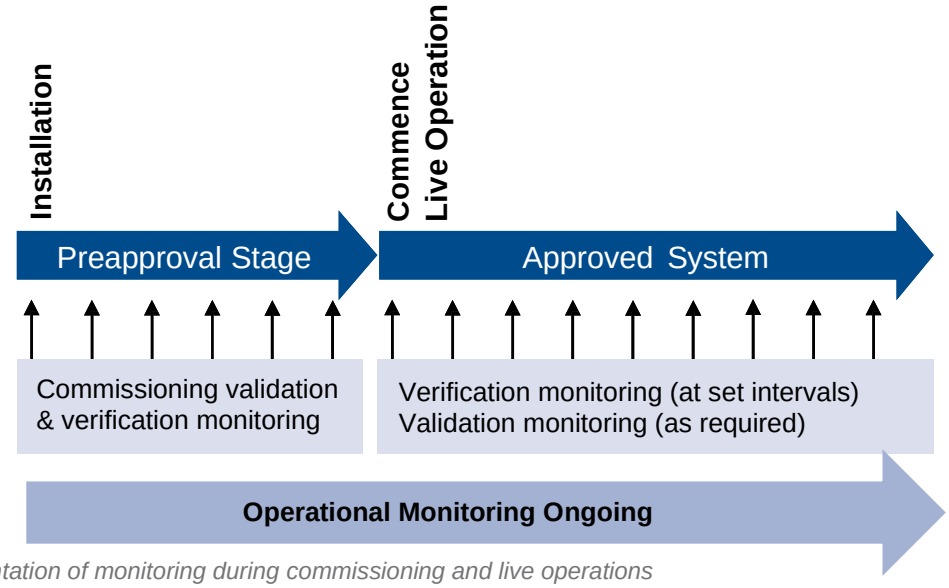

Figure 6: Representation of monitoring during commissioning and live operations

6.1 Validation monitoring – will it work?

There are two types of validation monitoring. One is validation during the preapproval stage of the treatment plant, also called commissioning validation, and the other is validation monitoring during live operation (Figure 6).

Commissioning validation ensures that the equipment and treatment process is operating effectively and ensures removal of hazards from the source water to fulfil the fit for purpose requirements.
Commissioning validation is based on the literature and/or experimental studies and the operational criteria that demonstrate the hazard reduction capability of the treatment to effectively control hazards. Commissioning validation demonstrates that the treatment plant

will operate under the manufacturer's specifications for operating criteria. For example, that the UV system is installed and operates under validation methods conducted by the manufacturer in relation to flow rate and dose.

Validation monitoring happens when the scheme commences live operation and it is to be carried out after any 'substantial changes' to the system are made. A 'substantial change' involves changing one of the primary components of the system (a new pump, a new filtration unit, new pipework) or any change of the influent water quality (switching from greywater to sewage, etc).

Both types of validation monitoring will validate the adequacy of the system in treating the water and to confirm that the system is not set up to fail. Depending on the outcome of the test results, the system can then be fine-tuned to ensure that the water quality objectives can be achieved.

A few reasons why a system may fail in the validation monitoring criteria are:

- Underestimation of pollutant loads in raw water.
- Underestimation of treatment levels required; and
- Failure to account for the interaction of the raw and treated water with pollutants in the natural environment.

6.1.1 Validation monitoring requirements

Commissioning validation monitoring is generally required to take place over a minimum of six weeks to gain a minimum of 6 samples from the inflow (influent reading) and the relevant CCPs in the process. This is essential to ensure that the treatment system works to the established operational limits and can be safely operated before recycled water can be reused on-site.

DOH will prepare a Commissioning Validation Sampling Program based on the proposed treatment train and the identified CCPs. The operational parameters of each critical control point and their corresponding operational targets will be monitored during commissioning validation. The CCPs will vary depending on the type of system in use and processes and will adjustment during commissioning validation to correct any failure or inefficiency of the system to achieve the operational targets. No approval to use will be granted until the system is producing the water quality expected for the intended end-use(s).

Commissioning validation monitoring is usually done over 7 weeks (once a week with a one week margin for error) or 12 weeks (fortnightly sampling with two weeks as a margin for error). A speeding up of the process is allowed as long as the 6 consecutive samples are obtained, however the ability to expedite this process will depend on the risk factors involved on a case-by-case basis (i.e. high risk end-uses will rarely be considered for an expedited process). Scheme managers shall notify DOH of any substantial changes in the treatment or source water after approval of the scheme. DOH will prepare a validation sampling program based on the proposed changes and the identified CCPs.

6.2 Operational monitoring- Is it working now?

Operational monitoring corresponds to the routine monitoring of control parameters that confirm the treatment processes are under control and operating within the operating criteria (Figure 5). Operational monitoring involves the selection and monitoring of parameters that are constantly measured to show that the system is operating as intended.

Operational monitoring is of critical importance as it demonstrates that individual barriers and preventative strategies for controlling hazards are functioning properly and effectively (i.e. under operational standards) to ensure that the product water always complies. This is the operator's mechanism to check for system efficiency and failures.

Monitoring involves a broad range of parameters with both observation (e.g. warning signs and alarms in place) as well as continuous online measures (e.g. DO, pH, turbidity, UV dose, and chlorine residual).

Examples of attributes that can decrease the efficiency of a system are:

- A change in raw water (influent) quality,
- Wear and tear of the system,
- A breakdown in the system's components,
- A lack of maintenance to enable optimum performance; and
- A lack of adequate calibration of instruments.

The risk assessment and HACCP process will have identified appropriate critical limits for water quality parameters that shall form part of the ongoing monitoring plan. It is the responsibility of the proponent of the recycled water scheme to prepare an ongoing operational sampling regime that reflects the risk assessment and HACCP process. This is the operators 'safety-net' to ensure that water supplies do not drop into non-compliance or that if they do a cause can be identified and the situation can be quickly rectified. The Water Unit will review the proposed schedule and either approve, request additional information, or recommend changes.

6.3 Verification (assessable) monitoring – Did it work?

There are two types of verification monitoring. One is verification during the preapproval stage of the treatment plant (also called commissioning verification), and the other is verification monitoring after the scheme commenced live operation (Figure 6). Both types of verification monitoring are done by testing the end-product water (i.e. the final effluent) and are based on the water quality objectives on Tables 7 and 8. The aim of verification monitoring is to ensure that the recycled water supplied complies with the recycled water quality objectives.

Commissioning verification monitoring is to be carried out in the commissioning phase before the scheme goes live. Commissioning verification ensures that the equipment and treatment process is able to achieve the recycled water quality objectives in a reliable manner. The commissioning verification is conducted simultaneously with the commissioning validation and operational monitoring generally over a minimum 6 week period. The results of the tests must be presented in the validation and verification report to DOH and is subjected to audit (it is the outcomes on which the system is assessed for compliance with the appropriate standards).

E.g. Testing for *E. Coli* in the effluent (after disinfection) is required to determine if the system is able to achieve the fit for purpose water quality objectives on Tables 7 and 8. However, during commissioning verification testing for *E. coli* in the influent of the plant may also be required to calculate the log removals the system is able to achieve.

Verification monitoring is conducted when the scheme is approved and is conducted as per Table 8. Verification monitoring demonstrates that the recycled water, produced by the treatment plant, complies with the water quality objectives over the life of the scheme. Failure during verification (assessable) monitoring is indicative of a failure in the operational

monitoring. The CCP that has failed should be checked and if necessary, replaced or repaired. The failure may also be required to be reported to DOH.

If testing of the approved scheme is conducted through PathWest laboratories the results are automatically transferred to the Department of Health database. Schemes using another NATA accredited laboratory shall submit the monthly results on request.

6.4 Monitoring for aesthetic quality

Although aesthetic quality of the water does not directly impact health, it is in the best interest of the supplier to monitor for aesthetic quality for the following reasons:

- Protection of reticulation infrastructure from corrosion;
- Protection of plumbing and fixtures; and
- Protection of equipment and items that are exposed to the water.

Several characteristics in recycled water may lead to corrosion, staining and deposition of residuals on the items exposed to the water. In order to protect the infrastructure and to minimise user complaints, these characteristics such as turbidity should be monitored. A problem with aesthetic quality is also a sound indicator that something may be amiss and must be addressed in the operational monitoring. Monitoring of aesthetic water quality is required for third pipe schemes where the water is used for in-house uses such as toilet flushing.

Table 7: Commissioning validation and verification monitoring requirements

Exposure Risk (level of human contact)	Potential end-users	Validation and verification monitoring [4,5,7,8] -6 samples[6]			
		Parameter	Effluent Compliance value[11]	Influent[3] monitoring frequency	Effluent monitoring frequency
High	• Multi-unit dwellings, internal use and external surface irrigation[2,17] • Agricultural irrigation – unprocessed foods (e.g. salad crops)[17] • Urban irrigation with unrestricted access and application[a, 17] • Communal use – flushing toilets and designated cold tap washing machines	E.coli[1]	<1 MPN or cfu/100mL	Weekly	Weekly
		BOD	<10 mg/L	Not required	Weekly
		SS	<10 mg/L	Not required	Weekly
		pH	6.5 – 8.5	Continuous Online or weekly	Continuous online
		Turbidity	<2 NTU (95% lle)[10] <5 NTU (maximum)	Continuous online or weekly	Continuous online
		Disinfection	• Cl[9]: 0.2 – 2.0mg/L • UV[13] • UVT[14] >75% • UV intensity: • drop <25% at 254nm • UV dose: 40 – 70ml/cm^2 • Ozone[15]	N/A	Continuous online
		Coliphages	<1 pfu/100mL	Fortnightly	Weekly
		Clostridia	<1 cfu/100mL	Fortnightly	Weekly

Exposure Risk (level of human contact)	Potential end-users	Validation and verification monitoring [4,5,7,8] -6 samples[6]			
		Parameter	Effluent Compliance value[11]	Influent[3] monitoring frequency	Effluent monitoring frequency
Medium	• Urban irrigation with some restricted access and application[b,17] • Fire fighting • Fountains and water features • Industrial use with potential human exposure • Dust suppression[17]	E.coli[1]	<10 MPN or cfu/100mL	Weekly	Weekly
		BOD	<20 mg/L	Not required	Weekly
		SS	<30 mg/L	Not required	Weekly
		pH	6.8 – 8.5	Continuous online or weekly	Continuous online
		Turbidity	<5 NTU (95% lle)[10]	Continuous online or weekly	Continuous online
		Disinfection	• Cl[9]: 0.2 – 2.0mg/L • UV[13] • UVT[14] >75% • UV intensity: drop <25% at 254nm • UV dose: 40 – 70ml/cm^2 • Ozone[15]	N/A	Continuous online
Low	• Communal sub-surface irrigation[17] • Urban irrigation with enhanced restricted access and application[c,17] • Agricultural irrigation; non-edible crops[17]	E.coli[1]	<1000 MPN or cfu/100mL	Weekly	Weekly
		BOD[12]	<20 mg/L	Not required	Weekly
		SS[18]	<30 mg/L	Not required	Weekly
		pH	6.5-8.5	Continuous online or weekly	Daily or continuous online
		Disinfection (if used)	Cl[9] : 0.2 – 2.0mg/L	N/A	Daily or continuous online
Extra low	• Woodlots with surface irrigation[17] • Sub-surface irrigation (non-food crops)[17]	E.coli[1]	<10000MPN or cfu/100mL	Weekly	Weekly

Table 8: Minimum ongoing monitoring requirements

Exposure Risk (level of human contact)	Potential end-users	Ongoing monitoring			
		Parameter	Compliance value[11]	Monitoring frequency	Audit frequency
High	• Multi-unit dwellings, internal use and external surface irrigation[2,17] • Agricultural irrigation – unprocessed foods (e.g. salad crops)[17] • Urban irrigation with unrestricted access and application[a,17] • Communal use – flushing toilets and designated cold tap washing machines	E.coli	<1 MPN or cfu/100mL	Weekly[d]	• Internal audit required every 3 years, external every 6 years • Plumbing maintenance and alteration audits recommended once every six years, including back flow and cross-connection auditing • Random audits may be carried out at any time
		pH	6.5 – 8.5	Continuous Online	
		Turbidity	<2 NTU (95% lle)[10] <5 NTU (maximum	Continuous online	
		Disinfection	• Cl[9]: 0.2 – 2.0mg/L • UV[13] • UVT[14] >75% • UV intensity: drop <25% at 254nm • UV dose: 40 – 70ml/cm^2 • Ozone[15]	Continuous online	
		Coliphages	<1 pfu/100mL	Monthly	
		Clostridia	<1 cfu/100mL	Monthly	
		Ongoing monitoring of coliphages and clostridia is dependent on the outcomes of the validation monitoring. For third pipe schemes where chlorine is not used as the primary disinfectant, chlorination will be required to provide a measurable residual at the point of use. Chorine residuals will be sampled at the delivery point.			

Exposure Risk (level of human contact)	Potential end-users	Ongoing monitoring			
		Parameter	Compliance value[11]	Monitoring frequency	Audit frequency
Medium	• Urban irrigation with some restricted access and application[b,17] • Fire fighting • Fountains and water features • Industrial use with potential human exposure • Dust suppression[17]	E.coli	<10 MPN or cfu/100mL	Monthly[d]	• Internal audit required every 3 years, external every 6 years • Plumbing maintenance and alteration audits recommended once every six years, including back flow and cross-connection auditing • Random audits may be carried out at any time
		pH	6.8 – 8.5	Continuous online	
		Turbidity	<5 NTU (95% Ile)[10]	Continuous online	
		Disinfection	• Cl[9]: 0.2 – 2.0mg/L • UV[13] • UVT[14] >75% • UV intensity: drop <25% at 254nm • UV dose: 40 – 70ml/cm^2 • Ozone[15]	Continuous online	
Low	• Communal sub-surface irrigation[17] • Urban irrigation with enhanced restricted access and application[c,17] • Agricultural irrigation ; non-edible crops[17]	E.coli	<1000 MPN or cfu/100mL	Monthly[d]	• Internal audit required every 3 years, external every 6 years • Plumbing maintenance and alteration audits recommended once every six years, including back flow and cross-connection auditing • Random audits may be carried out at any time
		pH	6.5-8.5	Daily or continuous online	
		Disinfection[16] (if used)	Cl[9] : 0.2 – 2.0mg/L	Daily or continuous online[16]	
Extra low	Woodlots with surface irrigation [17,19]	System integrity	Damage assessment and repair[20]	Annual	• Plumbing maintenance and alteration audits recommended once every six years,
	Sub surface irrigation (non-food crops)[17]	• No monitoring required.			

Source: Modified from the Original Draft Guidelines for the Use of Recycled Water in WA

Notes to Tables 7 and 8

a. Urban irrigation with the potential for full public contact, no control to restrict access or minimise spray drift
b. Urban irrigation with some restricted public access during irrigation using signs notifying the area is irrigated with recycled water and that the public should avoid contact
c. Urban irrigation with restricted public access. Signs plus a combination of:
    - no access after irrigation (nominally 1 to 4 hours or until irrigation is dry);
    - minimum buffer zones to the nearest point of public access.
    - drip irrigation near boundaries (surface or subsurface);
    - spray drift controls, e.g. low throw sprinklers, vegetation screening; OR
    - sub-surface irrigation.
d. Review frequency after 12 months operation

1. Effluent compliance value represent median of 6 consecutive samples for numbers of micro- organisms.
2. Third pipe schemes will require some validation (verification) monitoring that there is a chlorine residual present at the point of supply.
3. Testing requirements assume sewage as the source of influent.
4. Proponent may choose to challenge test to validate system against different strength influents.
5. Approval authority may direct proponent to challenge-test where adequate log removal must be demonstrated, e.g., novel configurations or high-risk installations.
6. A minimum of 6 consecutive samples is required during the validation period.
7. Refer to Table 9 for log removal criteria. For more detail refer to Tables 3.7 and 3.8 of the National Guidelines.
8. Monitoring described is indicative since monitoring programs will be prepared by DOH on a case by case situation to reflect the source(s), proposed treatment train and end use(s) of the recycled water.
9. Free chlorine after a minimum contact time of 30 minutes is recommended. Sufficient chlorine contact time calculations may also be required to demonstrate the log removals the system is able to achieve.
10. Limit met for turbidity prior to disinfection.
11. All exceedances of any of the values should be investigated and managed as an incident.
12. Based on filtered BOD if recycled water is sourced from treatment lagoons and it is for low exposure risk level end-uses. Only filtered BOD is used for treatment performance assessment of low exposure risk level schemes via treatment lagoons. Filtered BOD allows quality of pond effluent to be differentiated from BOD contributed by algae.
13. UV: Ultraviolet light. UV systems shall be self-cleaning and fitted with lamp failure with associated shut down of recycled water out of specifications. The UV unit shall be able to communicate with the program logic controller (PLC) to ensure that effective UV disinfection is happening at all times when recycled water is being produced. UVT, UV dose and UV intensity can be used independently or in combination as parameters to assess UV performance.
14. UVT: Ultraviolet light transmissivity
15. Unlike chlorine based disinfectants, ozone does not maintain disinfection residual. Ozone concentration and the contact time will be established in the future when more studies and data are available
16. As a minimum a chlorination system that is electrically interlinked with the pumps supplying recycled to holding tanks that will fail safe (i.e. no chlorine no pumping) and upon failure activate an alarm system. For Low Exposure Risk Level schemes it is acceptable to use weekly chlorine residual monitoring after the chlorinator if: i) the

chlorination system is interlocked with the delivery of recycled water ii) an alarm system is activated and, iii) free chlorine and on-site pH is included in the monthly designated regulatory sampling points.

17. Restrictions apply to the use of recycled water for irrigation purposes in Public Drinking Water Source Areas.
18. Suspended solids (SS) value not applicable if treated sewage is sourced from treatment lagoons or pond systems where elevated SS are generally due to the presence of algae
19. No public access allowed, fencing and signage required,
20. Damage assessment and repair of irrigation systems is required on an ongoing basis. Irrigation of woodlots with recycled water is not permitted during and after timber harvesting.

6.5 Use of indicator organisms to determine performance of recycled water schemes

In order to determine the efficacy of a treatment train for a recycled water supply, microbiological indicator organisms are used to demonstrate that pathogens are reduced to a safe level for the intended end-use in the final water product. The efficacy of the treatment train can be assessed by measuring the log reduction in the presence of indicator organisms at critical control points. For a guide to the relevant levels of log reductions expected for different end-uses based on the National Guidelines see Table 9. For more detail, please refer to page 103, tables 3.7 and 3.8 of the National Guidelines.

Table 9: Log reduction targets for designated uses of recycled water

End uses of recycled water	Log reduction targets[a]			Water quality objectives[b]
	Virus	Protozoa	Bacteria	
Third pipe reticulation with indoor and outdoor use	6.5	5.0	5.0	• E Coli <1 or cfu /100mL • Disinfection (chlorine residual or UV)
Third pipe reticulation with indoor use only or outdoor use only	6.0	4.5	5.0	• E Coli <1 MPN or cfu /100mL • Disinfection (chlorine residual or UV)
Municipal use with unrestricted access and application	5.0	3.5	4.0	• E Coli <1 MPN or cfu /100mL • Disinfection (chlorine residual or UV)
Municipal use with restricted access and application[c]	5.0	3.5	4.0	• E Coli <10 MPN or cfu /100mL • Disinfection (chlorine residual or UV) • BOD<20 mg/L • SS<30 mg/L
Municipal use with enhanced restrictions on access and application[d]	5.0	3.5	4.0	• E Coli <1000 MPN or cfu / 100mL • Disinfection (chlorine residual or UV) • BOD<20 mg/L • SS<30 mg/L
Commercial food crops consumed raw or unprocessed	6.0	5.0	5.0	• E Coli <1 MPN or cfu/ 100mL • Disinfection (chlorine residual or UV)
Non-food crops (trees, flowers)	5.0	3.5	4.0	• E Coli <10.000 MPN or cfu /100mL

MPN: most probable number; cfu: colony forming unit; BOD: biological oxygen demand; SS: suspended solids.

BOD and SS are an indication of secondary treatment effectiveness

[a] log reduction targets are minimum reductions required from raw wastewater.

[b] water quality objectives represent medians for number of E Coli and means for other parameters

[c] log reductions achieved by disinfection and at least one restricted access measure

[d] log reductions achieved by enhanced restrictions on access and application

The following indicator organisms have been selected to indicate water quality:

6.5.1 Escherichia coli

Escherichia coli is a bacteria from the thermotolerant coliforms group. E coli is the default indicator that is representative of faecally-derived bacteria in general. *E. coli* monitoring can often be used alone for low exposure recycled water applications.

6.5.2 Coliphages

For high exposure risk level applications, the next priority is to monitor coliphages (viruses that infect coliform bacteria).

Coliphages are considered to be representative of faecally-derived viruses. There are many types of coliphages, and the choice of which to monitor depends on the situation. However, usually one or both of two groups, somatic coliphages and FRNA coliphages (or MS2), are monitored.

If only one of the two groups of coliphage is monitored, the somatic coliphage is generally more conservative than the FRNA coliphages. The somatic coliphages are usually more numerous in lagoons and secondary treatment systems, and may even multiply in these environments. This greater potential for somatic coliphages to multiply in sewage means that they can provide some additional conservatism in some systems.

FRNA coliphages are sometimes preferred for large systems, such as large municipal sewage recycling schemes, if only one of the coliphage groups is monitored, however FRNA coliphages are less prevalent in human faeces than somatic coliphages. FRNA coliphage can be cultivated and enumerated and it is often used to perform challenge test to demonstrate the log removals a treatment train can achieve.

Coliphages are recommended as the indicator organism for viruses as, unlike cryptosporidium, the sample required for effective monitoring is small and easily transportable.

6.5.3 Clostridia

For high exposure risk level applications, the final priority is to monitor spores of sulphite-reducing clostridia or spores of Clostridium perfringens as representative of faecally derived protozoan oocysts. Clostridia is a surrogate for cryptosporidium and giardia as it has a greater resistance to inactivation than bacterial and viral pathogens and it is used as indicator of protozoa microorganisms.

The indicator organisms must be brought to within acceptable levels for the recycled water effluent to be deemed safe and usable. The efficacy of the treatment train can be assessed by determining log reductions of the indicator organisms.

6.5.4 Helminths

Helminths are parasitic worms that can infect humans and other animals. The most common method of exposure is from walking barefoot on the soil where the eggs (ova) and larvae can be present. Soil transmitted Helminths are endemic to the Kimberley region, north of the 20th parallel.

Helminth control is necessary in the following locations:

- north of the 20th parallel to irrigate public open spaces (parks, sports fields and municipal areas) and
- where the recycled water is used to irrigate pasture and fodder for beef cattle; or
- where the recycled water is used to irrigate pasture and fodder for dairy animals; or
- where the recycled water is used for drinking water for stock (except pigs, see section 3.2); or
- where the recycled water is used to wash down water for dairies.

Conventional primary and secondary treatment processes, including disinfection via chlorination or UV, may not ensure adequate removal of helminths such as intestinal nematodes. The specified treatment measures to reduce helminths numbers include at least 25 days detention in treatment lagoons (this may include either primary, secondary or maturation lagoons provided the helminth settling process is not disturbed by processes such as mixing, aeration or any other process) or a storage facility where all recycled water must be detained for at least 30 days from the time of the last discharged into the storage facility, or an approved method of filtration, such as sand or membrane filtration.

DOH will include testing for Helminths during commissioning and ongoing monitoring for those schemes requiring helminth control as mentioned above. Helminth monitoring requirements will depend on scheme location, source of water and intended end-uses and it is analysed on a case by case situation.

6.6 Monitoring for environmental performance

Sewage contains high levels of nutrients, particularly phosphorus and nitrogen, which have been identified as key environmental hazards. Other priority environmental hazards associated with specific recycled water uses include pH, boron, cadmium, chlorine disinfection residuals, hydraulic loading (water), salinity, chloride and sodium.

In order to identify the key environmental hazards an environmental risk assessment should be conducted. In evaluating environmental risk, applicants should consider the potential effect on the receiving environment in relation to: concentration, contamination, eutrophication, loss of biodiversity, nutrient imbalance, odour, pest and disease, salinity, sodicity, toxicity and waterlogging.

Based on the environmental risk assessment, a Nutrient and Irrigation Management Plan (NIMP) may be required to minimise the probability of environmental impact during irrigation of nutrient rich recycled water. The major component of the NIMP is an investigation of the properties of irrigated soils, the concentration of nutrients in the recycled water and the assessment of nutrient management practices.

Factors that must be considered before irrigating recycled water rich in nutrients include:

- the water quality and nutrient application rate and frequency;
- site environmental factors such as soil types, climate, and land slope;
- proximity of the intensive land use area to surface waterbodies (including ephemeral streams) and depth to groundwater;
- potential travel pathways for any leached or eroded contaminants;
- site history and contaminant contributions from surrounding land areas;
- value and importance of local water resources to the community;
- the quality of local waters and their sensitivity to harm; and

- protection measures employed onsite such as barriers, buffers and drainage controls (including diversion of stormwater away from irrigated areas).

Those schemes intending to use recycled water for irrigation should ensure that systems are well-matched to seasonal soil moisture levels, vegetation growth needs, protection of the soil and groundwater from increased nutrient concentrations, and the infiltration and nutrient retention capacity of the soil. Irrigation rates should be matched to seasonal evapo-transpiration rates and the water uptake needs of the irrigated vegetation. Local climate data from the Bureau of Meteorology is available at http://www.bom.gov.au/wa/. Irrigation rates should also consider site factors including root-zone, soil moisture content, irrigation method, land slopes and depth to water table. A minimum two metre vertical separation should be maintained between the irrigated surface and the highest level of water table at end of the wet- season to maintain aerobic soils. This limits water-logging and fosters contaminant control via soil filtration and microbial action. DOH recommends for schemes using less than 20kL of recycled water per day to ensure nutrient application rate is in accordance with WQPN 22 irrigation with nutrient rich wastewater (2008). DWER will set specific monitoring conditions for those schemes producing more than 20 kL of recycled water per day.

7. Management

7.1 Capacity and competency of scheme managers

Recycled water providers will be required to demonstrate to the DOH an appropriate level of competency to ensure that a safe water supply is maintained during the life of the project. In addition, the Economic Regulation Authority (ERA) may assess the capacity and viability of the project as part of the licence process. This also ties into appropriate level of training and capacity building for recycled water providers. Management competency is demonstrated through the implementation of the Recycled Water Quality Management Plan (RWQMP) which is base on the 12 elements of the risk management framework. See DOH, RWQMP Template at : https://www.health.wa.gov.au/Articles/N_R/Recycled-water-in-WA

7.2 Licensing of schemes

Under the *Water Services Act* 2012 (Act), applicants may be required to hold a licence or seek an exemption from the licensing requirement to provide a water service. A water service licence can be obtained from the ERA. Alternatively, an applicant may seek an exemption from the Minister for Water.

7.3 Operational procedures

Operational procedures must be developed for each step in the treatment system of the recycling scheme to make sure that it remains safe. A clear, concise procedure to ensure that appropriate strategies for managing the significant risks that were identified in the risk assessment should be constructed.

The complexity of operational procedures will depend on the size, composition and the exposure risk levels associated with the recycled water supply.

Elements that should be included within an operational procedures plan are:

- Objectives - The objective of the operational procedure, i.e. what the procedure is trying to achieve.
- Management Strategies - Outlines the management strategies that will be implemented for managing the process step to maintain the integrity of the recycled water scheme and the final quality of the recycled water.

- Action - Steps taken to implement the management strategies, including when and by whom necessary tasks must be performed, maintenance requirements, consultation and monitoring.
- Performance Indicators - Identifies the monitoring parameters (assessable and measurable) that will be used to assess the performance of the management strategy.
- Response - Identifies the response which will be undertaken (and by who) if the management strategy is not working or there is a non-conformance with the procedure or monitoring limits.
- Reporting - Describes the reporting and review arrangement (including auditing) for each task in the plan. This would include how often, by whom and who to report to.

7.4 Incidents and emergency procedures

In the event of an incident or emergency in relation to a recycled water supply, considered and controlled responses are important to protect the health of the public and the environment. An incident or emergency is an event that poses an immediate potential or actual threat to the safety of public health.

The procedures that will be followed in an emergency should be documented in a similar manner to the operational procedures. All operators must be well versed in the emergency procedures and a copy of the procedures must be readily accessible. As a minimum, incident and emergency procedures would be expected to be developed for:

- non-compliance sample results for recycled water quality criteria
- unplanned disruptions to treatment processes and recycled water uses
- cross-connection incidents involving potable drinking water systems.

The procedures must include:

- the names of key emergency response personnel and their contact details
- personnel responsibilities and contact details (including all-hours telephone numbers)
- contact details for emergency services (e.g. ambulance, fire brigade, spill clean-up services)
- the location of on-site information on hazardous materials, including material safety data sheets and spill containment material
- sampling and monitoring requirements (where appropriate)
- steps to follow to minimise damage and control the emergency
- instructions and contact details for notifying the appropriate emergency services, the Department of Health, Western Australia (Water Unit), DWER, the local council, end-users and/or the community if necessary.

The recycled water scheme should be designed so that untreated or inadequately treated recycled water can be diverted from reaching end-users and sent for safe disposal. When recycled water may be temporarily unsuitable for use due to an incident or emergency, an alternative source (e.g. potable scheme water) should be made available for essential services (such as toilet flushing) to protect human health.

All employees of a recycled water scheme should be trained in the incident and emergency response procedures. The procedures should also be regularly practised and reviewed to ensure the response remains appropriate.

Following the occurrence of an incident or emergency, treatments, risks and the corresponding procedures should be reviewed and updated to reflect improvement of risk management process in order to include any lessons learnt.

Questions to be answered include:

- Did we previously identify and analyse the risk involved?
- Did we identify the actual causes in risk identification?
- Did we rate and assess risks and controls correctly?
- Did the control operate as intended?
- Were the treatment plans effective? If not, where could improvements be made?
- How our risk management in general could be improved?
- Who needs to know about these learnings and how should they be disseminated?
- What do we need to do to ensure that failure events are not repeated but that successes are?

7.5 Agreements

Whenever a recycled water producer supplies another entity with recycled water, the two parties should negotiate an agreement/contract. A 'Recycled Water Supply Agreement' must be made between the supplier and the user of the recycled water to ensure both parties know their responsibilities. The agreement will be stated in the licence of operation of recycling schemes.

The agreement should include:

- Water quality and quantity,
- Obligations and responsibilities of supplier and user
- Water characteristics (source, quality, quantity, pressure, flow variations),
- Responsibility for operation, maintenance, monitoring and auditing processes,
- Restrictions on use,
- Reliability of supply,
- Liabilities and insurance
- Financial arrangements,
- Contract duration and conditions for termination,
- Ownership of facilities,
- Contingency measures should problems arise.
- DOH requires the submission of the agreement before approval to use the recycled water.

7.6 Warning signs

Wherever water is being used for non-potable applications, erect prominent warning signs indicating, in English and any other primary languages predominately spoken in the area: "Recycled Water – Do Not Drink" (see Figure 7)

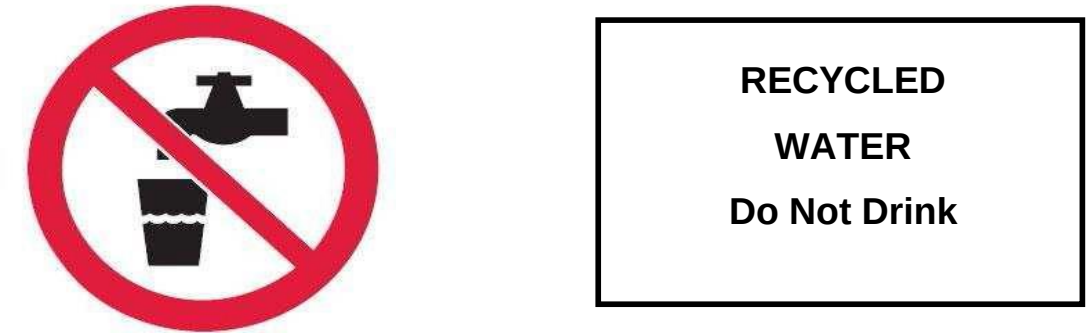

Figure 7: Examples of water recycling signs

All recycled water detention basins and storage areas should also be clearly sign- posted. The wording of these signs should state:

“WARNING – RECYCLED WATER – DO NOT DRINK OR SWIM”.

These signs must incorporate the following requirements:

- A minimum size of 20cm x 30cm on a white background with black lettering of at least 20mm in height.
- Contain the recommended International Public Information – Drinking Water Symbol with the Prohibition Overlay in RED.
- In compliance with AS1319 – 1994 Safety Signs for the Occupational Environment.
- Number of signs and size of wording should be determined on the basis of the visual distance from the observer.

In addition to the irrigation area, individual fixtures and points of access to the water system should have warning signs. Other warning signs may be required in bathrooms, hotel units and other premises using recycled water for toilet flushing or laundry uses.

7.7 Compliance with National Plumbing code

Distribution systems (including all pipe work, fittings and drainage of the water) should be designed to meet the following requirements:

- Compliance with Australian Standards:
  - AS/NZS 3500 - National plumbing and drainage Standards;
  - AS2845.1: Water supply - Backflow prevention devices; Part 1: Materials, design and performance requirements
  - AS 5200: Technical specification for plumbing and drainage products – Procedures for certification of plumbing and drainage products

- Ensure the separation and prevention of cross connection between recycled water and potable water systems; and
- Incorporation of a mechanism for the disinfection or slug dosing of distribution pipe work with disinfectant or algaecide to control biofilms and bacterial re-growth. This only applies when there are microbiological tolerance levels to monitor.

7.8 Plumbing for third pipe supplies

The fundamental principal in the design of a third pipe recycled water distribution system is to maintain separation and provide identification of potable water systems and recycled water systems. Separation is required to prevent health risks from cross contamination and possible ingestion of water. If a system is to be connected to the potable water supply system, backflow prevention devices must be installed and the plumbing must be done in accordance with AS 3500.

The following preventive measures must be taken to prevent any possible cross-connections:

- If potable supply is used as top up water for the recycled water supply, an approved air gap which complies with AS2845.1:1998 Water supply: Backflow prevention devices; Part 1: Materials, design and performance must be installed in the potable supply at the point where it enters the recycled water systems.
- Compliance with AS 3500.

All recycled water pipe work must be readily identifiable and distinguishable:

- All pipe work including taps and should be colour-coded (lilac) in accordance with AS/NZS 3500.5
- Visible signs in accordance with AS/NZS 3500.1 must be attached to all fixtures and storage tanks to indicate a non-potable source of water.
- Compliance with other relevant items of the AS 3500.

Complete pipe work plans should be maintained and updated to provide a permanent record of the location and depth of the recycled water pipes.

7.9 Access

Access control to the irrigation area is required when recycled water quality is of medium or low exposure risk level quality or where sub-surface irrigation is not the method of irrigation.

The water user must maintain effective control over public access to the areas being irrigated. This can be achieved by two common methods:

- Night time irrigation commencing after 9.00pm and ceasing at least 1 hour before sunrise, and provision for a withholding period prescribed in Table 13; and/or
- Simple non-continuous barriers that direct the public towards signage or fencing with lockable gates.

Table 10: Irrigation area minimum withholding times

Exposure Risk Levels	Minimum Withholding Times
High	Not required
Medium	1 hour
Low	4 hours
Extra Low	Not applicable

7.10 Irrigation method and design

The type of irrigation method will determine both the treatment level required and the extent of public access control. The method of irrigation will also determine the design of runoff controls. Sub-surface irrigation is much safer and requires fewer restrictions than water which is irrigated above ground and exposed to the air.

For instance, urban irrigation with restricted public access using low exposure risk level water quality requires signs plus a combination of:

- no access after irrigation (nominally 1 to 4 hours or until irrigation are is dry);
- minimum buffer zones to the nearest point of public access;
- drip irrigation near boundaries (surface or subsurface);
- spray drift controls, e.g. low throw sprinklers, vegetation screening; OR
- sub-surface irrigation

7.10.1 Irrigation in Public Drinking Water Source Areas

The use of recycled water for irrigation/drinking water augmentation in Public Drinking Water Source Areas requires the DOH close assessment.

7.10.2 Irrigation pipes

Irrigation pipes should be able to be drained or flushed to remove obstructions and/or water which is not of the required standard from the system. This is particularly important after the system has not been in use for an extended period of time or if the flow rate has been reduced over warmer months. Biofilms can build up in the pipes which may allow pathogens to grow without detection. A first flush mechanism is required to either move the first flush of water to a more intensive treatment process or to divert it to sewer.

7.10.3 Spray drift

Spray drift should be minimised when using a recycled water supply for irrigation purposes to prevent the risks associated with human exposure. Examples of control measures are timing of irrigation, use of low-throw sprinklers, vegetation screening (e.g. windbreaks), weather wind monitoring, and appropriate sprinklers design.

Spray drift can also incur complaints if aesthetic values are exceeded. The provider is expected to maintain a record of the complaints and the measures implemented to alleviate the problem, even if the health guidelines have not being exceeded.
Spray drift into areas accessible by the public can be minimised by using some of the following methods:

- Buffer zones
- Tree/shrub screens
- Selection of large droplet design sprays
- Lower spray height
- Anemometer switching systems
- Irrigating in weather conditions that would not cause spray drift

Spray drifting onto public drinking fountains, into natural or artificial water bodies, onto buildings, playgrounds and barbeque and picnic table areas is not permitted. Where spray irrigation is used, establish buffer zones from the edge of the irrigation area to the nearest dwellings or public areas where contact with the recycled water would be likely. The following on-site controls are recommended to minimise potential for exposure to recycled water when spray irrigation is used:

- High exposure risk level water quality - minimum on-site controls;
- Medium exposure risk level water quality – spray drift control or buffer zone of at least 25 metres;
- Low exposure risk level - spray drift control and a buffer zone of at least 25 meters.

Irrigation systems should be installed and operated so that there is no surface runoff and to ensure that ponding does not occur, as this can lead to mosquito problems and a greater risk of human exposure.

7.11 Algae

The retention of recycled water in open storages at any stage of the treatment or distribution has the potential to promote the growth of algae. These may be harmless green algae, however there is also a risk of potentially toxic blue-green algae (cyanobacteria). Algae in

recycled water can significantly reduce its quality for many applications. Some species of blue green algae have the potential to produce toxins which can pose a risk to human health.

For schemes subjected to regular algal blooms, a blue-green algal emergency response plan should be developed. The emergency response plan should detail:

- Allowance for alternative supply systems;
- Measures to allow the screening or filtering of recycled water before supply or application;
- Suitable mechanisms to clean and flush the distribution system; and
- An algae monitoring program.

7.12 Mosquito management

In Western Australia, mosquitoes can be serious pests as well as potential vectors of disease-causing viruses and parasites. Ross River virus disease and Barmah Forest virus disease occur state-wide in environmentally-driven cycles and the rare, but potentially fatal Murray Valley encephalitis, occurs in the northern half of the State.

Mosquitoes breed in fresh, brackish, salt and polluted water in natural and artificial situations, as well as artificial containers. Examples of recycled water reuse infrastructure that may support mosquitoes include water storage tanks, open storage facilities, drains, leaking or pooling irrigation systems.

It is essential that the implementation of recycled water use does not enhance mosquito breeding and the transmission of disease. The water provider must implement a mosquito management program if mosquito breeding risk is identified as an issue through the health risk assessment. Information and guidance on mosquito management program planning can be obtained from the Medical Entomology of the DOH. The contact details are:
Phone: (08) 9285 5500
Email: medical.entomology@health.wa.gov.au
Web: https://www.health.wa.gov.au/articles/J_M/Mosquito-management

Some key preventative measures that relate to the design and maintenance of infrastructure are discussed below:

- Construction of any infrastructure that holds water must be designed to minimise mosquito breeding.
- Regular ongoing maintenance and monitoring of all structures associated with storage or treatment of water is necessary to minimise mosquito breeding.
- Irrigation systems that will utilise recycled water should be designed to prevent surface ponding by appropriate irrigation scheduling and by ensuring that there is no leakage.
- Holding tanks should be designed and maintained to permanently prevent the entry of mosquitoes.
- Larvicides for potable applications must be used in accordance with manufacturer's instructions. (e.g. Methoprene).

8. Awareness and training

8.1 Training and awareness and needs

Operators and end-users will require a basic knowledge of how the recycled water supply works and what the associated risks and controls are involved in maintaining a safe recycled

water supply. Operators in particular must be aware of how to manage and operate the system and will require a level of training in a particular systems use.

Operators must be familiar with:

- Emergency and incident procedures
- Reporting documentation for monitoring, non-compliance and incidents
- Accurate sampling methods
- Accurate methods of monitoring and reporting sample data
- Interpreting sampling and operational data
- The layout of the system (flow diagram)
- Equipment maintenance
- Equipment operation
- Communicating effectively with end users
- Occupational health and safety issues

End-users are the people who utilise the recycled water for an approved and anticipated activity such as irrigation or toilet flushing.

End-users should be familiar with:

- The basic structure of the recycled water scheme
- Health risks associated with different uses
- How the recycled water can be used safely
- Advice in relation to the storage of the treated effluent
- How the recycled water should not be used (risky end uses that the effluent is not intended/treated for)
- How to handle the effluent (personal hygiene and barrier issues)

Suppliers of recycled water and end-users may also have an impact on the source of the recycled water. These organisations/users should be made aware of how different inputs:

- can affect the quality of the influent (e.g. impacts in plant influent quality as a result of flushing down medicines or use of detergents with high concentrations of phosphorous).
- can affect or damage components of the treatment train

People who do not usually visit a location that utilises recycled water or a processing location (visitors) should be made aware of:

- The presence of recycled water
- How to handle the effluent (personal hygiene and barrier issues)
- Where and how the recycled water is reused

Training or awareness arising from each of these groups should be addressed as part of the risk management process. Formal courses, handbooks, site inductions, on the job training and reminder posters or publications are all valid ways of ensuring that people involved with recycled water remain safe.

8.2 Operator qualifications

There are currently no specific training courses available within WA to teach operators how to fully manage and administer a recycled water supply system. However, given the need to protect public health (and the pivotal role that the operator plays in this), formal operational qualifications are required for the operator.

8.3 Service contracts

After the wastewater treatment plant is commissioned, and before a permit to use is issued, the manager of the recycling scheme shall provide a copy of the plant service maintenance contract to the Department of Health. The contract should specify the scheduled maintenance of plant equipment and the competencies of the contractor. The service contract should be for a minimum of two years. It is responsibility of the scheme manager to ensure a service agreement remain as long as the wastewater treatment plant is in operation. Adequate service maintenance reduces the risk of plant downtime, equipment failure and operator's error while maintaining the assets.

The names, addresses and telephone numbers of service and maintenance contractors should be prominently shown to all onsite plant operators. The contractors should be consulted if the plant is not performing to the expected specifications and shall be contacted in case of plant failure.

8.4 Community consultation and education

The idea of recycling water can seem unpalatable to some members of the community and there may be concerns about the implementation of a recycled water supply. Effective, sustained dialogue with stakeholders during the conceptual and implementation phases of a project will help ensure that agreement on where a recycled water supply is situated, how it is used and how it is run can be reached amicably.

A communication strategy to create a functional dialogue with stakeholders and the local community should form part of the project plan.

9. Operational reporting and audit

Each stage of the risk management process should be recorded in the RWQMP. Planning stages, commissioning and ongoing management including methods, data sources, and reasons for decisions should all be recorded. To create a history of the recycled water supply and reference material for periodic reviews and audits, certain data must be kept readily accessible. Records are an important aspect of good corporate governance. The making and control of records should consider:

- Any regulatory requirements,
- The cost of creating and maintaining records
- The benefits of reusing information

9.1 Record Keeping

Document control procedures shall be implemented to ensure that all copies of documents referenced in the RWQMP are current and controlled. Table 14 presents an example of which records are required.

Table 11:Documentation and reporting

Record	Description
Volumes of wastewater	Total water flows to the plant influent
Volumes of recycled water produced	Total recycled water flows shall be recorded for all recycled water delivered to end users
Percentage of recycled water used by end use	Volumes of recycled water used per year for each one of the approved end-uses
Water quality testing	Details of results of analytical testing should be maintained
Online monitoring data	Details of results of operational parameters should be maintained
Discharge to sewer and residuals	Where applicable the volumes and occurrence of discharges from the system to the sewer such as overflows or waste streams shall be recorded as per any conditions set by the local water authority. Where residuals are managed by alternative processes, reporting shall be as agreed with by the relevant regulatory authority.
Operational & Maintenance plan	Any check list and maintenance of on system components should be recorded and these records maintained
Complaints	Any complaints should be recorded and these records maintained and reported in DOH annual report
Training	All training activities and list of attendances with the corresponding signatures should be recorded and these records maintained

9.2 Annual report

The reporting of monitoring programs, monitoring results, incidents, compliance and maintenance programs is paramount and is required to be submitted to DOH as part of the annual report.

Annual reports shall be submitted to DOH via email wwalert@health.wa.gov.au by 30 September each year. The report corresponds to the immediately preceding financial year and contains the detailed information in the Annual report Template. DOH will respond to annual reports on a case-by-case basis.

9.3 Audit reporting

The scheme manager is responsible for ensuring auditing of the scheme is conducted. The frequency of internal and external audit will depend on the risk level exposure and the conditions of approval to operate the recycling scheme. Internal audit shall occur at least every three years and external audit should occur every six years, when major changes of the scheme are proposed or at the discretion of the Chief Health Officer. Audits will confirm that the management and operational strategies are being adhered to and that any non-compliance or incident has been dealt with in an effective and efficient manner.
Audit tool can be accessed on the DoH web site
http://ww2.health.wa.gov.au/Articles/J_M/recycled-water-schemes-audit-tool

It is recommended that all external auditing is to be undertaken by an accredited, independent, third-party auditor.

9.4 Non-compliance reporting

From time to time it may be necessary for the recycling scheme manager to notify DOH of events that may affect recycled water quality.
Notifiable events to DoH can be classified as either:
Events Level 1 – major level public health impact with potential to require public notification
Events Level 2 – minor level public health impact requiring exception notification.

Events – Level 1 include:

- Allegation of illness from public associated with a recycled water scheme
- Closure of a recycled water scheme (resulting in the supplying wastewater treatment plant needing to utilise an emergency and unauthorised treated wastewater disposal method)
- 'High' Exposure Risk Level recycled water scheme where two consecutive microbial results at regulatory sampling point(s) are above the health-based water quality objective as defined in the DoH approval
- Identified cross connection of a recycled water scheme with a drinking water supply
- Any other major hazardous event that is considered a public health risk

The notification shall be by phone 9222 2000 within 24 hours of becoming aware of the event. Confirmation shall be by e-mail within one working day to wwalert@health.wa.gov.au.

Events – Level 2 include:

- Recycled water scheme where two consecutive microbial results at regulatory sampling point(s) are above the health-based water quality objective as defined in the DoH approval (not including 'High' Exposure Risk Level Recycled water schemes)
- Release of wastewater into a recycled water scheme where an algal bloom exceeds the nominated alert mode level as per the Department of Health's Algae Response Protocol
- Incident with minor public health impact resulting in a cessation of recycled water supply with an anticipated duration of greater than 24 hours (not resulting in the supplying wastewater treatment plant needing to utilise an emergency and unauthorised treated wastewater disposal method)

The notification shall be by e-mail within one working day to wwalert@health.wa.gov.au.

When the agreed actions in response to the event have been successfully implemented, the event will be closed out. The event, the actions implemented, and the event close-out shall all be reported in the annual report. Further guidance on non-compliance reporting can be found in the Recycled Water Incident Reporting Protocol.

For sewage spills please refer to the Wastewater Overflow Response Procedure on the Department of Health website (e-mail: ssalert@health.wa.gov.au).

Licensed water service providers which are required to establish a Memorandum of Understanding with the Department of Health in accordance with the Water Services Act 2012 may have additional non-compliance reporting requirements.

10. Reviews and continuous improvement

The development of the RWQMP is an important tool for the ongoing implementation and management of the scheme in which performance is continually evaluated and reviewed. The review of the RWQMP facilitates the evaluation of the overall performance of the scheme, helps to identify areas of concern and assists in determining priorities for the recycling scheme.

The review process includes short term activities, incident management evaluation and long term activities. Short term performance evaluations include, for example, the analysis of monitoring data to confirm the recycled water conforms to the water quality objectives in Table 8. Review of incidents is critical to identify problems and implement measures to minimise future incidents. The evaluation of incidents also assists in the continuous improvement of existing protocols to achieve better planning and preparedness for the future. Short term performance evaluations include the implementation of recommendations from internal and external audits.

Examples of review activities are listed below:

- the periodic check and update of the RWQMP to include any changes to the scheme such as changes in wastewater volumes, changes in the treatment train, changes in the population using the recycled water
- the evaluation of annual reports and audits (both internal and external audits) to ensure the management process is functioning satisfactory or otherwise corrective measures are implemented in a timely manner.
- the periodic review and update of the hazard identification and risk assessment to incorporate any additional risks or changes in the risk level because of changing conditions over time
- ongoing review and interpretation of monitoring data
- periodic review of records to confirm they are completed and accurate including emergency response contact details
- periodic review and evaluation of training activities and requirements

For details on documentation, reporting, evaluation and audit refer to the RWQMP Template.

11. Obtaining approval for recycled water schemes

There are four steps in the across-agency approval process for recycling schemes for urban developments as depicted in Figure 8. For more details of the activities and agencies involved in each stage, please refer to the Guidelines for the approval of non-drinking water systems in WA (2013). This document can be obtained from:
Guideline for the approval of non-drinking water systems in Western Australia (www.wa.gov.au)

Applicants are encouraged to contact DOH during the “option evaluation and concept design study”, stage of the project to discuss all potential sources, treatments and end-uses of the recycling scheme. Based on those discussions and after an analysis of the best options, applicants are required to submit a preliminary design study including, as a minimum, information on sections 1, 2, 4 and 5 of the RWQMP with information from other sections of the RWQMP if available at the time of submission.

DOH will contact the applicant for further information or clarification to prepare an “approval in principal” or” permit to install the apparatus for the treatment of sewage” during the detailed design stage. A letter of approval to install with specific conditions and a validation and verification monitoring plan, based on the information provided by the applicant, will be prepared by DOH.

The application process for approval of recycling water scheme is outlined on the DOH website: https://www.health.wa.gov.au/Articles/A_E/Application-process-for-approval-of-recycling-water-schemeThere is also a copy of the application form and a template for Recycled Water Quality Management Plan (RWQMP).

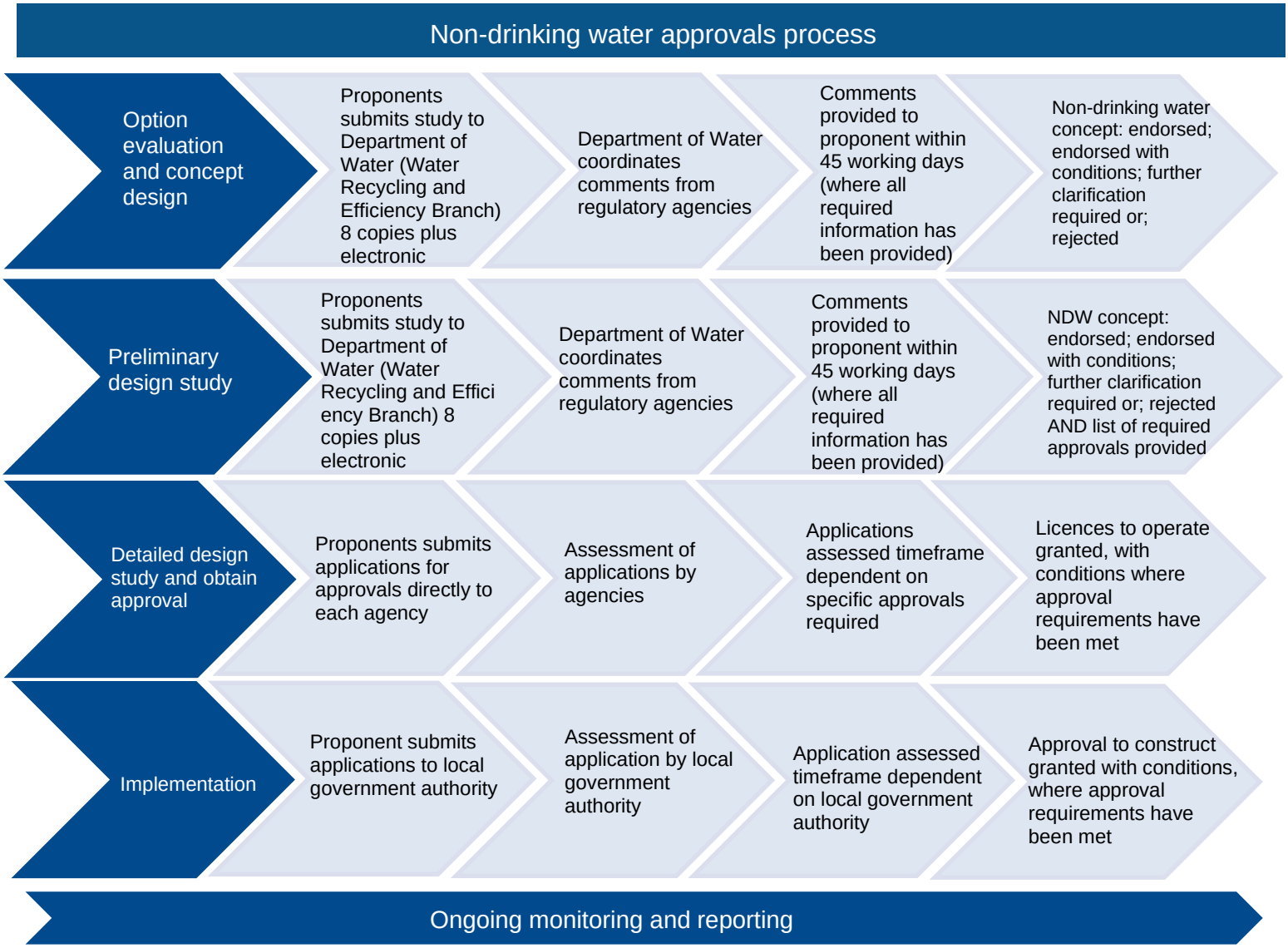

Figure 8: Overview of approval requirements for urban developments

(Source: Draft approval framework for the use of non-drinking water in Western Australia 2010)

During the commissioning phase the applicant must upgrade the RWQMP and complete the commissioning validation and verification report to demonstrate the treatment plant is producing the water quality objectives in a reliable manner. During the commissioning of the plant recycled water cannot be used for the intended end-use(s).

While the RWQMP is completed after the "approval in principal" is given, the earlier submission of these documents means that any requirements can be identified in advance and the applicant/scheme manager is fully aware of all the obligations which may be placed on them.

A permit to use the recycled water will be issued after the submission of an upgraded RWQMP that includes the commissioning validation and verification report. As part of the conditions of approval, annual reports are to be submitted to DOH.

A copy of the application form and a template for Recycled Water Quality Management Plan (RWQMP) are located on the DOH website: https://www.health.wa.gov.au/Articles/A_E/Application-process-for-approval-of-recycling-water-scheme.

Table 12: List of contacts

Department of Health, Water Unit	May Holman Building, 189 Royal Street, EAST PERTH WA 6004 Phone: 9222 2000 https://www.health.wa.gov.au/
Department of Water and Environmental Regulation	The Atrium, Level 4 168 St Georges Terrace PERTH WA 6000 Phone: 6364 7000 Fax: 6364 7001 Email: info@dwer.wa.gov.au Department of Water and Environmental Regulation (www.wa.gov.au)
Economic Regulation Authority	Level 4, Albert Facey House 469 Wellington Street Perth WA 6000 Phone: 6557 7900 Fax: 6557 7999 www.erawa.com.au/

Glossary

BOD:	Biological oxygen demand
Black water:	Wastewater from toilets, latrines, and privies, containing faeces or body fluids, and wastewater containing significant food residues or high concentrations of toxic chemicals from household cleaners. It is also known as brown water, foul water, or sewage.
CCP:	Critical Control Point - a point, step or procedure at which control is essential to prevent or eliminate a hazard or reduce it to an acceptable level.
Clostridia:	Spores of sulphite-reducing clostridia or spores of Clostridium perfringens are representative of faecally derived protozoan oocysts. They are monitored in high risk end uses.
cfu:	Colony forming units.
Critical limit:	A prescribed tolerance that must be met to ensure that a critical control point effectively controls a potential health hazard; a criterion that separated acceptability from unacceptability.
Commissioning validation:	Assesses whether a recycling scheme will meet the water quality compliance values during the installation and set-up of the plant. Validation testing takes a minimum of six (6) weeks.
Commissioning verification:	Verification testing of treated recycled water that confirms the treatment is meeting the water quality compliance values. Verification testing is undertaken at the end of the treatment train.
Coliphage:	Coliphages are considered to be representative of faecally-derived viruses. There are many types of coliphages, and the choice of which to monitor depends on the situation. However, usually one or both of two groups, somatic coliphages and FRNA coliphages, are monitored. If only one of the two groups of coliphage is monitored, the somatic coliphage is generally more conservative than the FRNA coliphages.
***Escherichia coli* (*E. coli*):**	The most common thermotolerant coliform present in faeces and used as indicator of faecal contamination.
Greywater:	Wastewater from clothes washing machines, showers, bathtubs, hand washing, lavatories and sinks that are

	not used for disposal of chemical or chemical-biological ingredients.
HACCP:	Hazard Analysis Critical Control Point.
Hazard:	A hazard is a biological, chemical, physical or radiological agent that has the potential to cause harm to people, animals, crops or plants, other terrestrial biota, aquatic biota, soils or the general environment; for example: • the protozoan parasite Cryptosporidium parvum is a hazard to human health • salinity is a hazard to soils • Hazardous Event: a hazardous event is an incident or situation that can lead to the presence of a hazard — that is, what can happen and how; for example: • failure at a recycled water treatment plant leading to C.*parvum* passing into the distribution system of a dual-reticulation system is a hazardous event • bursting of a pipeline reticulating recycled water high in phosphorus is a hazardous event
Helminths:	Helminths are parasitic worms that can infect humans and animals and include soil transmitted helminths which are transmitted to humans through contact with contaminated soil containing faeces.
Log reduction:	Used in reference to the physical-chemical treatment of water to remove, kill or inactivate microorganisms such as bacteria, protozoa and viruses (1-log removal = 90% reduction in density of the target organism, 2-log removal = 99% reduction, 3-log removal = 99.9% reduction, etc).
MPN:	Most Probable Number.
NTU:	Nephelometric turbidity unit.
Operational monitoring:	The routine monitoring of control parameters such as turbidity, UV light, that confirm the treatment process are under control and operating within the operating criteria.
Point of supply:	The physical point of transfer of the recycled water to the user.
Recycled water:	Water generated from sewage, (including greywater, yellow water, black water) or from industry that is treated to provide fit-for-purpose water quality for its intended

	beneficial use. Treated wastewater can be used by either the recycled water service provider itself, a business supplied by the recycled water service provider, or supplied through a third pipe scheme for urban reuse.
Restricted access:	Restricting access during irrigation of an area. An acceptable method of restricting access is posting visible signs notifying that the area is irrigated with recycled water and that the public should avoid contact with sprays. Public access restrictions do not cover on-site workers. On-site worker access should be restricted as far as it does not impede on their duties and to ensure compliance with relevant occupational health and safety requirements.
Recycled water service provider:	An entity that owns infrastructure for the production and supply of recycled water
RWQMP:	Recycled Water Quality Management Plan
Recycling scheme:	A recycled water project with an elaborate and systematic plan of action to identify and manage risk from wastewater collection to end use.
Sewage:	Any kind of sewage, nightsoil, faecal matter or urine, and any waste composed wholly or in part of liquid. Examples may include but are not limited to Greywater, Yellow water, Blackwater and Wastewater.
Sewer mining:	A process of extracting wastewater directly from a sewer (either before or after a wastewater treatment plant) for use as recycled water
SS:	Suspended solids
Third pipe scheme:	A third pipe scheme provides non-drinking water to multiple users as an additional water supply network to the mains scheme that supplies drinking water and the sewerage scheme that takes used water away from the house. Also referred to as 'Dual reticulation scheme'
TN:	Total nitrogen
TP:	Total phosphorous
Yellow water:	Wastewater from urine

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