

Operator experience with recycling in Australia

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Abstract

Qualitative results from a survey undertaken by the Oz AQUAREC team of a select group of reuse schemes in Australia are presented and discussed. A database of some 450 reuse schemes in Australia has been compiled from information provided by scheme operators and from the literature. Based on this database, 12 schemes in Australia representative of technologies, applications for reclaimed water, and different jurisdictional and geographic locations were selected for further investigation. A survey in the form of a self-completing questionnaire was sent to operators of this representative group of reuse scheme managers to assess a broad range of operational issues. The database and survey are a component of the information gathered as part of the international AQUAREC project, which is developing integrated concepts in water recycling. The components of the questionnaire include plant location, process and capacity, operation and maintenance, ownership, finance and marketing and social issues. A summary of the qualitative results that were obtained from the questionnaires in Australia is provided with the common themes that emerge together with lessons learnt in the various integrated aspects of scheme operation. As many of the schemes selected are at the forefront of reuse, not only in Australia but also internationally, the information presented gives a broad overview of the current status of the experience with the integrated aspects of reuse in Australia.

Keywords: Reuse schemes; Survey; Current status; Operating experience; Recycling technologies; Financing; Community consultation

1. Introduction

The University of Wollongong is one of 17 international partners in the AQUAREC Project,

which is developing integrated concepts in water recycling. As part of the international data collection of reuse schemes for AQUAREC, a database of some 450 reuse schemes in Australia was developed. The data collected for this database were provided by scheme operators for the larger

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and more innovative schemes and from literature surveys including the review undertaken by the Australian Academy of Sciences and Engineering [1] for a large number of smaller regional schemes.

From this database 15 reuse schemes were selected for more detailed assessment. The selection included reuse schemes that were representative of the various technologies currently being utilised for reuse. The selection also included schemes from most states and territories in Australia and from different climatic zones. The questionnaires and collated data provided information on the operational experiences of existing schemes that can be used in the development of future guidelines for scheme operation.

Operators were asked to complete a 20-page electronic questionnaire that sought considerable detail on many diverse aspects of reuse schemes including financial, operation and management, monitoring and performance, failures that have occurred and community consultation and communication issues. Ten of the questionnaires were completed; three were filled out via interviews. The information was collected on the basis of confidentiality of the individual scheme and of the person providing the information. This was seen to be important to ensure that the most frank and detailed assessment of the scheme's performance was provided without the need for public explanation. Some questionnaires were not completed because of confidentiality issues or because the operators had some difficulty in getting clearance from management to release the information.

2. Scheme description

2.1. Treatment processes

The level of treatment of the reuse schemes from the completed questionnaires included two with secondary treatment, two with tertiary treatment, and the remaining six with advanced

treatment processes. All of the six advanced treatment plants used double membranes, and the remaining plants included one each of conventional treatment plus filtration and disinfection (the Title 22 standard), soil aquifer treatment, lagoon treatment, and conventional secondary treatment plus disinfection. The size of the schemes surveyed ranged from 0.01–0.1 Mm³/y (2), 1–5 Mm³/y (3) and larger than 5 Mm³/y (5). As most of the reuse schemes surveyed have only been in operation for a few years or less, two of the plants were currently operating at more than 75% of capacity and one was below 25% capacity.

The factor that most influenced the decision to invest in the reuse scheme was environmental abatement with seven of the schemes reporting that this was very influential in the decision. One scheme reported that pressure to construct a water recycling facility to improve the environment came directly from the local community. Six scheme managers also reported that both environmental abatement and improved productivity were combined in the decision to invest in the

Table 1
Uses for reclaimed water

Use for reclaimed water	No. of schemes	Total recycled water (Mm ³ /y)
Restricted landscape irrigation	3	1.66
Recreational unrestricted human contact	1	0.025
Recreational restricted human contact	1	50
Recreational non-contact	2	0.43
Restricted agricultural	2	1.31
Unrestricted agricultural	2	1.48
Other	1	40
Industrial non-food process water	1	1.516
Industrial cooling and manufacturing	2	24

scheme. Most of the schemes were complying with the relevant state or Australian guidelines for recycled water treatment and use.

2.2. Use for reclaimed water

The schemes surveyed used reclaimed water for a number of uses, and in some cases the scheme had more than one use for the reclaimed water. The responses are detailed in Table 1.

3. Scheme operation and management

Of the ten schemes that were reviewed, eight are subject to a regular environmental audit and

have in place a risk management plan. Nine of the schemes have a maintenance management plan.

3.1. Monitoring

Managers were asked about the monitoring of the schemes, and in particular if monitoring was on-line and if the purpose of the monitoring was for plant performance and/or for health risk or safety. Table 2 summarises the responses received. The monitoring for both health and safety requirements and plant performance includes parameters such as turbidity, total coliforms and chlorine residual, while plant performance is primarily monitored using pH, turbidity, conductivity, BOD and various nutrients.

Table 2
Monitoring of schemes

Parameter	No.	Monitoring on-line	Monitoring for performance	Monitoring for health risk/safety
pH	4	3	4	
Turbidity	4	4	5	3
TSS	1			1
Conductivity	2	1	3	
Total <i>Coli</i>	5		4	3
Fecal <i>Coli</i>	2		1	2
Nematodes				
Streptococcus				
Micro pollutants				
Total residual chlorine	3	5	4	4
Energy	4	2		
Chemical use	4	2		
Flow	5	3		
Temperature	1	1		
Odour			1	1
Oil and grease	1		1	1
Nitrogen	3		3	1
Ammonia	1		1	
Phosphorous	3	1	3	1
BOD	3		3	1
MLSS	1		1	
DO	1		1	
NFR			1	
TDS	1		1	
Pump run time	1	1		

3.2. Control strategies

Control strategies that are in place for potential risks from micropollutants such as pesticides, radioactive materials, pharmaceuticals and endocrine disruptors were mainly limited to source control, with a number of scheme operators undertaking research and developing risk management or contingency strategies including multiple barrier control.

None of the schemes surveyed was continuously staffed, but most had SCADA systems or similar to monitor the process and key process parameters. Nine of the schemes had an alarm system that reported remotely to a personal computer or phone, with the remaining scheme not responding to this question.

3.3. Barriers and consequence of failures

Operators were asked to identify barriers and time delays to prevent or buffer the impact of contaminants from reaching the end user. Of the eight that responded, most of those schemes that included membrane treatment processes depended primarily on the membranes as a barrier with disinfection as the main back-up. Other treatment processes included some form of storage in the treatment train that provided a barrier prior to distribution to the end-user. The consequences of failure of individual barriers was reported as being of low significance, as generally multiple barriers maintain the quality of final product water or the end-use can tolerate some water that is below standards without a major health or environmental impact (such as with some irrigation systems).

The consequence of individual barrier failure on the life of the plant was not considered to be significant by all of the respondents, with minor problems such as algal build up being the main problems reported.

3.4. Failure history

Six of the surveyed scheme operators reported failures that had occurred. Most of these failures were equipment malfunction or breakdowns including pumps and chemical dosing equipment, and in some cases the “failure” was an anomaly in results due to monitoring equipment malfunction. One failure was a result of algal build up in the distribution system. Failure was mainly detected by monitoring of the chlorine residual, turbidity and conductivity with a result outside the normal guidelines for the parameter being measured considered as a failure. None of the failures reported resulted in the supply of water that caused any health or environmental problems in any of the reported cases.

3.5. Complaints and interruptions

The schemes surveyed have a high reliability of supply to the end-users. Only one scheme reported a minor interruption to supply for farm irrigation, with all other schemes maintaining continuity of a water supply that met guidelines even with the failures reported above. The operators surveyed reported only one complaint, and that was of insufficient quantities of water being available. While the survey results indicate a very low complaint numbers, there was no assessment made of the reliability in reporting and recording of complaints about the scheme.

3.6. Inspections of distribution systems

The distribution systems were inspected on a regular basis by a small number of scheme operators with frequency mainly annual, but more frequent inspection of key elements such as reservoirs was undertaken weekly and valves and pumps inspected monthly in a small number of cases. There was only one case where the replacement of key elements in the distribution system such as pumps and valves was part of a main-

tenance management plan with most operators that responded to this question reporting that they were repaired or replaced only after failure. In a small number of cases the distribution system was not owned by the scheme operator, and these operators did not accept responsibility for inspection or maintenance of the distribution infrastructure.

4. Financial management

4.1. Pricing

The response of operators to a question about the pricing of reuse water was answered by all but one scheme operator, who was unable to respond due to commercial confidence requirements although the price was reported as less than the alternative potable source. Two schemes did not charge for water supplied to farmers for irrigation, as the primary purpose of the reuse scheme was for effluent disposal. In all responses the price did not reflect a market price but in most cases was set at a percentage (usually 75–80%), shadowing the potable water price. Only two schemes reported that the purpose of the scheme included reduced demand on the potable water supply with most schemes being a means of safe disposal of effluent and in some cases at a lower standard of treatment than would be required to discharge into the environment.

4.2. Payback period

Only two of the scheme operators reported that the financial payback period for the scheme was less than 25 years, with two reporting that the scheme would never repay the investment; the remaining operators did not respond to this question.

4.3. Funding source, guarantees and subsidies

All of the schemes surveyed were owned by public authorities, although in most cases these were semi-autonomous government agencies. The source of funds for the building of the scheme was primarily through grants, public loans, and tax-exempt investment finance, with the recovery of investment from tariffs of primary importance in only one case and less important in two other cases. None of the schemes was financed through equity investment, although two schemes involved build, own and transfer contracts.

4.4. Cost-benefit criteria applied

Operators were asked to identify the relative importance of criteria applied in the analysis of costs and benefits of the investment in the scheme. Their responses are summarised in Table 3.

The response to this question was poor, with less than half of the schemes responding. From

Table 3
Number of scheme operators identifying key cost-benefit criteria applied for eligibility for public funding

Relative importance	Costs/benefits without non-water supply benefits	Costs/benefits with non-water supply benefits	Part of a regional program	Technical/scientific merit	Qualifications of applicants	Social	Other
Primary role	1	1	2	2	1	2	1
Secondary role			1		1	1	
Criterion not required	1	2	1	1	1	1	

those that did respond there is a broad spread of responses, although there is a concentration of criteria that relate to the overall system operation and technology while social criteria were the primary criteria in only two schemes and had a secondary role in one other scheme.

5. Community consultation

The questionnaire asked scheme operators to detail aspects of the community consultation undertaken. Table 4 details the type of consultation strategies and techniques reported for the schemes and at what stage of the process the consultation was undertaken. As can be seen, there was considerable consultation undertaken during the planning phase with none reported during detailed design and start-up. There was some consultation after the commencement of the scheme, but this is very limited and mostly direct contact or responding to a hotline service. In

contrast, the focus of public education activities has been largely post-start-up as detailed in Table 5, with few education activities prior to the commencement of the scheme.

5.1. Are results of scheme performance are regularly communicated to end users?

The type of information and method used in reporting of scheme performance is detailed in Table 6, which indicates that many of the schemes have some form of reporting, although this is mostly in the form of monthly or annual published reports rather than a more proactive information sharing. A positive aspect is that in half of the schemes there was reported to be assistance given to customers in the understanding of the significance of the results reported. It should be pointed out that in some cases, such as for industrial reuse schemes, the schemes have a very small number of customers.

Table 4
Public consultation strategies employed

	Planning	Design	Start-up	After start-up
Reference or focus groups of users	6			2
Newsletters or other regular updates	5			
Customer surveys	3			
Hotline service	2			1
Customer/visitor center	2			
Other (mostly direct contact)				6

Table 5
Public education strategies employed

	Planning	Start-up	After start-up
Plant access or open days	1		3
Brochures or other written material		1	5
Use of print media for advertising			5
Use of e-media for advertising			4
Explanatory signage and warnings			7
Targeted material/training for end users			5

5.2. Management practices for behaviour risks of end-users

An important aspect in the management of reuse schemes is the understanding of end-user behaviour, and where necessary to manage the risks associated with their applications of the reuse water such as the potential for misuse of water or of cross-contamination through inappropriate management activities. Table 7 identifies the responses from scheme operators to the options for managing end-user risks.

5.3. Major challenges

Scheme operators were asked what the major implementation and operational challenges that they had met and to rank their importance. Their responses are summarised in Table 8. Commercial and financial issues seem to be the most important while political support seems to be of least significance as an issue.

6. Conclusions

The survey undertaken has included a number of the iconic schemes in Australia and while limited to a small number of schemes, it does provide a broad picture of the operation and management issues associated with reuse schemes in Australia. The schemes vary in size and in technical complexity and operate in different institutional frameworks and in different geographical locations. There are insufficient schemes surveyed to

draw any statistically valid conclusions however the responses to the issues surveyed in the questionnaire do not seem to follow a pattern that relates to any of these differences.

Table 6
Reporting of scheme performance

Results of scheme performance regularly communicated to end users:	No.
YES	7
NO	2
N/A	1
Type of communication used:	
Scheme specific newsletters	1
Publication in mass media	1
Web based information	1
Monthly or annual reports	3
Direct contact with users	2
Consumers assisted in developing an understanding of the significance of these results:	
YES	5
NO	1
N/A	4

Table 7
Management practices for end users behavior risks

Management practice	No.
Compliance auditing	1
Guidance provided	1
End user EMP	2
Flow control	1
Consultation/communication	2

Table 8
Major implementation and/or operational issues

Relative importance	Social	Technical	Institutional and legal	Commercial/ financial	Political	Environmental
Not a problem	5	3	3	1	5	1
Moderate problem	2	5	4	4	2	
Major problem	2	1	1	3	0	

The value of the survey is to provide operators with information on other scheme operation that will assist them in their future decision making and for the progressive development of best practice guidelines that are sufficiently flexible to accommodate the many different operating conditions experienced. The results of the survey of Australian schemes will be incorporated with results from the other countries surveyed as part of the AQUAREC project into a knowledge base for decision making and to determine best practice in reuse schemes.

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