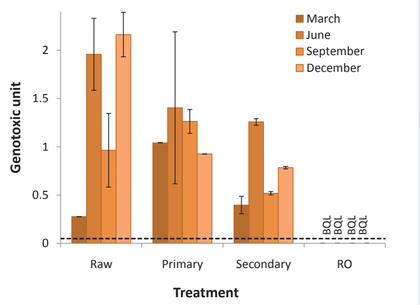
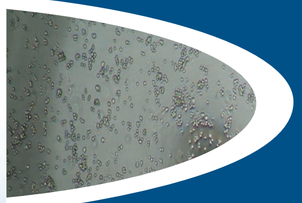
‘DNA damage’ (genotoxicity)



This bioassay measures DNA damage or genotoxicity.

Bars indicate the results of this bioassay in four seasonal samples from each of raw, primary, secondary and reverse osmosis treated effluent.

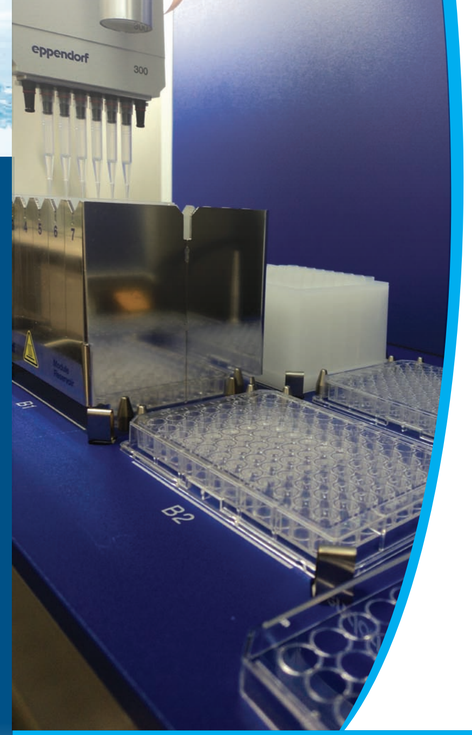
The level of activity that was detected in raw wastewater was completely removed through the treatment process, with no observed activity for samples treated by reverse osmosis.



The results show that:

- Raw wastewater had both significant concentrations of chemical contaminants as well as biological activity.
- The multiple barrier approach for wastewater treatment at Beenyup effectively removes all biologically active compounds and hence their related biological activity.
- Reverse osmosis was an effective barrier to biologically active compounds. None of the chemicals monitored in this study were detected in water treated by reverse osmosis. Genotoxic, phytotoxic, estrogenic and androgenic activity were likewise not detected in reverse osmosis water. The low level cytotoxicity that was detected in two out of four reverse osmosis treated samples is a result of the extreme sample concentration carried out for testing and not indicative of actual toxicity in the samples.
- The bioassay results were in agreement with the trends in contaminant removal during each stage of the treatment process that have been observed using chemical analysis.

This study has demonstrated the usefulness of combining multiple lines of evidence when assessing water quality. The toolbox developed in this project shows promise for application to water recycling initiatives with a range of end uses and allows a better understanding of the water quality issues involved. Validation and implementation of the toolbox for a variety of case studies is the next step to further verify and promote the utility of this approach.



This summary is based on data contained in the following report:

Reitsema, T, Nice, HE, Leusch, FDL, Quayle, P, Chapman, HF, Khan, SJ, Trinh, T, Coleman, H, Rawson, C, Gagnon, MM & Blair, P 2010, *Development of an ‘ecotoxicity toolbox’ to characterise water quality for recycling*, Water Science Technical Series, Report no. 36, Department of Water, Western Australia.

More information

The full report and more information on water recycling are available from the Department of Water’s website: www.water.wa.gov.au→Managing our water→water recycling→Ecotoxicity toolbox.

For more information, contact the **Water Science Branch** of the Department of Water.

Disclaimer

This publication is available at our website or for those with special needs it can be made available in alternative formats such as audio, large print, or Braille.

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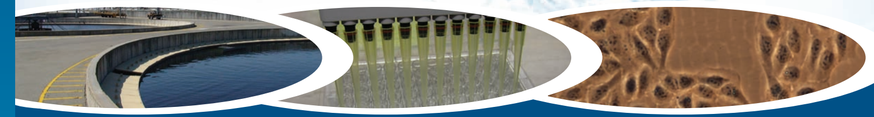
Assessing wastewater for recycling, using the ‘**ecotoxicity toolbox**’ approach



May 2011

Looking after all our water needs

With water in short supply in the south-west of Australia, attention is turning to the use of recycled water for both drinking and other uses. Currently, chemical analysis is used to determine what chemicals are present and at what level, for the purpose of assessing the risk to humans and the environment. Because wastewater is a complex mixture, the usefulness of this approach is limited.

In this project, an 'ecotoxicity toolbox' was developed to better understand the quality of wastewater. In this innovative approach, a range of biological responses were assessed, including cell toxicity, DNA damage, effects on photosynthesis and 'endocrine disruptor' type effects. The aim was to develop multiple lines of evidence, which, used together with the chemical data, will provide confidence in the assessment of water recycling schemes.

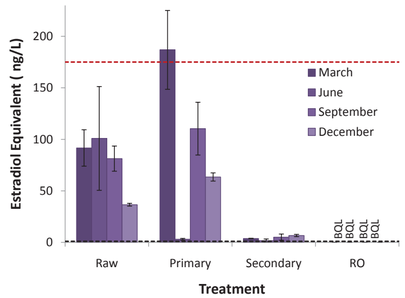
This brochure presents the findings of the Ecotoxicity Toolbox project as applied at the Advanced Water Recycling Plant at Beenyup, the site of the Groundwater Replenishment Trial.

Wastewater treated in a pilot advanced water treatment plant was assessed to determine the suitability of the treatment prior to a large-scale trial.

Samples were taken at various steps in the treatment train to characterise water quality through the treatment process. To determine seasonal effects, samples were taken every three months over the course of a year.

The following graphs and comments describe the results of the various 'bioassays' undertaken. In the graphs, where there are two dashed lines, the lower dashed line indicates the limit of quantification, with 'BQL' indicating those samples that were below the quantification limit. 'RO' means 'reverse osmosis treatment'.

'Estrogenicity'



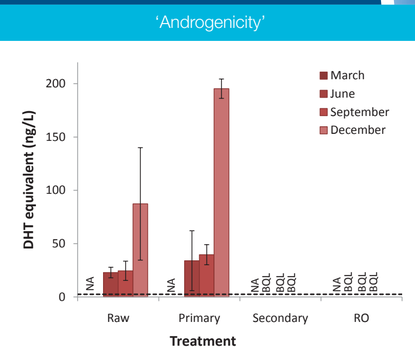
This bioassay measures estrogenic activity, which at high concentrations could cause feminisation of exposed organisms.

Bars indicate the results of this bioassay in four seasonal samples from each of raw, primary, secondary and reverse osmosis treated effluent. Data is presented as estradiol equivalents. The upper dashed line indicates the guideline value for estradiol given in the Australian Guidelines for Water Recycling (Phase 2).

The increase noted for primary treated wastewater is most likely due to reactivation of hormones that arrive in metabolised form at the wastewater treatment plant.

There is a clear reduction in activity through the treatment process, with no observed activity for samples treated by reverse osmosis.

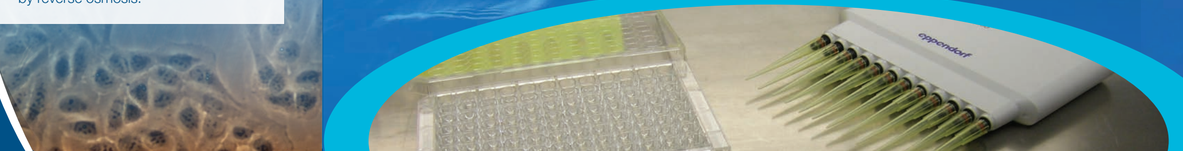
'Androgenicity'



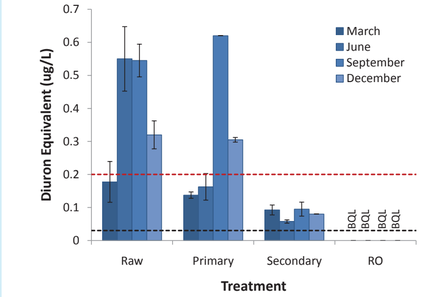
This bioassay measures androgenic activity, which at high concentrations could cause masculinisation of exposed organisms.

Bars indicate the results of this bioassay in three seasonal samples (the first was not available) from each of raw, primary, secondary and reverse osmosis treated effluent. Data is presented as dihydrotestosterone (DHT) equivalents. While there is no guideline for DHT, the testosterone guideline would be at 7000 ng/L on this chart.The increase noted for primary treated wastewater is most likely due to reactivation of hormones that arrive in metabolised form at the wastewater treatment plant.

There is a clear reduction in activity through the treatment process, with no observed activity for samples treated by reverse osmosis.



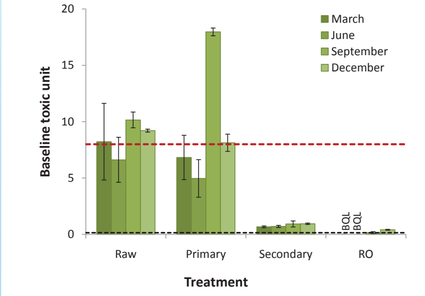
'Herbicide-like effects' (cytotoxicity)



This bioassay measures herbicide-like effects, otherwise known as phytotoxicity, in which photosynthesis in plants is inhibited.

Bars indicate the results of this bioassay in four seasonal samples from each of raw, primary, secondary and reverse osmosis treated effluent. The upper dashed line indicates a suggested environmental guideline based on the Australian and New Zealand Environment and Conservation Council guidelines for Diuron (this data is given in units relative to Diuron, a commonly used herbicide).There is a clear reduction in activity through the treatment process, with no observed activity for samples treated by reverse osmosis.

'Baseline toxicity' (cytotoxicity)



This bioassay measures cytotoxicity, also known as baseline toxicity or toxicity to cells.

Bars indicate the results of this bioassay in four seasonal samples from each of raw, primary, secondary and reverse osmosis treated effluent.

Data is presented as baseline toxic units. While there is no guideline for cytotoxicity, the US Environmental Protection Agency is currently considering a level of 8.1 units (indicated as the upper dashed line on the chart).

There is a clear reduction in activity through the treatment process, with observed activity for only two of the four samples treated by reverse osmosis. The level of activity that was detected in water treated by reverse osmosis is negligible and not of biological concern.