Risk Management Guidelines for Water Sensitive Urban Design

August 2008

Linked to:
Model WSUD Guidelines
Module 2.6 Managing Risk

WSUD Risk Management Guidelines

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1. Introduction

- The WSUD Risk Management Guidelines introduce a risk management framework for safe and sustainable water sensitive urban design schemes in Melbourne.
- These risk guidelines are one consideration of many in delivering effective water sensitive urban (WSUD) project in the ground. The full range of project design considerations are set out in the *WSUD Guidelines*.

Protecting public health and the environment is paramount when alternative water sources are being used. Careful planning, construction and monitoring are required to make sure reused water is safe.

The framework is designed to support straightforward risk management for simple projects, and a comprehensive approach for more complex projects and those that carry higher risks.

It can be used by Councils and by community, including developers and commercial and industrial businesses.

Tools for risk management at a household level are also included, so it's relevant to those with an interest in small scale domestic schemes.

Structure of these guidelines

There are four key sections of these guidelines.

Risk management approach - describes the approach to risk management and details the regulatory framework for alternative water sources.

Risk Management Framework – details the proposed risk management framework, including describing key steps and tasks.

Special considerations – managing potential liability issues related to water reuse schemes.

Risk management tools – resources to help develop a risk management plan.

Water Sensitive Urban Design

Water sensitive urban design (WSUD) embraces a range of measures that are designed to avoid, or at least minimise, the environmental impacts of urbanisation in terms of the demand for water and the potential pollution threat to natural waterways.

WSUD recognises that all water streams in the urban water cycle are a resource, not just drinking water. This includes:

- Rainwater
- Stormwater
- Potable mains drinking water
- Greywater (water from the bathroom sinks, shower, and laundry)
- Blackwater (toilet and kitchen)
- Water mining (sewer)

The following goals of WSUD will be explained in detail in this guide:

- Reduce potable water consumption
- Maximise water reuse
- Reduce wastewater discharge
- Minimise stormwater pollution before it is discharged to the aquatic environment
- Maximise groundwater protection.

Water recycling schemes can take many forms, from diverting washing machine water to the garden to installing treatment facilities on the industry floor or water mining.

Open spaces, industry, and commercial buildings are particularly suited for alternative water sources.

2. Managing water recycling risk

Water recycling schemes present public health, environmental and institutional risks. Identified risk exposures are detailed below. A more detailed outline of risks is provided in Appendix A.

People

Risks to human health can be caused by poor planning, design and maintenance of water schemes.

Environmental

Unauthorised discharge to the environment causing ecological risks to flora, fauna and soils can be triggered by poor planning, design and maintenance.

Financial and economic

Projects can become financially unfeasible due to poor design. This can lead to the abandonment of infrastructure and a particular initiative. In addition, management of peak flows (i.e. flood prevention) is necessary for safe conveyance of flows and protection of property.

Liability

The City is now playing a role in water treatment and supply and has compliance and due diligence requirements. Treatment failure and poor risk management processes can result in non-compliance and risk for public liability and contractual liability.

Reputation

The City is recognised as a leader in integrated water management. Any of the above risk exposures can impact on community trust.

Managing these risks is not purely achieved by regulation and managing assets and hazards. Ensuring communication and consultation between all stakeholders throughout the planning, design, implementation and management phases of a water recycling scheme is also critical.

2.1 Current risk management legislation and guidelines

A risk-based approach for alternative water sources, complying with legislative requirements and both national and state guidance is recommended.

The *Australian Guidelines for Water Recycling – Stormwater Harvesting and Reuse,* draft for public consultation, May 2008 was released by the Environmental Protection and Heritage Council (EPHC), National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC). Following the national approach to water recycling, these draft guidelines are incorporated into Phase 2 of EPHC's *Australian Guidelines for Water Recycling*.

The Victorian Government recently reviewed the state's public health and environmental framework for alternative urban water supplies. Results of the review were presented in the discussion paper, *A Framework for Alternative Urban Water Supplies,* released by the Department of Sustainability and Environment (DSE) in 2006. It documents regulations relating to alternative urban water supplies and concludes that current assistance for alternative water reuse is fragmented.

A summary of the review findings for each key water stream is below. A more detailed review of the legislative requirements is provided in Appendix B.

Rainwater

Rainwater only poses a low risk for domestic and commercial/industrial/irrigation uses. However correct installation and maintenance is still essential for safe water supply.

Because of the low risk profile, the collection and use rainwater is unregulated. Guidelines for using rainwater tanks were released by the EnHealth Council (responsible for the National Environment Health Strategy) in 2004.

Stormwater

Stormwater can be harvested and reused at local catchments. Increasingly local governments and developments are reusing harvested stormwater for open space irrigation.

Stormwater has a highly variable water quality due to local catchment variations. Draft guidelines for stormwater reuse for irrigation have been released by the EPHC - *Australian Guidelines for Water Recycling*

– *Stormwater Harvesting and Reuse,* draft for public consultation, May 2008. This document provides guidance for:

- Roofwater reuse for larger buildings (greater than residential dwelling)
- Stormwater reuse for small to medium scale open space irrigation.

All other stormwater harvesting and reuse applications should take a risk-based approach. These non-potable uses include:

- Toilet flushing
- Washing machine use
- Dust suppression
- Waterscape features (e.g. water fountains)
- Commercial food crop irrigation
- Home grown food irrigation
- Fire fighting, street cleaning
- Dual reticulation
- Industrial.

Greywater

If managed carefully, domestic greywater used within the boundaries of a property where it is generated can become a low risk. It's important that appropriate treatment takes place, with no cross connections, chemical management and appropriate end-uses such as underground garden and lawn watering, toilet flushing and clothes washing.

There are three types of greywater:

- Treated – where water is stored for more than 24 hours and requires treatment before reuse
- Diverted into plumbing – where water is diverted into plumbing fixtures for reuse within 24 hours
- Diverted with no plumbing – for example, running washing machine water directly onto gardens. No treatment or approvals are necessary for this diversion.

Treatment is required for uses that are medium risk:

- Laundry
- Surface irrigation
- Outdoor.

If multiple sites are generating greywater, both of these 'end use'-based rankings increase to medium and high respectively, and require treatment.

The collection and reuse of greywater is regulated. Schemes that discharge to the environment are subject to the works approval, licensing provisions and septic tank provisions of the *Environment Protection Act* 1970, depending on their flow rate.

Schemes that reuse treated or untreated greywater require water authority consent, typically to increase the level of backflow protection. A registered plumber must install this system. This is because legislation requires any changes to plumbing connections to have consent, not just water recycling proposals. For simple diversion devices, the reuse of untreated greywater is currently unregulated.

More information is provided in EPA Publication 812.2 - *Domestic Wastewater Management Series, Reuse Options for Household Wastewater.*

Wastewater

Wastewater has a high inbuilt risk which needs careful risk management. This is known as an 'inherent' risk. Water recycling is closely regulated under the Environment Protection Act and is subject to works approvals, licensing provisions and septic tank provisions. Victorian requirements for works approvals and licensing are outlined in the frameworks for using reclaimed water and recycled water. There is limited regulation of small water recycling systems.

Victorian Government requirements for project governance and environmental and health risk management within water recycling schemes are provided in:

- EPA Publication 464.2: Guidelines for Environmental Management: Use of Reclaimed Water
- EPA Publication 1015: Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management.

2.2 Risk management and governance procedures

Council recommends adopting the risk assessments framework shown in Figure 1 for any project. This assessment process is methodical and engages a range of stakeholders through a workshop format that can be separated into several key phases.

The model follows the PLAN, DO, CHECK, ACT model, supported by an Environmental Aspects and Impacts Register, standard risk assessment processes, and occupational health and safety requirements.

Figure 1. Risk analysis framework (Hart, B. T. et al. (2005). Ecological Risk Management Framework for the Irrigation Industry, Water Studies Centre, Monash University, Melbourne, Australia, 55pp (www.wsc.monash.edu.au))

Risk assessments can range from a qualitative assessment to a quantitative analysis employing mathematical relationships. The level of complexity is determined by:

- Information (or lack of) available
- Resources assigned to each risk.

Each potential treatment option has different risks associated with:

- Technology
- Site constraints
- Potential identified uses.

These risks are based on the requirement that water reuse schemes achieve a 'fit-for-purpose' water quality standard.

Risk assessments are required for water recycling schemes. However there is no explicit requirement to cover an environmental or public health issue. You must identify any risk impacts and issues where there is a compliance requirement for Council works when submitting details of water reuse schemes for inclusion on Council's risk register.

Defining risk

The **risk** is defined as the likelihood (probability) of an adverse event multiplied by the consequence if that event occurs.

Risks can be categorised as either:

- Inherent – the risks associated with the project concept itself, or
- Residual – the risks associated with the project after risk management controls have been put in place.

Examples

- A dual pipe estate using reclaimed sewage can be high inherent risk but low residual risk due to the extensive risk management controls.
- In contrast, local greywater recycling may present a lower inherent risk, but due to the limited reliable end use controls, could represent unacceptable residual risks.

These guidelines focus on using good management to minimise inherent risk to an acceptable residual risk level. The guidelines don't relate to projects with very high inherent risks as Council believes such projects should be reconsidered.

2.3 Commitment to risk management

Council supports and promotes responsible use of water sensitive urban design projects.

It recognises the limitations of current legislation for alternative water use schemes and advocates management that meets the needs of all users and the environment.

In its role as scheme manager, scheme participant, approval authority and community leader, the Council will implement and promote the use of 'fit for purpose' water through:

- Risk management
- Management procedures
- Communication
- Monitoring and reporting.

Risk management includes:

- User-based, risk-oriented approach to the analysis of ‘fit for purpose’ water management options
- Preventative risk management approach and an appropriate water quality management system
- Contingency planning and incident response capability.

Management procedures include:

- Water quality management at relevant points along the delivery chain, from water source to point of application or recycled water user
- Processes and procedures to protect public and environmental health
- Planning processes that integrate the needs and expectations of water users, regulators, employees, other stakeholders and the environment
- Appropriate technical expertise in developing and managing water schemes
- Training to ensure all managers and employees involved in the supply of treated water can implement, maintain and continuously improve a recycled water scheme.

Communication includes:

- Partnerships with stakeholders involved in managing water recycling schemes
- Best practice community consultation, enabling participation in decision-making processes relating to the design, delivery and management of schemes.

Monitoring and reporting includes:

- Regular monitoring of control measures and water quality
- Effective reporting mechanisms to provide relevant and timely information
- Regular performance assessment to improve management practices and meet stakeholder expectations
- Mandatory reporting of non conformances with critical limits and routine reporting of operational data.

3. Risk management framework

This risk management process has been developed for all water recycling schemes operated by Council that collect and treat stormwater, rainwater, greywater and wastewater. Figure 2 shows the risk management framework for water recycling schemes in the IMAP area.

A range of fact sheets are proposed to help guide residents. However, the scope of this framework does not include water recycling schemes developed and managed by residents.

The framework has three key phases, each with defined tasks that must be completed. More detail about these key steps is provided below.

Phase 1: Assess project significance and level of risk (steps 1-2)

Phase 2: Conduct risk assessment (step 3)

Phase 3: Develop, apply and monitor risk management plan (steps 4-6).

Resources that will help develop a risk management approach to water recycling include fact sheets, a project management checklist and a risk management plan template (see Section 5).

A risk management plan should cover:

- Regulatory requirements
- Scheme design
- Installation and operational procedures
- Monitoring
- Corrective action
- Communication and engagement protocols.

It should ensure multiple barrier controls are applied where necessary. For example:

- Asset control mechanisms
- Education
- Technological barriers
- Plumbing and distribution controls
- Signage
- Operational procedures.

Corporate governance: compliance and liability management

The lack of an Environmental Management System (EMS) at some Councils limits the potential for appropriate water quality management within recycling schemes. Until an EMS is developed, risk management documentation must be integrated into each Council's corporate governance processes. At this stage, the most appropriate mechanism for legal compliance and liability management is to ensure a risk management plan is included on the relevant Council's risk register.

The best approach to managing potential liability issues is to design a system that minimises the risk of improper or unauthorised use of a treated (and untreated) product. Also consider product quality to address risks of improper use. Adhering to plumbing and other regulations, running awareness and education programs and ensuring an appropriate frequency of monitoring will help manage these issues.

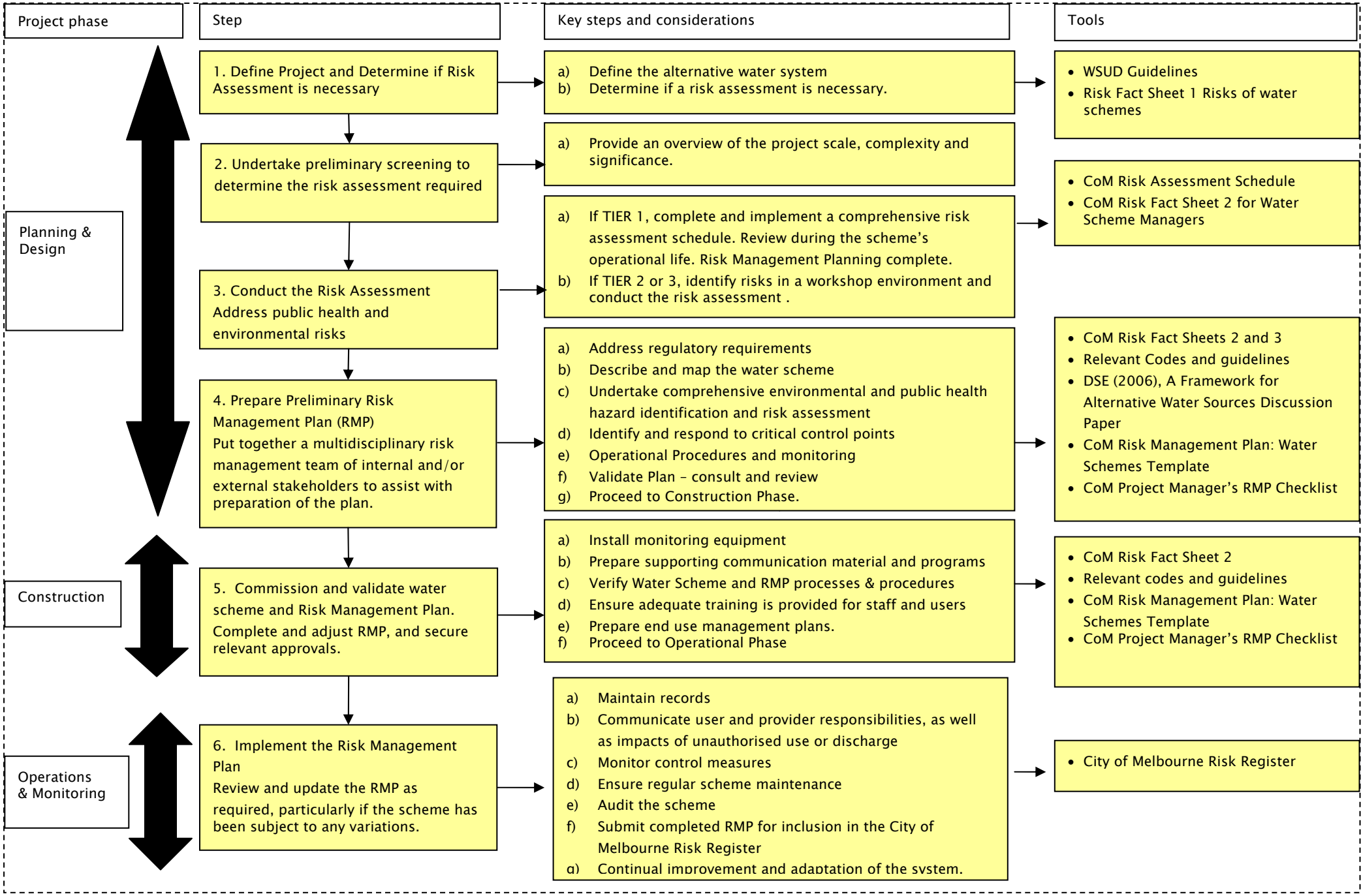


Figure 2. Risk Management Framework for Water Recycling Schemes

Step 1 - Define project and determine if a risk assessment is needed

1. Define the water recycling system

A project must be clearly defined for an effective risk assessment. This typically happens during the planning and development of a recycling scheme. Key information includes:

- Project scale
- Alternative water source or treatment (rainwater, stormwater, greywater, wastewater)
- Proposed end use for the alternative water.

A conceptual diagram is a useful tool for risk assessment. It communicates clearly to all stakeholders and links the water treatment system, people and the environment explicitly. The diagram should take a whole-of-system approach.

For **stormwater harvesting systems**, the diagram must start at catchment boundaries, detailing the treatment processes and end uses for the water.

For **wastewater reuse schemes**, it's important to include all scheme components such as storage and distribution systems. A common mistake is to take the boundary at the sewer diversion. This doesn't account for the impact of municipal and industrial customers on the sewer catchment.

Importantly, there must be **due consideration of water conservation measures** such as water efficient fittings and appliances, water efficient gardens and smart irrigation techniques before alternative water sources are considered. Demand management measures are effective in reducing some of the risks associated with water schemes.

2. Determine if a risk assessment is necessary

After defining a project, determine whether a risk assessment is necessary.

- Does the project involve using an alternative water source such as rainwater, stormwater, greywater, recycled water (e.g. water mining)?
- Does the project impact on the public health safety of the community?
- Does the project present a risk to the community or the environment?
- Is there a legislative requirement for a risk assessment?

If you answer 'yes' to any of these questions, a risk assessment is necessary and you must proceed to Step 2 – Preliminary screening to determine risk assessment as required.

Typical risks identified in the management of schemes are outlined in Appendix A.

Action:

Determine the scale and significance of your project and whether a risk assessment is required.

Step 2 - Preliminary screening to determine risk assessment required

Simple projects require a straight forward risk assessment that is easy to apply. Larger, more complex projects require a more detailed risk assessment.

1. Provide an overview of the project scale, complexity and significance

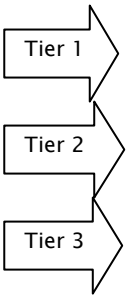
- Does your project provide a health risk to the community? If so, how many people are potentially impacted?
- Does your project present a potential risk to the environment?
- What is the significance of this project to the IMAP area?

Action:

Determine the scale and significance of your project.

Once the scale, complexity and significance of your project are determined, an appropriate risk assessment methodology can be identified.

Three tiers of risk assessment can be applied:



Qualitative risk analysis – words are used to describe the magnitude of potential consequences and the likelihood they will occur.

Semi-quantitative risk analysis – values are given to the qualitative scales (from Tier 1) to produce an expanded scale for ranking.

Quantitative risk analysis – numerical values (not descriptive scales) are provided for both the consequences and likelihood, using data from a variety of sources.

Use Table 1 to assess the appropriate risk assessment methodology for your project. Note that if a project falls between categories, the higher category for risk assessment applies.

Table 1: Outline of project scale and complexity with recommended risk assessment

Project significance	Scale and exposure	Complexity	Typical examples	Action
Small	Small scale – e.g. single building or household, depot	Simple project – limited exposure to the public	• Rainwater tank for limited uses • Rainwater tanks for all domestic and non domestic uses, other than drinking and personal washing • Small scale stormwater harvesting for outdoor use, toilet flushing, irrigation and discharge to the environment.	Identification of risks and management response (Tier 1)
Medium	Intermediate scale – e.g. multi-rise building, day care centre	Simple process with a higher level of exposure to the public. Complex process with limited exposure to the public.	• Rainwater tank for limited uses • Rainwater tank (for public use) • Mechanical greywater reuse system • Large scale rainwater harvesting for personal washing • Treated/untreated household greywater for toilet flushing or outdoor use • Domestic and non domestic stormwater harvesting for laundry, toilets and outdoor use • Large scale stormwater harvesting for outdoor use, toilet flushing, irrigation, fire protection and discharge to the environment • Larger scale domestic or non	Semi-quantitative evaluation of risks and management response. Rank risks using (Tier 2)

Project significance	Scale and exposure	Complexity	Typical examples	Action
			domestic greywater system for laundry and outdoor use.	
Large	Large scale - multi-rise building, office building, large public open space	High complexity e.g. requires ongoing management and control systems	• Stormwater harvesting and reuse • All wastewater treatment schemes including Water (sewer) mining • All large non domestic greywater schemes for irrigation and other uses • Stormwater harvesting for personal use/washing.	Detailed risk assessment – refer to CoM guidelines (Tier 3)

* This table is based on information contained within *A Framework for Alternative Urban Water Supplies* (Department of Sustainability and Environment, 2006).

Action:

Determine the scale and significance of the project then risk assessment 'tier'.

Step 3 – Conduct the risk assessment

A risk assessment must now be conducted.

The *Australian Guidelines for Water Recycling* recommend a risk-based approach for designing and evaluating water reuse options. These guidelines were developed by the Environment Protection and Heritage Council (EPHC) and the Natural Resource Management Ministerial Council (NRMMC) in 2006.

A HACCP (Hazards analysis and critical control points) risk assessment process identifies the critical control points (CCPs) for managing water systems.

HACCP – Hazard analysis and critical control points

IMAP proposes to adopt the Hazard and Critical Control Point Analysis (HACCP) risk management framework for alternative water schemes.

HACCP is a preventative risk management system that prepares for foreseeable contamination events and incidents. Importantly, it involves customers in risk management, and gives operations staff a mechanism to pro-actively identify and correct problems.

It is consistent with the Australian standard for risk management (AS/NZS 4360:2004).

The HACCP framework is used within the food industry and is increasingly being adopted by the water industry for managing risks associated with water recycling schemes.

The HACCP framework should be applied to risk management of all Tier 3 water recycling schemes in the IMAP region covered within the scope of these guidelines.

What is HACCP?

The HACCP approach systematically identifies all hazards in recycled water that can potentially affect human or environmental health. The risk from each hazard is then identified by estimating the likelihood that each event will happen and its consequences. Finally, preventative measures are put in place to control hazards. New measures are added or existing measures improved if necessary.

Flow diagrams are used in the HACCP process to analyse hazards and associated risks. Critical Control Point, critical limits, monitoring, corrective actions and verification procedures help to ensure high quality assurance. The process requires record keeping along with independent audits and review.

HACCP helps people explicitly understand and document critical risks including:

- Risk to intended customers
- Risk from product misuse
- Statutory obligations.

The HACCP process is illustrated in Appendix C.

1. Tier 1 **Tier 1 – Qualitative risk analysis**

For simple projects, a qualitative risk analysis is appropriate.

- Provide a clear description of the risk by using the simple checklist of typical risks encountered in water recycling management (in Appendix A)
- Clearly describe actions to manage the risk, either from a design perspective or an ongoing management
- Complete a Tier 1 risk assessment schedule, ensuring adequate control measures are in place
- Verify that these measures work as planned once your scheme is completed
- Review the risk assessment schedule throughout its life.

Whilst the risk management planning process is now complete, variations may be needed if a scheme expands or is upgraded. It's also necessary to check that a project retains this risk ranking, otherwise more comprehensive risk management planning will be needed.

Risk assessment schedules must be submitted to the local Council for inclusion on its risk register.

Action:

Provide a qualitative risk analysis, clearly describing the risks associated with the project and the design and/or management responses

2. Tier 2 **Tier 2 – Semi-quantitative risk analysis**

For a Tier 2 risk assessment, the five point scoring system ranks identified risks based on risk likelihood and consequence (Australian Standards AS/NZS, 2000, 2004). These are described in Table 2. A focused workshop is recommended to define and explain the risks of a particular application. To ensure consistency with each Council's corporate reporting processes; a risk assessment profile should be incorporated into the appropriate management system.

Table 2: Semi-quantitative risk matrix for risk assessment

	CONSEQUENCE				
LIKELIHOOD	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost certain (5)	5	10	15	20	25
Likely (4)	4	8	12	16	20
Moderately likely (3)	3	6	9	12	15
Unlikely (2)	2	4	6	8	10
Rare (1)	1	2	3	4	5

Action:

Complete the semi-quantitative risk assessment analysis and report the outcomes according to corporate reporting guidance.

Tier 3 risk analysis is triggered where there is insufficient information to classify risk. If high risks are identified in the Tier 2 risk assessment, a more detailed risk assessment is warranted. Proceed to a Tier 3 Quantitative risk assessment.

3. Tier 3 – Quantitative risk assessment

A Tier 3 risk assessment is required when high human health and/or environmental risk is identified in a Tier 2 risk assessment. The Tier 3 quantitative risk assessment examines the highest risks in more detail.

Human health risks

While alternative water can be a safe resource, reliable treatment is essential to minimise risks. Human risks from reused water are primarily due to exposure to pathogenic micro-organisms causing illness, and in extreme cases, death. Pathogenic organisms such as viruses, bacteria and parasites can be discharged into waterways by humans infected by a disease or a carrier. Wastewater typically has high concentrations.

Treatment is required to reduce pathogens. The level of treatment is determined through the risk-based approach of defining the water quality needed for end uses. A higher water quality is generally needed as potential human exposure increases. Tools including 'quantitative microbial risk assessment' (QMRA) and 'quantitative chemical risk assessment' (QCRA) can be used to assess risk to human health by exposure to pathogens and chemicals.

More information is provided in EPA Publication 1015: Guidelines for Environmental Management: *Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management*.

Environmental risks

Water recycling schemes can pose several environmental risks. These are site-specific and depend on the topography, geography and location associated with specific water treatment technology and water end use. Key environmental risks are:

- Impact on the aquatic environment
- Impact on the land primarily from irrigation
- Production of greenhouse gases
- Production of biosolids and other wastes.
- Impact on the aquatic environment
- Impact on the land primarily from irrigation.
- Suitability of reused water depends on soil conditions, site topography and geology. A land capability assessment needs to be undertaken at the planning stage.

- Increased salinity can impede plant growth and degrade soil conditions. Soil sodicity from the high presence of sodium ions relative to magnesium and calcium ions can degrade the soil structure.
- Increased nutrient levels may benefit adjusted urban botanical landscapes but can pollute groundwater and waterways.

Production of greenhouse gases

Water recycling can be energy intensive and emit greenhouse gases. It's important to ease these impacts through good project design. See Module 2.4 - Being Carbon Sensitive in the *WSUD Guidelines* for more detail.

Production of biosolids and other wastes

Water recycling schemes can emit harmful waste products such as biosolids. These need to be managed.

Legislation and licensing

An EPA discharge licence is required for all wastewater (sewage) discharged to the environment for volumes over 5,000litres/day. There is no current legislation relating to the discharge of stormwater. The local environmental condition must be considered when planning to use alternative water sources.

If a project has a Tier 2 or 3 ranking, it must be supported by a risk management plan. Preparing a plan is covered in Step 4 below.

Action:

Undertake Tier 3 risk assessment with detailed consideration of human health and/or environmental risks. This includes preparing a risk management plan (see Step 4 below).

Step 4 – Preparing a risk management plan

A risk management plan needs to be undertaken for Tier 2 and Tier 3 risk water reuse schemes.

A plan covers all aspects of a water reuse scheme from collection to end use. It should:

- Address regulatory requirements
- Provide catchment and scheme analysis
- Document the risk assessment process and apply appropriate control measures and corrective action
- Include multiple barrier controls where required
- Outline water scheme governance structures
- Outline monitoring, maintenance and communications protocols.

A template for preparing a risk management plan is available in Section 5.

A multi-disciplinary team is required to develop a risk management plan. It should include key internal and where relevant, external stakeholders impacted by a proposed scheme. Therefore some preliminary stakeholder analysis is needed when planning a water reuse scheme.

1. Address regulatory requirements

Wastewater and greywater treatment schemes have specific regulatory requirements. They are subject to:

- Works approvals
- Development of health and environmental management plans
- Consent from water or regulatory authorities.

Elements of stormwater schemes are regulated, for example diversion of stormwater from a waterway. Stormwater treatment schemes that intend to improve the quality of discharge to the environment are regulated by the State Environment Protection Policy (SEPP) (Waters of Victoria).

Risk Fact Sheet 2 outlines relevant regulatory requirements. Review the detail of these requirements closely, particularly for wastewater treatment plants.

Consult the Department of Human Services and EPA Victoria regarding all schemes presenting environmental and public health risks to make sure the most appropriate risk assessment, management and monitoring approach is adopted. A review of regulation covering water schemes is provided in Appendix B.

Regulatory requirements for water recycling schemes

Wastewater treatment and water recycling schemes are high risk projects and therefore have additional regulation and management requirements.

All proposed schemes of this nature must refer to:

- EPA Publication 464.2: Guidelines for Environmental Management*: Use of Reclaimed Water*
- EPA Publication 1015: Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management).

Requirements include:

- Consultation with Department of Human Services (DHS) and EPA from the early stages of project planning
- Compliance with predetermined discharge limits and operating specifications around:
- water quality
- site management
- permitted end uses and restrictions
- monitoring, reporting and auditing
- Preparation and submission to EPA Victoria of a **HEMP** (see below) for dual pipe water recycling schemes
- Annual compliance reporting
- Preparation of Environmental Improvement Plans or equivalent for reclaiming water to non-potable water standards
- Works approval from EPA Victoria and a licence or site-specific exemption (based on HEMP)
- Development of formal agreements between supplier and users of reclaimed water, outlining:
- governance arrangements
- treatment objectives
- risks
- control measures
- responsibilities for operation, maintenance, monitoring and use
- EPA approval and DHS endorsement for all non-potable water recycling schemes in Victoria

- Communication to residential users about appropriate use of recycled water and potential risks associated with misuse.

HEMP

The development of a Health and Environment Management Plan (HEMP) is essential for sustainable recycling within a dual pipe scheme to ensure it will comply with performance objectives of EPA's *Dual Pipe Water Recycling Guidelines*.

It is comprised of two key aspects that cover the production and delivery of non-potable recycled water:

- HACCP-based risk management plan
- Recycled water quality management plan (RWQMP).

Council's Risk Management Framework and planning approach can be easily integrated into the HEMP. Further details on regulation relating to water recycling are provided in Appendix B.

2. Describe and map the water scheme and its catchment

Water recycling schemes require a flow diagram that defines:

- Steps and processes
- Control mechanisms
- Responsible stakeholders
- Intended uses of alternative water.

Use the conceptual diagram from Step 1 and expand it to cover:

- All inputs to a source water (generic or specific depending on the presence of trade waste dischargers in the relevant catchment)
- Treatment processes and system inputs (i.e. chemicals, treatment residue)
- Distribution networks
- Storage systems and their capacity
- End use locations, including:
- receiving environments
- areas irrigated or products serviced
- sensitive ecological species/locations/waterways in the vicinity.

Consult with your risk management team and other stakeholders to check each step of the flow diagram for accuracy.

As you progress through the steps, update the process flow to reflect any changes, as these will result in different hazards and control measures. The flow diagram should also map critical control points (CCPs) and water quality monitoring once these are determined.

3. Identify environmental and public health hazards and assess their risk

In a source water scheme, all hazards that could potentially risk human and/or environmental health must be identified in detail.

A risk management team gathers data relating to:

- Water source characteristics (flow reliability, physical/chemical/microbial constituents)
- Treatment technology performance
- Neighbouring operations that could impact on source water quality
- Receiving environments
- User expectations
- Equipment capability
- Maintenance needs
- Potential exposure routes.

A logical process should be followed:

- Identify specific hazardous contaminants and hazardous events relating to the scheme, based on data collected and risk management team knowledge of the site (known as critical control points (CPP's), started in Step 2)
- Identify the specific source and concentration of contaminants, where relevant
- Identify hazardous events that could pose public and environmental health risks
- Estimate the level of risk associated with each, based on Councils Risk Assessment Schedule
- Determine and prioritise significant risks
- Identify existing preventive measures for each one, and estimate their residual risk profile
- Identify alternative measures to reduce the risk to a safe level, if the residual risk is unacceptable.

This process will assess a range of risks, such as those associated with unauthorised use or discharge, treatment failure, operational procedures, monitoring systems capability and construction. Significant hazards must be removed or reduced to acceptable levels for a scheme to be viable.

Step 4 may require the use of best practice risk management approaches such as the HACCP system in addition to human health and environmental assessments.

Assessing health risks

Health risk management cannot be prescriptive. Control measures adopted for water reuse schemes depend on the quality of the alternative source water being treated and the routes of exposure (aerosol inhalation, direct exposure or dermal contact, accidental ingestion). Key considerations for health risk management include:

- Hazards and existing control measures
- Human exposure routes for biological and chemical hazards
- Exposure assessments for each intended use
- The treatment process's capability to meet and maintain microbial criteria standards for water recycling
- Criteria for monitoring/management/training and other supporting programs.

A **Quantitative Microbial Risk Assessment** (QMRA) model is the most appropriate for the management of risks associated with the delivery of non-potable recycled water, as presented in EPA Victoria's Publication 1015: *Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management*. These guidelines identify water quality targets to guide health risk management for dual pipe schemes.

Water recycling schemes adopt DALYs (disability adjusted life years) to measure tolerable or acceptable levels of public health risk, and set a range of performance targets for chemical and microbial hazards. The reference pathogens are rotaviruses, Cryptosporidium parvum and Campylobacter. Exposure assessment models determine probabilities and levels of infection following exposure to these reference organisms. Risk is then characterised according to DALYs.

More information on managing health risks associated with recycled water is provided in:

- Australian Water Recycling Guidelines
- EPA Victoria's Publication 1015: Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management.

Assessing environmental risks

Water scheme hazards related to environmental health are generally chemical and physical in nature. They include total suspended solids, boron, cadmium, chlorine disinfection residuals, increased hydraulic load, nutrients, salinity, chloride and sodium. They can be caused by treatment failure, over watering irrigated areas and unauthorised discharge.

Common impacts include:

- Environmental contamination
- Eutrophication
- Loss of biodiversity
- Salinity
- Other detrimental impacts on groundwater, soil and surface water quality.

An environmental risk assessment helps us to understand the sensitivity of receiving environments, and of the catchment's capability to use water supplied by a scheme.

For risk management, key steps include:

- Identify hazards and existing control measures
- Identify all environmental exposure routes
- Conduct a **Land Capability Assessment** (LCA), where the intended use is irrigation of open space
- Model and design the stormwater treatment system to achieve best practice stormwater quality objectives and schedule works for optimum risk management, where the intended use is discharge to the environment
- Assess the treatment process's capability to meet water quality objectives associated with treatment
- Ensure appropriate control measures are specified
- Establish criteria for monitoring/management/training and other supporting programs.

Land Capability Assessment

A Land Capability Assessment (LCA) is required for all reclaimed water schemes generating water for open space irrigation.

The LCA helps identify the tolerance of an area proposed for irrigation to treated water. Its primary focus is assessing nutrient, salinity, and sodicity impacts (groundwater, soil structure, and salt mobilisation across these areas). The plan should be supported with detail on recycled water quality, source water inputs, water/sewage piping and stormwater drainage.

The LCA helps establish:

- Appropriate irrigation application rates
- Scheduling for a site, irrigation methodology
- Operational and maintenance procedures
- Groundwater and stormwater controls
- Receiving environment monitoring and reporting.

For further details refer to:

- EPA Publication 464.2: Guidelines for Environmental Management: Use of Reclaimed Water
- EPA Publication 1015: Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management.

Plumbing and distribution controls

Plumbing and distribution controls are specified for wastewater treatment schemes to ensure appropriate levels of access and system control. A number of standards should be applied, including:

- AS/NZS 3500 National Plumbing and Drainage Code
- AS 1345 – Identification of the contents of piping, conduits and ducts
- Water Supply Code of Australia (WSA 03-2002)
- Plumbing Industry Commission Recycled Water Plumbing Guidelines.

This area of control is very important due to the hazardous events that can result from poor asset management. Installation requirements help to avoid pathogen, chemical or physical contamination from backflow into the potable water system, pipework failure and cross-connections.

To reduce risk, make sure that:

- Licensed plumbers are employed
- Appropriate backflow prevention is installed (dual check meters or dual check valves are used)
- Installations are audited
- Approved watermarked materials are used
- Alternative water source piping is not close to potable water infrastructure
- Purple identification is used for dual pipe assets
- Access to infrastructure such as taps and other outlets is restricted
- Prohibition signage and regular inspections are displayed.

When a multiple barrier approach is used for these controls, the failure of one barrier can be compensated for by the effective operation of remaining barriers.

4. Identify and respond to critical control points

Make sure critical control points (CCPs) are identified after a comprehensive risk assessment of your proposed scheme is conducted and appropriate control measures for the site are established.

A CCP is a point, step or procedure at which control must be applied to prevent, eliminate or reduce a hazard to acceptable levels.

CCPs require measurable operational parameters and critical limits. They should have real time monitoring with an immediate response capability when a hazard increases beyond its critical limits. Table 3 provides examples of potential CCPs and criteria.

Table 3: Potential CCPs, critical limits and corrective actions

Potential CCP	Hazard	Critical limit	Monitoring	Corrective action
Primary disinfection and storage	Enteric bacteria, viruses, giardia	Total chlorine residual over 2mg/L	Continuous alarm monitoring and alarms with automatic feedback to chlorine dosing	Inspect and repair fault.

Filtration of recycled water	Enteric bacteria, viruses, protozoa and Helminths	Turbidity limits	Continuous online monitoring	Repair faulty operation, increase coagulant dose, filter backwash, stop supply – identify problem and take action

Adapted from the Australian Water Recycling Guidelines (2006).

Not all steps can be considered a CCP, unless they monitor and enable prompt corrective action. A range of tools exist to help determine CCPs and Figure 3 shows a process for identifying CCPs.

A critical limit is a maximum or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent or reduce a hazard to an acceptable level. Critical limit setting should relate to a measurable parameter that reflects the management of a risk.

Corrective action includes immediate action once a critical limit is reached, with the ability to divert or cease supply of treated water if required. It's also necessary to clearly outline responsibility for an action as well as a clear understanding of the potential causes of a breach of the limit.

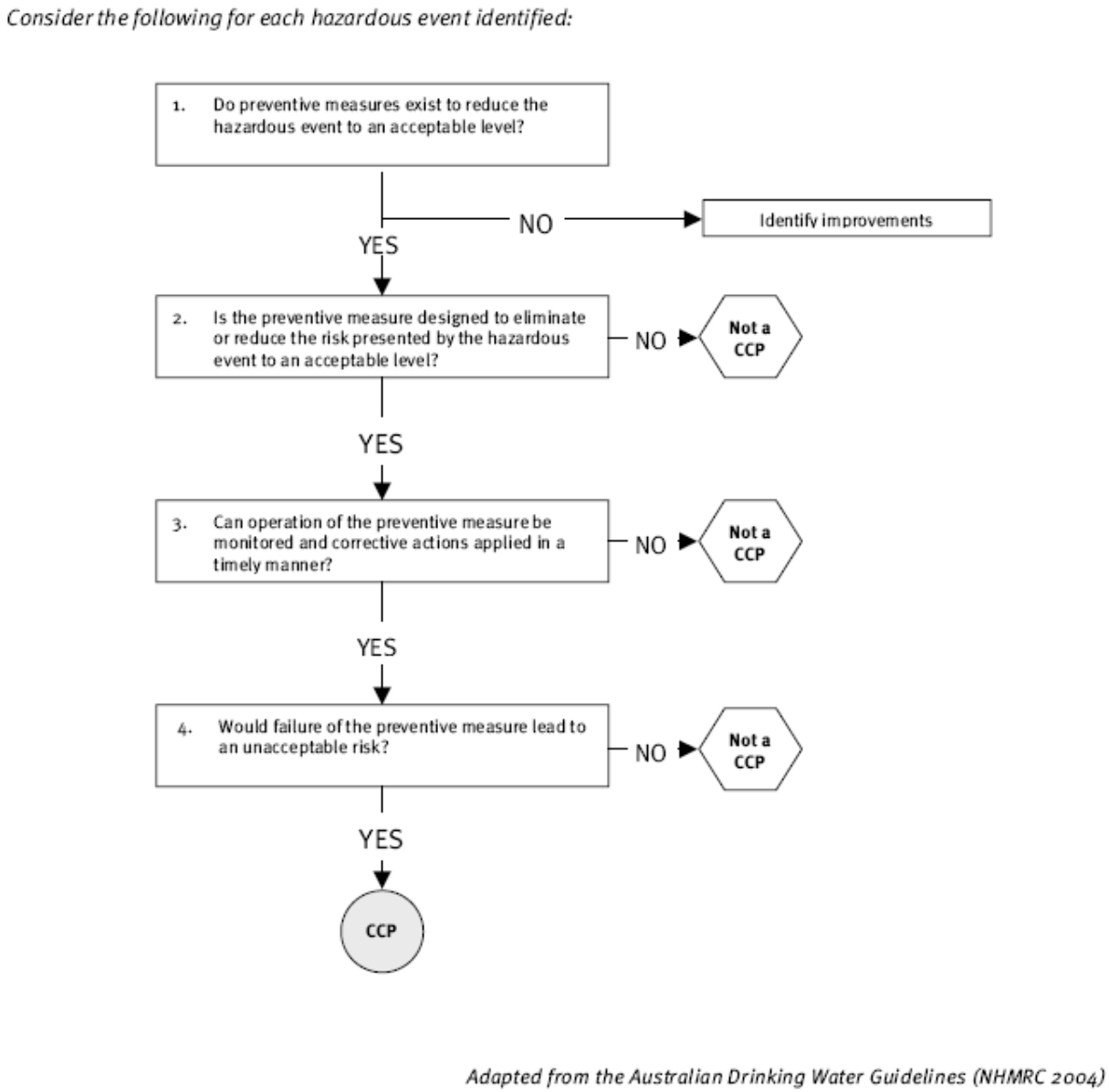


Figure 2. Identifying critical control points (CCPs)

5. Operational procedures and monitoring

Develop a monitoring protocol for the range of procedures, preventative measures and CCPs that have emerged from the risk assessment process. Ideally, design monitoring as continuous and rapid and capable of generating prompt corrective action, where relevant.

Determine the relevant water quality characteristics to be monitored, as well as the frequency and locations where it will be undertaken. Design your monitoring system around the final protocol.

A monitoring template for ongoing monitoring is provided in Section 5.

Start documenting procedures for operational performance, such as equipment use/maintenance and chemicals and materials specification. These can later be compiled into an operations manual. The manual should also document:

- Community and water scheme user involvement,
- Incident response related communication systems
- Education and engagement programs.

6. Validate plan – consult and review

Once a preliminary risk management plan is completed, its processes must be reviewed to check that it accurately reflects the risks of the scheme and proposes appropriate management solutions.

Validation usually means developing a rigorous analytical and testing regime for wastewater reuse schemes (water mining). This includes:

- Developing a monitoring regime to ensure a reuse scheme is operating according to its design parameters (see Section 5 for a template)
- Consulting relevant stakeholders
- Reviewing the plan.

7. Proceed to construction phase

Once a risk management plan is validated, construction of and installation of a water scheme can begin. Components of the plan relating to construction and contractor practices should be reviewed and the responsibilities of key contractors clarified.

Step 5 – Commission and validate

1. Prepare management plans

At an early stage, you need to know the end use of treated water from a scheme. Options include domestic, urban, commercial and irrigation uses.

Supplying water to users outside the boundaries of a scheme can highlight new risks. Timely consideration of this potential will have an impact on design. It's therefore necessary to prepare an end-use management plan that explains how a user will manage the use of the treated water.

End-use risk management plans should place barriers in a range of measures including:

- Educational (placement of appropriate signage across the site)
- Asset control (ensuring access controls are in place)
- OHS processes (masks, protective clothing, procedures to avoid staff exposure to risks)
- Distribution control (shut down mechanisms to respond to treatment failure).
- Detail for these Risk Management Plans depends on the risk profile of a scheme.

2. Install monitoring equipment

Scheme control points need monitoring equipment that can track system performance in real time or collate data for later analysis.

Critical control points (CCPs) need automated early warning systems that can respond rapidly to a hazard. This means a system that can shut down or divert water if a critical limit is reached.

These systems can be chemical, physical or biologically based, and should be able to screen a range of contaminants in a specific manner. They should be selected based on:

- Accuracy
- Ability to deliver high sampling rate
- Minimal skill and training requirements
- Reliable and rugged physical form.

All proposed monitoring equipment should be installed during the construction phase as many will be inline and or integrated into other components of the treatment system.

Real-time monitoring is generally appropriate for health issues. However if the risk results from long term factors such as salinity, then regular sampling rather than on-line sampling may be appropriate.

3. Prepare supporting communication material and programs

Provide users and staff with a clear outline of risks and management controls relating to your water recycling scheme, through targeted:

- Engagement
- Information materials
- Prompts
- Signage.

Place informative or prohibition type signage at targeted locations within the scheme (if it is public access) and at points of use (if access is limited).

Signs should be placed at:

- Each key process step or critical control point to remind staff of hazards, control measures and corrective action
- Relevant user points to inform users of the risks of unauthorised use.

The risk profile of your scheme will help determine the range of risks and control measures that need to be communicated to staff, contractors and other users.

4. Provide adequate training for staff

Make sure that staff, contractors and users are trained to use, manage, or maintain a water recycling scheme. This is a critical measure relating to distribution network control. A risk profile helps:

- Determine areas in which training is required
- Provide guidance on identifying potential opportunities for unauthorised use and discharge to the environment
- Provide guidance on improper system management or maintenance.

Staff must be trained to deliver all control measures and corrective actions outlined in the risk management plan, including how to respond to system failure.

5. Verify scheme and risk management plan processes and procedures

Verification happens during the construction phase of a project. The water recycling scheme and preliminary risk management plan must be checked and validated. Assess key steps in the process as well as a scheme in full trial operation. You can't verify a system as compliant until the scheme is operating.

The results of the verification process inform any changes to the risk management plan. This must occur for high risk schemes, in particular water recycling, before they begin operating. In these cases, it will also form the basis of the final approvals process.

Step 6 – Implementing a risk management plan

1. Maintain records

Record keeping is an essential part of risk management and due diligence.

For example, managers of water reuse schemes must keep a register of all users of the recycled water, which includes their addresses, the quality and quantity of supply and what the water is used for. This register of users is strongly recommended for all other recycling schemes.

For wastewater treatment schemes, the risk management plan, training programs and monitoring data must be continuously updated and maintained. This approach is also recommended for all other schemes.

2. Communicate responsibilities, as well as impacts of unauthorised use or discharge

The responsibilities and risks associated with a water reuse scheme should be communicated to users to avoid improper use of recycled water. For example:

- Education campaign – to inform users that treated water is not for drinking, outlining:
- impacts of improper use
- measures for avoiding improper use
- Signage and community engagement around a constructed wetland – to advise visitors about:
- avoiding contact with untreated water
- potential impacts of improper recreational activities on the treatment system.

Both users and managers are responsible for protecting a scheme.

3. Monitor control measures

Your scheme will present risks that require control measures. There may also be some critical control points (CCPs) requiring real time monitoring.

You must monitor the performance of all risk management control measures and CCPs established in Stage 3, and operational in Stage 4 of this Risk Management Framework. Document the performance of these measures and attach the results of this process to the risk management plan.

Whilst corrective action is in place to address scheme hazards, you must evaluate the degree to which CCPs tend towards critical limits. Variations to source water quality can add new hazards and may impact on the efficacy of existing control measures. The existing measures should be adjusted based on the review.

A template for monitoring water quality and CCPs is provided in Section 5.

4. Regularly maintain the scheme

Monitor and review the efficacy of contractor maintenance specifications throughout the implementation phase of a water reuse scheme. Poor cleaning and maintenance can clog treatment media, introduce higher levels of hazards to the scheme and even cause treatment failure. This is particularly the case for stormwater treatment and wastewater treatment schemes. Check for issues related to:

- Scheduling
- Materials used for replacing system components
- Response times
- Communication systems
- Any other aspects specific to the scheme type.

5. Audit the scheme

Determine an audit schedule for your scheme. Wastewater treatment schemes require an annual audit and revalidation of the risk management plan when variations occur.

The audit schedule will depend on:

- Scheme specific considerations, such as the lifecycle of materials and treatment systems
- The nature of hazards, control points and control measures.
- The schedule may also depend on the incremental impacts of treated water. For example, the continued use of treated wastewater for irrigating the same open space area.

6. Submit risk management plan for inclusion in Council's risk register

Submit the completed risk management plan to legal and governance teams for inclusion in Council's risk register. For the City of Melbourne, this should include an overall assessment of the risk of the water recycling system according to its eight key risk exposure areas.

7. Continually improve and update the system

The adaptive risk management approach advocated by IMAP is cyclical in nature. As knowledge of the system is gained and experience with management evolves, the system can be continually improved to address:

- Technological advancement and innovations can be incorporated into the system
- Changes in practices and address any gaps identified.

4. Risk management tools

A variety of tools will support IMAP's risk management framework. Drafts are below for:

- Fact sheets
- Checklists
- Risk management templates
- Operational monitoring template.
- Additional fact sheets are also recommended to help manage risk associated with water recycling at a household and business level.

1. Fact sheets

The proposed fact sheets will explain risk management measures to ensure water quality, health and environmental risk management measures, including:

Risks associated with water schemes

A summary of risks associated with the planning and management of water recycling schemes. Features a table for conducting a risk-based analysis of scheme options.

Business/council – water scheme manager

Fact sheets proposed for stormwater, rainwater, greywater and wastewater schemes. These will cover:

- Potential hazards and hazardous events
- Environmental impacts of water schemes
- Regulatory requirements
- Step-by-step risk management framework and checklist
- End use application considerations (i.e. urban versus irrigation uses).

Each fact sheet will recap on integrated water cycle management (IWCM) principles in the context of selecting appropriate reclaimed water sources.

Stakeholder/community consultation guidelines

These fact sheets will outline an approach for consulting key stakeholders about the design and management of water schemes. Criteria for effective consultation from the *National Water Recycling Guidelines* include:

- Allow stakeholders to study evidence and draw their own conclusions
- Keep the decision-making process transparent and fair
- Share responsibility for solving supply and disposal problems.
- Scheme managers must adopt this approach to ensure public acceptance of recycled water and stakeholder confidence. Key steps include the following:
- Identify key stakeholders, their needs and expectations
- Develop a communication strategy to engage stakeholders that identifies their role in key decision making processes
- Provide information on perceived and actual risks.
- Respond to stakeholder concerns
- Develop an education campaign that explains the impacts of unauthorised use of treated water, as well as mechanisms in place to protect a water scheme.

Household – water scheme

While information for household water reuse schemes is available it is inconsistent and not easily sourced. Two fact sheets targeting the use of rainwater and treated/untreated greywater will be developed that summarise potential hazards, regulatory requirements, maintenance advice, recommendations from EPA's Domestic Wastewater Management Series and risk management measures (possibly presented as a basic checklist). These fact sheets could be integrated into existing Council water brochures which give tips to help households reduce their water use, or they could be produced as separate documents.

Household/business/council participating or benefiting from a water scheme

A fact sheet or postcard to potential participants in a water scheme about specific risks and how to participate in consultation. This fact sheet should provide a link to Council publications highlighting water conservation tips.

4.2 Checklist

A draft checklist to support this framework is provided in Table 4. This checklist is based on current Victorian regulatory requirements relating to water schemes and best practice preventative risk management.

The checklist covers all risks associated with:

- The overall planning, design, delivery and management process
- Consultation
- The overall project management
- Contractor management
- A water scheme and its treatment steps, controls, monitoring and verification points.

Certain steps will refer project managers to relevant regulatory code and guidelines.

The checklist should reflect the roles of key project players, such as landscape architects, contractors and users that hold primary risk management responsibility for various parts of a project. It should also cover mechanisms to check the performance of risk-related aspects of their work. This is particularly important when there is limited understanding of the delivery and maintenance of a scheme, such as complex water recycling schemes and stormwater treatment schemes.

Contractors

Risks associated with construction include:

- Temporary supply
- Cross connections
- Backflow prevention
- Dual pipe installation
- Pressure testing
- Appropriate test certification and approvals
- Signage and tagging
- Access control
- Plumbing sign off.

- For stormwater reuse projects, risks include:
- Limited contractor experience
- Destruction of treatment vegetation
- Contamination of filtration media from sediment accumulating due to poor construction
- Blockages
- Hydraulic overloading
- Poorly timed, planned and supervised project installation.

Landscape designer

Risks associated with stormwater reuse within specific project types including constructed wetlands, rainwater harvesting and bio retention risk systems include:

- Treatment failure due to poor design
- Inadequate filtration media
- Poor construction and maintenance specifications
- Unspecified temporary protection for vegetation and treatment media during the construction phase.

Council staff

Risks are associated with inadequate maintenance, resulting in blockages and failure of a treatment system as well as potential risks to the environment and public health.

This checklist, while comprehensive, is a generic checklist for all water schemes using alternative water sources. If more detailed planning frameworks and guidelines are required, refer to:

- EPA Publication 464.2: *Guidelines for Environmental Management: Use of Reclaimed Water* - Appendix A – Reuse Scheme Checklist and Appendix E – Environmental improvement plan checklist: wastewater, greywater and stormwater schemes
- EPA Publication 1015: Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management Appendix 3 – Managing the Supply System: for wastewater reuse and recycling schemes
- Council Risk Management documentation and support from its Legal and Governance branch.

How to use the checklist

The checklist contains a list of risk management actions that should be completed as part of the design, construction and operational phases of a major stormwater, greywater and wastewater treatment scheme.

For maximum risk management, actions relating to each phase should be completed before moving to the next phase in project implementation. The low level of risk associated with rainwater harvesting requires standard risk management planning as outlined in Section 3 of this document.

Actions are generic and relate to all water schemes. However those:

- Coded '*' relate specifically to water recycling
- Coded '**' relate specifically to stormwater treatment schemes discharging directly to the environment.

Table 4: Risk management checklist

Project		
Purpose of plan	To identify, assess and manage the risks associated with the supply of reclaimed water	
Type	<Stormwater Reuse> <Water Recycling> <Greywater Reuse> <Rainwater>	
End use	<Irrigation> <Facilities> <washdown> <other>	
Approval overview	Risk management plan approved Certified site supervisor designated…….. Scheme Verified EIP/HEMP/HACCP Plan – EPA Approved……	DATE DATE DATE
Steps	**Project planning – system design for optimal risk and environmental management**	**Y/N Initial/ Date**
Consider risk management approach		
1.	Integrated urban water cycle management discussion and decision making. Select the most appropriate water source for reuse based on the intended use and desired environmental outcome. Undertake overall project risk assessment in accordance with Council's risk register to determine the most appropriate risk management approach for the scheme.	
2.	Identify and document requirements under: • EPA regulatory requirements • Australian risk management standard • Council policy.	
3.	Discuss proposed scheme and risk management approach with EPA Victoria and DHS.	
Identify team and stakeholders		
4.	Start preparing a risk management plan and EIP or HEMP/ Recycled Water Quality Management. Plan if required (Water recycling treatment schemes only**)** depending on outcomes of initial discussions with the EPA, DHS and others.	
5.	Assemble a multi-disciplinary RMP team with sound knowledge of the proposed project to develop, verify and implement the risk management plan. Team members from the following areas should be included: • Design • Environment • Project Management • Parks or Engineering (as relevant) • Communications • Participating external consultants.	
6.	Identify all stakeholders impacted by a project. Develop appropriate mechanisms for their involvement including an agreement covering the interests of suppliers and users.	
Document intentions for the scheme		
7.	Describe and document the: • Quality of the water source to be treated • Water quality desired • Intended use and receiving environments • Required treatment process • Storage • Distribution networks • Potential impacts on water source quality • Other potential exposure routes. Identify the intended use of the recycled water, its limitations and potential users.	
Map the scheme		
8.	Construct a project-specific process flow diagram from catchment to consumer, outlining all the steps in the production and use of the water. Use the process flow to create a draft risk map based on identified risk pathways.	
9.	Validate and confirm the flow diagram to be complete and accurate through: • Consultation with the RMP team • Direct assessment of the flow diagram.	
10.	Conduct a hazard analysis, identifying significant hazards and hazardous events and estimating their level of risk.	

Risk assessment and risk mapping		
11.	Undertake environmental and health risk assessment. Include a land capability assessment if the water will be used for irrigation purposes.	
12.	Identify existing control measures in place to manage identified risks. Screen and prioritise significant risks qualitatively (estimated) and where possible quantitatively.	
13.	Develop and finalise the risk map based on steps 10-14.	
Critical control points		
14.	Identify critical control points and establish critical limits to ensure hazards are controlled and corrective action is taken. Identify additional preventive measures and strategies.	
15.	Establish mechanisms for operational control and monitoring of all critical limits.	
16.	Document all critical control points, critical limits and target criteria.	
Design and approve treatment		
17.	Functional and detailed project design, incorporating selection of treatment process, supported by comprehensive community consultation. Design treatment to deliver to appropriate specifications: • Consider the risk of increased greenhouse gas emissions • Maximise scale and efficiency of the water distribution supply. Plan the treatment and disinfection regime in accordance with EPA Publication 730.1: *Disinfection of Reclaimed Water.*	
18.	Source EPA Victoria works approval if required.	
Develop monitoring protocol		
19.	Determine the characteristics to be monitored including frequency and monitoring points.	
20.	Document procedures and monitoring protocols for operational performance. Program regular inspection and maintenance of equipment.	
21.	Establish procedures for corrective action in response to non conformance with CCPs or recycled water user feedback.	
22.	Validate the monitoring system to ensure it triggers corrective action when a critical limit is not met.	
23.	Verify the system is in compliance. Verify that hazards, CCPs and critical limits are appropriately set.	
24.	Establish a comprehensive documentation/record keeping process.	
25.	Finalise preliminary risk management plan and HEMP/RWQMP if required. Seek EPA and DHS endorsement.	
	System construction	
26.	**Stormwater treatment schemes only** Supervise construction to ensure treatment system and media meet specification requirements and that poor construction practices do not result in: • Contaminated media • Blockages • Future maintenance issues. Implement a staged approach to the installation of infrastructure and the establishment of vegetation. Ensure protection mechanisms are in place for sediment and erosion control throughout the construction phase. Implement litter and sediment control measures as per Council's *Construction Management Plan* guidelines.**	
27.	Install alarm systems, automatic controls and on line monitoring to detect process malfunctions.	
28.	Install reclaimed water distribution systems in accordance with: • AS/NZS 3500 National plumbing and Drainage Code, AS 1345 – *Identification of the contents of piping, conduits and ducts* • Water Supply Code of Australia (WSA 03-2002) • Plumbing Industry Commission *Recycled Water Plumbing Guidelines**.	
29.	Ensure that: • Above ground distribution systems are no closer than 100mm to potable water pipes • Below ground systems are laid no closer than 300mm from potable water pipes.	
30.	Install approved registered air gap or backflow prevention device where potable water is supplied into the reclaimed water as make up water.	
31.	Identify the distribution network and supply advisory signs, tags and labelling in accordance with approved plans.	
32.	Undertake cross connection testing to avoid connection of a scheme to the potable water system. Document the process and attach a map showing potable water connection removal from the system prior to any connection and metering of recycled water.*	
33.	Meter installation requested - Onsite system connected to treated water meter if required.	
34.	Commission and validate treatment plant and distribution systems.	

35.	Validate risk management plan processes and procedures to ensure they control hazards effectively.	
36.	If required, prepare end use risk management plans.	
37.	Secure EPA/DHS final approvals prior to supply of water to scheme.	
38.	**Stormwater treatment schemes only**. On completion of all construction activities, remove temporary protection measures from treatment media and begin establishing vegetation.**	
Operations and monitoring		
Register users		
39.	Maintain an up-to-date register of users and provide to EPA as required.	
Implement communications protocol		
40.	Ensure responsibilities are understood by and communicated to all staff, including information of the impacts of unauthorised use or discharge.	
41.	Ensure contractors and employees maintain appropriate experience and qualifications. Document training and maintain records.	
Inspection		
42.	Implement an inspection of non potable supply systems.	
43.	Conduct regular inspections of treatment and disinfection systems.	
Monitor and review		
44.	Implement and monitor public access controls.	
45.	Review the performance of maintenance specifications and contractors in relation to: • Treatment media blockages • Structural issues • Pedestrian health and safety. This includes pit cleaning, drainage maintenance and stormwater treatment media management amongst others.**	
46.	Implement incident response and management plan/protocols including a commitment to notify EPA, DHS and users immediately if there are any non-compliance issues.	
47.	Audit system annually. Revalidate risk management plan periodically or when variations in conditions occur.	
48.	Collect and evaluate data to assess system performance Identify emerging risks and problems.	
49.	Integrate document control system into the Council risk register, with all environmental aspects and impacts addressed in an Environmental Management Plan. Monitor these environmental impacts.	
50.	Evaluate corporate risk and ability to maintain compliance.	

4.3 Risk management plan template

A template is proposed to support water recycling schemes.

A draft template has been developed based on the Preliminary HACCP Plan developed for the *Salisbury Stormwater to Drinking Water Aquifer Storage Transfer and Recovery Project.* This project is one of the first stormwater schemes to develop a HACCP-based risk management plan. It's currently being trialled on the Royal Park Wetlands Stormwater Reuse Scheme. Prompts are provided under each heading to help with the process.

A template for water recycling schemes can be produced based on the success of this trial together with more detailed risk management planning templates presented in Victorian and national water recycling codes and guidelines.

The proposed structure of the template is:

1. Introduction

1.1. Project Background
1.2. Legislative requirements
1.3. Stakeholders
1.4. Potential Risks – Overview
1.5. Risk Management Team

2. Preliminary HACCP Plan

2.1. System analysis
2.1.1. Broader catchment description
2.1.2. Wetlands system description
2.1.3. Irrigation system description
2.2. Describe product
2.3. Intended uses
2.4. Schematic representation
2.4.1. Verification
2.5. Hazard identification and risk assessment
2.5.1. Hazard analysis
2.5.2. Project risk assessment
2.5.3. Preventive measures
2.5.4. Risk assessment schedule (Council risk register)
2.6. Critical and quality control points, control measures and critical limits
2.7. Monitoring and corrective action procedures
2.8. HACCP plan verification and validation
2.9. Documentation and record keeping
2.10. Supporting programs

3. Implementation

3.1. Implementation considerations
3.2. Outstanding
3.3. Plan review

Appendices

Draft operational monitoring template

Risk management checklist

HACCP process overview

.

4.4 Draft operational monitoring template

Exact monitoring location	Parameter	Frequency /Dates	Targets/ Critical limits	Early warning action criteria	Corrective action	Notification	Resp. for sampling	Resp. for assessing results

Note targets for critical control points are termed critical limits

Based on template extracted from the Australian Nation Health and Medical Research Council's *Australian Drinking Water Guidelines Community Water Planner.*

Appendix A

Overview of risks associated with water recycling schemes

Table 1: Overview of risks associated with water sources and water schemes

Water Source	Potential hazards and hazardous events
Stormwater - runoff from permeable urban surfaces	• Hazards • Nutrient impacts (fertilisers, open space and agricultural land) • Chemical impacts (industrial areas) • Oil and petrol impacts (road areas) • Other contaminants (constructed drainage, paths, variable dependant on land use activities) • Salinity • Pathogens • Sediment (construction activities) • Hazardous events • Poor performance or failure of treatment system • Poor reliability of processes • Overloading of collection and treatment systems • Uncontrolled watering of outdoor areas • Backflow • Aerosol exposure through irrigation systems • Exposed siting of stormwater scheme (close to sewers, roads, etc that increase risks) • Destruction or smothering of treatment vegetation via sediment accumulation • Clogging of filter medium, blockages of drainage layers (specifically bioretention systems) • Hydraulic overloading of stormwater treatment systems
Rainwater - roof runoff	• Hazards • Nutrient impacts (faecal and atmospheric nitrogen from roof, leaves) • Chemical impacts (lead and other agents from roof) • Bacterial Pathogens (faecal waste from animal active on roof) • Contaminants from tank/roof materials • Traffic emissions and industrial pollution (airborne) • Hazardous events • Cross connections • Poor filtration and flushing devices • Poor maintenance and cleaning of gutters (leaves) and tanks (sludge) • Inadequate heating of rainwater for pathogen management • Uncovered tank leading to bulk, unfiltered entry of contaminants • Potential breeding ground for mosquitoes • Backflow of collected water into reticulated supply • Low heating temperature if connected to household hot water services (60C required to avoid Legionella and inactivate enteric pathogens)

Greywater - Domestic type wastewater except for toilet water and kitchen water	• Hazards • Nutrient and salt impacts (food scraps, detergents, washing liquids) • Chemical impacts (household cleaning agents, domestic and garden chemicals, paints) • Other contaminants (kitchen sink, laundry troughs, personal care products) • Oils (cooking, car care) • Pathogens (faecal contamination from laundry waste, cross connections) • Inappropriate disposal of other solvents and petrochemicals • Hazardous events • Unintended use through cross connections • Uncontrolled use of water in limited areas (i.e. overloading of garden) resulting in soil damage or eutrophication of nearby waterways • Poor cleaning and maintenance systems – while gloves are required to clean light greywater systems with filters, it is unclear to what degree toilet cisterns require cleaning. It also raises the question as to whether a toilet's efficiency will be impacted by greywater quality, particularly if it is not accessible for appropriate cleaning • Backflow of untreated greywater into reticulated supply • Inadequate indirect plumbing from source to end use • General ability of existing approved greywater storage and treatment systems to manage risks associated • Not releasing untreated greywater according to 24 hour holding limit
Wastewater - all domestic and industrial sewage	• Hazards • Nutrient impacts (food wastes, detergents, personal care products) • Chemicals, heavy metals, hydrocarbons, oils (boron, cadmium, commercial/ industrial discharge in neighbouring catchment) • Pathogens (faecal discharge to sewer) • Salinity • Pharmaceuticals • Use of water treatment chemicals – spills, unauthorised use, chlorine disinfection residuals • Build up of contaminants, sediments, and slimes within the system (from inadequate cleaning) • Hazardous events • Potential for unauthorised use (cross connections, non-compliance with plumbing standards and codes, use of inappropriate plumbing and construction materials) • Treatment failure or poor stability and reliability of process (chemical dosing, disinfection, equipment malfunction, inadequate mixing of treatment chemicals) • Poor storage management, • Poor catchment analysis and management • Poor maintenance and management risks including system cleaning, solids removal, sewer load licence agreements, and waste residue management • Biofouling • Inadvertent or unauthorised use or discharge to environment • Unclear governance of scheme • Overloading of collection and treatment systems • Sewage overflows

	• Flow variations and inadequate pressures • Burst or leaks • Inadequate information to users about permitted uses • Potential for unauthorised use • Uncontrolled delivery to receiving environment – infrastructure, irrigated areas, waterways, human use • Inadequate backup for key processes within treatment system • Limited ability of local government to utilise the planning scheme to endorse the risk management procedures of wastewater treatment systems designed to treat less than 5,000 kL a day (their installation does not require validation and EPA approval – systems must be EPA-endorsed for market use, but are considered septic systems for council approval). Is conformance to AS/NZS standards is sufficient to manage operational and maintenance risks? • Uncontrolled watering of outdoor areas

Note: Not all the hazards and hazardous events are within the Council's control (such as household greywater system design and management). However they are raised as areas where Council can play an informative role by providing community risk management tools.

Appendix B

Literature review: regulation, codes, standards, guidelines

The literature review identifies means to address water recycling sustainability issues specific to Council in the areas of:

- Environmental and health risk management
- Liability management and compliance
- Characteristics of effective approaches for long term sustainable water recycling.

The review is structured to address both corporate and municipal needs. Key areas and documents are listed below.

Risk management frameworks

- HACCP Risk Management Approach
- AS/NZS 4360:2004 Risk Management

National codes and guidelines

- Draft National Water Recycling Guidelines
- Australian Guidelines for Sewerage Systems – Reclaimed Water (ARMCANZ/ANZECC, 2000)
- Australian Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC, 1997)

Victorian codes and guidelines

- Guidelines for Environmental Management: Use of Reclaimed Water (EPA Publication Number 464.2)
- Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes: Health and Environmental Risk Management (EPA Publication 1015)
- Code of Practice for Small Wastewater Treatment Plants (EPA Publication Number 500, 1997)
- Guidelines for Wastewater Irrigation (EPA Publication Number 168)
- Domestic Wastewater Management Series – Reuse Options for Household Wastewater (EPA Publication Number 812.1) – Updated Feb 2006

Other

- City of Melbourne (2005), Water Sensitive Urban Design Guidelines
- Department of Sustainability and the Environment (2006), A framework for alternative urban water supplies: Discussion paper
- Queensland Water Recycling Guidelines
- Construction Inspection Checklist – South Bay Water Recycling CA
- Page, D., Dillon, P. et al (2006) A risk management method for stormwater reuse
- World Health Organisation (2002), Managing Water in the home: accelerated health gains from improved water supply
- Melbourne Water (2005), Constructed Wetland Systems: Design Guidelines for developers

In undertaking the literature review, analysis and recommendations for the following areas were considered:

- Water recycling schemes that could be implemented in the IMAP region
- Risk management frameworks relevant to:
- water source contaminant levels
- recycled water end uses
- scale (household, high rise residential or commercial users)
- Process flow diagram specific to lighter water recycling sources (greywater) and household use
- Risk management measures at each stage of the process flow
- Catchment assessment (as part of the early planning stages)
- Third pipe management
- Evaluation and monitoring parameters
- Community consultation for acceptance and integration into surrounding environment
- Storage (untreated greywater is subject to a 24 hour temporary storage limit)
- Monitoring of treatment required to remove high organic and micro-organism concentrations and control pathogen levels
- Maintenance of desired water quality standards.

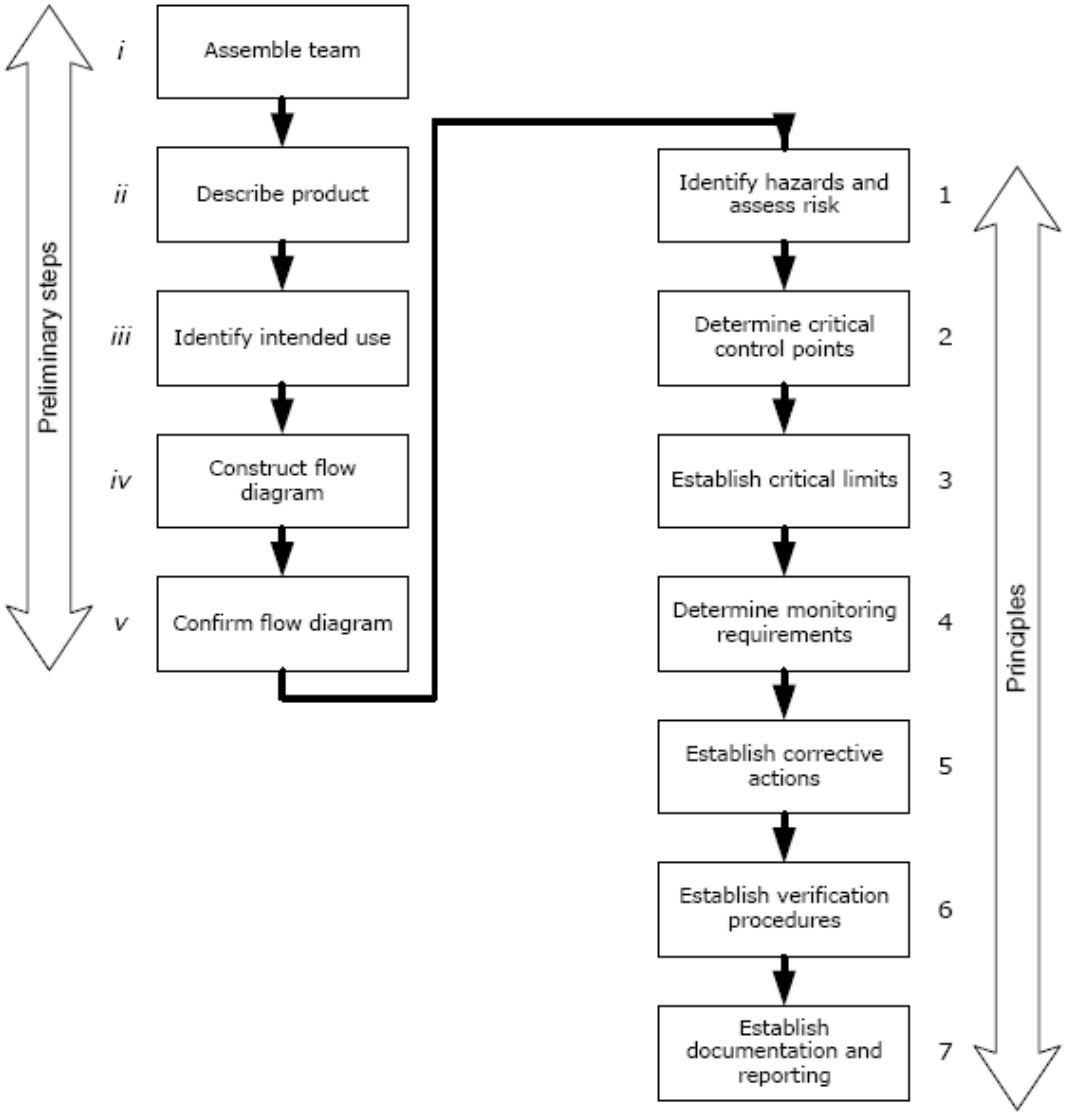
The *Australian Drinking Water Guidelines* have not specifically been reviewed. The preventative strategy from catchment to consumer is adopted within these guidelines, together with the steps and elements required to deliver safe drinking water. These are seen as transferable to the management of quality of a range of treated and untreated water sources.

Appendix C

HACCP framework

The following diagram outlines the preliminary steps and principles that inform the use of a HACCP-based risk management approach in the development of a preventative risk management plan. They are taken from the *Australian Water Recycling Guidelines*.

Figure C.1: The HACCP process



Adapted from Codex Alimentarius, WHO