



Use of Recycled Water in the Werribee Irrigation District

Regional Environment Improvement Plan

Contents

1.	Glossary	6
2.	Abbreviations	7
3.	Introduction	8
3.1	Purpose of the Regional Environment Improvement Plan	8
3.2	Scope of the EIP	8
3.3	Approval of EIP	8
4.	General Scheme Description	9
4.1	Background	9
4.2	Overview of the Werribee Irrigation District Recycled Water Scheme	9
4.3	Customers	13
5.	Roles and Responsibilities	14
5.1	Melbourne Water	15
5.2	Southern Rural Water	15
5.3	Customers	17
5.4	EPA Victoria	17
5.5	Department of Human Services	17
5.6	Department of Sustainability and Environment	17
5.7	Department of Primary Industries	17
5.8	EIP Representatives	18
6.	Recycled Water Quantity	19
6.1	Water Resources available to the Werribee Irrigation District	19
6.2	Reliability of Supply	20
7.	Recycled Water Quality	21
7.1	Sewage Treatment at the Western Treatment Plant	21

7.2	Legislation and Guidance Governing Recycled Water Quality	21
7.3	Quality Requirements for Recycled Water	22
7.4	Treatment Requirements for the Werribee Irrigation District	22
7.5	Current Recycled Water Quality	24
7.6	Treatment Reliability	24
8.	Werribee Irrigation District Characteristics	28
8.1	Introduction	28
8.2	Geology	28
8.3	Landforms	28
8.4	Soils suitable for Irrigation	28
8.5	Groundwater	30
8.6	Werribee River	31
8.7	Drainage	31
8.8	Existing land uses	33
8.9	Climate in the WID	35
9.	The Irrigation Management Plan	36
9.1	Salinity	36
9.2	Sodicity	40
9.3	Nutrients	43
9.4	Contaminants	48
10.	Summary of existing environmental issues in the WID	52
10.1	Management Recommendations for Recycled Water Suppliers	53
10.2	Management Recommendations for Customers	53
11.	Storage	54
11.1	The Head of the Road Storage (HORS)	54
11.2	The Chlorination Retention Storage	54
11.3	On-Farm Dams	54

12.	Recycled Water Transport and Distribution	56	
12.1	Transport and Distribution Infrastructure	56	
12.2	Reliability of the transport and distribution system	57	
12.3	Risks associated with the transport of recycled water	57	
12.4	Continued Delivery of River Water	59	
13.	Use of Recycled Water	60	
13.1	Water Use	60	
13.2	Shandy Rules	60	
13.3	Split Running Rules	62	
13.4	Risks associated with Customer Use	64	
13.5	Mitigation Measures	67	
13.6	Standards of Environmental Management required from the Customers	67	67
14.	Asset Maintenance and Inspection	69	
14.1	Melbourne Water Assets	69	
14.2	SRW Assets	69	
15.	Emergency Preparedness and Response	70	
15.1	Incidents and impacts	70	
15.2	Failure to meet Class A requirements	70	
15.3	Recycled Water Spillage	71	
15.4	Algal Bloom Management at WTP	71	
16.	Monitoring and Reporting	72	
16.1	Summary of Environmental Monitoring and Reporting	72	
16.2	Water balance	73	
16.3	Recycled water monitoring	73	
16.4	Runoff and channel flushing monitoring	74	
16.5	River Water Monitoring	75	
16.6	Groundwater monitoring	76	
16.7	Shandied water monitoring	76	

16.8	Soil monitoring	76
16.9	Monitoring Records	79
16.10	Reporting	79
16.11	Trigger Levels	81
16.12	Incident Reporting	84
16.13	Auditing	84
16.14	EIP Review	85
16.15	Future monitoring and research required	86
17.	Communication and Training	87
17.1	Liaison between Melbourne Water and Southern Rural Water	87
17.2	Liaison between Southern Rural Water and the Customers	87
17.3	Community Liaison	87
17.4	Complaints Management	87
17.5	Information Sessions	88
17.6	Extension Program	88
18.	References	90
19.	Appendices	91
	Part 2: Supporting Documentation	104
1.1	Customer Supply Agreement	104
1.2	Stakeholder Reference Group Issues Paper Schedule	104
1.3	Irrigation Management Plan	104
1.4	Grower's Kit	104
1.5	Recycled Water Quality Management Plan (Melbourne Water)	104

1. Glossary

Class A Standard means Recycled Water treated to a Class A standard in accordance with EPA Victoria's 'Guidelines for Environmental Management: Use of Reclaimed Water' Publication 464.2, June 2003.

Customer means a customer of Southern Rural Water who has signed an agreement with Southern Rural Water to be supplied with Recycled Water within the Werribee Irrigation District. The Customer is responsible for ensuring that the Customer Site Management Plan (CSMP) requirements are met.

Customer Site Management Plan means the plan that must be prepared by Customers in accordance with EPA requirements to use Recycled Water. See Appendix A for template.

Customer Site Management Report (CSMR) must be submitted by Customers annually to confirm for the EPA that the necessary controls and good practice measures are in place at the farm level.

Customer Supply Agreement means the legal document outlining the contract between the entitlement holder and Southern Rural Water.

Distribution System means Southern Rural Water's channels and associated assets used for supply of river water and/or Recycled Water to the Werribee Irrigation District Customers.

EPA Guidelines EPA Victoria Publication No. 464.2 Guidelines for Environmental Management – Use of Reclaimed Water 2003

Grower's Kit means the folder of Fact Sheets, other resources and customer agreements that was distributed to growers at the information sessions conducted in September and October 2004. Customers can obtain a Grower's Kit or part thereof by contacting Southern Rural Water.

Headworks System means Melbourne Water's works upstream of the Interface Points used to supply Recycled Water.

Interface Points means the flanges immediately upstream of the Supply Control Valves where ownership of the Recycled Water transfers from Melbourne Water to Southern Rural Water as shown in Figure 4-1.

Recycled Water means reclaimed water treated to a Class A Standard at the Western Treatment Plant.

River Water Only customer means a customer of Southern Rural Water who has NOT signed an agreement with Southern Rural Water to be supplied with Recycled Water within the Werribee Irrigation District.

Supply Control Valves means the valves owned, operated and maintained by Southern Rural Water immediately downstream of the Interface Points to control the supply of Recycled Water.

WID means the Werribee Irrigation District as defined under the Water Act 1989.

WTP means Melbourne Water's Western Treatment Plant at Farm Road, Werribee.

2. Abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council
Ca	Calcium
DHS	Department of Human Services
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
ECse	Soil Electrical Conductivity
ECw	Water Electrical Conductivity
EIP	Environment Improvement Plan
EPA	Environment Protection Authority
ESP	Exchangeable Sodium Percentage
GL	Gigalitres (1 GL = 1,000 ML)
ha	Hectare
HACCP	Hazard and Critical Control Points
ISO	International Standards Organisation
IMP	Irrigation Management Plan
K	Potassium
Mg	Magnesium
ML	Megalitres
N	Nitrogen
Na	Sodium
OHS	Occupational Health & Safety
PERFORM	Prompt Emergency Response for Melbourne Water
P	Phosphorus
QMP	Western Treatment Plant Recycled Water Quality Management Plan
SAR	Sodium Adsorption Ratio
SEPP	State Environment Protection Policy
SRW	Southern Rural Water
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
UV	Ultraviolet
WTP	Western Treatment Plant

3. Introduction

3.1 Purpose of the Regional Environment Improvement Plan

The Regional Environment Improvement Plan (EIP) for the Werribee Irrigation District (WID) Recycled Water Scheme aims to:

- Identify and explain the management of the environmental and health risks associated with operation of the recycled water scheme
- Address the concerns of growers and the wider community where these are met by implementation of management controls.

The EIP has been prepared and structured to meet the requirements of Victorian EPA publication No. 464.2 *Guidelines for Environmental Management – Use of Reclaimed Water* 2003 ('the EPA Guidelines').

3.2 Scope of the EIP

The EIP addresses environmental issues associated with the operation of the whole WID Recycled Water Scheme from the Western Treatment Plant (WTP) through to the use by Customers in the WID.

It aims to generally discuss issues for customers however site-specific details and controls are addressed in a separate Customer Site Management Plan (CSMP), which are prepared by each Customer.

3.3 Approval of EIP

EPA Victoria has formally approved this document as required by the EPA Victoria *Guidelines for Environmental Management – Use of Reclaimed Water* (the 'EPA Guidelines'). In approving this document, EPA Victoria formally endorses that the recycled water (including 'shandied' water) is environmentally sustainable provided it is used in accordance with the EIP and CSMP. The Department of Human Services (DHS) endorses that the recycled water is safe for human use by approving the Scheme as a Class A recycled water scheme. As part of this process a Stakeholder Reference Group has been consulted during the development of the EIP. The Stakeholder Reference Group consists of representatives from the Vegetable Growers Association, SRW Customer Consultative Committee, Rate Payers of Werribee South Inc, Werribee South Farmers Vic Inc, Werribee Young Farmers Group, Western Region Environment Council, Wyndham City Council, Environment Victoria and Port Phillip Westernport CMA.

4. General Scheme Description

4.1 Background

The Victorian State Government and Melbourne Water have adopted an objective of recycling 20% of treated effluent from Melbourne's Eastern and Western Treatment Plants by 2010.

The Western Treatment Plant at Werribee receives domestic sewage and industrial wastewater from the central, northern and western suburbs of Melbourne. The plant receives an average daily flow of around 500 ML. Three types of sewage treatment are employed at the plant including lagoon treatment, land filtration and grass filtration. Effluent is discharged to Port Phillip via four EPA Victoria licensed outlets.

The Western Treatment Plant is being progressively upgraded until 2005, essentially to meet EPA Victoria performance standards for effluent quality. This includes reducing nitrogen loads being discharged to Port Phillip by 500 tonnes per year. In addition treatment processes have been upgraded to meet Class A recycled water standards as defined by DHS.

The development of water recycling schemes reduces nitrogen loads to Port Phillip, improve security of supply for users, increase the economic viability of the region, and help to return environmental flows to the stressed Werribee River. Water recycling is a key component of the sustainable development in the Government's Werribee Vision.

4.2 Overview of the Werribee Irrigation District Recycled Water Scheme

The WID Recycled Water Scheme is Melbourne's largest commercial recycled water project. It represents a significant step towards achieving the Government's 20% recycling target by 2010. The project also aims to provide a sustainable future both for Werribee vegetable growers and the surrounding environment. This significant project will deliver up to 8,500 million litres of recycled water a year to over 100 growers in the WID. From December 2004, a six-kilometre pipeline carrying recycled water from the WTP will supplement the water supplies derived from the Werribee River and groundwater bores. Southern Rural Water (SRW) will be responsible for distributing the recycled water via the existing distribution system to its customers.

For the first five years, the recycled water will be mixed (shandied) with water from the Werribee River to reduce its salinity. SRW has developed an Irrigation Management Plan (IMP), which outlines the controls necessary to ensure that the salinity and other aspects of the shandied product do not impact on the long-term sustainability of the area. Key findings and recommendations from the IMP are included in this document. The full document is contained in Part 2: Supporting Documentation.

By 2009, Melbourne Water will have reduced the salinity of the recycled water to a sustainable level. This water will be of a suitable quality for horticultural use without restriction. After 2009, Customers will surrender their access to river water sales. Under the Government's White

Paper, *Our Water Our Future*, there is an undertaking to return the majority of the associated water savings to the Werribee River as environmental flows.

The recycled water scheme consists of the following infrastructure:

- A lagoon sewage treatment system including an activated sludge plant at the Western Treatment Plant
- A chlorine disinfection plant which will provide a chloramine residual
- An ultraviolet light (UV) disinfection plant
- Two pump stations located immediately before and after the UV and chlorine disinfection plants
- A transfer main from the Head of the Road Storage, which transfers recycled water from the WTP along side the Geelong Freeway to the junction with the SRW irrigation carriers (4/1 Pipeline and Main Channel) just north of the WID
- Two control valves and discharge structures immediately downstream of the point where the Melbourne Water Headworks System joins the SRW Distribution System
- Monitoring points within the treatment and transfer systems, which will ensure recycled water quality meets Class A and the EIP requirements
- Equipment to control shandyng of recycled and river water at the point that recycled water enters the SRW Distribution System
- Open irrigation channel system, on farm infrastructure and drains.

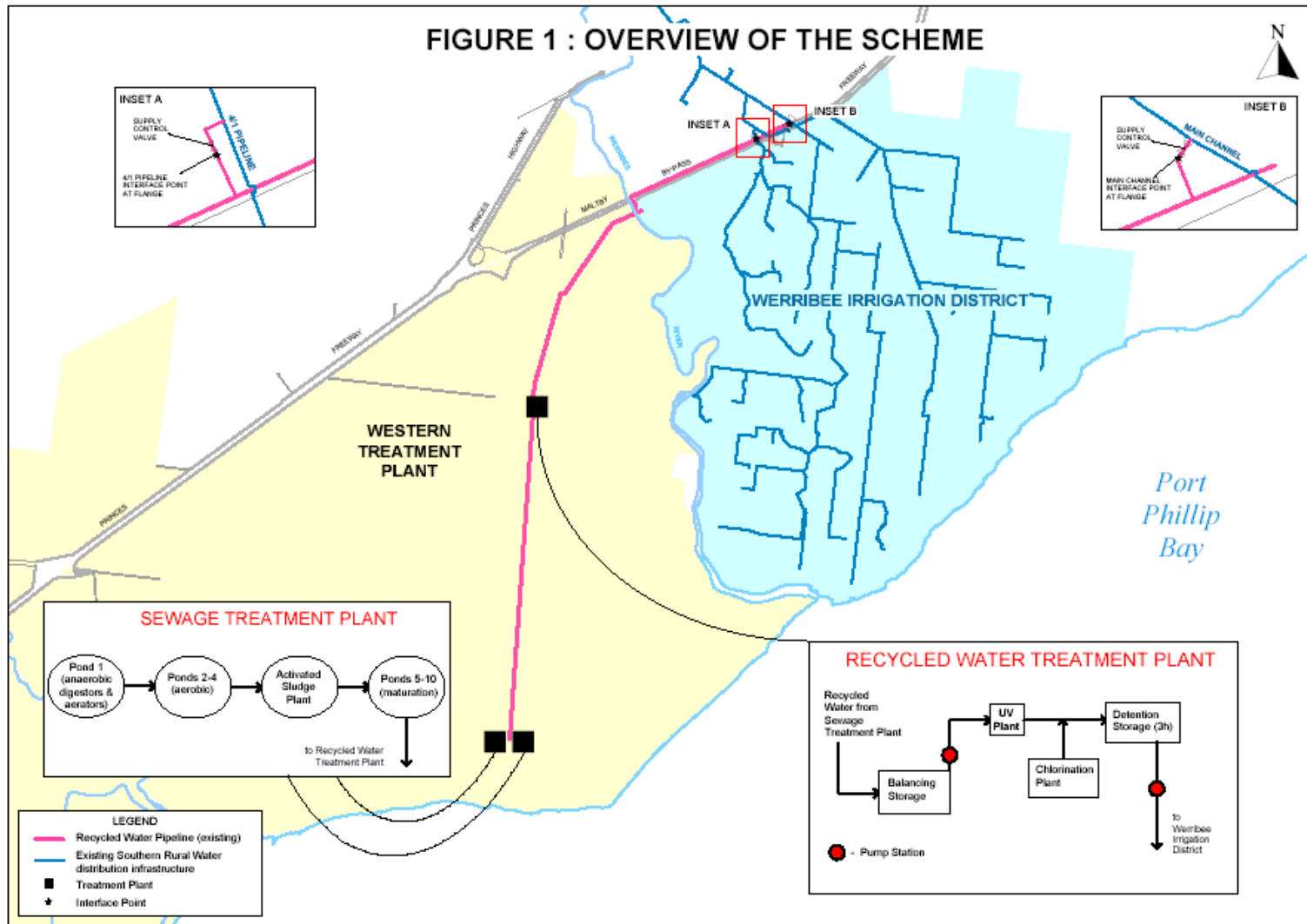


Figure 4-1 Overview of the Scheme

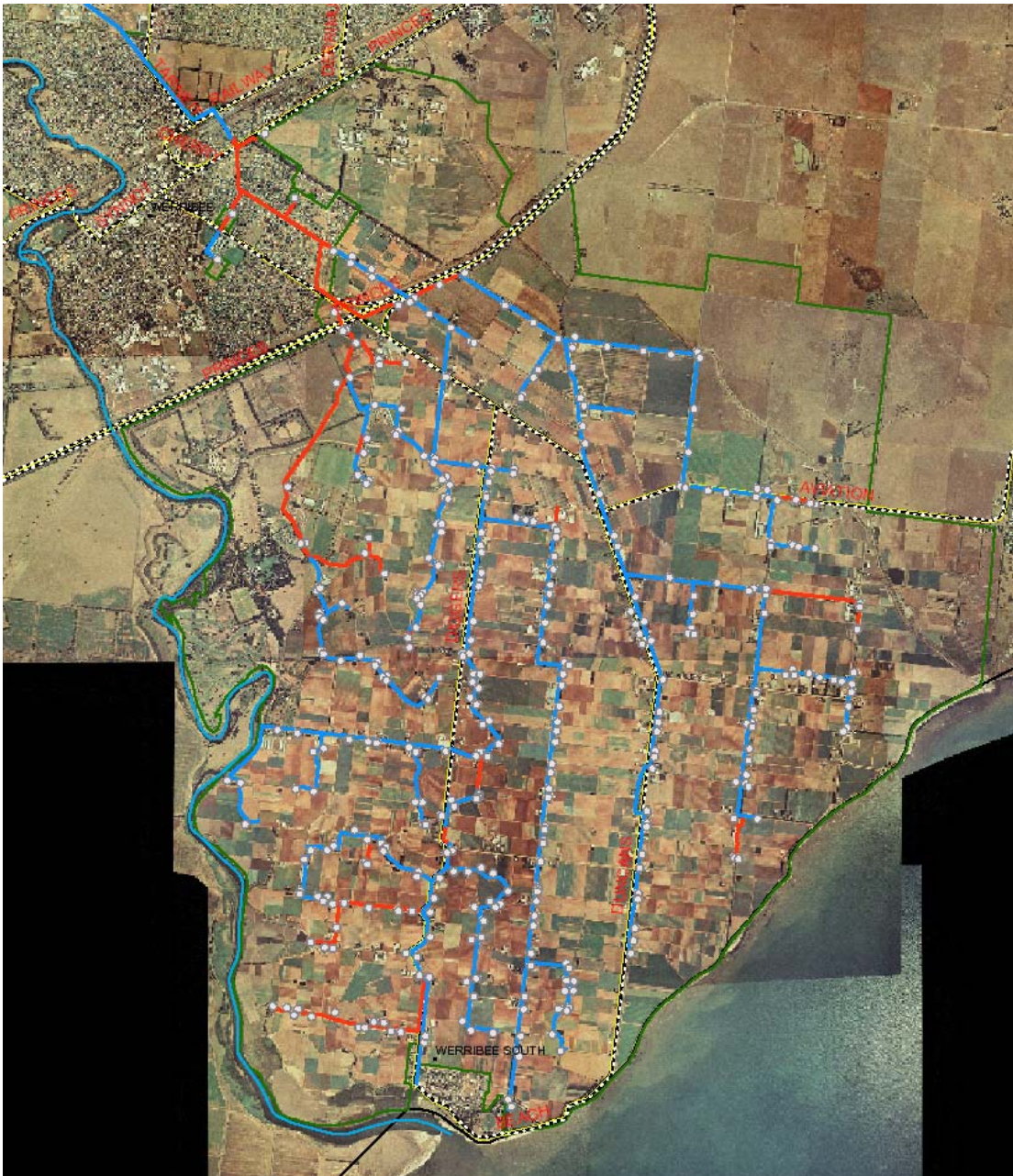


Figure 4-2 SRW Distribution System

blue lines = channels

red lines = pipelines

green lines = drains

The site plans of the individual Customers are included in each individual CSMP.

4.3 Customers

The recycled water will be distributed via the SRW irrigation channel system to the users within the district that have signed Customer Supply Agreements with SRW. It is expected that the number of Customers will increase with time.

The primary use of the recycled water within the district will be to irrigate crops predominated by lettuce, broccoli and cauliflower.

Additional details about each customer involved will be provided in individual CSMPs and a customer database maintained by SRW. Recordkeeping will comply with the requirements of the privacy legislation.

5. Roles and Responsibilities

The roles and responsibilities of the parties involved in the WID Recycled Water Scheme are set out in the following legally enforceable documentation:

- The Bulk Supply Agreement between Melbourne Water and SRW
- The Customer Supply Agreement between SRW and each Customer
- Memorandum of Understanding between SRW, Melbourne Water and DSE

The key points from these documents are detailed in the remainder of this section and elaborated in the appropriate sections of this EIP where further clarification is required.

Figure 5-1 provides a context by outlining the government relationships with respect to the Scheme and where the EIP fits into this context.

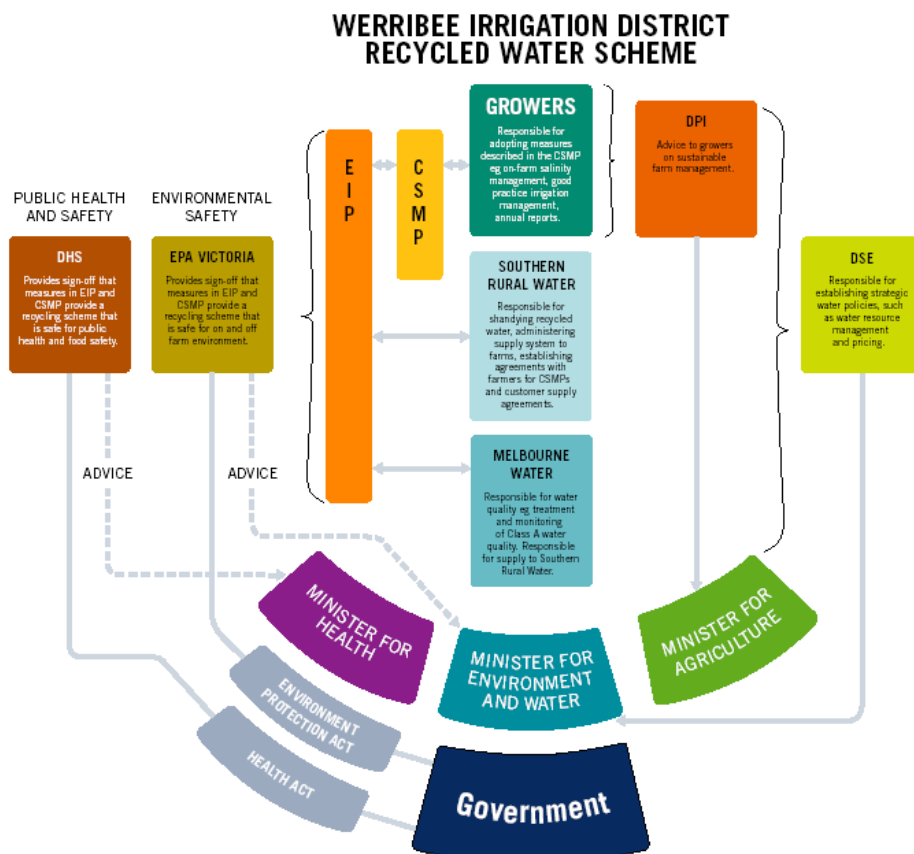


Figure 5-1 Government Relationships for the WID Recycled Water Scheme

5.1 Melbourne Water

Melbourne Water Corporation, as the bulk supplier of the recycled water for the scheme, is responsible for:

- Complying with the EPA Guidelines and the requirements of the EIP
- Supplying Class A recycled water in accordance with the requirements of the Bulk Supply Agreement
- Operating and maintaining the Class A treatment process and plant to achieve the quality standard
- Ensuring the Headworks System is operated in accordance with this EIP
- Maintaining the Headworks System
- Obtaining EPA Victoria endorsement of the EIP
- Coordinating the ongoing maintenance of the EIP
- Providing an annual report on findings and compliance to EPA Victoria (forward copy to SRW)
- Organising periodic independent audits (As defined in Section 16.13) of the areas of the EIP for which Melbourne Water is responsible
- Communications for recycled water in a Melbourne context
- Finalising and implementing (in consultation with City West Water and other stakeholders) the Salinity Reduction Strategy. This includes reducing the salinity of the recycled water to an electrical conductivity of 1,000 μ S/cm by 2009.
- Further investigating the rate of decay of chloramines through the Headworks and Distribution Systems
- Monitoring and further investigating the impact of boron and iron on crops grown in the WID and if necessary, initiating trade waste programs to reduce levels

5.2 Southern Rural Water

SRW, as the retailer of irrigation water to the WID, is responsible for:

- Complying with the EPA Guidelines and the requirements of the EIP
- Ensuring the operation of the Distribution System is undertaken in accordance with the EIP. In particular, ensuring the water supplied to the Customers is of a quality that is outlined in the agreed shandyng rules until the salinity of the recycled water is reduced to a sustainable level such that shandyng is no longer required. See Section 13.2 for the Shandy Rules.
- Operating and maintaining the Supply Control Valves and the Distribution System up to the customer supply point.
- Monitoring groundwater and surface water to ensure there are no adverse environmental impacts.

- Ensuring that each Customer has completed a CSMP, which meets the requirements of the EPA Guidelines, before recycled water is supplied
- Ongoing soil testing as outlined in Section 16.8
- Monitoring and auditing Customers in accordance with EPA Guidelines and verifying that customers are meeting the requirements of the CSMPs
- Keeping a register of information about the Customers including site addresses, quality and quantity of supply, and the end-uses of the water. This information will be reported each year to EPA Victoria.
- Informing the Customers of the potential risks associated with the use of the water, and assisting in the management of those risks. This includes the provision of Information Sessions as outlined in Section 17.5.
- Ensuring there is ongoing liaison with key stakeholders, including the community.
- Providing public on-line access to water salinity and nutrient information from the recycled water, river water and shandy water.
- Providing a reliable system for recording and responding to complaints
- Maintaining the sections of the EIP which cover the activities and responsibilities of SRW and the Customers
- Assisting Melbourne Water with the overall maintenance of the EIP including, but not limited to, the provision of updates to documentation upon reasonable request in writing by Melbourne Water
- Providing an annual report on its findings on compliance to EPA Victoria (forward copy to Melbourne Water)
- Communications in a local context
- Organising periodic independent audits (As defined in Section 16.13) of the areas of the EIP for which SRW is responsible
- Providing an extension officer (As defined in Section 17.6) including the provision of Information Sessions
- Develop the following plans within the timeframes specified in Section 16.15 to improve management practices:
 - Sustainable groundwater management plan (in response to existing issues)
 - Sustainable irrigation scheduling and application rates (in response to existing issues)
 - Soil health management plan, primarily focussing on soil sodicity (in response to existing issues)
 - Salinity management plan for the WID (in response to existing issues)
 - Nutrient management plan (in response to existing issues)

5.3 Customers

The Customers are responsible for:

- Using the recycled water in an environmentally sustainable fashion as defined by their CSMPs
- Maintaining any irrigation water distribution system on their site
- Use Recycled Water in accordance with the CSMP
- Allowing site access to SRW for the purpose of undertaking environmental monitoring
- Participating in site audits as required
- Reporting annually on compliance with the CSMP

5.4 EPA Victoria

EPA Victoria is responsible for the approval of the EIP and CSMP. EPA Victoria provides formal endorsement that the scheme is environmentally sustainable provided the EIP and CSMP are complied with.

5.5 Department of Human Services

DHS is responsible for the endorsement of the recycled water as Class A. Melbourne Water will submit the WTP Recycled Water Quality Management Plan (QMP) and detailed disinfection plant validation results to support the application for endorsement. DHS provides formal endorsement that the scheme is safe for public health and food safety, provided the EIP, CSMPs and QMP are complied with.

5.6 Department of Sustainability and Environment

The Department of Sustainability and Environment (DSE) is responsible for establishing strategic water policies, such as water resource management, pricing and communications in a state context.

5.7 Department of Primary Industries

The Department of Primary Industries (DPI) is responsible for enabling the recycled water to be used in an economically sustainable way for the irrigators.

The Department of Primary Industries has extension programs that operate throughout the region. The Department of Primary Industries has committed a dedicated extension officer for the WID to make recommendations to DSE on the future extension needs, to aid in completion and maintenance of the CSMP, and to aid irrigators with all decision making surrounding the recycled water.

5.8 EIP Representatives

The EIP Representatives listed below shall be responsible for reporting and the periodic review and maintenance of the EIP and related documentation. They shall be the primary point of contact in each organisation for issues relating to the EIP. The EIP Representatives shall liaise with the Operating Representatives, as defined in the Bulk Supply Agreement.

If the names, positions or contact details of the EIP Representatives change, each party must notify the other party and amend the EIP accordingly.

SRW EIP Representative:

Name and/or Position:

Phone:

Postal Address: 1 Tower Road, Werribee VIC 3030

Melbourne Water EIP Representative:

Name and/or Position:

Phone:

Postal Address: PO Box 4342, Melbourne VIC 3001

6. Recycled Water Quantity

6.1 Water Resources available to the Werribee Irrigation District

The modelling undertaken for the Werribee and Bacchus Marsh irrigation supply system predicted the system can provide sufficient volume to meet water right allocations in 97 out of 100 years. The 1966/67 drought was the last time that 100% water allocation was not available and the reduced allocation again in 2003/4 is within this prediction.

The WID customers have water rights to take water from the Werribee River on a take or pay allocation. Flows in the Werribee River are controlled by SRW which determines releases from the Melton, Pykes Creek and Merrimu Reservoirs upstream.

The seasonal allocation methodology is applied and has been the basis for water allocation in the Werribee basin for many years. In the first instance, water right must be secured before any other allocation is made available. Once this is secured, 10,000 ML is then set-aside for the next irrigation season. Any additional amount is then allocated as “sales” entitlement. The allocation is reviewed monthly and any changes are communicated to customers to enable them to make their on-farm decisions. Importantly, the system is not capable of withstanding a prolonged drought.

SRW holds water consumption records for each customer in the WID. Historically the customers have used 130% of their water allocation supplementing their requirements either from surplus river water or their licensed entitlement of ground water. Typically the District has 10,000 ML/ annum of water rights, uses 3,000 ML/annum of sales water from the Werribee River and 2-3,000 ML/annum of bore water. For a detailed list of delivered volumes, refer to Table 1.3 in the Irrigation Management Plan (Part 2: Supporting Documentation).

Prior to 2002, water availability has not been severely restricted. This has resulted in high water use practices within the WID that may be able to be refined through efficient irrigation scheduling (RMCG and URS, 2004).

In Summer 2003/4 prolonged drought conditions resulted in a ban on the use of ground water being enforced, whilst the allocation of river water was reduced to 40%, hence precipitating the need for a Rescue Package negotiated between a group of customers and the state government in December 2003.

The Rescue Package that was negotiated outlined in addition to existing surface water rights and a short-term supply of potable water, the growers could have access an allocation of recycled water. The package negotiated between grower representatives and the government consists of two stages that were further refined in October 2004. The first stage, referred to as the Interim Package, outlines the package until 2009. The Interim Package was negotiated to reflect the fact that the salinity of the recycled water constrained the volume of recycled water that could be supplied. The salinity of the recycled water will be reduced to a sustainable level by 2009 through the WTP Salinity Reduction Strategy. The second stage refers to the package after 2009. After 30 June 2009, recycled water customers will surrender their rights to sales water.

As a result of the negotiated package, a disinfection plant, pump stations and a pipeline from WTP were constructed with a capacity of 55 ML per day. This capacity was designed to improve the long-term security of supply to the WID and to allow for future growth.

6.2 Reliability of Supply

Melbourne Water is committed to providing SRW with 55ML per day of Class A recycled water with a system reliability of 95% over any monthly period, excluding power outages. Until 2009, SRW is responsible for the salinity of the shandied product due to mixing Werribee River water with recycled water. The reliability of the supply of this shandied irrigation water will be dependent on the salinity of both the recycled and river water, and the recommendations of the IMP. The IMP defines the salinity trigger levels to protect crops, soils and groundwater.

Issues of security of supply for recycled water from Melbourne Water are covered by a Bulk Supply Agreement between Melbourne Water and SRW. The Customer Supply Agreements between SRW and the customers cover the security of supply of shandied water. These agreements take into account constraints such as those set out above.

7. Recycled Water Quality

7.1 Sewage Treatment at the Western Treatment Plant

The Western Treatment Plant at Werribee is one of the largest sewage treatment plants in the world, covering approximately 11,000 hectares. It serves about 1.6 million people in the central, northern and western suburbs, and treats about 54 per cent of Melbourne's sewage. It also services most of the city's industrial areas. On average, it treats about 500 ML per day of sewage before discharging treated effluent to Port Phillip under an EPA Victoria discharge license.

The majority of sewage is treated through the advanced 55 East and 25 West lagoon systems. They treat sewage by passing it slowly through a chain of ten ponds, allowing naturally occurring bacteria to consume biodegradable matter. The first stage of lagoon treatment is a covered anaerobic (without oxygen) process, where bacteria digest organic material. The anaerobic reactor speeds bacterial digestion and membrane covers over this section of the lagoon capture the biogas, which is generated during anaerobic digestion. The biogas is used to generate electricity to run the plant and also reduces greenhouse gas emissions and odour. From here a portion of the effluent flows through ponds 1-4 before activated sludge treatment. The remainder is diverted directly to the activated sludge plant to remove nitrogen. The whole flow then traverses the final 5 ponds to pond 10 where it is either discharged into Port Phillip or recycled for use on the paddocks of the Werribee Farm. The portion that is diverted to the WID Recycled Water Scheme is disinfected with UV radiation and chlorine.

The remaining 20% of sewage is treated in modern lagoon systems with a similar pond structure but no activated sludge process.

Refer to Section 4.1 for a schematic and Appendix B for a more detailed treatment flow diagram.

Initially, recycled water will be supplied from only the 55East lagoon system at the WTP. The upgraded 25West lagoon system was recently commissioned. It is expected the treated effluent from the 25West lagoon system will be approved by the DHS as Class A recycled water by the end of 2005. Once approved, recycled water will be able to be supplied via either lagoon system, hence further improving the reliability of supply.

7.2 Legislation and Guidance Governing Recycled Water Quality

Effluent quality at the Western Treatment Plant is governed by its EPA Victoria accredited licence issued under the *Environment Protection Act 1970*. This licence is designed to minimize the environmental impact of the discharge to the receiving environments including Port Phillip. Treatment at the plant has been 100% compliant with this licence since 1998/9. In addition, the WTP on-site EIP identifies and sets challenging targets for all significant environmental issues related to the plant.

The EPA Victoria *Guidelines for Environmental Management: Use of Reclaimed Water (2003)* set the level of treatment and water quality objectives needed to address environmental, public health and quality issues associated with the nature of the end-use scheme. If recycled water is used for irrigation on crops that are to be eaten raw, the recycled water must comply with EPA Victoria Class A. Class A recycled water undergoes treatment processes that reduce pathogens to such low levels that they do not pose a risk to health from sensitive end-uses such as application on crops consumed raw.

The *ANZECC (2000) Australian New Zealand Guidelines for Fresh and Marine Water* also discuss water quality in the context of irrigation for agricultural use. In particular the guidelines cover salinity, sodicity, chlorine and heavy metals and sets trigger values where appropriate. These have been considered in developing the scheme and the IMP.

7.3 Quality Requirements for Recycled Water

The recycled water for the WID meets the requirements for Class A recycled water as defined in the EPA Guidelines. The key parameters that the water has to meet through the treatment processes are listed below:

<10 E. coli per 100ml

<1 helminth per litre

<1 protozoa per 50 litres

<1 virus per 50 litres

In addition ANZECC Water Quality Guidelines include trigger values for a range of parameters including biological parameters, salinity, sodicity, inorganic constituents (nutrients) and pesticides that may potentially impair the environment. The Water Quality Guidelines aim to maintain the productivity of irrigated agricultural land while protecting associated water resources, in accordance with principles of Ecologically Sustainable Development. The guidelines are in Table 9-5.

7.4 Treatment Requirements for the Werribee Irrigation District

EPA Victoria has confirmed that water from the lagoon systems treatment at the WTP meets Class B recycled water quality requirements. To meet Class A requirements, further disinfection is required. This is achieved by use of a UV disinfection plant and a chlorine disinfection plant, which comprises chlorine dosing and appropriate contact time. This ensures there is reliable reduction of pathogens to the levels required for Class A.

The addition of chlorination to the treatment chain for the recycled water is not without some environmental and occupational health and safety risks. These risks and their associated controls are listed in the Table 7-1.

Table 7-1 Environmental risks associated with chlorination of recycled water

Risk	Controls	Controlled Risk
Chlorine gas leaks from the disinfection plant impacting on staff and local wildlife values	A system of maintenance, detectors, alarms and contingency plans in compliance with the Dangerous Goods Act and OH&S requirements has been implemented.	Low
Leaks to groundwater of chlorine disinfected recycled water from the disinfection retention storage before residual levels of chlorine / chloramine have reached acceptable levels	The disinfection retention storage is lined with both lime stabilised soil and a HDPE liner. The welds in the latter were completed under a QA system.	Low
Residual chloramine levels could impact on soil or aquatic organisms if recycled water leaks from the pipeline.	Pipeline is constructed to WSAA standards and pressure tested prior to use. Standard leak testing has been undertaken. Results of these tests have been far below the upper limits.	Low
Disinfection failure leads to need for chlorinated recycled water not meeting Class A standard to be discharged to the environment.	The chlorination plant includes a control interlock that uses the chlorine level and the detention time to assess whether the disinfection target (CT) has been met. If the target is not met, the supply pumps are disabled, preventing recycled water supply to the WID. Water that has not met the Class A disinfection requirement is redirected to the on-site irrigation scheme at the WTP as Class B recycled water and not supplied to WID customers	Low
Scouring of pipes leads to chlorinated recycled water to be discharged to the environment.	Scours are rerouted back to lagoon treatment via the western trunk sewer or diverted into the on-site irrigation system for use by the Werribee Agricultural Group at the Western Treatment Plant. Some scours require the water to be pumped into a tanker and transported to WTP.	Low

Risk	Controls	Controlled Risk
Chlorination process results in excessive levels of chloramines which can damage leaves of more delicate crops	Reid (2004) concluded that, and EPA Victoria has subsequently endorsed, a chloramine level of 4 mg/l will not have a phytotoxic effect. Residual chloramine levels are monitored to ensure that on leaving the chlorination plant detention storage they are below this trigger level. As the water leaves the detention storage the concentration will reduce further during the time it takes for the water to reach the crops.	Low

7.5 Current Recycled Water Quality

A summary of the effluent quality in the 12 months to October 2004 is provided in Appendix D. Melbourne Water is continuing to upgrade the WTP, therefore it is expected that effluent quality will progressively improve in the future.

7.6 Treatment Reliability

7.6.1 Risks and Controls for Recycled Water Quality

The potential risks to the quality of recycled water delivered by Melbourne Water are listed in Table 7-2 together with details of the appropriate controls:

Table 7-2 Water Quality Risks and Controls

Risk	Controls	Controlled Risk
Significant storm events causing effluent to pass more quickly through the lagoon system	With multiple ponds in series the lagoon system has plug flow hydraulics. This means that extra flow into the lagoon system simply pushed extra flow out of the final pond. The net effect is a day reduction in detention time for every extra day of flow into the lagoon. The disinfection system has been designed to cater for poorest quality lagoon effluent including wet weather events. For further information, see the WTP Recycled Water Quality Management Plan in Part 2: Supporting Documentation.	Low

Risk	Controls	Controlled Risk
Breakdown in the activated sludge process	Maintenance and on site contingency plans WTP Recycled Water Quality Management Plan reference	Low
Algal blooms in the 55E lagoon system	Algal Bloom Contingency Plans (see Appendix E)	Low
Failure of the UV and chlorination process to meet treatment parameters	The chlorination plant includes a control interlock that uses the chlorine level and the detention time to assess whether the disinfection target (CT) has been met. If the target is not met, the supply pumps are disabled, preventing recycled water supply to the WID. Water that has not met the Class A disinfection requirement is redirected to the on-site irrigation as Class B recycled water and not supplied to WID customers. The UV system will be validated under 'worst case' quality conditions. Online monitoring will continuously verify water quality and UV dose to ensure disinfection performance.	Low
Growth of biofilms in the Melbourne Water delivery pipes to SRW could block filters, pumps and irrigation heads. There is no risk to health.	Residual chloramine levels from the chlorination process should prevent growth. Disinfection scours can be performed if problems occurring on farms are due to biofilm growth in Melbourne Water's pipeline.	Low

The recently-commissioned infrastructure improvements at the 25W treatment lagoon will lead to the production of effluent of the similar quality as the 55E lagoon. Upon Class A approval from the DHS, the alternative supply will help to further improve reliability of the production of Class A recycled water from the WTP.

7.6.2 The WTP Recycled Water Quality Management Plan

The WTP Recycled Water Quality Management Plan (QMP) has been developed to ensure that Melbourne Water undertakes its activities in a manner that supports its commitment to provide quality recycled water for customers in the WID. The QMP has been endorsed by the DHS. It references the plans, policies, procedures, standards and appropriate work practices that ensure that risks are appropriately managed. The QMP uses the HACCP process to manage risks. HACCP is a quality management approach used predominantly to assure food safety but is being strongly adopted by the water industry. The adoption of the HACCP system enables independent certification to be obtained.

The QMP covers processes that are managed by Melbourne Water for the 55 East lagoon system. Specifically, from the point of transfer into the WTP at the Western Trunk Sewer, to the Interface Points with the SRW Distribution System. It covers the processes taking place in the sewage treatment lagoons, the activated sludge plant, the UV plant, the Chlorination plant and Melbourne Water's recycled water storage reservoirs. It identifies three critical control points; quality of the water in the treatment lagoons, the UV disinfection and the chlorine disinfection.

Monitoring of the water quality in lagoon 6 and 8 will indicate whether the lagoons are treating the water as expected. By monitoring indicator organisms like E.coli which have rapid analysis techniques there is sufficient time built into this control for laboratory test to be returned, before treated effluent is diverted from lagoon 10 for recycling. Any deviation from set critical limits will result in recycled water being drawn from alternative Class A certified lagoons or the supply being discontinued until the necessary criteria are met. The disinfection system has been designed to cater for worst-case conditions from tests over the last 3 years. Therefore it is only in extreme events that supply would need to be interrupted. As additional controls, a UV plant and a chlorination plant have been installed to disinfect the effluent from the lagoons before it enters the WID pipeline.

The UV disinfection is provided to ensure protozoa (*Cryptosporidium* and *Giardia*) are reduced to safe levels. UV disinfection is controlled to ensure the correct dose is applied. The applied dose is a function of UV lamp output, the attenuation of the UV light by the water (transmittance) and the recycled water flow being treated. During commissioning, the UV disinfection system was validated by demonstrating appropriate removal of a test organism. This defined minimum values for UV lamp output and transmittance and maximum flow. These are monitored continuously to ensure the plant provides the required level of disinfection.

The chlorination plant is designed to provide a 2-log removal of viruses. Chlorine disinfection control is defined by the contact time and concentration of chlorine (CT). The CT target value has been set and ensures that under poorest lagoon effluent conditions, the chlorine dose and detention time applied to the recycled water will enable a 2-log reduction in viruses. The CT is a critical control point (CCP) and is measured using online monitoring equipment. Both the chlorine concentration and the detention time are monitored and the CT calculated continuously. An alarm and automatic cutoffs preventing recycled water leaving the plant will be activated if there is any failure to meet the desired CT value.

When chlorine reacts with residual ammonia in the lagoon effluent chloramines are produced. If the chloramine residual in the water used for irrigation is too high, it can damage delicate leaf crops such as lettuce. Reid (2004) concluded that, and EPA Victoria subsequently endorsed, a chloramine level of 4 mg/l will not have a phytotoxic effect on the crops grown in the WID. The disinfection plant has been designed for chlorine levels around 5mg/l as the water leaves the disinfection plant detention storage with concentrations dropping further during the time it takes for the water to reach the crops. The continuous monitoring of chlorine levels will also be used to ensure the chlorine level does not exceed safe levels. An alarm will be triggered and pumping stopped if the chlorine level exceeds the maximum value.

The water quality monitoring program is discussed in Section 16.2.

7.6.3 Risks and Controls for Shandied Water Quality

The Class A recycled water is mixed or shandied with water from the Werribee River by SRW. The Werribee River water quality does not need to meet Class A requirements and parameters like salinity, nutrients and pollution levels vary seasonally and after storms. Monitoring of river water quality is carried out continuously for salinity (EC) and monthly for other parameters to provide trend analysis as outlined in Section 16. The outcomes for salinity (EC), E. coli, Total Phosphorus, Total Nitrogen, Total Kjeldahl Nitrogen (TKN) and Oxidised Nitrogen over the 3 years dating back to June 2001 are shown in the graphs in Appendix F.

To ensure that the use of recycled water is sustainable in the short and longer term in the WID, consultants were appointed to carry out a study to address the environmental issues of concern for the area. This study, the IMP, is discussed further in Section 9. The final report details the controls that are necessary to protect the quality of the soils, crops and environment. SRW has incorporated some of these requirements into a procedure governing the mixing of recycled water and river water. See Section 13.2 for the Shandy Rules.

In conjunction with the IMP, a Salinity Reduction Strategy has been developed by City West Water and Melbourne Water to outline how salinity levels in recycled water will be reduced to a sustainable level by 2009.

8. Werribee Irrigation District Characteristics

8.1 Introduction

This section examines the characteristics of the area to provide the context for the discussions in Section 9 of this EIP, which summarises the results of the IMP. Input from the Marsden Jacob Werribee Review in 2003 and the Irrigation Management Plan completed in September 2004 are included here as appropriate.

8.2 Geology

The WID consists of the Werribee Delta Sediments that cover the whole area except for small areas along the Werribee River that consist of recent alluvial sediments.

The Werribee Delta Sediments form an alluvial fan that is generally not more than 30m thick and is comprised of silts, sands and minor gravels (Nolan-ITU, 2001). The Werribee Delta Sediments overlie the following geological units:

- newer volcanic basalt;
- tertiary sediments (including the Brighton Group, overlain by Fyansford Formation, in turn overlain by the Werribee Formation); and
- bedrock (undifferentiated, possibly Ordovician or Silurian marine sediments)

8.3 Landforms

The majority of the WID has now been laser graded and as such appears as a plain of cultivated paddocks gently sloping to Port Phillip.

The area is situated on the eastern bank of the alluvial delta of the Werribee River. The surface alluvium of the delta soils is derived from basalt and sandstone and is represented by soils ranging from red brown clay loams to fine sandy loams. These highly mineralised soils are fairly well textured, but inherently low in organic matter.

8.4 Soils suitable for Irrigation

The area is already using irrigation, predominantly by overhead sprinklers. Marsden Jacob (2003) and the IMP (RMCG and URS, 2004) concluded that the soils of the WID are excellent agricultural soils due to their superior drainage capability. These soils are suitable for intensive agriculture such as growing vegetables. The majority are classified as Irrigation Class II (Table 8-1).

Table 8-1 Major soil types of the Werribee Irrigation District and their agricultural capacity

Soil type	Soil Class	Crop suitability	Potential leaching fraction
Werribee Fine sandy Loam (light)	Class I	Suitable for most vegetables except asparagus and some specialty vegetables	>20%
	Class II		12-20%
Werribee Loam (medium)	Class II	Suitable for most vegetables except asparagus and some specialty vegetables	12-20%
Duetgam fine sandy loam (light)	Class I	Suitable for most vegetables except asparagus and some specialty vegetables	>20%
	Class II		12-20%
Hopper clay loam (heavy)	Class II	Suitable for most vegetables except asparagus and some specialty vegetables	12-20%
	Class III		8-12%

Recent soil test results indicate that the existing soil salinity should be severely impacting on crop yields (RMCG and URS, 2004). This has not occurred due to the primary salt contributing to the elevated salt level being calcium nitrate, rather than the toxic sodium chloride and the use of frequent irrigation on hot days. The IMP has further highlighted effective management practices employed by WID growers to avoid yield reductions such as maintaining high soil moisture and the application of calcium nitrate and gypsum.

Irrigated soils in the WID are slightly sodic, which infers that impacts on soil structure are possible. Current irrigation management ensures that soil sodicity does not significantly impact on soil structure and drainage capacity, primarily through the application of gypsum to the soil.

Nutrient application rates to the soils of the WID are high and it is likely that the high concentration of phosphorus in the soils will cause elevated concentrations of phosphorus in surface water runoff in the WID (see Section 9.3.3). It is also possible that significant amounts of nitrogen are being leached from the soils and may be reaching groundwater (see Section 9.3.2). Management of these environmental impacts are discussed in detail in Section 9.

Historical data on soils has not been sufficient to establish a baseline of current levels of salinity, sodicity, nutrients and heavy metal contamination. A limited survey of these data have been recorded in the IMP (RMCG and URS, 2004). In order to obtain baseline data, soil testing will be conducted as per the CSMP and Section 16.8. SRW will organize this baseline monitoring on behalf of the growers.

8.5 Groundwater

Groundwater salinity varies across the WID from relatively fresh to extremely saline (Table 9-3, Section 9.1.4). There is also a threat from saline intrusion either from seawater or adjacent aquifers, which could be facilitated by continued extraction above sustainable extraction rates. As a result, SRW manages groundwater extraction and in times of severe drought can result in a ban on extraction, as occurred in Summer 2003/4. SRW monitors a series of boreholes to measure water levels, salinity and nutrients across the District. A location map for groundwater monitoring boreholes is in Appendix G.

Groundwater levels are currently kept well below the surface by the ongoing pumping of groundwater for irrigation purposes. Any changes in current pumping practice may impact on groundwater levels, and the risk of saline intrusion due to falling groundwater levels or to crops from surface salinisation due to rising water levels will need to be identified via monitoring and addressed as appropriate (see Section 16.6).

SKM (2004) identified the principal source of water entering the aquifer is through vertical recharge processes associated with rainfall, irrigation accessions and channel leakage. Outflow from the aquifer is dominated by groundwater extraction for irrigation with lesser, but still substantial contributions from sub-surface outflows, discharge to the Werribee River and to Port Phillip (SKM 2004).

The model developed by SKM (2004) has demonstrated a number of important hydrogeological features of the aquifer that have arisen in the past two years as it has become stressed by increased groundwater extraction and reduced recharge from irrigation accessions. These features include:

- Accelerated drawdown apparent over the entire WID from 2002 to present;
- A general reversal in flow to the Werribee River. Under normal conditions water discharges from the aquifer to the Werribee River bed. As groundwater heads have declined in the aquifer in recent years the flux of water discharging to the Werribee River has decreased and a reverse flux of water out of the Werribee River into the aquifer has developed. The significance of this finding is that the Werribee River is tidal and contains saline water within much of the WID and hence the water entering the aquifer from this source is saline;
- A reversal of flow to Port Phillip. Under normal conditions flows at the coast are primarily from the aquifer to Port Phillip. As the aquifer has been stressed in recent years this flux has been reduced and a reverse flux of water from Port Phillip to the aquifer has developed.

Results obtained from the numerical modelling study by SKM (2004a) can be used to develop effective methods of managing the groundwater resource. Of particular interest is the establishment of trigger levels in key observation bores that are aimed at identifying critical drawdown levels that define the acceptable groundwater levels at key observation bores. The trigger levels are related to the onset or prevention of potentially adverse impacts associated with the flux of water from Port Phillip to the aquifer and the flux of water from the Werribee River to the aquifer.

It is predicted that modest levels of groundwater extraction can be tolerated over the next two years without risking major water quality decline (SKM 2004a). The aquifer would be expected to return to its “normal” condition (ie those conditions commonly observed prior to 2002) over

the medium term, if the groundwater extraction is limited to 25% of allocation or less in the next two years. Further recovery is dependent on surface water irrigation allocations in future years. Low levels of groundwater extraction allow the aquifer to recover over time and the modelling has indicated that after a few years of groundwater extraction at rates less than 25% of allocation the aquifer will nearly have returned to pre-2002 conditions. Note that this is not a "full" recovery to the highest-ever recorded levels but is considered a sufficient recovery to avoid the risk of water quality decline.

Continued groundwater extraction at 50% or greater of the total licensed volume is very likely to result in high rates of flow of saline water (compared to pre-2002 conditions) from the Werribee River and Port Phillip into the aquifer. This is considered to be highly damaging to the water quality of the aquifer and such conditions should be avoided. Consequently SRW has set groundwater extraction at 25% for the next two years to allow for groundwater recovery.

8.6 Werribee River

The Werribee River is generally no greater than one metre above mean sea level along much of the WID. The river is tidal as far upstream as just after the Werribee Park Golf Club (approximately 4 km from the river mouth)(SKM 2004a). SKM (2004a) concluded that the potential for leakage of salt water into the aquifer from the river increases substantially as drawdown within the District increases.

After 2009, Customers will surrender their access to river water sales. Under the Government's White Paper, *Our Water Our Future*, there is an undertaking to return the majority of the associated water savings to the Werribee River as environmental flows.

8.7 Drainage

An extensive network of surface drains, which often run parallel to existing water supply channels, governs surface drainage in the WID towards the south, into Port Phillip and the Werribee River. There are twelve drains in total, six drain directly to the Port Phillip and six drain directly to the Werribee River (pers comm. Jeff Bonning, SRW). Eight of these drains have capability to have channel water discharged directly to them. However, these drains predominantly collect both irrigation and rainfall runoff, and carry nutrients, particularly phosphorus and nitrogen, to Port Phillip. Monitoring of the drainage water shows elevated levels of salinity (EC approximately 1000 $\mu\text{S}/\text{cm}$ and nutrients (N and P) approximately 1.2 - 1.3 mg/L). However, flow volumes in the drains are predominantly from intense rainfall periods and overall are relatively low (Figure 8-1). For example, 210ML per year for one of the major drain, compared with 30% losses in the channel (

), therefore the potential for negative impacts is limited (RMCG and URS, 2004). The data also highlights that current irrigation practice contributes little flow to the drains and any significant flow is linked with heavy rainfall events.

	Channel volume delivered ^A (ML)	Pumped from diversion weir in Werribee River ^B (ML)	Loss through leachage in channel ^B (ML)
Average	10608	15154	4546
Minimum	7672	10960	3288
Maximum	13715	19593	5878

^AData from 1990/91 to 2003/04 (RMCG and URS, 2004)

assumes 30% leachage from volume delivered (SKM, 1998)

Table 8-2. Estimated leakage from channels into the groundwater in the Werribee Irrigation District.

SRW has a permanent monitoring station for phosphorus and nitrogen on a major drain to monitor the level of nutrients being exported from that catchment. Whilst concentrations of nutrients are high, there has been only one significant flow event to carry a load of any magnitude into Port Phillip in the 3 years to March 2004 (Figure 8-1). This occurred during a large rainfall event.

Total nitrogen concentrations in surface water drainage average 1.3 mg/L with a maximum of 4.5 mg/L and a minimum of 0.1 mg/L (RMCG and URS, 2004). Total phosphorus concentrations in surface water drainage average 1.2 mg/L with a maximum of 8.5 mg/L and a minimum of 0.1 mg/L (RMCG and URS, 2004). These levels are low compared to those found in the groundwater and are above those in the Werribee River water. The nitrogen and phosphorus are most likely to originate from fertilisers applied to the WID soils, which are then picked up by surface water run-off. These levels are above the acceptable levels for surface waters of 0.6 mg/L as prescribed by the SEPP (Waters of Victoria). The potential for impacts on receiving waters is strongly restricted by the low flow volumes (Figure 8-1) in the drains, which ensure the total additional nutrient load is relatively low.

The irrigation classes of the WID soils and irrigation practices indicate that there is significant subsurface drainage in the WID (Table 8-1). They can support a high leaching fraction, which helps control salinity in the root zone.

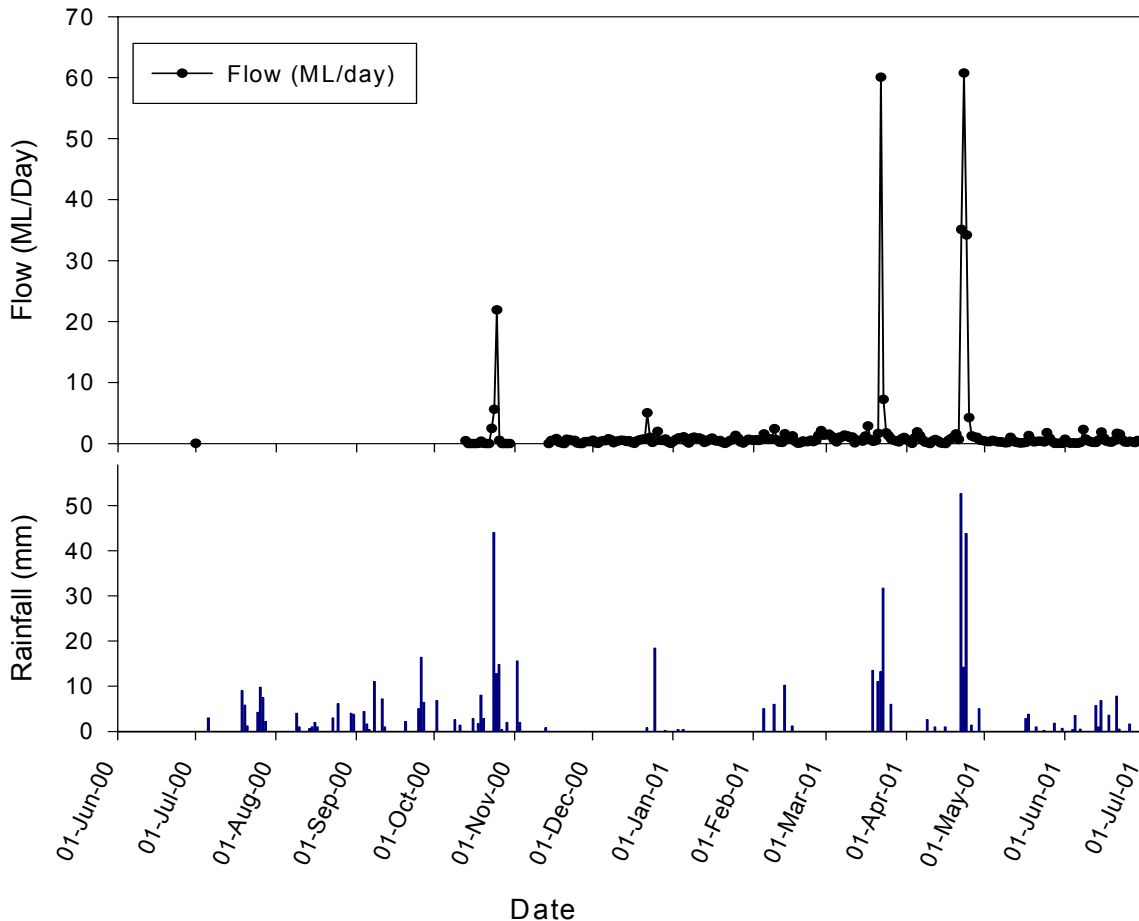


Figure 8-1 Comparison of rainfall and flow of a major drain in the WID.

Total flow for the year was 210 ML and rainfall was close to average (524 mm compared with the average of 557 mm (see Climate section below).

8.8 Existing land uses

The WID covers an area of approximately 2,900 ha, of which over 70% is considered suitable for vegetable production. The area is almost fully developed with the capacity for expanding the irrigated area limited to no more than 250 ha with the majority of this being located in the north-east of the District.

The WID is intensively subdivided with the number of allotments totalling 405 in 2001, an increase of 100 allotments since 1978. In 2001 over 50% of allotments were less than 8 ha in size with a further 37% between 8 ha and 16 ha (Marsden Jacob, October 2003).

However the actual number of landowners and management units are contracting with the average farm management area being estimated by Phillips to be around 25 ha in 2001 and increasing. These trends are occurring through leasing rather than land sales.

Land use within the WID is dominated by market gardening (See Figure 8-2), accounting for over 82% of the total area with pasture and lucerne production accounting for a further 15%.

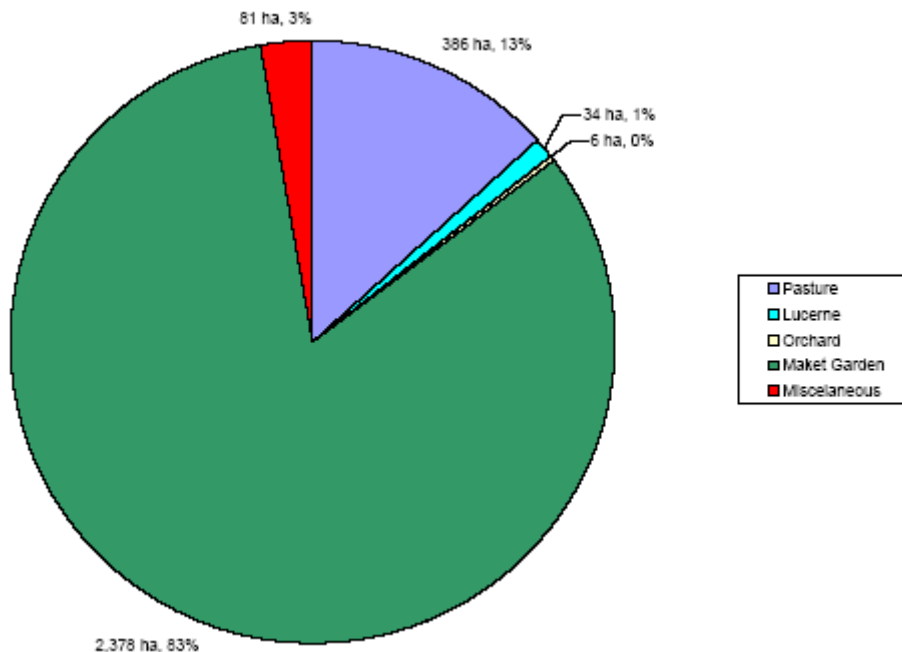


Figure 8-2 Irrigated land use of the WID (2002/2003; Marsden Jacob Associates 2003)

The main vegetable crops grown are broccoli, lettuce and cauliflowers accounting for over 80% of the intensive market garden area, with smaller areas of cabbages, onions, artichokes, celery and fennel also grown.

Up to 4 harvests a year are grown due to the use of overhead irrigation sprinklers and plant seedlings from nurseries rather than direct seeding. Irrigation methods in the district are commonly fixed overhead sprinklers utilised for vegetable growing. The overhead sprinkler irrigation systems are efficient compared with other forms of irrigation, except drip irrigation. Drip irrigation has been trialed in the WID but not adopted. Drip irrigation could offer some water use efficiencies and some benefits in managing potential impacts from saline water. These potential benefits are unlikely to be seen in the short term because:

- It would take a long time (up to ten years) for practices to change and an investment in drip irrigation to occur.
- Drip irrigation will not be appealing to Customers based on water use efficiency or environmental improvement alone, there must be significant production benefits to drive the investment.
- Drip irrigation needs to be verified as the most efficient and productive method for irrigation in the WID.

Most farms in the District contain houses that are generally occupied by the land managers.

8.9 Climate in the WID

Records from the Laverton RAAF and Werribee Research Farm show little difference in measured evaporation and rainfall (Table 8-3). As the Laverton RAAF weather data is more recent, this has been used for the following observations. Average annual rainfall in the WID is 557 mm with 10th percentile 376 mm and a 90th percentile of 713 mm.

Table 8-3. Summary of annual rainfall and evaporation from the nearest weather stations to the Werribee Irrigation District

Station No	Station Name	Commenced recording	Last Record	Mean annual	
				Evaporation (mm)	Rainfall (mm)
87065	Werribee Research Farm	1913	1980	1410	547
87031	Laverton RAAF	1941	2004	1579	557

Source – Bureau of Meteorology, Australia

Mean evaporation exceeds mean rainfall all year round (Figure 8-3). These data suggest runoff in the region will be minimal, on average, and characterised more by intense rainfall events or by excessive irrigation.

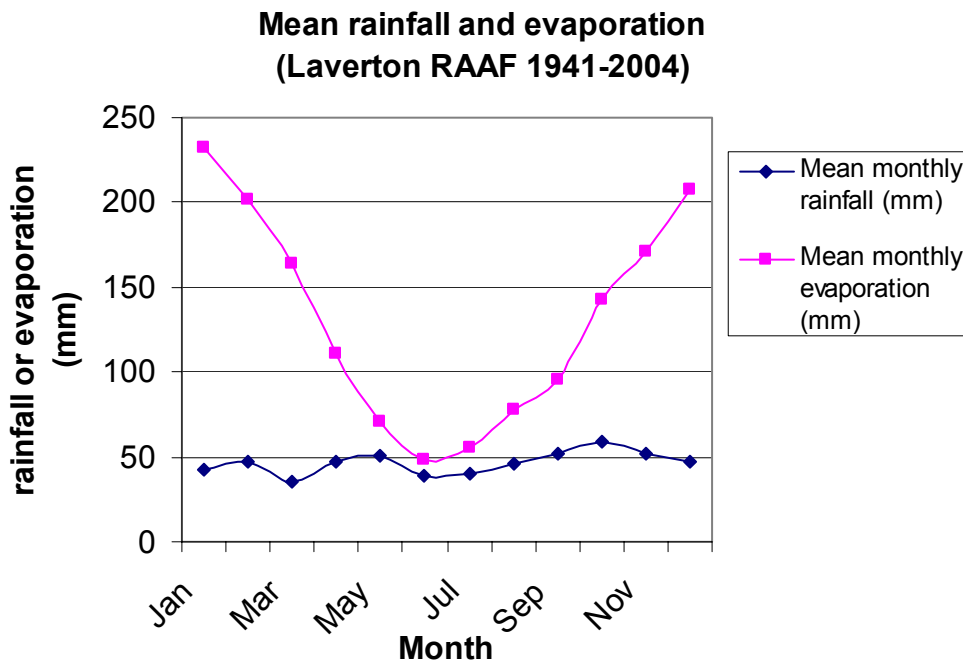


Figure 8-3. Mean monthly rainfall and evaporation in the Werribee Irrigation District

9. The Irrigation Management Plan

URS and RMCG were appointed to complete an Irrigation Management Plan for the WID (RMCG and URS, 2004). The key focus of this study was to address the range of issues that could impact on the environmental sustainability of the use of recycled water in the District. Their findings and conclusions are summarised here and the full document is contained in Part 2: Supporting Documentation.

9.1 Salinity

9.1.1 Rationale for a shandied water salinity (EC) target of 1000 $\mu\text{S}/\text{cm}$ in the short and long term

RMCG and URS (2004) recommended that the long-term salinity of irrigation water in the WID should not exceed an electrical conductivity (EC) of 1000 $\mu\text{S}/\text{cm}$. The factors used to assess this recommendation were:

- Management practices – depends whether management practices are below average, best practice, or extra (eg. application of calcium nitrate)
- Soil type – depends on the degree to which soil is well drained or poorly drained
- Enterprise – depends on level of salt tolerance of the species being grown
- Production level – depends on what production level is considered acceptable

The maximum desirable salinity for the WID was determined as part of the IMP and previous investigations as outlined in the IMP. It was assumed:

- Normal management practices – best practices generally employed for vegetable production, but not exceptional practices
- Soil types range from Class I to Class III, with the worst case for salinity impacts being Class III
- Enterprise is vegetables, with the most salt-sensitive crop being lettuce
- Desired yield potential is 100%

Note that the Virginia Scheme in South Australia is able to utilise higher salinity water (~1,800 $\mu\text{S}/\text{cm}$), due to the presence of more permeable soils that allow higher leaching fractions to be achieved. Similarly, on-site operations at WTP are able to utilise higher salinity water because the enterprise is production of pasture for grazing, and pasture species are relatively salt tolerant.

The recycled water currently has an annual average EC above 1,700 $\mu\text{S}/\text{cm}$ (Table 9-3). It is anticipated that this will be reduced to below 1,000 $\mu\text{S}/\text{cm}$ within five years by reducing the inflow of salts to the treatment plant and additional treatment.

Salinity can impact on sustainability outcomes and crop production in the following ways:

- Osmotic impacts on plant production due to increases in soil salinity

- Plant toxicity impacts due to increases in soil salinity
- Foliar impacts on plant health due to recycled water salinity
- Groundwater salinity increase due to saline water irrigation

The limiting factor for irrigation water salinity is the potential osmotic impacts on salt sensitive crops such as lettuce, onions and fennel (Table 9-1). In order to avoid yield reductions in salt sensitive crops the long-term average annual salinity of the irrigation water in the WID should not exceed an EC of 1,000 $\mu\text{S}/\text{cm}$. This limit is appropriate in the long-term because:

- The potential for toxicity / foliar impacts increase significantly for the more salt sensitive species grown in the WID if irrigation water is above 1,000 $\mu\text{S}/\text{cm}$ (Table 9-1).
- The potential for osmotic impacts increase significantly on some of the poorly drained soils in the WID if irrigation water is above an EC of 1,000 $\mu\text{S}/\text{cm}$ (Table 8-1 and Table 9-1). Note the majority of soils in the WID are considered to be Class II soils on the basis of their drainage capacity and agricultural potential. This limits the degree to which high leaching rates can be used for salinity management, in comparison to Class I soils.
- Irrigation water of 1,000 $\mu\text{S}/\text{cm}$ does not require intensive salinity management such as high application of calcium nitrate and maintaining high leaching fractions (Table 9-1), which are currently employed for irrigation with saline groundwater.
- Substitution of groundwater use by 1000 $\mu\text{S}/\text{cm}$ EC recycled water can contribute to a reduction in leaching fractions and chemical applications required to manage more saline water used in the WID.
- The potential reduction in leaching fractions can reduce existing nutrient leaching to groundwater and mitigate potential nutrient leaching issues from recycled water irrigation (see Section 8.5).

Table 9-1 Soil salinity and irrigation water salinity thresholds where yield may decline and the leaching fractions required to maintain soil salinity below salinity thresholds using two water salinities

Crop	Soil salinity threshold (EC _{se} , dS/m)			Ideal leaching fraction of two Irrigation water qualities ^A		Irrigation water salinity threshold for direct toxicity to plant leaves from overhead application			
				1000 uS/cm EC _w	1800 uS/cm EC _w	100% yield		90% yield	
	100% yield	90% yield	75% yield	Leaching fraction (%)	Leaching fraction (%)	EC _w (dS/m)	EC _w (µS/cm)	TDS (ppm)	EC _w (µS/cm)
Broccoli	2.8	3.9	5.5	4	7	1.9	1900	1150	2600
Cauliflower	2.5	na	na	5	8	0.9-2.7	900-2700	600-1850	
Lettuce	1.3	2.1	3.2	9	17	0.9	900	600	1400
Onion	1.2	1.8	2.8	10	19	0.8	800	550	1200
Cabbage	1.8	2.8	4.4	7	12	1.2	1200	800	1900
Celery	1.8	3.4	5.8	7	12	1.2	1200	800	2300
Lucerne	2.0	3.7	5.2	7	12	1.3	1300	900	2200
Fennel	1.1	na	na	11	21	na	na	na	na

na – not available, EC_{se} = electrical conductivity of soil saturation extract EC_w = electrical conductivity of irrigation water.

^A To maintain soil salinity at 100% yield target. 1000 µS/cm = 1 dS/m = 610 TDS ppm or mg/L (may vary slightly depending on water source). Data extracted from the Werribee Irrigation District Irrigation Management Plan, ANZECC and ARMCANZ (2000) and Grattan (2002).

Note: The values in this table are guides only and their validity for each specific use should be verified by the user.

It should be noted that in more recent years the salinity of the Werribee River water has, at times been at EC levels significantly higher than 1,000 µS/cm (Table 9-3). This history indicates that high salt levels can be managed within the WID, but with substantial effort and cost. If recycled water is to be utilised at current salinity levels it will need to be shandied with low salinity river water to reduce the annual salinity load. It is assumed that this practice will only be required to reduce salinity in the short-term as recycled water will decrease to 1000 µS/cm in five years.

9.1.2 Salinity of river and bore water used in the WID

The flow-weighted average annual salinity of river water supplied to Werribee growers over the last 20 years has been approximately 1,000 µS/cm. Theoretically, if irrigation water were being supplied at a constant salinity level of 1,000 µS/cm, there would not be a need for specific salinity management practices to maintain productivity. However, this is not the case, since the current river water supply is highly variable in terms of salinity. From year to year, the average salinity can vary from 697 µS/cm to 1,680 µS/cm. In any particular month, salinity of the Werribee River water has been known to vary from as low as 59 µS/cm to as high as 3,300 µS/cm. In addition, groundwater is used by some growers, with salinity levels likely to be between 1,000 µS/cm and 2,000 µS/cm. (Note that the lighter soils in the WID are better able to cope with higher salinity levels than the heavier soils.) Therefore, whilst the District would be

expected to manage the average river water salinity without significant problems, there is a challenge in managing the peaks in salinity, and specific management practices have been developed in response to this.

9.1.3 Impact of proposed supply of recycled water

In order to achieve delivery of irrigation water with an average salinity as close as practical to 1,000 $\mu\text{S}/\text{cm}$, while acknowledging that river water salinity is often greater than this level, a set of “operating rules” have been developed for shandyng recycled water with river water (see Section 13.2). The current salinity of the recycled water is approximately 1,800 $\mu\text{S}/\text{cm}$. Shandyng according to the shandy rules (Section 13.2) will mean the average salinity of irrigation water delivered via the channel system will increase by about 100 $\mu\text{S}/\text{cm}$. However, this increase is offset by reduced usage of high salinity groundwater (through substitution with recycled water) and reduced variability (maximum annual average salinity of irrigation water delivered via the channel system will be reduced from 1,680 to 1,542 $\mu\text{S}/\text{cm}$). These factors reduce practices required to manage the increased salinity.

This scenario is therefore considered sustainable, however the volume of recycled water that can be distributed while adhering to the “operating rules” is very limited (generally less than 25% of the capacity of the recycled water supply pipeline).

In the long term RMCG and URS (2004) proposed that the salinity of the recycled water be reduced to an average EC of 1,000 $\mu\text{S}/\text{cm}$.

9.1.4 Salinity of groundwater

Groundwater salinity is highly variable in the WID (RMCG and URS, 2004). Saltwater intrusion has been detected along the shoreline and also the Werribee River, but not in bores located about 1.5 km from the coast. Irrigation bores are likely to have a salinity ranging between 300 $\mu\text{S}/\text{cm}$ and 3,700 $\mu\text{S}/\text{cm}$ with an average value of about 2,000 $\mu\text{S}/\text{cm}$ (excluding seawater-impacted bores). When groundwater salinity is taken into account, the effective flow-weighted District average salinity of current irrigation water (river water and groundwater) is 1,318 $\mu\text{S}/\text{cm}$ EC. Adverse impact from using saline groundwater is mitigated by maintaining moist soil conditions and high leaching fractions, and by avoiding the use of groundwater during hot summer periods.

The salinity of the groundwater is also influenced by leachate from the channel systems used by SRW, irrigation and rainfall (SKM 2004).

9.1.5 Management practices adopted to mitigate impact of water salinity

RMCG and URS (2004) noted that growers adopt the following practices to mitigate impacts on crop production during periods of high salinity:

- Apply calcium nitrate to reduce foliar impacts and reduce sodium concentrations in the soil
- Keep the soil moist to reduce osmotic and toxicity impacts from salinity and increase leaching and reduce soil salinity

- Avoiding the use of high saline water during hot summer periods (eg if groundwater salinity is high)
- Apply gypsum to retain soil structure, which enables higher leaching rates

Many customers may already be aware of this, but as part of the CSMP and Information Sessions, customers using recycled water have been made aware of these practices.

9.1.6 Summary

It is expected that slightly higher salinities of the shandied water can be managed by Customers in the short term by utilising management practices outlined in Section 9.1.5. On a District scale, salinity will not increase as a result of provision of recycled water (Summarised in Table 9-2). However, in the short-term increases and seasonal spikes may be required to ensure water supply. Given the current shandy rules (Section 13.2) the predicted salinities of irrigation water in these situations will be manageable (RMCG and URS 2004).

Table 9-2 Historical and predicted average salinity levels of water source in the WID

	Flow-weighted average salinity electrical conductivity ($\mu\text{S}/\text{cm}$)	
	Historical	Predicted
River water (1990/91 -2002/03)	1007	
River water and ground water (1990/91 – 2002/03)	1318	
Recycled water from WTP 2000-2004	1700 (average)	
Predicted recycled water from WTP post- 2009		<1000
Predicted EC for shandied water-short term (2004-2009)		1131
Predicted EC for shandied water and Bore water-short term (2004-2009)		1301
Predicted EC for shandied water- long term (2009 -)		987

Source (RMCG and URS, 2004)

9.2 Sodicity

The sodicity of the soil can be measured by the following methods:

- Exchangeable sodium percentage (ESP), being the proportion of sodium absorbed onto the clay mineral surfaces as a proportion of the total cation exchange capacity (CEC, the ability of soil particles to adsorb cations); and
- Sodium adsorption ratio (SAR;), being the relative concentration of sodium to calcium and magnesium in the soil solution.

SAR is primarily used as a measure of the sodicity of water and is calculated as the following:

$$\text{Equation 1} \quad SAR = \frac{Na +}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Where concentrations of cations are expressed in meq/L.

To convert from mg/L to meq/L

$$Na \text{ (mg/L)}/23 = \text{meq/L}$$

$$Ca \text{ (mg/L)}/20 = \text{meq/L}$$

$$Mg \text{ (mg/L)}/12.2 = \text{meq/L}$$

or

$$\text{Equation 2} \quad SAR = \frac{\frac{Na}{23}}{\sqrt{\frac{\frac{Ca}{20} + \frac{Mg}{12.2}}{2}}}$$

Where concentrations of cations are expressed in mg/L.

9.2.1 SAR of water sources in the WID

The SAR of the Werribee River water has been estimated recently by Jarvis (2002) from four samples taken between June and September (i.e. the months of relatively high water salinity). These SAR values ranged between 5 and 10 for waters with ECs above 1000 $\mu\text{S}/\text{cm}$ (RMCG and URS 2004; Table 9-3). Data from the Victorian Water Resources Data Warehouse (<http://www.vicwaterdata.net/vicwaterdata/home.aspx>) indicated SAR of river water to be lower prior to this period (1977-1990; Table 9-3)

The SAR of the groundwater calculated on recent major ion analyses (May 2004) ranged between 10 and 64 with an average value of 26. Results from samples collected from bores located at the Western Treatment Plant indicate that SAR values range between approximately 10 and 25 (RMCG and URS 2004; Table 9-3).

Groundwater SAR levels and electrical conductivities suggest that soil structure could be degraded by relative sodium concentrations. However this has not been reported and therefore it is likely that groundwater users have effective management practices to mitigate the impacts of sodicity. The SAR levels in the groundwater are significantly higher than those in the recycled water or river water.

In most cases substitution of groundwater with shandied or reduced salinity recycled water will result in a reduction of the total salt load from irrigation water.

Table 9-3. Sodium absorption ration (SAR) and electrical conductivity of water sources in the Werribee irrigation District.

Water Source	SAR			Electrical conductivity ($\mu\text{S}/\text{cm}$)			Sample date
	min	max	average	min	max	average	
River Water	5	10				>1000	2002 ^A
	1.8	5.4	3.2	240	2400	984	1977-1990 ^B
Ground water	10	62	26	330	20000	2000	May-04 ^A
Recycled water	6.6	12	8.5	1600	1900	1700	2000-2004 ^A

na = note available

^ARMCG and URS (2004)

^B<http://www.vicwaterdata.net/vicwaterdata/home.aspx>

9.2.2 Sodidity management

A high concentration of soil sodium can be toxic to plants. High SAR in irrigation water can cause severe dispersion of clay particles within the soil resulting in a reduction in soil porosity and permeability. This can lead to soil water logging and poor plant production. The sodicity levels of the WID soils (from a limited data set) are high to very high and require management. Sodic soils do not suffer from dispersion unless they come into contact with fresh water. Therefore the risk of soil structure decline is presented by rainfall. This is managed by the application of gypsum or calcium nitrate. This increases the ratio of calcium to sodium in the soil and decreases the SAR of the soil, which in turn reduces the risk of soil structural problems. RMCG and URS (2004) estimated that current application rates of gypsum in the WID are 5 tonnes/ha/year, similar to that as advised (2.5 – 5.0 t/ha) by Rengasamy and Bourne (1998). Current practice in the WID is also to add organic matter (primarily fowl manure) to the soil as a conditioning agent. Depending on its salt content, the organic matter can also buffer sodicity impacts.

9.2.3 Implication of Current Management Practices for salinity and sodicity

The consequences of current management practices are:

- Irrigation application rates are above plant water requirements
- Significantly elevated soil salinity and sodicity from irrigation with saline water and the high use of calcium nitrate
- Significant accessions of irrigation water to groundwater due to salinity management practices (probably the cause of elevated nutrient levels in the groundwater)
- Current management practices are costly for growers, particularly the application of calcium for salinity management.

The details of the existing soil impacts from irrigation practices are presented in Section 10.

These consequences are primarily caused by the salinity of irrigation water, particularly groundwater. They need to be addressed to ensure the WID is a sustainable irrigation district.

The most effective mechanism for improving water quality management practices is through existing investigations such as sustainable groundwater use studies being undertaken by SRW and environmental management programs such as EnviroVeg, Horticulture Australia environmental assurance and state government department extension programs. The appropriate management practices for the WID are not currently fully developed. RMCG and URS recommended that the following investigations and management plans are required:

- Investigation and development of a sustainable groundwater management plan
- Investigation of appropriate and sustainable irrigation scheduling and application rates
- Development of a soil health management plan, primarily focussing on soil sodicity
- Development of a salinity management plan for the WID

See Section 16.15 for the program to develop these plans. It should be noted that the above programs are required in response to existing water quality issues for groundwater and river water. The development of recycled water irrigation should act as a catalyst for these programs by providing excellent baseline and ongoing data through the implementation of the CSMP, information sessions and EIP.

9.3 Nutrients

9.3.1 Nutrient balances when irrigating with recycled water

Very high nutrient application rates from fertilisers are currently occurring in the WID and are possibly impacting on the environment as seen in soil, surface water and groundwater analyses. This issue needs to be addressed to ensure the WID can continue to be managed as a sustainable irrigation district (RMCG and URS, 2004). This is a fertiliser management concern for the whole district, not just recycled water users.

Predicted nutrient application rates from the recycled water (Table 9-4) highlight the limited amount of nutrients contributed from recycled water in the short term (3-20%), relative to what is thought to be common fertiliser practice (RMCG and URS, 2004). However, in the long term when the a salinity of recycled water is decreased to an EC of 1000 $\mu\text{S}/\text{cm}$, greater volumes of recycled water will be used, and a significant amount of nutrients (14–92%) will be present in the water, relative to current practice.

Table 9-4. Nutrient concentration of shandied water and concentrations of NPK applied to soils in the WID

Fertiliser source		Unit	Nutrients		
			N	P	K
Short term (2004-2009)					
Shandied water	Concentration	mg/L	3	2	5
	Applied to soil	kg/ha/crop	9	5	12
Fertiliser	Min	kg/ha/crop	115	25	70
	Max	kg/ha/crop	260	55	110
	Shandied water	Min	%	8	20
Nutrient:Fertiliser	Max	%	3	16	8
Long term (Post 2009)					
Shandied water	Concentration	mg/L	15	9	21
	Applied to soil	kg/ha/crop	36	23	52
Fertiliser	Min	kg/ha/crop	115	25	70
	Max	kg/ha/crop	260	55	110
	Shandied water	Min	%	31	92
Nutrient:Fertiliser	Max	%	14	42	48

assumes

Short term recycled water:riverwater shandy ratio is 1:4

Long term recycled water:river water shandy ratio is 1:0.2

2.5 ML or 250 mm/ha/crop

There will be some adjustment for recycled water nutrients required in the long-term as there will be more in the water and the concentrations will vary less, due to less shandyng. A nutrient management plan will be developed within 5 years (See Section 16.15).

In the short term there is no risk posed by nutrient levels of the highly shandied water (RMCG and URS, 2004). Table 9-2 provides a crude estimate of a typical range (minimum and maximum) of NPK that are commonly applied fertiliser and will be applied in shandied water (short term only) in the WID (RMCG and URS 2004). Customers will be encouraged to calculate nutrient budgets and to reduce their fertiliser applications in line with nutrients supplied in recycled water in the long term, and to meet agronomic requirements. In the short term levels will be so low in recycled water that the growers do not need to calculate detailed nutrient budgets due to recycled water although they will need to consider this small additional nutrient load for their participation in WID nutrient management plan development. Yields in Table 9-2 have been extracted from other data and during the Information Sessions a more accurate assessment of yields for the WID will be recorded to assist Customers with nutrient budgeting. Recycled water users will be assisted in nutrient balance calculations to enable an adjustment of fertiliser application rates, which will compensate for additional nutrients in the recycled water. This assistance will be through the CSMP, the Information Sessions, the Department of Primary Industries Extension Officer, and auditing of the CSMP

It is anticipated that overall phosphorus application rates in the WID will be reduced in the future, due to a regional nutrient management plan. For the long-term scenario, in order to ensure the recycled water does not supply more phosphorus than the rate to be specified in the

nutrient management plan, it is possible that phosphorus reduction of the recycled water will be required. However, until the region successfully implements a nutrient management plan for all irrigators, and further research is conducted to optimise nutrient application rates and fertilization methods for the District, the relative level of P applied in shandied water would be considered insignificant compared with other inputs (Table 9-4).

The development of a nutrient management plan is not required in response to the introduction of recycled water in the short-term, rather it is in response to existing nutrient issues. Post 2009, the nutrient balance for the District needs to be revised with the EIP and consideration given to techniques required for balancing nutrients inputs with output.

9.3.2 Nutrient in river water and ground water

The nutrient levels within the Werribee River are relatively low. In terms of environmental quality objectives for rivers and streams, the State Environment Protection Policy (SEPP; Waters of Victoria) specifies that for the lowlands of the Werribee River the objectives are ≤ 0.6 mg/L Total N and ≤ 0.045 mg/L Total P, for 75th percentile levels. For 2000 to 2003, the 75th percentile of total N and P was 0.67 mg/L and 0.054 mg/L (RMCG and URS, 2004). Therefore the nutrient levels in the Werribee River are slightly above SEPP objectives, but would not contribute insignificant agronomic amounts of N and P.

Recent groundwater samples recorded concentrations of total nitrogen ranging between 0.2 mg/L and 98 mg/L Total N (RMCG and URS, 2004). This originates mainly from agricultural activities (RMCG and URS, 2004). The addition of nutrients through leakage of channel water into the groundwater system will be minimal in the short-term (given the significant shandying required to decrease salinity). With the reticulation of shandied water and current leakage rates from the WID channels. Concentrations of total phosphorus ranged between non-detectable at 0.01 mg/L Total P and about 1 mg/L, except for Bore 145270, which had a concentration of 8.24 mg/L Total P (RMCG and URS, 2004).

Monitoring programs for groundwater and river water quality, to protect these resources, are outlined in Section 16.

Figure 9-1 Nutrients applied in low and high fertiliser application and shandied water compared with crop removal

Crop	Applied in short term shandy			Minimum fertiliser applied			Harvest	Removed at harvest			Excess		
	N	P	K	N	P	K	Yield	N	P	K	N	P	K
	kg/ha/crop			kg/ha/crop			t/ha/crop	kg/ha/crop			kg/ha/crop		
Broccoli	9	5	12	115	25	70	20	90	13	180	34	17	-98
Cauliflower	9	5	12	115	25	70	50	119	23	225	5	7	-143
Lettuce	9	5	12	115	25	70	50	100	18	180	24	12	-98
Onions	9	5	12	115	25	70	60	108	21	180	16	9	-98
Cabbages	9	5	12	115	25	70	50	147	24	147	-23	6	-65
Celery	9	5	12	115	25	70	190	308	79	700	-184	-49	-618
Lucerne	9	5	12	115	25	70	29	115	116	180	9	-86	-98
Artichokes	9	5	12	115	25	70	na	na	na	na	na	na	na
Fennel	9	5	12	115	25	70	na	na	na	na	na	na	na
2004-2009				Maximum amount									
Crop	Applied in short term shandy			Maximum fertiliser applied			Harvest	Removed harvest			Excess		
	N	P	K	N	P	K	Yield	N	P	K	N	P	K
	kg/ha/crop			kg/ha/crop			t/ha/crop	kg/ha/crop			kg/ha/crop		
Broccoli	9	5	12	259	55	109	20	90	13	180	178	47	-59
Cauliflower	9	5	12	259	55	109	50	119	23	225	149	37	-104
Lettuce	9	5	12	259	55	109	50	100	18	180	168	42	-59
Onions	9	5	12	259	55	109	60	108	21	180	160	39	-59
Cabbages	9	5	12	259	55	109	50	147	24	147	121	36	-26
Celery	9	5	12	259	55	109	190	308	79	700	-40	-19	-579
Lucerne	9	5	12	259	55	109	29	115	116	180	153	-56	-59
Artichokes	9	5	12	259	55	109	na	na	na	na	na	na	na
Fennel	9	5	12	259	55	109	na	na	na	na	na	na	na

Assumes: Short term recycled water:riverwater shandy ratio is 1:4 applied at 2.50 ML or 250 mm per ha/crop. Fertiliser rates are from common practice for vegetables in the WID (RMCG and URS, 2004). na – indicated data not available. Harvest yields have been taken from Salvestrin (1998)

9.3.3 Nutrients in surface water drainage

The surface water drainage quality results suggest there is a pre-existing nutrient concern in the WID. As outlined in Section 8.7, flow volumes are relatively low. Of these low volumes, the significant flows are linked to heavy rainfall events.

Potential environmental impacts are controlled through the CSMP and where Customers do not already have best management practices operating, improvements recommended for the Customer complies with the CSMP (See Appendix A). This includes an Information Session for all Customers of recycled water and/or their nominee. Agriculture Victoria has also committed to an extension program in conjunction with the CSMP to ensure compliance with the CSMP and the related obligations with respect to irrigation and fertiliser management practices.

The irrigation classes of the WID soils and irrigation practices indicate that there is significant subsurface drainage in the WID (Table 8-1). The soils can support a high leaching fraction, which helps control salinity in the root zone. Best-practice agriculture aims to minimise contamination of run-off water by ensuring soil nutrient levels are low. The surface water drainage suggests that soil nutrient levels are elevated and are having a minor impact on the surrounding environment, particularly the lower reaches of the Werribee River. Recycled water irrigation can affect this situation by:

- Introducing additional nutrients to the WID and therefore increasing nutrient levels in the soil and surface water.
- Acting as a catalyst for more efficient application of nutrients, by providing information and training on available nutrients, plant nutrient requirements and nutrient balance calculations. This process could significantly reduce the total nutrient application in the WID.
- Enabling significant substitution of current fertiliser application, particularly by replacing current practices of liberal application of dry fertilisers by the more efficient application method of fertigation (in the sense that recycled water contains nutrients in dissolved form). This process could significantly reduce the total nutrient application in the WID. It is assumed that the development of CSMPs and annual information sessions will result in a reduction in nutrients applied in the WID.

9.3.4 Managing nutrients

In terms of water quality management, the most effective mechanism for improving management practices is through existing investigations such as sustainable groundwater use studies being undertaken by SRW, and environmental management programs. Existing environmental management programs include EnviroVeg, Horticulture Australia environmental assurance and state government department extension programs.

In terms of nutrient application rates, the most effective mechanism for improving management practices is also through existing environmental programs. These programs should be able to assess appropriate nutrient application rates through the development of a detailed nutrient management plan for the WID. The appropriate management practices for the WID are not currently fully developed. The following investigations and management plans are required:

- Investigation and development of a sustainable groundwater management plan to safeguard the resource
- Investigation of appropriate and sustainable irrigation scheduling and application rates to reduce demand and accessions to groundwater
- Development of a soil health management plan, focussing on soil sodicity, salinity and nutrients
- Development of a salinity management plan for the WID focussing on incoming salinity to minimise salt loads, maximise production and reduce costs
- Ultimately move towards pipelining of the open channels, to overcome losses from the channel system.

See Section 16.15 for the timeframe for developing the plans. It should be noted that the above programs are required in response to existing water quality issues. The development of recycled water irrigation may act as a catalyst for these programs by providing excellent baseline and ongoing data through the implementation of the CSMPs and Information Sessions.

9.4 Contaminants

9.4.1 Heavy metal and metalloid

For Werribee River water, all observed contaminant levels are well below ANZECC and ARMCANZ (2000) limits. Baseline groundwater data collection is currently being undertaken. Coffey (1992; cited by RMCG and URS, 2004)) found very low concentrations of metals in groundwater bores at the WTP, even though raw sewage had been used for irrigation at the WTP for one hundred years. These observations suggest that the risk of contamination of ground water with heavy metals from irrigation of shandied water is extremely low and it is not anticipated that groundwater would be adversely impacted by heavy metals in the recycled water.

Heavy metal and metalloid concentrations in the recycled water (without dilution) are generally very low and meet irrigation water quality guidelines for irrigation water. Therefore the risk of any impacts due to contaminants is considered negligible. This includes potential risks to soil biota, plant health and human health. Levels of boron and iron in the recycled water should be noted as these levels are above the long-term trigger levels. After 20 years, a risk analysis and potential reduction plan may be required if these levels are not reduced. However, recent data from the recycled water indicate a median value of 0.47 mg/L for boron. The slightly elevated concentrations of boron are within recommended levels for irrigation water, except for Jerusalem Artichokes (ANZECC and ARMCANZ, 2000). Given the dilution of the recycled water and the shandied water that will be received on average by the grower (ie 20-70% see Table 9-4) this risk is mitigated further, but still warrants monitoring.

The proposed monitoring program set out in Section 16 will ensure heavy metal and metalloid contaminants are monitored on an on-going basis to confirm they are below relevant trigger level values so there are no detrimental impacts on soils, crops or other water sources in the WID.

Table 9-5. Metal and metalloid concentration in recycled water from two Australian reuse schemes compared with guidelines trigger values

Heavy metal and metalloid	Symbol	STV (mg/L) ^A	LTV (mg/L) ^A	CCL (mg/kg) ^A	Virginia Pipeline Scheme, SA. Recycled Water (mg/L) 2002/03		WID Groundwater October 2004 (mg/L)		WID river water (DiversionWeir; mg/L)	WID Recycled Water (mg/L)	
					Median	(90 th Percentile)	Median	(90 th percentile)		Median	(90 th Percentile)
Aluminium	Al	20	5	-	0.141	0.252	0	0	-	0.09	0.336
Arsenic(total)	As	2	0.1	20	0.002	0.003	0	0.001	0.004	0.002	0.0044
Barium	Ba	-	-	-	0.004	0.005	0.0415	0.071	-	0.009	-
Beryllium	Be	0.5	0.1	-	0.0005	0.0005 ^D	0	0	-	0.001	-
Boron	B	<0.5 – 15 ^B	0.5	-	0.366	0.407	0.4	0.95	0.28	0.47	0.734
Cadmium	Cd	0.05	0.1	2	0.0005 ^D	0.0005 ^D	0	0	0.0002	0.0002	0.0001
Chromium(III)		-	-	-	-	-	0	0.003	-	-	-
Chromium(VI)		0.1	0.1	-	0.01 ^D	0.01 ^D	0	0	-	-	-
Chromium(Total)	Cr	-	-	-	0.003	0.0049	0	0.003	0.003	0.003	0.006
Cobalt	Co	0.1	0.05	-	0.0009	0.0011	0	0	-	0.002	0.002
Copper	Cu	5	0.2	140	0.0045	0.021	0.002	0.004	0.008	0.005	0.008
Fluoride	F	2	1	-	1.0	1.3	0.5	0.75	0.18	-	-
Iron	Fe	10	0.2	-	0.03 ^D	0.041 ^D	0.01	0.035	3.48	0.19	0.568
Lead	Pb	5	2	260	0.002	0.0033	0	0	0.002	0.001	0.0026
Lithium	Li	2.5 ^C	2.5 ^C	-	0.009	0.010	0.0135	0.025	-	0.02	0.25
Manganese	Mn	10	0.2	-	0.07	0.117	0.02	0.164	0.09	0.11	0.12
Mercury (inorganic)	Hg	0.005	0.002	2	0.001 ^D	0.001 ^D	0	0	0.0001	0.0001	0.00005
Molybdenum	Mo	0.05	0.01	-	0.012	0.016	0.001	0.004	-	0.003	0.0036
Nickel	Ni	2	0.2	85	0.012	0.018	0.0015	0.009	0.01	0.02	0.016
Selenium	Se	0.05	0.02	10	0.003 ^D	0.003 ^D	0	0.001	-	0.001	0.0008
Uranium	U	0.1	0.01	-	-	-	0.003	0.007	-	-	-
Vanadium	V	0.5	0.1	-	0.0055	0.013	0	0	-	0.001	0.002
Zinc	Zn	5	2	300	0.027	0.054	0.006	0.012	0.02	0.016	0.0178

^ASTV and LTV = Short and long-term trigger values, CCL = Cumulative Contaminant Loading limit (ANZECC and ARMCANZ 2000).

^B see Table 9.8 for detailed descriptions for plant tolerances

^C 0.075 mg/L for citrus crops

^DSeveral samples were less than the detection limit and in this case the detection limit has been used to calculate statistical parameters - not available

Recycled water data sources SA Water pers comm. (Virginia Pipeline Scheme) and RMCG and URS (2004)

9.4.2 Organic compounds

To identify compounds of potential concern (Part 2: Issue Paper 24), EPA considers:

- a) Compounds that have been shown to impact on aquatic organisms living in water receiving large amounts of sewage. This provides an extreme worst-case scenario for irrigation, since aquatic organisms live continuously in the water and are relatively sensitive to chemicals. Key compounds in sewage that have been found to impact on aquatic organisms are:
 - i. Metals, particularly copper;
 - ii. Detergents;
 - iii. Chlorine residuals from disinfection;
 - iv. Estrogenic compounds (endocrine disrupting chemicals);
 - v. Organophosphate pesticides such as diazinon and chlorpyrifos; and
 - vi. Ammonia.
- b) Compounds used in large volumes in industry or the community;
- c) Compounds that are proposed to be regulated in other countries. An example is proposals to regulate organic compounds in biosolids, such as detergents and plasticisers; and
- d) Compounds identified by the community or research organisations as emerging concerns. Key compounds in this category are:
 - i. Endocrine disrupting chemicals; and
 - ii. Pharmaceuticals

All the compounds identified above have undergone a detailed regulatory assessment for WID recycled water. Only chlorine residuals are considered to need specific management control.

Some further information on the key compound groups is provided in the Fact Sheets within the Grower's Kit. The Grower's Kit is contained in Part 2: Supporting Documentation.

9.4.3 Chlorine residuals

Chloramines can occur in recycled water that has been disinfected with chlorine. The potential levels of chloramines in the WID recycled water are between 2-5 mg/L (Issue paper 17 and associated review by Reid, 2004). Shandyng of the recycled water and breakdown of the chloramine in the channels and farm dams will result in the irrigation water being approximately 1 mg/L.

Chloramines will decay with time and it is possible that the concentration of chloramines will reduce if irrigation water is held in on-farm dams for a number of days. Further investigation of chloramine decay rates is required to accurately assess this.

The potential areas of concern for chloramines are human health impacts and toxic impacts on plants. Reid (2004) investigated the potential for toxic impacts on plant health due to chloramines. The preliminary conclusions were:

- The studies reviewed suggest that 2-5 mg/l chloramine irrigated directly on crops such as lettuces and broccoli would not result in phytotoxic symptoms, significantly higher concentrations (eg 10-20 mg/l) would be needed to induce these symptoms;
- It appears unlikely that phytotoxicity would manifest in any plant species as a result of irrigation with 2-5 mg/l chloramine, however, effects on highly sensitive plants cannot be excluded;
- Researchers in the late 1980's spray irrigated a wide range of crops with chlorine, reporting impacts on peppers and tomatoes required 8 mg/l of chlorine, impacts on lettuce required 18 mg/l while broccoli impacts needed 37 mg/l of chlorine. Seedlings were not affected;
- The potential impact of chloramines was examined in the trials for the Monterey horticultural scheme in California. Spray irrigation of a range of crops (including lettuces, broccoli and cauliflower) with 5 mg/l chloramine did not impact on crops. The Monterey Scheme continues to use recycled water with chloramine concentrations that average 5 mg/l.

If a pressurised Distribution System is installed and 100% recycled water flows, it will be necessary to consult EPA Victoria to determine whether some irrigation trials using elevated chloramines levels would be necessary.

The levels of chloramines that can potentially reach the Werribee River or Port Phillip are minimal due to the well-drained nature of the WID soils and the absence of significant irrigation run-off (Section 8.7) There is also a significant time period between the delivery of recycled water to irrigation properties and the potential discharge of chloramines to receiving waters. This is due to storage of water in on-farm dams as well as time taken for water to reach receiving waters after irrigation. Reid (2004) indicates that a period of 2-3 days will result in the decay of a large proportion of chloramines in the recycled water. Therefore the risk of significant concentration of chloramines reaching receiving waters is extremely low.

RMCG and URS (2004) concluded that current research suggests that chloramines do not present a risk to plant health, human health or the environment, including soil microbes.

10. Summary of existing environmental issues in the WID

The soils of the WID are excellent agricultural soils due to their superior drainage capability. These soils are suitable for intensive agriculture such as growing vegetables. Some of the existing (RMCG and URS, 2004) issues are:

- Soil EC_{se} results would indicate that the existing water soil salinity should be severely impacting on crop yields. This has not occurred due to the management practices of the growers.
- Existing irrigated soils in the WID are sodic, which infers that impacts on soil structure are possible. Current irrigation management ensures that soil sodicity does not significantly impact on soil structure and drainage capacity.
- Nutrient application rates to the soils of the WID are high. It is likely that the high concentration of P in the soils has caused significant concentrations of P in surface water runoff in the WID, however, runoff volumes are low. It is also possible that significant amounts of N are being leached from the soils and may be reaching the groundwater table.
- There are a number of pre-existing soil conditions in the WID. The introduction of recycled water will not exacerbate these issues.
- Recycled water irrigation can act as a catalyst for the improvement of knowledge through detailed landholder surveys and on-farm surveying that will be conducted as a part of the implementation of the CSMPs. Existing management issues that need to be addressed in existing and potential management plans are detailed in Section 10.

The existing (RMCG and URS, 2004) consequences of current management practices include:

- Soil health: Significantly elevated soil salinity and sodicity from irrigation with saline water and the high use of calcium nitrate. Note that the levels of soil salinity and sodicity are an issue only because salt-sensitive annual crops such as lettuce are being grown.
- Surface water quality: It is likely that the high concentration of phosphorus in the soils will cause significant concentrations of phosphorus in surface water run-off in the WID.
- Groundwater quality: Significant accessions of irrigation water to groundwater due to salinity management practices have resulted in elevated nitrogen levels in the groundwater.
- Increased water consumption: Demand for irrigation water is elevated due to high application rates for salinity management.

These issues are primarily caused by the salinity of irrigation water, particularly groundwater. To ensure the WID can continue to be managed as a sustainable irrigation district these need to be addressed.

10.1 Management Recommendations for Recycled Water Suppliers

- Continued monitoring of potential contaminants in recycled water to ensure they remain below ANZECC and ARMCANZ (2000) guidelines
- Decrease the salinity of the recycled water sufficiently to ensure irrigation water electrical conductivity remains less than 1000 $\mu\text{S}/\text{cm}$ by 2009
- Undertake annual soil monitoring
- Pipeline the SRW Distribution System
- Operate the system in accordance with the Shandy Rules

10.2 Management Recommendations for Customers

Management recommendations for the customer are listed in the CSMP (Appendix A). Briefly, in order to assist growers in managing the introduction of recycled water, general good agricultural practice for use of shandied water in the WID would be:

- Annual soil sampling to monitor and manage soils salinity, sodicity and nutrient levels so as to prevent degradation of soils on-farm and minimising negative off-site impacts
- Aim to maintain soil salinity below an EC_{se} of 1.2 to 2.8 dS/m (1,200 to 2,800 $\mu\text{S}/\text{cm}$) depending on crops grown (see Table 9-1)
- If soil salinity rises, management practices such as irrigating during the night and maintaining a moist growing environment (particularly on hot days) may help minimise salinity effects
- Aim to maintain soil Exchangeable Sodium Percentage (ESP) below 6. Lettuce and onion is assumed to not suffer from toxic impacts unless the ESP is between 15 and 40, however, soil structural problems may occur at soil ESP's greater than 6.
- If soils ESP increases above 6, this could be managed by applying gypsum or calcium nitrate to the soil and leaching before planting.
- Scheduling irrigation to achieve maximum yield, including approximately a 10% leaching fraction (Table 9-1), and stopping irrigation automatically.
- Monitoring for algae blooms in water storages and if a toxin producing blue-green algae is suspected, taking the appropriate actions as outlined in the Fact Sheet (See Part 2: Supporting Documentation – Growers' Kit)

11. Storage

There are several points where recycled water is stored and these are described in the following sections.

11.1 The Head of the Road Storage (HORS)

Water that is used for recycling is drawn from the final pond of the 55 East lagoon system and pumped to the HORS. The pumps that fill the HORS operate on level sensors so should not overflow. In the case of system failure, an overflow is provided from the HORS to the drainage network that returns water via the licensed discharge point to Port Phillip. The HORS supplies all recycled water that is used on the WTP site and water used to maintain lagoon habitat values across the site. This ensure rapid turnover in the storage and minimises the risk of algal blooms. The HORS is also the likely point of supply for future recycled water schemes.

11.2 The Chlorination Retention Storage

Treated effluent from the HORS is pumped via a chlorination injection point to the chlorination retention storage where sufficient contact time with the chlorine is provided to ensure Class A Guidelines are met. The storage has been created by digging out an area, stabilising the insitu clay with lime, piling up the removed material to create banks or bunds, lining the area with an HDPE liner for extra protection and roofing the area over. The roof has been provided to prevent contamination by birds and to cut out UV from sunlight, which interferes in the chlorination process.

11.3 On-Farm Dams

All the farms in the WID have dams into which irrigation water is directed from SRW's Irrigation Channels. These hold 1 to 2 ML on average with many of the farms managing with smaller dams, which hold one day's supply of irrigation water. This drives a need by many customers to have a very responsive and reliable supply of irrigation water.

The dams dug out hollow may need to be clay lined with the appropriate size clay. This may either be found in-situ or need to be brought in.

Growers order an amount of water as required from SRW via a telephone automatic service or the internet. Overflows from dams are rare due to customers only ordering the volume of their dam – also many dams are higher than the inlet from the channel so once a common level has been reached, no further water can go into the dam. Dams away from channels or supplies under pressure may overflow but generally water returns to drains.

When comparing the leakage from the channel, leakage from dams is insignificant. If there is evidence of significant leakage from a dam, Customers are required to rectify the problem.

The risk of algal blooms in farm dams is minimal due to the fast turnover of water in the dams. Each Customer is responsible for managing algal blooms on their properties. All Customers have received a fact sheet about algal blooms in the Growers' Kit (refer to Part 2: Supporting Documentation).

11.3.1 On-Farm Treatment

Water users may have filter arrangements installed ahead of pumps to reduce the likelihood of blockage of water distribution pipelines on each site. Algal growth is the most likely source of materials that could cause blockages, and as water users will have open storages into which recycled water is being supplied, there is the potential for algal growth in those storages.

12. Recycled Water Transport and Distribution

12.1 Transport and Distribution Infrastructure

The WID receives recycled water up to a maximum instantaneous peak flow rate of 55 ML per day through a distribution network as follows:

- Variable speed pumps which can respond automatically to demand for recycled water when there is a drop in pressure in the pipeline
- A combination of new and existing Melbourne Water pipelines of ductile iron and cement lined. The pipes are underground except at the Werribee River crossing and for the majority follow the routes of other pipelines associated with the Western Treatment Plant. There are scour points for maintenance. The new pipeline feeds in two places into SRW's irrigation off-take. The flow of recycled water will be controlled via the supply control valves which will be owned, operated and maintained by SRW.
- Instrumentation and telemetry to detect flow and quality of the recycled water, river water and the final shandied water. Any failure to meet set quality parameters results in the recycled water supply being shut down.
- The SRW distribution system consists of a weir to divert water from the Werribee River down a pipeline. This then splits into a network of concrete open irrigation channels, which predominantly run along the roads in the area. Farms are served by a system of dethridge wheels, which need to be operated manually when requests for water are made. All customers are metered to measure usage.
- A pipeline feasibility study has been completed for the Werribee Irrigation District which looked at pipelining the remaining 50 km of open concrete channels in the Werribee Irrigation District. The feasibility study summary is contained in Appendix H. The feasibility study investigated four main pipeline options which were each evaluated taking into consideration future demand, level of service, construction timeframe, capital and operating costs. The preferred option involved a gravity pipeline with a reduced peak capacity based on a flattened demand and a three to five year construction period. The total cost of the preferred option has been estimated at around \$25 million, however, at this stage no firm decision has been made. Future long term planning decisions for the WID will need to be supportive of any pipelining proposal before a final commitment can be given by all parties.
- The next step in the process will be to develop a Business Case for pipelining of the WID. This is expected to take place by 2006. Once the business case is completed, consultation with growers and Government will commence and subject to the full support of growers and Government on possible funding arrangements, pipelining of the Werribee area could commence within two to three years time and completed within a five year timeframe.

12.2 Reliability of the transport and distribution system

The key design elements incorporated to maximise reliability in the Melbourne Water infrastructure are summarised below:

- Construction of plant, pumps and pipelines have been in accordance with the WSAA and Australian standards
- Both pump stations have had additional standby pumps incorporated to cover breakdowns and planned maintenance
- Scour points have been incorporated into the Melbourne Water pipeline to allow for maintenance and repair
- Melbourne Water has a comprehensive maintenance program in place with maintenance planned wherever possible in conjunction with SRW to minimise disruption to supply by predicting periods of low demand
- Management and contingency plans to cover plant failures
- SRW has contingency plans in place for loss of service from pipeline or channel breaks

12.3 Risks associated with the transport of recycled water

A risk assessment was conducted which identified the following risks to the environment and public health arising from the transport of recycled water.

Table 12-1 Risk management of recycled water transport

Risk	Controls	Controlled Risk
Poor recycled water pipeline design could lead to high energy usage and costs and a failure to meet Melbourne Water commitments to reduce energy use	The design sized new pipelines to keep energy costs low. Pumps are variable speed, which also minimises energy wastage.	Low
Spills from the pipeline could impact on the Werribee River, the freeway or residential areas	Pipelines are constructed from durable materials to WSAA standards and are pressure tested during commissioning.	Low
Incorrect connections to the recycled water supply leading to a risk of cross contamination of other pipelines, particularly drinking water	Minimal risk due to the large size of the recycled water pipeline and the use of lilac tape to distinguish it from other pipes. There are very few drinking water pipelines in the area.	Low

Risk	Controls	Controlled Risk
Leaks from the SRW irrigation channels can pollute the local environment / Port Phillip and wastes water	Maintenance of the channels to minimise leakage. Also to reduce water losses in transmission and as the open channels become old, they are being replaced by pipeline. In the medium term, SRW will be considering accelerating the conversion to pipeline to conserve water. See Section 12.1.	Low
Growth of algae in the irrigation channel system	SRW uses 'Cupricide' to manage filamentous aglae in channels with a dosage of approximately 8 litres per 5ML of flow.	Low
Risk to public health from people swimming in or drinking water from the irrigation channels	A total of 46 signs will be located in the District along roads at points where they cross the channels. EPA Victoria and DHS have reviewed the locations. The signs in the District will read 'Werribee Irrigation District. Do not drink irrigation water' in accordance with AS 1319: Safety Sign Standard. See Appendix I for sign template and map of locations.	Low
Overflow of excess irrigation water from the delivery channels into Port Phillip	Channel flows are set in accordance with customers' orders, extra water is not carried within the system. SRW expects that customers take the water that is ordered and also that customers provide sufficient notice to planning staff if they wish to shut down earlier than scheduled. This allows planning staff to place cancelled orders into other customers' dams where possible, or reduce flows at the main off-take or channel off-takes in accordance with reduced demand.	Low

Risk	Controls	Controlled Risk
	<p>Many customers on the ends of channels also agree to take water that may outfall from the system. In most cases outlet doors to these customers are left open to pick up surplus water.</p>	

12.4 Continued Delivery of River Water

SRW has committed to continuing to deliver river water as per the Split Running procedure to customers within the WID that do not sign Customer Supply Agreements. SRW has carried out monitoring and developed a procedure on ‘split running’ to ensure that the supply of river water is as free of recycled water as practicable. This is included in Section 13.3.

The Channel Management Report (Appendix J) outlines the expected residual volumes of recycled water that could be delivered to River Water Only customers. If standard practices are followed, the residual volumes of recycled water that will be delivered on River Water Only days will be negligible. In the event that fall-back practices are implemented, the residual volume of recycled water delivered to a River Water Only customer will not exceed 5%. Therefore the risk that a River Water Only customer will receive a significant volume of recycled water is low. The worst-case scenarios are outlined in Appendix 12 of the IMP.

DHS and EPA Victoria have deemed the use of recycled water, managed in accordance with the EIP, safe and sustainable for the irrigation of vegetable crops in the WID if good management practices, as outlined in the CSMP, are followed. Due to the insignificant amount of residual shandied water to be supplied to River-Water-Only Customers, these customers do not require a CSMP. However for the safe and sustainable use of all irrigation water, good management practices, as outlined in the CSMP, are recommended.

13. Use of Recycled Water

13.1 Water Use

At 20 October 2004, 130 growers had signed expressions of interest to enter contracts for the recycled water. It is expected that as the scheme becomes more established that take up will expand to the full allocation.

Use of the recycled water is predominantly for irrigation of market gardens using a grid system of sprinklers across laser-graded paddocks. Other customers include nurseries, orchards and livestock farmers using recycled water on pasture or animal feed crops (Figure 8-2). SRW maintains records of its customer base and usage.

Sprinkler irrigation is commonly fixed overhead sprinklers utilised for vegetable growing. The overhead sprinkler irrigation systems are efficient compared with other forms of irrigation, except drip irrigation. Drip irrigation is discussed in Section 8.8.

The Chief Veterinary Officer has approved the use of recycled water without restriction for irrigation of pastures for cattle farming.

13.2 Shandy Rules

13.2.1 Definitions

Terms have the meaning described in the Customer Supply Agreement, including:

'Distribution system' means the open channels, pipelines, drop bar checks, offtake regulators and meter outlets used to supply customers with irrigation water

'Recycled water salinity' means the salinity, in $\mu\text{S}/\text{cm}$ (EC) units, measured immediately upstream of the connection points to Southern Rural Water's delivery system on Spur 4/1 and the Main Pipeline.

'River water salinity' means the salinity, in $\mu\text{S}/\text{cm}$ (EC) units, measured at McMurray's Weir located on the Main channel upstream of the recycled water connection points, or if the distribution system is not in operation, measured at SRW's Werribee Diversion Weir pool.

'Shandied water salinity' means the salinity, in $\mu\text{S}/\text{cm}$ (EC) units, measured downstream of the connection point to SRW's delivery system on Spur 4/1, and measured downstream of the connection point to SRW's delivery system on the Main Pipeline.

13.2.2 Operating Rules

- a) On any day that Recycled Water is being supplied the Shandy Limit shall be as specified in Table 1.
- b) In determining the Shandy Limit for a day from Table 13-1 of the Customer Supply Agreement, Southern Rural Water may use the Werribee River Water Salinity and the Recycled Water Salinity measured at any time not more than 48 hours prior to the day.
- c) Subject to any tolerances allowed pursuant to Section 13.2.3 of the Customer Supply Agreement, the volume of Recycled Water taken into the Werribee Irrigation District must not cause the Shandied Water Salinity to exceed the Shandy Limit.

13.2.3 Tolerances

On any day that Recycled Water is brought into the distribution system the Shandied Water Salinity may exceed the Shandy Limit by not more than 100 $\mu\text{S}/\text{cm}$ for short durations whilst water regulations is underway or adjustment to flow is occurring. The period of variance will not exceed six hours.

13.2.4 Reporting

Southern Rural Water shall maintain a record of daily salinity levels at each of the salinity monitoring sites and make them available for viewing on SRW's web site and/or at SRW's Werribee office.

Table 13-1 Salinity of shandied water that can be supplied given a range of water allocations relative to river water salinity

		Seasonal Water allocation	Expected frequency in 30 years	Salinity target	
				ECw ($\mu\text{S}/\text{cm}$)	TDS (ppm or mg/L)
Water allocation model	1	100% +	27 years	Less than 1000	
	2	75%-100%	1 year	1400+	850
	3	50%-75%	1 year	1600+	970
	4	Up to 50%	1 year	1800+	1100

ECw = electrical conductivity of water

Note: in winter when the Werribee River water salinity increases, dilution may not be possible to meet the target ECw. Waterline will advise all recycled water customers if water salinity changes from the target ECw.

13.3 Split Running Rules

13.3.1 Definitions

Terms have the meaning described in the Customer Supply Agreement, including the following:

‘Distribution system’ means the open channels, pipelines, drop bar checks, offtake regulators and meter outlets used to supply customers with irrigation water.

‘Efficiency of supply’ means the volume of water received in comparison to the volume of water delivered expressed as a percentage.

‘Irrigation season’ means the period of supply that irrigation water is made available for use commencing on 1 July and finishing on 30 June in any year.

13.3.2 Operating Rules

The following rules will apply to the supply of water in the Werribee Irrigation District under Split-running, please refer to Appendix J Channel Management Report for a detailed outline of how the operating rules were established:

- a) Shandied Water and River Water will be made available on the days specified in a Table selected by Southern Rural Water from Table 1, 2, 3, 4 or 5, or any other Table that may be determined in accordance with clause 4.
- b) The phasing in or out of Recycled Water will start when daily flow changes are made (early morning and late afternoon) when the system is operating. Recycled Water will be shut off on the day before the start of a River Water period; however, no guarantee can be given that the system will be free of shandy residues in River Water periods.
- c) As total weekly demand changes, Southern Rural Water will determine whether to operate according to Table 1, 2, 3, 4 or 5, or to any other Table that may be determined in accordance with clause 4.
- d) On days shown on the Table selected in accordance with clause 2.1(c) to be Shandy Days the water available will be Shandied Water, and only Customers that have satisfied the requirements for the use of Recycled Water may order water for those days.
- e) Recycled Water customers may order water on River Water days but preference may be given to other customers on those days.
- f) To maintain reasonable efficiency of supply and minimise system losses a minimum flow rate of 50 ML/d is required before the system is operated.
- g) Notwithstanding anything to the contrary in this clause, SRW may deliver water on a Shandy Day to Customers that have not satisfied the requirements for the use of Recycled Water:
 - i. When the previous day on which the Distribution System was operated as a River Water Day; and

- ii. Such deliveries conclude prior to Recycled Water being brought into the Distribution System.

13.3.3 Reporting

Southern Rural Water will periodically report on usage for Recycled Water customers to allow Customers to monitor their usage of both River Water and Recycled Water.

13.3.4 Alterations to Split-running days

Prior to the commencement of each irrigation season, or at other times with at least 21 days notice, Southern Rural Water may:

- a) Increase or decrease the number of days that Shandied Water and/or River Water is specified in Tables 1, 2, 3, 4 and/or 5;
- b) Replace or delete Table 1, 2, 3, 4 or 5;
- c) Add additional Tables.

13.3.5 Constraints of supply

Operating under Split-running will require frequent changes between Shandied Water and Recycled Water and may reduce the volume of Recycled Water that can be supplied.

Table 1: Typical 7-day operation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Shandy	River Only	Shandy	Shandy	River Only	River Only	Shandy

Table 2: Typical 6-day operation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Shandy	River Only	Shandy	Shandy	River Only	River Only	

Table 3: Typical 5-day operation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	River Only	Shandy	Shandy	River Only	River Only	

Table 4: Typical 4-day operation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		Shandy	Shandy	River Only	River Only	

Table 5: Typical 3-day operation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			Shandy	River Only	River Only	

13.4 Risks associated with Customer Use

A risk assessment has identified the key risks arising from the customer use of the water that need to be controlled. These are summarised in the following table together with a summary of the key controls.

Table 13-2. Risks associated with customer use

Risk	Controls	Controlled Risk
Leaks in the on farm delivery system	Customers need to check for leaks regularly and fix as required. CMSP	Low
Risk to public health from people swimming in the on site dams or drinking the water from sprinklers	CSMP. Signs on significant public roads in District that read, 'Werribee Irrigation District. Do not drink irrigation water' as required by AS1319: Safety Sign Standard.	Low
Algal blooms in farm dams	CSMP. Rapid turnover of irrigation water. Fact Sheet in Grower's Kit. The chloramine residual may reduce the likelihood of blooms.	Low
Increased salinity of irrigation water due to evaporation from dams	CSMP. Rapid turnover of irrigation water	Low
Increased salinity / sodicity / nutrient and contaminant (pesticides) levels and loss of structure / permeability in soils	IMP, CSMP and EIP. Including site-specific water balance calculations and nutrient budgets. Soil monitoring program (Section 16.8)	Low
Waterlogging due to incorrect irrigation practices leading to impacts on crop quality or surface water run off	CSMP, IMP and EIP	Low
Leaching to manage salinity may impact on waterlogging, nutrient loading and increased risk of groundwater salinity	CSMP, IMP and EIP	Low
Impact on soil biota / germination of chlorine / salinity etc.	CSMP, IMP and EIP	Low

Risk	Controls	Controlled Risk
Increased salinity, nitrates and other pollutants in ground water. Heavy metal risk is not increased by the use of recycled water from data provided	CSMP, IMP and EIP	Low
Loss of productivity and / or quality of crops (Boron toxicity / chloramines)	CSMP, IMP and EIP. Soil monitoring program (Section 16.8)	Low
Loss of irrigation efficiency and surface water pollution due to drift	CSMP	Low
Pollution of surface water from run off of irrigation water	CSMP, IMP and EIP	Low
Loss or lack of public acceptance due to community fears about health risks associated with recycled water	Melbourne Water is currently incorporating recycled water into its Emergency Response Plans. A broader Industry Response Plan will also include recycled water where appropriate. Melbourne Water continues to liaise with the relevant authorities regarding communications. National Response Strategy as part of the Coordinator for Reclaimed Water Development In Horticulture Project (www.recycledwater.com.au)	Low
Unwanted recycled water goes onto neighbouring land / housing leading to complaints and / or legal action.	CSMP	Low
Litigation claims by Customers that recycled water has damaged their soils.	Baseline data and subsequent monitoring to be established in accordance with the Irrigation Management Plan to protect both customers and suppliers (Section 16)	Low

Risk	Controls	Controlled Risk
Rises in ground water levels leading to salinity risk by capillary action	Monitoring and management of ground water levels by SRW in accordance with the EIP (Section 16)	Low
Surface water run off due to rain leading to loss of top-soil and sediment loads to Port Phillip.	Surface runoff relatively low volumes (Section 8.9)	
Odour impacting on the local community	Recycled water has no discernable odour	Low
Risks to workers exposed to spray if recycled water / river water shandy used	The Class A guidelines have been formulated to ensure that there is minimal health risk associated with coming into contact with recycled water. The WTP Recycled Water Quality Management Plan (refer Section 7.6.2) will ensure the recycled water meets Class A guidelines consistently. In addition, Customers will be required to ensure all staff members and visitors are aware of any requirements associated with the use of recycled water.	Low
Produce using recycled water is not acceptable to the market including supermarkets, Melbourne's markets and consumers	Research based on older recycled water schemes indicates that the market acceptance of recycled water is strong. In addition, the DHS, in conjunction with Horticulture Australia, is continuing to liaise with major buyers and Quality Assurance companies to ensure accurate information is available to decision-makers.	Low
Risks to health of consumers of the produce from use of recycled water / river water shandy	The DHS has certified Class A water as suitable for the irrigation of crops eaten raw. The WTP Recycled Water Quality Management Plan (refer Section 7.6.2) will ensure the recycled water meets Class A guidelines consistently. CSMP	Low

Risk	Controls	Controlled Risk
Ineffective implementation of the management controls leads to environmental risks	SRW will regularly audit the CSMPs. Independent auditors will periodically audit the EIP for Melbourne Water and SRW (refer to Section 16.13 for details).	Low
Risk that pigs on Customers' farms consume recycled water or products irrigated with recycled water.	The CSMP outlines the controls necessary to ensure that risks associated with pigs are mitigated.	Low

Each customer is required by the EPA Victoria guidelines to prepare a site-specific management plan (the CSMP) before they can receive recycled water. This details the controls that they are going to implement to manage most risks listed above. See Appendix A for the CSMP template. The aim of the template is to indicate the minimum standard that is required and propose methodologies for the customer to manage the risks on their site. However alternative methodologies that meet or exceed the required standard of risk management can be utilised where desired.

13.5 Mitigation Measures

Potential risks to the beneficial uses of groundwater, soils and surface waters will be minimised by a series of mitigation measures, which are detailed in the CSMP. In addition human health risks are minimised by the use of Class A recycled water and additional mitigation measures detailed in the CSMP. Refer to Appendix A.

13.6 Standards of Environmental Management required from the Customers

Prior to the use of the recycled water in the WID existing practice resulted in some environmental impacts, such as run-off (by irrigation or rainfall) and seepage/leaching exporting nutrients to Port Phillip. To facilitate the overall environmental improvements that will arise from the use of recycled water, the Department of Primary Industries has developed for Customers a significant program to improve the environmental performance of the WID through information sessions, assistance and incentives. This is linked to the EIP process through requirements within the Customer Supply Agreement to comply with minimum environmental standards and attend information sessions by set dates. Growers taking recycled water will be given short-term assistance for the duration of this irrigation season to comply with CSMP.

On this basis, the minimum level of performance acceptable in the EIP is:

- Where environmental impacts are occurring the current environmental performance of the WID must not decrease with the use of recycled water;
- That good practice environmental measures for the horticulture and irrigation industry must be seen to be developed and implemented.
- That where environmental impacts are not currently occurring, the protection of beneficial uses are maintained; and
- The use of recycled water is linked to a requirement to participate in Information Session (Section 17.5).
- The obligations of the customer are outlined in more detail in the CSMP (Appendix A).

14. Asset Maintenance and Inspection

14.1 Melbourne Water Assets

A maintenance manual for the Scheme outlines:

- Equipment Schedule
- Software Configuration and Set up
- Fault diagnosis and modification
- Routine maintenance schedule

A copy of the Melbourne Water WID Recycled Water Scheme Maintenance Manual will be kept at Western Treatment Plant.

14.2 SRW Assets

The SRW WID maintenance program covers both the supply system and the drain system. With regard to the supply system, the maintenance program activities include:

- Desilting
- Repairing channel leaks
- Weed control
- Structure, pipeline and meter maintenance

The number of sections of concrete lined channel requiring repairs is increasing over time as the general condition of the channel is deteriorating.

Repairs to joins and concrete cracks are undertaken in accordance with the suppliers' specifications. Other works and activities are undertaken in accordance with the relevant standards and practices.

15. Emergency Preparedness and Response

15.1 Incidents and impacts

Emergency or non-compliance incidents have the potential to impact the environment. Within one month of execution of the Bulk Supply Agreement, Melbourne Water and SRW will have developed and implemented Emergency Response Plans. The Emergency Response Plans will cover the following potential incidents:

- Failure to meet the Class A requirements
- Spillage of recycled water
- Algal bloom
- Unauthorised use of recycled water

Each of these incidents has the potential to cause impacts to the environment and public health, including:

- Surface water pollution
- Groundwater pollution
- Soil contamination
- Human and animal health.

As detailed below, management measures are in place to ensure environmental and public health impacts are minimised in the case of an emergency or non-compliance incident.

Incidents, as defined by the Emergency Response Plans or as otherwise defined by the Bulk Supply Agreement, shall be rectified in accordance with the Bulk Supply Agreement. In particular, if an incident may cause harm to the environment or cause risk to the health or safety of any person, the responsible party must immediately deploy a team to deal with the incident and rectify the problem. Section 16.12 outlines incident reporting requirements.

In addition, an Industry Response Plan for recycled water is currently being created. It will define which agencies take lead roles during particular incidents.

Contingency plans have also been developed by the Customers and are included in their CSMPs.

15.2 Failure to meet Class A requirements

In accordance with EPA Victoria Guidelines any non-compliant results for Class A recycled water must be immediately reported to EPA Victoria and DHS. The WTP Recycled Water Quality Management Plan ensures the recycled water consistently satisfies the Class A guidelines before it is supplied. The control points are designed to ensure that detection and corrective action can be implemented before the recycled water reaches the supply pump station. These include:

- Monitoring points within the lagoons with sufficient time for water quality analysis parameters before the water tested enters the disinfection process. Water not meeting the standard required will be diverted and discharged to Port Phillip.
- Continuous monitoring of UV dose and regulation of flow through the UV system to ensure adequate dose is supplied. If the UV system fails the supply pump station is shut down.
- Two continuous monitoring points within the chlorination contact storage to ensure correct dosing and correct chlorine residual with time to activate pump shutdowns before inadequately chlorinated recycled water can enter the recycled water supply pipeline. This water will be recirculated through the chlorinator or used as Class C on the WTP site until the water returns to Class A requirements.

For the system to fail there would need to be a systemic failure of the disinfection system while the lagoon performance was unusually poor. If this was to occur the failure would need to be rectified and supply resumed only after DHS and EPA Victoria approval has been reconfirmed.

Once the recycled water is shandied with river water and enters the open channel system in the WID, the mixed product can no longer be guaranteed as Class A. This is the same as the current situation with the use of river water alone. Class A requirements only concern recycled water and therefore this is not considered to be a failure.

15.3 Recycled Water Spillage

Spills or leaks from the recycled water pipeline may occur at any location, however the area in which it is adjacent to the Werribee River presents the greatest risk in terms of contamination of the Werribee River. In the event of a spill in this area, protocols have been established for notification of Melbourne Water by Victorian Open Range Zoo staff.

15.4 Algal Bloom Management at WTP

An Algal Emergency Response Plan has been developed by Melbourne Water and is included as part of this EIP (refer to Appendix E), in accordance with the EPA Guidelines. The Plan includes:

- The framework for managing blue-green algal blooms
- Blue-green algal monitoring program including sampling and identification of bloom
- Threshold blue-green algal cell numbers that trigger actions
- The appropriate government bodies to notify and to seek advice from

For algal management on farms, refer to the Algal Management Fact Sheet in Part 2: Supporting Documentation – Grower’s Kit.

16. Monitoring and Reporting

All sampling must be completed in accordance with:

- EPA Publication 669, April 2000 – “Groundwater Sampling Guidelines”
- EPA Publication 441, March 2000 – “A Guide to the Sampling and Analysis of Waters, Wastewaters, Soils and Wastes”

16.1 Summary of Environmental Monitoring and Reporting

Below is a summary of the environmental parameters which will be monitored, and who is responsible for their completion and reporting. Appendix K outlines the detailed monitoring program.

Table 16-1. Environmental monitoring – frequency and responsibility

Parameter	Frequency	Time	Responsibility		
			Melb Water	SRW	Land owner
Water Balance (Section 16.2)					
Rainfall, evaporation and volumes of recycled water used	Monthly		√		√
Volume of channel water and bore water used	Monthly			√	√
Review Water Balance	Annually	July	√	√	
Recycled Water (Section 16.3)					
Recycled water quality parameters in the treatment plant	Monthly		√		
Monitoring of trade waste inflows as per Trade Waste Agreements	Annually	July	√		
Run-off (Section 16.4)					
Monitoring of drain flow quantity	Continuous			√	
Monitoring of drain flow quality	3 major flows/year			√	
River water (Section 16.5)					
Salinity of river water where extracted for use in WID Channel system	Continuous			√	
Quality of river water where extracted for use in WID Channel system and post WID	Quarterly			√	
Groundwater (Section 16.6)					
Groundwater depth and salinity	Quarterly			√	
Quality of groundwater	Bi-annually	Jan-July		√	
Soils (Section 16.8)					
Chemical analysis of soils	Annually	Jun-Sept		√	√

Parameter	Frequency	Time	Responsibility		
			Melb Water	SRW	Land owner
Nutrient balance					
Nutrient balance calculations	Annually	July-Nov		√	√
Customer Site Management Plan					
Completion of annual Customer Site Management Report and audit.	Annually	July-Nov		√	√
Regional Environmental Improvement Plan					
Completion of annual Environment Improvement Report and Audit	Annually	Nov-Dec	√	√	

Note – Auditing frequency will be reviewed annually and could be decreased once the scheme and its customers have verified good practice as defined in the EIP.

16.2 Water balance

Southern Rural Water will maintain a record of:

- Daily rainfall and evaporation for the Werribee Irrigation District (Climate averages for Station: 087031 LAVERTON RAAF)
- Volumes of recycled water, channel water and bore water used in the WID
- Volumes of water lost through the channel system (overflows and leakage)

These data will be used to estimate an annual WID water balance as part of the annual EIP report.

16.3 Recycled water monitoring

Melbourne Water will undertake monitoring of both health and environmental parameters in the recycled water.

Melbourne Water's recycled water monitoring program for health, livestock and food safety parameters is outlined in the WTP Recycled Water Quality Management Plan. This plan has been approved by the DHS as part of the Class A approval.

16.3.1 Process Monitoring

Process monitoring requirements are outlined in the WTP Recycled Water Quality Management Plan. Monitoring points exist in the lagoon system, online in the UV Plant (UV dose, transmissivity and flow) and online in the Chlorination plant (chlorine dose, residual and detention time for chlorination). Reporting against performance targets will be conducted annually. Where targets are not met, actions will be identified and delivered.

16.3.2 Product Monitoring

The monitoring of the supply will be undertaken in accordance with the Table 5 in the EPA Guidelines and as per the recommendations in the IMP. Reporting against the EPA Guidelines and ANZECC and ARMCANZ Guidelines will be conducted annually. If any of the results approach the ANZECC and ARMCANZ (2000) guideline values, intensified testing will be undertaken and if required, actions will be taken.

The parameters and monitoring frequency are outlined below.

Continuous Monitoring:

- Electrical Conductivity (EC)

Weekly Monitoring:

- pH
- BOD₅
- Suspended Solids
- E.coli

Monthly Monitoring:

- | | | | |
|--------------------|-------------|-----------|-------------|
| • Total Nitrogen | • Magnesium | • Boron | • Lead |
| • Total Phosphorus | • Sodium | • Colour | • Zinc |
| • Calcium | • Potassium | • Cadmium | • Aluminium |
| | • SAR | • Copper | |

Annual Monitoring:

- | | | | |
|-------------|--------------|------------|-----------------|
| • Silver | • Iron | • Antimony | • Inorganic TDS |
| • Arsenic | • Mercury | • Selenium | • Organic TDS |
| • Barium | • Lithium | • Tin | |
| • Beryllium | • Nickel | • Thorium | |
| • Chromium | • Manganese | • Vanadium | |
| • Cobalt | • Molybdenum | • Chloride | |

Refer to Appendix K for the detailed monitoring program.

16.4 Runoff and channel flushing monitoring

SRW will continue its current surface water monitoring program (quality and quantity) as outlined in Section 8.7. Customers will undertake site appraisals for the presence of water-logging and contaminated run-off as part of the CSMP. There are 12 drainage points from drainage systems in the WID. Four of these drain relatively minor areas. Of the remaining 8 drain outlets (2 drain to the river and 6 drain to Port Phillip), 3 of the major drains will have

flow measured. These included drain D11 (river), D5 (Bay) and D6 (Bay). The flows from these drains will be used to estimate total flow from the district, assuming drainage is relative to the drain's catchment area. Drain D5 will be monitored for drainage water quality using the existing flow and sampling station installed in this drain. Water quality data from this drain will be used to estimate nutrient loading in all other drains. SRW will also monitor overflow from channels required to manage water delivery through the channel system. Random sampling of other drains will also be undertaken at two points during at least three rainfall events each year.

Parameters that will be measured in the composite sample from major flow will include:

- pH
- Salinity (Electrical Conductivity)
- E. coli
- Total N
- Total P
- Cu, Cd, Zn, Pb

The drainage map of the district (Appendix L) will be used to calculate total flows from all drains and loadings of N and P entering the Werribee River and Port Phillip.

Refer to Appendix K for the detailed monitoring program.

16.5 River Water Monitoring

EPA Victoria is endorsing the use of recycled water given the management regimes outlined in this EIP and the CSMP.

In the short term it is recommended that river water be monitored monthly, for the parameters listed above under "Recycled Water Quality". An ongoing monitoring program can then be determined for river water depending on the results. This ongoing monitor program would be continuous monitoring of EC and quarterly monitoring of the parameter listed below, except for Cu, Cd, Pb and Zn which could be analysed once a year.

Parameters that will be measured in the Werribee River water (RMCG and URS 2004) are:

- | | | |
|--------------------|-------------|-----------|
| • pH | • Calcium | • Boron |
| • Salinity (EC) | • Magnesium | • Copper |
| • E. coli | • Sodium | • Cadmium |
| • Total Nitrogen | • Potassium | • Zinc |
| • Total Phosphorus | • SAR | • Lead |

Refer to Appendix K for the detailed monitoring program.

16.6 Groundwater monitoring

In 2004, a draft Groundwater Management Plan that was developed by local landholders and relevant agencies for the management of groundwater resources within the water supply protection area, was not approved by the Minister for Water. However due to the recent water management issues that have arisen due to drought conditions, the Minister endorses that an Advanced Plan be developed for the area in accordance with section 32 of the Water Act 1989. SRW in consultation with relevant agencies and landowners in the area will commence the advanced planning process in 2005.

Flow meters are installed on all active commercial bores and will be read at least twice annually by SRW. See Appendix G for bore locations. Groundwater level and EC monitoring will continue from state observation bores at a monthly frequency as a minimum. Monitoring of some private bores for EC will occur at a lesser frequency. Nitrogen and phosphorus will be monitored from a sample of state bores twice annually as a minimum.

Groundwater assessments have been undertaken by the water users, prior to application of any recycled water, with the aim of establishing baseline data on the groundwater conditions.

Ongoing monitoring of the 24 observation bores in the WID will include depth and salinity monthly and all other monitoring will be annually at a similar time period. All samples will be taken compliant with EPA Publication 669, April 2000 – “Groundwater Sampling Guidelines”

Groundwater quality will be analysed for (RMCG and URS, 2004):

- pH
- Salinity (Electrical Conductivity)
- Nitrate nitrogen
- Nitrite nitrogen
- Ammonium nitrogen
- Total nitrogen
- Total phosphorus

Refer to Appendix K for the detailed monitoring program.

16.7 Shandied water monitoring

The EC of shandied water will be monitored continuously.

16.8 Soil monitoring

Soils should be sampled and analysed in compliance with EPA Publication 441, March 2000 – “A Guide to the Sampling and Analysis of Waters, Wastewaters, Soils and Wastes”

Soil samples will be taken before irrigation with recycled water commences and annually thereafter. The number of samples required will depend on the size of the farm and the range of

soil types in the areas where recycled water will be used. One sample bulked from 4 sample cores (keeping similar depths separate) to a depth of 1m, per soil class (Table 8-1), per farm, per year will be required and the soil sample must be taken at a similar time each year from the same area. The first sample (baseline sample) should be completed as soon as practical from contracting to use recycled water and before the use of shandied water on the property. Baseline soil samples will be archived by SRW for future reference. The annual sampling after the baseline sample should be from the same sample location (discussed below) and taken at a time when the sample point defined in the baseline sampling is expected to be without crop and not recently fertilised. This time becomes the annual sampling time for this property (preferably September or October). If this is not practical or possible, annual samples should be taken at similar times in the year (preferable September or October). A sample log must be kept for all soil samplings identify if the soil is fallowed, any recent (last 4 weeks) application of fertilisers or soil amendments and if the sample location is cropped (preferably the samples will be taken when the sample area is not being cropped).

The soil sample procedure will require:

1. Sample sites for each property to be identified within each different soil class (as defined in Table 8-1) and must be representative of a typical soil which has been used for agricultural production on the farm.
2. Each sample site identified on a map of the property and cross referenced using GPS coordinate with an error of ± 3 m to identify a reference point for sampling
3. Bulked samples consist of 4, 50mm cores taken randomly at approximately 3m from the reference point, preferable perpendicular to the cultivation direction. Then similar depths of each core are bulked to provide the soil sample for analysis. Soil depths should be: till layer (0-30cm), directly beneath the till layer (30-45cm) and to depth (85-100cm).
4. Each bulked sub-sample should then be dried at 70C and passed through a 2mm sieve prior to storage in a sealed labelled container, which should be archived for future reference.
5. Soil tests required on each sample annually are outlined in Table 16-2,

Table 16-2. Summary of soil sample analysis and frequency of analysis to be undertaken on farms using shandied water

	Soil test	Sample depth and year to sample															
		0-30 cm					30-45 cm					85-100 cm					
		Year					Year					Year					
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	pH (1:5 soil:water)	√	√	√	√	√	√		√			√	√				√
	Salinity (Electrical Conductivity, 1:5 soil:water) and ECse calculated.	√	√	√	√	√	√		√			√	√				√
	Olsen phosphorus (Plant available P)	√	√	√	√	√	√		√			√	√				√
	Nitrate nitrogen (Plant available N)	√	√	√	√	√	√		√			√	√				√
	Total cation concentration and exchangeable calcium, magnesium, sodium, potassium and Exchangeable Sodium Percentage (ESP).	√	√	√	√	√	√		√			√	√				√
	Boron (plant available)	√	√	√	√	√	√		√			√	√				√
	Clay dispersion (Emerson)	√	√	√	√	√	√		√			√	√				√
	Total cadmium (mg Cd/kg soil on a dry weight basis)	√				√	√		√			√					√

The analysis program may be reviewed on a site-specific basis depending on the previous year's data.

These results will be available to Customers for their records and will include analysis summaries of the parameters in Table 16-2. SRW will ensure that these tests are undertaken and it will be necessary for the appointed contractor to access Customers' properties. The initial soil sampling and analysis will be funded by the Government. Future tests will be managed by SRW and cost recovered from individual growers.

Soil analysis will be incorporated into the CSMP during the auditing process.

16.9 Monitoring Records

Melbourne Water and SRW will retain all water and soil monitoring records for a period of at least 10 years in order to analyse trends, and comply with the EPA advice related to auditing requirements for the EIP.

These records will include:

- Monitoring data – recycled water, surface water (SRW only), groundwater (SRW only) and soils (SRW only);
- Flow data for recycled water supplied to customer/s;
- Analysis of trends in the parameters monitored;
- Inspection and maintenance reports; and
- Details of incidents and corrective action taken.
- Melbourne Water and SRW will make available all environmental monitoring records to EPA Victoria and Customers upon request.

Refer to Appendix K for the detailed monitoring program.

16.10 Reporting

Melbourne Water will submit an annual report to EPA Victoria, which includes:

- A summary of recycled water monitoring data, including an evaluation of results against the appropriate criteria and a review of trends from previous data if appropriate
- A summary of details and findings from the maintenance and inspection program for the Headworks System
- Summary of incidents and non-conformances, including corrective and preventive action
- Summary of complaints, including follow-up action
- Proposed forthcoming improvement actions or programs
- A summary of audit results and outcomes

SRW will submit an annual report to EPA Victoria, which includes:

- A summary of shandied recycled water monitoring data, including an evaluation of results against the requirements outlined in the EIP and a review of trends
- Runoff and drainage flow and nitrogen and phosphorus loadings leaving the district through the drainage system
- A summary of results from soil and groundwater monitoring conducted by both SRW and the water users as outlined in the EIP (including an evaluation of quality and a review of trends).
- A summary of results from soil and groundwater monitoring conducted by both SRW and the water users as outlined in the EIP (including an evaluation of quality and a review of trends)

- A summary of details and findings from the maintenance and inspection program for the SRW Distribution System
- A listing of each site receiving recycled water from the scheme, including quality, quantity and use of recycled water (eg irrigation)
- Summary of incidents and non-conformances, including corrective and preventive action
- Summary of complaints, including follow-up action
- A summary of audit results and outcomes
- Proposed forthcoming improvement actions or programs

16.11 Trigger Levels

The initial triggers values below (Table 16-3) will be reviewed on an ongoing basis as more data is accumulated over time for the WID.

Table 16-3. Trigger points and responses for environmental areas monitored

Trigger Point	Response
Recycled Water	
Metals and metalloids are detected in the recycled water at levels above ANZECC and ARMCANZ (2000) STV and LTV (Table 9-5) guidelines	Identify source of the metal or metalloid and rectify.
Recycled water nutrient levels increase from baseline values by 20% over two month period.	Investigate reasons for nutrient level increase and rectify, Modify shandying as appropriate for nutrient balances on-farm
If any known extreme and/or hazardous toxicant levels are detected in the recycled water	Cease supply of recycled water to the WID channel system and investigate the source of the toxicants. Contact the EPA for advice. Note this is very unlikely to occur at this site.
Water Balance	
Water balance indicates that irrigation application rates are significantly above appropriate levels (determined after accurate water use data is available)	Investigate cause (such as leaking on-farm dam, significant over watering). Assess consequence and rectify if required.

Trigger Point	Response
Soils	
Soil sample results indicate increases in soil sodicity baselines (i.e. >20% rise in ESP – Exchangeable Sodium Percentage). Or soil ESP exceeds 15%	Investigate cause and rectify. Develop sodicity management plan.
Soil salinity increases from baseline measurement by > 1000 µS/cm ECse	Investigate cause and rectify. Develop salinity management plan.
When soil chemistry levels increase by more than 20% from environmental acceptable baseline levels. Or, reaching ANZECC and ARMCANZ (2000) Cumulative Contaminant Loading Limit.	Identify the reason for the increase and rectify
Annual soil nutrient levels increase by 20% from baseline	Investigate reasons for nutrient level increase and rectify if attributable to recycled water (otherwise nutrient management plan is required)
River Water	
Metals and metalloids are detected in the Werribee River at levels above ANZECC and ARMCANZ (2000) STV and .LTV (Table 9-5)	Inform EPA and take appropriate action, if required.
When river water does not meet appropriate microbial standards for irrigation of crops grown in the WID (i.e. <1000 E. coli/100ml)	Determine source of E. coli contamination and rectify
Surface drains	
When drainage water flows are recorded during the irrigation season when significant rainfall has not occurred	Identify source of runoff and adjust practices accordingly.

Trigger Point	Response
Drainage water monitoring indicates elevated nutrient loads that could have significant impact on receiving environments. Or exceed State Environment Protection Policy (SEPP) guidelines.	Review fertilizer and irrigation application rates summarized in CSMP and encourage best management practice that is economically, socially and environmentally sustainable.
Groundwater	
When water table has risen significantly from baseline values (by 20% seasonally) or is within depths recommend from the groundwater monitoring report.	Identify the source of excess water and rectify
When nutrients or salt in the groundwater have risen significantly from baseline concentrations (by 20%)	Identify the source of contaminants and rectify

16.12 Incident Reporting

In the event of an emergency that impacts on the WID Recycled Water Scheme, either Melbourne Water or SRW will be responsible for the incident management depending on the nature of the event. The Emergency Response Plans and Industry Response Plan (refer Section 15) will define roles and responsibilities in cases of incidents.

If Melbourne Water is responsible it will notify SRW, EPA Victoria and other relevant stakeholders and manage the incident in accordance with Melbourne Water's PERFORM Incident Management Program. SRW will assess whether the Customers need to be informed.

If SRW is responsible it will notify Melbourne Water, EPA Victoria and other relevant stakeholders and manage the incident in accordance with SRW's Corporate Incident Emergency Response Plan. It will assess whether the Customers need to be informed.

In addition emergencies could occur on individual customer's properties. Reporting of these will be via the "Annual Compliance Statement" submitted by each customer annually to SRW. A leak that impacts on a waterway needs to be reported to EPA Victoria at the time of the incident.

The Customer shall, when required by SRW:

- Keep an accurate record of the quantity of water taken under this Agreement and allow SRW to inspect this record at all reasonable times and to provide a copy of the record when requested;
- Provide a description of the area irrigated, or to be irrigated, during any period; and
- Keep and provide such other information as reasonably required by SRW for the effective and efficient management of water resources with the Werribee Irrigation District.

If the Customer identifies quality problems with the Shandied Water taken by the Customer, the Customer must notify SRW immediately of this problem and in writing within 24 hours of becoming aware of such problem.

16.13 Auditing

Auditing is important to ensure that Melbourne Water, SRW and the Customers meet their obligations under EPA Victoria Guidelines. An audit program has been developed in accordance with the principles of ISO 14010 *Guidelines for Environmental Auditing*.

The objectives of the audit program are to assess:

- Compliance with EPA Victoria Guidelines
- Compliance with relevant statutory requirements
- Compliance with the EIP by Melbourne Water and SRW
- Compliance with the CSMPs by Customers and SRW. Initially, every 4 years all CSMPs must be audited with approximately 25% audited every year. The auditing frequency will be reviewed annually to determine if it is appropriate.
- Levels of environmental risk and effectiveness of management practices.

The EIP must undergo a statutory audit every 3 years (EPA) and be reviewed annually by an EPA approved auditor. If it is subsequently deemed unnecessary to conduct audits on an annual basis, the frequency may be extended. Melbourne Water and SRW will each arrange suitable independent audits to assess their own performance. SRW is also responsible for the audits of the CSMPs. The scope of each statutory audit is outlined below.

By 31 December 2004 provide the results of the baseline monitoring program for the Scheme, as outlined in the EIP

By 31 August 2008, and every 3 years thereafter, Melbourne Water and SRW must jointly submit to EPA Victoria an environmental audit report pursuant to section 53V of the Environment Protection Act 1970, prepared by an environmental auditor appointed under the Environment Protection Act 1970 in relation to the risk or possible harm or detriment to the air, water, groundwater and land environments caused by the recycling of treated wastewater from the WTP in the WID that are part of the EIP as determined by:

- Review of any systems, plans, procedures, monitoring programmes, data, records, reports or other information relevant to the scope of the audit;
- Inspection of any relevant activities, processes, plant and/or equipment used within the scheme; and
- Collection of and/or modelling of any data as the auditor sees fit.

The environmental audit report referred to above must:

- Indicate if the activities are in compliance with the approved EIP and indicate if the Scheme causes a risk of any possible harm or detriment to the air, water, land or groundwater environment as determined by an assessment of compliance with the EPA Guidelines and relevant State Environment Protection Policies;
- Where a risk or any possible harm or detriment to the environment has been determined, recommend any measures necessary to reduce the risk to an acceptable level;
- Where the risk is not able to be determined, recommend any measures necessary to ensure that risks and level of compliance will be able to be determined in future; and
- Include recommendations to improving environmental performance, management systems, monitoring programmes or other recommendations as the auditor sees fit.

16.14 EIP Review

The EIP will be reviewed in 2009 when the salinity of the recycled water is reduced below an EC of 1,000 $\mu\text{S}/\text{cm}$, after any other significant alterations to the scheme, and if an annual audit requires it to be. Each review will take into consideration changes to:

- Western Treatment Plant operations
- The quality of recycled water supplied to the scheme;
- The Scheme;
- Water users;
- The EPA Guidelines;

- Statutory and regulatory requirements; and
- Melbourne Water and SRW policies.

Major updates of the EIP will be sent to the relevant stakeholders for approval. The review will be coordinated by Melbourne Water or by a suitably qualified third party with experience in water recycling schemes, on behalf of Melbourne Water.

16.15 Future monitoring and research required

The appropriate management practices for the WID are not currently fully developed. The following investigations and management plans are required (RMCG and URS, 2004):

Within 2 years:

- Investigation and development of a sustainable groundwater management plan

Within 5 years:

- Investigation of appropriate and sustainable irrigation scheduling and application rates
- Development of a WID-specific nutrient management plan for the crops grown in the WID.

Within 8 years:

- Development of a soil health management plan, primarily focussing on soil sodicity
- Development of a salinity management plan for the WID

These investigations require fund/support from the State Government and Department of Primary Industries.

The time frames above may be shortened by trigger values (Table 16-3) being exceeded during the annual monitoring program.

It is assumed that the timeframe of five years (when large volumes of recycled water can potentially be utilised) will be sufficient to conduct these investigations. It should be noted that the recommended programs are required in response to existing water quality issues.

The development of recycled water irrigation may act as a catalyst for these programs by providing excellent baseline and ongoing data through the implementation of site management plans and information sessions.

The development of a nutrient management plan is not required in response to the introduction of recycled water in the short-term, rather it is in response to existing nutrient issues. After 2009, the nutrient balance for the District needs to be revised with the EIP and consideration given to techniques required for balancing nutrients inputs with output.

17. Communication and Training

17.1 Liaison between Melbourne Water and Southern Rural Water

There will be regular liaison between the two organisations to ensure continued quality and security of supply.

17.2 Liaison between Southern Rural Water and the Customers

SRW has an established Customer Consultative Committee for its Western Irrigation Business with representatives from the WID. It also produces a quarterly newsletter which is mailed to all of these customers.

In addition, periodic shed meetings and informal gatherings with customers are held in which issues can be raised and addressed. SRW field staff present in the District often engage on one to one discussions with growers.

17.3 Community Liaison

A Stakeholder Reference Group was established to provide a formal liaison forum between the scheme providers, customers and stakeholders.

Beyond the commissioning of the Scheme, it is proposed that the Stakeholder Reference Group meetings continue for the first six months with all current members. After six months, the Stakeholder Reference Group will review its Terms of Reference and constituency after which the group will continue to hold meetings on an annual basis and on a needs basis.

17.4 Complaints Management

SRW has established a complaints recording system and register for the purpose of documenting and acting on complaints received about the scheme, from the community and stakeholders.

When a complaint is received by SRW, it will be documented on a incident notification form, which is then entered into the incident register and issued to the Recycled Water Management Group.

For each complaint, the following will be documented:

- The name and address of the complainant
- Time and date of the incident
- The location of the incident
- The name of the SRW officer dealing with the complaint

- The nature of the complaint, including the outcome of follow up investigations, and actions to prevent recurrence of the incident.

Once a resolution to the complaint has been achieved, follow up contact with the complainant should be undertaken.

A summary of complaints received by SRW will be provided in the annual report to EPA Victoria.

17.5 Information Sessions

In September and October 2004, a series of three grower information sessions were conducted. All SRW customers in WID were invited to attend. The sessions covered salinity and sodicity, public health and food safety risk management, the CSMP and the Customer Supply Agreement. As part of the Engagement Strategy commissioned by the Department of Sustainability and Environment, together with SRW, Melbourne Water and the Department of Primary Industries, a Grower's Kit for potential recycled water users in the WID was developed. All attendees of the Information Sessions received the Grower's Kit.

An information session on the EIP and irrigating with recycled water will be available for all Customers and users (Operators) of recycled water. This information session must be attended by one of the signatures of the CSMP and the appropriate nominee (irrigator) within the first year of its use. The Information Session is also available to non-recycled water users at full cost.

Further information sessions will then focus on providing Customers with the knowledge to check if they are currently operating their farms in an environmentally sustainable manner, and if not, provide them with the information and contacts required to improve their current practice. The Information Sessions will focus on:

- Correct uses for recycled water
- The environmental risks
- Nutrient and fertiliser management when irrigating with recycled water
- Managing salinity and sodicity
- Irrigation scheduling and systems performance.

The content of the Information Session requires approval from the EPA before it is commenced.

17.6 Extension Program

The Department of Primary Industries has extension programs that operate throughout the region. These programs continue on a needs basis, and most Customers would be familiar with the VegCheque programs, that provide information on many issues such as insect pest management. Due to concerns of irrigators surrounding recycled water, the Department of Primary Industries has committed a dedicated extension officer for the WID to make recommendations to DSE on the future extension needs, to aid in completion and maintenance of the CSMP, and to aid irrigators with all decision making surrounding the recycled water. The

Recycled Water extension program currently requires the delivery of Information Sessions, as required by the EPA, to irrigators undertaking to use recycled water. These sessions are required by the EPA to be completed within 12 months of the recycled water commitment. One of the primary roles of the recycled water extension officer is to ensure that these information sessions are relevant and interesting to irrigators, while ensuring the EPA requirements are met. The long term Recycled Water extension program will be based on a partnership between SRW, DSE and DPI. The partnership is necessitated by the lack of capacity within DPI to adequately resource the program, and the sharing of responsibility.

The long-term Recycled Water extension program will specifically focus on:

- The capacity of Customers to adopt improved irrigation and fertiliser practices
- The interpretation and implementation of the CSMP

It is important to the Department of Primary Industries to ensure the recycled water can be used in an economically sustainable way for the irrigators.

18. References

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19. Appendices

Appendix A Customer Site Management Plan Template

Appendix B WTP Recycled Water Quality Management Plan –
Process Flow Diagram

Appendix C Environmental management of chlorine residuals in
recycled water (Reid, 2004)

Appendix D Summary of WTP water quality monitoring results for
the 12 month to October 2004

Appendix E WTP Algal Emergency Response Plan

Appendix F River Water Quality Monitoring Data

Appendix G Groundwater Monitoring Bores and Private Bores

Appendix H Summary of SRW pipelining feasibility study

Appendix I Sign Template and Map of Locations

Appendix J Channel Management Report

Appendix K Monitoring Program

Appendix L Drainage Map of the WID

Part 2: Supporting Documentation

- 1.1 Customer Supply Agreement
- 1.2 Stakeholder Reference Group Issues Paper Schedule
- 1.3 Irrigation Management Plan
- 1.4 Grower's Kit
- 1.5 Recycled Water Quality Management Plan (Melbourne Water)

PLEASE NOTE:

The Customer Supply Agreement and Recycled Water Quality Management Plan were not final documents at the time of submission to EPA. Please contact the EIP Representatives from Melbourne Water or SRW for the final documents if required.

The Grower's Kit is a working document. It is intended that the Kit will be added to throughout the Scheme as relevant information for Customers becomes available. For the current contents of the Grower's Kit, please contact the EIP Representative from SRW.