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Recycling water from sewage into drinking water: a "high level" health risk we should only take as a "last resort".

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<u>Declaration of interest statement</u>

I do not have any contracts, consultancy arrangement or research grants from any companies that may derive major financial gains from building sewage recycling plants (eg engineering companies such as CH2M Hill, Veolia Water etc) nor from institutions that may be involved with the large sums of monies that will be needed to finance these types of projects (eg Macquarie Bank, Babcock and Brown, and/or water infrastructure funds).

In making this submission I am expressing my own opinions on a matter of the very important public interest and concern as a medical and public health expert in the field of microbiology and infectious disease. I am not making any adverse imputations on the possible motives of any party who may be seeking to promote the recycling of treated sewage into water for human use as drinking water. The statements made herein represent my own considered opinions and judgements and do not necessarily represent those of any employer of mine or of any other institution with which I may be, or may have been, affiliated.

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Executive summary

Recycling water from sewage into drinking water was recently promoted by the Productivity Commission both in their draft report and particularly in the press statements - with headlines such as “National productivity commission recommends drinking of recycled waste water” (1).
I believe such public recommendations given by the commission are irresponsible.
It seems to be based on poor and misleading information presumably given to the commission by lobbyists and the very “rent seekers” the commission warns to be wary of in their April 2011 draft report.

While technically feasible, even if done with the currently optimal processes available (i.e. multiple barriers including reverse osmosis membrane), the community needs to be very wary. It should be a “last resort” option for many reasons, but especially because of the potential “catastrophic” public health implications if something in this complex and “very high risk” process goes wrong.

Even from just a monetary cost point of view, recycling water from sewage into drinking water is associated with very high initial capital costs and also high ongoing monetary and energy costs. The Commission correctly stressed that the inappropriateness of the extraordinary costs of desalination plants. However the plants that recycle water from sewage are the same as desalination plants and use the same technology (re RO membranes). Thus the capital cost will be almost identical. It is only the ongoing energy costs that are likely to be slightly lower (but these will still be substantial). The slightly lower energy costs are because the water source (sewage) has a lower salt concentration than sea water. However if appropriate microbiological testing and other additional steps that are needed are put into place because such a “High Risk” water source is now used, any likely potential savings from energy savings will likely be substantially negated.

From a health perspective these are “Very High Risk” proposals (2). They reverse 150 years of good public health policy – striving to keep sewage out of our drinking water supplies. When we need to recycle water from highly contaminated sources, it is much safer to use it via *separated pipelines* for industrial purposes (as do Singapore and Brisbane). Putting it into drinking water should be a “last resort”. This was the conclusion of the most extensive scientific review on this issue in the US by their National Research Council (3). “It should be adopted only if other measures—including other water sources, *non-potable* reuse, and water conservation—have been evaluated and rejected as technically or economically infeasible.” I agree with this conclusion from the National Research Council. I find it difficult to see how the Productivity Commission could come to any other conclusion if they had reviewed all the appropriate material that pertains to this issue.

Sewage contains very high concentrations of pathogens and drugs. Viruses (the most difficult pathogens to remove) can be in concentrations of more than 10^6 per litre - orders of magnitude higher than even the most polluted rivers. The technical and human performance standards required for recycling water from sewage into drinking water safely will need to be proportionately higher than current practice. This will be difficult to achieve as we have already skills shortages. Governments and water utilities also need to ensure that the system will work *all* the time (even a 99% satisfactory technical performance means there is a 1% failure rate and the population may be exposed to pathogens 3 days a year). Acceptance of even low failure is not an option.

Reverse Osmosis (RO) is the most effective way to remove the viruses and drugs from sewage. RO should remove virtually all viruses and drugs. Surprisingly, little in-use data are available to check this. These membranes seem to leak and/or perform less than expected. In Brisbane, RO only removed 92% of antibiotics (4). Recent safety reviews, including an Australian review (5) (but based on the previous study (3)), showed viruses were still detected post-treatment at 3 of 7 sites on some occasions. The calculated virus removal ranged from only 87% to >99.995% (log 1 to log 5). Even relatively very large non-viral agents, (e.g. a protozoan such as Giardia) were not always removed. This poor performance by some RO membranes in removing viruses and drugs has also been seen in some more recent studies. As pointed out in the Australian Guidelines for Water Recycling Augmentation of Drinking Water Supplies, we need however a consistent log 9.5 (or about 10 billion fold) reduction for Enteroviruses (2). This less than optimal performance was *when the system was not known to be malfunctioning* (e.g. induced leaking O rings or pinhole tears in membranes as an experiment). Modelling suggests that lowered performance might occur as often as 5 days per year (6).

Current surrogate testing (e.g. organic carbon, electrolytes) can only detect a 1% membrane leak (or bypass). This is only a log 2 reduction, well short of the log 9.5 reductions we need checked for virus removal and reasonable safety (2).

We should also take into account similar views when expressed by international water experts (as quoted in the Financial Times April 2007). Veolia's Mr Frerot says: "To my knowledge, there are only two places in the world where treated waste water is gradually mixed into tapwater: the town of Windhoek, in Namibia, and Singapore."

In Windhoek, that is because the river is more polluted than the waste water, he says. In Singapore, it is a political choice designed to reduce dependence on supplies from neighbouring Malaysia - and accounts for less than 1 per cent of water consumed.

Ultimately, says Mr Frerot, the most cost-effective solution to water shortages developing in many towns and cities must surely be to supply such treated waste water for use in industry and irrigation, in place of the tapwater used today. "That would halve the demand for natural water," he says. "That is what we should do, before talking about drinking waste water."

In conclusion we should only adopt recycling water from sewage into drinking water as a “last resort”.

It is unlikely that in Australian cities that this type of “recycling” will ever need to be adopted. Other measures—including using other water sources, *non-potable* reuse, more dams, water conservation, and then trading of rural to city trading water rights — are all much less likely (if evaluated as alternatives to recycling water from sewage into drinking water), to be rejected as technically, environmentally or economically infeasible. Even if the community should ever find the need to do this type of "high risk" water recycling, we will also need *real time* tests to be developed to show we have adequate removal of all human pathogens such as viruses *all of the time*. With current testing methodology we are now more likely to *not know* at all or know *only after* processed but contaminated water from sewage is already recycled in our reservoirs.

References

1. Matt Johnston. National productivity commission recommends drinking of recycled waste water
Herald Sun. April 14, 2011

2. Australian Guidelines for Water Recycling Augmentation of Drinking Water Supplies. Environment Protection and Heritage Council, National Health and Medical Research Council and Natural Resource Management Ministerial Council. May 2008. Canberra. http://www.ephc.gov.au/sites/default/files/WQ_AGWR_GL__Augmentation_of_Drinking_Water_Supplies_Final_2008_05.pdf Accessed April 6th 2009

3. National Research Council (1998) Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies with Reclaimed Water. National Academy Press, Washington, DC. http://www.nap.edu/openbook.php?isbn=0309064163 Accessed April 6 2009.

4. Watkinson AJ, Murby EJ, Costanzo SD. Removal of antibiotics in conventional and advanced wastewater treatment: implications for environmental discharge and wastewater recycling. Water Res. 2007;41:4164-76.

5. Khan S and Roser David. Risk Assessment and Health Effects Studies of Indirect Potable Reuse Schemes. Final Report. Centre for Water and Waste Technology School of Civil and Environmental Engineering. University of New South Wales. NSW, 2052, Australia. April 2007. http://www.lgaq.asn.au/lgaq/publications/Risk%20Assessment%20and%20Health%20Effects%20Studies%20-%20WSAA%20Version.pdf Accessed April 6 2009.

6. Roser D, Khan S, Davies C, Signor R, Petterson S and Ashbolt N. Screening Health Risk Assessment for the Use of Microfiltration-Reverse Osmosis Treated Tertiary Effluent for Replacement of Environmental Flows. Final Report. Centre for Water and Waste Technology School of Civil and Environmental Engineering University of NSW. October 2006.

Comments on errors and other corrections needed in Productivity Commission's draft report

The Commission has made some statements and recommendations in their draft report that I believe need to be modified or changed. These are addressed below.

Chapter 6 — Supply of water, wastewater and stormwater services
State and Territory Governments should adopt policy settings that allow the costs and benefits of all supply augmentation options to be considered using a real options (or adaptive management) approach.
Information on costs, risks and benefits to consumers of all augmentation options should be made publicly available and views of the community sought, especially regarding sensitive options like potable reuse.
Bans on particular augmentation options (those explicitly stated and those that are implied by government decisions) should be removed, including those on:
- *rural–urban trade (to allow water to be allocated to its highest value use)*
- *planned potable reuse (unplanned potable reuse occurs commonly without any apparent ill-effects).*

While I agree with most of the points above, the part of the last dot point that states statement "unplanned potable reuse occurs commonly without any apparent ill-effects" I believe is both wrong and dangerous. Millions of people (mainly children) die every year around the world because "*unplanned potable reuse occurs commonly".* Deaths occur not only in developing countries because of this *but also in developed countries*. In Canada, a Royal Commission was set up after deaths followed sewage leaks into water supplies.

Your statement is thus not only unbelievably wrong but dangerous. How can it have been made by anyone with a social conscience? It suggests the lowest common denominator re health and deaths is acceptable economic practice.

The recycling of wastewater and stormwater is increasing (section 2.3). Notwithstanding the river-based disposal of treated wastewater and reuse downstream (box 2.2), in Australia recycled wastewater and stormwater has been kept separate from the potable water supply, and instead has been used for non-potable purposes or discharged to the environment. (For a period of time in Orange recycled water was introduced into one of the town's dam (Orange City Council 2009b).) This however, is not the case in other countries. For example, Singapore recycles treated wastewater for potable and non-potable uses. Recycled water meets 30 per cent of Singapore's water demand (PUB 2010; 2011).

This statement is highly misleading. In Singapore the majority of recycled water is used for industry and not for potable use (close to 99% for non-potable use and the recycled water is piped to industry via a separate pipeline from the potable water supply).

Australia (it has occurred in Orange), there are places where there is unplanned potable consumption of untreated stormwater and treated wastewater. For example,

wastewater from upstream towns and cities that has been treated to a secondary or tertiary treatment level and undergoes natural treatment as it heads downstream. In many towns, stormwater enters the river system through drains.
Unplanned indirect potable reuse of treated wastewater has occurred in cities and towns that source drinking water from the Murrumbidgee and Murray Rivers.
Adelaide has long taken drinking water from the Murray River.
In recent years Canberra has sourced drinking water from the Murrumbidgee River and is in fact using its own stormwater.
Sources: ActewAGL (2011b); Alexander (2007); Costello (2006).

I will reiterate what I said earlier;
The statement or implication that "unplanned potable reuse occurs commonly without any apparent ill-effects" and is thus by implication is not a major issue, I believe is both wrong and dangerous if left as it is. Millions of people (mainly children) die every year around the world because "unplanned potable reuse occurs commonly".

Best practice for the last 150 years is to stop or significantly decrease "unplanned indirect potable use" of water source from sewage or stormwater. Why is the Commission trying to negate this fundamental health principle?

16 AUSTRALIA'S URBAN
WATER SECTOR
Energy costs
One of the largest operating costs for urban water utilities is energy. Energy is mainly used for the pumping and treatment of water. Pumping water from locations a significant distance away can significantly contribute to energy use. Moreover, moving from primary to secondary, or secondary to tertiary levels of treatment can double the energy intensity of the process (Kenway et al. 2008).
The proportion of energy used in different activities along the supply chain varies between cities (figure 2.2). In Adelaide, the majority of energy is used in the pumping of water, representing over 70 per cent of total energy used. Sydney also uses a high proportion of energy for pumping, at over 55 per cent. In contrast, water pumping in Brisbane only accounts for about 6 per cent of energy used, with treatment being the most energy intensive activity at just under 50 per cent. The reasons for these differences are likely explained by some of the cost drivers discussed earlier, especially the availability of sites to provide storage at higher altitudes than the point of consumption. In Melbourne and the Gold Coast wastewater treatment is the higher user of energy at about 50 per cent.

The water sector's energy costs are likely to rise in the future, due to a combination of increasing energy prices and desalination plants coming online, which are relatively energy intensive compared to other supply sources (Australian Academy of Technological Sciences and Engineering, sub. 34).

I have no problem accepting the argument on high energy costs, especially for pumping water uphill and for desalination plants. However why then does the Commission place sewage recycling in such a favourable light in so many places in the draft report?

The energy cost of any sewage recycling plants that puts water into the drinking water supply will involve both these factors in a very significant way compared to other means of water security (such as dams). Why are sewage recycling plants and their energy cots not mentioned as an example somewhere (i.e. the energy for RO membrane filtration and pumping cost of a sewage recycling plants) e.g. in this section?

Supply augmentation

There has been large investment in supply augmentation in recent years, ranging from households installing rainwater tanks and greywater systems to the construction of large desalination plants. The combined capital expenditure program of 30 of Australia's largest water utilities is approximately $30 billion over the period 2005-06 to 2011-12 (WSAA 2009). This section outlines some of the larger supply augmentation projects initiated by both government and water utilities themselves that have been completed in recent years, are currently underway, or will begin (or could begin) in coming years.

Desalination plants

Many jurisdictions have invested heavily in desalination plants in recent years. Desalination is a climate independent source of water, making it a more certain supply source than surfacewater and groundwater alternatives. Large desalination plants have been, or are being, built to service capital cities, and many desalination plants have been built to service private users, often in mining operations. Desalination plants have been built, or are currently being built, to service Sydney, Melbourne, south-east Queensland, Perth and Adelaide (table 2.4). The capacity and cost of the desalination plants vary greatly, with Perth and south-east Queensland constructing smaller desalination plants, between 45 and 50 GL, and costing between $387 million and $1.2 billion respectively, compared with Melbourne's desalination plant which has a capacity of 150 GL and the construction will cost an estimated $3.5 billion. It has been reported that the Melbourne plant is the largest desalination plant in the Southern Hemisphere (Miller and Schneiders 2010). The Adelaide desalination plant was originally designed to have a 50 GL capacity but will now be built to provide 100 GL of water. This plant was funded jointly by the Australian and South Australian Governments (Office for Water Security 2009; WSAA 2010b).

Dams

Augmenting supply through building new dams has become more difficult in recent years for a number of reasons, including:

• there are fewer options available with the best sites already used
• the opportunity cost of the land has increased
• dams are dependent on rainfall
• the community has changed its view on environmental impacts of dam, construction, such as the impact on native fauna and flora, and significant environmental ecosystems and processes

I note above that the recent cost for desalination capacity is about $200million per 10GL capacity. This relatively is a very expensive water source (dams are far more cost effective). The Commission correctly points this out and argues against some of this construction. However the cost of building a sewage recycling plant will be almost exactly the same as building a desalination plant. Why is there such inconsistency in not showing these costs for sewage recycling plants?

I also note from the Commissions figures and examples below that the cost of increased water security by increasing Dam capacity is between $10 to $30 million per extra 10Gl capacity (or about *one tenth* the costs of desalination and sewage recycling plants and *without the same ongoing high energy cost* for desalination and sewage recycling plants).

Table 2.4 **Large desalination plants**

Location	*Project*	*Estimated cost of construction*[a]	*Capacity*	*Ability to increase capacity*	*Completion date*
		$m	GL/annum	GL/annum	
Sydney	Kurnell	1 890	90	180	2010
Melbourne	Wonthaggi	3 500	150	Up to 200	2011
South-east Queensland	Tugun	1 200	49		2009
Perth	Kwinana	387	45		2006
	Binningup	955	50	100	2011
Adelaide	Port Stanvac	1 830	100		2011

[a] Costs were incurred in different years, making them not directly comparable.

Sources: Costa (2010); Gallop (2005); Hinchliffe (2010); Partnerships Victoria (2010); SA Water (2011c); Sydney Water Corporation (sub. 21); Water Corporation (ndb); WSAA (2010b).

Nevertheless, there are a number of dam-related projects currently underway. Significant projects include the upgrading of the Hinze Dam, which serves south-east Queensland, which will almost double its storage capacity from 161 GL to 310 GL (table 2.5). This upgrade is due to be completed in December 2010. An enlargement of Canberra's Cotter Dam is also underway, which will increase its capacity from 4 GL to 78 GL (WSAA 2010b). The project is expected to be completed in late 2011 (ACTEW 2010a).

Table 2.5 **Large dam projects**

Location	*Project*	*Estimated cost*[a]	*Capacity*	*Completed*
		$m	GL	
Canberra	Expansion of Cotter Dam	363	78[b]	2011
South-east Queensland	Upgrade of Hinze Dam	395	310[c]	2011
	Wyaralong Dam	348	103	2011
Melbourne	Tarago Reservoir reconnection and upgrade	97[d]	37.5	2009

[a] Costs were incurred in different years, making them not directly comparable. [b] Expansion from initial capacity of 4 GL. [c] Expansion from initial capacity of 161 GL. [d] Cost of the water treatment plant needed to reconnect the reservoir.

Sources: ACTEW (2010a); Melbourne Water (nda); QWI (nd); Seqwater (2009); WSAA (2010b).

Wastewater recycling

Australia's largest wastewater recycling project is the Western Corridor Recycled Water Scheme located in south-east Queensland. It comprises three advanced water treatment plants that treat wastewater to supply power stations and industry. It is expected to supply about 36 GL per year (table 2.6). Recycled water might also be used to replenish Wivenhoe Dam for indirect potable reuse when south-east Queensland's water storages fall below 40 per cent (increasing this trigger point would increase operating costs and the likelihood of dam spilling) (QWC 2010b).

One of Australia's largest residential water recycling schemes is the Rouse Hill Water Recycling Scheme in Sydney's north-west. Treated wastewater is distributed via a third pipe for toilet flushing, laundry washing and outdoor uses. Currently 19 000 homes are involved and eventually it will service 36 000 homes. The plant will treat about 4.7 GL of wastewater each year for use (Sydney Water 2010a).

Table 2.6 **Large water recycling projects**

Location	*Project*	*Estimated cost*[a]	*Supply/ Capacity*	*Completion*
		$m	GL	
Sydney	St Mary's Replacement Flows Project	250	18	2010
	Rouse Hill Water Recycling Scheme	60[b]	4.7	2008
	Rosehill-Camellia Recycled Water Scheme	100	4[c]	2011
Wollongong	Wollongong Water Recycling Plant	25	>7.3	2006
Melbourne	Eastern Treatment Plant – Tertiary Upgrade	380		2012
	West Werribee Recycled Water	114		2013
South-east Queensland	Western Corridor Recycled Water Project	2 600	36[d]	Completed
	Murrumba Downs Sewage Treatment Plant	197	11[e]	2010
Perth	Kwinana Recycled Water Scheme	28	6	2004
Adelaide	Glenelg to Adelaide Park Lands Recycled Water Project	76	5.5	2010

[a] Costs were incurred in different years, making them not directly comparable. [b] Cost of the upgrade only. [c] Can be expanded to 7 GL. [d] Expected supply for urban water use. Total capacity is expected to be greater. [e] Based on 4 ML per day.

Sources: GHD (2009); Glenelg to Adelaide Parklands Recycled Water Project (nd); QWC (2010b); Sydney Water (2006; 2009; 2010c; ndc; ndd); Unity Water (nd); Water Corporation (nda; 2008); WSAA (2008; 2009; 2010b)

I note the only example given above where technology used is stated as being potentially appropriate for potable water (Western Corridor recycled water project) that the cost is $2,600 million but *for only 36 GL of water capacity*. This appears to be a much higher costs per 10 GL of capacity than the even the desalination costs quoted elsewhere in the draft paper.

Public health

Access to clean water for drinking and washing, and reliable wastewater services are vital for public health. Indeed, the history of government involvement in urban water supply systems is very much tied up with public health concerns. Improvements in the standard of urban water and wastewater systems during the nineteenth and the first half of the twentieth century played a major role in reducing the prevalence of diseases such as typhoid and cholera in various countries (Barzilay, Weinberg and Eley 1999).

While gains in public health made in the distant past are often taken for granted in developed countries such as Australia, contributing to good public health outcomes remains an important objective for the urban water sector. Achieving this objective involves managing risks to public health, for example, the risk that people will get sick from ingesting water that contains microbial and chemical hazards. There is evidence that this risk is not always well managed in some regional areas (chapter 6).

Managing such risks efficiently does not usually involve eliminating all risks entirely. Consider a situation where there are large benefits available from developing a fit-for-purpose recycled water product for garden watering, toilet flushing and other uses. A risk eliminating approach might specify that the quality of such water needs to be comparable to that of potable water on the grounds that a small number of people may drink it. Such a requirement might make the project uneconomic, meaning that a large benefit is lost in order to eliminate what may have been a very small risk.

The above is true re never having zero risk. However we should continue to strive (as has been public health policy) to make the risk as close to zero as possible and lower the risk by using better and cleaner source waters when these sources are available. One will need a “risk eliminating approach” if any such water is recycled into drinking water however. However this is very expensive approach compared to most other water sources and also a much higher risk to public health as the sources’ water has such high concentrations of drugs and microbes.

Rent seeking
Where governments face different options for how to provide or regulate a service it is common that the vast majority of the community will be only slightly affected by the decision taken, while a small minority stand to gain or lose significantly.
Making an efficient decision requires that both diffuse and concentrated interests are taken into account, but the political process can err by giving undue weight to the latter.
The reason for this is that those strongly affected by a decision are most likely to be motivated to lobby for their preferred outcome, a practice known as rent seeking.
For example, while the vast majority of water users might benefit slightly from some urban water being purchased from irrigators, it may be that the strongest lobbying would come from a relatively small number of businesses in irrigation areas that would face significant costs.

I can only agree. Unfortunately the Commission seems to have been captured by rent seekers given their recommendations (without appropriate costing and caveats) on recycling water from sewage into drinking water.

Costs associated with ‘lost’ or delayed investment
Compliance costs and regulatory uncertainty have the effect of reducing the returns and riskiness associated with investments, thereby lowering their attractiveness.
Regulatory delays also potentially reduce investment, and can lead to sub-optimal investment strategies. For example, if there is a need for supply augmentation and the most attractive investment (from a cost–benefit viewpoint) is delayed by the regulatory process, the delay might lead to a less efficient investment taking place because it can be delivered in the truncated timeframe. This leads to an inefficient outcome, relative to the preferred investment, that can be considered a cost associated with regulatory delay.
Kerry McIlwraith, the chief financial officer of ACTEW, highlighted the impact of regulatory uncertainty on supply augmentation decisions:
So in a real options analysis once you introduce uncertainty what became apparent was that the dam would be chosen almost on every occasion because you had more possibility of [it proceeding] but the others just have been very difficult to get into place [due to the challenges associated with] getting interstate agreements, the environmental issues associated with each one and different environmental regulators. The Murrumbidgee–Googong pipeline had to go through New South Wales, the ACT and the Feds to get decisions and they had different views. We’ve managed to get two down and the third one we have an approval of sorts to proceed. But it’s the uncertainty of progressing those that makes it difficult. We’re still negotiating after some considerable period with Snowy Hydro about releasing the water in an amount that works for us as well. But to get that project to work we also need the pipeline so that we can pump the water, otherwise we wouldn’t be able to pump enough to make it a worthwhile proposition. (trans., pp. 83–84)1

I note from above that for just one important reason “Costs associated with ‘lost’ or delayed investment”, the dam option would have been chosen. It is also important to note however that there were many dam options looked at in the extensive ACTEW analyses that were done. Other than the Lower Cotter other localities for a new dam that were possible were the Tennent Dam, another dam on the Cotter

River but upstream plus others. *All the Dam options were much more economic compared to the sewage recycling option.*

The most expensive options available in monetary and energy costs were a desalination plant on the coast and then pumping the water to Canberra and a sewage recycling plant. Why did the Commission not quote or use any of these economic comparisons that ACTEW has already done? I can only presume that "rent seekers" prevented this from happening, presumably by being very selective in what information has been given to the commission.

It is important to subject proposed regulations to cost–benefit analysis (CBA). A CBA of a regulatory proposal involves systematically evaluating all of its impacts on the community and the economy, and not just the immediate or direct effects, financial effects or effects on one group. It should, to the maximum extent possible, value the gains and losses from a regulatory proposal in present day monetary terms, thereby enabling assessment of whether the benefits of the proposal exceed the costs. Such analyses should be made available to the public and it is highly preferable that the public be able to comment upon them prior to final decision making.

I can only agree. So why has this not been done in the draft report for recycling water from sewage into drinking water proposal? However the relative public health risks need also to be part of this type of analysis.

Analysis based on the limited information available to the Commission, suggests that it would have been considerably less costly (and more economically efficient) to obtain extra water through purchases from irrigators in the southern connected Murray-Darling Basin (box 6.3). The fact that a desalination plant was preferred suggests that there may have been an implicit government veto on the purchasing option, due to its political sensitivity.

If this is true for desalination plants (re other option being considerably less costly) then the same will hold for sewage recycling plants - as it is the same technology.

Prohibition on the planned potable use of recycled water
It is poss ble to treat stormwater and wastewater to a standard that makes it suitable for human consumption. Water that is recycled in this way can be piped into water supply dams or injected into aquifers that are used as a source of potable water. Where wastewater is used, recycling offers a source of water that is largely independent of rainfall. A major advantage of using recycled water for potable rather than non-potable use is that separate distr bution infrastructure is not required. Various countries, including the United States and Singapore, use recycled water as a source of drinking water in a planned way (ENTOX, TOXIKOS and the University of NSW 2008).

Many of the statements above are not true or else misleading. Sewage recycling is not completely independent of rainfall as a water source. When there is a drought the amount of water available from sewage significantly decreases (because the population adopts more water saving habits). While this recycled water can in theory be made suitable for human consumption, there is no testing currently used that can show it is consistently safe to use. Also in Singapore a separate pipeline is used to circulate the treated water. Further only a token amount is added to potable water supply in any case in Singapore (see appendix). Moreover why are there no costings given? In sections before this one, all the down sides of desalination plants are appropriately given, yet these sewage recycling plants are the same type of plants. Why this inconsistency from the Commission in its draft report. This perceived bias is somewhat disconcerting as it is coming from the Commission that should be above this.

There are many instances, in Australia and elsewhere, of wastewater being treated and discharged to a river system that supplies downstream communities with potable water. This practice is known as unplanned potable use of recycled water. For example, most of the ACT's wastewater is treated and discharged into the Molongolo River, which flows into the Murrumbidgee River which in turn flows into the Murray River. Along the way this water forms part of the water supply for many cities and towns, including Adelaide. The Commission is not aware of any major health concerns associated with this source of supply.

I will yet again reiterate what I said earlier:
The statement or implication that "unplanned potable reuse occurs commonly without any apparent ill-effects" and is thus by implication is not a major issue, I believe is both wrong and dangerous if left as it is. Millions of people (mainly children) die every year around the world because "unplanned potable reuse occurs commonly".

Deaths occur not only in developing countries because of this but also in developed countries. In Canada a Royal Commission was set up after the deaths following sewage leaks into water supplies. Your statement is thus not only unbelievable wrong but dangerous. How can it have been made by anyone with a social conscience? It suggests the lowest common denominator re health and deaths is acceptable economic practice.

Best practice for the last 150 years is to stop or significantly decrease "unplanned indirect potable use" of water source form sewage or stormwater. Why is the Commission trying to negate this fundamental health principle?

In contrast, more direct and planned use of recycled water for drinking is less common and remains contentious. Indeed, the NWC reports that New South Wales, Victoria and South Australia have policy bans that preclude the use of this option (NWC 2010b), despite these states utilising unplanned potable use of recycled water originally sourced from the ACT and elsewhere. In Queensland, three advanced water treatment plants have been built that have the capacity to supply south-east Queensland with drinking water, but a decision has been taken that they are only to be used for this purpose when dam levels fall below 40 per cent (Queensland Government nd).1 Recycling was also proposed for Toowoomba; however, government support for this project was withdrawn following community
opposition (box 6.4).
(1). The SEQ Water Grid Manager reported that there are significant savings on operating costs from not utilising this source when dam levels are higher (DERM,
Box 6.4 Toowoomba recycled water proposal
Toowoomba is located 127 kilometres west of Brisbane in the headwaters of the Darling River. It is one of Australia's largest inland cities, with a population of 95 000. The population of the greater Toowoomba region is 135 000.

In the face of declining dam levels in the early 2000s, Toowoomba City Council began to assess various options for augmenting supply. These options included new dams, water produced from coal seam gas operations, groundwater and piping water from the Brisbane River system. For cost, environmental and reliability reasons, planned potable reuse of wastewater was identified as a preferred option. The environmental benefits related mainly to reduced nutrient and salt exports to the Darling River.
This option involved building an advanced water treatment plant (using reverse osmosis technology) to process more than 5000 megalitres of wastewater sourced from the city's wastewater treatment plant. Most of this water was to be piped to an existing dam to become part of the city's potable water supply, with some lower quality water being used for other purposes, including coal washing and irrigated agriculture.
The estimated cost of the project was $68 million and Council sought part-funding from the Australian Government's Water Smart Australia program in 2005.
There was fierce debate about this proposal in Toowoomba. People opposing the project ran a high-profile public campaign warning of possible public health risks, even though the plant was to produce water of a higher quality than the existing supply. This campaign reportedly extended to measures such as displaying babies' bottles with toilet paper in them.
According to the then mayor, the Australian Government took the unusual step of requiring that a poll be held to gauge the level of support for the project in Toowoomba before a decision on funding would be made. The poll was held in July 2006. The vote in favour of the project was 38 per cent, with 62 per cent opposed. In light of this result the project did not proceed.
Subsequently, a 38 kilometre pipeline was constructed to transport water from Wivenhoe Dam (Brisbane's main dam) to Cressbrook Dam near Toowoomba at a cost of $187 million.
Sources: Toowoomba City Council (2005); Diane Thorley, trans., pp. 419–31.

I note the disparaging way the opposition by those in Toowoomba who did not approve of putting water recycled from sewage into drinking water, is presented. I also note the cost of the ultimate solution (the pipeline) to the water problem was at a cost of $187million to be able to supply 18 Gl of water per year to Toowoomba and completed within 12 months. I agree this is expensive but it is still about half the cost of a desalination capacity (and thus a sewage recycling plant) of around $400million per 20GL capacity.

Thus the pipeline option seems to have more cost effective than the sewage recycling project (the estimated $68 million figures quoted seems unrealistically low given other data presented in the draft report that suggests $400 million for a 20 Gl sewage recycling plant is more likely). Again it suggests an evident bias by the Commission in their report. This bias needs to be addressed as Commission is supposed to be objective and impartial, especially on economic issues re data presentation.

"The project cost $187 million and was designed to initially supply 14,200 megalitres of water each year. The pipeline has the capacity to increase water supply to 18,000 megalitres per year catering for expected population growth and demand until 2051, should it be needed.

In November 2009, Toowoomba's dam levels were at under 9%. Without the construction of a pipeline, total dam depletion was predicted to occur by September 2010. Construction of the pipeline commenced in January 2009 and the pipeline became operational in January 2010, ensuring that Toowoomba and

surrounding communities did not run out of water.”
(http://www.dip.qld.gov.au/projects/water/toowoomba-pipeline-project.html).

It could be argued that governments that impose policy bans on the potable use of recycled water are responding appropriately to the health and other concerns of the community. It would appear, however, that the weight of scientific evidence is that the risks of using recycled water for drinking purposes can be satisfactorily managed (NWC 2010b). Given this, the Commission is in agreement with the NWC that rather than impose outright policy bans:
… decisions on whether to use recycling for drinking purposes should objectively consider the risks, the costs and the benefits through a transparent and participatory process. (NWC 2010b, p. 1)

I don’t agree. There is insufficient data to make this conclusion. Of the few studies available, these show that RO process in sewage recycling, despite the claims of proponents, does *not* consistently remove all drugs and pathogenic microbes.

Unwarranted preference given to water reuse and recycling for non-potable use
The Australian, State and Territory Governments give preference to supply augmentations that involve reusing or recycling water for non-potable uses by subsidising them or mandating their use. Although reuse and recycling options can provide benefits in addition to water supply, the Commission’s view is that the preference given to these options is in most instances not justified by these additional benefits. Evidence and analysis of this issue are presented later in the section on integrated water cycle management, and this suggests that the costs to the community of unwarranted preference being given to water reuse and recycling for non-potable use are substantial.

If you are just interested in monetary issues and are happy to ignore Public Health and the potential for very large numbers of people to become ill and even die then your statement above is true. However I can only yet again reiterate that the best practice for the last 150 years is to stop or significantly limit the chance that any sources of water from sewage in entering the drinking water supply.

Scope for efficiency gains in pricing recycled water
The principles for pricing recycled wastewater and stormwater are no different from those for potable water. Essentially, the prices should reflect the cost of providing the water to users.

I think this is from an economic perspective a reasonable approach. Given that the capital and running costs of a sewage recycling plant are however so high ($200 million per 10 Gl capacity for construction alone), if this recommendation was followed it is hard to see how sewage recycling into drinking water would ever be economically viable in this country for if it were done properly and safety with appropriate real time testing for appropriate human pathogens (e.g. viruses) and drugs. It is thus hard to see why the Commission could have been recommending this as a viable economic option in its draft report or in press and media statements. The inconsistency compared to statements made by the

Commission on desalination plants is staggering (and that is before the Public Health issues are taken into account when the process should fail).

Submission

Introduction

One of the major advances in Public Health over the last 150 years has been to keep micro-organisms that are commonly found in the faeces of people and animals, out of our drinking water supplies. We are protected by treating drinking water (with chlorination, flocculation, etc) but also and just as important, in the protection of our catchment areas by minimising the entry into them of human and other waste (both treated and untreated).

Protecting the catchment is important because no disinfectant or sterilising system works instantaneously. They all rely on time to kill micro-organisms. Thus the more micro-organisms present in the water initially, the longer it takes to kill them. If there are large numbers of organisms present, then there is a bigger risk that all these micro-organisms may not be eradicated before the water is consumed by people.

The problem with proposals to recycle sewage into our drinking water supply is that this is a fundamental reversal of one of the basic principles that have helped keep our drinking water safe (i.e. keeping sewage out of our catchment area or from drinking water sources).

Sewage has the highest concentrations of pathogenic micro-organisms (e.g. viruses) and drugs compared to any other water source.

Membranes and reverse osmosis do not remove all drugs and salts

The equipment and membranes that will be involved with sewage recycling proposals (e.g. filtration, reverse osmosis, etc) are technologically very advanced systems. *Providing that they work*, they should be effective in protecting us from the large numbers of disease-caused by micro-organisms present in sewage including viruses (although in use verification data is very sparse).

Despite what is frequently claimed or implied by those promoting this technology for the recycling of sewage into drinking water, reverse osmosis (RO) does *not* remove all salts and nitrates from treated water (about 1 to 2% of salts and between 10 to 50% of nitrates are not removed). In Brisbane, reverse osmosis appeared to only remove about 92% of antibiotics from treated water derived from sewage (ie only about a one log reduction).

There is only very limited data available on how well reverse osmosis removes viruses, when used on large volumes of sewage. Direct testing for viruses is rarely or infrequently done, because of cost and technological problems. Thus other markers are used to assess performance (eg pressure, conductance changes, organic carbon etc.) which are in effect used as "surrogate" markers to assess virus and pathogen removal from water. However if we used salts or nitrates as surrogate markers for virus removal, then we would obviously be far from happy with the performance of RO to remove viruses. Some pilot studies and some operational tests from Singapore suggest that all viruses are removed by RO. However the data remains very limited (eg only about 20 tests for enteroviruses appear to have been documented in the Singapore expert report). Recent safety reviews, showed viruses were still detected post-treatment at 3 of 7 sites on some occasions. The calculated virus removal ranged from only 87% to >99.9 95% (log 1 to log 5).

Even if a system does remove all viruses when it is working normally, there always remains a risk, that something may go wrong on occasion (as is the case with any complicated engineering system). We need to remember that there have been numerous recent outbreaks of water-borne infections in the US, Canada and Europe that have resulted from both human failure and equipment failure involving much simpler water treatment processes (chlorination, filtration, flocculation, etc). This recycling process is an addition to any water system and hence an added risk.

I can only agree with the comments made in the recently released environmental discussion paper by the eWater Cooperative Research Centre:

"No treatment system anywhere in the world can be guaranteed to be absolutely failsafe 100% of the time. Consequently, equally important to the treatment system chosen must be the provisions made for detecting failure and ensuring that there is no break-through or leakage of incompletely treated water or wastes."

It needs to be noted that when in Brisbane recently, fluoride was added to the water supply for the first time, the system malfunctioned and incorrect levels of fluoride were added to the water supply for a prolonged period of time (see appendix). This was supposedly via an automated state of the art and fool-proof system. It was also a system much less complex what what is proposed and needed for recycling water from sewage into the potable water supply.

It is also important to also note that in other countries where water from sewage has been recycled (which has been mainly for industrial use by separate pipelines in any case), that in general *all sewage from industrial areas, hospitals, abattoirs, pathology laboratories etc., are excluded from the recycling schemes*. This is because of fears that there may be larger quantities of unknown chemicals or other toxins in sewage from these types of sources in comparison to standard domestic sewage from residential areas. There concerns are based on worries that not all the toxins, chemicals etc from industrial areas may be removed by the sewage recycling processes and also that these chemicals may be more likely to damage the membranes using in reverse osmosis. Thus there is a perceived risk that sewage from these areas may increase the chance of a malfunction in the recycling process because of membrane failures. If we then recycle all the sewage from cities (as is currently suggested for many areas e.g. Canberra, Brisbane - because otherwise duplicate pipelines etc. need to be constructed), we will be participating in schemes that will thus incorporate some industrial waste-water as a source. This has not been done anywhere else in the world. We thus have no where else from which we judge efficacy and safety performance.

This is a "High Risk" proposal

If we do a Risk Assessment, this proposal is "high" risk, if one assesses it by the criteria set out in the risk matrix table from the Australian Drinking Water Guidelines – indeed it is probably "very high" risk. The reason for this "high" risk rating is that even though it should be rare that failures would occur with the system, the consequence of a failure, if it occurs in a large city such as Canberra or Brisbane, then tens of thousands of people, or more, could potentially be exposed to pathogens.

Pumping recycled water from sewage into drinking water is rarely done elsewhere in the world

It is frequently stated in the media by proponents and I note in the Commission's paper that this is not a new proposal because frequently everywhere else in the world sewage is recycled into drinking water. I believe however, that those types of statements are either false or highly misleading and show what has been the undue influence of rent seekers and other lobbyists generating public misinformation.

The main example usually given is Singapore. However the water recycled in Singapore from sewage is used almost entirely for industry. The recycled water is very good quality water with a low salt content and it is offered at discount price. Thus it is very much in demand by high volume industry water users such as computer chip manufacturers. This recycled water is kept separated from their drinking water by the use of separate pipelines. By 2010, in Singapore, only a token 1% (or less) of their potable water is recycled from sewage (which is put back into their drinking water supply reservoirs).

Most recent proposals for recycling water from sewage, emphasise all the "non drinking" water purposes that this water will be used for, and it appears that they keep this recycled water away from their potable supplies as much as possible (eg information supplied by the large multi-national engineering company CH2M Hill which is involved with the recycling plant in city of Oxnard in California). In most other areas of the world where water is recycled from sewage "indirectly" into potable water supplies, it is usually done by replenishing aquifers and often because of the previous over-extraction of this underground water which has then resulted in the risk that salt water would enter the aquifer (eg Orange County and Oxnard). When recycled water is put into aquifers, there are usually also very long retention times before any recycled water is used. This means the many natural processes we have to help protect us against pathogens can still operate (eg major dilutions of the added water and prolonged storage or retention times). These natural processes result in viruses, bacteria etc dying off with time – often a 10 fold reduction in numbers every few weeks. In addition if water flows slowly through natural and shallow wetlands, UV light and other factors will usually kill human pathogens, and thus this wetland process is also protective. These types of additional safety barriers however will often not be present if something should go wrong. During any times of drought these additional barriers are likely to be significantly impaired.

Any recycled water from sewage will also need to be pumped uphill (as sewage plants are always at the bottom of any city's water process) via newly constructed separate pipelines. If not pumped via a separate pipeline, any recycled water be effectively going to be recycled directly into a potable water system (regarded by almost all in the water industry and elsewhere as unacceptable risk - as only done in Windhoek in Namibia).

It is not just my view that when it was proposed to recycle water from sewage in Canberra, this was something very radically different from accepted international health standards. An article in the Financial Times (London) points out that this system proposed for Canberra has really not been done anywhere else in the world (see attachment) -

"Veolia's Mr Frerot says: "To my knowledge, there are only two places in the world where treated waste water is gradually mixed into tapwater: the town of Windhoek, in Namibia, and Singapore."

In Windhoek, that is because the river is more polluted than the waste water, he says. In Singapore, it is a political choice designed to reduce dependence on supplies from neighbouring Malaysia - and accounts for less than 1 per cent of water consumed.

Ultimately, says Mr Frerot, the most cost-effective solution to water shortages developing in many towns and cities must surely be to supply such treated waste water for use in industry and irrigation, in place of the tapwater used today. "That would halve the demand for natural water," he says. "That is what we should do, before talking about drinking waste water."

This also means that there a few epidemiological studies that have been done elsewhere to access safety, are unlikely to be very useful for accessing the safety of this proposal for Canberra or Brisbane. Windhoek is probably the only comparable example for what was proposed for Canberra. Using a developing country in Africa for such analysis is problematic and not appropriate. There is thus a paucity of published data available that shows this proposal is safe.

I note this point is also made in the recently released Heath and public safety report form ACT government committee, "there have been relatively few systematic epidemiological studies of long-term health outcomes in communities supplied with drinking water supplemented by purified water."

There are other safer uses for recycled water rather than using it as drinking water

I am not arguing against using recycling water from sewage. I do however believe that one of the last places we should put this recycled water is into the *drinking* water. We should use it for other purposes such as industry, power stations, irrigation, etc. It is only if we then still have problems with a deficiency of water for drinking and household use that we then should consider recycling it into our potable water supply. There are places in the world where there are few alternatives but to recycle this type of water into potable water supplies. In general those are areas that have very poor average annual rainfalls (300 mm a year or less) and/or problems that have resulted after they have extracted too much water from aquifers: sea water would otherwise enter it and therefore leave them without any drinking water or with very badly compromised drinking water (eg Orange Country). None of those situations however is applicable to Canberra, Brisbane or other Australian capital cities. ACTEW's own Future Water Options Report stated that Canberra's average annual rainfall was sufficient for one million people.

A needless risk for the population; Canberra as an example

In Canberra generally, without water restrictions, about 65 GL/year (on average) of water is extracted from reservoirs. With Level 3 restrictions about 40 GL is taken from storage. In an average year, however more than 210 GL of water enters the current dam storage system from rain. Even during the recent record drought since 2001 to 2010, despite relatively mild water restrictions initially, the Canberra community managed to keep dams at reasonable levels (more than 50% of capacity). The exception was the year 2006 when there was very low rainfall and there were only about 25 GL inflows into storage. However at the beginning of 2006 (ie 5 years into the current prolonged drought) there was still storage levels at 68% of capacity. This had however dropped to about 35% by the end of 2006. We would only have serious problems if we have repeatedly, year on year, very low inflows. Such low inflows however would represent an over 80% reduction on our average inflows. Even in the worst case scenarios from CSIRO on climate change, there are only predictions of a possible 30% reduction in inflows over the long term. While such reductions would obviously be a problem, it would still mean that there would be more than enough water available to meet the needs for the Canberra community, as even a 30% reduction would mean on average that about 160 GL would still flow into our dams each year.

In Canberra water currently leaves storage for purposes of domestic and industry consumption (about 40 GL per year with level 3 restrictions). There is also a loose of about 10 GL a year through evaporation from storage and leakage. The local rivers also need to have water released from storage, with a minimum requirement of about 4 GL per year. This minimum usage adds up to a total requirement of about 54 GL per year of inflows into Canberra's dams with current usage patterns.

2006 was a very dry year with poor inflows into Canberra's dams. However despite this, in that year 17 GL was either released from or spilled over the dam wall of the Cotter and

Googong dams (12.7 GL and 4.3 GL respectively), despite inflows of only 25 GL. (Releases from these two dams are the only water that is "lost" from Canberra's storage system). The dams would have been quite adequate to supply Canberra's needs without water restrictions if much higher environmental flow requirements has not been imposed from 2000 on. In retrospect we also did not have enough reduction in environmental releases in place earlier enough in 2006, despite the poor rainfall and inflow being evident half way through the year.

Australia needs to learn from Canberra's mistakes in 2006. Dry years like 2006 are likely to occur again. In retrospect, we need to -

- ensure storage is adequate (as acknowledged by the ACT Government's Water Security Report;
- decrease our domestic use of water earlier (by water restrictions) when storage is in crisis; and
- better monitor and control the amount of water we released from these dams as river flows.

If these last two points were done better in the future, the ACT could have saved more than 20 GL of water a year during periods of drought in Canberra. This is the equivalent volume (or more) of the amounts of water likely to be recycled from the largest example of the prosed sewage-recycling plan for Canberra.

- Improved water storage capacity by a new Dam (such as the enlarged 78 Gl Cotter dam - now being built), will increase water security by a much larger amount per year than any of the previous potable water recycling from sewage proposals but at a much lower cost (money and energy) and with a much lower health risk to the population.

This is a very high energy proposal – it is not green or environmentally friendly

It is also important to remember that the sewage recycling plant proposal using reverse osmosis is really the same as a desalination plant. It therefore requires large amounts of energy (approximately 6,000 kilowatt/hours of electricity per ML of water produced). In Canberra it is estimated that will produce an extra 57,000 tonnes of extra $CO2$ per year from plant operations. The recycled water proposal involved the water to be pumped over 13 km and uphill (it involves a 260 metre lift, firstly to the lower Cotter catchment and then again up to the Stromlo treatment plant). This pumping requires substantially energy requirements (more than the processing itself). These figures come from the recently released "Preliminary investigation of environmental issues discussion paper" which also points out that to be carbon neutral the process will require an additional 300,000 trees per year to be planted. To expend this energy with all its associated greenhouse gas emissions when this is not necessary in Canberra seems a very poor choice. Not only is this a very costly monetary exercise, the associated ever ongoing high-energy consumption will be contributing to the very problem blamed for changing our climate in the first place! It would be economically and environmentally irrational for the Productivity Commission endorse such an outcome.

There are also other environmental impacts arising from the necessity to get rid of wastewater (10% to 20% of water used) from the RO process itself and the high concentrations of brine, salts, microbes, drugs and other products this water will contain. The high concentration of pathogenic micro-organism in this water will require its own detailed risk assessment and risk management plans, especially for their safe disposal (and especially if transport of part of this material is planned). With desalination plants this "waste' material (mainly water with a high salt concentration) is usually put back into the sea. Disposing of the much more toxic "waste" material from a sewage recycling plant is a much more difficult and expensive task.

Procedures for testing micro-organisms are inadequate

In addition, the monitoring of this process will rely mainly on markers other than measuring micro-organisms to know whether the system may have malfunctioned (from an infection point of view this is known as using surrogate markers). There would be very little or no direct monitoring of most of the microbes that cause diseases if present in water. Previous testing such as Total coliform counts are recognised currently as being among the poorest testing markers for faecal contamination and water safety. E.coli counts are superior, but still have major limitations. While E. coli counts will be measured, there is not likely to be much in the way of human virus cultures or PCR testing etc, as the current technology for monitoring viruses that cause human disease (eg enterovirus) is expensive, slow, not yet standardised and not readily available. Unfortunately, while many faecal indicators are superior to *E. coli* and enterococci, these tests for the much smaller viruses (and the micro-organism thus most likely to get thru RO membranes) have not been developed to a point where there are methods readily available that are inexpensive and simple for routine use.

Currently and in the past, relatively speaking not much microbiological testing has been done in water (predominantly coliforms, E.coli and testing for Giardia and cryptosporidiosis). This is fine when your water supply is from a relative pristine source (eg in in Canberra where the main source of water for drinking in most years is the two dams on the upper parts of the Cotter River (Corin and Bendora), which have pristine catchment areas. If recycled water or water from other less pristine sources (e.g. Murrumbidgee River) are used then these are all much higher risk water sources. Thus I believe (and is implicit in the latest Australian drinking water guidelines) there will need to be substantial increases in both the frequency and types of testing being done. There will need to be additional testing for enterococcus, bacteriophages, spores of *C. perfringens* and if feasible *enteroviruses*, *norovirus* and *rotavirus*.

Spores of *C. perfringens* are very hardy and also largely of faecal origin. Thus if *C. perfringens* is present it is an indicator for viruses and parasitic protozoa that may also be present. Bacteriophages are viruses that infect bacteria and those that infect coliforms are known as coliphages, or more generally, phages. Phages have been proposed as microbial indicators as they behave more like the human enteric viruses which pose a health risk to water consumers if water has been contaminated with human faeces. Research results show that phages cannot be considered as reliable indicators, models or surrogates for enteric viruses in water. Enteric viruses have been detected in drinking water supplies despite tests that were negative for phages.

Need to explore many other water saving options

If we use Canberra as an example again, there are many other ways we could save the amounts of water being planned by this sewage-recycling proposal (even assuming it were necessary, as opposed to storage augmentation). If we use water from the current Molonglo sewage outflows for non-drinking water purposes (such as for irrigation, keeping Lake Burley Griffin filled, industry, sewer mining etc), then instead of needing to extract 50 GL of water from our dams, we may well only need to extract 40 GL or even less per year. Water tanks on houses, better use of grey water etc., (but in themselves higher cost options compared to dams) will also decrease the amounts of water we need to draw from our dams. If we look at other options rather than always seeming to include either desalination and/or sewage recycling (via similar plants), we will be recycling much more water, but in ways that should have little consequence for human health if something went wrong. And then we will also be able to better save our pristine and safer water (e.g. in Canberra with its Cotter catchment), for its best purpose, using it as a safe, inexpensive water supply. .

Risk management

Recycling water from sewage into drinking water is a "high risk" procedure because large numbers of people will be potentially exposed to a large variety of pathogens in the water, if the system malfunctions. The way to eliminate this risk is to avoid altogether recycling water from sewage into drinking water. Using Canberra an example there are many other ways of obtaining or saving 20 GL of water – all safer and less expensive than the sewage recycling proposal of a few year ago.

If however the sewage recycling into drinking water proposal were to go ahead, then the risk could be best minimised by only using the process at times of major shortages of water. Mr Michael Costello (Managing Director, ACTEW) in a letter he sent to me (see appendix) said "essential insurance which we hope … will seldom, if ever, have to call upon." (see below)

> The balance of probability is that the extremely severe conditions of 2006 will not be repeated, and that there will be sufficient water to meet our needs without having to use recycled water. But what we have learned over the last few years is that for whatever reason we can no longer rely on the long-term averages. While it is unlikely, it is possible that we may face several more years in which river flows and inflows into our dams are at the extremely bad 2006 levels or worse. The consequences of this risk eventuating are so severe that even though it is a small risk we cannot afford not to take out insurance against it. And that is how we should see the recycled water project – as essential insurance which we hope we will seldom, if ever, have to call upon.

I think his suggestion is a very sensible approach. If we proceed with the recycling plant then we can avoid exposing the population to any "risk" from recycled sewage being placed into drinking water if we don't use the plant. It is likely that for the vast majority of the time we will have adequate water storage, and thus the recycling plant will not be operating, as is pointed out by Mr Costello himself. And I believe it is also likely to be the case once we have a larger storage capacity in place, such as the enlarged Cotter Dam. Once Canberra has a larger Cotter Dam (by 2011 to 2012) and becomes wiser with how the water from dams is used, we should never find ourselves back in the situation of late 2006 and early 2007 re low total water storage levels. This then however implies that the expenditure on such a plant will be a "white elephant" and on economic ground should probably never proceed.

I understand the Productivity Commission has traditionally opposed "gold plating" or "white elephant" investments. Why the change in its outlook in its draft report that seems to recommend sewage recycling plants?

However I note that in both the draft health and environmental reports, and in the current future plans for Canberra that a pilot recycling facility is still being planned. Even the concrete footing for it has been laid at the Molonglo treatment works. This appears to be inconsistent with what Michael Costello has written previously and needs to be clarified, as this issue is very important in any strategy to minimise risks.

It is also important to note that in general any disinfectant and chemical sterilising agent works better at higher temperatures. Canberra has colder water than most other Australian cities. Therefore longer contact times will be needed to achieve the same level of removal of organisms (ie log reductions) as would be needed elsewhere. This is an added reason why it is very important to have organisms in concentrations as low as possible in any water that is being processed. Temperature has important implications for chlorination of water and other disinfection processes such as any planned UV therapy. I also note that lower temperatures mean the membranes do not work as well and at the very least need to be replaced more often. Given Canberra's cold water temperatures compared to other areas of Australia and Singapore, California etc, this is a significant factor that needs to be considered.

If the sewage recycling proposal were to go ahead, (notwithstanding its public health and economic irrationality), then we need to have as many safety barriers in place as possible and many of these should be "natural". This means having very large dilution effects and long retention times before the water is used for drinking. This can only be done if the recycled water is in large reservoirs (eg the enlarged Cotter Dam or the Googong Dam). If the Googong Dam is used it should not go to that Dam via the reticulated water system. It is also preferable if by some means the recycled water could move very slowly (weeks or months) to the storage facility through some type of slow moving and shallow water system (eg wetlands) so that natural processes including UV light from the sun, as well as other factors, could help remove any pathogens and drugs that may be present, especially if a mishap occurs in the recycling plant.

Conclusion

There are many in the community who are greatly (and rightly) concerned about current proposals (such as suggested by the Commission) to recycle water from sewage into drinking water. I believe currently such proposal do not have enough safeguards for our population, nor have other options for recycling water, that does not involve recycling into drinking water, been adequately investigated and followed with appropriate community consultation.

Recycling water from sewage into drinking water is a "very high risk" procedure. It is an additional risk that the population does not need be exposed to, as in the vast majority of times we can store and access much safer and cheaper water for drinking purposes.

My belief remains that putting recycled water from sewage into drinking water should be one of the last options we should adopt to improve water security, as it is a retrograde step in terms of water quality, and potentially a retrograde step in terms of cost to the community. There are numerous other ways by which we could either save or find alternative sources for the proposed amount of water to be recycled into drinking water. Most are also safer, cheaper and more environmentally friendly. I thus cannot see why we should contemplate subjecting the population of Australia to this needles risk unless it is truly a "last resort" and then only after we have much better monitoring processes in place.

Appendices

Risk assessment Australian Drinking water standards

Table A4 *Qualitative measures of likelihood*

Level	Descriptor	Example description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Table A5 *Qualitative measures of consequence or impact*

Level	Descriptor	Example description
1	Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs
2	Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs
3	Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
4	Major	Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
5	Catastrophic	Major impact for large population, complete failure of systems

Table A6 *Qualitative risk analysis matrix – level of risk*

Likelihood	Consequences				
	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
A (almost certain)	Moderate	High	Very high	Very high	Very high
B (likely)	Moderate	High	High	Very high	Very high
C (possible)	Low	Moderate	High	Very high	Very high
D (unlikely)	Low	Low	Moderate	High	Very high
E (rare)	Low	Low	Moderate	High	High

Financial Times; Purified sewage is unpalatable

By Ross Tieman

Published: April 18 2007 03:00 | Last updated: April 18 2007 03:00.

http://www.ft.com/cms/s/352bc47a-ed4a-11db-9520-000b5df10621.html

In March this year, Jim Service, the chairman of water supply company Actew Corporation, and councillors from the Australian city of Canberra dutifully drank bottles of purified sewage water as they unveiled plans to recycle part of the city's wastewater into tapwater.

Within days, Professor Peter Collignon, director of infectious diseases and microbiology at the Canberra Hospital, wrote an open letter laying out his concerns about the health implications of the scheme.

What assurance could there be, he asked, that treatment would remove all disease-causing bacteria and viruses, as well as hormones and pharmaceutical compounds present in sewage?

It is a good question. As Antoine Frerot, chief executive of Paris-based global water champion Veolia Water, observes: "Louis Pasteur said 150 years ago that we drink 90 per cent of our illnesses. That is why water treatment was created."

Around the world, water companies and their equipment suppliers insist we have the technology to render sewage safe to drink - but they don't all guarantee they can pick up hormones or unexpected compounds. "This is an area in which we and others are doing a lot of research," says Roger Radke, chief executive of Warrendale, Pennsylvania-based Siemens Water Technologies.

Microfiltration through polymer membranes, followed by reverse osmosis through membranes can remove even viruses if a small enough pore size is specified, says Mr Radke, though to drink the water, you had better then pass it under ultra-violet light to be sure to kill microscopic parasites such as cryptosporidium and giardia.

But this adds expense. In reality, the level of treatment is dictated by standards that have been deemed necessary by regulators for the intended use. And when deployed, it typically comes at the back-end of the traditional waste-water treatment process.

In the case of Canberra, waste water would be treated in the conventional way with chemical and bacteriological processes to remove solids and create water of the quality that is typically released back into rivers around the world.

Actew says it is still investigating exactly which processes the water would then undergo before being pumped into the supply reservoir. It says it would expect to use a combination of micro-filtration and ultra-filtration to remove microscopic particles, contaminants and pathogens; reverse osmosis to remove salts, organic compounds and viruses; and ultra-violet disinfection/oxidation to additionally ensure any trace of organic material is destroyed. A final option is to let the water flow through an artificial marshland before joining the reservoir.

After that, the reservoir water would pass through an existing treatment plant before entering the tapwater distribution system.

Canberra, like many Australian towns, is short of water because of a drought that has proved longer, and more severe, than anyone forecast. Last year, residents of Toowoomba, Queensland, rejected proposals for a similar waste water-to-tapwater scheme in a referendum in which health concerns played a key role. The Canberra proposals could prove equally contentious.

Veolia's Mr Frerot says: "To my knowledge, there are only two places in the world where treated waste water is gradually mixed into tapwater: the town of Windhoek, in Namibia, and Singapore."

In Windhoek, that is because the river is more polluted than the waste water, he says. In Singapore, it is a political choice designed to reduce dependence on supplies from neighbouring Malaysia - and accounts for less than 1 per cent of water consumed.

Yet all around the world, city populations consume treated water drawn from rivers that receive treated wastewater from communities further upstream. Just as the citizens of Rouen, in France, drink the waste water of Parisians, the same is true in the River Thames in the UK, the Colorado in the US, and the Rhine in Germany and its neighbours. Without wastewater, these rivers would almost run dry.

Treatment prior to drinking is imperative: a 2003 study found the level of hormones in the River Seine sufficient to change the gender of some of its fish. And a study by the Netherlands government found that using Dutch rainwater even to flush toilets would pose a health risk.

If we are going to drink treated wastewater, says Mr Frerot, the best strategy, where geological conditions permit, is to reinject it into aquifers - as happens in Berlin and Adelaide. The soil acts as a natural filter, and the time-lag provides additional water for abstraction in periods of peak summer demand. Man is merely shortening the natural cycle.

Otherwise the most obvious and economically viable solution, he suggests, is to use treated waste water for industry and irrigation. Orange County, in California, adopted Siemens' micro-filtration and reverse osmosis to treat waste water a decade ago, initially reinjecting it into aquifers, and subsequently selling additional supplies to farmers and industry - which covers the cost of the additional treatment, says Mr Radke.

In Australia and elsewhere, some towns have a second distribution system for "reticulated" water used by householders for garden watering and washing cars.

Meantime, treated sewage water is widely used to supply industry, farms and golf courses, freeing up "natural" supplies for tapwater. Veolia alone has 100 such facilities in France, and others scattered from Honolulu to Durban in South Africa.

Dégremont, a Suez Environment subsidiary, cleans wastewater from Grasse, France's perfume capital, to bathing standards, says Dégremont chief operating officer Remi Lantier, providing water quality guarantees for fish farms downstream.

Pumping treated waste water into marshlands and reed beds, where sunlight and plants complete the purification, is an option too. But the outfall from even a small town would require a vast swamp to be effective.

The simplest solution for small communities, says Mr Radke, is to buy a Siemens skid-mounted modular unit - the size of a small car - for a few thousand, or tens of thousands of dollars, and turn waste water into irrigation quality water by passing it through membranes.

Dégremont's Mr Lantier says companies like his can produce ultra-pure water in which the only molecules are H20. He likens the safety issue to that in the nuclear industry, standards are that stringent.

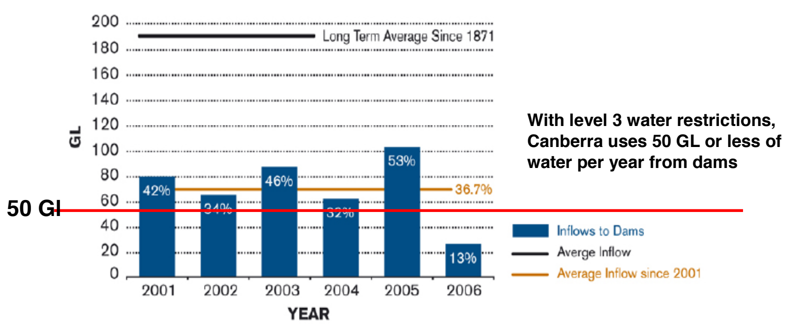
Globally, says Mr Lantier, only 45 per cent of the world's collected waste water is treated. The most urgent priority is to treat the 55 per cent released untreated. Of that treated, 20m m3 a day is recycled - about 2 per cent. He expects that proportion to triple in coming decades.

Ultimately, says Mr Frerot, the most cost-effective solution to water shortages developing in many towns and cities must surely be to supply such treated waste water for use in industry and irrigation, in place of the tapwater used today. "That would halve the demand for natural water," he says. "That is what we should do, before talking about drinking waste water."

Inflows into Canberra's main dams (2001-2006)

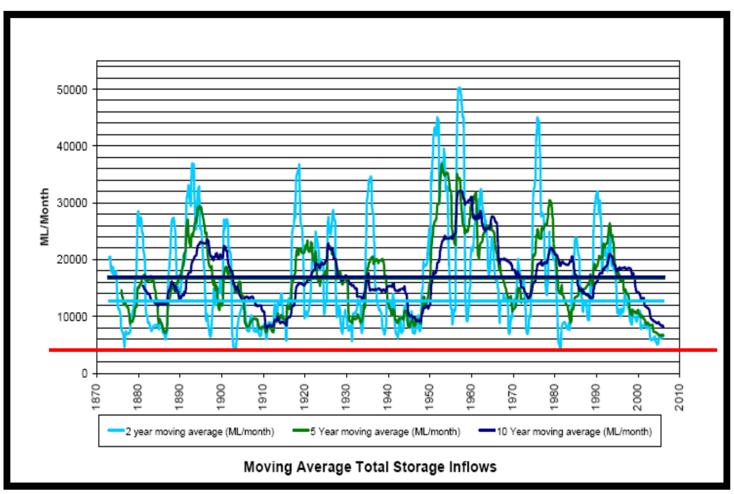
Inflows to Corin, Bendora and Googong Dams (2001-2006)

ACTEW figures and graphs. Note however this excludes Cotter dam which receives about 25% of Cotter catchment area rainfall



Moving Average Inflows to Corin, Bendora and Googong Dams

red line is min requirement for Canberra with water restrictions
50 GL/Yr or 4,000 ML per month



Excess releases of water as river flows in 2006

These are the views of a forestry consultant (Chris Borough) from figures that were obtained from ACTEW re releases of water from our Dams in 2006 and also water consumption figures.

> Peter,
> As we now have all the statistics for 2006 it should be possible to be fairly objective.
>
> The Cotter dam has a capacity of 3.7 GL (see ACTEW website). The dam must be kept at 90% capacity to protect endangered fish needs. Thus the effective use that can be made of the 3.7 GL is substantially lower than the other storages
>
> The data supplied directly by ACTEW's engineers (updated for Dec 2006 - attached) clearly shows that legislation required 5.6 GL to flow from the Cotter Dam (a large amount and again should be reviewed in the analysis of Options) but in practice 12.7 GL was released or went over spillway. That is 7.1 GL was wasted. I can't see how the 2 GL claimed makes any sense in the light of the attached numbers. It could be that water was pumped from the Murrumbidgee (near the old pumping Station) back into the system after it was released from Cotter – this needs checking as they do have that capacity.
>
> With water restrictions in place we do use about 50 GL/a – well below the amount claimed in the newspaper ads. Our average use (average since 1996/7) for Winter has been 118 ML/d and for Summer 219 ML/d. A quick browse of the actual use figures published in Canberra Times shows numbers ranging from around 150 ML/d in mid summer to 100 ML/d in mid winter. Say 130 ML/d * 365 days is 47.45 GL – close enough to 50. The consumption for 2003/4 was 53 GL and 2004/5 51 GL (ACTEW website). If you add the 17 GL that was released from Googong and Cotter from both environmental flows and waste, the total usage figure does increase to >60 GL/a.
>
> Rather than spend millions of dollars on treating and adding 9 GL to an already overloaded Cotter Dam we could achieve the same result by not wasting the 7.1 GL from Cotter and the 1.8 GL from Googong (ie a total of 8.9 GL). I feel most Canberrans would prefer tougher usage restrictions to save the 0.1 GL required without all the inherent risks and massive capital and ongoing pumping/treatment costs of using treated water.
>
> The real issue for society is that energy cost will only go up as concerns about climate go up and fossil fuels run out. Why on earth would a "today" government commit to such a wild scheme that guarantees a commitment to use valuable fossil fuel ad infinitum from an almost non-existent gain?

Why not push for the enlarged Cotter Dam with less fuss over water levels for fish as the most logical way to go to avoid losses. Forget treatment of wastewater if we can avoid it. Use the treated wastewater as a substitute for useful things like ovals and parks.

Attached is ACTEW supplied table of water flows.

Chris Borough
Forest Science Consultancy Pty Ltd
PO Box 4378 Kingston
ACT 2604 AUSTRALIA
email: chrisborough@actewagl.net.au

Month	Corin (ML)		Bendora (ML)		Cotter (ML)		Googong (ML)	
	Required	Actual	Required	Actual	Required	Actual	Required	Actual
Jan-06	1362	6613	915	1675	465	2690	400	537
Feb-06	357	8074	923	1199	505	1484	228	323
Mar-06	83	6790	255	521	465	705	156	479
Apr-06	255	7518	854	914	535	742	62	279
May-06	241	7004	527	544	465	566	226	340
Jun-06	375	5848	1057	1102	535	676	300	362
Jul-06	770	4196	1265	1470	465	1218	400	602
Aug-06	2221	4465	2172	2135	465	1426	310	376
Sep-06	1478	4975	2321	2368	535	1548	379	608
Oct-06	414	7488	1055	1140	465	743	78	153
Nov-06	429	4735	507	739	450	705	13	128
Dec-06	176	2541	249	392	292	236	0	123
Sum (GL)	8.2	70.2	12.1	14.2	5.6	12.7	2.6	4.3
Excess (GL)				2.1		7.1		1.8

Jan-07	122	2669	610	865	184	281	57	149
Feb-07	210	1164	267	347	150	224	190	185

-----Original Message-----
From:
Sent: Thursday, 8 March 2007 3:42 PM
To:

Subject: Questions relating to data provided by Environment Australia

Dear Mr ,

Thankyou for your email of 15 January 2007, regarding environmental flow releases from ACT water supply dams.

ACTEW has a licence to abstract water from the Googong Reservoir and Corin, Bendora and Cotter Reservoirs for the purpose of water supply. The licence is regulated by the Environment Protection Authority. The Licence is guided by the *Environmental Flow Guidelines 2006* and stipulates minimum environmental flow requirements for Corin, Bendora, Cotter and Googong Reservoirs that ACTEW must meet. Under the Licence the environmental flows are categorised as baseflow, riffle maintenance flows and pool maintenance flows.

Please find the responses to your questions below.
1. Environmental flow release rates from Googong (and Cotter) have a minimum flow requirement, as opposed to Corin and Bendora, which have a target flow. ACTEW is in breach of the Licence if flows are under released. It is very difficult to exactly match minimum flow release requirements, due to the operational constraints such as time taken to close valves in large water mains. ACTEW err on the side of caution to ensure that Licence requirements are not breached.

In addition, a riffle maintenance flow was released during the month of March. This is a high flow for three consecutive days. To achieve the minimum flow and time span required, the release errs on the higher side. A riffle release is required every two months under the Licence to ensure environmental obligations are met. Further to this, the flow release is measured at a river gauge located some 8 kms downstream. During March, 18 mm of rain fell in the area between Googong dam and the river gauge, and the catchment runoff is included in the flow measured by the river gauge.

2. River gauging stations are checked for accuracy every month. Depending on the location and type of gauge, a correction to the preceding month of recorded flow can be adjusted +/- 6%. The data in the tables provided are flows that have been corrected, and so required and actual flows can appear worse after the fact. Although it is difficult to ensure total accuracy of gauging stations, ACTEW is working to improve the level of accuracy.

3. Please note that there was a data error related to the figures in question. The actual release figures for January 2006, for Bendora and Corin were mixed up, and need to be swapped around. This has since been corrected.

4. During March the flow release exceeded the minimum required amount, due to operational constraints associated with the mini hydro plant at Bendora dam.

5. Under the Licence ACTEW can release less environmental flow in the following month, if over-releases have occurred in the previous month. However, only 10% of the following months target can be carried over.

6. Two riffle maintenance flows were released during this time, which is a high flow release for three consecutive days. To achieve the minimum flow and time span required, the release errs on the higher side.

In addition as the ACT was in Permanent Water Conservation Measures during June-October, a larger base flow was required to be released daily under the Licence. When Stage 2 Water Restrictions or higher Restrictions are introduced, this amount reduces in an attempt to conserve the water supply for ACT.

If you have any further queries, please contact me and I can direct you to the appropriate person.

Regards,

ActewAGL House
Level 9, 221 Canberra ACT 2601
Phone: 02 6248 3174
Fax: 02 6248 3567

Singapore drinking water contains very little recycled water from sewage

This is the text from an email I sent to MLA's on this matter.

I think that a few of you were surprised (and probably a bit sceptical) when I sent around a previous email stating that water from sewage was not recycled into the drinking water of Singapore to any significant extent. The common perception here in Australia seems to be that large amounts of water recycled from sewage are consumed in Singapore.

Since I sent my previous email I understand many of you have received emails, personal contacts or had material sent to you suggesting what I sent to you before and stated previously was incorrect on the Singapore water situation.

Below and attached are a number of different sources that allows you to independently check on the accuracy of my statements.

Hardly any (1% or likely less) of potable water in Singapore comes from recycled sewage (it seems to be mainly used by industry and is delivered by separate pipelines to drinking water and at a lower price). Thus looking at Singapore to establish any adverse health effects from this process in their population will be impossible as they hardly drink any of this type of recycled water.

Currently only 1% of Singapore potable water is recycled.
My sources for this are three different ones plus the Singapore water website
http://www.pub.gov.sg/NEWater_files/faq/index html

How will NEWater be used?

A. We will continue to use NEWater for direct non-potable purpose by industries, commercial buildings, etc. As for Indirect Potable Use (IPU), 3 million gallons a day of NEWater, about 1% of the total volume of water consumed daily, has been blended with raw water in our reservoirs. The amount will be increased progressively to reach about 2.5% of the total volume of water-consumed daily by 2011.

The 2005 application form for NEWater that clearly shows there are two different pipelines and recycled water is kept separated from potable water (at least in 2005 it had said it is NOT for potable use).

"As NEWater is for non-potable use, customers will have to provide separate pipework for potable and non-potable water supply within their premises." http://www.scal.com.sg/index.cfm?GPID=263

The 2nd source is a Financial Times London article. "In Singapore, it is a political choice designed to reduce dependence on supplies from neighbouring Malaysia - and accounts for less than 1 per cent of water consumed."

The third source is a 2007 publication from a group at the Uni of Queensland (who I understand are in favour of recycling sewage water for drinking - but see their excellent summary of other places that use recycled water). They give Singapore as an example and say "small portion" into reservoir; page 30). This group also has figures and comments on the very high-energy costs of this reverse osmosis proposal (see page 19).

The Challenges of Water Recycling Technical and Environmental Horizons. January 2007. Compiled by Jeff Foley, Damien Batstone, Jurg Keller. Advanced Wastewater Management Centre. The University of Queensland, Brisbane QLD 4072. Australia
Publication available at http://www.awmc.uq.edu.au/awmc_wr_challenges.pdf

Extracts from "Indirect potable use and expansion of the Cotter Reservoir: Preliminary investigation of environmental issues Stage 1. Issues Discussion paper"

May 2007
Report compiled by:
Professor Gary Jones
Adjunct Assoc. Professor Mark Lintermans
Professor Richard Norris
Dr David Shorthouse
On behalf of eWater Cooperative Research Centre

Conceptual information about two options for recycling Canberra water has been provided by ACTEW. With both options (A and B), treated wastewater derived from tertiary treatment of sewage will progress from the existing Lower Molonglo Water Quality Control Centre (LMWQCC) to a proposed new on-site facility, for further treatment. The 'advanced' treated water will then be recycled into the lower Cotter catchment where it will enter the Cotter Reservoir, via a constructed wetland and probably a local stream.

Two other outputs of the new plant will be liquid and solid wastes, depending on the treatment option the plant uses. These wastes will either re-enter the LMWQCC with the incoming raw sewage, or, in the case of the reverse osmosis plant wastewater ('brine') from Option A, be piped to evaporation ponds north of Uriarra, for ultimate disposal elsewhere.

ACTEW also proposes also to enlarge the capacity of Cotter Reservoir from 4 GL to 78 GL (GL stands for gigalitre, 1 thousand million litres) to hold the treated water along with other catchment in-flows. Recycling of 25 ML each day is expected initially, rising to 50 ML per day once the new dam wall has been constructed (ML stands for megalitre, 1 million litres).

eWater notes that the technical information so far available on the treatment options is insufficient to carry out a detailed evaluation or proper environmental risk assessment.

Our preliminary evaluation of the international literature indicates that a well designed and well operating 'Option A' type system (micro/ultrafiltration + reverse osmosis + UV/peroxide oxidation) *has the potential* to remove all viral and bacterial contaminants and organic pollutants, and to reduce salts, nutrients and heavy metals to concentrations similar to, or lower than, that found in natural catchment run-off — this being the appropriate environmental benchmark for our analysis. Notwithstanding, one potential environmental issue noted is the comparatively weaker removal of the nutrient nitrate by reverse osmosis. This could, subject to other environmental factors, increase the risk of algal blooms and uncontrolled aquatic plant growth in Cotter Reservoir.

No treatment system anywhere in the world can be guaranteed to be absolutely failsafe 100% of the time. Consequently, equally important to the treatment system chosen must be the provisions made for detecting failure and ensuring that there is no break-through or leakage of incompletely treated water or wastes. The environmental concerns relating to system failure include:
• infection of fish and other biota by viral and other pathogens — something that could occur during even a single, short failure event;
• accidental land and water contamination because of pipe rupture — especially the treatedwater pipe crossing over or under the Murrumbidgee River;
• contamination of local land, streams and groundwaters due to constructed wetland 'overflow' or leakage; and
• shut-down of flow at critical ecological times — especially for wetlands and stream ecosystems that become established under an artificial flow regime.

Advanced water treatment is an energy-intensive process, especially where significant water pumping is required (as here). Preliminary estimates of the power requirements for the new treatment process are about 6000 kW (kilowatts). Assuming operations 24 hours a day, 365 days

per year, this translates to an estimated greenhouse gas emission rate of about 57,000 tonnes of carbon dioxide per year from plant operations.
The 'Option B' treatment train (using ozone–biologically activated carbon instead of reverse osmosis) would use a little less energy than Option A. However, there appear to be few other water treatment and environmental advantages of Option B over Option A.

In any treatment process, one of the biggest environmental risks lies with the handling and disposal of the concentrated waste stream. Issues that need to be further addressed are:

- contamination of birds and animals that will be attracted to the 'brine' ponds,
- groundwater contamination by the wastes,
- brine pond failure and run-off to adjacent streams,
- waste pipe eruption and discharge,
- waste management during prolonged wet periods,
- wind dispersal of dried waste accumulated on site,
- vehicular accident during transport of dried waste.

Water transfers to Cotter catchment
The proposed water-treatment wetlands will need to be sited where the soils, slope and drainage characteristics are capable of dealing with an inflow of 25–50 ML per day. Evaporation and loss through seepage need to be small to maximise the extra water the project aims to make available. The wetlands may be contaminated by pests carried on the wind or by birds, and bird excreta may also reduce water quality.

Water from the wetland is likely to be discharged into a nearby stream before reaching Cotter Reservoir. Subject to further analysis, it is reasonable to expect if water is discharged at rates approaching the proposed 25–50 ML/day that major ecological impacts on local streams will occur. There may be ways to mitigate such impacts to some extent, for example through the use of more than one stream. However, consideration should be given to direct piping and discharge of treated water to the Cotter Reservoir as a less environmentally impacting option.

Technical Report & Risk Assessment
The technical report will build on the Discussion paper through a consideration of potential responses or solutions to environmental issues. Issues to be considered are those included in the Discussion paper, and possibly additional issues identified during the community consultation process. For each issue the report will discuss:

- the likelihood that it will eventuate,
- the environmental consequences if it does eventuate,
- the potential for amelioration through management actions, siting or engineering solutions,
- proposed solutions to it.

As with the Discussion paper, some issues will be difficult to evaluate because we currently have insufficient understanding of the biological processes involved, and/or insufficient details of the proposed activities. For such issues eWater CRC will identify:

- the reasons for the uncertainty surrounding the issue,
- the additional investigations or information required to adequately assess the issue,
- the timing for full understanding of the issue.

The investigation of these issues will, by necessity, be a desk top study. It will be principally aimed at identifying those critical issues that have the potential to result in major environmental damage. These may include those for which the ACT Government has insufficient information to make an assessment, or those for which there are no apparent amelioration measures. The report will articulate the assumptions made in underpinning the assessment of issues.

New treatment process
(i) At a high level, ACTEW is considering two 'treatment trains' as described below. Both treatment train options commence with tertiary treated sewage from the existing LMWQCC. The additional purification steps will be carried out in a new water purification plant to be built on the site of the existing LMWQCC.

Option A

Microfiltration/Ultrafiltration → Reverse Osmosis → UV/H_2O_2 oxidation → Wetland/Stream → Cotter Reservoir

Option B

+/– Microfiltration/Ultrafiltration → Ozone/BAC → UV/H_2O_2 oxidation → Wetland/Stream → Cotter Reservoir

BAC = Biologically activated carbon
UV/H_2O_2 = Ultraviolet light combined with hydrogen peroxide

The major difference between the two options is the omission of reverse osmosis in Option B, being replaced by ozone–biologically activated carbon treatment. Microfiltration/Ultrafiltration is also a sub-option within Option B. Option A will also include carbon dioxide stripping and pH adjustment before transfer of the treated water to the Cotter system.

(ii) Treated water will be pumped from the new purification plant at LMWQCC to a site approximately 13 km from the plant and through a height differential of approximately +260 m. ACTEW have advised that the treated water pumping regime currently being considered is a constant 25 ML/day for 365 days per year with the option to increase that to 50 ML/day if and when required (e.g. after completion of the Cotter Reservoir enlargement).

Microfiltration/Ultrafiltration (MF/UF), Reverse Osmosis (RO) and Ozone/BAC processes.
ACTEW proposes to return solid and liquid wastes from the MF/UF and Ozone/BAC processes (if chosen) to the raw sewage inlet treatment stream at LMWQCC.
However, the proposed RO Plant will generate a separate liquid waste or 'brine' stream — so called because it will contain significant quantities of dissolved salts as well as nutrients, organic compounds and virus particles not removed by ultrafiltration. The waste stream — about 10% of the total volume passing through the plant — will be transported by a separate pipeline to a site located to the north of the Uriarra Homestead and (former) Forestry settlement. There it will be dried through evaporation ponds (or mechanical means if required). The residual waste solids collected by this process will be disposed of by a method yet to be identified by ACTEW, but which may include trucking to land-fill sites outside the ACT.

Enlargement of Cotter Reservoir
An integral part of the project is the enlargement of Cotter Reservoir to allow treated water to be stored and returned as required to the normal potable treatment and supply system. This will be achieved by constructing a larger dam wall immediately downstream from the existing wall. The new wall will increase the maximum storage of Cotter Reservoir from its current volume of about 4 GL to 78 GL. Enlargement of the Cotter Reservoir to 78 GL would increase the total area inundated by about 260 ha.

Land proposed for possible wetland treatment sites was formerly managed as a pine plantation. Under current ACT Government proposals for restoration of this catchment the area is to be planted with native species and allowed to revert to a predominantly native vegetation type dominated by *Eucalyptus mannifera and E. macrorhyncha*, possibly reflecting its original pre-1750 woodland or forest vegetation. In 2007 the former plantation area is regenerating with some native vegetation, some dense pine wildlings and other weeds, particularly along the water-courses.

New treatment plant and water quality
An evaluation of potential environmental (and human health) risks must be predicated on the performance of the water treatment process being applied. From a technical perspective* there are a number of major issues requiring close attention and scrutiny with regard to the two treatment trains options:
1. the pathogen and contaminant removal efficiency of the new treatment plant under normal operating conditions;
2. the reliability of the entire process (treatment and waste management) and the provisions for timely detection of and response to system failure; and

3. the level of energy consumption and greenhouse gas emission.

In section 3.1, two treatment train options are summarised. Beneath these summary descriptions lies an enormous amount of treatment infrastructure and process detail that is yet to be finalised by ACTEW. The final built plant could be any one of a multiplicity of possible combinations of specific treatment technologies (type and brand) and operating processes (pressures, flow rates, backwash procedures, etc.).

We have necessarily assumed, within the range of possibilities under Options A and B, that the final treatment system selected by ACTEW will be the very best system available, based on all internationally available treatment & monitoring technologies and operating experiences.

In evaluating these systems, it is also pertinent to note that the feed water to the new treatment plant will have already undergone tertiary treatment at the LMWQCC. Water treated by these means has been discharged under licence to the Murrumbidgee River for many years. A range of contaminants and bacterial pathogens will have been significantly reduced in concentration through this tertiary treatment, before the feed water enters the new Water2WATER treatment system. *We also note that the technical information so far provided to eWater CRC, or available on the Internet from experiences elsewhere, is insufficient to carry out a proper risk assessment of the performance of either Option A or Option B. By necessity, this will be achieved during the Stage 2 analysis and reporting process.*

Treated water quality under normal operations
Option A
Our preliminary scan of the international literature indicates that a well designed and well operating 'Option A' type system (MF/UF+RO+UV/H2O2) *has the potential* to remove all viral and bacterial contaminants and organic pollutants, and to reduce salts, nutrients and heavy metals to concentrations similar to, or lower than, that found in natural catchment run-off.
This assumption will be further tested and evaluated through more detailed scientific review during preparation of the Stage 2 Technical Report (refer sec. 2.2). We consider the critical issues of system reliability and monitoring, which impinge on our preliminary assessment, in section 4.1.2 following.

Initial technical evaluations commissioned by ACTEW indicate the following operational performance (treated water quality) for the Option A configuration:

Water Quality Variable	Unit	Feed Water (average)	Treated Water (average)
Total dissolved solids	mg/L	490	<50
pH		7.7	7 – 7.5
Total Nitrogen	mg/L	15	2–3
Total Phosphorus	mg/L	0.2	<0.2
Total Organic Carbon	mg/L	4	<0.25
Viruses and Bacteria	No./100mL	-	Below detection
EDC	ng/L	-	Below detection
NDMA	ng/L		<10

EDC = endocrine-disrupting chemicals; NDMA = n-nitrosodimethylamine

We note with some caution that these figures are initial estimates of a handful of target contaminants provided by engineering consultants to ACTEW. And, the figures are averages — measures of typical performance — rather than the full operational performance range expected from best to worst case. For more detailed assessment of treatment plant performance, such information — and more, including real-world time series data from similar plants operating elsewhere in the world — is required.

One of the potentially important environmental issues noted here, and also in the international literature, is the comparatively poor removal of inorganic nitrogen compounds, especially nitrate and ammonia, by reverse osmosis — typically reported as only 50–90% removal (compared to 95–98%+ for other chemical contaminants).

It is intended that further 'natural' treatment will occur in the receiving wetlands to be constructed above Cotter Reservoir. While this may be true in principle (including the possibility of some denitrification — conversion of nitrate to nitrogen gas), it is also quite possible that the wetland will actually cause some deterioration in the quality of water entering Cotter Reservoir; for example, due to excreta from the bird and wildlife population that will be attracted to the wetlands. Because the daily discharge rates proposed (25–50 ML/day) are high compared to natural flow rates in the stream(s) that may receive water from the wetlands, little or no 'in-stream' treatment of the water is likely, unless the design of the wetland system enables it to significantly retard discharge flows (which is unlikely).

Given the above, in on-going planning, consideration also should be given to direct discharge of water to Cotter Reservoir. This would also obviate concerns raised in section 4.4 about the hydrological impacts on Cotter catchment streams that may receive the treated water.

Treatment plant reliability and monitoring
Whatever the final built plant (Option A or B), no treatment system anywhere in the world can be guaranteed to be absolutely failsafe 100% of the time. Consequently, equally important to the treatment system chosen must be the provisions made for detecting failure and ensuring that there is no 'break-through' or leakage of incompletely treated water or wastes. System failure can be minor — performance moving outside approved operating range — or major — a complete failure of the system, with the risk, if not managed, of untreated or partially treated water being transferred into the Cotter catchment or Cotter Reservoir.
The environmental concerns relating to system failure include:
• infection of fish and other biota by viral and other pathogens — something that could occur during even a single, short 'failure event' (see sec. 4.3.2 for more details);
It will be imperative to ensure that the treatment system includes 'state of the art' real time monitoring at critical control points throughout the process all the way through to Cotter Reservoir. Linked to this must be the ability to, almost instantaneously, by-pass the treated water back to the normal LMWQCC treatment stream instead of into the Cotter catchment.
At the present time, we consider the issue of system-reliability, monitoring and response one of the biggest unknowns with the proposed Water2WATER treatment system.

Energy consumption and greenhouse gases
Advanced water treatment is an energy intensive process. Internationally, the major energy consuming and, consequently, greenhouse gas-emitting parts of the process tend to be reverse osmosis and pumping.

Estimates of energy consumption for the proposed process are in the order of:
• Dual membrane filtration (MF/UF) 400 kWhr/ML
• UV treatment 200 kWhr/ML
• Reverse Osmosis 800 kWhr/ML
• Pumping to discharge site 3000–5000 kWhr/ML (*estimate only).

A similar plant to that proposed under Option A operating in Singapore uses 700–900 kWhr/ML . The contribution, if any, of pumping to that energy use is at present unknown.
Preliminary estimates by ACTEW's consulting engineers of the power requirements for the new treatment process are about 6000 kW (kilowatts).
Based on an estimated greenhouse gas emission rate of 1.08 kg CO_2/kWhr, and assuming operations 24 hours a day, 365 days per year, this level of energy consumption translates to an estimated greenhouse gas-emission rate of about 57,000 tonnes of carbon dioxide per year from plant operations.

There may be opportunities to use heat generated from the plant itself, and other green energy sources to minimise or offset the net carbon dioxide emissions. New tree plantations may also be a possible source of carbon offsets. About 300,000 trees per year would need to be planted to offset the estimated carbon dioxide production rate.

Waste management
In any treatment process, wastewater or otherwise, one of the biggest environmental risks lies with the handling and disposal of the concentrated waste stream. With the proposed Water2WATER treatment process, solid and liquid wastes will be generated at the new LMWQCC site. The liquid waste concentrate from the reverse osmosis (RO) process will be pumped to the Uriarra area for evaporation in purpose-built ponds, and subsequent disposal of solids.

The RO liquid waste ('brine') will contain high concentrations of salts, chemical contaminants and some bacterial and viral pathogens (it is unclear from the information provide to the CRC whether the waste stream will be disinfected prior to pumping).

The volumes of RO liquid 'brine' waste will be quite high — estimated to be about 10–15% of the total volume of water passing through the new plant — about 3–4 ML/day initially and more than double that volume at full capacity.
We note that management of concentrated liquid wastes is a well understood and generally well managed process internationally (at least in wealthier countries). Nevertheless, there are many examples of failures around the world that have led to significant and even catastrophic environmental consequences. Consequently, the risks inherent in such waste disposal processes need to be properly evaluated and managed.

Water transfer to Cotter catchment
The water transfer raises at least three potential risks to the aquatic fauna of the lower Cotter catchment:
• introduction of alien fish species as either eggs, larvae or small juveniles,
• introduction of disease organisms,
• introduction of endocrine disruptors to Cotter Reservoir.

Pathogens
The major concern for the introduction of disease organisms relates to the potential spread of Epizootic Haematopoietic Necrosis Virus (EHNV). This virus, unique to Australia, was first isolated in 1985 on the alien Redfin Perch. It is characterised by sudden high mortalities of fish displaying damage to the renal haematopoietic tissue, liver, spleen and pancreas. The threatened Macquarie Perch found in the Cotter catchment is one of several species known to be extremely susceptible to the disease. EHNV was first recorded from the Canberra region in 1986 when an outbreak occurred in Blowering Reservoir near Tumut. Subsequent outbreaks have occurred in Lake Burrinjuck in late 1990, Lake Burley Griffin in 1991 and 1994, Lake Ginninderra in 1994 and Googong Reservoir, also in 1994.

The EHNV disease has not been recorded from the Cotter system.
It is probably reasonable to assume that the Water2WATER treatment process, if designed and operating effectively to eliminate any potential disease organisms relevant to human health, would also remove EHNV. Consequently, the likelihood of this virus being introduced into the Cotter system through discharge of treated water is considered to be low, assuming the Water2WATER treatment process does not fail (refer to sec. 4.1.2).

Nevertheless, an accidental introduction could lead to severe consequences for Cotter fish populations especially Macquarie Perch, and further investigation of issues surrounding EHNV (including the design of a monitoring system) will be necessary.

Endocrine disruptors
The addition of endocrine-disrupting chemicals to waterways is a threat only recently recognised in Australia. These chemicals either disrupt normal hormone function, or mimic hormones to give an unnatural response. One group of endocrine disruptors is the environmental oestrogens which can mimic the female hormone oestrogen. Major sources of environmental oestrogens are pesticides, detergents and prescription drugs such as antibiotics. In Europe and America there is growing evidence of the changed sex ratios or feminisation of many aquatic species, particularly fish, which have been exposed to environmental oestrogens. This can have severe impacts on the ability of the species to successfully reproduce. Little research has been conducted in Australia on this problem, but it represents a real threat to Australia's streams, and further investigation is required. In principle, the reverse osmosis and advanced oxidation treatment that form part of the recycled water infrastructure for Option A should be effective in removing all such organic chemicals.

Nevertheless, there are sufficient uncertainties around system design and performance at the current time to warrant more detailed analysis of this issue for the Stage 2 technical report.

Wetland site impacts
The location proposed for discharge of the treated water is in an area of moderately steep slope with soils that are prone to erosion. With the information to hand it is not possible to assess how effectively the proposed wetlands will perform in terms of flow, potential for erosion, residence time, and vegetation growth.

Largely because of the previous land-use for this area there will be a need for detailed study of slope, soil and drainage characteristics on which to base the design of a system of wetlands suitable to receive the quantity of treated water (25–50 ML/day) expected for the project. There may be a need to consider alternative locations elsewhere in the lower Cotter catchment for wetland sites more suited to their role, flow requirements and restoration proposals in the catchment. Or indeed, alternative means of waste treatment and disposal.

As noted in section 4.1.1, the water-treatment value of the proposed wetlands appears marginal at best, and potentially detrimental. Of course, beyond these water-treatment issues, there are quite possibly incidental ecological benefits that would arise from the new wetlands, and some of these are briefly listed in section 5.2. Whatever the case, the pros and cons of the proposed wetlands should be carefully re-evaluated during on-going analysis and planning.

Stream impacts
Water from the wetland is likely to be discharged into a nearby stream before reaching Cotter Reservoir. Although the CRC has not yet had time to carry out proper hydrological modelling (it will do so during the stage 2 technical study), it is reasonable to expect if water is discharged at rates approaching the proposed 25–50 ML/day that major ecological impacts on local streams will occur. Scouring, incision and enlargement of the stream channel would be expected, with consequent loss of in-stream, and possibly riparian, plant and animal habitat, as well as major impacts on nutrient processing.

Fish in Cotter Reservoir are likely to perceive a wetland-stream discharge flow of 25–50 ML/day as a signal of the presence of a significant tributary, and attempt to migrate up this 'tributary'. If such flows were larger than the Cotter inflow during the spawning season of native fish (October–December), fish may attempt to spawn in the wetland discharge, a waste of scarce reproductive effort in threatened native fish.

There may be ways to mitigate such impacts to some extent, for example through the use of more than one stream. However, along with the issues raised in previous sections, this is another reason to carefully consider whether direct discharge of treated water to the Cotter Reservoir may be a better environmental option.

Environmental opportunities
This paper has highlighted many potential environmental risks of the Water2WATER project that must be further evaluated and carefully considered.

How many viruses may not be removed if there was just a small bypass of water though or around membranes.

`See discussion on this website. Water Recycling in Australia`

"An unemotional and rational discussion of the facts as best that they can be scientifically supported". The aim of this blog is to make information available to concerned or interested members of the community.

http://waterrecycling.blogspot.com/2007/05/risky-conversation-collignon-khan.html

PC comment. This website and its co-ordinator (Dr Stuart Khan from UNSW) are generally in favour of the recycling of water from sewage into drinking water. However from my perspective is has good discussions of most of the issues surrounding debates on this issue. It has many divergent views presented and includes good and relatively dispassionate discussions of scientific facts and other issues.

This is an extract of a discussion on how much water with viruses might escape via membrane or system leaks.

I was very interested in the discussion you and Mark had about math's. I share Marks' concerns and I think my math's came out similar to what I think Mark (and now you) are saying. My worry is what happens if 1% of the water does not go through the reverse osmosis membranes. That is different to 1% of the membrane failing. If 1% of the membrane failed, I presume large volumes of water would go through any rupture, as the high pressure in the system would drive the water that way. This presumably would be readily picked up by continuous pressure measurements etc. However it may only take very small leaks, tears etc to have 1% of the water volume go via some alternate pathways. I then don't see how any in-line measuring system will pick up such a small loss (eg pressure etc).

I thus agree with your comment that we need some type of regular measuring system developed that detects micro-organisms (especially viruses) rapidly and efficiently (presumably some type of viral molecular PCR testing– however even when we get over the practicalities of getting rapid results, PCR only picks up what you suspect is there. It won't pick up viruses etc that you don't have their genetic code included in the primers for your testing).

If 1% of water bypassed the RO system, then it likely means the numbers of viruses removed will be log 2 less than when the system had no leaks. This means that if there was say log 6 viruses per 100 litres of water (1 million viruses) in the original sample, then log 4 virus (10 thousand) would still be coming out the other end.

This is why I believe that you should not recycle water from sewage into our drinking water if there are other reasonable options to obtain water or decrease the amounts of water being taken from our potable water supplies (eg sewer mining for irrigation etc). If we have no choice but to recycle sewage for drinking water, then we firstly need to have some type of monitoring of viruses operating fairly regularly (I would think at least twice daily - but such systems do not seem to currently exist for everyday use). There also as you have said, needs to be multiple other barriers in place after the RO system, so that if something does go wrong you have added safety barriers in place. That is why I am so vocally against the current Canberra proposal - I do not think the proposal is needed plus it is not safe enough.

In Canberra, we have enough water from other sources. We thus don't have to take this risk. However even if this proposal was to proceed, nearly all of the natural safety barriers that should be in place, will have been removed. People should note that in the recently released draft environmental report that the implications of membrane and system failure are commented on (more so than in the draft health report). In the environmental report, concerns are raised re the large volumes of water that will be put upstream of the very small Cotter dam. Because of these reasonable environmental concerns, I note that there is a proposal to consider putting the recycled water directly into the small Cotter reservoir (3.8 GL) instead of into artificial wetlands (which don't look to be able to work very well in the Canberra proposal anyway). This will mean that the sewage recycling proposal is then really a "direct" potable recycling scheme, that the recycled water will only have very short retention times and only relatively small dilution effects. Also there will be no slow exposure via shallow marshes, wetlands etc where UV light and other factors might have a protective and polishing effect on any viruses or other pathogens that might be in the water if a mishap with the equipment occurred. To go ahead with this proposal without finding better ways to test to ensure firstly that micro-organisms such as viruses may have slipped through (eg from small membrane leaks etc as per your previous math's discussion) and then also remove as many natural safety barriers as possible, strikes me as leaving this as a "high risk" proposal but without now any safety nets.

None of the discussion about Canberra's water2water proposal I have seen so far, have made me feel any happier about its overall merits and safety. I think short-cuts on health and safety look like they are going to be taken. Even if this proposal goes ahead, it in my view should not start until we have a much bigger dam available to capture the recycled water. This will allow a much bigger dilution effects and much longer retention times to be available as natural protection barriers. A larger dam that can be kept "offline" for periods will also allow us to presumably quarantine any recycled water until we know it is "safe" by appropriate test results. Even without the bigger dam, we need some type of accredited monitoring system for viruses to be readily available and in regular use so that if a failure in the system occurred, we firstly know about it and we then can then try as best we can to keep any contaminated water out of our drinking water supplies.

Peter Collignon

Extracts from "Intestinal illness through drinking water in Europe. December 2005"

A number of epidemiological tools have been used to investigate possible associations between drinking water and disease. Of these, randomised controlled trials (RCTs) represent the most robust methodological approach. Typically, households are randomly assigned to different water treatment groups.

Two studies conducted in Canada have looked prospectively at the incidence of gastrointestinal illness due to the consumption of drinking water from sewage contaminated surface waters meeting current (as defined at the time of study) water quality criteria [Payment *et al*., 1991, 1997]. In the first of these studies, people in households randomised to receive domestic reverse osmosis (RO) water filters were found to have a lower annual incidence of gastrointestinal illness (0.50 per person/year) in comparison to tap water drinkers (0.76, $p<0.01$); estimating that 35% of the gastrointestinal illness reported by tap water drinkers was water-related. In a successive, larger trial, it was estimated that tap water was accountable for between 14-40% of gastrointestinal illness.

Although both Canadian studies used randomisation, participants were not blinded to the type of water treatment received which can improve the validity of results. Hellard *et al*. [2001] conducted a double-blinded RCT in Melbourne, Australia. The drinking water in the study area was reported to be of high quality, derived from a highly protected source treated with chlorination only. Six hundred households received either real or sham RO water treatment units (WTUs). Over a period of 68 weeks participants completed a health diary reporting gastrointestinal illness symptoms. The study found 0.80 highly credible gastroenteritis (HCG) cases per person/year and the ratio of HCG episode rates for families with real vs sham WTUs was 0.99 (95% CI: 0.85, 1.15, p=0.85), indicating that the RO-filters did not significantly reduce the HCGI incidence.

In the US, Colford *et al*. [2005] conducted a triple blinded RCT cross-over intervention study. The drinking water in this study area was derived from a challenged source treated with conventional chlorination and filtration methods to conform to all current US regulatory standards. Participants received either a sham or real treatment device for six months before switching to the opposite device for a further six months. The active device contained a 1 µm absolute ceramic filter and used UV-light. A total of 2366 HCG episodes were recorded for the 1296 participants over a period of 12 months (1.83 cases/person/year). The relative rate estimate of HCG (sham vs real device) was 0.98 (95% CI: 0.86, 1.10), no reduction in gastrointestinal illness was detected following use of the real treatment device. Further studies from the Americas have shown an association between sporadic cases of illness and use of unfiltered municipal or non-municipal water [Birkhead and Vogt, 1989] and variation in drinking water turbidity [Morris *et al*. [1996], Schwartz *et al*. [2000]).

What is evident from outbreaks implicating public supplies is that harmful pathogens have the potential to reach a large body of consumers resulting in substantial economic and health-related costs, which is shown by the April 1993 *Cryptosporidium* outbreak in Milwaukee [Mackenzie *et al.* ,1994]. As a result of a **filtration failure** at a public water supply it was estimated that around 403,000 people suffered illness, 4,400 people were hospitalised and 100 people died, though these figures have been disputed by others [Hunter and Syed 2001]. The total cost of outbreak-associated illness in the Milwaukee outbreak was estimated to be US$96.2 million [Corso *et al*., 2003]. Furthermore, in a review of 25 studies on the economic burden associated with common water-related diseases [Bartram *et al*., 2002: 78], the cost of an outbreak reflected as a proportion of gross domestic product per person for 7 enteric outbreaks of waterborne disease ranged from 0.002 to 0.230. Whilst costs such as health care expenses, direct and indirect productivity loss, and bottled water purchase are incorporated into these estimates, the absence of macroeconomic costs (for example, reduced consumer confidence and tourism decline) means that the financial burden is underestimated.

Documented Public Water Supply Outbreaks

A total of 86 enteric disease outbreaks associated with EU public drinking water supplies for the years 1990 to 2004 were detected.

The majority of groundwater outbreaks occurred in Finland (31%) and the majority of surface water outbreaks occurred in England (44%). All outbreaks in Scotland and Northern Ireland involved surface water supplies, the majority of outbreaks in Finland (83%) and France (71%) involved groundwater supplies, and a large number of outbreaks in England involved surface water supplies (48%). Groundwater supply outbreaks reported a greater number of case s of illness (60%) than surface water supplies (32%). The country-specific trends for England, France, and Finland reported here tend to reflect the predominant source of supply utilised for drinking water (as reported by Bartram *et al.,* 2002: 87).

Of the 54 outbreaks where a pathogen could be isolated from cases and the source of the supply was known, 89% of surface water outbreaks were of protozoan origin compared to 46% of groundwater outbreaks (Table 3).

Table 3: Outbreaks by Pathogen Group and Source of Supply

Pathogen	Water Source		Total
	Groundwater Outbreaks	Surface Water Outbreaks	
Bacteria	7	2	9
Protozoa	12	25	37
Virus	7	1	8
Total	26	28	

Water quality testing was reported in 88% of outbreaks. Of 62 outbreaks reporting whether or not a pathogen was present in the drinking water, 45% found a positive result (Table 4).

The outbreaks listed above by no means constitute a definitive list of outbreaks in the EU. As previously noted, outbreak reports were required to meet criteria to avoid inclusion of duplicates, to be referable to the published literature and to allow data analysis, which will undoubtedly have led to an underestimation of the number of outbreaks identified.

The Canadian Council of Ministers of the Environment (CCME) multi-barrier approach to safe drinking water identifies three key elements (source water, drinking water treatment plant, and distribution system) to be managed in an integrated manner using tools such as water quality management and monitoring, legislation, and guidelines [Federal-Provincial-Territorial Committee on Drinking Water, 2002].

Sixty-one of the 86 outbreaks previously identified had sufficient information available regarding contributory failures to be utilised in the development of a generic outbreak fault tree (see Figure 1).

Failures occurring at the 'source' of the supply and during 'treatment' occurred with similar frequency and mean contributory scores. 'Distribution' system failures occurred less often but with higher mean contributory scores. Failures associated with the 'detection' of, and response to, microbial and non-microbial pathogens occurred the least often and had the lowest mean contributory score.

Looking in more detail at 'source' water failures, both 'livestock activity' and 'rainfall' base events often featured in outbreaks (41% and 44% of outbreaks respectively) which is consistent with the identified seasonality of month of outbreak onset. 'Sewage discharge into the water' or 'onto surrounding land' had higher mean contributory scores (18.4 and 21.8 respectively) than 'rainfall' (17.9) and 'livestock' (14.9), but relatively low frequency of below 10%. The low mean contributory scores for rainfall and livestock are likely due to the existence of further barriers (such as treatment and detection) between source water contaminated with surface water runoff and the consumer. Direct sewage contamination of the surrounding land or water may be intense thus compromising effectiveness of further barriers such as treatment. With regard to 'treatment' base events, 'chronic filtration failures' were the most frequently documented (38% of outbreaks), yet, 'temporary filtration failures' attained the highest mean contributory score of 58.8. Looking in more detail at 'source' water failures, both 'livestock activity' and 'rainfall' base events often featured in outbreaks (41% and 44% of outbreaks respectively) which is consistent with the identified seasonality of month of outbreak onset. 'Sewage discharge into the water' or 'onto surrounding land' had higher mean contributory scores (18.4 and 21.8 respectively) than 'rainfall' (17.9) and 'livestock' (14.9), but relatively low frequency of below 10%. The low mean contributory scores for rainfall and livestock are likely due to the existence of further barriers (such as treatment and detection) between source water contaminated with surface water runoff and the consumer. Direct sewage contamination of the surrounding land or water may be intense thus compromising effectiveness of further barriers such as treatment. With regard to 'treatment' base events, 'chronic filtration failures' were the most frequently documented (38% of outbreaks), yet, 'temporary filtration failures' attained the highest mean contributory score of 58.8.

Results have implications for the treatment of groundwater and surface water supplies and the monitoring of metrological, microbial, and non-microbial data. Although distribution system failures were considered to have the greatest contribution to surface water outbreaks, surface water supplies suffered most often from treatment failures. Of the treatment failures, chronic filtration failures occurred most often and temporary interruption to filtration was the most influential in causing such outbreaks. This is consistent with the finding that 89% of surface water outbreaks were associated with protozoa.

Published case studies of waterborne disease outbreaks--evidence of a recurrent threat. Hrudey SE, Hrudey EJ.

Water Environ. Res. 2007 Mar;79(3):233-45.

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Residents of affluent nations are remarkably lucky to have high-quality, safe drinking water supplies that most residents of modem cities enjoy, particularly when considered in contrast to the toll of death and misery that unsafe drinking water causes for most of the world's population. Some may presume that drinking-water disease outbreaks are a thing of the past, but complacency can easily arise. A review of drinking water outbreaks in developed countries over the past 3 decades reveals some of the reasons why drinking water outbreaks keep occurring when society clearly has the means to prevent them.

Prevention of future outbreaks does not demand perfection, only a commitment to learn from past mistakes and to act on what has been learned.

http://www.ncbi.nlm.nih.gov/sites/entrez

The role of wastewater treatment in protecting water supplies against emerging pathogens. Crockett CS.

Water Environ. Res. 2007 Mar;79(3):221-32.

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Traditionally, regulators, dischargers, and even water suppliers believed that wastewater discharge meeting the levels of 200 cfu/ 100 mL of fecal coliforms in wastewater effluent was sufficient to protect against downstream microbial effects. However, these beliefs are now being challenged by emerging pathogens that are resistant to standard water and wastewater treatment processes, exhibit extended survival periods in the environment, can adversely affect sensitive subpopulations, and require extremely low doses for human infection.

Based on this new information, it is estimated that discharges of emerging pathogens from conventional wastewater treatment plants as far as 160 km upstream and cumulative amounts of wastewater discharge ranging from 2 to 20 ML/d have the potential to reach a water supply intake in a viable state at significant concentrations that could exceed regulatory limits for drinking water supplies, increase endemic risk from drinking water, and/or require additional drinking water treatment. Wastewater dischargers may be able mitigate this potential effect and achieve upwards of 6 log combined removal and inactivation of emerging pathogens to mitigate drinking water effects by using alternative treatment processes, such as filtration or UV light disinfection, or optimizing these processes based on site-specific conditions.

Recycled sewage in our water supply; a needless human health hazard in Canberra

This is a revision of the opinion piece I had previously written and was published in the Canberra Times in March 2007.

It is proposed in Canberra we will recycle about 9 GL (9 billion litres) of waste-water and then pump this treated water back into our reservoirs. It will then be used as part of our domestic water supply, which includes drinking water.

One of our most significant public health improvements was removing sewage from water supplies. Human waste contains numerous viruses, bacteria, protozoans and other microbes that frequently cause disease if ingested. While our sewage will be treated so that it is “safe” to drink, the mechanisms being proposed for this all have potential problems with performance. Thus there is a strong possibility that at times we will contaminate our water supply with disease causing micro-organisms.

Worldwide there are localities where there is no alternative but to accept the risks associated with using recycled sewage. However, whenever possible when we can avoid placing treated sewage into drinking water this is hazard obviously desirable to avoid. In Canberra there is no reason to take this risk. The ACT has large volumes of unused water. Indeed ii is a very large net exporter of water to NSW (about 471 GL per year). We also currently have one of the best water supplies from a safety point of view in Australia (and probably worldwide). Currently no human sewage enters our drinking water in our catchments. We are also very fortunate (and unique) in that minimal domestic animal waste enters the water supply because few farms are in our catchments. Most of our current Canberra water is good enough to bottle!

A number of methods are purposed to make this recycled sewage “safe” but how many systems work perfectly all the time? If membrane technology is used, can we be sure that these membranes will be able to accommodate the planned 24 million litres of recycled water that they need to filter each day? How will we know when there are small tears in parts of the membranes or leaks around seals? Bacteria are very small and so the pore size of these membranes needs to be < 0.2 microns otherwise all bacteria will not be removed. However when the pore size is so small, these membranes can become fouled unless other means are found to prevent blockage by larger waste material. Even such small pore sizes will still not remove viruses, which are much smaller. These membranes will not remove drugs passed in urine and faeces that are not broken down (such as oestrogens).

A “reverse osmosis” process is also going to be used. But there is a lack of details available to Canberra residents to see how effective this system may be in removing viruses (and drugs). We know that salts and nitrates are not all removed by this process and also that some drugs pass through the membranes used in reverse osmosis. Ultraviolet light will also be used as an additional sterilising agent. However this is far from an ideal disinfectant. There are many issues such as time of exposure, susceptibly of different microbes etc, for it to work. How can we be sure that this can handle 24 million litres of waste-water per day?

Safety monitoring is planned, presumably by culturing the water and looking at coliform counts. If coliforms (eg *E. coli*) are present in the treated water this implies faecal contamination (and thus a failure of the system). However, this type of monitoring has problems. Around the world numerous outbreaks with water contaminated with viruses and Cryptosporidiosis, have occurred despite low or zero coliform counts. In addition these indicator bacteria take 1 or 2 days to grow and identify. There does not appear to be a plan for storing 2 or 3 days of recycled water in a temporary reservoir. The water will effectively be pumped directly back into small Cotter dam after treatment. This will mean that even when we detect a failure with our treatment system, there will be little we can do about it because the contaminated water will already be in the dam. How often will this coliform testing be done? -every half hour, hourly, daily or just weekly?

In Canberra we do not need to recycle our waste-water back into our drinking water supply. The current proposal is for initially 9 GL of water per year to be recycled into our dams. On average however about 120 GL per year has been released from our dams into the rivers as environmental flows (46 GL) and as spills (75 GL). Spills are when dams overflow – which has occurred frequently, even in droughts, with the Cotter dam because of is low storage capacity. This released water is relatively “pristine” from an infection point of view. Why not find ways to withhold 9 GL of this water? Is this not a better option than pumping 9 GL of very expensively treated waste-water upstream into our reservoirs when we cannot be assured it will always be free of harmful microbes?

In Feb 2006, the Chief Minister announced the start of a transfer scheme commencing in Dec 2006 of 12 GL per year from the Cotter reservoirs to the Googong Dam. “This Scheme takes water that would otherwise spill over our dam walls, and makes it available for consumption in the Canberra region”. This amount is larger than the proposed 9 GL volume of recycled water. Can’t more water from the Cotter dams be transferred if we still have a shortage of water in the Googong dam? On average large amounts of water “spills” per year from the Cotter river system and into the Murrumbidgee River. Surely the amount transferred from the Cotter system to the Googong dam could be increased to say 20 GL per year and avoid the costs and risks of recycling sewage into our water supply.

This current proposal to recycle sewage also does not seem to make environmental sense. Effectively this will be putting 9 GL less water into our waterways. This is because 9 GL of water will be pumped back into our reservoirs instead of being released into our rivers as occurs currently. We could remedy this by letting an extra 9 GL out of our dams and into the rivers. That however would effectively mean that there is no net increase in the water supply for human use. If we did that we will have spent maybe $150 million or more to process and pump water back into our dams, just to let the same amount of water out again! It makes neither environmental nor economic sense.

Nearly all of the water that is released from ACT Dams as environmental flows plus natural flows, move into the Murrumbidgee River where it is then captured in the Burrinjuck Dam (capacity 1,025 GL) near Yass. Nearly all the water in the Burrinjuck Dam is for irrigation purposes, when it is let out for downstream users. One of the major uses of this water is for rice cultivation. In 2001 (Australian Bureau of Statistics), 1,924 GL was used for rice production in NSW/ACT. There is no rice production in the ACT, which means all this water is being used further downstream in the Murrumbidgee river system. If the rice growers down river from Canberra decreased their water usage by just 1%, that would mean that there would be another 19 GL available for the rivers. This is more than double the amount that is proposed to be saved by recycling our waste-water in Canberra. It does not appear to make sense to spend huge amounts of money recycling waste water and putting this water back into our Canberra drinking water, when at the same time we are releasing “pristine” water from these same dams for environmental flows especially when this released water is effectively being used mainly for irrigation purposes downstream to produce water intensive crops such as rice.

In my view this proposal to recycle sewage should not proceed in Canberra. We have ample flows of much safer water that could be stored and used for human consumption. If we proceed we will be creating a human health hazard needlessly for our population at great financial cost and without any obvious benefits to our environment.

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These are my personal views and do not necessarily reflect the opinions of the organisations whom I work for or I am associated with. Many of the necsassry facts to have an informed public debate are surprising difficult to find (eg environmental flows per year etc). My sources for information and web site are given in the appendix.

Appendix

The current total water available in the ACT per year is 494 GL. Slightly more than half of this is reserved for environmental flows and just under half (222 GL) is available for human usage if needed. In the past the ACT has extracted 65 GL of water per year for human use but of this 35 GL is returned to the river system after processing. This means that there is a net usage of only 30 GL (of the 222 GL that is available for human use). In the last year (2006) our usage has dropped to 50 GL per year, which means that the ACT is only extracting 15 to 20 GL of water (this is the amount of water not returned to the river system).

The ACT is a net exporter of water to NSW. On overage 368 GL/year flows into the ACT from NSW, via the Murrumbidgee River. However, 839 GL flows out of the ACT, via the Murrumbidgee. This means that the ACT exports 471 GL of water per year to NSW.

Large amounts of water are released from our dams each year as Environmental flows. On average this is 46 GL/year plus there is another 75 GL/year that flows into the rivers as spills. Thus currently on average the ACT from its reservoirs is putting 120 GL/year of water into our rivers that could otherwise be stored in our dams (this is in comparison to the net annual human use of water in ACT of about 20 GL/year).

The ACT has storage capacity if all the dams are full of about 200 GL. Currently about 50 GL/year is being taken out of that storage for human use (with 35 GL returned to the rivers after processing). The average annual environmental plus spill flows is 120 GL of which 45 GL is "released". Between 50 to 65 GL of water is extracted for domestic consumption each year. Total about 100 GL. Thus it appears that our dams really only have about 2 years of storage capacity if full re the amounts on average that are currently released or used from the dams.

One of the major users of water in Australia is rice cultivation. In 2001 (Australian Bureau of Statistics), 1,924 GL was used for rice production in NSW/ACT. The net use of water for human use per year in Canberra for our 350,000 people is 20GL. Thus one year's water use for the rice production that occurs downstream from Canberra is equal to 100 years use of current net domestic water use in Canberra.

The ACT is currently suffering a major water inflow problem and an increase in evaporation. However, there have been worse droughts than is currently being experienced in the ACT including the late 1800s, 1914, 1944 and 1981-83.

References and Sources

This source of information is reports from ACTEW 2004 Report, plus "The Need to Increase ACT's Water Storage 2004 http://www.actew.com.au/FutureWaterOptions/Documents/assessmentReport.pdf

ActewAGL Water Facts and "Future Water Options for the ACT Region in the 21st Century, http://www.actew.com.au/futurewateroptions/Reports.aspx

the Australian Bureau of Statistics
http://www.abs.gov.au/Ausstats/abs@.nsf/Previousproducts/4EB070C49861DA5DCA256F7200832FAE?opendocument

Burrinjuck Dam; http://www.tourism.net.au/articles/9051371

TRANSFER SCHEME LETS ACT KEEP WATER OPTIONS OPEN. 15 February 2006. Jon Stanhope, Chief Minister, Australian Capital Territory.
http://www.chiefminister.act.gov.au/media.asp?id=24&media=1087&section=24&title=Media%20Release

Industrial waste needs to be excluded from any sewage

Discharge pretreatment

When recharging aquifers for human consumption it is important to develop efficient pretreatment programs for industrial discharges into the sewerage, so that effluents have relatively "controlled" characteristics. Although this is not part of recharge legislation, it is definitely an essential component. The presence of industrial discharges into the sewer system is a concern, because they carry compounds that are hard to determine and remove, and that have unpredictable and even unknown effects, so they must be segregated from the water before infiltration. Because there is reuse of treated wastewater for human consumption, regardless of whether it is intentional or unintentional, the discharge of toxic compounds must be regulated so that only domestic water is used.

http://www.who.int/water_sanitation_health/wastewater/wsh0308/en/index.html

Other cities use recycled water from sewage mainly for uses other than drinking water

CH2M Hill to design advanced water purification facility for city of Oxnard

OXNARD, CA, April 25, 2007 -- CH2M Hill, a global full-service engineering, construction, and operations firm based in Denver, has been chosen to manage the design of an advanced water purification facility (AWPF) for the City of Oxnard, CA. The facility will provide the city with reclaimed water that can be used for landscape and agricultural irrigation, industrial process water and groundwater recharge.

The APWF project is a part of the City of Oxnard's Groundwater Recovery Enhancement and Treatment (GREAT) program, whose focus is to use existing water resources more efficiently. A major component of the GREAT program is the use of recycled water for multiple beneficial uses including irrigation of edible food crops, landscape irrigation, injection into the groundwater basin that forms a barrier to seawater intrusion and other possible industrial uses.

The recycled water for reuse will be generated by the new AWPF. The source of the recycled water will be the existing city water pollution control facility which has a capacity of 32.5 million gallons per day. The AWPF will treat the secondary water from the city water pollution control facility using a multiple-barrier treatment train consisting of microfiltration/ultrafiltration, reverse osmosis and ultraviolet -light based advanced oxidation processes.

The project will be constructed in two phases, with capacity of the initial phase at 6.25 million gallons per day. The capacity during the build-out phase is expected to reach 25 million gallons per day.

The City of Oxnard has purchased a 4.65-acre parcel located east of Perkins Road and north of a railroad line owned by Ventura County Railroad Company. The City's water pollution control facility occupies land on the west side of Perkins Road. The feed water for the AWPF will be directed from the secondary effluent channel at the WPCF to an inlet structure at the AWPF site.

In addition to agricultural and landscape irrigation, water will be available for local industrial users and groundwater recharge. Farms in Pleasant Valley and along the Santa Clara River will be supplied with the AWPF high-quality water for agricultural irrigation. Additional water will be distributed across the City for landscape irrigation using the remodeled Redwood sewage trunk line.

Groundwater recharge will be conducted by injecting the water into the ground using injection wells along Hueneme Rd. east of the AWPF. The groundwater injection will protect the aquifer from seawater intrusion and provide credit to the City against penalties for over-pumping groundwater. All of the end users (agricultural irrigation, landscape irrigation, injection in the aquifer and industrial) will be served with the highest water quality of the AWPF, which meets the groundwater recharge criteria.

In addition to the key objective of producing purified water, the AWPF will be open to the public and have educational, visitor, and research functions. A portion of the site will contain a demonstration wetland. The wetland feature complete with vegetation. In addition, the wetland system will build upon results from previous pilot wetland studies conducted by CH2M HILL in 2003-2005. The use of this natural system will provide an opportunity for community education, further research and the potential to use such wetland biota for community wetlands restoration.

The initial phase is expected to be fully operational by the end of 2009.

With headquarters in Denver, CO, employee-owned CH2M Hill (www.ch2m.com) is a global leader in engineering, construction, and operations for public and private clients. With $4.5 billion in revenue, it's an industry- leading program management, construction management for fee, and design firm, as ranked by *Engineering News-Record* (2006). The firm's work is concentrated in the areas of transportation, water, energy, environment, communications, construction, and industrial facilities. The firm has long been recognized as a most-admired company and leading employer by business media and professional associations worldwide. CH2M Hill has over 19,000 employees in regional offices around the world.

http://ww.pennnet.com/Articles/Article_Display.cfm?Section=ONART&PUBLICATION_ID=41&ARTICLE_ID=290952&C=PROJE

About CH2M HILL

Headquartered in Denver, Colo., employee-owned CH2M HILL is a global leader in engineering, construction, and operations for public and private clients. With $4.5 billion in revenue, CH2M HILL is an industry- leading program management, construction management for fee, and design firm, as ranked by Engineering News-Record (2006). The firm s work is concentrated in the areas of transportation, water, energy, environment, communications, construction, and industrial facilities. The firm has long been recognized as a most-admired company and leading employer by business media and professional associations worldwide. CH2M HILL has more than 19,000 employees in regional offices around the world.

Also see: "CH2M Hill to help lead five year research program on nutrient removal from wastewater"

Extracts taken from Australian drinking water standards

The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised.

Waterborne pathogens can cause outbreaks of illness affecting a high proportion of the community and in extreme cases causing death. How much treatment is needed will depend on the level of protection of water supplies. Completely protected groundwater may not require treatment, but all other supplies will require continuous disinfection. If water supplies are not completely protected from human and livestock waste, filtration is likely to be required.

Disinfection is the single process that has had the greatest impact on drinking water safety. There is clear evidence that the common adoption of chlorination of drinking water supplies in the 20th century was responsible for a substantial decrease in infectious diseases. Disinfection will kill all bacterial pathogens and greatly reduce numbers of viral and most protozoan pathogens. Combined with protection of water sources from human and livestock waste, disinfection can ensure safe drinking water. In the absence of complete protection of source water, filtration is likely to be required to improve the removal of viruses and protozoa.

All waterborne disease outbreaks are avoidable. Pathogens can only cause disease and death in humans if water source protection, pathogen removal by disinfection or filtration, or integrity of distribution systems fail.

The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply.

The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water. No single barrier is effective against all conceivable sources of contamination, is effective 100 per cent of the time or constantly functions at maximum efficiency. Robust barriers are those that can handle a relatively wide range of challenges with close to maximum performance and without suffering major failure.

Although it is important to maintain effective operation of all barriers, the advantage of multiple barriers is that short-term reductions in performance of one barrier may be compensated for by performance of other barriers. Prevention of contamination provides greater surety than removal of contaminants by treatment, so the most effective barrier is protection of source waters to the maximum degree practical. Knowing how many barriers are required to address the level of potential contamination in individual systems is important. This requires a thorough understanding of the nature of the challenges and the vulnerabilities of the barriers in place. In terms of reliability, there is no substitute for understanding a water supply system from catchment to consumer, how it works and its vulnerabilities to failure. Finally, a robust system must include mechanisms or fail-safes to accommodate inevitable human errors without allowing major failures to occur.

Any sudden or extreme change in water quality, flow or environmental conditions (e.g. extreme rainfall or flooding) should arouse suspicion that drinking water might become contaminated.

System operators must be able to respond quickly and effectively to adverse monitoring signals.

System operators must maintain a personal sense of responsibility and dedication to providing consumers with safe water, and should never ignore a consumer complaint about water quality.

Ensuring drinking water safety and quality requires the application of a considered risk management approach.

The process of keeping drinking water safe is one of risk management. This requires steering a sensible course between the extremes of failing to act when action is required and taking action when none is necessary. Lack of action can seriously compromise public health, whereas excessive caution can have significant social and economic consequences. Corrective action or system upgrades should be undertaken in a considered, measured and consultative manner. Failure to act when required (e.g. failing to shut down a system when disinfection is not working effectively) may lead to an outbreak of waterborne disease. Acting when not required (e.g. issuing a 'boil water' notice when that is not necessary) is usually less severe in the short term, but repeated occurrences waste resources and are likely to cause complacency in the long term, leading to failure to respond when it is truly necessary. Similarly, failing to install a treatment process when required could lead to waterborne disease; however, installing treatment processes that are not required could have a high financial cost and divert funds needed elsewhere.

Risk management is about taking a carefully considered course of action. As the obligation is to ensure safe water and protect public health, the balancing process must be tipped in favour of taking a precautionary approach.

Traditional preventive measures are incorporated as or within a number of barriers, including:

- catchment management and source water protection
- detention in protected reservoirs or storages
- extraction management
- coagulation, flocculation, sedimentation and filtration
- disinfection
- protection and maintenance of the distribution system.

The types of barriers required and the range of preventive measures employed will be different for each water supply and will generally be influenced by characteristics of the source water and surrounding catchment (see Box 3.2). Selection of appropriate barriers and preventive measures will be informed by hazard identification and risk assessment.

Box 3.2 *Examples of multiple barriers*

Large parts of Melbourne are supplied with high-quality source water from a highly protected catchment. Melbourne Water focuses much of its attention and resources on maintaining prevention of contamination at the source. The series of barriers for the majority of the water supply system include:

- protected forested catchments for harvesting of water with no human or livestock access
- large catchment reservoirs with long detention times
- additional detention time in seasonal storage systems
- disinfection of water before it enters the distribution system
- closed distribution systems.

In contrast, Adelaide is supplied with surface water derived from multi-use catchments and the Murray River where there is limited control over activities with potential impacts on water quality. As a result, the barriers applied are heavily weighted towards water treatment and downstream control to remove turbidity and microorganisms. Barriers include the use of multiple storage reservoirs, coagulation, flocculation, sedimentation, filtration and disinfection with long contact times before supply.

Provision of residual disinfectant through large parts of the distribution system is also an important barrier for both systems.

Catchment management and source water protection

Catchment management and source water protection provide the first barrier for the protection of water quality. Where catchment management is beyond the jurisdiction of drinking water suppliers, the planning and implementation of preventive measures will require a coordinated approach with relevant agencies such as planning authorities, catchment boards, environmental and water resources regulators, road authorities and emergency services.

Effective catchment management and source water protection include the following elements:
• developing and implementing a catchment management plan, which includes preventive measures to protect surface water and groundwater
• ensuring that planning regulations include the protection of water resources from potentially polluting activities and are enforced
• promoting awareness in the community of the impact of human activity on water quality.

Whether water is drawn from surface catchments or underground sources, it is important that the characteristics of the local catchment or aquifer are understood, and the scenarios that could lead to water pollution are identified and managed. The extent to which catchment pollution can be controlled is often limited in practical terms by competition for water and pressure for increased development in the catchment.

Effective catchment management has additional benefits. By decreasing contamination of source water, the amount of treatment and quantity of chemicals needed is reduced. This may lead to health benefits through reducing the production of treatment byproducts, and economic benefits through minimising operational costs.

In surface water catchments, preventive measures can include:
• selection of an appropriate source water (where alternatives exist)
• exclusion or limitations of uses (e.g. restrictions on human access and agriculture)
• protection of waterways (e.g. fencing out livestock, management of riparian zones)
• use of planning and environmental regulations to regulate potential water polluting developments (e.g. urban, agricultural, industrial, mining and forestry)
• use of industry codes of practice and best practice management
• regulation of community and on site wastewater treatment and disposal systems
• stormwater interception.

Detention in reservoirs or storages

Detention of water in reservoirs can reduce the number of faecal microorganisms through settling and inactivation, including solar (ultraviolet) disinfection. Most pathogenic microorganisms of faecal origin (enteric pathogens) do not survive indefinitely in the environment. Substantial die-off of enteric bacteria will occur over three to four weeks. Enteric viruses and protozoa will survive for longer periods (weeks to months).

Detention also allows suspended material to settle, which makes subsequent disinfection more effective and reduces the formation of disinfection byproducts.

Other preventive measures in reservoirs and storages include:
• reservoir mixing or destratification to reduce growths of cyanobacteria (taste, odour and toxin production)
• excluding or restricting human, domestic animal and livestock access
• diversion of local stormwater flows.

Extraction management

Where a number of water sources are available, there may be flexibility in the selection of water for treatment and supply. In such a situation it may be possible to avoid taking water from rivers and streams when water quality is poor (e.g. following heavy rainfall) in order to reduce risk and prevent problems in subsequent treatment processes.

Within a single water body, selective use of multiple extraction points can provide protection against localised contamination either horizontally or vertically through the water column (e.g. cyanobacterial blooms).

5.2 Microorganisms in drinking water

The microbial guidelines seek to ensure that drinking water is free of microorganisms that can cause disease. The provision of such a supply is of paramount importance to the health of a community.

The most common and widespread health risk associated with drinking water is contamination, either directly or indirectly, by human or animal excreta and the microorganisms contained in faeces. If the contamination is recent, and those contributing to the contamination include carriers of communicable enteric diseases (diseases of the gut), some of the microorganisms that cause these diseases may be present in the water. Drinking such contaminated water or using it in food preparation may cause new cases of infection. Those at greatest risk of infection are infants and young children, people whose immune system is suppressed, the sick, and the elderly.

Pathogenic (disease-causing) organisms of concern include bacteria, viruses and protozoa; the diseases they cause vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhoea, dysentery, hepatitis, cholera or typhoid fever.

The supply of safe drinking water involves the use of multiple barriers to prevent the entry and transmission of pathogens. The effectiveness of these barriers should be monitored by a program based on operational characteristics and testing for microbial indicators

Urbanisation and industrialisation increased the pressure on water supplies and systems of waste disposal, and by the middle of the 19th century, Britain was affected by major epidemics of cholera and endemic typhoid. John Snow and William Budd provided incontrovertible evidence of the role of water in transmission of these two diseases. Snow's case rested very simply on a comparison of cholera incidence among the customers of three London water companies (Snow 1855): one supplied filtered water; the second moved the source of its supply to a cleaner area of the Thames; the third persisted in supplying polluted Thames water. Budd appreciated that the sewer was merely the continuation of the diseased gut (Budd 1856), and applied what are now classic epidemiological concepts to the investigation of water as a vehicle for spreading typhoid. As a result, filtration of river-derived water became a legal requirement in London in 1859, and the practice gradually spread through Europe. By 1917, Sir Alexander Houston could draw attention to the effectiveness of London's systems of water treatment and delivery in stopping the waterborne transmission of typhoid. He pointed out that in America an annual mortality rate from typhoid of 20 or more per 100 000 people was considered normal (e.g. the rate in Minneapolis was 58.7); however, in London the annual mortality from typhoid was 3.3 per 100 000 (Houston 1917).

Budd's relatively simple precautions against typhoid were remarkably successful (Budd 1856). A century later, Hornick's experiments on volunteers helped to explain this success by showing typhoid to be relatively difficult to catch (Hornick *et al* 1966): around 10^7 *Salmonella enterica* serovar Typhi caused disease in only 50 per cent of his volunteer subjects. Kehr and Butterfi eld (1943), however, showed that a small minority of the population (about 1.5 per cent) need to ingest only a single typhoid organism to contract typhoid; to protect such individuals, more elaborate precautions are needed.

5.4.3 VIRUSES

Viruses are among the smallest of all infectious agents. In essence they are molecules of nucleic acid that can enter cells and replicate in them. The virus particle consists of a genome, either ribonucleic acid (RNA) or deoxyribonucleic acid (DNA), surrounded by a protective protein shell, the capsid. Frequently this shell is itself enclosed within an envelope that contains both protein and lipid. Viruses replicate only inside specific host cells, and they are absolutely dependent on the host cell's synthetic and energy yielding apparatus for producing new viral particles.

The viruses of most significance for drinking water are those that multiply in the human intestine and are excreted in large numbers in the faeces of infected individuals. Although they cannot multiply outside the tissues of infected hosts, some enteric viruses can survive in the environment and remain infective for long periods. Human enteric viruses occur in water largely as a result of contamination with sewage and human excreta. The numbers of viruses present and their species distribution will reflect the extent to which they are being carried by the population; however, the use of different analytical methods can also lead to wide variations in calculations of the numbers of viruses found in sewage. Sewage treatment may reduce numbers by a factor of 10 to 10 000, depending upon the nature and degree of treatment; however, even tertiary treatment of sewage will not eliminate all viruses. As sewage mixes with receiving water, viruses are carried downstream; the length of time they remain detectable depends on temperature, their degree of adsorption to particulate matter, penetration of sunlight into the water and other factors. Consequently, enteric viruses can be found at the intakes to water treatment plants if the water is polluted by sewage. However, proper treatment and disinfection should produce drinking water that is essentially virus free.

Recent methodological advances have revolutionised the diagnosis of viral diarrhoeal diseases, and waterborne outbreaks due to viruses have now been identified in both developed and developing countries all over the world, with many different strains of viruses isolated from raw and treated drinking water. Isolation of viruses from water indicates that a hazard exists, but it does not prove beyond doubt that water is a vehicle for transmission of disease.

Epidemiological proof of waterborne transmission of viral diseases is very difficult to establish, for a variety of reasons. Symptoms may not resemble those of typical waterborne diseases, and many of those infected will show no symptoms. Some infections, for example the hepatitis A virus, are difficult to trace to a source because of long incubation periods. Water is often only one of various routes of transmission, it is not always the major route, and adequately sensitive methods for detecting the infectious agent in water are often not available.

The occurrence of disease is also related to the relative level of immunity in the community. If, for example, the water supply has been repeatedly contaminated, the community may have become immune to some waterborne pathogens. Such a situation can be seen in some developing countries where the prevalence of pathogens is high and the standard of tap water is less than optimal. Visitors who drink the water frequently become ill, while the local community, especially adults, appear to suffer minimal morbidity. The immunity of the local population may, however, be acquired at the expense of the health of more susceptible individuals in that community, including children, the aged and people already in poor health.

Thus, a community consuming water with indicators of faecal pollution may show no discernible disease. Such a situation, however, is unstable. Apart from the risk to visitors, faecal pathogens affecting the locals may be introduced from, for instance, an immigrant or a seasonal outbreak of a disease such as cryptosporidiosis resulting from cattle in the catchment.

When illness occurs in a community, the route of infection needs to be confirmed by epidemiological investigation, even when the disease-causing organism is found in a suspect water supply.

Viruses

Adenovirus[a] Causes pharyngitis, conjunctivitis, gastroenteritis. Spread by inhalation, ingestion, direct contact. May contaminate water through sewage.

Enterovirus[a] May enter water via faecal contamination or sewage. Can cause gastroenteritis and other diseases, often symptomless. Can probably be spread by drinking water.

Hepatitis viruses[a] A and E viruses can be spread in drinking water contaminated with faecal material or sewage effl uent.

Norwalk virus[a] Causes gastroenteritis, can be spread in drinking water, bathing, food (especially shellfi sh) contaminated with sewage/faecal material.

Rotaviruses, Widespread in environment; can cause serious gastroenteritis in children, the elderly, and hospital pararotaviruses patients. May enter water through faecal material/sewage contamination.
and reoviruses (Reoviridae) [a]

TREATMENT OF DRINKING WATER

Conventional water treatment should result in a water that is essentially virus-free, except where the intake water has a high virus load. This would occur where the intake water receives partially treated or untreated sewage. In such cases, other processes, such as some of the membrane technologies, may have to be used to ensure removal of the viruses.

DERIVATION OF GUIDELINE

The infectious dose for many viruses may be as low as one particle. Many tentative guidelines give figures of one particle per 1000 litres of water, but testing for viruses is difficult and results can be variable. Although no guideline value has been established, *E. coli* (or thermotolerant coliforms) is generally used as an indicator.

GUIDELINE

No guideline value has been set for enteroviruses in drinking water. If enteroviruses are specifically sought, they should not be detected. If detected, advice should be sought from the relevant health authority.

GENERAL DESCRIPTION

Enteroviruses have a worldwide distribution. Within temperate climates most major epidemics occur during the later summer months, whereas in the tropics, disease can occur throughout the year. The viruses shed in the faeces of infected individuals are spread by the faecal-oral route. They occur in water either through faecal contamination or by discharge of sewage effluents (Dahling 1989). While waterborne transmission is probable, it has not been proven. The part played by low-level transmission has also been suspected but not proven. There is a suggestion that small numbers of viruses present intermittently or continuously in drinking water cause symptomless infections, and that these are spread by person-to-person contact to cause outbreaks of disease that have no apparent connection with water.

The virus can also be spread on unwashed foods, particularly in areas where raw sewage is used as fertiliser, or it may be transmitted on the feet of vectors such as houseflies. Infants, with their faeces contained in diapers, also provide a major route of dissemination, particularly in day-care centres.

AUSTRALIAN SIGNIFICANCE

Enteroviruses have not been detected in Australian drinking water. This may be because of the difficulties associated with detection and the limited number of studies carried out in this country. They have been detected in drinking water in many other countries, both developed and developing.

Storage reservoirs and intakes

- Detention times
- Reservoir design:
  - size
  - materials
  - storage capacity
  - depth of storage
- Seasonal variations:
  - stratification
  - algal blooms
- Treatment efficiencies (microbial removal)
- Protection (e.g. covers, enclosures, access)
- Recreational or human activity
- Intake location and operation
- Bulk transport:
  - pipeline material
  - length
  - flow rate and changes in flow rate

– cleaning systems

Human and animal waste represent the largest sources of potential hazards in drinking water. Both can include high numbers of enteric pathogens and large amounts of nutrients.

Table A3 *Examples of hazardous events*
Catchments and groundwater systems
Rapid variations in raw water quality
Sewage and septic system discharges

Table A4 *Qualitative measures of likelihood*

Level	Descriptor	Example description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Table A5 *Qualitative measures of consequence or impact*

Level	Descriptor	Example description
1	Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs
2	Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs
3	Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
4	Major	Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
5	Catastrophic	Major impact for large population, complete failure of systems

Table A6 *Qualitative risk analysis matrix – level of risk*

Likelihood	Consequences				
	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
A (almost certain)	Moderate	High	Very high	Very high	Very high
B (likely)	Moderate	High	High	Very high	Very high
C (possible)	Low	Moderate	High	Very high	Very high
D (unlikely)	Low	Low	Moderate	High	Very high
E (rare)	Low	Low	Moderate	High	High

A6 Preventive measures and multiple barriers

The identification, evaluation and planning of preventive measures should always be based on system specific hazard identification and risk assessment. The level of protection used to control a hazard should be proportional to the associated risk.

The multiple barrier principle should be employed and preventive measures should be comprehensive from catchment to consumer. Wherever possible, the focus of these measures should be to prevent contamination in the catchment rather than to rely on downstream control. Box A1 provides further information on catchment management and source water protection.

Table A8 *Estimated removals of enteric pathogens using multiple barriers*

	Estimated reduction in	
	Watershed protection	**Reservoir detention**
Bacteria	0.5–1 log removal	~ 1 log removal per 10 days storage Retention for over 60 days will provide almost complete removal.
Viruses	Complete removal of human enteric viruses if human waste excluded.	1–2 log removal Long-term detention (1–6 months)
Giardia	0.5–1 log removal	1.5–2.5 log removal

Removal of antibiotics in conventional and advanced wastewater treatment:

Implications for environmental discharge and wastewater recycling.

Watkinson AJ, Murby EJ, Costanzo SD.
Water Res. 2007 May 22; [Epub ahead of print]

National Research Centre for Environmental Toxicology, 39 Kessels Road, Coopers Plains, Brisbane, Qld 4108, Australia; Cooperative Research Centre for Water Quality and Treatment, PMB 3, Salisbury, SA 5108, Australia.

Abstract;
Removal of 28 human and veterinary antibiotics was assessed in a conventional (activated sludge) and advanced (microfiltration/reverse osmosis) wastewater treatment plant (WWTP) in Brisbane, Australia. The dominant antibiotics detected in wastewater influents were cephalexin (med. 4.6mugL(-1), freq. 100%), ciprofloxacin (med. 3.8mugL(-1), freq. 100%), cefaclor (med. 0.5mugL(-1), freq. 100%), sulphamethoxazole (med. 0.36mugL(-1), freq. 100%) and trimethoprim (med. 0.34mugL(-1), freq. 100%).

Results indicated that both treatment plants significantly reduced antibiotic concentrations with an average removal rate from the liquid phase of 92%. However, antibiotics were still detected in both effluents from the low-to-mid ngL(-1) range. Antibiotics detected in effluent from the activated sludge WWTP included ciprofloxacin (med. 0.6mugL(-1), freq. 100%), sulphamethoxazole (med. 0.27mugL(-1), freq. 100%) lincomycin (med. 0.05mugL(-1), freq. 100%) and trimethoprim (med. 0.05mugL(-1), freq. 100%).

Antibiotics identified in microfiltration/reverse osmosis product water included naladixic acid (med. 0.045mugL(-1), freq. 100%), enrofloxacin (med. 0.01mugL(-1), freq. 100%), roxithromycin (med. 0.01mugL(-1), freq. 100%), norfloxacin (med. 0.005mugL(-1), freq. 100%), oleandomycin (med. 0.005mugL(-1), freq. 100%), trimethoprim (med. 0.005mugL(-1), freq. 100%), tylosin (med. 0.001mugL(-1), freq. 100%), and lincomycin (med. 0.001mugL(-1), freq. 66%).

Certain traditional parameters, including nitrate concentration, conductivity and turbidity of the effluent were assessed as predictors of total antibiotic concentration, however only conductivity demonstrated any correlation with total antibiotic concentration (p=0.018, r=0.7). There is currently a lack of information concerning the effects of these chemicals to critically assess potential risks for environmental discharge and water recycling.

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Letter from Mr Michael Costello, Managing Director ACTEW

ACTEW CORPORATION

3 April 2007

Professor Peter Collignon
PO Box 11
WODEN ACT 2617

Dear Professor Collignon

I refer to your email of 27 March 2007 to members of the ACT Legislative Assembly concerning the proposal to recycle water in the ACT. As ACTEW Corporation has carriage of this project, I am responding to the email and the context of your radio interview (29 March) directly to you.

I welcome your comments in this important public debate, and assure you that they will receive due consideration. I think it useful, however, to provide some contextual information in relation to your comments.

A key assumption in ACTEW's planning is the impact of climate-change and climate variability on inflows into our dams. Based on the most pessimistic scenario in a report prepared for ACTEW by the CSIRO, inflows were assumed to have declined on average by 30% from the long term annual average. In fact inflows have declined by almost 65% on average over the last six years. In 2006, inflows declined by almost 90%, one of our worst year on record. Overall, total inflows of all rivers into ACT in 2006 were a mere 7% of the long-term average. So, it is not only the inflows into our dams that have declined, but all stream flows into the ACT have suffered. Statistics like this abound: whilst in the past we have had two individual years with such low inflows, this is undoubtedly the worst extended drought on record spanning 10 years. The rainfalls to the start of this year have been just as meagre as the one last year: considered as one the driest year on record. It is for these reasons that we are now examining water recycling as a new source of water. Recycling water from the Lower Molonglo Water Quality Control Centre (called Indirect Potable Use), and combining this with an enlarged Cotter dam will provide the long-term water security we need.

You have referred to the large volume of environmental flows released from our dams. ACT has a daisy chain of three dams on the Cotter river: Corin, Bendora and Cotter. All water released as environmental flows from Corin is captured and used from Bendora for town supply. Only water released from Cotter escapes down the river out of ACT, and these volumes are: 2004 (7.3GL); 2005 (8.5GL); 2006 (6.7GL). Releases from Googong have been: 2004 (1.5GL); 2005 (1.9 GL); 2006 (4.3GL). The slightly higher volumes you see for the Cotter dam are because this is a small dam, only 4GL capacity, and as such is prone to spill after a decent rainfall. This is one of the reasons why we are also committing to enlarge this dam to a new capacity of 78GL.

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ACTEW is aware of the need for security through diversity. It is for these reasons that we have progressed with innovative, non-storage options over the last few years including the Cotter Googong Bulk Transfer and Murrumbidgee River abstraction. We have also been active in negotiating a reduced environmental flow regime during the drought. At the moment, we are releasing environmental flows from cotter dam at a rate of 5 megalitres a day or about 2 gigalitres a year. Unfortunately, our modelling is indicating that the severity of the drought is such that these measures are not sufficient, hence the recommendations to Government of new options to secure supply.

On the matter of using recycled water, ACTEW is committed to only proceeding with this scheme if the purified water is safe and meets Australian Drinking Water Guidelines (ADWG) – the same quality criteria that apply to our current town supply. ACTEW will be using the multiple barrier approach as advocated in the ADWG: tertiary treatment at LMWQCC, followed by advanced treatment using mature and proven processes before the water is released into the catchment. Here it will be subject to further environmental polishing and detention time before it is drawn for yet another treatment process at Mt Stromlo Water Treatment Plant that uses chlorination and will be using UV disinfection by next year. This will provide assurance that water at least meets the ADWG. The first stage of this will provide initially 9 gigalitres a year, progressing to 18-20 gigalitres capacity.

Whilst the exact configuration of the purification process is yet to be determined, process steps under consideration are: micro\ultra filtration with pore sizes below 0.1-0.01 µm, small enough to remove all bacteria and pathogens; reverse osmosis or advanced oxidation using UV\hydrogen peroxide, and UV\ozone disinfection. The consultants engaged by ACTEW are currently examining which process best suits our needs. The process train will have built in integrity tests and interlocks to assist in safe operations: such as turbidity traces, conductance and pressure measurements, etc which would detect any treatment malfunction and either shut down the treatment or divert the treated stream to the river. These types of precautionary measures have worked reliably in all our treatment plants and in other parts of the world.

As you state in your letter, the technology we are examining is in use all over the world. The assessment ACTEW is carrying out is to determine its suitability for ACT conditions, specifically the water from Lower Molonglo Water Quality Control Centre. I need to stress that if the outcome of our work, which will be subject to extensive scrutiny, is that is it is not safe, then we will not be recommending that it progresses.

The balance of probability is that the extremely severe conditions of 2006 will not be repeated, and that there will be sufficient water to meet our needs without having to use recycled water. But what we have learned over the last few years is that for whatever reason we can no longer rely on the long-term averages. While it is unlikely, it is possible that we may face several more years in which river flows and inflows into our dams are at the extremely bad 2006 levels or worse. The consequences of this risk eventuating are so severe that even though it is a small risk we cannot afford not to take out insurance against it. And that is how we should see the recycled water project – as essential insurance which we hope we will seldom, if ever, have to call upon.

The final decision rests with the ACT Government, who have committed to extensive community consultation program and also commissioned an Expert Reference Panel to advise on the health aspects of the proposed project.

I would be happy to discuss this further if required.

Yours sincerely

Michael Costello AO
Managing Director

National Water Quality Management Strategy
Guidelines for sewerage systems

Reclaimed Water

National Health and Medical Research Council
Agriculture and Resource Management Council of Australia and New Zealand
Australian and New Zealand Environment and Conservation Council

http://www.environment.gov.au/water/publications/quality/index.html

Page 17

4.1 Direct potable

This involves the treatment of wastewater to such an extent that it can be fed into a potable treatment or supply system. It is not possible at present to provide any guidelines for this practice.

4.2 Indirect potable

This involves the augmentation of groundwater and surface waters with reclaimed water. Water may then be extracted from these sources and subsequently treated for potable purposes. Ideally the water supply should be taken from the best quality sources available. Contamination of a water source should be prevented or controlled by the maintenance of the barriers. Where pristine sources are not available indirect potable water may be used. Reclaimed water used for augmentation should be of equal or better quality than the receiving water.

This practice of augmentation of surface waters using reclaimed water occurs in many parts of Australia. High dilution and extended storage of raw water normally takes place prior to abstraction and subsequent treatment to ensure that potable water meets NWQMS (1996) *Australian Drinking Water Guidelines* (Appendix 1). In the future this type of indirect potable reuse may in some cases be the best planning option for management of the water cycle particularly where water resources are limited.

Groundwater recharge and surface water augmentation using reclaimed water should be approved on a site specific basis by the health and environment protection authorities.

A minimum of secondary treatment is needed in order to provide a raw water quality for subsequent treatment to potable quality. Additional pathogen reduction by means of disinfection may be necessary for some indirect potable uses.

Hydrological and geological characteristics along with soil type determine the suitability of specific sites for recharge.

By providing a retention period of 12 months prior to groundwater abstraction for potable use, virus numbers are reduced through die-off and adsorption.

Nitrogen content of surface and groundwaters supplemented by reclaimed water should be closely monitored.

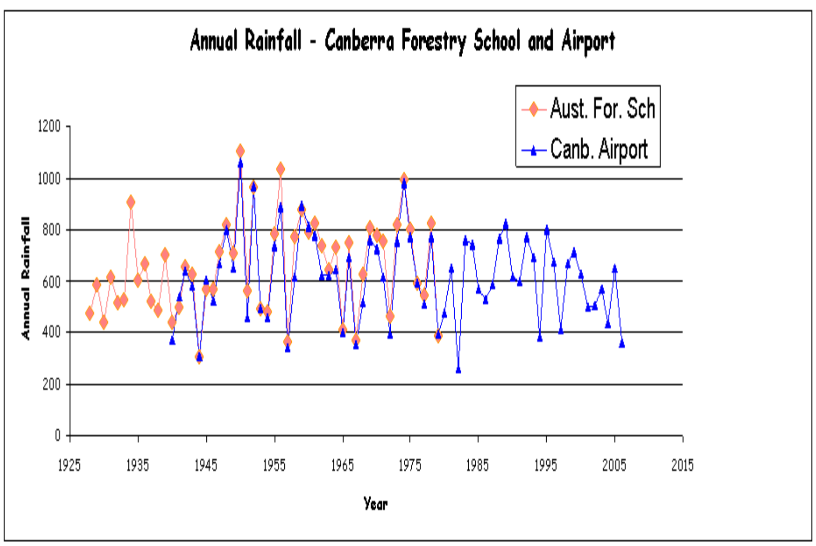
Total oxidised nitrogen levels should be less than 10 mg/L as N when diluted and abstracted for drinking purposes.

Long term Rainfall record in Canberra

Peter,

I chanced upon the rainfall data for Congwarra (1953 to 2004). These data show, of course, a higher rainfall than Canberra. The pattern clearly shown at Congwarra was that it was wetter in the 1950's through until about 1993 and then dropped, maybe from around 900 mm/a to 700 mm/a; quite a drop.

This stimulated me to locate the early Canberra records and they are best reflected in the two long-term stations at the Canberra Forestry School (Yarralumla) and the Canberra airport. In the period they overlap (1940 to 1979) there is amazingly close correlation; the Forestry School being sl. higher than the airport (Yarralumla is slightly wetter than airport). What is interesting to me is that the period 1928 to 1946 was dry with an average around 500 mm/a; this around the same as the current dry period (2001 – 2006). For CSIRO to claim in their report to ACTEW (Bates et al 2003) that their modelling has shown that run-off into the catchment has dropped by around 60% (rainfall closely matches catchment run-off) is simply not borne out by the data. I would interpret the current dry period to be similar to that of that late 1920's to the mid 1940's – like drought periods actually do occur in Australia. Fascinatingly 1942 was such a bad year down the South Coast of NSW that 100 of the 160 cows on "Haxtead" (near Central Tilba) died through lack of food/water.



Chris Borough
Forest Science Consultancy Pty Ltd
PO Box 4378 Kingston
ACT 2604 AUSTRALIA

National productivity commission recommends drinking of recycled waste water

- Matt Johnston
- From: *Herald Sun*
- April 14, 2011 12:00AM

The report recommends wide community consultation with the facts about the safety of recycling water / Herald Sun *Source:* Herald Sun

- Aussies could soon be drinking recycled water
- Commission recommends process be allowed
- "Give people choice... after they have information"

AUSTRALIANS could soon be drinking recycled waste water with a national productivity commission recommending the process be allowed.

A new report on Australia's urban water sector has also dubbed Victoria's desalination plant an efficiency dud, costing billions more than alternatives.

The productivity commission recommends scrapping water restrictions except for in "emergency" situations.

One way to get around water shortages while maintaining efficiency would be to allow used water to be pumped back into supplies, it says.

"Bans on particular augmentation options should be removed, including those on... planned potable re-use," the commission's draft report says.

It recommends wide community consultation where the facts about the safety of recycling water, and information about countries such as Singapore and the US where it already happens, be put on the table.

"A major advantage of using recycled water for potable (drinking) rather than non-potable use is that separate distribution infrastructure is not required," it said.

Presiding Commission Dr Wendy Craik said there was a strong case for reforming the sector and she said the cost of water restrictions on the community had been immense.

Lost community benefits because of stage 3a water restrictions in Melbourne cost about $150 million a year.

And choosing a massive desalination plant in Melbourne and Perth, rather than going with other options, costs communities up to $4.2billion over 20 years.

"Unless there is some kind of failure in the system you shouldn't have and shouldn't need water restrictions," Dr Craik said.

She said the commission recommended looking at water "contracts" instead, which would work in a similar way to internet contracts where you set a limit on your water use and pay more if you go over that limit.

Dr Craik said the point of putting recycled water back on the agenda was to consider all options and allow the community to choose.

"If a community says we would rather pay more for a desalination plant then fine," she said.

"Give people the choice... after they have all the information."

Relatively poor performance of Reverse Osmosis (RO) in the removal of Viruses from Drinking water

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION
PROGRAM
U.S. Environmental Protection Agency NSF International
ETV Joint Verification Statement
TECHNOLOGY TYPE: POINT-OF-USE DRINKING WATER TREATMENT SYSTEM
APPLICATION: REMOVAL OF MICROBIAL CONTAMINANTS IN DRINKING WATER
PRODUCT NAME: WATTS PREMIER WP-4V VENDOR: WATTS PREMIER
ADDRESS: 1725 WEST WILLIAMS DR.
SUITE C-20 PHOENIX, AZ 85027
PHONE: 800-752-5582 INTERNET http://www.wattspremier.com
NSF International (NSF) manages the Drinking Water Systems (DWS) Center under the U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) Program. The DWS Center recently evaluated the performance of the Watts Premier WP-4V point-of-use (POU) reverse osmosis (RO) drinking water treatment system. NSF performed all of the testing activities and also authored the verification report and this verification statement. The verification report contains a comprehensive description of the test.
EPA created the ETV Program to facilitate the deployment of innovative or improved environmental

VERIFICATION OF PERFORMANCE As discussed above, the systems were first subjected to a TDS reduction test to verify that the RO membranes would perform as expected. The observed TDS reduction ranged from 89% to 96%. The certified TDS reduction for the WP-4V is 97%. reduction of B. diminuta ("normal" and kanamycin resistant B. diminuta combined) ranged from 1.3 to 6.4, with an average log The bacteria and virus log 10 reduction data is presented in Table VS-2. The log 10 reduction of 1.9. The challenge organisms were detected in the effluent samples for all test units but Unit 2 for the "normal" B. diminuta challenge. Since the Unit 2 effluent count for kanamycin resistant B. diminuta was 4.3 log 10 , and all other effluent samples had bacteria counts greater than 4 log (data not shown), it is possible that there was a sampling or analytical error associated with the Unit 2 "normal" B. diminuta sample. Therefore, that sample was not included in the mean log reduction calculation for the bacteria.

The virus challenge data showed similar performance. The log 10 reduction of the fr virus ranged from 1.4 to 3.6, with an overall mean of 2.5. The log reduction of MS2 ranged from 1.2 to 3.7, with an overall mean of 2.6. A visual comparison of the log reductions versus the challenge water pH shows the mean log 10 reductions decreasing with increasing pH. However, an examination of the 95% confidence intervals around the means (see verification report for data) shows that the decreases are not statistically significant. The minimum observed log reductions equal removal of 95% of *B. diminuta*, and 94% of the viruses.

NSF 06/12b/EPADWCTR The accompanying notice is an integral part of this verification statement. July 2006
VS-iii

Table VS-2. Bacteria and Virus Log Reduction Data

Target pH	Initial Measured pH	Final Measured pH	Challenge Organisms	Log_{10} Influent Challenge	Geometric Mean Log_{10} Reduction Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Mean
7.5 ± 0.5	7.6	7.8	*B. diminuta*	6.4	1.8	6.4*	1.3	1.5	1.6	1.5
7.5 ± 0.5	7.5	7.8	Kanamycin Resistant *B. diminuta*	7.2	1.4	2.9	2.6	2.6	3.1	2.4
6.0 ± 0.5	6.1	6.5	fr	3.9	1.8	3.1	3.6	3.4	3.0	2.9
			MS2	3.8	2.3	3.4	3.7	3.6	2.9	3.1
7.5 ± 0.5	7.5	7.7	fr	4.5	1.9	2.4	2.3	3.1	2.8	2.5
			MS2	4.2	1.7	2.4	2.4	3.4	3.2	2.5
9.0 ± 0.5	8.9	9.0	fr	5.0	1.4	2.3	2.1	2.3	2.6	2.1
			MS2	4.6	1.2	2.4	2.0	2.3	3.0	2.1
						Overall Means:			*B. diminuta*	1.9
									fr	2.5
									MS2	2.6

*Number not included in mean log reduction calculation.

INTEGRITY AND PERFORMANCE EVALUATION OF NEW GENERATION DESALTING MEMBRANES DURING MUNICIPAL WASTEWATER RECLAMATION

James DeCarolis*, Samer Adham, Manish Kumar, Bill Pearce, Larry Wasserman *MWH
ABSTRACT
301 N. Lake Ave Suite 600 Pasadena, CA 91101
Various RO membrane integrity monitoring methods are currently being evaluated during pilot testing at the North City Water Reclamation Plant (NCWRP) located in San Diego, CA. The main purpose of the testing is to assess both direct and indirect monitoring techniques currently available to measure the integrity and reliability of RO membranes during water reclamation. Specific methods being evaluated include vacuum hold testing, conductivity probing, online conductivity/sulfate monitoring and soluble dye testing. In addition, the testing program is designed to assess the integrity of new generation RO membranes being offered for water reuse applications. The specific membrane suppliers participating in this study include Koch, Saehan, Hydranautics and

Toray. Field evaluations are being conducted in three distinct phases. Phase I testing was conducted between August – April 2005. During this time period, the integrity of RO membranes from each of the participating suppliers was assessed using the various test methods during operation on tertiary wastewater from the NCWRP. Phase I pilot testing was performed using single stage RO systems operating at feed water recovery of 50%. Results from Phase I showed each of the methods tested correlated well to virus rejection but varied in sensitivity and ease of implementation. In addition, the degree of virus rejection observed from the membranes varied among suppliers. The purpose of Phase II testing, currently underway, is to assess the impact of staging on the sensitivity of each of the integrity monitoring techniques tested during Phase I. Accordingly, the RO membrane, which showed the highest level of rejection during Phase I testing, is currently being operated in a two-stage system at feed water recovery of 75%. Lastly during Phase III, the sensitivity of selected monitoring techniques to purposeful breaches in integrity will be evaluated.

MS2 Challenge Experiments

Challenge experiments were conducted on all RO membrane systems using MS2 bacteria phage. Results of the MS2 seeding experiments are presented in Figures 9 and 10. As shown, 6 samples of RO feed and 6 samples RO permeate (per RO membrane) were taken during each seeding experiment. Results indicate that RO membranes 1, 2, and 4 achieved LRV > 4, while the RO 3 only achieved LRV of 2-2.5. These results correlate well with both vacuum decay and sulfate monitoring data presented above.

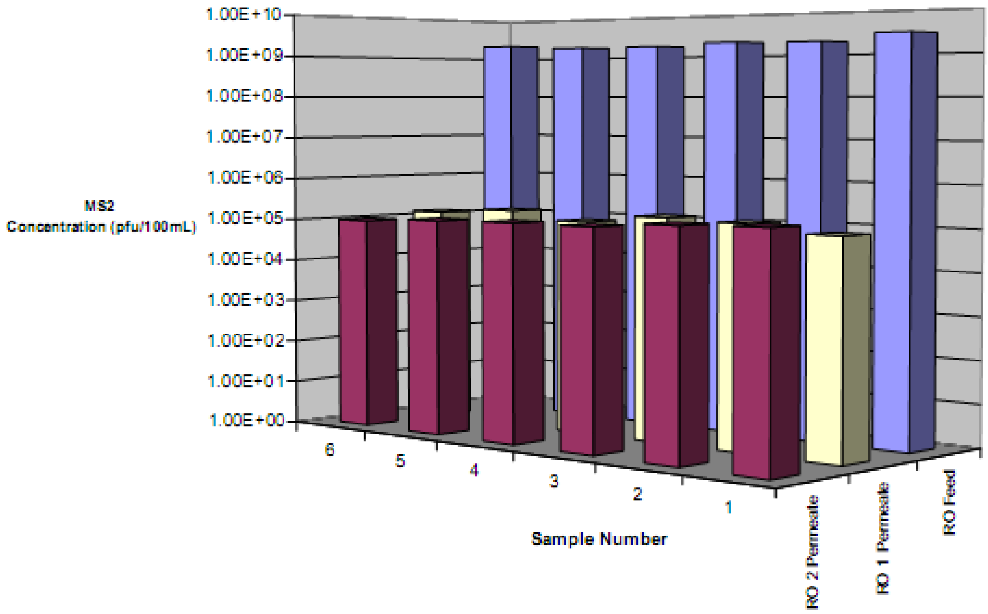


Figure 9: MS2 Phage Seeding Experiment Results (RO 1 and RO 2) Phase I

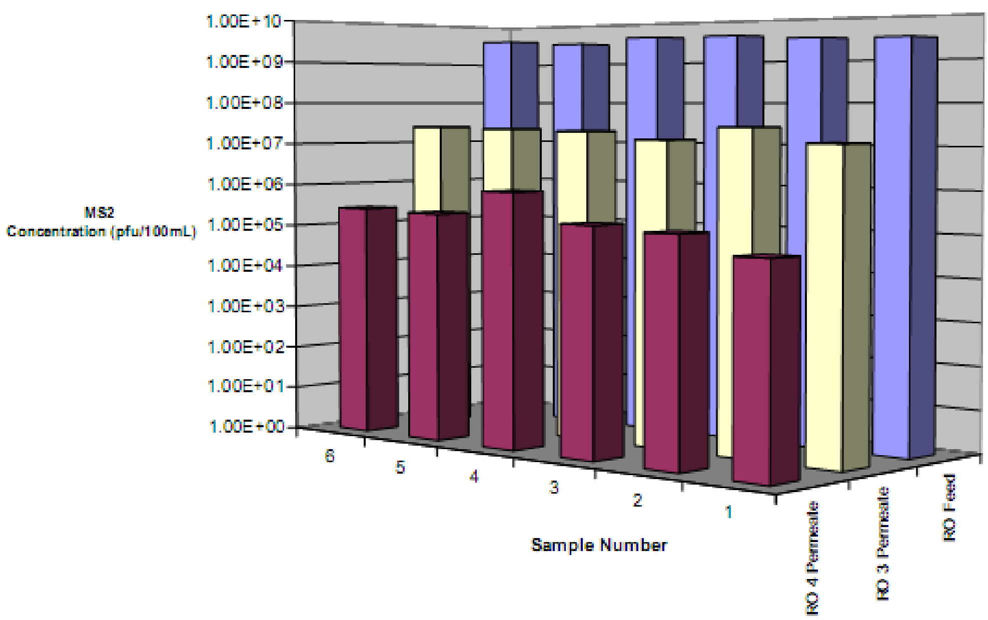


Figure 10: MS2 Phage Seeding Experiment Results (RO 3 and RO 4) Phase I

Numerous performance failures for virus removal and chemicals documented in Queensland report on "purified water"

Fluoride errors show system failures will likely not be rare if water from sewage is recycled into drinking water.

The recent failures to adequate control fluoride levels in Brisbane's drinking water highlights the dangers of recycling water from sewage. Human and/or technical errors allowed this to happen. Processing sewage for drinking water is much more complex than adding fluoride. It is very likely that periodic failures will also occur with sewage recycling. The numerous performance failures for virus removal and chemicals documented in a recently released Queensland report on "purified water" at Bundamba shows this may occur relatively frequently (Interim Water Quality Report. Feb 2009. Western Corridor Recycled Water Pty Ltd. http://www.qwc.qld.gov.au/Interim+water+quality+report)

There were also long delays in finding there were failures with fluoride levels. Testing and timing is a major problem with recycling sewage. There are no appropriate real-time tests that can detect the most likely and dangerous pathogens that might leak through the system (viruses). Some real-time testing is done in the Qld sewage recycle plants (organic carbon, turbidly etc) but this will only detect a 100-fold reduction in performance of the system. Therefore these types of tests cannot demonstrate that we are achieving the 10-billion fold reduction in virus numbers needed to make this high risk water source, safe to drink.

Proponents repeatedly assure us that sewage purification systems will remove all chemicals and pathogens. Also there are so many additional processes and barriers that contaminated water will never reach reservoirs. If any faults occur then testing will detect these as they occur and thus stop that contaminated water reaching the system. The reported performance of the Qld sewage recycling system is not reassuring however. Both viruses and drugs were still detected in treated water (even after the final advanced oxidation step) that would have entered the reservoir. A previous Qld study had also showed that large percentages of antibiotics still remain in treated water even after the reverse osmosis step. While most of the chemicals and drugs detected in the latest study were below public health limits, it is disconcerting that a system that is marketed as removing all drugs and pathogens, can still detect many of these after its final purification step (advanced oxidation). However, not only does it appear that the process does not remove all viruses, chemicals and drugs, it adds some potentially dangerous chemicals. Because membranes foul, chemicals frequently need to be added and adjusted during the "purification" process. The Qld report shows resultant disinfection products (many classified as carcinogens) were found above safe levels on many occasions in the treated water.

From my infection perspective, the most important testing (virus testing) was poorly done. Over the 6 month study, only 3 tests each were done for the viruses of most concern (eg Enterovirus, rotavirus, norovirus etc). Also no details are given to show how sensitive and accurate these tests were in detecting these viruses or whether the system is capable of showing that we have always achieved the 10-billion fold reduction in viral numbers necessary to make water from sewage safe. More testing was done for viruses known as phages (as this is easier and cheaper to do). This testing was still relatively limited, as only 60 tests each were performed for the two types of phages monitored. Worryingly on two separate occasions with F RNA-bacteriophages, there were failures. The authors dismiss these results as most likely false positive tests, but without convincing arguments (they failed to take duplicate samples to validate these results later nor did they give details on what positive and negative controls they were running for viruses with each test run).

I don't think their positive viral culture results were false results as the report claims. It is of particular note that their positive virus results occurred at the same time they had unsafe and high bromate levels measured. I think the most likely explanation is that the reverse osmosis membrane leaked or was bypassed. This meant less bromide was removed from the source water and this was then converted to bromate by the final oxidation step. If and when bromide leaks thru the reverse osmosis step, then it is not a surprise if very small pathogens such as viruses may leak through as well.

It is of note that in international safety reports cited by proponents for this technology, only limited virus testing has been done in the water produced form sewage recycling plants. Only 7 sites are quoted in safety reports. Despite this small sampling, in the nearly half of these test sites, viruses such as enterovirus were still found on occasion in the final treatment water and often reductions in viral numbers of much less than 10 billion were achieved. Some even had large size pathogens such as Guardia detected after wastewater processing. Thus it seems that failures of these sewage recycling systems to remove all viruses may occur more frequently than proponents of this very energy expensive technology suggest.

Levels of bromodichloromethane (a product formed after increased disinfectant chemical use for membranes), were also raised above "safe" levels on a number of occasions in the final water product. This problem seems difficult to fix. The suggested solution in the report however is for Queensland Health to raise the levels defined as safe (to above Australian guidelines) so that "failures" no longer occur. This seems hardly the appropriate for chemical by-products produced during the sewage recycling process and which are carcinogens.

The current (and appropriate) position of the Queensland government is to only allow water from recycled sewage to be added to drinking water as a "last resort". The recycled water that is produced now is used appropriately for power stations and refineries. This means that now much less water is used from Brisbane's reservoirs than in the past. Given the recent performance failure with fluoride and with the sewage recycling, we need to re-examine the trigger for this "last resort" option. Currently it is when dam levels fall below 40%. This is too high. Only about 200 Gl per year is now used for domestic and other uses in Brisbane. Forty per cent represents about 700 Gl (or over 3 and a half years domestic supply). A more appropriate trigger is probably 20%, which is still about 2 years of domestic supply (even with no further rain).

If we recycle water from sewage into drinking water, because of the very high associated health risks, energy consumption and costs, it should only be used as a “last resort”. When and if we do it, we need to also ensure we have adequate real-time testing in place that lets us know that all toxins, chemical, drugs and pathogens such as viruses are being removed to levels that will keep this treated water “safe” at all times. Available studies and the lack of appropriate real-time tests show that this currently cannot be consistently achieved.

Failures in Queensland to adequately monitor and control fluoride in drinking water

SEQWater puts too little fluoride in water supply

Article from:
By Craig Johnstone
May 19, 2009 12:00am

FIRST SEQWater overdosed southeast Queensland's water supply with fluoride, and now it has been discovered it is not putting enough in.

Still smarting from last week's embarrassing revelations that up to 20 times the allowable fluoride doses had been added to the water supply to about 4000 homes, State Government authorities have now admitted that too little is coming out of the tap.

SEQWater, the agency responsible for fluoridation, has revealed that all six water treatment plants adding fluoride to drinking supplies have failed to put enough of the chemical into the water.

The failure, blamed on a range of commissioning problems and equipment faults, potentially puts SEQWater in breach of health regulations governing fluoridation.

It is the latest mishap to have afflicted the controversial new system of distributing and supplying water around the region, after the Government's plans to introduce purified recycled water to the drinking reserves were also shelved by Premier Anna Bligh after dam levels began rising.

Queensland Health regulations dictate that average fluoride dosages must be 0.8 milligrams a litre but SEQWater's tests have shown that dosages for the first three months of this year have been as low as 0.04 mg/L.

SEQWater admitted to the dosage failure in a compulsory performance report it handed to Queensland Health last Friday – at the same time as it was battling the fall-out from the fluoride overdose at the North Pine treatment plant that affected about 400 homes and was not detected for two weeks.

The Bligh Government has committed $35 million to fluoridating the state's drinking water, about $10 million of which has gone to upgrading water treatment in southeast Queensland.

A spokesman for SEQWater said the low dosages were not surprising in the first few months of fluoridation and the start-up commissioning of the treatment plants. He said the minimum levels were recorded when the treatment plant being tested was "offline".

"From SEQWater's perspective this is absolutely to be expected," he said.

However, he admitted that he did not know for sure if the organisation had breached Queensland Health regulations, which stipulate that fluoride dosage should average within 0.1 of the optimum level of 0.8 mg/L.

Ms Bligh has ordered an investigation into the fluoride overdose incident.

Fluoride overdose a triple failure

Natasha Bita | May 16, 2009
Article from: The Australian

UP to three safeguard systems failed at the Brisbane water-treatment plant that released drinking water to residents with fluoride levels that were 20 times the legal limit.

The revelation came as the Queensland Government yesterday sent apology letters to the 4000 people in northern Brisbane whose water was dosed with 30 milligrams of fluoride per litre, rather than the 1.5mg/litre maximum, for three hours on May 2.

A member of the Queensland Government's Fluoridation Committee, toxicology expert Michael Moore, yesterday called for a review of fluoridation engineering to prevent a repeat bungle.

Mike Foster, a spokesman for Queensland government water authority Seqwater, yesterday admitted that up to three safeguard systems at the North Pine treatment plant had malfunctioned, allowing the fluoride overdose to occur.

The plant had been shut down for maintenance between April 27 and 30, but the dosing machinery continued to pour fluoride into the system.

When the plant came back online, a concentrated amount of fluoride flowed into the system and was not detected until another water company tested water in the pipeline, a process that took two weeks.

The Queensland Health Department's code of practice for water fluoridation warns of the need for back-up systems to prevent accidental overdoses. It specifically warns of the potential to overdose if the water supply is cut off but the fluoride continues to dose, as happened last month.

"All key components should be alarmed to alert the operator of a failure of the system," it says.

The fluoride overdose marks the second water crisis in six months to hit the Bligh Government, after it was forced to back down late last year on plans to add recycled effluent to southeast Queensland dams. The plan was deferred in the face of community and expert concerns about the safety of recycled water, but treated effluent will be added to dams when their levels fall to 40 per cent.

The overdose comes barely four months after Queensland became the last state or territory to introduce fluoride into drinking water.

Professor Moore, the chairman of Water Policy Research Australia, yesterday called for the safety aspects of fluoridation engineering to be re-examined.

"I'm a very firm believer in the benefits associated with fluoridation and this is the worst thing that could have happened," he said.

Professor Moore said the overdose was unlikely to have caused toxic effects.

Seqwater yesterday wrote to "sincerely apologise" to all affected residents in the suburbs of Warner and Brendale.

"It should not have happened and we are committed to ensuring it does not happen again," said the letter, co-signed by Seqwater chief executive Peter Borrows and Queensland Chief Health Officer Jeannette Young.

It says Queensland Health is confident the health hazards are "remote".

Fluoride overdoses can cause mottled teeth at concentrations above 1.5mg/litre and bone damage known as skeletal fluorosis at levels exceeding 4mg/litre, according to the Australian Drinking Water Guidelines.

"Fluoride is absorbed quickly following ingestion," the guidelines state. "It is not metabolised, but diffuses passively into all body compartments."

Fluoride injured 'won't be compensated'

Posted Fri May 15, 2009 7:37pm AEST

Brisbane residents who received water with elevated fluoride levels will not be able to take action, a lawyer says. (iStockphoto)

- Map: Brendale 4500

A Brisbane compensation lawyer says residents who received water with elevated fluoride levels will not be able to take action against the Queensland Government.
For three hours earlier this month some residents at Brendale and Warner, just north of Brisbane, were drinking water with a fluoride concentration 20 times higher than the recommended maximum limit.
An investigation is underway into an equipment malfunction.
Four thousand homes were affected and Premier Anna Bligh says they should receive an apology.
But lawyer Mark O'Connor says the Water Fluoridation Act prevents any legal action being taken against the Government over the bungle.
"The legislation makes it perfectly clear that there is no civil remedy for persons who drink fluoridated water, so regrettably if someone does have some illness that is caused by water fluoridation they don't have any civil remedy in Queensland," he said.
The Australian Medical Association says Brisbane residents could indeed suffer health problems from ingesting too much fluoride.
AMA Queensland president Dr Chris Davis says high levels can cause teeth pigmentation and brittleness of bones.
Meanwhile, water officials have begun distributing information to the public about the overdose.
Mike Foster from SEQ Water says up to 60 staff will be working this afternoon and tomorrow, running an information stand at the Strathpine shopping centre and making door-to-door visits in the affected suburbs of Brendale and Warner.
He says they will reassure people an investigation is underway, and the health risk was very low.
"Today's really just about the start of our process, the sort of mobilisation of our staff and some private contractors in to tomorrow, to ensure that every household and business in the Warner-Brendale areas actually do receive information about the North Pine fluoride incident," he said.

Water treatment error causes fluoride overload

Daniel Hurst
May 14, 2009

The State Government has ordered an investigation into a malfunction at the North Pine water treatment plant which resulted in 20 times the regulated level of fluoride being added to household water supplies north of Brisbane.
Premier Anna Bligh this afternoon appeared alongside Chief Health officer Jeannette Young and SEQWater spokesman Jim Pruss to assure the community there was an extremely minimal health risk as a result of the error, which occurred two weeks ago.
The water treatment plant had been shut down for maintenance but fluoride continued to be added to the system, resulting in a higher concentration of being added to the water supply when the treatment system returned to operation a short time later.
Ms Bligh said she had been advised up to 30 milligrams of fluoride per litre had been detected in a sample of water taken from the North Pine plant on April 29, well above the regulated maximum concentration of 1.5 milligrams per litre.
It is understood about 4000 households, including parts of Brendale and Warner, would potentially have received water to their pipes with elevated fluoride levels between 9am and 12pm on May 1.
Ms Young said any adverse health affects were "very unlikely".
She said someone who drank a large amount of water in the affected areas during the three-hour period may have experienced "very mild gastroenteritis", but she was not aware of any such cases in the past two weeks.
There would be no long-term health consequences, Ms Young said.
Ms Bligh defended not telling the public sooner, saying SEQWater was not aware of the problem until the results of the April 29 water sample came back on Tuesday.
The Premier, who continues to back the addition of fluoride to South-East Queensland water supplies, said she was personally informed of the result last night.
The malfunction, in which dosage units continued to add fluoride in the water treatment plant even though it was shut down for three days, was "completely unprecedented" in Australia, she said.
"I think it's important to understand this is an extremely unusual event," she told reporters in Brisbane.
Authorities have shut down the fluoride dosage units at the North Pine water treatment plant until an investigation is completed.
Mr Pruss said fluoride dosage units would be manually shut down at other SEQ plants whenever maintenance was required to prevent a repeat incident.

Premier Anna Bligh embarrassed by overdose of flouride in water supply

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Andrew Fraser | May 15, 2009
Article from: The Australian
QUEENSLAND Premier Anna Bligh has been severely embarrassed after 20 times the recommended maximum safe dose of fluoride was put into Brisbane's drinking water.

The incident occurred two weeks ago at North Pine Dam, on Brisbane's outskirts, where a treatment plant was shut down for general maintenance but fluoride kept being added automatically to the water.
Consequently, when the plant was turned back on, the water that contained an excessive amount of fluoride was put directly into the water supply of 4000 homes in the suburbs of Warner and Brendale, in Brisbane's north, between 9am and 12pm on May 1.
The concentration of fluoride in the water that flowed directly into households was 30-31mg per litre, while the regulated maximum is 1.5mg per litre.
The incident marks the second water problem for the Bligh Government, which was forced to back down late last year on plans to add recycled effluent to southeast Queensland dams. The plan was deferred in the face of community concerns about the safety of recycled water, but treated effluent will be added to dams when their levels fall to 40per cent.
While all other states have had fluoride in drinking water for years, the matter has always been more contentious in Queensland and fluoride was put into the drinking water in the state's southeast only at the start of this year.
Prolonged exposure to excessive fluoridation leads to gastroenteritis, but Queensland's Chief Health Officer, Jeanette Young, said that authorities did not receive any reports of widespread bouts of the disease at the time.
The error was discovered earlier this week when routine testing showed the high concentrations of fluoride.
Ms Bligh said she was "not happy" with what had happened. "This is unacceptable, and like a lot of Queenslanders, I've got a lot of questions about this," shesaid.
Ms Bligh said that despite fluoride being added to drinking water in various parts of Australia for nearly 50 years using this method, there had never been such an incident and she stressed that the matter would be "properly investigated".
She asked Mark Pascoe, chief executive of the Brisbane-based International Water Centre, to investigate the incident.
One priority of the investigation was establishing how the machinery that added the fluoride in the North Pine Dam treatment plant was not turned off automatically when the whole treatment plant was turned off.
Ms Bligh said the fluoride equipment was now being turned off manually in the other four treatment plants in southeast Queensland where fluoride was being added to the water.
Queenslanders for Safe Water convenor Merilyn Haines ran against Ms Bligh in her seat of South Brisbane to draw attention to the issue of fluoride being added to the water supply. She said yesterday that while she was not surprised by the accident, she was surprised by the way it had happened so soon after the introduction of fluoridation.
"That amount of fluoride is the equivalent of having 120 fluoride tablets in a litre of water, or 30 fluoride tablets in your standard glass," Ms Haines said.
"She's put people's lives at risk. Anyone who drank that water who was an asthmatic was at risk, as was anyone with a kidney disease."

Fluoride overload admission two weeks later

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May 14, 2009

Article from: Australian Associated Press

A QUEENSLAND water company has taken more than two weeks to tell the Government about a treatment plant malfunction that saw too much fluoride added to water supplies.

Premier Anna Bligh today said the malfunction occurred on May 1 but water service provider Seqwater only advised her Government and affected councils last night.

The Premier said she'd been advised there was an "extremely minimal health risk" from the malfunction, which came during a shutdown for scheduled maintenance.

The malfunction affected water supplies from North Pine Dam.

Ms Bligh said higher than usual levels of fluoride had passed through a pipeline servicing the Warner and Brendale areas north of Brisbane.

The flow lasted for three hours on the morning of May 1.

Ms Bligh has ordered an immediate investigation to determine how failsafe devices designed to prevent such an incident had malfunctioned.

Fluoride bungle not acceptable: Bligh

Posted Fri May 15, 2009 7:35am AEST

Updated Fri May 15, 2009 12:11pm AEST

The Government says test results took 12 days to identify the fluoride problem (ABC TV)

- Map: Brendale 4500
- Related Story: Malfunction blamed for fluoride overload

Queensland Premier Anna Bligh says residents should receive an apology over an excessive release of fluoride in drinking water supplies.

For three hours earlier this month some residents at Brendale and Warner, just north of Brisbane, were drinking water with a fluoride concentration 20 times higher than the recommended maximum limit.

The state Opposition says it should not have taken nearly two weeks for the Government to find out about the bungle.

Ms Bligh says Queensland Health and the Environment Department are preparing information for households.

"I think it should contain accurate and factual information about what happened, what they should be aware of, if they have any concerns and how they can find more information, and some form of apology about how this happened," she said.

"This is not acceptable. This is something Queenslanders should be able to rely on and in this case they haven't been able to."

The Government says test results took 12 days to identify the problem and Ms Bligh says she learned about it on Wednesday night.

She has ordered a full investigation.

Opposition Leader John Paul Langbroek says it is not good enough.

"It's more an issue of the management of the system and it is of concern that it took two weeks for the Government to be told about it and to release to the public," he said.
Mr Langbroek says the Government cannot afford to make mistakes on the purity of drinking water.
"The Government should be reassuring Queenslanders that they have got all the procedures in place, that fail-safe mechanisms are working properly and that this sort of thing is not repeated," he said.
The Australian Medical Association says Brisbane residents could suffer health problems from ingesting too much fluoride.
AMAQ president Doctor Chris Davis says high levels can cause teeth pigmentation and brittleness of bones.
"Queensland's chief health officer Doctor Janette Young has done an enormous amount of investigation of the households that were affected," he said.
"We have no reports that we're aware of [of] any symptoms that were reported anyway, which were increased salivation, nausea, vomiting and abdominal pain."