

Recycled water management plan and validation guidelines

November 2008

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Contents

1. Introduction	1
1.1 Scope of the <i>Water Supply (Safety and Reliability) Act 2008</i>	1
1.1.1 What is recycled water?.....	1
1.1.2 Who is a recycled water provider?.....	2
1.2 Aim of the guidelines	3
1.3 Relationships to other guidelines	4
1.3.1 Are there any other regulatory guidelines?.....	4
1.3.2 What other useful information is available?	4
1.3.3 Relationship to other legislation and regulations	4
2. Recycled water management plans (RWMP).....	5
2.1 What is a RWMP?.....	5
2.2 Do I need to prepare a RWMP?.....	5
2.3 Schemes sharing infrastructure.....	6
2.4 When do I need to prepare a RWMP?.....	7
3. How is a recycled water management plan developed?	9
3.1 Introduction	9
3.2 Administrative requirements	10
3.2.1 Nominee contact details and endorsement.....	10
3.2.2 Recycled water policy statement.....	11
3.3 Risk management methodology.....	11
3.4 Risk assessment team.....	11
3.5 Scheme description	12
3.6 Hazard identification, risk assessment and control measures	14
3.6.1 Hazard identification	15
3.6.2 Hazardous event.....	15
3.6.3 Risk assessment.....	16
3.6.4 Control measures.....	16
3.7 Determining critical control points, critical limits and alert levels	17
3.7.1 Critical control points.....	17
3.7.2 Critical limits	17
3.7.3 Alert levels.....	18
3.8 Scheme validation.....	18
3.8.1 What is validation?.....	18
3.8.2 Validation program requirements.....	18
3.8.3 Existing schemes	19
3.8.4 Pre-commissioning validation.....	20
3.8.5 Receiving water source.....	20

3.8.6	Commissioning validation	21
3.8.7	Validation methodology	22
	Historical data	24
	Scientific literature	24
	Manufacturer’s specifications	24
	Pilot plant studies	25
	Specific challenge testing	25
	On-site tracer studies	26
	Direct integrity testing.....	26
	Continuous indirect integrity testing	27
	Monitoring of final water quality	27
3.8.8	Commissioning verification.....	27
	Microbiological parameters	28
	Chemical parameters	28
	Biological monitoring.....	29
3.8.9	Revalidation of a RWMP	30
3.9	Scheme management.....	30
3.9.1	Monitoring procedures	30
	Source monitoring.....	30
	Operational monitoring	31
3.9.2	Verification monitoring	31
3.9.3	Laboratory analysis	33
3.9.4	Quality assurance and quality control	33
3.9.5	Management procedures.....	34
3.9.6	Non-conformance and corrective/preventive actions	34
3.9.7	Management of incidents and emergencies	34
3.9.8	Documentation, record keeping and internal reporting	35
	Documentation.....	35
	Record keeping	36
	Internal reporting.....	36
3.9.9	Supporting programs	36
3.9.10	Operator skills and training	37
3.9.11	Management review and continuous improvement.....	37
3.9.12	Internal auditing	38
4.	Validation program.....	39
4.1	How is assessment of the validation program for a recycled water scheme undertaken? ..	39
4.2	Who has to prepare the validation program?	39
4.3	Who has to apply for approval of the validation program for schemes augmenting drinking water supplies?	39

4.4	How is the validation program for schemes augmenting drinking water supplies assessed by the regulator?	39
5.	Process for approval of a RWMP	41
5.1	Who must apply for approval of a RWMP?	41
5.2	What is the assessment process for a RWMP?	41
5.2.1	What does the regulator consider when approving the RWMP?	41
5.2.2	What decisions can the regulator make?	42
5.3	Are there additional requirements for schemes which supply recycled water for augmenting a drinking water supply?	42
5.4	Can an approved RWMP be amended?	43
5.5	How long does an approved RWMP last?	44
5.6	If a RWMP is suspended, what process is followed to recommence supply?	45
5.7	What happens if the supply of the recycled water needs to cease permanently?	46
5.8	What happens if the relevant water quality criteria are not met?	46
6.	Glossary	47
7.	Attachments	53
8.	Appendix	55
	References	62

1. Introduction

The relevant recycled water provisions of the *Water Supply (Safety and Reliability) Act 2008* (the Act) commenced on 1 July 2008 and is administered by the Department of Energy and Water Supply (DEWS). The chief executive of DEWS is the regulator under the Act.

The Act includes provisions relating to recycled water. The primary aim of these provisions is to protect public health and, for certain schemes known as critical recycled water schemes, to ensure continuity of operation of the scheme to meet the essential water supply needs of the community or industry.

The Act requires that a recycled water provider must have either of the following before supplying recycled water unless they are covered by a transitional period:

- a recycled water management plan (RWMP) approved by the regulator; or
- an exemption from preparation of a RWMP granted by the regulator (refer to *Recycled water management plan exemption guidelines*).

Transitional periods about recycled water are summarised in ‘Table 1 Statutory deadlines for requirements to prepare a RWMP’ of these guidelines or specified in sections 631–634 of the Act.

The Act is available on line at <www.legislation.qld.gov.au>.

1.1 Scope of the *Water Supply (Safety and Reliability) Act 2008*

1.1.1 What is recycled water?

The Act covers specific sources of recycled water that are intended to be reused. The term ‘reused’ includes being treated to improve the water’s quality, but does not include merely being discharged into, or disposed of in, the environment. For example, water being placed in a dam to augment drinking water supplies is covered, but water being discharged into a river for disposal under an approval issued by the Environmental Protection Agency is not covered.

The following sources of recycled water are covered by the legislation:

1. **Sewage or effluent sourced from a service provider’s sewerage.** A service provider is defined in the Act as:

- a local government that owns infrastructure for supplying water or sewerage services
- a water authority that owns infrastructure for supplying water or sewerage services
- each person who is:
 - the owner of one or more elements of infrastructure for supplying water or sewerage services for which a charge is intended to be made; or
 - a person nominated in a regulation as a related entity of a person who is the owner of one or more elements of infrastructure for supplying water or sewerage services for which a charge is intended to be made.

Owning infrastructure for the production and supply of recycled water does not in itself qualify a person as a service provider unless the person also owns other infrastructure for the supply of a water or sewerage service. A service provider does not include a service supplied by infrastructure, if:

- the infrastructure is used solely for mining purposes; or
- the service is used only by:
 - the owner of the infrastructure or the owner’s guests or employees including, for example, guests at a resort; or
 - if the owner of the infrastructure is a body corporate for a community titles scheme under the *Body Corporate and Community Management Act 1997*—the occupants of lots in the scheme.

2. **Greywater sourced from a large greywater treatment plant** as defined in the *Plumbing and Drainage Act 2002*. A large greywater treatment plant is a plant capable of treating at least 50 kilolitres of greywater a day. While greywater is defined in the *Plumbing and Drainage Act 2002*, as wastewater from a bath, basin, kitchen, laundry or shower, whether or not the wastewater is contaminated with human waste, kitchen greywater is not allowed to be recycled.¹
3. **Wastewater**, other than water outlined in points 1 and 2 above. Wastewater means the spent or used water generated on premises from industrial, commercial or manufacturing activities, or animal husbandry activities prescribed under a regulation, other than spent or used water generated from an agricultural activity or a mining activity² or petroleum activity³. However, wastewater is not covered by the Act if:
 - it is not supplied to another entity, that is, if the wastewater is used by the entity generating the recycled water, it does not fall under the jurisdiction of the Act. The Department of Employment and Industrial Relations has jurisdiction under the *Workplace Health and Safety Act 1995* in those circumstances
 - it is supplied to an entity prescribed under a regulation as a related entity to the entity that produces the recycled water. At the date of the approval of this guideline, there was no regulation for any entity to be prescribed. However it is envisaged that related entities prescribed in any future regulation would include certain familial relationships. For example, it is likely to include supply of wastewater by a husband to his wife

Wastewater is only covered by the Act when it is supplied to another entity for reuse, where the other entity is not a related entity. Sewage, effluent or greywater is covered by the Act where it is reused by the entity that produces it, or supplied by that entity to another entity for reuse.

For the purposes of the Act, recycled water does not include for example stormwater, desalinated water or water extracted during coal seam methane gas extraction processes.

1.1.2 Who is a recycled water provider?

A recycled water provider means an entity that:

- owns infrastructure for the production and supply of recycled water; or
- another entity prescribed under a regulation, that owns infrastructure for the supply of recycled water. This only applies to a single-entity scheme and enables other entities which supply, but do not produce, recycled water to be covered by the legislation. For instance, a pipeline supplying recycled water from one entity to another may be prescribed under a regulation as a recycled water provider.

In some cases, recycled water schemes may operate in sequence, that is a recycled water provider may obtain their source water from another recycled water provider. For example, an advanced water treatment plant owner may treat and use effluent from a local government's sewage treatment plant; where the owners are different, both would be considered as recycled water providers and both require their own RWMP or exemption.

¹ Under the *Water Supply (Safety and Reliability) Act 2008* greywater does not include wastewater from a kitchen.

² Defined in the *Environmental Protection Act 1994* s. 147.

³ Defined in the *Environmental Protection Act 1994* s. 77(1).

A recycled water scheme can be declared a critical scheme by the regulator⁴. A critical recycled water scheme can involve either a single-entity or multiple-entities. For multiple-entity critical recycled water schemes⁵:

- there must also be a nominated scheme manager
- there may also be other declared entities, which are other entities other than the scheme manager or recycled water provider(s). Other declared entities are owners of infrastructure for the supply, rather than production and supply, of recycled water. These entities are specifically identified as other declared entities when a scheme is declared to be a critical recycled water scheme by the regulator. For example, in a scheme supplying recycled water to augment drinking water supplies where there is an entity who does not own infrastructure for the production of recycled water, but that entity does own infrastructure for the supply of recycled water (for example, a pipeline), that entity may be declared to be part of a recycled water scheme.

For the purpose of these guidelines, a reference to a recycled water provider also includes a declared entity under the Act.

1.2 Aim of the guidelines

These guidelines have been developed to provide information to recycled water providers and scheme managers about preparing a RWMP. The Act requires that RWMPs be prepared in accordance with these guidelines under section 201 of the Act.

These guidelines provide information about:

- preparing a RWMP and validation program
- submitting documents for approval by the regulator
- matters considered by the regulator in assessing RWMPs and validation programs
- seeking amendments to a RWMP
- responsibilities of recycled water providers.

It is anticipated that these guidelines will be reviewed.

In these guidelines, some of the regulator's requirements are mandatory as they are legislative requirements of the Act. Where the regulator's requirement is mandatory, the guideline will use the word 'must'. In this case, the recycled water provider must supply the information required and in the manner prescribed. It is the recycled water provider's responsibility to ensure that mandatory legislative requirements of the Act are met.

In other cases, the regulator's requirements are not mandatory. If the requirement is not mandatory the word 'should' is used in these guidelines and recycled water providers are able to follow the guideline suggestion if they choose, or alternatively choose their own methods or information for achieving requirements.

If a recycled water provider chooses to use their own method for satisfying the regulator's requirement, the regulator will assess that alternative approach against the regulator's policy objectives and the overarching aims of the Act. The explanatory material in this guideline is indicative of the regulator's policy objectives and the Act's aims, but the regulator may also choose to look at other information

4 The regulator may declare a recycled water scheme to be a critical recycled water scheme if the regulator reasonably believes the declaration is necessary to maintain continuity of operation of the scheme to meet the essential water supply needs of the community or industry or to ensure the appropriate management of risks to public health posed by the supply of recycled water under the scheme. Refer to sections 300–307 of the *Water Supply (Safety and Reliability) Act 2008* for additional information on the declaration of critical recycled water schemes. These sections also contain information about which of those schemes the regulator must declare critical.

5 A multiple-entity recycled water scheme includes more than one recycled water provider or at least one recycled water provider and another entity.

which supports its policy objectives and the Act's aims such as best practice industry standards, information provided by technical experts or other health-based information.

1.3 Relationships to other guidelines

1.3.1 Are there any other regulatory guidelines?

These guidelines are part of a suite of guidelines prepared to assist recycled water providers in understanding the requirements that the Act places on them. In addition to these guidelines, other regulatory guidelines in this suite include:

- *Water quality guidelines for recycled water schemes*
- *Recycled water management plan exemption guidelines*
- *Audit and annual reporting guidelines*⁶.

There are other guidelines, outlined in section 1.3.2, which provide advice on water recycling. However, the regulator must have regard to the *Recycled water management plan and validation guidelines* when determining whether to approve a RWMP.

1.3.2 What other useful information is available?

Other sources of valuable information are available for potential recycled water providers considering or intending to establish a recycled water scheme.

The *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (2006)* (AGWR Phase 1) and the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies (2007)* (AGWR Phase 2) outline a risk management approach to the production and use of recycled water based on the framework developed for the *Australian Drinking Water Guidelines (2004)*.

Phase 1 of the AGWR focuses only on sewage and greywater as sources of recycled water. They provide specific guidance on the use of treated sewage and greywater for purposes other than augmentation of drinking water supplies and environmental flows. More information on the AGWR can be found on the Environment Protection and Heritage Council website, available online at <www.ephc.gov.au>.

The module of the AGWR Phase 2 addressing augmentation of drinking supplies has already been published. Subsequent modules are being developed and will focus on other aspects of recycled water such as stormwater harvesting and end-uses such as modified aquifer recharge. All modules are based on a risk management approach.

The *Manual for Recycled Water Agreements in Queensland* published by the Queensland Government provides information and guidance on writing a contract for the supply and use of recycled water. The manual is available online at the DEWS website at <www.dews.qld.gov.au>.

WSAA National Wastewater Source Management Guidelines July 2008 have been approved and are a useful reference for any scheme which requires sewage source control.

1.3.3 Relationship to other legislation and regulations

Recycled water schemes may operate under different legislation which must be complied with, for example the *Workplace Health and Safety Act 1995*, *Plumbing and Drainage Act 2002* and the *Environmental Protection Act 1994*. The requirements of the *Water Supply (Safety and Reliability) Act 2008* do not negate the requirements of other legislation unless where expressly stated or by implication. It is the responsibility of the recycled water provider, or scheme manager where applicable, to determine and ensure compliance with relevant legislative obligations.

⁶ The *Audit and annual reporting guidelines* are being developed and will be made available when approved.

2. Recycled water management plans (RWMP)

2.1 What is a RWMP?

The purposes of a RWMP are (section 200 of the Act):

- to protect public health
- if the plan is for a critical recycled water scheme—to ensure the continuity of operation of the scheme.

A RWMP is a documented, risk-based system for managing the production and supply of recycled water. The implementation of a RWMP is intended to ensure safe water recycling, through the identification and minimisation of public health risks.

According to section 201 of the Act, a RWMP must:

- describe the recycled water scheme to which the plan relates; and
- include details of the infrastructure for the production or supply of recycled water under the scheme, and how the infrastructure is to be maintained; and
- identify the hazards and hazardous events that may affect the quality of the recycled water; and
- include an assessment of the risks posed by the hazards and hazardous events; and
- demonstrate how the risks posed by the hazards and hazardous events are proposed to be managed; and
- include details of the operational and verification monitoring programs under the plan, including the parameters to be used for indicating compliance with the plan to the extent the plan requires water quality to be maintained in accordance with the water quality criteria for recycled water.

Detailed information which should be considered and/or included in a RWMP is provided in section 3 of these guidelines.

2.2 Do I need to prepare a RWMP?

Section 201 of the Act requires:

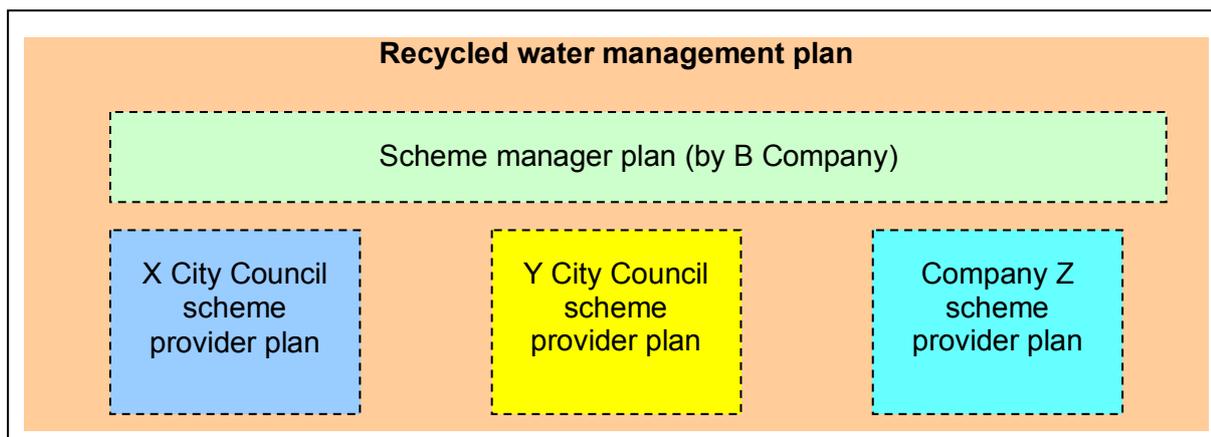
- for a single-entity recycled water scheme, a RWMP to be prepared by the recycled water provider for the scheme, unless the provider has an exemption for the scheme
- for a multiple-entity recycled water scheme, a RWMP to be prepared, consisting of a scheme manager plan prepared by the scheme manager⁷ and scheme provider plan(s), prepared by each recycled water provider and other declared entity, for the scheme.

Note: A multiple-entity recycled water scheme is not entitled to apply for an exemption

For example Diagram 1, shows a critical multiple entity recycled water scheme supplying recycled water to augment a drinking water supply. The scheme involves four entities; B company (the agreed scheme manager for the scheme); X city council; Y city council (supplies sewage treated to a specific level); company Z (further treats the recycled water using an advanced water treatment plant). The scheme would have the following plans:

⁷ There must be a scheme manager for all multiple-entity schemes. There is no requirement for a scheme manager for single-entity schemes. The scheme manager is the entity that all recycled water providers and declared entities of a critical scheme agree is the scheme manager; and if known at the time the scheme is declared this can be stated in the declaration. Alternatively, if the identity of the scheme manager is not known when the scheme is declared, the declared entities must give the regulator a notice about who is the scheme manager as soon as practicable after the scheme is declared.

Diagram 1



Alternatively, a recycled water provider may apply to obtain an exemption from preparing a RWMP⁸. For information on exemptions and applying for an exemption, refer to the *Recycled water management plan exemption guidelines*.

It is an offence for a recycled water provider to supply recycled water unless:

- there is a RWMP approved by the regulator
- there is an exemption granted by the regulator from preparing a RWMP
- a transitional period applies under sections 631–634 of the Act.

Note: Transitional periods expire over time and significant penalties apply for non compliance with the Act. See section 2.4 of these guidelines for further details about transitional arrangements.

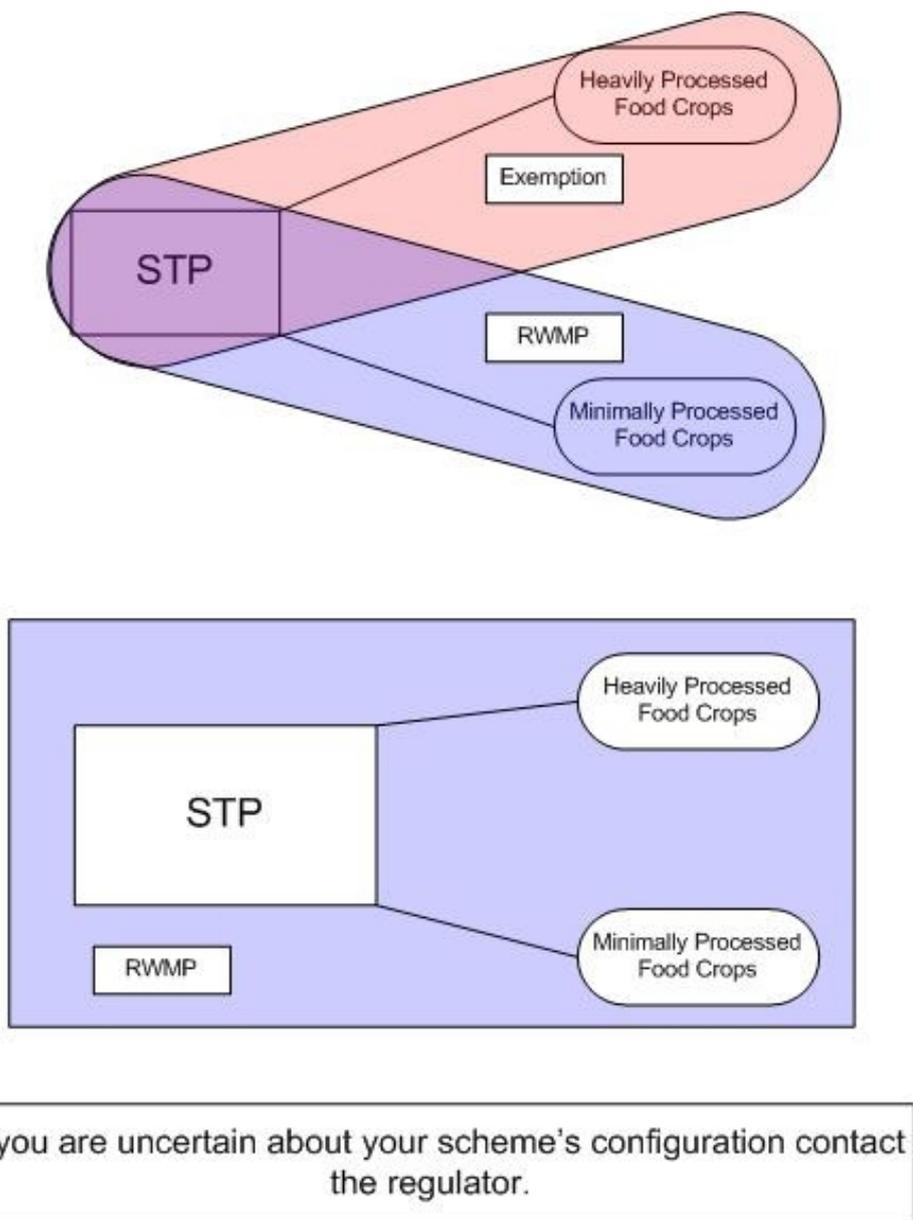
2.3 Schemes sharing infrastructure

The same infrastructure may be included in several schemes. This has the effect that the regulator may approve an exemption(s) for a number of uses of recycled water from one provider and only require a RWMP for the uses not exempted. For example, a service provider’s sewage treatment plant may supply one class of water for heavily processed food crops (for which an exemption has been granted) and another class of water for minimally processed food crops (for which no exemption has been granted). In this case a RWMP would be required for all infrastructure associated with the production and supply of the recycled water to the minimally processed food crops. The recycled water provider may nonetheless choose to prepare one RWMP that addresses the supply of both classes of recycled water.

Diagram 2 represents the options that may be chosen by the recycled water provider when they have schemes sharing infrastructure.

⁸ Entities in a critical recycled water scheme are not able to seek an exemption from preparation of a RWMP for that scheme.

Diagram 2



2.4 When do I need to prepare a RWMP?

A RWMP is not required while transitional periods are in place. However, for some schemes transitional periods have a staged implementation while for other recycled water schemes transitional periods do not apply. Further details are provided in 'Table 1 Statutory deadlines for requirements to prepare a RWMP'.

Table 1. Statutory deadlines for requirements to prepare a RWMP

Scheme type	Timeframes for requiring an approved RWMP or exemption granted	
Supply of recycled water for the augmentation of drinking water supplies.	Provisions commence immediately for all new and existing recycled water providers, that is, from 1 July 2008 these types of recycled water schemes must have an approved RWMP prior to supplying recycled water. There are no exemptions for this scheme type.	
Greywater (greater than or equal to 50 kilolitres/day).	Provisions commence immediately for all new and existing recycled water providers, that is, from 1 July 2008 these types of recycled water schemes must have an approved RWMP or exemption prior to supplying recycled water.	
Supply of recycled water for dual reticulation ⁹ or irrigation of minimally processed food crops	<p>New schemes</p> <p>Recycled water schemes commencing supply of recycled water on or after 1 July 2008 and before 31 December 2008 must have an approved RWMP or exemption in place within six months after the first day of supply.</p> <p>Recycled water schemes commencing supply on or after 31 December 2008 and before 1 July 2009 must have an approved RWMP or exemption in place by 1 July 2009.</p> <p>Recycled water schemes commencing supply on or after 1 July 2009 must have an approved RWMP or exemption in place before supply.</p>	<p>Existing schemes</p> <p>Existing recycled water schemes must have an approved RWMP or exemption in place by 1 July 2009.</p>
All other recycled water schemes	<p>New schemes</p> <p>Recycled water schemes commencing supply on or after 1 July 2008 must have an approved RWMP in place or exemption granted before a day that is 1 year after the day that recycled water is first supplied under the scheme.</p>	<p>Existing schemes</p> <p>Existing recycled water schemes must have an approved RWMP in place or exemption granted on or before 1 July 2013.</p>
<p>The regulator has a discretionary power to issue a notice requiring a RWMP. This power may be exercised if the regulator identifies the need for an early submission of a RWMP to minimise public health risks or the scheme becomes a critical recycled water scheme.</p>		

⁹ Those schemes that have been declared critical by the regulator and which supply or propose to supply at least 500kL/day for dual reticulation purposes, will be unable to apply for an exemption (refer section 250(1)).

3. How is a recycled water management plan developed?

3.1 Introduction

This section outlines the process to be followed by a recycled water provider, or scheme manager where applicable, when developing a RWMP. It also identifies the specific elements of a RWMP including mandatory requirements and additional material suggested for inclusion by the regulator. Some criteria apply to all types of recycled water schemes, whereas other criteria apply to specific types of schemes such as critical recycled water schemes, multiple-entity critical recycled water schemes and schemes that propose to supply recycled water for the augmentation of drinking water supplies.

Note: Section 3 of this guideline has been written with explanatory paragraphs underneath each subsection followed by specific criteria, which are the minimum requirements that may be used by the regulator in making a determination about a RWMP. Where decision making criteria are specific to certain types of schemes, this is indicated.

A RWMP is not a single document – it is a collection of documents comprised of an operational component and supporting information. Supporting information may include:

- referenced documents and procedures
- referenced appendices
- supporting programs
- any additional information requested by the regulator as part of the assessment of the plan.

A recycled water provider can provide any of these documents as evidence that it meets the mandatory, or suggested, criteria and these documents will be assessed by the regulator as part of the application process.

Where a recycled water provider has a current certification under the following standards:

- ISO 9001
- ISO 14001
- ISO 22000
- Hazard Analysis Critical Control Point (HACCP) issued by the Codex Alimentarius Commission

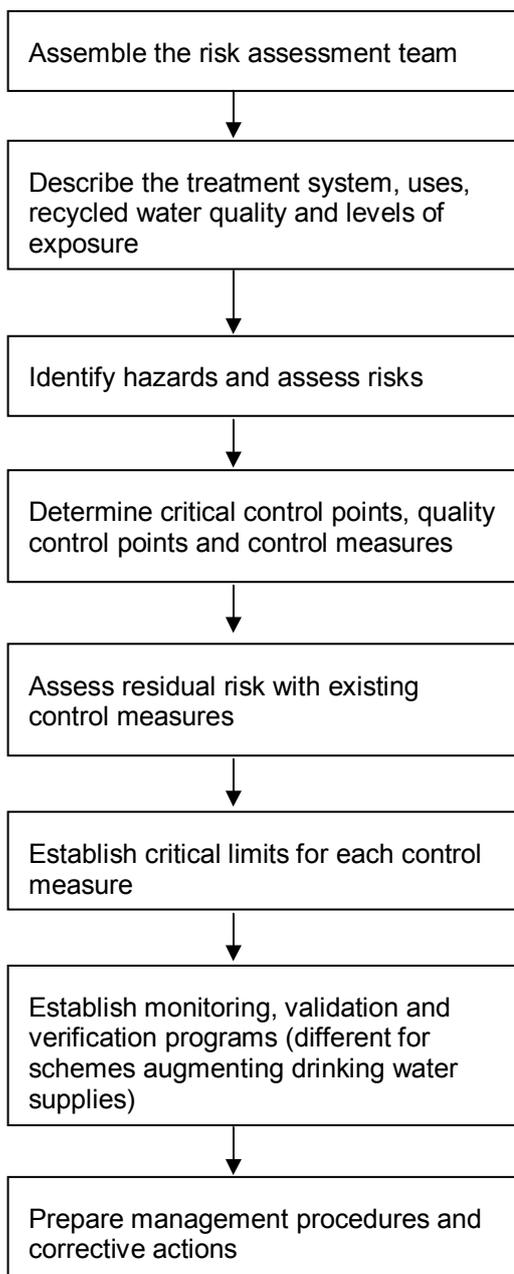
they may consider submitting a copy of their current certification with the RWMP.

If the recognised standard addresses a portion of the criteria under the RWMP, the regulator will consider submission of certification as sufficient evidence for meeting these specific criteria. If the recycled water provider chooses not to submit this certification, additional evidence of compliance with a criterion may be sought. If the recycled water provider chooses to submit their current certification to demonstrate compliance with particular criteria they should specify which criteria they meet for each certification.

Any material submitted in or with the RWMP that is outside the jurisdiction of the regulator to approve should be struck through (crossed out) to indicate that it does not form part of the RWMP for the regulator's purposes. If information has been struck through that the regulator believes does constitute a matter within its jurisdiction, or information is required to be struck through that has not been, the regulator will approach the recycled water provider regarding necessary changes.

The steps generally involved in developing a RWMP are outlined in Diagram 3. For existing schemes some components of the process may already exist.

Diagram 3. Typical process for preparing a RWMP



3.2 Administrative requirements

3.2.1 Nominee contact details and endorsement

Criteria for all schemes:

- The RWMP should be signed and endorsed by the recycled water provider, or scheme manager where applicable.
- The RWMP should identify the person (nominee) that is responsible for the RWMP and provide full contact details for this person.

Criteria specific to multiple-entity critical schemes:

- The nominee responsible for the scheme manager plan should be from the organisation that is the scheme manager and full contact details of the nominee should be provided.
- Each scheme provider plan should also have a nominee, with the nominee's full contact details included. Each nominee should be from the organisation that is the scheme provider.

3.2.2 Recycled water policy statement

Section 2.1.4 of the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)* provides that a policy statement for recycled water should be included to indicate and formalise the commitment to responsible, safe and sustainable use of recycled water. Any policy statement for recycled water should provide a basis for developing more detailed guidelines principles and implementation strategies. Therefore a policy statement should be clear and succinct, and should address broad issues and requirements, such as:

- commitment to 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 of recycled water
- the opinions and requirements of all parties' responsibilities under the recycled water scheme, employees, users of recycled water, other stakeholders and the wider community

Criteria for all schemes:

- A recycled water policy statement should be included.

3.3 Risk management methodology

Risk management focuses primarily on preventing hazardous events from occurring rather than mitigating the impacts once they have occurred. Risk management is gaining importance within the water industry and has been used in the *Australian Drinking Water Guidelines (2004)*, the *Australian Guidelines for Water Recycling (Phase 1) 2006; Managing Health and Environmental Risks and Australian Guidelines for Water Recycling (Phase 2) 2008; Augmentation of Drinking Water Supplies*. There is a range of risk management methodologies that could be used to form the basis of the RWMP such as HACCP system, which is used extensively in the manufacture of food, or ISO 22000, or *AS/NZS 4360:1999 Risk Management*.

Any risk management methodology can be used by a recycled water provider, or scheme manager where applicable, for the RWMP, as long as it is consistently applied.

Criteria for all schemes:

- The RWMP must be based upon a risk management methodology which is identified in the RWMP.
- The risk management methodology should be consistently applied in the RWMP.

3.4 Risk assessment team

The risk assessment team is responsible for completing the identification of potential hazards and the risk assessment, and may also be further involved in the development and implementation of the RWMP. The size of the team and the skills required will depend on the complexity of the recycled water scheme. Team members should have appropriate knowledge and expertise in various facets of the

recycled water process. Members should include personnel from operations, quality control, laboratory, maintenance, management, as well as external consultants and recycled water users where applicable.

Criteria for all schemes:

- The risk assessment team should be multi-disciplinary, including staff from all areas of operations.
- At least one member of the risk assessment team should have formal risk assessment training or equivalent experience or skills, and this should be documented. The remaining members of the team should receive an introduction to the risk assessment process, prior to commencing the risk assessment.
- The membership of the risk assessment team should be documented.
- The risk assessment team should form the basis of the ongoing RWMP review team.

Criteria specific to critical schemes:

- The risk assessment team should be multi-disciplinary, including staff from all areas of operations.

Criteria specific to multiple–entity critical schemes:

- The risk assessment team for the scheme manager plan should include representatives from each of the entities involved in the scheme.
- For each scheme provider plan:
 - the risk assessment team should include representatives from the entities immediately upstream and downstream of the relevant scheme provider plan; or
 - the recycled water provider should provide evidence that the entities upstream and downstream have received advice from the provider about the risk assessment.

3.5 Scheme description

The recycled water provider, or scheme manager where applicable, needs to have a thorough documented knowledge of the entire water recycling scheme, from source to point of supply. Point of supply means, in relation to water quality criteria, where possible, the physical point of transfer to the user. There are instances where this is not practical and will not accurately represent the water quality of the scheme. It is in these instances that the recycled water provider (or scheme manager where relevant) should discuss with the regulator options for monitoring points and the point of application of water quality criteria.

Source characterisation is an important part of the scheme description. This can be done by compiling existing water quality data on the source water and/or undertaking additional monitoring of the source water. The scope of the source water characterisation process will depend on the final uses of the recycled water. If the recycled water is to be supplied for uses which result in low levels of exposure to humans, the source characterisation may be limited to analysis of existing data.

For recycled water schemes augmenting drinking water supplies, all of the following criteria should be considered:

- microbial and chemical contaminants found in secondary effluent in Australia and overseas. The references below contain examples of potential and actual contaminants which may pose a risk to public health. These references below also identify these as environmental risks; this is outside the scope of these guidelines:
 - ‘Table 4.1 Constituents potentially found in recycled water, which could pose a risk to the environment’ of the AGWR Phase 1: Managing Health and Environmental Risks;
 - ‘Table 4.4 Chemicals detected in secondary treated sewage, maximum concentrations and guideline values’ of the AGWR Phase 2: Augmentation of Drinking Water Supplies.
- microbial and chemical contaminants known/likely to be disposed of to sewer based on the assessment of industries in the catchment area.

- chemicals of concern or general interest to the community, for example nitrosodimethylamine (NDMA).
- measurable parameters that can be used as surrogates and indicators of other parameters of interest and/or significance.
- chemicals and/or micro-organisms that can be used as indicators of the performance of Advanced Water Treatment Plant (AWTP) processes.
- chemical, biological and/or physical parameters that can impact on operational efficiency of the AWTP processes.
- chemicals that may have radiological activity.
- chemicals that can be produced through the AWTP processes.

For systems treating sewage, source characterisation may include existing sewage treatment plant (STP) effluent data such as environmental licensing performance data and existing STP influent data such as trade waste monitoring.

If there are information gaps in the data available, then further analysis of the source water will need to be performed. The source water monitoring should be conducted for an extended period so that temporal and spatial variations in influent quality can be fully characterised. Ideally this should cover at least one calendar year.

Note: If the proposed scheme is to supply recycled water for augmenting drinking water supplies it is strongly recommended that advice be sought from the regulator prior to commencing the source water characterisation.

Criteria for all schemes:

- The scheme description should include a process flow diagram that clearly indicates all steps in the treatment system, including the point of supply, the distribution system including storage and pipes, the receiving environment(s)¹⁰, areas of responsibility, any bypass systems and the proposed end use(s).
- The scheme description should include details on how the recycled water is provided to the user(s) up to the point of supply.
- The point of supply should be defined in the scheme description. This point nominates where monitoring of the water quality criteria occurs. If the point of supply is not nominated as the physical transfer point (that is, the point of transfer to the user), the scheme description should nominate where the point of supply actually occurs. An explanation of why the point of supply cannot be nominated at the physical transfer point should be given.
- The flow diagram should clearly indicate where the recycled water provider, or scheme manager where applicable, takes responsibility from a source water provider, and also where responsibility changes to the end user(s) or to another recycled water provider for further treatment. There should be no gaps in responsibility.
- A characterisation of the source water, including analysis of temporal and spatial fluctuations, should be included. This characterisation should include a trend analysis, assessment of the data reliability and identify any gaps in the existing data.
- A description of the recycled water product and its variability should be included. This will contain all existing information about the recycled water product, but does not remove the need to validate and verify the scheme prior to commencement of supply.

¹⁰ Receiving environments include, for schemes augmenting drinking water supplies, a receiving water source, and for all recycled water schemes the discharge location of the waste stream.

- The scheme description should include details of the end use(s) for the recycled water and water quality requirements¹¹.
- The scheme description should document the operating environment for the recycled water scheme. This may include circumstances such as partnerships, or other arrangements where the owner of the infrastructure is not the operator of the scheme; or irregular patterns of supply, such as seasonal shutdowns.

Criteria specific to critical schemes:

- The scheme description should include any possible alternate supplies of water, if alternative supplies are available, to be provided to users in the case that the supply of recycled water is temporarily, or permanently, unavailable, including the arrangements in place to secure alternate supplies and timeframes in which the alternate supplies can be accessed.
- A multiple-entity critical scheme should provide a diagram in the scheme manager plan that indicates the contractual relationships and arrangements between the entities.

Criteria specific for schemes augmenting drinking water supplies:

- Consideration of the following should be demonstrated as part of the source water characterisation:
 - Microbial and chemical contaminants found in secondary effluent in Australia and overseas. Refer to ‘Table 4.1 Constituents potentially found in recycled water, which could pose a risk to the environment’ of the AGWR Phase 1: Managing Health and Environmental Risks; refer to ‘Table 4.4 Chemicals detected in secondary treated sewage, maximum concentrations and guideline values’ of the AGWR Phase 2: Augmentation of Drinking Water Supplies. Both documents contain examples of potential and actual contaminants.
 - Microbial and chemical contaminants known/likely to be disposed of to sewer based on the assessment of industries in the catchment area.
 - Chemicals of concern or general interest to the community, for example, NDMA.
 - Measurable parameters that can be used as surrogates and indicators of other parameters of interest and/or significance.
 - Chemicals and/or micro-organisms that can be used as indicators of advanced water treatment plant (AWTP) processes.
 - Chemical, biological and/or physical parameters that can impact on operational efficiency of the AWTP processes.
 - Chemicals that may have radiological activity.
 - Chemicals that can be produced through the AWTP processes.

3.6 Hazard identification, risk assessment and control measures

Hazard identification, risk assessment and control measures are used for consistently identifying, ranking and controlling hazards, along with their associated risk, for the scheme. This process provides a framework to ensure that the recycled water supplied is appropriate for the intended use(s).

Criteria for all schemes:

- Hazard identification and risk assessment may be completed during planning or construction stages. The risk assessment should then be verified and updated upon completion.
- Sources for potential hazards should be identified.

¹¹ For additional information on water quality requirements for sources and uses of recycled water, refer to the *Water quality guidelines for recycled water schemes* issued by the regulator.

3.6.1 Hazard identification

A hazard is defined as a biological, chemical or physical agent in, or condition of, recycled water with the potential to cause an adverse health effect. A hazard may already exist in the product when it arrives at a process step, for example, pharmaceuticals in raw sewage, or it may occur at that process step, for example, disinfection by-products that occur during a disinfection step. Regardless of whether or not a hazard is controlled at a process step, the hazard should be identified as being present at that point in the process.

Sources for potential hazards should be identified to facilitate prompt corrective or preventive actions in the event that a hazard needs to be controlled at the source. The level of detail may vary, depending on how widespread or significant the hazard is. In some instances it may be possible to link the source to a particular trade waste customer, but in others it may only be possible to state that the source cannot be definitely identified, for example, domestic sewage.

The potential hazards will be specific to the type of source water and treatment processes for a recycled water scheme; however, consideration needs to be given to biological and chemical hazards and physical parameters. Biological hazards may include viruses, bacteria, protozoa, helminths, algae and cyanobacteria. Chemical hazards may include for example salts, nutrients, metals, pesticides, radiological compounds, pharmaceuticals or personal care products. Significant physical parameters such as turbidity, pH and biological oxygen demand, while not hazards in their own right, may affect treatment efficacy and consequently may result in health impacts. It is appropriate to consider these parameters in the hazard identification.

To assist in the compilation of a potential hazards list, a recycled water provider, or scheme manager where applicable, may use the following:

- any recycled water quality criteria for a parameter referenced in the *Water quality guidelines for recycled water schemes*, for the relevant recycled water source, class or use
- identification of a parameter during the source water characterisation
- expert knowledge of the scheme, which is held by the risk assessment team and is considered to be a significant hazard.

Note: If recycled water is being supplied for the augmentation of drinking supplies it is strongly recommended that advice be sought from the regulator regarding the identification of significant hazards.

Criteria for all schemes:

- All potential hazards must be identified at their introduction to the scheme (for example, source water, transmission or disinfection process creating by products). As per section 3.6.4. control measures will also need to be identified for each hazard. Where a hazard is not identified at a process step between its source and control measure it is assumed that this hazard passes through unmitigated.
- Biological and chemical hazards and physical parameters should be considered.
- All potential hazards should have their spatial and temporal variability assessed to ensure that seasonal or intermittent hazards are captured.

3.6.2 Hazardous event

A hazardous event is the result of a hazard or one that can lead to the presence of a hazard. Hazardous events that should be considered include the unauthorised or incorrect use of recycled water, as this will guide the recycled water provider, or scheme manager where applicable, on the appropriate onsite controls that should be facilitated through the use of agreements, or similar arrangements, between recycled water providers and users. Another example of a hazardous event would be the failure of a treatment plant.

Criteria for all schemes:

- Potential hazardous events could be identified and listed at each step in the process flow diagram.

3.6.3 Risk assessment

Risk is defined as the likelihood that identified hazards will cause harm in exposed populations including the magnitude of that harm (risk = likelihood x impact). Assessing risk enables the identified hazards to be ranked so that those with the highest risk can be controlled preferentially. Each risk assessment team will decide upon the cut-off point to determine ‘significance’, for example, all risks which are rated ‘medium’ or above are considered to be ‘significant’. Not all identified hazards will have an associated significant risk.

The risk assessment process provides the basis for ensuring that the treatment process is capable of removing or reducing the identified significant hazards to a level that meets the minimum water quality criteria.

Criteria for all schemes:

- The likelihood and impact of each identified hazard must be analysed in order to calculate the risk for that hazard.
- The risk assessment team should decide upon and document the cut-off threshold for significant risks.
- The risk assessment should take into account any existing management systems when assessing risk, for example, HACCP certification held by a wastewater treatment plant providing source water for an AWTP.

Criteria specific to multiple-entity critical schemes:

- Where possible, all entities within a multiple-entity critical scheme should collaboratively decide on, and consistently use, the same risk assessment methodology to allow for consistency within the scheme manager plan and scheme provider plans.
- The scheme manager plan for a multiple-entity critical scheme should contain a risk assessment that considers the risks to the entire scheme, as opposed to each entity only addressing risks that they can manage themselves.
- Each scheme provider plan in a multiple-entity critical scheme should document the risks that are present during their treatment processes, regardless of whether they control that risk or pass it on as an unmitigated risk to the next entity.

3.6.4 Control measures

For the purpose of these guidelines, a control, or preventive, measure is defined as any action or activity that can be used to prevent, eliminate or reduce a hazard to an acceptable level. An assessment of unmitigated risk will demonstrate the consequences of control measure failure or the consequences of passing the risk to another entity or user to control. An assessment of residual risk, with existing control measures in place, allows the adequacy of existing control measures to be assessed, for example, if residual risk is calculated as ‘high’ it may be necessary to implement additional or improved control measures for that hazard.

The final output of the hazard identification and risk assessment process should be a ranked table with all identified hazards, hazardous events, significant risks and control measures clearly documented.

Criteria for all schemes:

- All significant risks must have an associated control measure to ensure that the hazard is removed or reduced to an acceptable level.
- The risk assessment should assess both unmitigated and residual risk.
- The risk assessment ranked table should include the likelihood, impact and risk ranking for each hazard. The control measure(s) for each hazard should also be outlined in this table.

Criteria specific to multiple-entity critical schemes:

- Following the completion of the risk assessment for a multiple-entity critical scheme, risks should be attributed to the relevant entity where the risk is best controlled and should be documented in their scheme provider plan.

3.7 Determining critical control points, critical limits and alert levels

3.7.1 Critical control points

A subset of the control measures are those associated with a critical control point (CCP). A CCP is defined as a point, step or procedure at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level. A CCP identification flowchart may be used to determine whether a process step is a CCP. It is not essential that a flowchart be used, but any method that is used to determine CCPs needs to be consistent, logical and documented in the RWMP.

In contrast, for the purpose of this guideline, a quality control point (QCP) is a process step that is important, but not critical, to ensuring water quality for health purposes. A QCP cannot usually be monitored in a timely fashion or is not under the direct control of the recycled water provider or scheme manager where applicable. A QCP is still relevant to water quality and excludes environmental and aesthetic outcomes. Generally there are more QCPs than CCPs; this is recommended as too many CCPs can result in a loss of operational focus and diminish the importance of CCPs.

Criteria for all schemes:

- CCPs and QCPs should be correctly and separately identified using a documented and consistent process.
- Each process step in the process flowchart (or similar) should be assessed to determine if it is a CCP or a QCP, or neither.

Criteria specific to multiple-entity critical schemes:

- CCPs should be determined in the scheme manager plan, as opposed to the individual scheme provider plans. They should then be attributed to each relevant scheme provider plan for control and responsibility.

3.7.2 Critical limits

Critical limits define the value at which a hazard needs to be controlled at particular control points to ensure that an appropriate quality of water is produced. They define the cut-off point between acceptable and unacceptable; if these parameters are maintained they ensure the quality of the recycled water and inform the recycled water provider, or scheme manager where applicable, that the control measure is working. Critical limits can be derived from sources such as expert advice or knowledge, technical literature and manufacturer's information.

Critical limits should be able to be monitored continuously to provide a real time measure of the performance of a CCP.

A critical limit at a particular control point is not the same as recycled water quality criteria. The recycled water quality criteria apply at the verification step on the final water quality. Critical limits are used to inform the recycled water provider, or scheme manager where applicable, that a control measure is working, that is, if the control measure is operating within the critical limits, the final recycled water quality criteria will be met. This may mean that during the commissioning stages critical limits may be altered to optimise the performance of the scheme.

Criteria for all schemes:

- Every CCP should have a critical limit associated with it.
- Critical limits should be exact values, not a range. This does not preclude a CCP from having two distinct critical limits, an upper and a lower limit. This may be appropriate when too little of a substance may be as hazardous as too much, for example, chlorine residual.
- The process for monitoring a CCP should be clearly documented, including the responsibility for the monitoring and any required responses in the event of a critical limit being exceeded. This should be in a simple format, such as a flowchart, for ease of understanding by the relevant operator.
- A procedure for dealing with any exceedance of a critical limit should be documented and include details of the exceedance and corrective actions.
- Any exceedance of a critical limit should initiate a documented corrective action, as by definition, a critical limit exceedance means that the hazard is no longer under control.

3.7.3 Alert levels

Alert levels are more conservative than critical limits. They allow early warning to be given for potential exceedance of critical limits so that corrective actions can be implemented before the critical limit is exceeded.

Criteria for all schemes:

- Alert levels should be set for all CCPs.
- Exceedances of any alert levels that have been set should also initiate a documented corrective action. This action should prevent the critical limit from being exceeded.
- Alert levels should be set to ensure that sufficient time is given to allow appropriate corrective actions to be implemented, appropriate to the level of risk.

3.8 Scheme validation

3.8.1 What is validation?

Validation is the process of proving the effectiveness of control measures in reducing the risk posed by hazards or hazardous events. Validation demonstrates that if the RWMP is correctly implemented, the identified significant hazards will be controlled. There are several distinct phases of validation which are covered by these guidelines:

- Pre-commissioning validation (section 3.8.4) is generally done as part of a feasibility study during the design stage to determine what treatment processes would be required to meet the desired water quality. Individual components of the system may be validated during the pre-commissioning phase, although they will also need to be re-validated as part of the whole system once construction is complete.
- Commissioning validation (section 3.8.6) is performed to ensure that the system components control hazards to the expected level when used in conjunction with the other components in the treatment process.
- Commissioning verification (monitoring of final water quality section 3.8.8) is a type of validation, but is distinct from other validation methods because it is done by testing the end product water. This is performed to prove that the expected water quality can be produced consistently over time.

This section does not address ongoing monitoring of water quality, which is performed via operational monitoring and ongoing verification program. The requirements for operational monitoring and verification are addressed in section 3.9.

3.8.2 Validation program requirements

A validation program, for a recycled water scheme, is a documented program about how the plant or equipment used for the treatment of recycled water under the scheme are to be tested to show the

quality of the recycled water consistently meets the water quality criteria for the recycled water relevant to the scheme.

For schemes supplying recycled water for augmenting drinking water supplies, the recycled water provider, or scheme manager where applicable, must obtain approval of the validation program prior to submitting the RWMP to the regulator for assessment. Refer to section 4 for a description of the approval process and Attachment 1 for the process flowchart for approvals. A validation program for a scheme augmenting drinking water supplies will only contain a proposal for the way in which the commissioning validation and commissioning verification will be carried out, as pre-commissioning validation will have already been completed. The results of the validation program should be submitted with the application for approval of the RWMP. The outcomes of the validation should be reflected within the RWMP.

For all other recycled water schemes, the recycled water provider, or scheme manager where applicable, should submit their validation program as supporting information to their RWMP application. Refer to Attachment 2 for the process flowchart for approval.

For all schemes, the outcomes of the validation program should be reflected in the RWMP, that is, if the validation program reveals a need for additional monitoring or a specific alert level, this should be incorporated into the RWMP.

Criteria for all schemes:

- All validation programs should be documented and retained.
- The validation program should as a minimum include commissioning verification.

Note: For new schemes, if the point system, in ‘Table 2 Typical approaches for validation’ and ‘Table 3 Minimum point requirements’ is used, it requires details of pre-commissioning validation and commissioning validation. These should also be included in the validation program.

- The validation program should consist of a report that details the following for each item being validated:
 - the aim of the validation
 - the methodology used
 - the results of the validation undertaken
 - the conclusion of the validation, that is, was the aim of the validation met
 - a summary of outcomes from the validation program.
- Outcomes from the validation program should be incorporated into the detail of the RWMP.

Criteria specific to schemes augmenting drinking water supplies:

- The recycled water provider, or scheme manager where applicable, must obtain approval of the validation program prior to submitting the RWMP to the regulator for approval (section 202(4) of the Act).
- The validation program should include details of pre-commissioning validation, proposed commissioning validation and proposed commissioning verification.

3.8.3 Existing schemes

Existing AWTPs producing class A+ recycled water may not be required to fulfil validation requirements as detailed in these guidelines. The recycled water provider may instead provide 12 months of weekly treated water quality monitoring data that demonstrates the AWTP can consistently achieve the water quality criteria for class A+ recycled water as detailed in the *Public Health Regulation 2005*.

This principle applies to all existing schemes. If the recycled water provider is able to supply sufficient documentation regarding water quality for an existing treatment plant, then such documentation may fulfil validation requirements for the scheme.

However, if the recycled water provider is unable to supply sufficient documentation or is unable to meet any of the validation requirements, they should contact the regulator to discuss an acceptable alternative. Examples of this may include:

- a targeted monitoring program to provide further information in addition to available data which the recycled water provider is able to provide
- testing of a specific control measure to ensure its hazard reduction capability.

3.8.4 Pre-commissioning validation

Pre-commissioning validation is generally undertaken as part of a feasibility study, to determine what treatment processes would be required to meet the desired water quality, based upon the source water characterisation. This could be achieved using expert knowledge or literature reviews, or through construction and challenge testing of a pilot plant. Individual components of the system may be validated during the pre-commissioning phase, though they will also need to be re-validated as part of the whole system once construction is complete.

Validation should be considered in the planning stage of any new recycled water scheme. Prior to designing the treatment process, baseline information of the source water should be gathered. This information will underpin a risk assessment process and provide a basis for designing a process capable of removing any contaminants of concern, thus producing water that meets, or exceeds, specified water quality criteria.

For schemes augmenting drinking water supplies, the design of the process should include built-in safety margins ensuring that the end water quality can still be achieved if one, or several, of the treatment barriers are not fully effective. Alternatively, if there is only a single barrier to treat a particular hazard, then an automatic shut down or return for that barrier will be necessary. Confirmation of safety margins can be achieved by determining the log reduction capability, or percentage removal, of each treatment component for each indicator organism and contaminant of concern, or groups of contaminants of concern, or combinations of both. More information on indicative log reduction attributable to different treatment technologies is available in 'Table 4.9' of section 4.3 of the *AGWR Phase 2: Augmentation of Drinking Water Supplies* module.

The minimum acceptable log reductions of pathogens and indicator organisms for recycled water schemes augmenting drinking water supplies, is listed in 'Table 2' of the *Water quality guidelines for recycled water schemes*.

Criteria for all schemes:

- The recycled water provider should demonstrate that pre-commissioning validation has been considered in the planning stage of any new recycled water scheme.

3.8.5 Receiving water source

Recycled water for augmenting drinking water supplies must be supplied into one of the following receiving water sources:

- an aquifer
- a dam on a watercourse
- a lake
- a watercourse
- wetlands.

The receiving water source must be an effective barrier that allows for sufficient management of any risk to the health of the public associated with potential incidents relating to recycled water quality. The recycled water provider should provide evidence of the effectiveness of the barrier at the time of submitting their validation program. A regulator approved drinking water quality management plan that addresses the ongoing management of the barrier, including the ability to manage potential incidents, will be developed by the entity responsible for the receiving water source.

To be an effective barrier, storage conditions should be appropriate to ensure that substantial safety margins are in place to account for any and all possible delays in completing monitoring, communicating results and responding to results where necessary. This could be demonstrated through:

- water quality monitoring
- tracer studies
- hydrodynamic modelling of the storage
- various management options to control storage conditions.

Note: The regulator will not approve a RWMP for a recycled water scheme that proposes to supply recycled water to augment a supply of drinking water unless there is an approved drinking water quality management plan (DWQMP) for the water storage of a drinking water service provider that under Chapter 2, Part 4, Division 3, must have a DWQMP (section 207 of the Act)

Criteria specific to schemes augmenting drinking water supplies:

- The recycled water provider, or scheme manager where applicable, should submit evidence demonstrating that the receiving water source is an effective barrier.

Note: The evidence of the effectiveness of the barrier should be submitted with the validation program.

Assessment of the effectiveness of the receiving water source will be undertaken by the regulator on a case by case basis. Assessment will have regard to the *Australian Guidelines for Water Recycling (Phase 2): Augmentation of Drinking Water Supplies* and the *Public Health Regulation 2005*.

3.8.6 Commissioning validation

Commissioning validation is used to confirm whether treatment barriers have adequately removed chemical and microbial contaminants (hazards) ensuring that each individual barrier and the treatment system as a whole can achieve the log reduction required. Valuable information to support the validation process can be obtained by monitoring target chemical and microbiological parameters at key points throughout the treatment system.

The parameters chosen for validation at each individual barrier should include target parameters that are meant to be removed and/or inactivated by each barrier. It should include real hazards, such as pathogens or specific chemicals, as well as indicators or surrogates (as listed in section 8). Frequency of monitoring should be sufficient to prove effectiveness of the process against target parameters in a statistically valid manner.

To validate critical limits the scheme should demonstrate that operating within the chosen critical limits during the validation period corresponds with compliant results achieved in the associated commissioning verification period. This validates that the critical limits have been set at an appropriate level.

Surrogates and indicators which are listed in section 8 are well established and do not require further validation; they are considered to be theoretically validated. However, should the scheme wish to use a new or emerging surrogate or indicator that is not in section 8, this will need to be validated. This validation can be via theoretical or test methods.

Criteria for all schemes:

- All control measures should be validated prior to commencement of supply and this information should be referenced back to the critical limits, that is, validation should prove that performance below critical limits can be consistently achieved.

- The RWMP should demonstrate that the following elements have been validated according to the risks specific to the scheme and the water quality criteria as determined via the *Public Health Regulation 2005* and/or the *Water quality guidelines for recycled water schemes*:
- New or emerging surrogates and indicators used for monitoring should be validated, to prove that they accurately predict the level of hazard(s) they represent.
- All CCPs should be validated to prove their effectiveness against the hazard they control, or that the surrogate or indicator shows that the hazard would be controlled.
- Critical limits should be validated to prove that operating within critical limits ensures recycled water quality criteria are met at the verification step.

3.8.7 Validation methodology

Validation methods are numerous and varied. The validation program should be designed to meet the requirements of a specific scheme. The methods below are the broad categories of validation types, which should be considered by the recycled water provider, or scheme manager where applicable. More than one method should be used to validate individual treatment components. Methods used to validate may include:

- historical data, for example, from other schemes
- scientific literature
- manufacturers specifications and challenge studies
- pilot plant
- specific challenge testing
- on-site tracer studies
- direct integrity testing
- continuous indirect integrity testing
- monitoring of final water quality (commissioning verification).

The validation methods chosen should be appropriate to the scheme type, the technology used and the hazards identified. Advice on appropriate validation methods can be sought from the regulator.

Recycled water providers should consider ways in which their validation methodologies can be buffered from statistical errors. It is unlikely that any single validation methodology can ensure the performance of a complex treatment system to provide a specified water quality. One effective method is to ensure a spread of validation methodologies. Recycled water providers should use the 'points table' in 'Table 2 Typical approaches for validation' as a means of securing an appropriate spread of validation methodologies. This system works by apportioning a point value to each methodology. If used, recycled water providers should accumulate at least the minimum specified points total for their scheme type. Refer to 'Table 3 Minimum point requirements' for further details.

Points attributed to a validation methodology in 'Table 2 Typical approaches for validation' should only be counted once for the purpose of meeting the minimum points required in 'Table 3 Minimum point requirements'. This is the case regardless of how many times that methodology is used for different CCPs. This does not preclude the need to validate all CCPs, critical limits, surrogates and indicators.

Table 2. Typical approaches for validation*.

Pre-commissioning validation	Historical data, for example, from other schemes	✓ (1)	✓ (1)	✓ (1)	✓ (1)
	Scientific literature	✓ (1)	✓ (1)	✓ (1)	✓ (1)
	Manufacturer’s specifications	✓ (1)	✓ (1)		✓ (1)
Commissioning validation	Pilot plant	✓ (3)			
	Specific challenge testing	✓ (3)			
	On-site tracer studies	✓ (3)			
	Direct integrity testing	✓ (3)	✓ (3)		✓ (3)
	Continuous indirect integrity testing	✓ (3)	✓ (3)		✓ (3)
Commissioning verification	Monitoring of final water quality	✓ (5)	✓ (5)	✓ (5)	✓ (5)

Table 3. Minimum point requirements*.

Augmentation of drinking water supplies	14
Class A+	9
Class A to D	5
Non-sewage source, that is, greywater and wastewater	9

*The points referred to in Table 2 and 3 above are indicative only. For example, the weighting and awarding of points for each of the validation methodologies may vary depending on the regulator’s assessment of the quality and relevance of the material supplied by the recycled water provider.

Criteria for all schemes:

- Whichever validation method(s) is adopted, the validation method(s) should be appropriate for the type of recycled water scheme, that is, augmentation of drinking water supply, class A+, classes A to D and non-sewage sourced recycled water, the technology used and the hazards identified.
- If the points system is used:
 - The recycled water provider should meet the minimum point requirement applicable to their scheme type; and
 - The validation programme should indicate which combination of methodologies has been selected from Table 2 to meet the minimum point requirement.
- If the ‘points system’ is not adopted, the provider should give an indication of how an appropriate spread of methodologies were used or how the recycled water provider has otherwise taken steps to guard against statistical errors or other issues in using its validation methodology.

- Monitoring of final water quality must be conducted for all schemes.

Note: Validation methodologies are described in the following sections. The criteria listed with these methodologies only apply if that particular methodology has been chosen.

Historical data

Historical data from other schemes can be used to support the validation process but cannot be solely relied on. Historical data can be used as evidence to support the effectiveness of treatment barriers to remove contaminants of concern under conditions that may be experienced at the treatment plant. The historical data should be critically reviewed to ensure that it is directly applicable to the treatment process and operating conditions under investigation for example, different temperatures, volumes and pressures. The evaluation should include an assessment of whether treatment processes have been assessed in accordance with existing protocols, for example, United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*, or by independent agencies for example, California Department of Health.

Criteria for all schemes:

- Evidence should be provided that historical data is directly applicable to the treatment process and operating conditions for the scheme.
- The recycled water provider should submit a report, as part of the validation program, compiling all historical data including:
 - information on the source of the data for example, reports to regulators, trade waste data, research data
 - a summary of the results
 - a rationale for the data included
 - relevance to the source water characterisation.

Scientific literature

Peer-reviewed literature can be used to support the validation process but cannot be solely relied on. Scientific literature can be used as evidence to support the effectiveness of treatment barriers to remove contaminants of concern under conditions that may be experienced at the treatment plant. The scientific literature should be critically reviewed to ensure it is directly applicable to the treatment process and operating conditions under investigation for example, different temperatures, volumes and pressures. The evaluation should include an assessment of whether treatment processes have been assessed in accord with existing protocols for example, United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*, or by independent agencies for example, California Department of Health.

Criteria for all schemes:

- The recycled water provider should submit a reference list (for example, Harvard style may be used) for any peer-reviewed literature used to support the validation process.
- Evidence should be provided that the scientific literature is directly applicable to the treatment process and operating conditions for the scheme.

Manufacturer's specifications

Manufacturer's specifications can be used to support the validation process but should not be solely relied on. Any removal rates provided by the manufacturer should be confirmed by monitoring in a pilot plant or full-scale treatment plant study. Any reference to scientific data for example, manufacturer's challenge studies should be obtained and critically reviewed. Conditions under which experiments were performed should be confirmed as being appropriate for the conditions under which the full-scale plant will operate.

Criteria for all schemes:

- The recycled water provider should submit a list of manufacturer's specifications for each treatment component.
- The recycled water provider should submit details of any data or scientific evidence made available by the manufacturer including methodology and conditions under which testing was performed.
- The recycled water provider should submit details of all monitoring or testing undertaken to confirm the manufacturer's specifications including methodology and results.
- Evidence should be provided that the manufacturer's specifications are directly applicable to the treatment process and operating conditions for the scheme.

Pilot plant studies

A pilot plant is a small scale treatment plant that is directly comparable to the full-scale plant. Pilot plant studies can be used to support the validation process but cannot be solely relied on. If a pilot plant is used to validate the individual treatment components then evidence should be provided to show its performance is comparable to a full-scale plant.

Criteria for all schemes:

- The recycled water provider should submit evidence that the pilot plant is comparable to a full scale plant for example, comparison of volumes, pressure, size of treatment component and types of treatment components.

Specific challenge testing

Challenge testing can be used to support the validation process but should not be solely relied on. Challenge testing is designed to demonstrate the ability of a treatment process to remove a specific target organism or chemical contaminant. Challenge testing involves inoculating influent to a treatment process with a known quantity of micro-organisms or a known concentration of a chemical and then testing the treated water to determine how much is removed by the treatment step. The primary purpose of challenge testing is to establish a log removal value for a particular treatment barrier.

The United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*, provides detailed information on using challenge testing for the validation of a membrane filtration process for micro-organisms. This manual is designed for surface water and therefore uses *Cryptosporidium* as the indicator micro-organism and is located online on the US EPA website at <www.epa.gov>.

Other chemicals and microbiological parameters can be used to challenge test membranes. The parameters should be selected based on the criteria used for determining the parameters for source water characterisation. Chemicals chosen for challenge testing should include key indicators based on chemical type, molecular structure and shape, molecular weight or chemicals identified as having particular health or environmental concern. Refer to section 8 for examples from the literature of key indicators and surrogates.

Ideally, challenge testing should be performed and/or verified by an independent third party. The methods used for challenge testing should be documented. Samples of inoculated influent and the treated water should be taken in triplicate, that is, three samples individually tested. Challenge testing should be repeated under varying conditions which account for extremes that the full scale plant may be exposed to for example, concentrations, volumes, pressure and temperature.

If an independent third party is not engaged to perform and/or verify the challenge testing, a detailed description of the methodology and rationale behind the chosen methodology should be supplied to the regulator. Information on the conditions under which challenge testing was performed, results of analysis performed and an analysis of the data collected, including assessment of equipment performance, should also be provided.

Criteria for all schemes:

- The recycled water provider should submit a detailed description of the challenge test methodology used.
- The recycled water provider should submit a rationale for the chosen challenge test methodology, including parameters chosen and conditions under which challenge testing was performed.
- The recycled water provider should submit contact details and qualifications of the independent assessor, if used.
- The recycled water provider should submit the results of analysis performed for the challenge test.
- The recycled water provider should submit an analysis of data collected, including an assessment of the performance of the equipment under the challenge test.

On-site tracer studies

On-site tracer studies can be used to support the validation process but should not be solely relied on. On-site tracer studies may be used to demonstrate detention time in disinfection systems, lagoon treatment systems and reservoirs. If on-site tracer studies are used, the methodology should be documented and substantiated. All data collected as part of the on-site tracer study should be collated, reviewed and critically assessed by the recycled water provider.

For example, microspheres and nanospheres can be used to validate detention time and exposure in ultraviolet (UV) disinfection systems. These spheres can be passed through the UV system, collected from the end product water and then tested to determine exposure. Using microspheres and nanospheres can also help determine if the UV system has any ‘hot’ or ‘cold’ spots in the set up of the UV disinfection system.

Another example is the use of rhodamine dye studies. Rhodamine dye can be used for measuring, mapping and monitoring water systems, including studying and modelling surface and ground water systems, tracing contaminants, detecting leaks and measuring retention times.

Further information can be found in the United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*.

Criteria for all schemes:

- The recycled water provider should submit a detailed description of the tracer study methodology used.
- The recycled water provider should submit a rationale for the chosen tracer study methodology, including type of tracer and conditions under which the study was performed.
- The recycled water provider should submit the results achieved and the analysis of data collected during the tracer study.

Direct integrity testing

Direct integrity testing can be used to support the validation process but should not be solely relied on. A direct integrity test is defined as a physical test applied to a membrane unit in order to identify and isolate integrity breaches. Integrity breaches can develop in the membrane during routine operation that could allow the passage of chemicals and micro-organisms. A specific type of integrity testing is not mandatory as integrity testing varies for different membranes.

There are two general classes of direct integrity tests that are commonly used in membrane filtration facilities, namely pressure-based tests and marker-based tests. The pressure-based tests are based on bubble point theory, described in Appendix B, United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*. Bubble point theory involves applying a pressure or vacuum that is, negative pressure to one side of a membrane barrier and monitoring for parameters such as pressure loss or the displacement of air or water in order to establish whether an integrity breach is present.

Marker-based tests use either a spiked particulate or molecular marker to verify membrane integrity by directly assessing removal of the marker, similar to a challenge test. Chapter 4, United States

Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*, describes direct integrity testing in detail.

Manufacturer's instructions will be available on the direct integrity testing that is applicable to the membrane type. Most microfiltration and ultrafiltration membranes have a direct integrity testing system; however, not all reverse osmosis membranes have one.

Note: This methodology can also be utilised as part of an operational monitoring program.

Criteria for all schemes:

- The recycled water provider should submit a description of the type of direct integrity test(s) used.
- The recycled water provider should submit a rationale for the direct integrity test(s) chosen.
- The recycled water provider should submit results of direct integrity testing, including information on the conditions under which tests were performed, and the analysis of data collected.

Continuous indirect integrity testing

Continuous indirect integrity testing is not a physical test applied to a membrane module or membrane unit but instead involves monitoring some aspect of filtrate water quality as a surrogate measure of membrane integrity. Quality of membrane filtrate is very consistent and largely independent of fluctuations in feed water turbidity or particle levels. A marked decline in filtrate quality may indicate an integrity problem. Continuous indirect integrity testing is not as sensitive as direct testing for detecting integrity breaches. However, it offers some benefits including the ability to be operated in a continuous, online mode and its applicability to any membrane filtration system independent of manufacturer or system parameters.

Measurements of online parameters such as turbidity, particle counts and conductivity can be used pre and post treatment to provide removal information for the particular treatment barrier. For example, manufacturer's data may indicate a 95 per cent sodium chloride removal rate for a particular reverse osmosis membrane. Online monitoring of conductivity, as a surrogate, pre- and post-reverse osmosis filtration can provide information on whether the membranes, as installed in the treatment plant, are achieving this.

Note: This methodology can also be utilised as part of an operational monitoring program. Further information can be found in the United States Environmental Protection Agency *Membrane Filtration Guidance Manual 2005*.

Criteria for all schemes:

- The recycled water provider should submit a description of the type of continuous indirect integrity testing used.
- The recycled water provider should submit a rationale for this type of testing.
- The recycled water provider should submit results of indirect integrity testing, including information on the conditions under which tests were performed, and the analysis of data collected.

Monitoring of final water quality

The methodology for monitoring final water quality is addressed in the commissioning verification requirements section below. Monitoring final water quality will be referred to as 'commissioning verification' from this point onwards.

3.8.8 Commissioning verification

Commissioning verification will confirm that the final water quality consistently complies with the required water quality criteria. Parameters chosen for commissioning verification should be risk based. For schemes augmenting drinking water supplies this must include specific pathogens and chemicals of concern plus indicator or surrogate parameters.

The recycled water provider should submit documentation on the water quality testing carried out to demonstrate that the treatment system is reliable and robust and that the scheme is able to consistently provide the required water quality. The required water quality criteria for certain uses and classes of water are provided in the *Public Health Regulation 2005* or the *Water quality guidelines for recycled water schemes*. The regulator has the power to approve water quality criteria on a case by case basis.

The frequency of sampling during the commissioning verification period should be sufficient to give statistical confidence that the final water quality consistently achieves the required water quality criteria. A minimum of 13 weeks of twice-weekly testing is required for all schemes. Recycled water providers may choose at their own discretion to go beyond this. The regulator has the discretion to alter the duration of the verification period on a case by case basis. This could be at the initiation of the regulator or when requested by the recycled water provider or scheme manager.

If during commissioning verification any of the applicable water quality criteria are exceeded the provider should contact the regulator to discuss what action, if any, should be taken. Exceedances during commissioning verification should be reported to the regulator as soon as possible

If the process is changed in any material way during validation, the previous validation program may be negated. For example, a change to chemical dosing occurs where it was found during validation that undesirable by-products were being created. For a recycled water scheme supplying recycled water to augment a drinking supply, an amendment of the validation program will be necessary and the amended validation program will need to be submitted to the regulator for approval. For all other schemes the recycled water provider should discuss any proposed changes with the regulator. If the validation program is amended, the commissioning verification process will need to recommence. If a recycled water provider (or scheme manager where applicable) is unsure about the necessity for amending a validation program, advice should be sought from the regulator.

The recycled water provider should provide a statistical analysis of the data collected to determine the confidence level for meeting the water quality criteria required on a continuous basis. If statistical validity cannot be gained from the data set, further testing may be required.

Microbiological parameters

For AWTPs producing recycled water for augmenting drinking water supplies, monitoring for specific pathogens must be included in the commissioning verification program in addition to the microbiological indicators listed in Schedule 3B of the *Public Health Regulation 2005*. Consideration should also be given to specific pathogen testing in the ongoing verification monitoring program. Actual pathogens to be tested should be determined by the risk assessment.

AWTPs producing recycled water for augmenting drinking water supplies should also demonstrate the log removal of indicators for bacteria and viruses correlates with the log removal of actual pathogens. It is possible that the actual pathogen in the feed water may be too low to correlate with log removal indicators. If this is the case, the number of actual pathogens in the final treated water will need to be measured.

For AWTPs producing class A+ recycled water, the minimum microbial verification monitoring and water quality criteria for final treated water are listed in Section 18E, Schedule 3C of the *Public Health Regulation 2005*. Further commissioning verification and ongoing verification monitoring for specific pathogens should be considered as part of the risk assessment process.

Chemical parameters

The commissioning verification program for chemical parameters must include those chemicals which were identified during the source characterisation as significant risks, plus select surrogates and indicators¹² for those identified chemicals. This means that where it can be proven that specific chemical parameters are not within the source water for the scheme, that these chemicals do not have to

¹² Refer to section 8 of this guideline for examples of acceptable surrogates and indicators. If the provider wishes to use a surrogate or indicator not mentioned in section 8 justification for the selected surrogate or indicator *should* be provided to the regulator.

be monitored on an ongoing basis. Despite this, recycled water providers should check the makeup of their source water on a regular basis.

A surrogate is a quantifiable parameter that can serve as a performance measure of treatment processes that relates to removal of specific contaminants, for example, conductivity or total organic carbon for removal of chemical contaminants by reverse osmosis. An indicator compound is a chemical that can be used to measure the effectiveness of a process for a family or group of compounds in the treatment process of interest (Drewes, J, Sedlak, D, Snyder, S. & Dickenson, E. 2008, *Development of indicators and surrogates for chemical contaminant removal during wastewater treatment and reclamation*. Final project report, WateReuse Foundation, Alexandria, Virginia.). For instance for reverse osmosis treatment, compounds with a low molecular weight have a lower rejection rate and therefore compounds such as caffeine, nitrosodimethylamine (NDMA) and paracetamol are good indicators for low molecular weight compounds.

Similarly, Bisphenol A, estrone or chloroform are indicators for hydrophobic, non ionic compounds for assessing the efficacy of reverse osmosis filtration.

Biological monitoring

Results from biological monitoring may be used by a recycled water provider to support validation studies. More information is available in section 4.5.1 of the *AGWR Phase 2: Augmentation of Drinking Water Supplies* module. Further specific advice on biological monitoring can be sought from the regulator.

Commissioning verification confirms that the final water quality consistently complies with the required water quality criteria. The criteria listed below outline the regulator's requirements for all schemes and the evidence that the recycled water provider should provide. These criteria relate to the entire commissioning verification stage discussed above in section 3.8.8.

Criteria for commissioning verification for all schemes:

- Commissioning verification must include specific pathogens and chemicals of concern plus indicator or surrogate parameters.
- Commissioning verification should be conducted as close as possible to the point where recycled water is supplied.
- As part of the validation report, the recycled water provider should submit information on the commissioning verification testing carried out that:
 - demonstrates that the treatment system is reliable and robust and the scheme is able to consistently provide the required water quality prior to supply of the recycled water to the user(s)
 - includes the commissioning verification data including a trend analysis, assessment of the data reliability and any identified gaps in the existing data
 - includes a list of microbial and chemical parameters to be analysed during commissioning verification and provide a rationale for choosing the microbial and chemical parameters
 - provides details on the sampling point and method of sampling for each parameter
 - documents the frequency of sampling for each parameter
 - includes the result of analysis, compiled and presented in a format that includes the following details:
 - parameter
 - unit of measurement
 - guideline value
 - limit of reporting/detection
 - laboratory and appropriate accreditation
 - analytical method used
 - total number of samples
 - total number of positive samples
 - minimum and maximum concentrations.

Criteria specific to schemes augmenting drinking water supplies:

- For schemes augmenting drinking water supplies, commissioning verification must include specific pathogens and chemicals of concern plus indicator or surrogate parameters

3.8.9 Revalidation of a RWMP

Revalidation should occur following a significant change within the scheme. Triggers for revalidation may include:

- the introduction of new processes or equipment
- changes to the source water or product water quality
- increases in hazard concentrations
- new or emerging hazard(s) identified
- repeated systematic failures are detected
- catchment inputs increasing beyond the maximum flow tested during validation.
- addition of new influent source
- variation in process configuration, operational parameters or mode of operation
- new membrane specification
- new chemical used in treatment processes
- any unscheduled suspension to supply or operation.

Revalidation methods should be based on the criteria in sections 3.8.7 and 3.8.8. The chosen validation methods will be assessed by the regulator cumulatively. The points requirements in ‘Table 2 Typical approaches for validation’ and ‘Table 3 Minimum point requirements’ may not apply to revalidation. Guidance on revalidation may be obtained from the regulator on a case by case basis.

Depending on the scope of the revalidation, a full program of validation may not be required. In some instances the validation period may be shortened or only a specific piece of infrastructure may require validation. The revalidation requirements will be dependant upon the type and magnitude of alterations to the scheme. Guidance should be sought from the regulator on proposed revalidation.

Revalidation may also require the RWMP for the scheme to be amended. There will be circumstances where an amendment is not required however, if treatment processes or specifications of disposable components of the scheme (for example, chemicals or membranes) alter, without an amendment the provider may be operating outside of the scope of their approved RWMP. Refer to section 5.4 of these guidelines for details on amending a RWMP.

Similarly, a recycled water provider may be required to revalidate the scheme, when they wish to resume supply following a suspension of a RWMP, refer to sections 214–215 of the Act. In some cases this will require an amendment to the RWMP. Refer to section 5.4 of these guidelines for details on amending a RWMP.

Criteria for all schemes:

- The triggers for revalidation should be documented in the RWMP.

3.9 Scheme management

3.9.1 Monitoring procedures

Source monitoring

The source water for a recycled water scheme may change over time. Determination of monitoring frequency for each parameter should be risk-based. Review of source water characterisation should consider temporal variation, new hazards in the catchment for example, new industrial inputs and scientific advances in analytical techniques and risk profiles for particular hazards.

Criteria for all schemes:

- Ongoing source water characterisation should be included in a monitoring program.

Operational monitoring

For the purpose of these guidelines operational monitoring is defined as the act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is reliable and robust.

A need for continuous monitoring may lead to the use of representatives of hazards, that is, surrogates and indicators. For example, turbidity is used as a ‘measure’ of filtration efficiency, and pressure decay testing is used as a ‘measure’ of membrane treatment performance. This is appropriate, providing the surrogates and indicators are properly validated. A table of example surrogates and indicators is provided in section 8.

Monitoring is part of a feedback loop; it is vitally important that monitoring results are analysed and acted on and that the management system is flexible and responsive to these results. A monitoring program should also be flexible to allow for new hazards identified in the source water, new monitoring methods and/or scientific advancement.

Criteria for all schemes:

- The parameters selected for operational monitoring must, at a minimum, relate to those set in the water quality criteria.
- All critical limits should have an associated operational monitoring process. Preference should be given to online, real-time monitoring with alarms, where possible.
- When associated with a CCP, a critical limit should be able to be monitored continuously, and if not, the frequency of monitoring should be justified and documented. Additionally, operational monitoring should be responsive to non-conformances. For example, if a sample fails, the monitoring frequency is increased until three successive compliant results have been achieved.
- Details of operational monitoring procedures must be documented. Operational monitoring procedures should check the performance and implementation of control measures. The procedures for monitoring should include:
 - what is being monitored
 - how the monitoring is done
 - when the monitoring is done
 - where the monitoring is done
 - who is responsible for ensuring it is completed
 - the critical limits, alert levels and corrective actions.
- All monitoring equipment should be calibrated at documented intervals against manufacturer’s specifications. All calibration information should be documented and retained through the record keeping system.

Criteria specific to schemes augmenting drinking water supplies:

- The parameters selected for operational monitoring should, at a minimum, relate back to the risk assessment. If additional parameters are selected for monitoring, these should be detailed in the RWMP.

3.9.2 Verification monitoring

Verification monitoring is an assessment of the performance of the scheme. As opposed to operational monitoring, it does not occur in ‘real time’, and should be independent of operational monitoring. It is used to confirm product quality, compliance with water quality criteria and identify weaknesses in the existing control measures. It can also be used to assess whether critical limits are set appropriately. Verification monitoring can be used to identify minor changes that develop over a long period. For schemes supplying recycled water for augmenting drinking water supplies, or schemes using greywater

and wastewater as a source, the frequency of verification monitoring should also allow for temporal and seasonal variation where applicable¹³.

To ensure that compliance with the water quality criteria is maintained some of the parameters of the water quality criteria will need to be included in the verification monitoring program. However, it is not necessary to test all parameters at the same frequency.

In instances where a verification monitoring test result does not meet the water quality criteria, a recycled water provider or other declared entity or the scheme manager (whichever is the responsible entity) must notify the regulator of the details of the non compliance and the circumstances that gave rise to the non compliance (refer to section 5.8 of these guidelines for further information).

Additionally where recycled water is supplied to augment a drinking water supply, if, in any sample of the recycled water taken the value of a factor is more than the value stated in the *Public Health Regulation 2005* (unless under an approved RWMP relating to the recycled water a factor does not need to be monitored), an assessment of the risk to public health from the quality of the recycled water must be undertaken. This assessment should be undertaken by the responsible entity (the scheme manager, other declared entity or the recycled water provider) in consultation with the regulator. The health risk assessment should also include corrective and preventative actions to ensure that any risk is appropriately managed.

Note: The design of the verification monitoring program for schemes augmenting drinking water supplies should be risk based. The scheme must comply with all factors stated in Schedule 3B of the *Public Health Regulation 2005*, however not all factors need be routinely tested or tested at the same frequency. This may apply if the scheme can demonstrate, through the validation program that a factor is of low risk to the scheme.

Alternatively the scheme may decide to utilise surrogates or indicators in the verification monitoring program and choose a factor for inclusion in the verification monitoring program, which is indicative of the levels of multiple factors. This does not diminish the obligation of the scheme to comply with all factors and to ensure that the risk level of a factor does not change over time. The need for identifying changes related to the factors listed in Schedule 3B of the *Public Health Regulation 2005* may result in the need for annual monitoring or regular revision of risk assessments over time.

Auditing is also a form of scheme verification, but this is addressed separately in the *Audit and annual reporting guidelines*; these guidelines will be made available when approved.

Criteria for all schemes:

- There must be a documented verification monitoring program to prove that the required quality of recycled water is being delivered to the user(s).
- The verification monitoring program must be documented. The parameters selected for the verification monitoring program:
 - For schemes supplying recycled water to augment a drinking water supply must include those parameters which were identified during the source characterisation as significant risks, plus any surrogates or indicators used in their monitoring
 - For all other recycled water schemes as per the appropriate water quality criteria stated in the water quality guidelines, the *Public Health Regulation 2005* or information notice
- The parameters selected for verification must be linked to the significant risks identified during the risk assessment process.
- If the frequency of verification is not specified in the water quality criteria, the frequency should be justified and documented based upon the variability of the parameters that is, the more variable the parameter, the more frequent the verification should be.

¹³ Note, that for most other schemes the frequency is set within the *Public Health Regulation 2005*.

- Verification of recycled water quality should be conducted as close as practicable to the point of supply.
- Verification frequencies should be responsive to non-compliance. For example, if a sample fails, the monitoring frequency should be increased until three successive compliant results have been achieved.
- Verification monitoring programs should also be responsive to end user satisfaction and linked to the customer complaints procedure.

Criteria specific to schemes augmenting drinking water supplies:

- If the scheme wishes to exclude factors listed in Schedule 3B of the *Public Health Regulation 2005* evidence or justification should be provided as to why a factor has been excluded.
- The RWMP should contain a statement that the scheme manager or scheme provider will undertake a health risk assessment, including corrective and preventative actions, for situations where for any sample of the recycled water taken, the value of a factor is more than the value stated in *Public Health Regulation 2005*. The statement should also indicate that the scheme manager or scheme provider will comply with any protocols developed by the regulator in relation to public health risk assessments, and will implement any preventative or corrective action resulting from the risk assessment.

3.9.3 Laboratory analysis

These requirements apply to any laboratory analysis, this may include testing for commissioning validation, commissioning verification or verification monitoring or calibration purposes. The regulator's preference is for a laboratory that is National Association of Testing Authorities (NATA) accredited for the analysis to be used where it has the capability and capacity.

Where a NATA accredited analysis is not used the recycled water provider should supply documentation of the methodology including the quality assurance (QA)/quality control (QC) procedures used to perform this analysis.

Criteria for all schemes:

- The recycled water management plan should include a protocol stating how laboratory analysis will be undertaken. This protocol should include:
 - Details of the laboratory (that is NATA accredited) that is being used for all analysis that is required to be provided to the regulator.
 - Where a NATA accredited laboratory is not used for an analysis to be provided to the regulator, the recycled water provider should supply documentation of the methodology including the QA/QC procedures used to perform this analysis.
- There should be a procedure documenting that all laboratory data and results will be retained through the record keeping system.

Criteria specific to multiple-entity critical schemes:

- Recycled water providers, and other declared entities, should have a procedure for consistent reporting of laboratory results for the scheme.
- There should be a procedure in the scheme manager plan for reconciling laboratory results for the scheme that come from different laboratories, which may have different analytical methods or detection limits for the same parameters.

3.9.4 Quality assurance and quality control

All operational and verification monitoring should be undertaken within a QA/QC framework. QC generally involves conducting the monitoring and calibration tasks, whereas QA involves checking the QC results, analysing and auditing them.

Operational staff generally conduct QC, but the same staff should not also be responsible for QA, as there needs to be independent verification of the QC activities.

Criteria for all schemes:

- There should be a documented QA/QC framework that clearly differentiates between the two types of activities.
- All monitoring activities should be undertaken within the QA/QC framework.
- Responsibility for QA/QC activities should be documented and differentiated.
- The staff undertaking the QC should not also be responsible for QA.

3.9.5 Management procedures

Having documented management procedures will help ensure that activities are performed correctly and consistently. Procedures will generally contain the following information:

- the purpose of the procedure
- who is responsible for maintaining the procedure
- the tasks to be performed, when, and by whom
- the parameters to be monitored, and any relevant critical limits or alert levels
- record keeping requirements
- corrective actions in the event of non-conformance or exceedance of alert levels
- reporting requirements, both internal and external.

Criteria for all schemes:

- Management procedures should be developed for every activity that ensures the correct operation of the recycled water scheme, in order to ensure that the water quality criteria are met.
- All management procedures should be documented in operations manuals which should be 'controlled documents'. Relevant staff should have training in, and ready access to, these procedures.
- An indexed list of all management procedures should be documented and supplied as part of the RWMP.

3.9.6 Non-conformance and corrective/preventive actions

Non-conformance is a situation where there is a deviation from acceptable criteria set for internal limits set by the recycled water provider, for example, repeated exceedances of alert levels, exceedances of critical limit, failed internal audit or customer complaint.

This does not include exceedances of water quality criteria, which are addressed in section 3.9.2.

Corrective actions are those actions taken immediately to prevent hazards from reaching end users. Preventive actions are those taken to investigate the cause of the non-conformance and prevent it from happening again.

Criteria for all schemes:

- The definition of non-conformance for the scheme should be documented.
- The response that will be taken by the recycled water provider should:
 - include a requirement that the non-conformance and response is documented and retained
 - require corrective actions and, where possible, require preventive actions.

3.9.7 Management of incidents and emergencies

An incident and emergency response plan documents the procedure for any incidents or emergencies that may occur, which affect the production, supply or quality of recycled water. The incident and emergency response plan includes the protocols for communication between recycled water providers, or scheme manager where applicable, and users, as well as the regulator, and other stakeholders including the media.

Note: After a RWMP is approved, section 270 of the Act requires notification of certain incidents. Refer to section 5.8 for further details.

As outlined in section 208 of the Act notice must be given to the regulator as soon as practicable by the recycled water provider or other declared entity (or scheme manager where applicable), if production or supply of recycled water under the recycled water scheme stops, or is intended to be stopped, other than as provided for under the approved RWMP for the scheme or on a permanent basis.

Criteria for all schemes:

- There must be an incident and emergency response plan contained within the RWMP or included as a supporting document to the RWMP.
- The incident and emergency response plan should incorporate how notification will be made to the regulator, in the case of a non compliance of water quality criteria or production or supply stoppages (refer to section 208 of the Act).
- The incident and emergency response plan should contain a response to any incident or emergency that could plausibly affect the production, supply or quality of recycled water.
- The incident and emergency response plan should detail how staff have been and will be trained in the incident and emergency response plan.
- The incident and emergency response plan should:
 - detail how drills will be held to improve the response processes
 - outline the requirements for a debrief to be held with all relevant staff, contractors or regulator(s) following any incident and emergency
 - document a feedback loop of any preventive actions implemented as a result of an incident and emergency for the inclusion into the RWMP.

Criteria specific to multiple-entity critical schemes:

- There must be a scheme incident and emergency response plan documented in the scheme manager plan. This should detail who will be responsible for taking action during incidents and emergencies, the communication protocols between entities, including the recycled water providers and other declared entities, in an incident or emergency and the relationships to any existing emergency protocols located within the scheme provider plan(s).
- The scheme provider plan should specify that the provider will notify the scheme manager immediately, orally, and as soon as practicable in writing, of incidents and emergencies.

Criteria specific to schemes providing recycled water to augment drinking water supplies:

- The incident and emergency response plan should detail the communication protocols between the recycled water provider and the drinking water service provider when an incident or emergency has the potential to affect the quality of the water supplied to the receiving water source.

3.9.8 Documentation, record keeping and internal reporting

Documentation

All documents referred to in the RWMP or supporting programs which are necessary to ensure the safe production and supply of recycled water (and continuity of supply in the case of critical schemes) constitutes part of the RWMP and must be supplied to the regulator for assessment. Any referenced document not included, may be requested by the regulator for submission and assessment as part of the RWMP approval process (section 203 of the Act).

Criteria for all schemes:

- There should be a procedure for document control, to ensure that all copies of documents referenced in the RWMP are current and controlled.

- All internal documents mentioned in the RWMP should be referenced (for example, by using the Harvard system), current and controlled.

Record keeping

Record keeping is integral in demonstrating compliance with legislative requirements and auditing needs.

Criteria for all schemes:

- There should be a procedure for record keeping and document retention.
- Records should be maintained for all operations of the recycled water scheme. Document retention times should be based on any relevant regulatory requirements and to satisfy auditing needs.
- There should, where practicable, be a system for monitoring information to be recorded on template forms. Records from CCPs should be appropriately checked and counter-signed by a manager or supervisor.

Internal reporting

Internal reporting ensures that relevant information is communicated to all appropriate staff within a recycled water scheme.

Criteria for all schemes:

- There should be a procedure outlining how internal reporting and reviews will be conducted, specifying the timeframes within which information should be passed on.
- There should be a procedure for ensuring that monitoring and audit results are communicated to all relevant staff.

3.9.9 Supporting programs

Supporting programs contribute to the safe production and supply of recycled water but do not in themselves constitute control measures. Some will have been developed and put in place before the RWMP is completed, while others will be developed in conjunction with the RWMP.

Possible supporting programs are outlined in the paragraphs below. This is not a definitive list; supporting programs will change with the scope of the recycled water scheme.

Existing risk management programs—if existing programs are already in place they should form the basis of, and link with, any new programs being developed within the RWMP.

Agreements—these may be, for example, with users, suppliers or between entities in a multiple-entity critical scheme. For schemes with large numbers of users (for example dual reticulation schemes) agreements may take the form of product information sheets, which should be supplied to all users. Alternatively, the recycled water provider (or scheme manager where applicable) may wish to have individual agreements with each user (for example between the recycled water provider (or scheme manager where applicable) and the drinking water service provider responsible for a water storage receiving or to receive recycled water to augment the drinking water supply). Agreements with users may document the water quality supplied as well as the appropriate uses and onsite controls for this quality of water. Contractual arrangements may also assist to facilitate the relationship between entities in a multiple-entity scheme. Information on the content for agreements can be found in the *Manual for recycled water agreements in Queensland* on the DEWS website at <www.dews.qld.gov.au>.

Community involvement and awareness, media protocols and community information program—engagement with stakeholders such as local communities and other parties that are either affected by, or hold an interest in, a water recycling scheme is important to ensure their continued support. This program should identify all stakeholders and state the commitment of the organisation to appropriately engage these stakeholders. This should include evidence that stakeholders were appropriately engaged during the planning stages of the project. There should be a documented process for appropriately engaging stakeholders throughout the life of the recycled water scheme. This should link to the incident and emergency response plan, when communication to stakeholders is required.

Training and awareness programs—ongoing training programs should be available to improve and maintain staff proficiency through increased awareness, including the recycled water policy, hygiene, safety awareness and the consequences of plant failures, identification of process improvements and the minimisation of hazards and risks. Separate training packages should be provided for site visitors and contractors, which include hygiene and safety. Further details on training requirements are outlined in section 3.9.10 of these guidelines.

Maintenance and calibration—detailed descriptions, schedules and results for all plant equipment maintenance should be recorded and documented. Instrument calibration should be performed in a similar manner. Any external testing or maintenance of plant equipment and/or instrumentation should be performed by an accredited organisation and be documented.

Communications protocol— should incorporate how notification will be made to the regulator and other entities, in the case of a non compliance with water quality criteria or production or supply stoppages.

Research and development—monitoring programs focussed on research and development may assist the recycled water provider, or scheme manager where applicable, to identify unknown hazards and assess risks, ensuring their RWMP and treatment process remains as up to date as possible.

Additional supporting programs—could include source control via trade waste agreements or similar; monitoring programs, for example, source monitoring, operational monitoring and verification monitoring; control of hazardous chemicals such as those used in the production of recycled water and pest control.

Criteria for all schemes:

- The RWMP should include all the supporting programs for the scheme and list the associated documentation for each supporting program.
- The training and awareness program should document the existing skills and qualifications of operators who have responsibility for a particular process.
- The maintenance and calibration program should be signed off by an appropriately qualified person such as a registered professional engineer.

Criteria specific for critical schemes:

- The maintenance and calibration program should be signed off by a registered professional engineer.

3.9.10 Operator skills and training

A regulation may be made (section 586 of the Act) prescribing the qualifications or experience necessary for particular persons engaged in the production or supply of recycled water by a recycled water provider. This may include not only the recycled water provider but also includes employees, contractors or sub-contractors. It is the responsibility of the recycled water provider to employ or engage people who have the qualifications or experience prescribed under a regulation made under the Act (section 332 of the Act). There is currently no regulation in this regard. This section will be updated when regulations are in force.

3.9.11 Management review and continuous improvement

A regular review of the RWMP is required to ensure that it continues to accurately document the recycled water scheme. This also gives the opportunity for the RWMP to be improved over time. Under section 258 of the Act, the purpose of a regular review is to ensure the RWMP remains relevant with regard to:

- the operation of the scheme
- the water quality criteria for recycled water relevant to the scheme
- best practice industry standards for the production and supply of recycled water.

The frequency with which the regular review must be undertaken for the scheme will be set out in the information notice or notice of decision given at the time of approval of the RWMP. This frequency will be set at no less than 3 years for critical schemes or 5 years for other schemes.

The recycled water provider should also undertake their own reviews on a more frequent basis than this (that is, conduct their own ‘internal RWMP reviews’ which are responsive to certain triggers set out in the RWMP). Appropriate triggers for undertaking internal reviews may include significant scheme changes, an incident, emergency or an unscheduled stoppage of production.

Criteria for all schemes:

- The RWMP must have ongoing, regular reviews at the minimum frequency stated in the information notice or notice of decision (section 206 of the Act).
- The process for undertaking a regular review including matters to be considered should be documented.
- The regular review must address the matters in section 259 of the Act
- The regular review process should include a review of the risk assessment, monitoring frequency for each parameter and scheme description. The regulator may publish an information sheet on, or provide further guidance in the future, regarding regular review requirements.
- The RWMP should set out appropriate triggers for internal reviews. Triggers should include situations where the provider becomes aware of changes to the water quality criteria, significant scheme changes, an incident or emergency, an unscheduled stoppage of production or supply for example, other than those planned as a result of maintenance.

3.9.12 Internal auditing

Auditing is a form of verification of the performance of the scheme and is essential to ensure that compliance with the RWMP is maintained. The regulator will state (section 206 of Act) the intervals of internal audits of the RWMP in the notice of the decision or information notice for a decision to approve a RWMP.

Criteria for all schemes:

- There should be a procedure and schedule for internal auditing, which are included as supporting documents to the RWMP.
- The systems, processes or procedures to be audited should be scheduled according to their risk. The audit schedule should be responsive to failed audit results.
- Audit results should be documented and retained according to document control procedures.
- An audit report must be written in accordance with the *Audit and annual reporting guidelines*¹⁴.

Criteria specific to multiple–entity critical schemes:

- There should be a procedure for internally auditing the scheme as a whole in addition to the internal auditing of each entity’s compliance with their approved plan and conditions.

¹⁴ The Audit and annual reporting guidelines are being developed and will be made available when complete

4. Validation program

A validation program documents how the plant and equipment used for treating recycled water under the scheme will be tested to show the quality of the recycled water consistently meets the water quality criteria for recycled water relevant to the scheme.

4.1 How is assessment of the validation program for a recycled water scheme undertaken?

For schemes supplying recycled water for purposes other than augmenting a drinking water supply, consideration of the validation program and the results of the validation program take place as part of the assessment process of the RWMP. However, entities are encouraged to contact the regulator to discuss validation of their schemes prior to preparing a RWMP to ensure that the validation program will be adequate and appropriate.

For schemes supplying recycled water to augment a drinking water supply, the Act contains specific provisions for approving and amending a validation program (sections 235–242 of the Act¹⁵). The validation program should provide evidence of the effectiveness of the receiving water source as a barrier enabling management of any risk to the public of any public health

Attachments 1 and 2 in section 7 outline the differences between validation programs for schemes augmenting drinking water supplies and other schemes.

4.2 Who has to prepare the validation program?

If the scheme is a single-entity recycled water scheme, the recycled water provider must prepare the validation program.

If the scheme is a multiple-entity scheme, the scheme manager and each recycled water provider must prepare a validation program. In this case the scheme manager is responsible for submitting the validation program (comprising the scheme manager validation program and the individual provider validation programs) for approval by the regulator.

4.3 Who has to apply for approval of the validation program for schemes augmenting drinking water supplies?

The recycled water provider, for a single-entity recycled water scheme, and a scheme manager for a multiple-entity scheme must submit the validation program for approval by the regulator.

The application must be in the approved form, accompanied by a copy of the validation program and the fee¹⁶ prescribed under regulation. The regulator may seek additional information about a validation program.

4.4 How is the validation program for schemes augmenting drinking water supplies assessed by the regulator?

When considering the validation program, the regulator must have regard to:

- the validation program; and
- any additional information from the recycled water provider or scheme manager, refer section 238 of the Act; and
- these guidelines; and

¹⁵ Consideration of the results of the validation program are included in the RWMP submitted to the regulator for approval.

¹⁶ Currently there is no prescribed fee for an application for approval of a validation program.

- any advice received by the regulator from an advisory council or any other entity the regulator considers appropriate; and
- relevant water quality criteria for the recycled water.

Within 10 business days the regulator must decide to (refer section 241 of the Act):

- approve the validation program without conditions and issue a notice of the decision; or
- approve the validation program with conditions and issue an information notice; or
- refuse to approve the validation program and issue an information notice.

An information notice gives the applicant the right to seek internal review of the decision and an applicant may appeal to the relevant court if they disagree with the review decision.

The recycled water provider for a single-entity recycled water scheme and the scheme manager for a multiple-entity scheme may amend a validation program for a recycled water scheme by applying to the regulator for approval to amend. The process to amend the program is the same process applicable to applying for approval of a validation program for the scheme in the first instance.

Note: The evidence of the effectiveness of the receiving water source as a barrier should be submitted with the validation program. Refer section 3.8.5.

5. Process for approval of a RWMP

5.1 Who must apply for approval of a RWMP?

For a single-entity scheme, the recycled water provider must apply to the regulator for approval of the RWMP for the scheme (section 202 of the Act).

For a multiple-entity scheme, the scheme manager must apply to the regulator for approval of the RWMP for the scheme (section 202 of the Act). As mentioned previously, the RWMP for a multiple-entity scheme comprises the scheme manager plan and a scheme provider plan for each declared entity for the scheme. While the scheme manager and declared entities must prepare their individual plans, the scheme manager is the only one who can submit the RWMP to the regulator for approval (sections 201–202 of the Act).

An application for approval of a RWMP must be in the approved form accompanied by a copy of the RWMP and the fee¹⁷ prescribed under regulation (section 202 of the Act).

Note: For a RWMP for a scheme supplying recycled water to augment a drinking water supply, the regulator will not:

- assess a RWMP, unless a validation program has been previously approved by the regulator (section 205 of the Act);
- approve a RWMP, unless there is an approved drinking water quality management plan for the water storage, if the supply of the recycled water is into a water storage of a drinking water service provider.

5.2 What is the assessment process for a RWMP?

5.2.1 What does the regulator consider when approving the RWMP?

The RWMP is assessed and approved by the regulator (section 205 of the Act). In assessing the RWMP the regulator must have regard to:

- the RWMP
- additional information supplied by the recycled water provider to the regulator under section 203 of the Act¹⁸
- these guidelines
- the relevant water quality criteria
- information obtained under section 204 by the regulator from an advisory council or any other entity that the regulator considers appropriate
- the approved validation program for schemes supplying recycled water to augment a drinking water supply.

The regulator may also have regard to other matters that advance the public health objectives of the *Water Supply (Safety and Reliability) Act 2008*. For example, during assessment, the DWQMP for the water storage, the DWQMP for any drinking water treatment plants taking water directly from the water storage and the RWMP for the scheme, will be considered collectively to ensure that public health risks across the seven barriers can be adequately managed.

¹⁷ Currently there is no prescribed fee for an application for a RWMP.

¹⁸ The regulator may request a variety of different types of additional information where needed to assist them in making a decision regarding the application. This may include information about arrangements relating to the supply of recycled water under the scheme or the intended use of the recycled water. This assists the regulator in having a level of confidence that the recycled water being supplied and the use of the recycled water are appropriate. Any information requested by the regulator under section 203 of the Act may be subject to a request to be verified by statutory declaration.

The timeframes for a decision by the regulator about an application made to approve a properly made RWMP are as follows:

- if a request for additional information has not been made in relation to the RWMP—within 80 business days of receiving the RWMP
- if a request for additional information is made in relation to the RWMP—within 80 business days after the information has been provided.

5.2.2 What decisions can the regulator make?

Following consideration of the application, the regulator must make a decision about the application (section 206 of the Act) to either:

- approve the RWMP
- approve the RWMP with regulator conditions
- refuse to approve the RWMP.

The regulator must provide the applicant with a notice of the regulator's decision within 10 business days of making the decision. If the RWMP is approved without regulator conditions, the regulator must give the applicant a written notice of the decision. If the RWMP is approved with regulator conditions or the regulator refuses to approve the plan, the regulator must give the applicant an information notice.

If a RWMP is approved by the regulator, the notice of the decision or information notice will state for the RWMP for the scheme the intervals at which:

- regular reviews of the RWMP must be conducted (not less than three years for a critical scheme, or otherwise not less than five years)
- internal audits must be conducted (not less than two years)
- regular audits (conducted by an external third party) must be conducted (as determined by the regulator).

If the RWMP is refused by the regulator or the applicant disagrees with the regulator conditions stated on an information notice, the applicant may appeal the decision. Refer to Chapter 7, Parts 1, 2 and 3 of the Act for further details about internal reviews and appeals of the regulator's decision.

Note: All approved RWMPs will be subject to certain statutory conditions (section 208 of the Act) requiring that:

- notice be given to the regulator as soon as practicable by the recycled water provider or other declared entity (or scheme manager where applicable), if production or supply of recycled water under the recycled water scheme stops, or is intended to be stopped, other than as provided for under the approved RWMP for the scheme or on a permanent basis
- supply of recycled water must stop to a particular entity under a scheme, if a recycled water provider, or other declared entity becomes aware that the entity is using the recycled water other than in a way or for a purpose provided for under the RWMP.

5.3 Are there additional requirements for schemes which supply recycled water for augmenting a drinking water supply?

There are additional requirements for schemes which supply recycled water to augment a drinking water supply (section 207 of the Act). Before a RWMP can be approved, the following requirements must be met:

- obtaining approval from the regulator of a validation program (additional information on validation programs for schemes which supply recycled water to augment a drinking water supply has been provided in section 4 of these guidelines).

- obtaining approval from the regulator of a DWQMP for the storage (for example, the dam, that will receive the recycled water). Refer to the section 3.8.5 of this guideline for further information.

DWQMP's for any drinking water treatment plants taking water directly from a water storage containing recycled water, must be approved prior to recycled water being supplied into the water storage.

The regulator may also have regard to other matters that advance the public health objectives of the Act. For example, during assessment, the DWQMP for the water storage, the DWQMP for any drinking water treatment plants taking water directly from the water storage and the RWMP for the scheme, will be considered collectively to ensure that public health risks across the seven barriers can be adequately managed.

5.4 Can an approved RWMP be amended?

There are different types of amendments to a RWMP including:

- **an amendment requested by the recycled water provider (single scheme) or scheme manager (multiple-entity scheme)** (section 212 of the Act). The relevant entity can apply for the plan to be amended other than under section 209 to 211.

Note: This type of amendment is subject to the detailed considerations undertaken by the regulator outlined in section 5.2 of this guideline, for example, the regulator can seek additional information, seek advice from another entity or consider compliance with relevant guidelines or water quality criteria.

- **minor amendments by agreement (section 209 of the Act)**. The relevant entity may, with the regulator's agreement, amend the approved RWMP for the relevant scheme, if the amendment is only to:
 - correct a minor error in the plan
 - make another change that is not a change of substance
 - record a change of name or change of ownership in an entity that is part of a scheme.

Note: A minor amendment of a RWMP is not subject to the detailed consideration undertaken by the regulator for assessing a RWMP, as outlined in section 5.2 of this guideline.

- **an amendment instigated by the regulator to an approved RWMP for a single-entity recycled water scheme (section 210 of the Act)**. The regulator may require the provider to amend the RWMP if it is satisfied an amendment is required:
 - to protect public health
 - if the scheme is a critical recycled water scheme, to ensure the continuity of operation of the scheme.
- **an amendment instigated by the regulator to an approved RWMP for a multiple-entity critical recycled water scheme (section 211 of the Act)**. The regulator has the ability to instigate an amendment to an approved RWMP for a multiple-entity recycled water scheme comprising the scheme manager plan and scheme provider plans if satisfied an amendment is required to:
 - protect public health
 - ensure the continuity of operation of the scheme.

Note: Regulator instigated amendments under sections 210 and 211 of the Act, are subject to a show cause process before the regulator's amendment to the plan is required. This allows the recycled water provider (or scheme manager in a multiple-entity critical scheme) to make submissions to the regulator about the proposed amendments. If, after considering properly made submissions, the regulator is still satisfied that the amendments should be made, the regulator will give the provider a notice requiring the provider to amend the plan in the stated way within a stated timeframe. This summary does not contain all of the Act requirements and providers should refer to sections 210 and 211 of the Act for full details.

5.5 How long does an approved RWMP last?

RWMPs do not have a specified expiry date. However other provisions may apply.

For example, the regulator may suspend or cancel a RWMP if the regulator is satisfied or reasonably believes the recycled water provider, scheme manager or other declared entity for a recycled water scheme ('responsible entity') to which the plan relates has not complied with the RWMP, or the conditions of the RWMP, or a compliance notice (section 213 of the Act).

If the regulator intends to suspend or cancel a RWMP, the regulator must give a show cause notice about the proposed action. Copies of the show cause notice must be given to each of the entities in the scheme. The regulator must consider all properly made submissions before making a decision to either suspend or cancel the plan. A responsible entity that receives a copy of a show cause notice may make a submission in relation to the notice.

If after giving a show cause notice about suspending or cancelling a RWMP and after considering all properly made submissions the regulator decides to suspend or cancel the RWMP, the regulator must within 10 business days after making the decision give an information notice to:

- for a single-entity scheme, the recycled water provider
- for a multiple-entity scheme, the scheme manager.

If after considering any properly made submissions the regulator decides not to suspend or cancel a plan, the regulator must within 10 business days after making the decision give a notice to:

- for a single-entity scheme, the recycled water provider
- for a multiple-entity scheme, the scheme manager that the suspension or cancellation will not take place.

Note: If a plan is suspended, the suspension ends only when the resumption of supply of recycled water under the recycled water scheme to which the plan relates is taken to be approved by the regulator. Applications for resumption of supply are made under section 215 of the Act.

The regulator may also suspend the RWMP for a scheme if the regulator has received a notice that the production or supply of recycled water under the scheme has temporarily stopped (section 214 of the Act).

The Act requires that notice be given to the regulator when unplanned or unscheduled stoppages not covered under the approved RWMP, occur. Notice of the unplanned stoppage gives the regulator the option of suspending the plan if appropriate in the circumstances. It is likely that a plan would be suspended if, for example, both production and supply of recycled water was stopped for an extended period.

Suspending a plan enables the regulator to require that the scheme be validated before approving the resumption of supply of recycled water under the scheme. If supply of the recycled water ceased because of the loss of a major customer but the treatment plant continued to operate, it is unlikely that the plan for the scheme would need to be suspended.

Note: If a plan is suspended, the recycled water provider for a single-entity scheme, or the scheme manager for a multiple-entity scheme must obtain approval from the regulator to recommence supply.

5.6 If a RWMP is suspended, what process is followed to recommence supply?

If a RWMP has been suspended, the regulator may give approval for the resumption of supply of recycled water under the scheme following an application to the regulator (section 215 of the Act). The application must be in the approved form, be accompanied by enough information to enable the regulator to decide the application and be accompanied by the fee¹⁹ prescribed under a regulation.

After considering an application and any information the regulator considers relevant to the application, the regulator must, as soon as practicable, decide to:

- approve the application without conditions; or
- approve the application on the condition that:
 - the scheme be ‘validated’ by undertaking the validation program for the scheme; and
 - testing of the plant and equipment under the program shows the quality of the scheme’s recycled water consistently meets the relevant water quality criteria for the scheme – and that the relevant entity for the scheme (that is, a recycled water provider in a single entity scheme, or a scheme manager for a multiple entity scheme) gives evidence satisfactory to the regulator; or
- refuse to approve the application and direct the scheme manager (for a multiple entity scheme) or a recycled water provider (for a single entity scheme) to amend the recycled water management plan (or in the case of a multiple entity scheme, any of the scheme manager plan or any of the scheme provider plans) in the way the regulator considers appropriate – and to apply to the regulator for approval of the amendment; or
- refuse to approve the application.

The regulator must notify the recycled water provider for a single-entity scheme and the scheme manager for a multiple-entity scheme of the decision within 10 business days after deciding the application.

If an application is approved without conditions, the regulator must give a notice of the decision.

If an application is approved with conditions or refused, the regulator must give an information notice.

An information notice gives the applicant the right to appeal the decision.

The resumption of supply of recycled water under the recycled water scheme is taken to be approved at the following stated times:

- when the notice of the decision is given to the relevant entity – where the application was approved without conditions; or
- when the regulator gives the relevant entity a notice that it is satisfied with the relevant evidence provided – where the application was approved on the condition that (1) the validation program be undertaken, (2) the testing of plant and equipment under the program shows that the quality of the scheme’s recycled water consistently meets the water quality criteria relevant to the scheme and (3) the relevant entity gives the regulator satisfactory evidence of the previously mentioned testing; or
- when the amended plan for the scheme is approved – where the application was refused under the circumstances where the regulator directed an entity under section 215(4)(d) of the Act, or directed a recycled water provider under section 215(4)(c) of the Act to amend a plan and to apply for approval of the amended plan.

¹⁹ Currently there is no prescribed fee for an application for resuming supply.

5.7 What happens if the supply of the recycled water needs to cease permanently?

The scheme manager, recycled water provider and other declared entities have an obligation to give the regulator notice if they propose that the supply of recycled water under the scheme will permanently stop, and in relation to a critical recycled water scheme, there is no other entity willing to take over the operation of all or part of the scheme (section 230 of the Act).

If the recycled water scheme is not a critical recycled water scheme, the notice to the regulator must be given at least 30 days before supply of the recycled water is proposed to stop, unless the provider has a reasonable excuse for not giving notice.

If the recycled water scheme is a critical recycled water scheme, the notice to the regulator must be given at least 60 days before supply of the recycled water is proposed to stop unless the recycled water provider for a single-entity scheme or the scheme manager for a multiple-entity scheme has a reasonable excuse for not giving notice. There is a significant maximum penalty for non compliance. Longer timeframes apply for critical recycled water schemes to enable the regulator to consider the potential need to take action to ensure the continuity of operation of a critical recycled water scheme. The regulator or another person authorised by the regulator, may be given authority to take over operation of certain infrastructure in a critical scheme to ensure the continued operation of the scheme.

Notice of the entities intention to cease supply must be submitted in the approved form and state the date by which supply of recycled water is proposed to stop. The regulator may request additional information about the notice or require any information in the notice or additional information to be verified by statutory declaration. Failure to supply the additional information or verification of information without a reasonable excuse and within the reasonable timeframe stated in the notice, renders the notice given by the entity void, that is, the notice ceases to have effect. Additionally, if supply continues after the date stated in the notice by the entity, the notice of intention to cease supply ceases to have effect.

Once supply under the scheme actually stops, the entity must give the regulator notice of the stoppage within five days after supply actually stops. This notice must be in the approved form and state the day on which the supply of recycled water actually stopped. The regulator may cancel a RWMP if the regulator has received a notice that the supply of recycled water under a scheme has permanently stopped.

5.8 What happens if the relevant water quality criteria are not met?

Once a RWMP is approved, section 270 of the Act requires a recycled water provider, other declared entity or the scheme manager (where applicable), to undertake certain notifications to the regulator where they become aware of a non-compliance. The non-compliance refers to non-compliance with the recycled water management plan to the extent that the water's quality under the plan must be consistent with any water quality criteria for recycled water.

Notification must be given to the regulator which provides the details of the non compliance, and the circumstances that give rise to the non-compliance.

The notification must be made to the regulator immediately unless there is a reasonable excuse. There is a significant penalty for non-compliance with this requirement of the Act. If the notice is given orally, the responsible entity should give the regulator notice of the information in the approved form as soon as practicable. This form is available online at <www.dews.qld.gov.au>.

It is not a reasonable excuse for the responsible entity to fail to give the relevant information to the regulator on the grounds that notification might tend to incriminate the entity. However, if the responsible entity is an individual, evidence of, or evidence directly or indirectly derived from, the relevant information that might tend to incriminate the entity is not admissible in evidence against the entity in a civil or criminal proceeding, other than a proceeding for an offence about the falsity of the information.

6. Glossary

Term	Meaning
AGWR	The <i>Australian Guidelines for Water Recycling: Managing Health and Environmental Risks: Phase 1</i> (2008) or the <i>Australian Guidelines for Water Recycling Phase 2: Augmentation of Drinking Water Supplies</i> .
Approved recycled water management plan	A recycled water management plan approved by the regulator and not suspended or cancelled, under Chapter 3 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
AS/NZS	Australian Standards/New Zealand Standards.
<i>Audit and annual reporting guidelines</i>	The guidelines issued by the regulator under section 571(1)(l) and (m) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Commissioning verification	A type of validation, but is distinct from other validation methods, because it is done by testing the end product water. This is performed to prove that the expected water quality is being consistently produced.
Conditions	(a) of an approved recycled water management plan, means— (i) any regulator conditions for the plan; or (ii) a condition mentioned in section 208(2), (3), (5) or (6) of the <i>Water Supply (Safety and Reliability) Act 2008</i> that applies to the plan; and (b) of an exemption, means— (i) any regulator conditions for the exemption; or (ii) the condition mentioned in section 256(1) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Control measure (preventive measure)	Any action or activity that can be used to prevent, eliminate or reduce a hazard to an acceptable level.
Corrective actions	Corrective actions are those taken immediately to prevent hazards from reaching end users for example, actions taken following non-compliance with water quality criteria.
Critical Control Point (CCP)	A point, step or procedure at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level.
Critical recycled water scheme	A recycled water scheme declared to be a critical recycled water scheme under Chapter 3 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Declared entity	A multiple–entity critical scheme means each recycled water provider and other entity, other than the scheme manager for the scheme, declared to be part of the scheme under Chapter 3, Part 8 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Directions	A direction given under sections 435–436 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .

Term	Meaning
Dual reticulation	As defined in the <i>Public Health Regulation 2005, s18AB</i> . Note this definition contains the term ‘domestic uses’. It is the department’s policy that the interpretation of the words ‘domestic uses’ as it applies to recycled water only includes non drinking and non bathing water purposes such as toilet flushing, cold water laundry tap and external use for wash down and irrigation of lawns and gardens. For clarity this interpretation means that each of these domestic uses of recycled water, even if they are applied in a commercial premises, would be captured as dual reticulation. For example, toilet flushing (which is a domestic use) in a commercial premises. The department does not consider ‘domestic uses’ of recycled water to include those uses that require drinking water quality such as cooking or bathing.
Exceedance	Water quality that goes outside identified limits. These limits may include alert levels, critical limits or water quality criteria.
Exemption	Means an exemption granted under Chapter 3 Part 5 of the <i>Water Supply (Safety and Reliability) Act 2008</i>
Greywater	Wastewater from a bath, basin, laundry or shower, whether or not the wastewater is contaminated with human waste.
HACCP	Hazard Analysis and Critical Control Point.
Hazard	A biological, chemical or physical agent in, or condition of, recycled water with the potential to cause an adverse health effect.
Hazardous event	A hazardous event is the result of a hazard or one that can lead to the presence of a hazard.
Heavily processed food crops	Includes but is not limited to those crops that are heavily processed before consumption, for example sugar cane, cocoa, cereal crops such as wheat, rice and corn grown for flour production and crops grown for oil production such as sunflower, canola and flax seed.
Industry code or best practice management document	A published standard by a body that the regulator considers to be a recognised industry body.
Influent	Liquid waste flowing into a recycled water provider’s treatment facility.
Minimally processed food crops	As defined in the <i>Public Health Regulation 2005</i> , includes carrot ,onion, pumpkin, rockmelon, broccoli, cabbage, tomato, avocado, banana, mango, apple, olive, peach, herbs and lettuce
Multiple–entity recycled water scheme	A scheme involving the production and supply of recycled water by more than one recycled water provider, or at least one recycled water provider and another entity, and includes— <ul style="list-style-type: none"> • each recycled water provider and other entity declared to be part of the scheme under a declaration for the scheme made under Chapter 3,Part 8 of the <i>Water Supply (Safety and Reliability) Act 2008</i> • the infrastructure for the production and supply of the water stated to be part of the scheme under the declaration.
NATA	National Association of Testing Authorities.
Non–conformance	An internal situation whereby a deviation from the acceptable criteria has occurred.

Term	Meaning
Non-critical scheme	A scheme which has not been declared by the regulator as critical under section 304 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
DEWS	The Department of Energy and Water Supply.
Operational monitoring	The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a critical control point (CCP) is reliable and robust.
Point of supply	In relation to water quality criteria means, where possible, the physical point of transfer to the user. There are instances where this is not practical and will not accurately represent the water quality of the scheme. It is in these instances that the recycled water provider (or scheme manager where relevant) should discuss with the regulator options for monitoring points and the point of application of water quality criteria.
Preventive actions	Actions taken to investigate the cause of a non-conformance or non-compliance and prevent it from happening again.
Public open spaces	Any open space, such as parks, sporting fields, botanical gardens, racecourses, school ovals, municipal parks and gardens, golf courses, footpaths, car parks, road verges or where either members of the public, staff or employees may be exposed to recycled water. It does not include gardens in domestic residences, nor agricultural farmland.
Receiving water source	Means the water bodies listed in section 18AD(1)(d) of the <i>Public Health Regulation 2005</i> .
Recycled water	Any of the following that are intended to be reused— <ul style="list-style-type: none"> • sewage or effluent sourced from a service provider’s sewerage • greywater sourced from a large greywater treatment plant within the meaning of the Plumbing and Drainage Act 2002 • wastewater, other than water mentioned in the previous two dot points
Recycled Water Management Plan (RWMP)	For a single-entity recycled water scheme—a plan about the production and supply of recycled water under the scheme by the recycled water provider for the scheme. For a multiple-entity recycled water scheme—a plan about the production and supply of recycled water under the scheme consisting of a scheme manager plan and a scheme provider plan for each declared entity in the scheme.
<i>Recycled water management plan and validation guidelines</i>	The guidelines issued by the regulator under section 571(1)(i) and (j) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
<i>Recycled water management plan exemption guidelines</i>	The guidelines issued by the regulator under section 571(1)(k) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Recycled water provider	An entity that: <ul style="list-style-type: none"> • owns infrastructure for the production and supply of recycled water; or • another entity, prescribed under a regulation, that owns

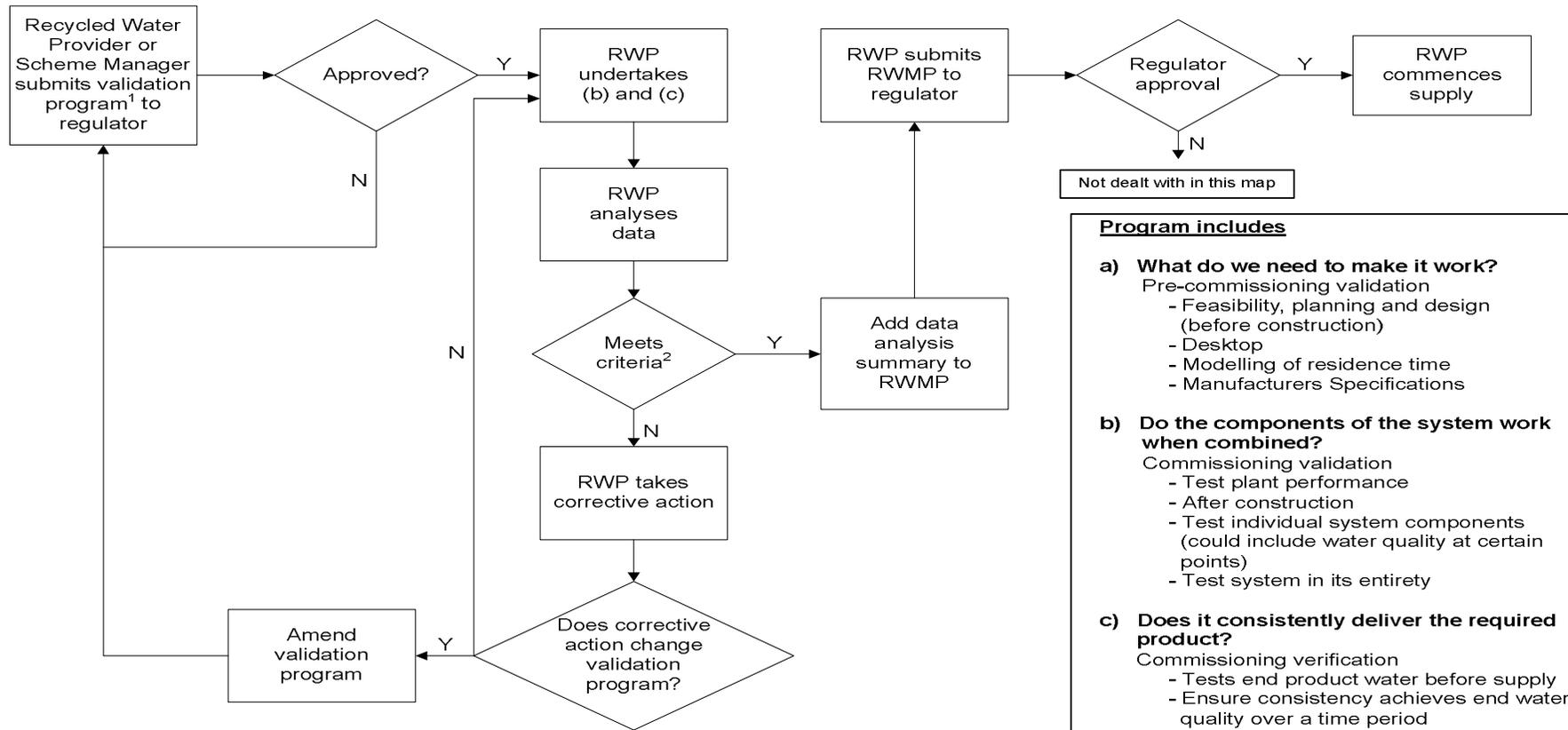
Term	Meaning
	infrastructure for the supply of recycled water.
Recycled water scheme	A single-entity or a multiple-entity recycled water scheme.
Regulator	The chief executive of the Department of Energy and Water Supply (DEWS).
Regulator conditions	(a) for an approved recycled water management plan—see section 205(1) of the <i>Water Supply (Safety and Reliability) Act 2008</i> (b) for an exemption—see section 253(1) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Reused	Includes being treated to improve the water’s quality, but does not include merely being discharged into, or disposed of in, the environment.
Risk	The likelihood that identified hazards will cause harm in exposed populations including the magnitude of that harm (risk = likelihood x impact).
Scheme manager	The scheme manager for a multiple-entity recycled water scheme is the entity: (a) the recycled water providers and other entities declared to be part of the scheme agree is the scheme manager for the scheme; and (b) either— (i) stated in the declaration under Chapter 3, Part 8 of the <i>Water Supply (Safety and Reliability) Act 2008</i> for the scheme to be the scheme manager; or (ii) stated in the notice given under section 307(2) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Scheme manager plan	For a multiple-entity recycled water scheme, means a plan about the how the scheme manager for the scheme is to coordinate management of the scheme to ensure the continued operation of the scheme.
Scheme provider plan	For a multiple-entity recycled water scheme, means a plan about the production or supply of recycled water under the scheme by a recycled water provider or other declared entity for the scheme.
Service provider	<ul style="list-style-type: none"> • A local government that owns infrastructure for supplying water or sewerage services • A water authority that owns infrastructure for supplying water or sewerage services • Each person who is: <ul style="list-style-type: none"> – the owner of one or more elements of infrastructure for supplying water or sewerage services for which a charge is intended to be made; or – a person nominated in a regulation, under the <i>Water Supply (Safety and Reliability) Act 2008</i> as a related entity of a person who is the owner of one or more elements of infrastructure for supplying water or sewerage services for which a charge is intended to be made. • A service provider does not include a service supplied by infrastructure, if: <ul style="list-style-type: none"> – the infrastructure is used solely for mining purposes – the service is used only by:

Term	Meaning
	<ul style="list-style-type: none"> ○ the owner of the infrastructure or the owner’s guests or employees, including, for example, guests at a resort; or the owner of the infrastructure who is a body corporate for a community titles scheme under the <i>Body Corporate and Community Management Act 1997</i>—the occupants of lots in the scheme.
Sewage	Household and commercial wastewater that contains, or may contain, faecal, urinary or other human waste.
Sewerage	A sewer, access chamber, vent, engine, pump, structure, machinery, outfall or other work used to receive, store, transport or treat sewage.
Single–entity recycled water scheme	A scheme involving the production and supply of recycled water by only one recycled water provider, and includes, if the provider owns infrastructure for the supply, or the production and supply, of the water—the infrastructure.
Source water	Any water destined for further use. This includes but is not limited to sewage, for treatment at a wastewater treatment plant, and treated sewage, for further treatment at an advanced wastewater treatment plant.
Spot audit	An audit conducted under section 262 of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Statutory condition	Any conditions imposed under section 208 of the <i>Water Supply (Safety and Reliability) Act 2008</i> for a recycled water management plan or section 256 of that Act for an exemption.
Step–in powers	The powers of the regulator under section 535 of the <i>Water Supply (Safety and Reliability) Act 2008</i> , or another person appointed by the regulator, to operate a recycled water provider’s infrastructure.
Supply	<p>In relation to recycled water, means—</p> <ul style="list-style-type: none"> (a) for greywater, sewage or effluent that is recycled water— <ul style="list-style-type: none"> (i) reuse of the recycled water by the entity that produces it; or (ii) supply of the recycled water, by the entity that produces it, to another entity for reuse; or (b) for other recycled water—supply of the recycled water, by the entity that produces it (the producer), to another entity for reuse, other than another entity prescribed under a regulation as a related entity of the producer.
Supporting programs	The many actions that contribute to the safe production and supply of recycled water but do not in themselves constitute control measures.
Transitional period	The transitional periods stipulated under Chapter 9, Part 5 of the <i>Water Supply (Safety and Reliability) Act 2008</i> , by which the recycled water provider must comply with the Act, and either have an approved RWMP or an exemption granted by the regulator or cease supply.
Treated effluent	Sewage that has been treated.
Validate	To carry out testing of the plant or equipment used for the treatment of recycled water under the scheme to show the quality of the recycled water consistently meets the water quality criteria for recycled water relevant to the scheme.

Term	Meaning
Validation program	A documented program about how the plant or equipment used for the treatment of recycled water under the scheme are to be tested to show the quality of the recycled water consistently meets the water quality criteria for recycled water relevant to the scheme.
Wastewater	Wastewater as defined in the <i>Water Supply (Safety and Reliability) Act 2008</i> as the spent or used water generated on premises from industrial, commercial or manufacturing activities, or animal husbandry activities prescribed under a regulation, other than spent or used water generated from an agricultural activity or a mining activity or petroleum activity.
Water quality criteria	<p>(i) the standards for the quality of recycled water, relating to the sources and uses of the water, prescribed in a regulation under the <i>Public Health Act 2005</i>;</p> <p>(ii) the criteria for the quality of recycled water, relating to the sources and uses of the water—</p> <p style="padding-left: 40px;">(A) stated in a guideline, if any, made by the regulator about the quality of recycled water; or</p> <p style="padding-left: 40px;">(B) in relation to the quality of recycled water to which a recycled water management plan or an exemption relates—stated in a regulator condition for the plan or exemption.</p>
<i>Water quality guidelines for recycled water schemes</i>	The guidelines prescribed by the regulator under section 571(1)(h) of the <i>Water Supply (Safety and Reliability) Act 2008</i> .
Water service provider	A person registered under Chapter 2, Part 3, of the <i>Water Supply (Safety and Reliability) Act 2008</i> , as a service provider for a water service.

7. Attachments

Validation Program for Recycled Water Schemes supplying recycled water to augment Drinking Water Supplies ATTACHMENT 1

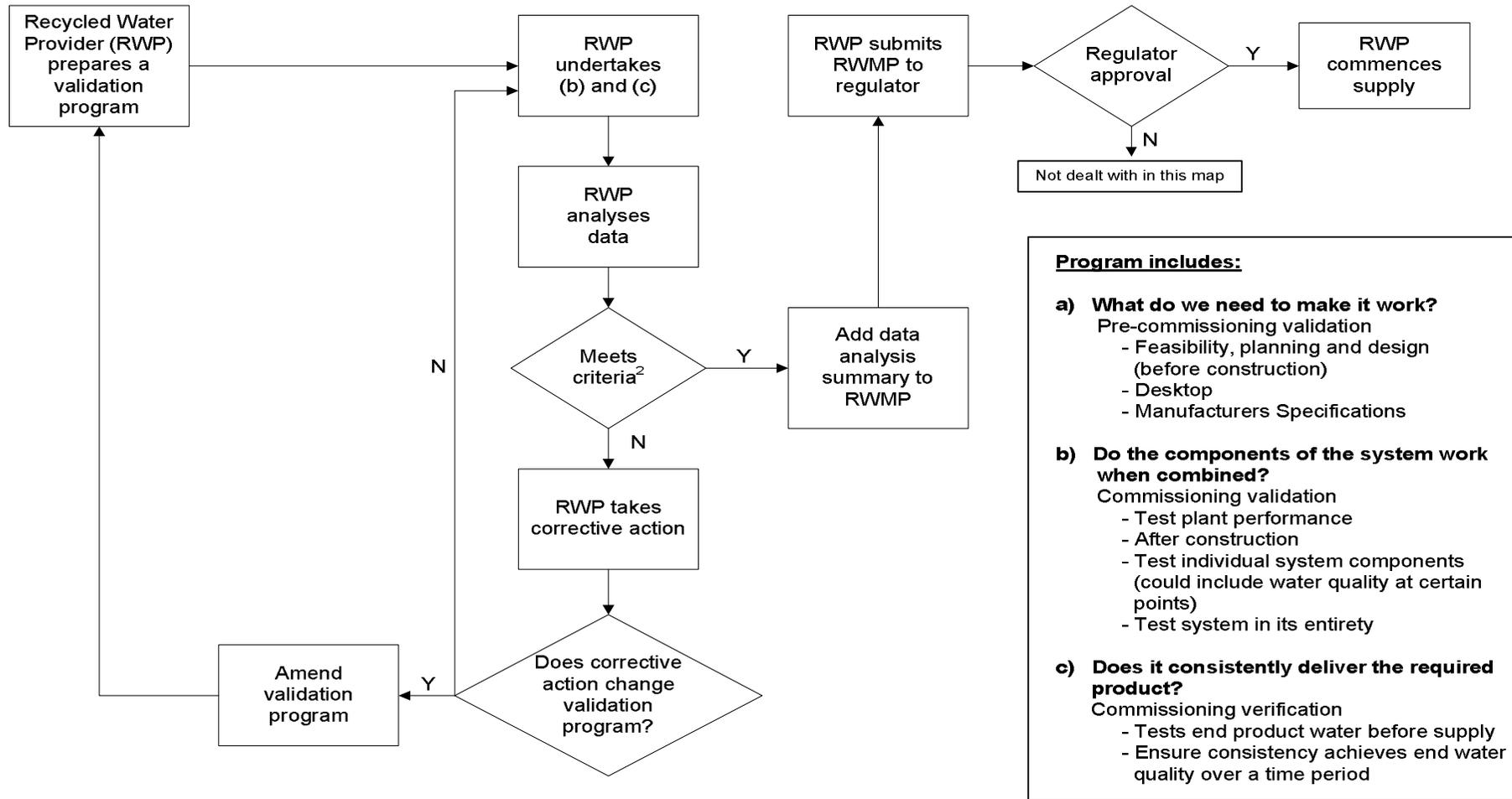


¹ Validation Program includes specific details on pre-commissioning validation (a) and proposal for undertaking commissioning validation (b) and commissioning verification (c)

² To be prescribed in the Public Health Regulation 2005, NRW Water Quality Guidelines for Recycled Water Schemes.

³ Note that the above diagram does not represent all application scenarios

Validation Program for All Other Recycled Water Schemes



1 Validation Program includes specific details on pre-commissioning validation (a) and proposal for undertaking commissioning validation (b) and commissioning verification (c)

2 To be prescribed in the Public Health Regulation 2005, NRW Water Quality Guidelines for Recycled Water Schemes or other approved guidelines, codes of practice, etc.

3 Note that the above diagram does not represent all application scenarios

8. Appendix

Examples of surrogates and indicators for advanced water treatment processes (Information in this table is taken from the Drewes et al., 2008).

Δ denotes change in the concentration of chemical or measurement

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
Ozone	Δ UV absorbance (254 nm)	S	• Oxidation performance
	Δ Color (436 nm)	S	
	Contact time (C * t)	S	
Ozone	Δ Atenolol	I	• Compounds with a >90% removal using ozone under the following conditions: tertiary treated recycled water with TOC<10 mg/L; C*t > 26 mg min/L
	Δ Atorvastatin, Δ o-Hydroxy atorvastatin, Δ p- Hydroxy atorvastatin	I	
	Δ Benzophenone	I	
	Δ Benzyl acetate	I	
	Δ Benzyl salicylate	I	
	Δ Bucinal	I	
	Δ Butylated hydroxyanisole	I	
	Δ Caffeine	I	
	Δ Carbamazepine	I	
	Δ Ciprofloxacin	I	
	Δ DEET	I	
	Δ Diclofenac	I	
	Δ Dilantin	I	
	Δ Erythromycin-H ₂ O	I	
	Δ Estriol	I	
	Δ Estrone	I	
	Δ Fluoxetine	I	
	Δ Galaxolide	I	
	Δ Gemfibrozil	I	
	Δ Hexyl salicylate	I	
	Δ Hexylcinnamaldehyde	I	
	Δ Hydrocodone	I	
	Δ Ibuprofen	I	
Δ Isobutylparaben	I		
Δ Ketoprofen	I		
Δ Methyl salicylate	I		

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
	Δ Metoprolol	I	
	Δ Naproxen	I	
	Δ Nonylphenol	I	
	Δ Norfluoxetine	I	
	Δ Ofloxacin	I	
	Δ Paracetamol	I	
	Δ Phenylphenol	I	
	Δ Primidone	I	
	Δ Propranolol	I	
	Δ Propylparaben	I	
	Δ Salicylic acid	I	
	Δ Sulfamethoxazole	I	
	Δ Tonalide	I	
	Δ Triclocarban	I	
	Δ Triclosan	I	
	Δ Trimethoprim	I	
Ozone	Δ Acetyl cedrene	I	<ul style="list-style-type: none"> Compounds with a 90 - 50% removal using ozone under the following conditions: tertiary treated recycled water with TOC<10 mg/L; C*t > 26 mg min/L
	Δ Bisphenol A	I	
	Δ Indolebutyric acid	I	
	Δ Iopromide	I	
	Δ Isobornyl acetate	I	
	Δ Meprobamate	I	
	Δ Methyl dehydrojasmonate	I	
	Δ Methyl ionine	I	
	Δ Musk ketone	I	
	Δ Musk xylene	I	
	Δ OTNE	I	
	Δ Simvastatin hydroxy acid	I	
	Δ Terpeneol	I	
Ozone	Δ NDMA	I	<ul style="list-style-type: none"> Compounds with 50 - 25% removal using ozone under the following conditions: tertiary treated recycled water with TOC<10 mg/L; C*t > 26 mg min/L
	Δ Vanillin	I	

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
Ozone	Δ TCEP	I	<ul style="list-style-type: none"> Compounds with <25% removal using ozone under the following conditions: tertiary treated recycled water with TOC<10 mg/L; C*t > 26 mg min/L
	Δ Chloroform	I	
	Δ EDTA	I	
	Δ TCPP	I	
	Δ TDCPP	I	
Advanced Oxidation	Δ UV absorbance (254 nm)	S	<ul style="list-style-type: none"> Oxidation performance
	Δ Color (436 nm)	S	
Ozone with H₂O₂	Δ Acetyl cedrene	I	<ul style="list-style-type: none"> Compounds with >90% removal using AO under the following conditions: RO treated water; 7 mg/L ozone; 3.5 mg/L H₂O₂; 2 minute contact time.
	Δ Atenolol	I	
	Δ Atorvastatin (including o-hydroxy-atorvastatin and p-hydroxy-atorvastatin)	I	
	Δ Benzophenone	I	
	Δ Benzyl acetate	I	
	Δ Benzyl salicylate	I	
	Δ Bucinal	I	
	Δ Butylated hydroxyanisole	I	
	Δ Caffeine	I	
	Δ Carbamazepine	I	
	Δ Ciprofloxacin	I	
	Δ DEET	I	
	Δ Diclofenac	I	
	Δ Dilantin	I	
	Δ Erythromycin-H ₂ O	I	
	Δ Estriol	I	
	Δ Estrone	I	
	Δ Fluoxetine	I	
	Δ Galaxolide	I	
	Δ Gemfibrozil	I	
	Δ Hexyl salicylate	I	
Δ Hexylcinnamaldehyde	I		
Δ Hydrocodone	I		
Δ Ibuprofen	I		
Δ Indolebutyric acid	I		
Δ Isobornyl acetate	I		

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
	Δ Isobutylparaben	I	
	Δ Ketoprofen	I	
	Δ Meprobamate	I	
	Δ Methyl dihydrojasmonate	I	
	Δ Methyl ionine	I	
	Δ Methyl salicylate	I	
	Δ Metoprolol	I	
	Δ Musk ketone	I	
	Δ Musk xylene	I	
	Δ Naproxen	I	
	Δ Nonylphenol	I	
	Δ Norfluoxetine	I	
	Δ Ofloxacin	I	
	Δ Paracetamol	I	
	Δ OTNE	I	
	Δ Paracetamol	I	
	Δ Phenylphenol	I	
	Δ Primidone	I	
	Δ Propranolol	I	
	Δ Propylparaben	I	
	Δ Salicylic acid	I	
	Δ Simvastatin hydroxy acid	I	
	Δ Sulfamethoxazole	I	
	Δ Terpineol	I	
	Δ Tonalide	I	
	Δ Triclocarban	I	
	Δ Triclosan	I	
	Δ Trimethoprim	I	
Ozone with H₂O₂	Δ NDMA	I	<ul style="list-style-type: none"> Compounds with 90–50 % removal through AO under the following conditions: RO treated water; 7 mg/L ozone; 3.5 mg/L H₂O₂; 2 minute contact time.
	Δ Iopromide	I	

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
Ozone with H ₂ O ₂	Δ EDTA	I	<ul style="list-style-type: none"> Compounds with 50-25 % removal through AO under the following conditions: RO treated water; 7 mg/L ozone; 3.5 mg/L H₂O₂; 2 minute contact time.
Ozone with H ₂ O ₂	Δ Chloroform	I	<ul style="list-style-type: none"> Compounds with <25 % removal through AO under the following conditions: RO treated water; 7 mg/L ozone; 3.5 mg/L H₂O₂; 2 minute contact time.
	Δ TCEP	I	
	Δ TCPP	I	
	Δ TDCPP	I	
Physical separation such as Reverse Osmosis	Δ Conductivity	S	<ul style="list-style-type: none"> Filtration performance of high-pressure membranes
	Δ UV absorbance at 254 nm	S	
	Δ Hardness	S	
	Δ Total organic carbon (TOC)	S	
	Δ Total dissolved solids	S	
	Δ Boron	S	
Reverse Osmosis	Δ Indolebutyric acid	I	<ul style="list-style-type: none"> Compounds with a >90% removal using RO under the following conditions: recovery 80%; permeate flux ~20 litres per square metre per hour; pH 6.5.
	Δ Acetyl cedrene	I	
	Δ Atenolol	I	
	Δ Atorvastatin (including o-Hydroxy atorvastatin and p-Hydroxy atorvastatin)	I	
	Δ Benzyl acetate	I	
	Δ Benzyl salicylate	I	
	Δ Bisphenol A	I	
	Δ Bucinal	I	
	Δ Butylated hydroxyanisole	I	
	Δ Caffeine	I	
	Δ Carbamazepine	I	
	Δ Ciprofloxacin	I	
	Δ DEET	I	
	Δ Diclofenac	I	
	Δ Dilantin	I	
	Δ EDTA	I	
Δ Erythromycin-H ₂ O	I		

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
	Δ Estriol	I	
	Δ Estrone	I	
	Δ Fluoxetine	I	
	Δ Galaxolide	I	
	Δ Gemfibrozil	I	
	Δ Hexyl salicylate	I	
	Δ Hexylcinnamaldehyde	I	
	Δ Hydrocodone	I	
	Δ Ibuprofen	I	
	Δ Iopromide	I	
	Δ Isobornyl acetate	I	
	Δ Isobutylparaben	I	
	Δ Ketoprofen	I	
	Δ Meprobamate	I	
	Δ Methyl dihydrojasmonate	I	
	Δ Methyl ionine	I	
	Δ Methyl salicylate	I	
	Δ Metoprolol	I	
	Δ Musk ketone	I	
	Δ Musk xylene	I	
	Δ Naproxen	I	
	Δ Nonylphenol	I	
	Δ Norfluoxetine	I	
	Δ OTNE	I	
	Δ Paracetamol	I	
	Δ Phenylphenol	I	
	Δ Primidone	I	
	Δ Propranolol	I	
	Δ Propylparaben	I	
	Δ Salicylic acid	I	
	Δ Simvastatin hydroxy acid	I	
	Δ Sulfamethoxazole	I	
	Δ TCEP	I	
	Δ TCPP	I	
	Δ TDCPP	I	

Treatment	Parameter (Δ removal differential)	Surrogate(S)/	Treatment removal categories and conditions
	Δ Terpineol	I	
	Δ Tonalide	I	
	Δ Triclocarban	I	
	Δ Triclosan	I	
	Δ Trimethoprim	I	
Reverse Osmosis	Δ Chloroform	I	Compounds with a 50-25% removal using RO under the following conditions: recovery 80%; permeate flux ~20 litres per square metre per hour; pH 6.5.
	Δ NDMA	I	

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