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30 October 2007

Dr Hanna Jaireth
Secretary
Standing Committee on Planning and Environment
ACT Legislative Assembly
GPO Box 1020
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Dear Dr Jaireth

I submit the following for the **committee's inquiry on water use and management**, in particular relating to item (g) on the relative financial, environmental and potential health impacts of water capture and reuse practices.

**Introduction**

With increasing pressure on water supplies, recycled water is being raised as an option in water management, both for *non-potable* uses such as irrigating golf courses, parks, and crops, and for *potable* drinking water purposes. Using recycled water for non-potable use saves potable water for drinking, given that less potable water is used for non-potable uses.

Augmentation of drinking water supplies is considered in two categories, namely:

- *Indirect augmentation*, involving the discharge of treated recycled water into a receiving body of water such as a river, reservoir or aquifer, before re-treatment and subsequent supply as drinking water

- *Direct augmentation*, where treated sewage or stormwater is recycled without going through an intermediary receiving body of water

Indirect use of recycled is the preferred approach of these two, as it offers the advantages of dilution, additional treatment through natural processes, and additional time, which can range from several weeks to years.

The *Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies* canvass the use of recycled water (treated sewage and stormwater) to augment drinking water supplies. The document was released for public comment in July 2007 (Natural Resource Management Ministerial Council & Environment Protection and Heritage Council, 2007). The guidelines state that the importance of the time factor listed above for indirect augmentation "cannot be overstated" (p. 3). This time is critical, the document argues, for operators and regulators to assess recycled water treatment and recycled water quality, and to intervene where necessary before the water is supplied to those drinking it. The guidelines also caution that theoretical detention times and dilution can be greatly reduced by short-circuiting i.e. preferential flows in storages that reduce the transport time between inlets and outlets.

**Critical issues on water recycling, especially for drinking purposes**

1. *A major flaw with recycling sewage into the drinking water supply is that it reverses a basic principle underlying public health, thus creating the need for complex management systems*

The Public Health Movement began in Britain about 150 years ago. It resulted in greatly improved sanitation and consequently reduced the likelihood of contact with disease-producing organisms spread via human excreta. Recycling sewage reverses the principle that involves protecting catchment areas by minimising the entry of human and other waste. Consequently, it represents a risk management task of major proportions. The range of issues discussed in *Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies* (Natural Resource Management Ministerial Council & Environment Protection and Heritage Council, 2007) underlines the inherent difficulty in principle with such an approach. Such issues include:

- Elaborate management systems and monitoring processes throughout the life of the scheme on a 24/7 basis
- The need to continuously maintain robust and reliable multiple barrier systems, with corrective procedures requiring immediate implementation in order to protect public health
- The need for system operators to have appropriate skill and training levels on an ongoing basis. Lack of knowledge is a significant cause of waterborne disease outbreaks, with a continuous capability required to quickly and effectively respond to adverse monitoring signals
- The need for complex systems of information and documentation on high-risk chemicals, micro-organisms, types of treatment to be applied, use of storages and receiving waters etc.
- The need for rigorous regulatory oversight to ensure that recycled water systems are managed and operated correctly. Lack of regulatory oversight has contributed to waterborne illness from drinking water supplies

2. *Although the Australian Guidelines for Water Recycling stress the importance of the need for protecting public health and a precautionary approach, lack of certainty about a wide range of issues suggests that the precautionary principle is compromised*

Water recycling schemes appear to be most favoured by those with an engineering mindset, but are questioned more by those with knowledge of toxicology, microbiology, and the science of micro-contaminants. Technological optimism is characteristic of the first group, whereas the complexity of the issues involved, together with growing ignorance, are raised by the second group.

Examples of the latter type of concern include the initial discovery of CFCs and the later discovery of their role in destroying the ozone layer; and mad cow disease, where many BSE-infected animals had entered the human food chain before controls on high-risk offal were introduced.

Even within the engineering group, it is apparent that there are varying assessments of risk. For example, two Fellows of the Australian Academy of Technological Sciences and

Engineering recently commented as follows. John Radcliffe (2007, p. 8), author of the Academy's 2004 review, *Water Recycling in Australia*, confidently asserts: "However, the community is not sanguine about the recycled water being sent straight into the water-supply scheme, even though technically there is very little risk in doing so. Knowledge that further natural remediation can occur within a large water body, such as a river or reservoir, gives comfort to users." On the other hand, Barry Sanders (2007, p. 10), formerly general manager of the Water Corporation of WA, states: "The community has shown good sense in being wary of potable re-use plans often promoted by scientists and environmentalists with little regard for the facts or the risks inherent in some of their proposals .... the discharge of treated wastewater immediately upstream of a relatively small reservoir in Toowoomba is virtually direct re-use and was sensibly rejected."

Particular concerns raised about recycling water for drinking water purposes follow:

- In spite of the use of technologies such as reverse osmosis, there is concern about the risk of pathogens and a variety of chemicals being able to pass through the filtering process and therefore endangering human health and life. The chemicals include, for example: drugs (including illegal ones), hormones, and chemical agents in personal care products (e.g. antibacterials in soaps) that are commonly found in trace concentrations in effluent.

- Professor Peter Collignon (2007) from the ANU considers that recycling sewage into drinking water is a “high risk” procedure because large numbers of people could be exposed to a large variety of pathogens in the water, if the system malfunctions. The *Australian Guidelines for Water Recycling* document lists microorganisms (bacteria, viruses, protozoa, helminths) of concern in sewage, which can cause widespread, acute and life-threatening disease outbreaks (Table 4.3, p. 23). Examples of a wide variety of potential hazardous events are also listed (Table 4.2, p. 22).

  Some examples of system failures at the level of water treatment systems include: chemical dosing failures, disinfection failures, equipment malfunctions, failure of alarms and monitoring equipment, formation of disinfection by-products, inadequate filter operation and backwash recycling, power failures, sabotage and natural disasters, significant flow variations through water treatment systems, and failure of staff to respond appropriately to alarms or fluctuations in treatment processes.

  Professor Don Bursill is well known and highly regarded in the Australian water industry. As author of Australia's drinking water guidelines he has stressed that recycled sewage for drinking water should be a last resort, warning that people could die if the system failed and there was an outbreak of disease. For example, human error by plant operators in Spencer, Massachusetts, released caustic soda into the town's water, causing a shutdown of supply. More than 80 people were rushed to hospital, suffering burns and eye problems (Topsfield, 2007).

  The risks posed by pathogens are significant, and are increased by any sudden or extreme change in water quality, flow or environmental conditions such as extreme rainfall or flooding. Other significant issues of concern raised by Professor Collignon in relation to recycling proposals for Canberra include:

- short retention times for recycled water, effectively making it almost a direct augmentation system, with the attendant higher risks involved (Collignon, 2007, p. 6)

- the current technology for monitoring viruses that cause human disease (e.g. enterovirus) being expensive, slow, not yet standardised and not readily available (p. 10).

- Given that human beings are now exposed to around 75,000 artificial chemicals (Trivedi, 2007), it is not surprising that an extensive range of chemicals is detected in secondary treated sewage. These include inorganic chemicals, disinfection by-products, pesticides, fragrances, pharmaceuticals and their metabolites, other organic chemicals e.g. phthalates, radiological particles, and chelating agents (Natural Resource Management Ministerial Council & Environment Protection and Heritage Council, 2007, Table 4.4, p. 26). Rates of diseases with potential links to chemical exposures have been increasing e.g. testicular cancer in young men.

  Such an array of chemicals is beyond the current capacity of health and environmental authorities to evaluate. There is now an increasing likelihood that regulators will need to rethink the way in which mixtures of chemicals impact on health, as recent research demonstrates additive and synergistic of various chemicals in combination. That is, chemical-by-chemical risk assessment has provided a false sense of security (Trivedi, 2007). A specific example follows.

  Estrogenic effects in wild fish in rivers in the UK have been shown to be widespread, and wastewater discharge can contain endocrine-disrupting compounds (EDCs) at levels that pose a potential risk when such water is used as a drinking water source. The effect of exposure to complex mixtures is particularly relevant for EDCs, and there is evidence of estrogens and also androgens in treated effluents in Australia (Falconer, Chapman, Moore, & Ranmuthugala, 2006). Of concern are unresolved questions relating to the detection and removal of such potentially harmful contaminants.

  Further, the underlying processes in membrane filtration are not fully understood, with large molecules such as hormones apparently undergoing a form of metamorphosis to slip through nanometre-scale barriers. Reverse osmosis is more effective for pharmaceutically active compounds (with 0.1 to 0.3% slipping through the membrane) than hormones (11 to 60% slipping through, even though hormones have equal or greater bulk) (Fisher, 2007a). Collignon (2007) states that, contrary to those promoting reverse osmosis technology, it does not remove all salts and nitrates from treated water, and a study in Brisbane showed that RO removed about 92% of antibiotics from treated water derived from sewage.

  The above demonstrates that there is much complexity in understanding the operation of reverse osmosis and nanofiltration technologies, with the science of micro-contaminants still evolving. The technology of detection and removal is hardly mature, in contrast with the assertions of the engineering fraternity (Fisher, 2007a, 2007b). In addition, the huge array of chemicals and their interactions presents many unknowns, and is a major challenge in terms of monitoring and prevention, particularly if the waste streams from facilities such as hospitals enter the mix.

3. *Water recycling proposals for drinking water are energy intensive. Water supply and use issues need to be integrated into a consolidated climate change adaptation strategy, including the accelerated development of low carbon or carbon neutral advanced water treatments*

It is argued that the multiple-barrier approach used in the management of drinking water supply is an essential requirement, as single barriers are less likely to remove individual hazards all the time. A treatment train therefore typically incorporates membrane filtration, reverse osmosis and advanced oxidation. This approach inevitably has high energy requirements. In Canberra it is estimated that it would produce an extra 57,000 tonnes of extra $CO_2$ per year from plant operations (Collignon, 2007, p. 8). In addition, pumping recycled water can represent up to 60% of the cost of running water supply systems (Radcliffe, 2007), with the pumping required for a proposed Canberra recycling plant involving substantial energy requirements for pumping to the Cotter Dam and to Mt Stromlo Water Treatment Plant. To offset the proposed Canberra emissions linked to water recycling would require an additional 300,000 trees per year to be planted (Collignon, 2007, p. 8). However, there is an increasing critique of carbon offset approaches e.g. Downie (2007). With tree planting in particular, carbon can again be released to the atmosphere through droughts or bushfire, and biologists consider that with further warming the biosphere will become a source of carbon rather than a net sink. This weakness again underlines the need to include water use strategies within a broad climate change adaptation strategy.

4. *In order to avoid too much emphasis being placed on technology as a solution to water management issues, lateral thinking approaches to problem-solving within a much broader framework need to be applied. These should take into account other issues such as values and knowledge of environmental issues*

The equation I = PAT states that environmental impact (I) is a product of population size (P), affluence or consumption per capita (A) and technology (T). Thus questions such as "What number of people can Canberra support at what level of water use?' should become part of the policy framework informing water issues. Increased attention to demand management approaches can also address the affluence (A) factor.

The volume of water actually used for drinking purposes or for food preparation is about 10% of household consumption. A different strategy is required to obtain significant reduction in the consumption of reticulated water of potable quality. The question becomes: "How can we secure a supply of potable water at the same time as we reduce the use of potable water for purposes and activities that do not need to use water of drinking water quality and do so in an equitable manner?" (Troy, Holloway, & Randolph, 2005/2006, p. 43). Collignon (2007, p. 10) explores a range of such water saving options. For example, he suggests that if water from the current Molonglo sewage outflows is used for non-drinking water purposes (such as irrigation, keeping Lake Burley Griffin filled, industry etc.), then instead of needing to extract 50 GL of water from local dams, there would only be a need to extract 40 GL or even less per year.

Another example is the use of recycled wastewater for domestic use using dual supply systems to the home, with recycled water supplied through purple pipes for garden watering, toilet flushing and laundry use, as at Rouse Hill and Olympic Park/Newington (Sydney) and Mawson Lakes (Adelaide) (Radcliffe, 2007, p. 8). Such schemes for non-potable purposes can be cost effective if developed at the time of land subdivision (Sanders, 2007, p. 9). A variety of such measures could obviate the need for an expensive water recycling scheme for drinking water purposes. In addition, larger policy questions need to be tackled such as the large volumes of water going downstream for inappropriate purposes such as rice growing.

5. *There is a need for critically based public consultation and educational approaches drawing on a variety of expertise from health and environmental fields to balance the current approach emphasising engineering and "technical fixes"*

Surveys of capital city dwellers in Australia confirm a high degree of acceptance for a number of applications such as irrigation of golf courses, public parks, playing fields and also more recently agriculture, including pastures, vegetables and fruit. In Canberra, public consultations on the Water2WATER project directed at recycling sewage into the drinking water supply found that 53% had an initial reaction that was positive, whereas 22% were only conditionally positive, with ongoing concerns about issues such as health (Manidis Roberts, 2007). The idea of the public being an impediment to the use of recycled water starts to emerge more when recycled water is proposed for personal use. That is, when the issue becomes less abstract and more personal, people are more averse to the idea. A total of 42% of Australian city-dwellers are confident to drink the water, which more or less reflects the outcome at Toowoomba (38% in favour) (Marks, 2006, 2007). Historical levels of acceptance of drinking the water in the USA and Australia have settled below half the population with the result that proposed systems have had to be abandoned (Marks, 2006).

Conflict is inevitable when a controversial issue is considered by communities, but Marks warns against a top-down approach, commonly termed the DAD (decide-announce-defend) strategy, particularly for a taken-for-granted essential service. Top-down "educational" approaches tend to emphasise technical fixes. For example, in keeping with Singapore's patriarchal governance style, its Public Utilities Board used intensive campaign methods to raise people's awareness of NEWater from its plant, which uses microfiltration, reverse osmosis, and UV treatment technologies. The methods included a documentary feature film, media briefings and reports, and distributing 1.5 million bottles of NEWater for the public to see and sample. In more democratic political economies, politicians who are publicly observed drinking bottled recycled water, can perhaps invoke people's tendency to trust and follow authority, but can also make an intelligent community wary of such pranks, which work to dampen trust in authorities.

With deeper consideration by the community of these issues, the question has to be asked: How many people have the necessary chemical, microbiological, and systems knowledge to make an informed judgement about the risk management issues involved in water recycling? With more critique and understanding of this kind, the high public acceptance figures mentioned above are not likely to be nearly as robust. In every case when questions including drinking the water are asked, initial enthusiasm falls to around or well below half a given population. This is likely to remain the case when alternatives are evident, such as demand reduction, non potable uses of recycled water, and stormwater use, as well as household rainwater and greywater collection (J. Marks, personal communication, 23 September 2007).

**The current position in relation to water recycling in Canberra**

A July 2007 fact sheet released by Actew summarised two water purification plans then under consideration, namely a 50ML/day plant with an estimated capital cost in the order of $220 million to $270 million, and operating costs of the order of $23 million per year. The estimated capital cost for a 25ML/day plant was in the order of $180 million, with operating costs of about $10 million per year. In Actew's own documents, these plants rated particularly poorly in relation to greenhouse gas emissions, with the 50 ML/day plant scoring less than one star out of a possible five. The 25 ML/day plant is rated at one star out of a possible five.

In October 2007, the ACT Government announced that, as part of a broader water plan, it would build a "demonstration" water purification plant at a cost of $55 million to show how well the process works. However, even though it states that the plant would be for "purposes other than drinking", letters to *The Canberra Times* generally agreed with an assessment by ANU Professor Patrick Troy that this was a "subtle subterfuge" to break down barriers to drinking recycled sewage (Alexander, 2007). Such a strategy could easily run into problems by breaching the community's trust, as outlined above. Further, it seems inordinately expensive for the purpose outlined. Cheaper options should be explored for water that could be recycled from the existing wastewater treatment plant, rather than spend money on higher tech demonstration infrastructure. If necessary, a filtration modification to the existing plant could perhaps produce water that is suitable for all non drinking uses, the stated purpose for the demonstration recycling plant. This issue could be further explored by the committee.

**Conclusion**

Because water recycling schemes for drinking reverse a long standing public health principle of separating water and sewage supplies, they necessarily require elaborate management and monitoring schemes that are expensive to implement, with high capital and running costs. Further, as such schemes would be expected to remain in long-term use, there are significant costs involved in reversing this approach.

The *Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies* (Natural Resource Management Ministerial Council & Environment Protection and Heritage Council, 2007, p. 63) argue that drinking water augmentation is the leading edge of recycled water use. There is much debate about a variety of issues including water quality, potential impacts on public health, and reliability and regulation. The fact that understanding and knowledge will never be complete suggests that new issues will regularly emerge, such as further potential hazards. These, together with the assessment of epidemiological effects, would necessitate yet further expenditure.

Recycled water for purposes other than drinking (combined with other strategies for practically reframing the use of water and reducing demand) is likely to constitute a much more sensible and less expensive approach. I believe the Standing Committee on Planning and Environment could usefully raise questions about whether $55 million for a demonstration recycling plant constitutes a wise use of funds for the ACT.

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