DELIVERING SUSTAINABLE URBAN WATER RECYCLING - AN ENVIRONMENTAL REGULATOR'S PERSPECTIVE OF DUAL PIPE NETWORKS

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ABSTRACT

The recently released Victorian Government White Paper, '*Our Water Our Future: Securing Our Water Future Together*' features water recycling as a key component for delivery of sustainable water resource management in the urban environment. There is a significant emphasis on substituting drinking water with alternative water resources. One way of achieving this objective is to promote the use of dual pipe networks in new residential developments to deliver recycled water for non-potable uses such as garden watering and toilet flushing.

There are a number of residential dual pipe schemes operating in Australia and overseas. In NSW, the Rouse Hill development area has implemented a recycled water system for garden watering and toilet flushing. The City of St Petersburg in Florida, USA, is one of the best known reuse schemes, having been in operation since 1977. Other examples in the development stages include Mawson Lakes in South Australia and Pimpama Coomera in Queensland. In Victoria there are a number of apparently committed urban dual pipe schemes including Aurora Development in Epping North, Sandhurst and Eynesbury Estate. Schemes being investigated include developments at Cranbourne and Wyndham.

While recycled water should be viewed primarily as a valuable resource, potential microbiological and chemical risks have resulted in the use of recycled water being subject to strong regulatory oversight. Effective regulatory oversight is important to maintain community and industry confidence and thus support for recycling, ensure protection of health and the environment, encourage innovative approaches and provide stable frameworks for investment in recycling.

This paper discusses the potential contaminant issues that need to be considered and managed in establishing a dual pipe scheme. This paper also highlights the processes being undertaken to provide the regulatory oversight needed to facilitate residential dual pipe schemes.

1.0 CONTAMINANTS THAT MAY CONSTRAIN RECYCLING

Sewage can contain a range of inorganic and organic contaminants that need consideration and potentially management to underpin sustainable water recycling. These contaminants can be present in the raw sewage due to a range of sources such as industrial (trade waste) discharges, domestic chemical use, the use of therapeutics, contributions from food preparation (i.e. kitchen sink), human excretion (such as heavy metals that are a component of the diet), sewerage system infiltration and leaching from the plumbing system.

The key contaminant groups that are potentially relevant to urban water recycling are listed in Table 1:

Table 1: ***Contaminant Groups and Key Risk Areas***

Contaminant groups	Key risk areas
Salinity and sodium	Environment impacts through sodicity and impact on soil structure and plant growth Environment impacts through movement into surface waters and groundwaters.
Heavy metals	Impacts on human health through accumulation in soils and residential (child) ingestion and uptake into irrigated produce. Exposure through direct contact with water in residential or industrial uses is also a potential pathway. Impacts on environment through impacts on soil organisms eg phytotoxicity and movement into surface waters and groundwaters.
Trace organics: such as surfactants, hydrocarbons, endocrine disruptor compounds	Impacts on human health through residential soil accumulation and ingestion and uptake into irrigated produce. Exposure through direct contact with water in residential or industrial uses is also a potential pathway. Impacts on environment through impacts on soil organisms eg phytotoxicity and movement into surface waters and groundwaters.
Nutrients such as nitrogen and phosphorous	Impacts on environment through movement into surface waters and groundwaters.
BOD and suspended Solids	Environmental through soil clogging, reductions in plant growth through soil anaerobic conditions and nutrient depletion and aesthetic issues such as odour generation following storage.
pH	Environmental through soil damage

A challenge with managing these contaminant groups in dual pipe recycling schemes is that the majority of the available guidance is heavily focused on large scale irrigation users. These users can implement customised and potentially complex irrigation management practices to address key risk areas. However, in residential scenarios, it is problematic to rely on the end users managing garden watering in a tightly defined manner. Instead, the water quality needs to match the anticipated residential behaviour patterns and the development characteristics such as local soil types.

1.1 Available Guidance for Managing Salinity, Sodium and Nutrients

The difference between agricultural and residential uses becomes particularly significant for salinity, sodium and nutrient management. There is a significant difference in the water quality that may be acceptable for the two scheme categories, since large scale users can undertake formal irrigation scheduling run-off management, soil monitoring and addition of products such as gypsum to manage elevated levels of salinity, sodicity and nutrients. In contrast, the residential scenario water quality requirements depend on the expected residential behaviours coupled with assumptions on parameters such as the local soils and climate.

The available guidance is lacking on the appropriate management of these parameters in residential water recycling. Some examples of the available guidance are:

- The current *National Guideline Use of Reclaimed Water* (ARMCANZ, ANZECC, NHMRC, 2000) notes that for almost all recycling applications control of nutrients, toxicants, salinity and sodicity will be required. However, specific guidance is not provided, other than a generic reference to the *NWQMS Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC/ARMCANZ, 2000).

- The South Australian guideline (SA DHS, SA EPA, 1999) notes that for residential non-potable use, the chemical quality should comply with raw water criteria for drinking purposes. However, this criteria relates to nitrate and nitrite rather than total nitrogen and does not specifically reference phosphorous management or salinity/sodicity in residential settings. General guidance on the risks from salinity and sodicity in irrigation water is provided and guidance on nutrient management in municipal settings is provided, but this later guidance is focused on the development of irrigation management plans for large scale users;

- The Victorian reclaimed water guideline (EPA, 2003) notes the importance of assessing and managing nutrient and salinity risks and establishes a nominal limit of 5 mg/L total nitrogen and 0.5 mg/L total phosphorous where there is a significant risk of direct off-site movement of reclaimed water. However, while a companion document provides detailed information on irrigation management (EPA, 1991) detailed guidance in relation to management of salinity and nutrients in residential recycling schemes is not provided.

- The United States *Guidelines for Water Reuse* (US EPA, 1992) is heavily focused on pathogen treatment and management, making only a brief reference to I*rrigation with Reclaimed Municipal Wastewater: A guidance manual* (Pettygrove and Asano, 1984);

- The NSW guidelines for *Urban and Residential Use of Reclaimed Water* (NSW RWCC, 1993) note the importance of nutrient and salinity management and requires that the supply authority 'undertake appropriate soil, irrigation and site specific studies before seeking approval from EPA for the scheme';

- With regard to managing potential risks to surface waters, *the State Environment Protection Policy (Waters of Victoria)* adopts the approach in the *NWQMS Australian and New Zealand Guidelines for Fresh and Marine Water Quality (*ANZECC/ARMCANZ *2000)*, providing surface water quality investigation triggers and a risk assessment framework as the basis for assessing and managing nutrient and salinity run-off risks. This is supplemented with a range of documents such as *Risk Assessment Approach – Ecosystem Protection* (EPA Victoria 2003, Publication 790.1) and *Nutrient Objectives for Rivers and Streams – Ecosystem Protection* (EPA Victoria 2003, Publication 792.1).

1.2 Managing Heavy Metals

The majority of Australian water recycling guidelines for sewage management include references to soil criteria and water quality criteria for heavy metals. However, there are some differences in the criteria in the various guidelines due to the different times that the documents were prepared. Currently, the *National Environment Protection Measure (Assessment of Site Contamination)* (1999) is the key national reference for soil investigation criteria and a risk assessment framework, while the *National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)* provides the equivalent criteria for surface waters.

The levels of trace elements and heavy metals in reclaimed water are typically low compared to concentrations that would constrain recycling and indeed, inputs of phytotoxic compounds such as copper and zinc are often below the amounts often used to correct trace element deficiencies (EPA Victoria, 1991). While heavy metal levels are typically low and not expected to constrain dual pipe recycling, individual schemes will need to undertake site specific assessments of catchment inputs that could potentially result in elevated concentrations.

1.3 Managing Organic Contaminants

Organic contaminants are typically not considered to be a major limitation for water recycling. There are currently limited criteria for organic contaminants in recycled water. Where criteria for organic contaminants in irrigation water is provided, such as in the national Australian and South Australian guidelines, the information is focused on agricultural chemicals such as herbicides. This contaminant grouping would be expected to be more relevant to water extractions from surface waters in agricultural areas, rather than the irrigation of recycled water. However, organic contaminants will be assessed during the review of National Urban Water Recycling Guidelines (discussed below).

1.4 Managing BOD, Suspended Solids and pH

BOD, suspended solids and pH are not expected to be a significant limiting factor in the urban recycling of sewage, since the recycled water will be produced from relatively advanced treatment processes for pathogen removal.

1.5 Input Management

As part of the Victorian Government's commitments under the White Paper, a review of the State's trade waste management framework will be undertaken. This review has the potential to improve sewage quality and reduce any contaminant constraints imposed on water recycling. This review is supported by a VicWater – EPA partnership to develop trade waste management tools for the water industry and cleaner production programs to deliver reductions in priority contaminants such as salt.

2.0 GUIDELINES TO FACILITATE DEVELOPMENT OF URBAN RECYCLING SCHEMES

2.1 National Guidelines

A process has been established for updating the current national water recycling guidelines, the National Water Quality Management Strategy document *Use of Reclaimed Water* (ARMCANZ, ANZECC, NHMRC, 2000). This process will introduce Hazard Analysis and Critical Control Point (HACCP) principles to the guideline and expand the focus from being predominantly relevant to agricultural recycling of sewage to include detailed information on urban recycling and grey-water management.

This process is being overseen by a Steering Committee involving standing committee representatives of the Natural Resources Management Ministerial Council, the Environment Protection and Heritage Council, the National Health and Medical Research Council, the Australian Health Ministers Council and the CRC for Water Quality and Treatment. Three technical working groups are developing the guidance and it is anticipated that the guidelines will be finalised by the end of 2004.

2.2 Victorian Guidelines

In conjunction with the National process is work being undertaken in Victoria to develop detailed guidance for management of environmental and health issues with dual pipe networks. This guidance will build from the *Guidelines for Environmental Management: Use of Reclaimed Water* (EPA Victoria, 2003) and will be supported by a model management plan for a dual pipe development.

This process is being driven by a steering committee involving representatives from EPA Victoria, the Department of Human Services, the Department of Sustainability and Environment, the Municipal Association of Victoria, the Australian Institute of Environmental Health, the Plumbing Industry Commission, the Victorian water industry and the development industry (represented by the Urban Development Industry Association, the Association of Land Development Engineers and Coomes Consulting Group).

The steering group is supported by four technical working groups providing guidance on: plumbing and system controls; environmental management controls; microbiological management controls; and resident education measures. A key feature of the working group programs has been that the initial phases involved detailed and documented reviews of risks and scheme case studies to provide a solid basis for guidance and transparency to the process. The focus of the various working groups is described below.

2.3 Plumbing and System Controls

The working group's role is to identify all the key risk areas of water recycling associated with plumbing standards and plumbing installation and operational management of the urban dual pipe supply networks. The group will analyse those risks and make recommendations regarding appropriate management.

The guidance is expected to recommend a number of key controls to ensure the successful operation of the recycled water supply system including:

- measures to reduce the risk of cross connections between the potable water supply system and the recycled water supply system including an inspection and auditing program;

- a management program including sampling, disinfection and other dosing requirements to ensure appropriate water quality performance standards are maintained to the customer interface; and

- a description of how the reticulated recycled water supply system will be operated to manage potential spills and system cleaning/maintenance.

2.4 Environmental Management Controls

Given the potential significance of nutrients, salinity and sodicity in residential water recycling, the working group is primarily focusing on environmental issues associated with these parameters.

The review work involves investigation of the hazards posed by these parameters and the factors that will influence actual risks, such as use patterns of water in residential areas, local soil conditions, local waterways and stormwater management scenarios. The integration of this information will enable the acceptable recycled water quality parameters to be determined with linkages to necessary management controls (such as stormwater wetland treatment where a development uses recycled water with elevated nutrient concentrations).

A key aspect of this assessment is examining the potential impact of recycled water use in large-scale urban water recycling on stormwater quality. This specifically relates to the use of recycled water to irrigate residential gardens and including an assessment of inappropriate outdoor uses of water such as leaving hose taps on, car washing on driveways and washing down impervious surfaces. This assessment needs to also consider the permanent water saving measures for Melbourne recently introduced by the White Paper. These measures include such restrictions as the use of rain or soil moisture sensors on automatic watering systems in private gardens.

2.5 Microbiological Management Controls

In establishing the detailed guidance for urban dual pipe networks and the associated management plan, the *Guideline for Environmental Management: Use of Reclaimed Water (2003)* provides a useful framework. This framework includes the establishment of a Class A water quality criteria and requirements for water quality verification and ongoing monitoring, including on-line process surrogates. The translation of this framework to a detailed risk management framework can build on the use of HACCP principles within the National Guideline process. The key areas being covered by the working group are:

- Microbiological water quality criteria required for urban dual pipe networks in order to provide public health protection for defined uses of the water eg residential garden spray irrigation and key risk areas if management controls fail eg if a potable system cross connection occurs in a household;

- A risk management framework for delivering the required water quality, including verification and ongoing monitoring of recycled water quality from treatment facilities;

- Monitoring and management of recycled water quality within the reticulation system; and

- Management controls that may be necessary to manage microbiological health risks (requires close liaison with the plumbing and resident education groups).

2.6 Resident Education Measures

The working group is developing detailed guidance for the education and participation of communities in urban dual pipe schemes, supported by a case study model management plan to demonstrate implementation of this guidance. In developing this guidance the working group is assessing existing communication strategies, both in Australia and overseas, and will provide recommendations on the success of these approaches.

It is expected that the model management plan will:

- address education activities relevant to environmental and health management, including tailored material targeted at particular groups or activities eg employing plumbers for household work; and

- address perceptions and concerns that a community may have.

3.0 GUIDELINE IMPLEMENTATION AND STRUCTURE

Compliance with the detailed guideline will be a requirement for all dual pipe recycling schemes and therefore the guideline controls need to be applicable to all recycling schemes. As such, the guideline will focus on key principles and management control objectives and minimise prescriptive detail. However, the guideline will also be an effective mechanism for delivering harmonisation of requirements in critical areas, therefore, the benefits and costs of prescriptive guidance for specific areas will need to be considered.

The model management plan supporting the guideline will act as a case study to provide a high level of prescriptive detail for the development of residential recycling schemes acting as a case study for implementation of the detailed guideline. However, the model management plan will not be a mandatory document. At individual developments, alternative management controls could be proposed, provided they comply with the objectives of the detailed guideline.

The coordinated development of detailed guideline and a model management plan is intended to minimise duplication of effort by the regulators and the industry, provide clarity regarding regulatory requirements and assist harmonisation and integration of urban dual pipe management controls.

It is anticipated that the guidance and model management plan will be available in late 2004.

4.0 REFERENCES

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