# Coorong, Lakes and Murray Waterkeeper

WATERKEEPERS AUSTRALIA®
MEMBER

10 September 2008

The Secretary
Senate Standing Committee on Rural and Regional Affairs and Transport
Parliament House
Canberra ACT 2600

Dear Sir/Madam,

**Senate Inquiry into Water Management in the Coorong and Lower Lakes**

## Background

The Coorong, Lakes and Murray Waterkeeper (CLMW) welcomes the opportunity to provide input into the Senate inquiry into water management in the Coorong and Lower Lakes.

The (CLMW) is a program of the River, Lakes and Coorong Action Group Inc., a member of Waterkeepers Australia Inc. Members must meet 13 Quality Criteria and are actively engaged in protecting and restoring waterways for all living things to enjoy. Healthy waterways are also seen as critical infrastructure for human society and economy.

Waterkeepers are engaged in monitoring the condition of the water and engaging with other users of the waterway. They speak up and educate others on behalf of the waterway and the communities dependent upon them.

## Preamble

The Coorong, Lakes Alexandrina and Albert Wetland (commonly referred to as the Coorong and Lower Lakes) was included in the list of Ramsar Convention Wetlands in 1985. The Wetland met eight of the nine possible qualifying criteria. Australia has embedded its commitment to the protection of the ecological characteristics the site in the Commonwealth Environmental Protection and Biodiversity Conservation Act.

There is a considerable level of misunderstanding of the natural history of the Coorong and Lower Lakes. However the scientific evidence is clear that since its formation the Lakes Alexandrina and Lake Albert were predominantly fresh water for more than 95% of the time. Occasional but short lived incursion of sea water did occur. Under normal circumstances the estuary (where fresh and saltwater intermingled) was limited in range from the Murray Mouth and Point Sturt. (Sim T &

Muller K., *A Fresh History of the Lakes: Wellington to the Murray Mouth, 1800s to 1935*. River Murray Water Catchment Board, 2004)

With the expansion of irrigation schemes along the Murray-Darling, the natural flow of the Murray was significantly diminished resulting in more frequent and serious incursion of salt water. It was for this reason the series of barrages were constructed to conserve the fresh water assets of the two lakes. The connection between the Coorong and the Lower Lakes is fundamentally important despite the engineering impact on the region.

Flows of water over the barrages are important for refreshing the estuary of the north lagoon of the Coorong and the Murray Mouth. To further enhance connectivity (limited by the barrages) fish ladders have been constructed.

For the first time in history the Murray Mouth closed in 1981. Significantly despite the clear warning signs of a system under stress extraction have increased by 300%.

**Present condition of the Coorong and Lower Lakes**

As is now widely recognized the ecological state of the Coorong and Lower Lakes is under serious threat.

The Lower Lakes and Coorong provide critical habitat for international and Australian migratory birds. A habitat that supports 1% of species population at any given time is considered very significant. The Coorong, Lakes Alexandrina and Albert Wetland provides habitat for up to 30% for some migratory species. All together there has been a dramatic decline in bird populations of up to 95%.

Aside from its obligations under the Ramsar Convention, Australia has committed itself to several international treaties including migratory bird agreements with China, Japan and South Korea. It is puzzling then to see Australia's predilection for condemning Japan over its whaling activities but failure I regards its obligations to Japan and the protection of migratory birds.

The recent announcement by the Hon Peter Garrett, Minister for the Environment, Heritage and the Arts that an assessment be undertaken as to whether the Wetland should be listed under the EPBC Act as a critically endangered ecological community is welcomed. However the completion of that assessment is programmed for September 2011. Sufficient scientific evidence exists to inform an immediate decision to have the Wetland listed as critically endangered.

See for example Phillips W and Muller K (2006) *Ecological Character of the Coorong, Lakes Alexandrina and Albert Wetlands of International Importance*. SA Department for Environment and Heritage.

Recent rains have given hope that with minimal amounts of fresh water acidification of the Lakes can be prevented. Following rains in late Autumn and again in Winter pH levels have risen in sites formerly identified as acidic. Vegetation growth is occuring spontaneously.

**The Future**

Despite claims by Commonwealth Ministers and others, it is not too late to save the Lower Lakes. Any failure of Ministerial responsibility to ensure the protection of these Wetlands would be culpable; an appalling example to the citizens of this country and the international community.

Wetlands are among the world's most productive biosystems, accounting for 25% of food production, essential nutrient recycling, water purification, flow management and biodiversity. They make up 6% of the earth surface and account for 20% of its carbon. It is ironic that in circumstance where climate change is such an issue the natural carbon sequestration function of wetlands would be ignored.

Despite the natural benefits of wetlands there is talk of abandoning the wetlands and not just those of the Lower Lakes. Curiously we have removed vital water far from its source into regions of very low humidity using highly inefficient systems to move and apply that water. Recent ABS statistics show that 13% of MDB water is lost in transmission. (*4610.0.55.007 – Water and the Murray – Darling Basin – A Statistical Profile 2000-01 to 2005-06*). Then there are excessive losses in the irrigation methods still being used in some part of the country.

Fixing these wasteful systems would deliver substantial benefits. Indeed the National Water Initiative through reforming irrigation infra-structure was expected to return 3000 gigalitres of water.

If the worst case climate change predictions eventuate, Australian agriculture will need to be remodeled. The wholesale uncontrolled expansion of private surface capture needs to be curtailed so too the unsustainable exploitation of groundwater. Private dams account for as much as 20% of surface water in the MDB. ( M. Young & J McColl. *A future-proofed Basin*. University of Adelaide, 2008)

To destroy the fresh water ecology of rivers and their wetlands would be akin to someone standing on a rock in the ocean that provides barely enough space for their footprint busy mining it for some pecuniary benefit.

The Coorong and Lower Lakes and the other Ramsar wetlands in the MDB must be conserved. There is the capacity to do just that but we need the political will and integrity for it to happen.

It is sheer vandalism to fall behind climate change predictions, throw up the hands and on the basis of future difficulties fail to act while we have time to do so.

Up to 350 gigalitres may be needed to ensure the Lower Lakes do not turn acid through the coming summer. It is not too late and there is sufficient water available to ensure their conservation. This water can be obtained from various sources and are canvassed in the response to the Terms of Reference that follows.

The calls to flood the Lakes with sea-water is ecological vandalism and the damage done will be hard if not impossible to redress. (See Kerri Mullers Senate Inquiry Submission/Evidence)

# Terms of Reference

1. On 27 August 2008, the Senate referred water management in the Coorong and Lower Lakes for inquiry and report by 30 September 2008.

    a. **the volume of water which could be provided into the Murray-Darling system to replenish the Lower Lakes and Coorong;**

Opinions of government ministers and officers of the MDBC claiming that between 1050 and 1250 gigalitres is required to stop acidification are misleading. Expert opinion is that from 250 - 350 gigalitres is required to ensure the Lakes do not acidify over the summer.

According to an article in *The Australian,* "Putting water back in the rivers". August 13, 2008 the MDBC estimated that on July 31, 2008 there were 810 gigalitres held in private dams upstream of Wilcannia and 1090 gigalitres in public dams.

In the same article the MDBC is cited as estimating 80% transmission losses of waters by the time they reached the lower Lakes. Elsewhere and more recently they have stated losses of between 10-50%. Figures are somewhat rubbery. Assuming that the entire storage was released and the estimated transmission losses 380 gigalitres would reach the Lower Lakes. However it is acknowledged that some water needs to be retained for critical human needs of Broken Hill residents.

The term "transition losses" is a misleading one too - betraying an engineering perspective rather than environmental perspective. These so called transmission losses are vital to restore the health of the Darling River channel. Far from a waste of water it is just what the system needs.

There are other closer sources of water that would not have the significantly high levels of transmission losses claimed by the MDBC. There is approximately 650 gigalitres of carry over water from last year available in NSW, Victoria and South Australia. Some of this could be purchased and made available as river flow.

The Victorian Government is endeavouring to divert 75 gigalitres from the Goulburn for urban use in Melbourne. This is a travesty at a time when every drop is needed for the river system and associated Ramsar sites. This proposal should be rejected by the Commonwealth Environment Minister and the water returned to the river.

    b. **options for sourcing and delivering this water, including:**
        i. **possible incentive and compensation schemes for current water holders who participate in a once-off voluntary contribution of water to this national emergency**,

*Possible Incentives/Compensations*

- Reduction or suspension of water license fees (where these apply) for a period.
- Income Tax reductions.
- Guaranteeing market rates that apply immediately prior to the announcement of the purchase scheme.
- Create a national honour roll to be given wide public exposure and official recognition naming those irrigators who voluntary contributed to the saving of the Murray, its Lower Lakes and Coorong.

**ii. alternative options for the acquisition of sufficient water,**

A State of Emergency could be declared by the Commonwealth and a proportion of available water be compulsorily acquired.

The Commonwealth could also honour its international treaty obligations and its own obligations under the EPBC and use its constitutional and external affairs powers to compulsorily acquire water for urgent environmental needs.

**iii. likely transmission losses and the most efficient and effective strategies to manage the delivery of this water,**

Figures put out by the MDBC are inconsistent. Transmission losses of between 10-50% are cited most recently but earlier they were stating losses of up to 70-80% at another.

Much of the length of the River Murray channel is saturated. Carefully controlled releases through the system of locks and weirs would ensure the containment of the volume of water moved within the saturated river channel and the `losses' should be minimal.

In any event, as stated in relation to question 1 a, "transmission losses" are not a bad thing. The condition of the Darling River would be greatly enhanced if water stored above Wilcannia were released. A river needs to be able to flow and replenish its immediate flood plain environment.

**iv. Commonwealth powers to obtain and deliver water and possible legislative or regulative impediments, and**

Given it is a signatory to several international treaties that apply to the Coorong and Lower Lakes, an Australian government committed to upholding the rule of law and its international responsibilities would invoke External Affairs powers and compulsorily acquire water if necessary.

Compensation should also be given to those from whom the water was obtained.

The Commonwealth's own EPBC Act obligates it to protect the Coorong and Lower Lakes. Failure to do so when it has the capacity to acquire water vital for the sustainability of the Lower Lakes is in my opinion culpable neglect and a very poor example to the nation.

**v. assessment of the potential contribution of bringing forward irrigation infrastructure spending under the Council of Australian Governments agreement to deliver water to save the Coorong and Lower Lakes;**

The initial responses to the crisis in the Lower Lakes and Coorong have been inadequate. In 2006 the Commonwealth Government projected water savings from implementation of the National Water Initiative of approximately 3,000 gigalitres. The one million dollars to be invested by the current Commonwealth Government in the Victorian Food Bowl is going to deliver only a small proportion of the estimated 3,000 gigalitres. The Victorian Government plans to pipe one third of the saving (75 gigalitres) to Melbourne.

Savings from infra-structure changes throughout the MDB should be significant. Figures published by the ABS show that the water supply industry in the MDB loses 13% of the water resources due to poor supply systems.

Then there are the losses on farm from inappropriate irrigation technologies. The effectiveness of some sprinkler irrigation systems is very low resulting in an effective loss of up 90% of the water. Conversion to sub-surface irrigation systems would dramatically reduce these losses.

The Commonwealth Government has compromised the potential water savings in agreeing to hand Victoria a billion dollars for such an abysmal return as indicated above. Given this weakness, other water saving options become even more significant. The over-allocation of water should be addressed immediately and the water recovered given to back to environmental flows.

**b. the impact of any water buybacks on rural and regional communities and Adelaide including compensation and structural adjustment; and**

Any impacts are significant and one does not wish to add to these or catapult communities into hardship. Living in a community seriously affected by a lack of water, I am very much aware of the hardship that results.

However some irrigation activity should never have been permitted. Prudent governance may have foreseen the problems of diverting water in some cases many hundred of kilometres from the river source into areas of low natural rainfall and very low humidity.

Climate change projections make irrigation even less sustainable in these locations as reduced inflows translate to significant reduction in surface flow. Failure to act in the face of this future may result in very significant community hardship. It is better to address the problem now. Alternative agricultural or pastoral regimes could be adopted that are not irrigation dependent.

Moving agriculture activity to areas where water budgets are more favourable is also an alternative. Communities and individuals could be provided incentive to move to more productive and sustainable use areas.

Government facilitated decentralisation of some types of industry and services should also be part of the mix to enable these communities to continue and to contribute to the national economy.

Some communities do not have sufficient resources now to irrigate crops. They have had a significant loss of income as it is. For some the sale of water is an opportunity to derive some form of income. This is true of people living around the Lower Lakes who have a water entitlement but are either unable to access the water or it is unusable because it is too saline. Irrigators are facing difficult times and some may be forced to sell their entitlements upstream. They would much prefer that the South Australian government purchase that water so that it stays in the Lower Lakes. However the South Australian Government has declined this offer.

### c. any other related matters.

Effective and sustainable water management entails a mix of appropriate actions and policies. It is disturbing to see the persistent and damaging fixation on destructive engineering “solutions” to the “problems” of the Lower Lakes and Coorong.

Despite a report showing a net loss 10 gigalitre flowing through the Murray Mouth, that would result from the construction of a bund to split Lake Alexandrina into largely saline area with a smaller fresh water channel. (Environmental Flows and Water Quality Objectives for the River Murray Project Board. *Options for Water Savings from the Lower Lakes for improved flows in the Coorong and through the Murray Mouth.* MDBC Technical Report 2001/11)

It is disturbing to see the General Manager of the Murray Darling Association promoting the scheme, especially given that this organisation “Seeks to ensure that the environmental integrity of the Murray-Darling Basin is conserved and protected” (see the Murray Darling Association website).

The proposed Pomanda Island temporary weir in Lake Alexandrina below Wellington is a folly that no self-respecting, informed politician, let alone a Commonwealth Minister for the Environment, would want to leave as a legacy.

This 700,000 tonne, 300,000 cubic metre 2.6 kilometre monstrosity can only be considered for a moment by those willing to ignore the vital connection between the River Murray and the Coorong, Lakes Alexandrina and Albert Wetland. There is a vital interplay between hydrology, wetland ecology and human health no-where is it more important than this particular site. I refer the honourable Senators to the following websites where further details on this important interplay can be obtained: www.stoptheweir.com and www.riverlakescoorong.com.au.

Despite initial claims that it was not possible engineers have been able to extend depth of the urban water pump intakes from the lower Murray; pushing out their timelines for the construction of the weir.

While critical human needs were being touted as the justification for the weir, the evidence is clear. Adelaide and the regional centres dependent on water from the lower Murray have not suffered any critical shortage of water. Indeed South Australia's critical human needs have been guaranteed for the current water year.

The announcement by the SA Government in November 2006 of an impending human crisis of drinking water, claims used as justification for the weir, are hardly credible when no quota on urban or industrial use has been implemented. Evidence from Brisbane's experience, shows that an urban community can sustain itself on much less water than is generally consumed. The quota per person in this instance was 140 litres per day – a generous amount at any time.

Despite the widespread concerns about water into the future we have the Executive Director of the Water Services Association of Australia quoted as saying that the long term objective of his Association is to end water restrictions by securing new sources of water for urban consumption. ("30 bn to improve water infrastructure" *Herald Sun* 3rd September 2008) reference)

The proposal by the Victorian Government to divert 75 gigalitres of water from the Goulburn to Melbourne for urban consumption is entirely consistent with this perspective. However it is an action to be condemned, especially given the shortage of water for irrigators and the river environment itself, when urban water consumption can be reduced by demand management. Further resources can be obtained by stormwater harvesting and waste water recycling.

I have been told personally by people involved in the campaign to stop this diversion that there are Victorian irrigators who would rather see this 75 gigalitres flow down

2. **The implications for the long-term sustainable management of the Murray Darling Basin system for inquiry and report by 4 December 2008, with particular reference to:**

    a. **the adequacy of current whole-of -basin governance arrangements under the Intergovernmental Agreement;**

The Intergovernmental Agreement is inadequate an promoted in a way that deceives the Australian public. Much has been made of the independence of the new Murray Darling Basin Authority but it is not truly independent. It is subject to direction by the Ministerial Council and the Basin Officials Committee.

What we have is a system that establishes the same partisan and parochial capacity of the old system which is responsible for so much of the impact we are now confronting.

The new Authority is accountable to the Basin Official Committee.  The new agreement gives "... autonomy for the Authority to prepare the Basin Plan and deliver programs within the Basin, in the context of clear accountabilities to the Commonwealth Minister, the Ministerial Council and the Basin Officials Committee." (3.1.1)

The old unfair water-sharing arrangements still apply and cannot be changed "...unless otherwise agreed by all parties through the Ministerial Council or the Basin Officials Committee as appropriate." (3.2.9)

"...role (of the Authority) will be the responsibility for implementing the decisions made by the Ministerial Council and the Basin Officials Committee." (3.3.6)

"The Basin Officials Committee will:
(d) set objectives and outcomes in relation to River Murray
operation by the Authority" ....

(f) be responsible for high level decision making in
relation to operation of the River Murray System; ..."(3.3.13)

While the Intergovernmental Agreement claims to covers  the "whole-of-basin", it leaves out of its control vast water resources in the Goulburn, Murrumbidgee and the northern reaches of the Darling.  These are vital parts of the region drained by the Murray - Darling system.

Groundwater is excluded from the agreement.

**b. the adequacy of current arrangements in relation to the implementation of the Basin Plan and water sharing arrangements;**

The current arrangements are inadequate.  The time line for the full implementation of the Basin Plan and water sharing arrangements is far too long.  In the long term 1,500 gigalitres is to be returned to the river as environmental flow.  However, the progress toward that target is far to slow.

Unless we have a return to better rainfall patterns, delaying environmental flows down the Murray risks the viability of the Coorong and the Lower Lakes already threatened with acidification.  It also damages Australia's international standing.

Given the possibility of declining water inflows resulting from climate change and the slow progress and the apparent weakness of the Intergovernmental Agreement to overcome parochial and capricious State interests, the Commonwealth should assume control of the basin and implement a system which:

1) ensures the rivers is guaranteed sufficient water, a maintenance flow, to ensure its flows to the sea

2) recognises the rightful share of water resources for the environment, along with industry and critical human need seems a more responsible and sustainable approach to water sharing.

c. **long-term prospects for the management of Ramsar wetlands including the supply of adequate environmental flows**;

The Commonwealth of Australia is obligated to protect the Ramsar wetlands. It must do all it can to meet its legal obligations.

First and foremost attention needs to be given to securing the short term survival of the Ramsar wetlands. After all they provide essential environmental services that benefit mankind and the diversity of plants and animals integral to a healthy and prosperous planet. Water is available for immediate application as noted earlier in this response (see section).

The longer term can be planned for with actions that will produce better results for wetlands. These include:

- reforms of irrigation infrastructure. As noted earlier these can return significant quantities of water
- recycling of waste water
- urban storm water harvesting
- demand management. The weaning of urban populations away from excessive consumption
- installation of household rainwater tanks
- changing land use practices such as the adoption of minimum till which significantly reduces the loss from soil evaporation. Minimum till also reduces the oxidation of carbon naturally sequestered in the soil. (see Peter Andrews, *Back from the Brink*. ABC Books, 2006) This will have a significant impact on diminishing global warming resulting from carbon dioxide.
- the withdrawal of irrigation activities from climatically and hydrologically unsuitable areas
- returning irrigation to the most ecologically sound areas, that is, the natural river floodplains
- moving agriculture to areas that are predicted to benefit from increased rainfall
- changing to more drought tolerant and less water demanding drops
- planting vegetation along the edges of rivers, wetlands and any remaining irrigation channels. This will provide shade and micro-climate benefits, especially the reduction of evaporation. It will also slow the flow of water maximising the benefit to wetlands and floodplains (see Peter Andrews cited earlier)
- adopting natural sequence farming will reduce the area of cropped land by to approximately one third. This remaining third can achieve 500% increase in productivity more than off-setting the losses from reduced cropping (see Peter Andrews cited earlier)
- manage the water anticipated (but rarely referred to) from the increased

magnitude of storms and floods. The MDB has large storage capacities. These should be managed in such away that environmental water and river maintenance water can be stored and then distributed in times of lower rainfall.

**d. the risks to the basin posed by unregulated water interception activities and water theft;**

Recent evidence of unregulated water interception should mobilise governments to bring this under control. Instead we see apparent complicity on the part of some governments in this practice; a practice hostile to good environmental outcomes and the national interest.

While the inadequate control over the whole of the Murray Darling Basin continues States will be able to continue permit a situation where parochial interests override the interests of the whole water way so vital to the environmental sustainability and the nations long term economic viability.

The exponential growth needs to be brought under control. In many places the subdivision of larger farming properties is accompanied by an exponential growth of private small dams. This needs to be brought under control.

So too does the exploitation of ground water which proceeds apace in some areas. There should be a moratorium on further groundwater exploitation and an audit conducted of current use and available reserves.

Water theft should be heavily penalised and countered by a commitment to diligent auditing of off-takes and monitoring of activities. This is hardly a difficult task given modern technology and access to satellite imagery.

e. **the ability of the Commonwealth to bind state and territory governments to meet their obligations under the National Water Initiative;**

Please refer to the South Australian Environmental Defenders Office (EDO) submission.

**f. the adequacy of existing state and territory water and natural resource management legislation and enforcement arrangements; and**

Please refer to the South Australian Environmental Defenders Office (EDO) submission.

**g. the impacts of climate change on the likely future availability of water**

Some projections of the impacts of climate change are very disturbing.

*"Whilst there are limitations to the degree to which the risks can be summed, evidence suggests a likely impact on stream flow in 20 years time of between 2,500 and 5,500 GL/year. Given an average annual run off of 24,000 GL, the risks clearly have the potential to significantly affect the quantity of the shared water resource."*

(Van Dijk, A. et.al 2006 *Risks to the Shared Water Resources of the Murray-Darling Basin*, Murray-Darling Basin Commission, Canberra)

However as stated earlier estimates for savings from reforms to irrigation supply infrastructure are significant; that is up to 3000 gigalitres.

As also discussed in section 2 c. of this response there are actions that can be taken to reduce these impacts.

Again as noted in section 2 c., there is also the other side to the climate change equation not often spoken about. That is the increased intensity of flood and storm events. These circumstances can be taken advantage of by the wise use of existing and new storage capacities and by adopting agricultural practices that are more opportunistic in nature.

Assuming worst case scenarios for climate change and current water use arrangements the future looks grim. However, we have not reached these conditions and it is imprudent to deliberately destroy Ramsar wetlands on the basis of a hypothetical future.

Australia, along with a large number of other nations has or is about to implement policies to address green house gas emissions. These measures may have significant impact in ameliorating if not avoiding forecasted conditions.

Yours faithfully

Paul Davis
Coorong, Lakes and Murray Waterkeeper
email: waterkeeper@riverlakescoorong.com.au
ph: 08 8585 6974
mobile: 0414 560 748

with Richard Clark & Associates

# Report on Sustainable Water Options for Adelaide

Sustainable Focus Pty Ltd
11 Gething Crescent
Bowden SA 5007
ABN 34 098 471 651
www.sustainablefocus.com.au
info@sustainablefocus.com.au

September 2008

Assisting organisations move towards sustainability.

# Executive Summary

The purpose of this report is to review water options for Adelaide under current and future scenarios of population growth and climate change and to recommend more sustainable strategies to cost-effectively meet Adelaide's water requirements, while achieving the best possible associated environmental and social outcomes.

Adelaide's water supplies are at immediate risk with historically low flows in the River Murray and this will be a long term problem as climate change accelerates. Under expectations of continued population growth and climate change the traditional approach to water management of importing water to Adelaide in continually larger amounts from ever increasing distances, or by ever increasingly costly methods, while continuing to discharge stormwater and treated effluent to downstream rivers, estuaries or the sea is obviously an inherently unsustainable direction.

Adelaide has a combination of hydrological characteristics which sets it apart from all the other capital cities in Australia. First, the plains areas of Adelaide are underlain by a series of quaternary and tertiary age aquifers, with the latter virtually free from past pollution. The total storage capacity of water in these aquifers is not accurately known but is many times the total storage capacity of the reservoirs in the Mt Lofty Ranges. This opens up the potential for Aquifer Storage and Recovery. Second, despite Adelaide and its hinterland receiving the lowest rainfall of all the Australian capital cities, because it has most of its urban areas built over unstable flood deposition fans and ancient flood plains it has a very high risk of severe damages in large flood events. While our focus during the early years of the twenty-first century has been much engaged with drought, if a storm similar to that which occurred over North Adelaide in February 1925 were to occur again under our present development situation, it is reasonable to suggest that lives could be lost and property damage would be extensive.

Defining sustainability for urban water systems is a critical first step in comparing water supply options. Since water supply is essentially associated with water diversions, storages and quality modifications, the effects of water supply operations cannot be divorced from their impacts on other aspects of water management. The authors have developed a definition of sustainability as related to urban water management and have compared the currently considered urban water supply options for Adelaide against performance criteria related to this definition. Principles to be adopted for attaining sustainable water systems and the need for a transition strategy to make the necessary changes are also outlined.

Table A shows the ranking of the options against the sustainability performance criteria. The scoring and ranking of the options are inevitably subjective. However, if the definition of sustainability is accepted in some form as presented, the authors believe it will be difficult to dramatically change the relative ranking of the options. Also provided in Table A are order of magnitude estimates of the quantities of supplies that could be made available via these options in the near future.

**Table A. Analysis and ranking of water options along with order-of-magnitude estimates of preferred, feasible supply sources.**

| Category | Assessment | Score (out of 50) | Gigalitres (GL) |
|---|---|---|---|
| Demand management | Highly cost effective with excellent environmental and social benefits. | 41 | 64 |
| Stormwater harvesting | As above, but particularly compatible with reduction in flood damages and urban amenity. Has future growth potential | 41 | 60 |
| Existing catchments | Existing catchments are a proven and reliable option. | 35 | 82 |
| Wastewater reuse | Offers great potential for large scale future cost effective supplies with high environmental benefits, but problems to be overcome for immediate re-use in urban areas. | 32 | 15 |
| Rainwater tanks | While popular with the community relatively expensive and difficult to manage. | 28 | 6 |
| Groundwater use | Groundwater extraction without recharge is inherently unsustainable, but offers scope for immediate emergency supplies. | 26 | 0 |
| Desalination | Useful measure of last resort but expensive and energy intensive therefore not an immediate priority. | 22 | 0 |
| River Murray | The River Murray is failing and should not be relied on as a long term supply. | 19 | 0 |
| Increased storage/Mount Bold expansion | Storage relying on River Murray inflow and subject to climate change impacts is not recommended. | 9 | 0 |
| **Total** | Based on conservative estimates exceeds current water use. | | **227** |
| Current water use | | | 216 |

Table A shows that demand management, stormwater harvesting, existing catchments, wastewater reuse and rainwater tanks can supply all of Adelaide’s water requirements with excellent environmental, social and financial outcomes. The volumes of stormwater and wastewater will grow as the city develops and thus have significant future potential. Adoption of these options will lead to reduced costs and much greater benefits in the long term.

Continued extraction of water from the River Murray, desalination and/or increasing reservoir storage do not fit with the sustainable directions outlined.

Climate change is now widely accepted as a reality, along with planned future growth for Adelaide. Water planning is in crisis through past fragmentation and low levels of resourcing. While sustainability is widely touted, it has received very little analysis. The authors are convinced that sustainability in respect to water planning requires a 'Total Water Cycle' approach which addresses the use, re-use and close management of local water sources before casting the net wider to other sources.

It is recommended that the following actions be undertaken in parallel as a matter of the greatest urgency:

- Establish a comprehensive long term demand management program with a residential target of 140 litres/person/day and a commercial/industrial target of 20% improvement in water use efficiency. As part of this, change the pricing structure for water by increasing the volumetric costs and reducing other charges to provide more incentive for users to reduce their demand to meet the overall target levels.
- Undertake an assessment of the capacity of the aquifers beneath Adelaide to support temporary groundwater 'mining', with treatment as necessary, as an emergency water supply, and commence determination of the limits of the aquifers for storing and recovering bulk water harvested from treated stormwater and wastewaters. Research means for exploring and raising the limits, as warranted.
- Commence implementation of a major metropolitan-wide stormwater harvesting program in partnership with local governments and SA Water.
- Identify and pursue strategies for making the total flow of treated wastewater acceptable for urban or peri-urban water supplies in a manner that directly or indirectly reduces the demand by the urban users on non-sustainable water sources by an amount equal to the total of the wastewater flow.
- Provide a single State government department with responsibility for multi-purpose, participatory, total water cycle planning, within the context of the State Water Plan. The Plan to cover the whole gamut of natural and engineered water systems. The department to be responsible for the immediate Water Security investigations.
- Broaden the present Water Security investigations to better define the costs and benefits of the long-term water options for Adelaide using total water cycle principles and judged on sustainability criteria as laid out in this report, but with a greater level of resourcing including:
    - consultation with Local Government and others who have successfully initiated and developed the more sustainable options to date; and
    - a program of information and consultation with the broader community on the implications, benefits and costs of the options as they emerge and progress.
- Put on hold funding proposed for desalination and reservoir storage and redirect to more sustainable options once the above assessments have confirmed the preferred options as feasible.
- Protect and improve existing catchments.
- Prescribe quaternary aquifers to prevent excessive extraction (this will be a specific issue as other sources of water become more scarce).

# Contents

# 1. Introduction

Traditionally, as water demands have continued to grow, supplies have been imported to Adelaide in continually larger amounts and from ever increasing distances – first from the Mt Lofty catchments and then from the River Murray. At the same time, the volumes of stormwater runoff and sewage effluent, generated as a direct consequence of the growth of Adelaide, have been discharged in ever increasing quantities to downstream rivers, estuaries or the sea.

While the systems that have been established have brought about great benefits in public health, prosperity and convenience, the upstream environments from which the water is diverted, and the downstream environments which receive the unused and polluted waste flows, have all suffered. The flood risks within the urban areas have also escalated to a dangerous level, while the extensive concreting and undergrounding of the urban drainage networks have reduced amenity and significantly reduced habitat for biodiversity.

Now Adelaide's water supplies are at immediate risk with historically low flows in the River Murray and this will be a long term problem as climate change accelerates. Under expectations of continued population growth and climate change the traditional approach to water management can only lead to increased environmental and social damages and rapidly rising costs for water supply and discharge. It is obviously an inherently unsustainable direction.

The purpose of this report is to review water options for Adelaide under current and future scenarios of population growth and climate change and to recommend more sustainable strategies to cost-effectively meet Adelaide's water requirements, while achieving the best possible associated environmental and social outcomes. It should be noted from the outset that reviewing water options for Adelaide covers a far broader scope than water supply only. In fact it can be argued that the development of water supply systems without paying due attention to the bigger picture has brought us to this point where we obviously have to make changes. This report sets out to define sustainability for urban water systems as a critical first step in comparing water supply options.

## 2. Defining sustainability for urban water systems

Target 3.9 of the State Strategic Plan is 'Sustainable water supply: South Australia's water resources are managed within sustainable limits by 2018'. However, despite a careful search the authors have not been able to find a definition of water sustainability that is used by the State Government in relation to its urban water planning, nor any ranking of options for urban water systems to address the present and emerging water management problems.

The closest that the Government has come to this exercise recently is embodied in the 'Water Proofing Adelaide' (WPA) project. However, while the report discussed aspects related to its identified alternative sources, there was no ranking of them to support the choice of a preferred supply mix.

Defining sustainability for urban water systems is a critical first step in comparing water supply options. Since water supply is essentially associated with water diversions, storages and quality modifications, the effects of water supply operations cannot be divorced from their impacts on other aspects of urban and regional water management such as flooding, pollution, biodiversity conservation and amenity. Energy and greenhouse impacts of water supply must also be quantified and managed, particularly where the options for increasing water availability are energy intensive. A holistic definition of sustainability in relation to urban water management is therefore required. It must cover all these aspects of water management and must therefore include the other major urban water systems of drainage and sewerage, as well as water supply. Table 1 provides a definition of sustainability as related to urban water management developed by the authors against which urban water options may be judged.

**Table 1. Definition of and criteria for assessing sustainability of urban water systems**

| Category | Assessment criteria |
|---|---|
| Reliability of services | Reliable water supply and other water services for household and industry into the foreseeable future including access to sufficient clean water for recreation, amenity and aesthetics and freedom from interruption by accident or malice. |
| Affordability | Affordable water supply for household and industry into the foreseeable future. |
| Current availability | Adelaide is facing a water crisis. The speed at which proposed supply options can be brought on line is of critical importance at present. |
| Human health | Healthy water supply and disposal for people including the supply of water that is fit for purpose including potable and non-potable water and the removal of stormwater and wastewater from living areas to avoid disease and inconvenience |
| Protection from flood damage | Minimal damage to persons and property from floods (or sea storms) up to a nominal recurrence interval of one in 100 years, but also building in the ability to survive more infrequent, but 'catastrophic', storm events occurring (say) once in 500 years. |
| Upstream and in-stream environmental protection | Upstream (of Adelaide) and in-stream (in Adelaide) environmental protection including the promotion of biodiversity and quality habitat through:<br>• minimising diversion of water from supporting environments and maintaining environmental flows in our river systems<br>• minimising land impacts on native vegetation |
| Downstream environmental protection | Avoidance of downstream (of Adelaide) environmental impacts from the discharge of excessively polluted water (including nutrients and sediments) to land, river systems and/or coastal marine habitats. |
| Greenhouse emissions | Reduce greenhouse emissions of Adelaide's water supply compared with 1990 levels in line with South Australia's Strategic Plan and Tackling Climate Change Strategy by dealing with emissions from construction and operation of water supply and treatment infrastructure (mainly associated with energy use). |

The key to achieving sustainability for urban water systems will lie in the design of a system of water infrastructures and operations that can best satisfy these criteria.

Once criteria have been established setting targets can be addressed. Even without formally addressing definitions and criteria it is noted that several agencies have already set targets that are implicitly related to definitions and criteria for sustainability. Among these are:

1) The Australian Coastal Waters Study provides specific targets as follows:

- The total load of nitrogen discharged to the marine environment should be reduced to around 600 tonnes (representing a 75% reduction from the 2003 value of 2400 tonnes).
- A 50% load reduction in particulate matter (from 2003 levels) would be sufficient to maintain adequate light levels above seagrass beds for most of the time.

2) The Adelaide and Mount Lofty Ranges NRM Plan provides twenty year Regional Targets of 75% stormwater use and 100% of wastewater reuse.

3) The State Strategic Plan includes Target T3.1 ‘Lose no species: lose no known native species as a result of human impacts’.

The Stormwater Management Authority has been established with responsibility for coordinating the assessments of flood risk and drawing up plans to reduce the level of incipient flood damages in Adelaide.

# 3. Water related characteristics unique to Adelaide

One of the main barriers to progress in water reform is the tendency of authorities to seek ‘one size fits all’ solutions to our many water problems. Thus the same solutions tend to be slavishly copied from area to area across the whole of Australia with little regard to the local conditions, i.e. the industry acts globally without thinking locally first.

Adelaide has several hydrological characteristics which, when taken together, set it apart from all the other capital cities in Australia. Some of these characteristics, and their implications, are central to the investigation of sustainability and the layout of sustainable urban water systems at least cost. Unfortunately, since sustainability itself has not been previously defined in relation to urban water systems, it is not surprising that these features have not been adequately recognised, investigated and incorporated into a coherent water policy across the full water management spectrum. Two major characteristics are the:

- topography of Adelaide in relation to its flood potential; and
- existence of major underlying aquifer systems suitable for bulk storage of water captured for future supplies in drier years.

The first will cause problems for the sustainability of Adelaide unless it is addressed. The second is a potentially major advantage in addressing the sustainability of water supplies.

## 3.1 Flooding

Australia is widely recognised as a land of droughts and floods. With respect to the former, Adelaide and its hinterland share the lowest rainfall of all the Australian capital cities. However, it is less well recognised that, at the other end of the water spectrum, Adelaide has most of its urban areas built over unstable alluvial flood sedimentary fans, terraces and flood-out areas and is thus at a high risk of severe damages in large flood events.

The present system of stormwater drainage can deal relatively successfully with minor and even medium flood events. However, above this threshold, flood water will spill out of the perched channels and travel by pathways that are very difficult to predict. In a major flood, overflows will originate in the eastern suburbs. Fast travelling water will spill down roads and through gardens creating debris dams which will cause major erosion and damages. The water will slow, deepen and pool as it enters the western suburbs.

Taken in conjunction with the present drought crisis, the above information points to the conclusion that the past water management and development regimes have delivered Adelaide a position where it cannot claim to be sustainable in respect of foreseeable risks in either flood or drought conditions.

Moreover, as the city and its population expand and the potential for intensified floods and droughts associated with climate change emerge, these inherent problems will only worsen. While our focus during the early years of the twenty-first century has been much engaged with drought, if a storm such as that of February 1925 were to occur again (when 125 mm of rain fell over North Adelaide in 3 hours), it is reasonable to suggest that, following the subsequent development of the western suburbs and continued encroachment of development onto flood plains, many lives could be lost and property damage would be extensive.

## 3.2 Aquifer systems

The plains areas of Adelaide are underlain by a series of quaternary and tertiary age aquifers. In general, the upper quaternary aquifers are shallow, individually limited in extent and often saline. However in places, mainly where these aquifers are recharged from surface flows, good but limited supplies of water can be extracted with salinities within potable standards. Of greater potential, however are the two deeper, thicker and more homogeneous tertiary aquifers, which are presently used for larger irrigation and industrial supplies.

In the past, a sustainable level of extraction from the tertiary aquifers has been limited by the slow rate of their natural recharge. The aquifers are separated from direct vertical recharge from rainfall and surface flows by thick layers of overlying clay. The main path for recharge is horizontal, via relatively low salinity surface flows entering via the extensive fault lines at the foot of the hills face areas. Because of the slow rate of horizontal recharge over the long distances from the recharge areas to the areas where supplies are taken, local over extraction has taken place and large areas of reduced pressure now exist.

Over the past 15 years recharge has been shown to be feasible by drilling into the aquifers and recharging with surface water. This dramatically short-circuits the longer and slower natural recharge process and greatly enhances the possibility of using the aquifers for storage of larger volumes of lower salinity water.

The total storage of water in these aquifers is not accurately known but is generally estimated by hydrogeologists to be many tens or even hundreds of times greater than the total storage capacity of the reservoirs in the Mt Lofty Ranges. However, since most of the water in storage in the aquifers is only of marginal quality and could not be removed without causing major subsidence problems, it is the potential to progressively exchange increased volumes of the marginal quality stored water with artificially introduced and easily recoverable fresh water that is of greater interest.

This is further discussed in the next sections.

# 4. Adelaide and regional water balance

## 4.1 Present water balance

Table 2 shows the present sources of water used for water supply to Adelaide in comparison to the unused outflows, as given in the 2005 Water Proofing Adelaide (WPA) report. The inflows cover the present levels of water demand.

**Table 2. Current Water Balance for Adelaide**

| INFLOWS to the Supply System | Average Year (GL) | Dry year (GL) |
|---|---|---|
| River Murray | 80 | 171[1] |
| Adelaide Hills | 121 | 30 |
| Groundwater | 9 | 9 |
| Rainwater tanks | 1 | 1 |
| Stormwater reuse and recycled wastewater | 5 | 5 |
| **Total** | **216** | **216** |
| **OUTFLOWS** | | |
| Stormwater (including hills face runoff) | 160[2] | 50 |
| Treated effluent from coastal wastewater treatment plants | 70[3] | 70 |
| **Total** | **230** | **120** |

Notes
1. Pumping from the Murray is higher in dry years to offset reduced inflows from the Adelaide Hills
2. Appears high. 115 GL more likely. Dry year appears correct at 50 ML
3. Appears low. Should equate to about 40-50% of supply

The tabling of the water balance in this way gives a broad indication of the general supply and demand situation but does not address many of the more detailed problems, particularly those associated with water quality and the amount of storage required to overcome flow variability. The table does however indicate that the existing and potentially available sources of water in an average year, represented by the addition of both the inflows and outflows, at 446 GL/annum, are well in excess of the existing level of the average year demand of 216 GL/a. In fact the outflows alone are higher than the required inflows in an average year. Average water quantities, per se, therefore do not appear to be a major problem at present in relation to average levels of demand, although the challenges of securing adequate drought storage, reducing flows due to climate change and increasing demand due to population growth must obviously all be addressed. The future water balances under climate change and population growth are addressed below.

Despite the above, Adelaide's water supplies are at immediate risk due to low flows in the River Murray combined with over-allocation of upstream flows. Other serious underlying problems are the rising salinity of the River Murray and the potential for algal blooms[1] within South Australia. These emerging problems have been widely recognised over the past two decades during which time very little planning has been undertaken to secure alternative, additional sources of water for Adelaide.

In view of the above, emergency measures may now have to be taken to access supplies from alternative sources that can be brought on line quickly. It would obviously be advantageous if these sources were those that will go on to be developed further into the future.

## 4.2 Future water balance

The information in Table 2 assumes present day average levels of demand and outflow. However, this information is insufficient for future planning under expectations for population growth to two million persons (State Strategic Plan Target 1.22), and climate change with an expectation of

[1] CSIRO, Oct 2003,"Is the River Murray Water Quality Deteriorating? A Salinity Perspective". MDBC, Dec 2007, "River Murray System Drought Update No 11"

reduced rainfall, higher temperatures leading to higher evaporation rates and more extreme weather patterns.

The WaterCress water systems planning model, used by the Department of Water Land and Biodiversity Conservation and local governments for their water resource assessments and water systems designs, has been used to simulate the Adelaide and regional water flows and to assess the feasibility of supplying demands from different combinations of source waters (Clark, 2003). These results have been reworked to investigate the way in which the Adelaide water balance will change under scenarios of population growth, urban development and climate change. The rate of change of all these factors is highly uncertain. The following assumptions have been made for illustrative purposes when the population reaches two million in about 2030-2050.

Ongoing urban expansion and consolidation is assumed, including smaller gardens requiring irrigation. A 13% reduction in rainfall is assumed which results in a 30% reduction in runoff from the Mt Lofty and hills face catchments. Because of their higher runoff efficiency, the runoff per unit area of the urban catchments only reduces by 17%, however, since the urban catchments, under a doubling of the population, are assumed to increase in area by at least 1.5 times, the total stormwater runoff actually increases. Wastewater has the largest increase since it is less influenced by climate change and rises in direct proportion to the population growth.

Table 3 uses figures given in Table 2 above and shows that under the assumption that only 70% of all wastewater and stormwater flows could be harvested, then, even under the assumed level of climate change and a population growth to two million, the total harvestable flow would remain greater than the demand, without either the River Murray or desalination as supplies. Whilst estimates only, the figures illustrate the increasing and significantly large proportions of the total future water budget that stormwater and treated effluent (in particular) could provide.

**Table 3. Water balance for 2 million population and 13% reduction in rainfall**

| **Water Demand** | **Now GL/a** | **2050 GL/a** |
|---|---|---|
| Potable water for internal purposes (discharged to wastewater treatment plants) | 100 | 200 |
| Potable or non-potable water for external purposes and lost by evapotranspiration | 102 | 154 |
| **Total** | **202**[1] | **354** |
| **Estimated Potential Harvestable Water** | | |
| Mt Lofty Ranges flow to the Adelaide reservoirs | 121 | 85 |
| 70% of stormwater runoff (current total runoff assumed at 115 ML/a)[2] | 80 | 100 |
| 85% of internal supplies returned as wastewater (suitable for non-drinking purposes) | 85 | 170 |
| **Total** | **286** | **355** |

Notes 1. Reduced from 216 GL shown in Table 1 by exclusion of present 'non-mains' supplies
2. 70% capture achieved by present stormwater schemes in Adelaide. Conservative estimate of runoff assumed

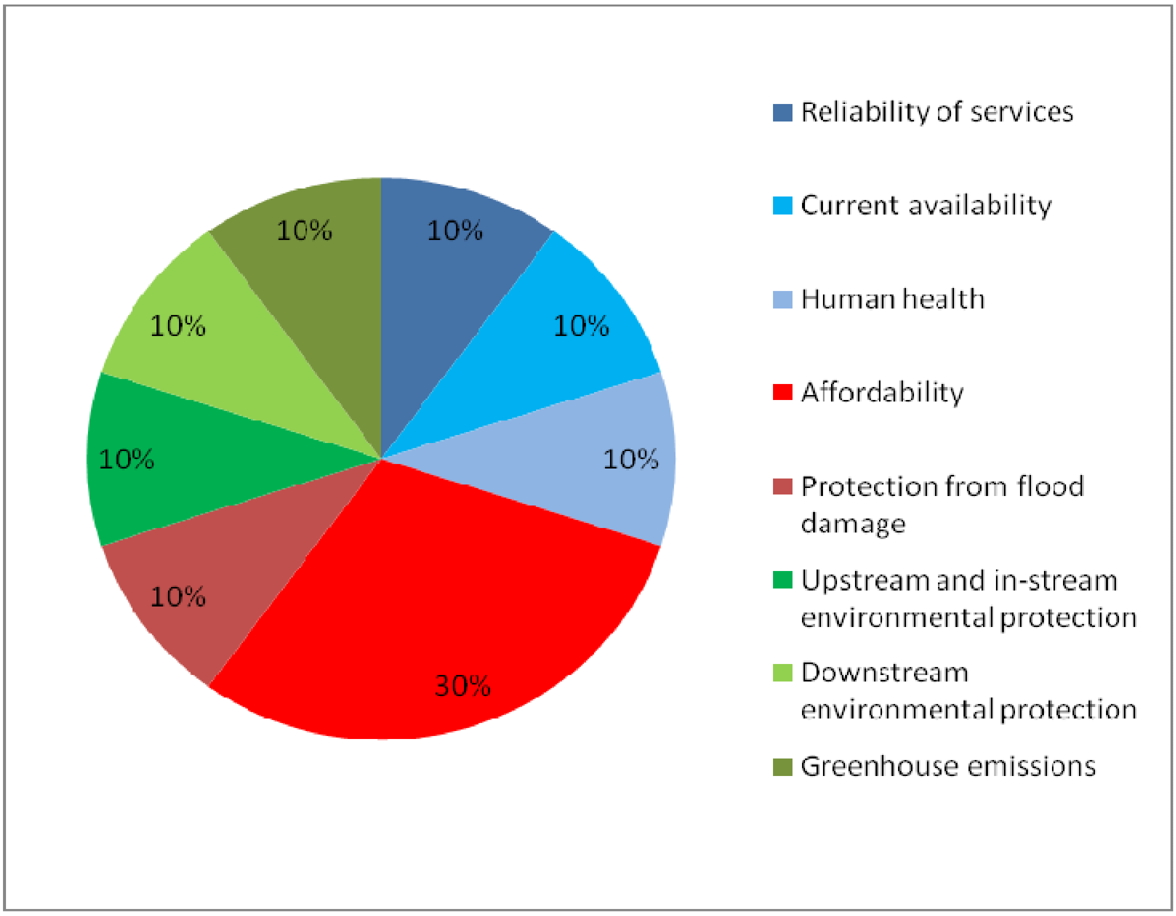
We believe the figures in Table 3 are conservative. They are estimates based on the amounts that are being presently captured and supplied. These can be expected to increase as experience and technologies progress. They confirm that even without desalination or the River Murray, the local flows are sufficient to supply present demands and could potentially remain sufficient into a future involving a doubling of Adelaide's population and an expectation of reduced rainfall caused by climate change.

The amount of storage required to carry the flows through drought conditions is addressed in subsequent sections.

## 5. Assessment of options

A range of water supply options are assessed against the criteria listed in section 2. Each option is given a score from 0-5 based on its merits, apart from affordability which is scored out of 15 to reflect the importance of an affordable water supply. Figure 2 shows the allocation of scores against each sustainability criterion.

**Figure 2. Sustainability criteria weighting**




The criteria have been loosely grouped according to the three pillars of sustainability as follows:

- The blue criteria reflect social sustainability considerations (30%)
- The red criteria reflect economic sustainability considerations (40%)
- The green criteria reflect social sustainability considerations (30%)

Obviously many of the criteria reflect more than one sustainability pillar so this only provides a rough guide. The sum of the scores gives the total for the option analysed. The higher the score the better the supply option.

The 1994 EWS report "Future Water Supplies: 21 Options for the 21$^{st}$ Century"[2] contained a list of 21 possible options for future water supplies in SA. Included were options such as pipelines from the Ord River, diversions of rivers inland, icebergs, etc. These options were all shown to have major disadvantages and many would rank very poorly against the sustainability criteria defined here-in. The current set of water supply options considered here-in include those which were rated

[2] EWS (SA Water) Library Ref 94/4

most highly in the EWS report and/or are still widely recognised as legitimate options under present conditions. Options assessed are:

1. River Murray
2. Existing catchments
3. Rainwater tanks
4. Stormwater harvesting, wastewater reuse and groundwater extraction.
5. Demand management
6. Desalination and interconnector
7. Increased reservoir storage

Stormwater, wastewater and groundwater are considered in the same section since they are all located within the Adelaide area itself and have close synergies in the manner in which they may be developed.

The scoring and ranking of the options are inevitably subjective and should only be regarded as an initial screening. It is hoped that the process draws attention to the definition of sustainability, the inter-action that different water supply options have with the sustainability criteria and illustrates the fundamental importance of the decisions that must be made with respect to our future water supplies on the future development directions of Adelaide itself.

## 5.1 River Murray

The River Murray provides 80 GL or 37% of Adelaide's water in an average year and 180 GL or 79% in drought years[3]. In fact 91% of the total water delivered state-wide in 2006/07 (245 GL) was supplied from the Murray.[4]

It is now well documented that the River is failing, suffering from over-extraction and reduced rainfall. Although urban water use only comprises a very small part of the total diversions from the River Murray and further supply rights could be purchased, further diversions will be to the detriment of other users and will be seen to be socially undesirable where alternative options for Adelaide could be pursued that would not be detrimental to others.

Pumping from the River Murray is an energy, and therefore greenhouse, intensive process. In 2005/06 SA Water supplied 234 GL with only 48.7% sourced from the River Murray. The associated electricity consumption for all water supply activities was approximately 280 GWh, an overall energy intensity of 1.2 kWh/kL. However, in the dry year of 2006/07 SA Water supplied 245 GL[5] with 91% supply from the River Murray. The electricity consumption was approximately 530 GWh, an overall energy intensity of 2.2 kWh/kL. If the energy intensity is reduced 30% to include only major pumping and water treatment and increased by 5% to lift the proportion of supply from the Murray to 100%, the energy intensity of supplying potable water from the Murray is estimated at 1.6 kWh/kL.

Table 4 provides an assessment of the River Murray as an urban water option.

---

[3] Waterproofing Adelaide
[4] SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
[5] SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf

**Table 4. Assessment of River Murray**

| Category | Assessment criteria | Score |
|---|---|---|
| Reliability of services (5) | Flows in the River Murray are steadily decreasing and becoming more saline and there is a widespread acceptance of the need to wean Adelaide off this source of water which is increasingly unreliable. | 0 |
| Affordability (15) | At present pumping from the River Murray is affordable. As competition for water in the Murray and energy costs increase affordability will reduce. WPA cost estimate $1.1-$1.3/kL. | 9 |
| Current availability (5) | At present water from the River Murray is easily accessible. | 4 |
| Human health (5) | Water from the River Murray requires extensive treatment prior to potable use. Upstream inputs to the River Murray include sewage, pesticides and fertilisers. Supplies presently meet potable standards. | 4 |
| Protection from flood damage (5) | Supply from the River Murray does nothing to reduce flood risk for Adelaide. | 0 |
| Upstream and in-stream environmental protection (5) | Supply from the River Murray results in diversion of water from supporting environments and reduces environmental flows in the river system | 0 |
| Downstream environmental protection (5) | Supply from the River Murray does nothing to reduce downstream environmental impacts for Adelaide. | 0 |
| Greenhouse emissions (5) | Greenhouse emissions from pumping water over such long distances are relatively high. Estimated energy intensity of 1.6 kWh/kL. | 2 |
| **Overall (50)** | | **19** |

## 5.2 Existing catchments

The total runoff from the Onkaparinga, Torrens, South and Little Para catchments into the Mt Lofty Range reservoirs is about 180 GL/a of which 15 GL/a is lost by evaporation, 10 GL/a is diverted by farm dams and 34 GL/a spills. Thus 121 GL/a or 56% of Adelaide's reticulated supplies are provided from these sources. This drops to only 30 GL or 14% in drought years[6].

The total storage capacity of the Adelaide reservoirs is 222 GL. Further capture of the 34 GL/a presently spilled would require about 3 to 6 units of storage for each unit of spill saved. Moreover, evaporation losses and salinity rapidly increase as the storage sizes increase so that achieving an average long term supply equal to the long term average inflow is an impossibility using surface storages.

Further diversions could be sourced from catchments further north and south, but these sources are also expected to reduce by 30% under predicted climate change scenarios and diversions would create environmental damages.

An alternative is to release Mt Lofty Ranges water from the reservoirs for storage in the Adelaide aquifers. This has been proposed by CSIRO and appears an attractive alternative to additional

[6] Table 1, Water Proofing Adelaide

surface storages[7]. However, the limits to aquifer storage need to be assessed. Storage in the fractured rock aquifers within the Mt Lofty Ranges should also be investigated. Environmental flow requirements must still be met.

Table 5 provides an assessment of existing catchments as an urban water option.

**Table 5. Assessment of existing catchments**

| **Category** | **Assessment criteria** | **Score** |
|---|---|---|
| Reliability of services (5) | Flows vary significantly from year to year. Expected reduction of 32% under climate change impacts with higher variation from year to year. If flows can be stored (eg in aquifers), relatively high reliability. | 4 |
| Affordability (15) | Very affordable. | 12 |
| Current availability (5) | At present water from the existing catchments is easily accessible. | 4 |
| Human health (5) | Water from the catchments requires treatment prior to potable use but is of a relatively high standard. | 4 |
| Protection from flood damage (5) | Supply from the existing catchments already provides an important service in flood mitigation by reducing flows from the Adelaide Hills through the suburbs in storm events. | 3 |
| Upstream and in-stream environmental protection (5) | Supply from existing catchments results in diversion of water from local supporting environments. Land impacts on biodiversity have occurred in the past. | 2 |
| Downstream environmental protection (5) | Storage and supply from the existing catchments already reduces stormwater discharges to the natural environment. Does not reduce sewage flows to the gulf. | 2 |
| Greenhouse emissions (5) | Greenhouse emissions from pumping water from existing catchments are relatively low. Assume emission intensity of 0.4 to 0.6 kWh/kL for conventional water treatment[8]. | 4 |
| **Overall (50)** | | **35** |

## 5.3 Rainwater tanks

Adelaide has more rainwater tanks per capita than any other Australian capital city and there is great community interest in rainwater capture and reuse. Roof runoff is generally of potable quality with little treatment however the captured rainwater is relatively expensive (due to the cost of system installation) and maintenance requirements are not always managed well at the household level.

The total amount of roof runoff generated in Adelaide is estimated to be about half of the total stormwater runoff (say presently about 50 GL/a). This is the highest quality water available from any of the sources. It also runs off with minimum losses in all rainfalls and therefore has a high reliability. However, because of roof designs and tank capacity limitations, only part of this water could be easily harvested by individual houses.

[7] Verbal Peter Dillon, CSIRO
[8] http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

Rainwater tanks and water recycling appear to have greater immediate application in industrial situations where economies of scale exist.

On-site storage capacity in the form of tanks can be used to reduce peak flows in mains water supply. The benefit of tanks for mitigation of peak flow rates in water supply and the additional benefit of reduction in stormwater flooding have not been adequately investigated.

Table 6 provides an assessment of rainwater tanks as an urban water option.

**Table 6. Assessment of rainwater tanks**

| Category | Assessment criteria | Score |
|---|---|---|
| Reliability of services (5) | Reliability will vary with year to year variations in rainfall, household use and level of maintenance of systems. | 3 |
| Affordability (15) | Very expensive. WPA cost estimate $5.6/kL. NWC cost estimate $3-$11 depending on connected roof area.[9] | 3 |
| Current availability (5) | Rainwater tanks can be relatively quickly installed and plumbed in. | 3 |
| Human health (5) | Rainwater from roofs is considered as potable by the Department of Health but maintenance requirements should not be underestimated. | 3 |
| Protection from flood damage (5) | Rainwater tanks plumbed into indoor uses will provide some flood mitigation benefits. | 3 |
| Upstream and in-stream environmental protection (5) | No negative impacts on the upstream environment. | 5 |
| Downstream environmental protection (5) | Some benefits in the reduction of stormwater discharges. | 4 |
| Greenhouse emissions (5) | While greenhouse emissions are associated with tank manufacture this is offset by relatively low energy use from direct indoor reuse. | 4 |
| **Overall (50)** | | **28** |

Improvements in rainwater tanks are seen to be a major growth area in conjunction with the development of more sustainable homes (both existing and new). The development of on-site systems, including solar energy, composting toilets, greywater recycling and rainwater (and other water) storage devices should be encouraged by research, regulations and incentives. Until costs can be reduced and maintenance standards improved, rainwater tanks and greywater recycling are seen to only have a small role in Adelaide's water supply mix. The greatest contribution may initially come from the industrial sector. By 2050, this situation may have changed as on-site technologies continue to develop.

## 5.4 Stormwater harvesting, wastewater reuse and groundwater extraction.

Stormwater harvesting, wastewater reuse and groundwater extraction are addressed together, but in separate sub-sections, since they all have interlinkages with aquifer storage and recovery.

[9] The cost-effectiveness of rainwater tanks in urban Australia, Marsden Jacob Associates for the National Water Commission

Based on WPA information present levels of combined stormwater harvesting and wastewater reuse is about 5 GL/a and groundwater consumption is 9 GL/a. The present total stormwater and wastewater flow is given by WPA as 230 GL/a. These sources are generated in almost direct proportion to the growth in population and development; hence they have an intrinsic sustainability in respect to their future availability as potential water supply sources.

Since the aquifers are spatially distributed over a wide area of central and western Adelaide and recharge and recovery of stormwater and wastewater can only be established in sufficiently large volume rates by spatially distributing the bores across the extent of the aquifers, the development of these sources will be necessarily best accomplished via decentralised systems. This raises particular issues in relation to land planning and building designs which are addressed in section 7.

As noted above, the total capacity of the tertiary aquifers is uncertain but may be of the order of 100 times the capacity of the Mt Lofty reservoirs. Clark (AWA 2003) addressed the amount of storage required in surface and aquifer storages under various strategies in which stormwater and wastewater were used to augment Mt Lofty catchment runoff in order to replace reliance on River Murray water. Assumptions were made based on the experience gained by the demonstration projects at Mawson Lakes and elsewhere. Clark assumed that because of limitations on open space for wetlands to capture stormwater, only 70% of the stormwater could be harvested, however 95% of wastewater could be recycled. Stormwater and wastewater would be stored by a network of distributed bores in the upper and lower tertiary aquifers.

Clark's modelling showed that only 50 to 250 GL of aquifer storage would have to be accessed in order to reliably supply present day demands throughout a 100 year period receiving the past record of historical rainfalls under various combinations of sources and supplies in which:

- Mt Lofty catchment water was mainly retained as the primary source for 'in-house' potable demands
- treated wastewater was used as the primary source for non-potable demands including toilet flushing and all garden and open space irrigation within the City, and
- stormwater was used in conjunction with the above, or as a fill-in for either or both sources if/when they failed.

The large range of 50 to 250 GL of aquifer storage arose because of the different matching that could be made between the different combinations of the supply sources and the demands, with each having markedly different seasonal patterns, i.e. Mt Lofty runoff is markedly winter oriented; stormwater is similar but also has a larger summer component; in-house demands and wastewater flows are essentially seasonally constant, while irrigation demands are markedly summer oriented. The use of rural catchment and stormwater runoff for supplying irrigation therefore requires large storage volumes. The use of treated wastewater for toilet flushing and constant industrial purposes requires virtually no storage at all.

In general, because of the lesser variability and greater reliability of stormwater and the constant supply of treated wastewater flows, the amount of aquifer storage required to provide a reliable supply over 100 years for a typical urban area when using a combination of these sources (assuming they could be satisfactorily treated to acceptable standards), was found to be of the order of 5 to 8 times less than the surface reservoir storage required when the supply was sourced from Mt Lofty rural catchments.

Clark found that the space required for wetlands to capture 70% of the stormwater flow at any location would constitute about 5% of the upstream urban catchment area. Since 12.5% of new development areas is commonly assigned as open space, the wetlands could be sited within these areas. However such open areas may not be suitably located, or may not exist where development has been intensive. To date open spaces where wetlands could exist in already developed areas have been located in parks, golf courses, airports and re-development zones.

In areas where development has left few open spaces, wetlands could be replaced by the adoption of permeable paving, underground 'buffer' tanks and rainwater tanks. Alternatively, the water quality and treatment aspects of wetlands could be foregone in favour of small-footprint rapid sand filtration plants. In the extreme, high risk flood-prone buildings could be removed to make way for linear parks which could contain mini-wetlands, as well as creating walking and bicycling tracks and enhanced public amenity and biodiversity.

Clark (AWA 2005) also showed that the largest peak flood flow rates in urban areas of Adelaide will continue to occur in summer rather than winter. Flood detention dams situated in urban areas (as are increasingly being required under urban consolidation trends) are generally required to be larger than would be required for stormwater harvesting. Since stormwater harvesting will occur mainly in winter, when the full capacity of the dams are not required for flood mitigation, the dams can be used for both flood mitigation and harvesting at no additional cost.

Overall Clark's modelling showed that approximately 900 bores would be required for aquifer injection, storage and recovery under the supply strategy that entailed access to 60 GL of aquifer storage.

The feasibility of storing large quantities of water in the aquifers beneath Adelaide is the key to the use of stormwater and wastewater as new sources of low cost water supplies that will bring with them all the other benefits of sustainability, as defined. Recent trials by CSIRO have shown that aquifers can be used for water treatment and transmission in addition to storage. Water of potable standard was extracted from an aquifer at Parafield which had been previously recharged by stormwater, which had only been treated before injection by passing through a wetland. The recovered water exceeded drinking water standards and was bottled as drinking water for publicity purposes[10]. The ability to recharge in one location, and recover in another, offers the potential for water trading between rechargers and users without the need for linking pipelines.

If however, the usable capacity of aquifer storage and recovery is found to have lower limits than has been generally informally identified by hydrogeologists (about 60-80 GL), the option exists to pump stormwater (possibly after pre-treatment) to the nearest existing reservoirs, after which it can be treated to potable standards in the existing treatment plants. This may be a short term solution while the broader planning aspects of a more decentralised system involving spatially distributed wetlands and ASR bores is sorted out.

### 5.4.1 Stormwater harvesting

The total amount of stormwater generated is far in excess of the flows on the Adelaide plains before urban development took place. The quality of the flows varies from very good (eg roof runoff) to poor (eg runoff from arterial roads). The negative impacts of stormwater on coastal environments are well documented.

Poor quality runoff is best treated at or near its point of generation. Where possible, this can be done using wetlands, which then enhance biodiversity and urban environments and can assist in flood mitigation. The cleaned water is then suitable for supply. It is in sufficient quantities to be used for augmentation of potable supplies after storage in underlying aquifers and will grow in volume along with the expansion of the city. Its volume is less affected by climate change than supply from dams on rural catchments.

The location of capture and treatment storages can be made compatible with a program for reducing flood damages.

Estimates of harvestable stormwater vary significantly, including:

- WPA assessment of 15 GL.
- Todd Hodgkin 50 GL[11].
- The Cities of Salisbury, Playford and Tea Tree Gully are in the process of completing projects to extract 20 GL by themselves[12]. Most of the harvesting schemes are being designed for a 70% capture efficiency.
- The South Australian Liberals proposed 89 GL of stormwater capture and reuse[13].

[10] CSIRO publication
[11] Aquifer Storage Capacities of the Adelaide Region Report DWLBC 2004/47
[12] City of Salisbury press release 21/7/2005
[13] South Australian Liberals website http://www.martin2010.com.au/Pages/Article.aspx?ID=389

The Adelaide and Mount Lofty Ranges NRM Plan provides a twenty year Regional Target of 75% stormwater harvesting and use.

Over the past 15 years stormwater has gone from being generally regarded as a nuisance to being a potential resource. The State Government is working with local governments on stormwater harvesting and reuse through its Stormwater Management Authority. The Government is contributing some funding to the Authority for projects incorporating floodplain mapping, preparation of stormwater management plans and priority stormwater infrastructure works[14].

Most advances in stormwater management have been left up to individual local Councils, developers and research organisations. Although considerable success has been achieved, progress has necessarily been ad hoc and almost completely uncoordinated in respect to any State policies, plans or strategies.

In view of the potential of stormwater, much more needs to be done, the question of responsibility for planning needs to be addressed and the whole process needs to be accelerated by an order of magnitude.

Table 7 provides an assessment of stormwater harvesting as an urban water option.

**Table 7. Assessment of stormwater harvesting**

| **Category** | **Assessment criteria** | **Score** |
|---|---|---|
| Reliability of services (5) | Flows vary from year to year but less than flows from catchments. With flows stored through ASR relatively high reliability. | 4 |
| Affordability (15) | Relatively inexpensive. WPA cost estimate $0.1-$1.5/kL. | 12 |
| Current availability (5) | Will take some time to fully identify preferred configurations and construct. Groundwater may be used in the meantime. | 3 |
| Human health (5) | Relatively easy to treat to potable standards if required. | 4 |
| Protection from flood damage (5) | Significant flood mitigation benefits subject to sufficient detention capacity. | 4 |
| Upstream and in-stream environmental protection (5) | No negative impacts on the upstream environment. | 5 |
| Downstream environmental protection (5) | Very significant benefits in the reduction of stormwater discharges. | 5 |
| Greenhouse emissions (5) | Relatively low greenhouse emission option. Assume 0.7-1.2 kWh/kL for brackish reverse osmosis[15]. | 4 |
| **Overall (50)** | | **41** |

[14] http://www.ministers.sa.gov.au/news.php?id=3228

### 5.4.2 Wastewater reuse

Wastewater is excess to all previous flow regimes. It constitutes a present large pollution source. The level of mandatory cleansing to make it acceptable for discharge to the environment makes it suitable for irrigation, toilet flushing and other industrial purposes at little or no additional treatment cost. However, under the existing system layout, where the sewage treatment plants are sited on the coast, the cost of reticulating the treated water back for re-use is a potentially large cost.

To date wastewater reuse has focussed on peri-urban irrigation. The proximity between the northern and southern wastewater treatment plants and the irrigation areas reduces the reticulation cost. Some of this use replaces past unsustainable extractions of groundwater, however additional allocation to new irrigation ventures requires a closer examination of the relative long term costs and benefits of re-use by first users or use by the range of possible new users.

The flow of wastewater is essentially constant. It therefore has virtually zero need for storage if used for supplying constant demands (eg toilet flushing and certain industrial uses). This is a large advantage which greatly reduces its cost as an alternative water source.

Sections of the public have shown a strong aversion to acceptance of even highly treated wastewater for drinking and washing, even when health standards are met or surpassed. Several hierarchies of preferences for the use of treated wastewater have been obtained. These generally indicate wide acceptance for garden irrigation with growing un-acceptance for more ‘personal’ uses. It is less well known that several towns along the Murray River and in the Mt Lofty Ranges discharge their treated effluent into the creeks and rivers that inflow to the water supply reservoirs, although on a minor scale overall, and that this practice of recycling effluent through river flows is an accepted practice on a much wider scale in most water supply systems in Europe.

The Australian Coastal Waters Study provides specific targets for wastewater as follows:

- The total load of nitrogen discharged to the marine environment should be reduced to around 600 tonnes (representing a 75% reduction from the 2003 value of 2400 tonnes).
- A 50% load reduction in particulate matter (from 2003 levels) would be sufficient to maintain adequate light levels above seagrass beds for most of the time.

The Adelaide and Mount Lofty Ranges NRM Plan provides a twenty year Regional Target of 100% of wastewater reuse.

The Government has announced that it will spend about $426 million over four years on upgrades and expansion of wastewater treatment plants and water recycling infrastructure to meet the increasing demand of the State’s growing population. About $80 million will be spent in 2008/09. The upgrades will increase the percentage of wastewater reused in South Australia from 29% to 45%. This includes the Glenelg Waste Water Treatment Plant to Adelaide Parklands project which will be a first instance of bringing recycled water into Adelaide’s CBD. These schemes have not, however, been framed within a long term integrated plan for managing Adelaide’s water systems.

Table 8 provides an assessment of wastewater reuse as an urban water option.

[15] http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

**Table 8. Assessment of wastewater reuse**

| Category | Assessment criteria | Score |
|---|---|---|
| Reliability of services (5) | Consistent flows from year to year and proven re-use technologies provide a high level of reliability. | 4 |
| Affordability (15) | Relatively inexpensive, but depends on treatment required. WPA cost estimate $1.0-$1.75/kL. | 9 |
| Current availability (5) | To develop and construct additional wastewater reuse schemes will take some time. | 2 |
| Human health (5) | Not an issue for non-potable purposes. Cross-connection with potable supplies possible, but low risk even then. Can be treated to potable standard, but very low level of present public acceptance. | 3 |
| Protection from flood damage (5) | No significant flood mitigation benefits. | 0 |
| Upstream and in-stream environmental protection (5) | No negative impacts on the upstream environment. Can assist upstream environments if used to replace upstream sourced supplies. | 4 |
| Downstream environmental protection (5) | Very significant benefits in the reduction of effluent discharges. | 5 |
| Greenhouse emissions (5) | Low greenhouse emission option. 0.8-1.0 kWh/kL for wastewater reclamation[16]. | 4 |
| **Overall (50)** | | **31** |

### 5.4.3 Groundwater extraction (without artificial recharge)

As a general principle long-term groundwater extraction rates should not exceed the long-term aquifer recharge rates. While recharge rates rise to partly compensate for rises in extraction rates, continued high extraction rates raise the risk of drawing high saline water into the existing usable aquifer zones. While the lower tertiary aquifers are now under prescription, thus limiting the total extraction from them, unconstrained extraction from the upper quaternary aquifers will continue unregulated.

An average of 18 GL/a rising to 24 GL/a was withdrawn over the decade 1990-2000 via about 1,200 private irrigation bores over the Northern Adelaide plains. A similar rate of withdrawal had been in existence for many years previously and is still continuing despite estimates that these rates are many times in excess of the natural recharge rates. Since the aquifers extend over at least double this area, the withdrawal of emergency supplies of about the same order would appear to be feasible.

Groundwater can be brought on-line quickly as an emergency supply. In areas with buildings or flood prone land extraction of groundwater needs to be carefully managed to avoid the possibility of subsidence if Hindmarsh Clay is dewatered or pressures are excessively reduced.

[16] http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

Table 9 provides an assessment of groundwater extraction without managed aquifer recharge as an urban water option.

**Table 9. Assessment of groundwater**

| Category | Assessment criteria | Score |
|---|---|---|
| Reliability of services (5) | The large volume available ensures high reliability over the short term, but recharge is required over the longer term to sustain higher supply rates. | 2 |
| Affordability (15) | Relatively inexpensive. Can be accessed close to demand. Will require treatment. Estimate $0.75-$1.00/kL. | 12 |
| Current availability (5) | Can be brought on line very rapidly as 'emergency' source. Groundwater has been a traditional source of emergency supplies with last use in Adelaide during the drought of 1954. | 5 |
| Human health (5) | Relatively easy to treat to potable standards if required. Some shallow groundwater sources chemically contaminated. | 3 |
| Protection from flood damage (5) | No significant flood mitigation benefits unless used in conjunction with stormwater harvesting and ASR. | 0 |
| Upstream and in-stream environmental protection (5) | Unsustainable for additional supply without artificial recharge. Rates of natural recharge are poorly known. No particular benefit to upstream environments | 0 |
| Downstream environmental protection (5) | Unsustainable supply without recharge. No particular benefit to downstream environments | 0 |
| Greenhouse emissions (5) | Low greenhouse emission option. 0.7-1.2 kWh/kL for brackish reverse osmosis[17]. | 4 |
| **Overall (50)** | | **26** |

## 5.5 Demand management

There is a widespread tendency to focus on the sources of water supply during drought. However, there is the opportunity to reduce the amount of water we use in the first place. This is not a trivial matter. In South East Queensland, per capita mains water consumption reduced from 300 litres per day in 2005 to 129 litres per day in 2007 – a reduction of 57%[18]. This followed the introduction of a comprehensive demand management program Target 140, a campaign to achieve a regional average water use target of 140 litres per person per day.

The Target 140 program included[19]:

- The Residential Excessive Water Users Compliance Program under which households which use above a specified allocation without a legitimate reason are exposed to penalties.
- Water restrictions.
- Requirements for industry to implement Water Efficiency Management Plans.

[17] http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf
[18] Queensland Water Commission http://www.qwc.qld.gov.au/tiki-read_article.php?articleId=260
[19] Queensland Water Commission http://www.qwc.qld.gov.au/Demand+management

- Requirements for new houses to substitute 70,000 litres per annum from rainwater or local recycling and to incorporate water efficient fixtures.
- A comprehensive water rebate scheme.
- Pressure and leakage reduction programs. Brisbane City Council has saved 20 megalitres (ML) of water per day under such a program.[20]

The Target 140 program has recently been slightly softened to Target 170 to reflect the reduced scarcity of water at this time.

In 2006/07 average residential consumption per household in the metropolitan Adelaide area was 246 kL for an estimated population supplied of 1,095,000[21]. Based on an average household size of 2.4 persons[22] this gives a daily per capita water consumption of 280 litres. If a program similar to Target 140 is introduced this has the potential to reduce Adelaide's residential water consumption by 50%. Sustainable Focus has taken into account the different climate and in particular rainfall amount and distribution in making this recommendation.

Average daily per capita consumption including commercial, industrial and residential use was 388 litres in 2006/07[23] By deduction, commercial and industrial water consumption is approximately 108 litres per person per day. A twenty percent reduction in industrial and commercial water consumption could be expected through a targeted water efficiency program based on the practical experience of Sustainable Focus.

Overall, the potential saving from a strong demand management program (supported with pricing reform – refer below) targeting residential and commercial/industrial users would therefore be in the order of 160 litres per capita per day, equivalent to 64 GL per annum.

The South Australian State Government has a rebate package to encourage the harvesting of rainwater and to reduce water use in the home. Rebates are available for water efficient showerheads, toilets, washing machines and garden products, home water audits and installation of rainwater tanks[24]. This program is a beginning. A much more comprehensive approach is needed. This should include making the program as simple and non-bureaucratic as possible and including additional measures. An example of an additional measure is reducing mains pressure at each household or the neighbourhood level to less than 500 kPa. Above this pressure most water efficient fixtures are not guaranteed to function and water wastage is inherent. Obviously fire and other systems require higher pressures but 500kPa is more than sufficient for all household needs.

Pricing is an essential component of managing demand. In South Australia the two-tier structure for residential customers for 2007/08 includes:

- $0.50/kL for water use from 0-125 kL.
- $1.16/kL for water use above 125 kL.

The new three tier structure for 2008/9 is:

- $0.71/kL for water use from 0-120 kL.
- $1.38/kL for water use from 120-520 kL.
- $1.65/kL for water use above 520 kL.[25]

Costing water in the vicinity of $1 per tonne provides little incentive to reduce consumption. While the new tariffs are higher, the increases are most heavily weighted towards the lowest water users (42% increase below ~ 125kL compared with 19% increase above 125kL). This effectively

[20] Brisbane City Council http://www.brisbane.qld.gov.au/BCC:BASE::pc=PC_2452
[21] SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
[22] Australian Bureau of Statistics http://www.censusdata.abs.gov.au/ABSNavigation/prenav/ViewData?&action=401&tabname=Summary&areacode=405&issue=2006&producttype=QuickStats&textversion=true&navmapdisplayed=true&&breadcrumb=PLD&
[23] SA Water Annual Report 2007 http://www.sawater.com.au/NR/rdonlyres/FFAE4759-C70E-4322-B6ED-00E74F92EA60/0/SAWater_AR_Parliament_2007.pdf
[24] http://www.ministers.sa.gov.au/news.php?id=3228
[25] http://www.ministers.sa.gov.au/news.php?id=2515

disadvantages more efficient water users. Pricing for commercial users also needs to be addressed. Based on an average residential consumption per household in the metropolitan area of 246 kL the direct unit charge for water supply would be only $203 per annum. However, the overall cost of water is much greater than the unit charge. There are annual fixed supply charges for water supply of $160 and sewer at $1.42 per $1,000 property value. Based on a median house price of $420,000 the fixed charges total $756 – this is almost four times the variable cost.

If a 50% reduction in household water use was targeted, the average household's water bill would only reduce by 10%. Again, this provides little incentive for householders to reduce use and would likely soon reduce the momentum of any demand management plan. Redressing the balance between fixed and variable charges is urgently required.

One option proposed by Mike Young (University of Adelaide) and Jim McColl (CSIRO) proposes a flat rate charged per kilolitre of water with no water supply charge. This has been modelled by Intelligent Software Development which has shown that the existing tariff structures disadvantage low income households and low water users and that shifting to a flat tariff would redress the balance significantly[26]. We believe this rationale could be taken even further by removing all standing water and sewer charges and putting in place a tariff that allows for a reasonable amount of water at a reasonable price and then rises steeply to provide incentives for water efficiency and management. The average cost per household could remain the same. Table 10 provides an assessment of demand management as an urban water option.

**Table 10. Assessment of demand management**

| **Category** | **Assessment criteria** | **Score** |
|---|---|---|
| Reliability of services (5) | If well designed and implemented, demand management programs are a proven and reliable option | 4 |
| Affordability (15) | Highly affordable option. Small changes made at the household level. No significant infrastructure required. | 15 |
| Current availability (5) | Demand management programs can be brought on-line quickly. | 4 |
| Human health (5) | No issues with human health, if suitably structured. | 5 |
| Protection from flood damage (5) | No flood mitigation benefits. | 0 |
| Upstream and in-stream environmental protection (5) | Demand reduction will assist in returning water to upstream environments. | 4 |
| Downstream environmental protection (5) | Significant benefits in the reduction of effluent volumes. | 4 |
| Greenhouse emissions (5) | Lowest greenhouse emission option. | 5 |
| **Overall (50)** | | **41** |

26 http://www.intelligentsoftware.com.au/files/Fairer%20Water%20Pricing%20Policy%20for%20Adelaide%20Residents-Public.pdf

## 5.6 Desalination

A $1.1 billion 50 GL desalination plant at Port Stanvac was recently announced. This option will provide a source of water regardless of rainfall. It is however very difficult and energy intensive to remove salt from water – it is much easier to remove other common impurities. The saltier the water the higher the difficulty and the greater the energy use. This means that desalinating groundwater, stormwater or even wastewater is much easier than desalinating sea water. Overall, this makes desalination of sea water a relatively high cost, high greenhouse intensity option.

An associated $304 million inter-connector pipeline, to be completed in 2014, is proposed to connect reservoirs in the North and South of Adelaide, providing greater flexibility in managing Adelaide's water distribution system[27]. This has been proposed as part of the sea desalination scheme. While not stated, the pipeline would presumably be needed as a result of the location of the desalination plant towards the south of Adelaide while the bulk of demand is in the north. However, the bulk of the stormwater, wastewater and groundwater storage is in the north of Adelaide and thus the establishment of the pipeline without taking future options into account could disadvantage the viability of these future options.

Table 11 provides an assessment of desalination as an urban water option.

**Table 11. Assessment of desalination**

| Category | Assessment criteria | Score |
|---|---|---|
| Reliability of services (5) | Consistent flows regardless of rainfall and proven technologies provide a high level of reliability. | 4 |
| Affordability (15) | Relatively expensive. WPA cost estimate $1.50-$2.00/kL (assume based on operating costs, excluding National Emissions Trading Scheme). The true cost would be much higher as the $1 billion capital cost needs to be paid off. | 6 |
| Current availability (5) | Will take time to construct and commission proposed plant. | 3 |
| Human health (5) | Water will be treated to meet potable standards. | 4 |
| Protection from flood damage (5) | No flood mitigation benefits. | 0 |
| Upstream and in-stream environmental protection (5) | Only marginal benefits on the upstream environment. | 4 |
| Downstream environmental protection (5) | Significant negative impacts on the downstream environment resulting from brine discharge to the Gulf. No improvement to existing impacts from stormwater and wastewater discharges. | 1 |
| Greenhouse emissions (5) | Highest greenhouse emission option. 3-5 kWh/kL for reverse osmosis of seawater[28]. Almost ten times more energy intensive than standard water treatment and four times more energy intensive than reverse osmosis of stormwater or wastewater. | 0 |
| **Overall (50)** | | **22** |

[27] http://www.ministers.sa.gov.au/news.php?id=2515
[28] http://www.aph.gov.au/library/pubs/rb/2005-06/06rb02.pdf

### 5.7 Mt Bold expansion/increased reservoir storage

The State Government is continuing to pursue increased storage capacity. This was initially foreseen as involving the doubling of the capacity of the Mt Bold reservoir to two years of storage[29], but now appears to be including other possible sites with a target of 384 GL. Since increasing the storage associated with existing Mt Lofty catchment inflows will only provide a very small increase in supply, the storage is presumably to be filled with water from other sources. These have not been identified, but are believed to mainly involve the River Murray.

It is estimated such a project would take up to ten years to design and build. Given the long lead time, climate changes would need to be projected out to at least 2050 to determine the value of the project, which is highly sensitive to the effects of climate change. The authors share the Conservation Council of South Australia's (CCSA) concerns regarding destruction of unique habitat (in the case of Mt Bold) which will impact on threatened species[30].

The authors agree that additional storage is required to attain adequate water security for Adelaide. However, in semi-arid climates such as Adelaide's, groundwater storage is preferable to surface storage if it can be found. Investigations into increased surface storage capacity in the Mt Lofty Ranges appear premature until the capacity of the groundwater aquifers and the sources of the waters to be stored have been adequately examined. Table 12 provides an assessment of increased storage capacity as an urban water option.

**Table 12. Assessment of increased storage capacity**

| **Category** | **Assessment criteria** | **Score** |
|---|---|---|
| Reliability of services (5) | Provides additional storage but probably reliant on River Murray inflows which will be increasingly uncertain. | 1 |
| Affordability (15) | Highly expensive storage option at a minimum cost of $850 million with very little additional benefits. | 1 |
| Current availability (5) | Will take up to 10 years to construct. | 0 |
| Human health (5) | Water is assumed to be treated to potable standards. Refer River Murray. | 4 |
| Protection from flood damage (5) | Could be designed to have additional flood mitigation benefits. | 2 |
| Upstream and in-stream environmental protection (5) | Major negative impacts on the upstream environment through the possible destruction of habitat with dependant threatened species. | 0 |
| Downstream environmental protection (5) | No downstream environmental benefits. | 0 |
| Greenhouse emissions (5) | Claimed quadrupling of the carbon footprint[31]. | 1 |
| **Overall (50)** | | **9** |

[29] http://www.ministers.sa.gov.au/news.php?id=3228
[30] Water in a Changing Climate, Conservation Council of South Australia, June 2008
[31] Water in a Changing Climate, Conservation Council of South Australia, June 2008

# 6. Summary of options

The various water options have been ranked using the scores in the Tables in section 5.

The use of the sustainability criteria separates the options quite dramatically. While the scoring has been subjective, it is difficult to envisage that using the criteria others would not reach a similar overall ranking of the options. The authors believe that the criteria can be justified on the basis that their adoption will support the needs of present and future generations of Adelaideans.

While the amounts that can be supplied from the various high ranked 'preferred' options cannot be known accurately at this time, it is possible to suggest and examine a supply mix compatible with the ranking. The authors have therefore allocated a nominal preferred supply for each option assessed in Table 13 below. While these figures are based on limited information, they show that demand management, stormwater harvesting, wastewater effluent re-use and rainwater tanks have the capacity to augment existing supplies from the Mt Lofty catchments into a next era of urban water management, that is specifically directed towards long term sustainability. Neither augmentation from the River Murray or from desalination of sea-water will be required.

Only 15 GL/a of wastewater is initially included in this calculation. The reason for this is that wastewater is seen by the authors as the giant 'sleeper' amongst water supply options. Once sustainability has been accepted in some form as presented, the importance and potential of wastewater recycling will be fully appreciated. The challenge to the water industry will be to find ways to solve the actual and perceived problems of turning wastewater into a resource for public acceptance as a future water supply, recognising that this does not have to be as a potable supply. The implications for this transition are discussed in the next section. We recommend additional reuse outside of the metropolitan area to further reduce downstream environmental impacts in the interim.

The authors recognise that further investigation is required to clarify several areas of present uncertainty associated with making stormwater and wastewater primary water sources for future water supplies. However, these sources of water fit so closely the sustainability criteria that any present areas of uncertainty or ambiguity should be addressed as problems to be overcome rather than barriers to not proceeding at all.

Desalination and/or increasing reservoir storage in the Mt Lofty catchments do not fit with the sustainable directions outlined. Stormwater harvesting and temporary groundwater mining can be brought on line as quickly, at lower overall cost, and in a manner compatible with the longer term sustainability strategy outlined in this report.

The authors preferred supply mix will take some time to come on line. In the case of a short term emergency arising with the present water supply system, the mining and possible treatment of groundwater is recommended.

**Table 13. Summary and ranking of options assessed**

| Category | Assessment | Score (out of 50) | Gigalitres (GL) |
|---|---|---|---|
| Demand management | Highly cost effective. Using water more efficiently is hard to beat. Propose ‘supply’ of 64 GL based on reducing residential use to 140 litres/person/day and a twenty percent reduction in commercial and industrial water use. Comprehensive program required. | 41 | 64 |
| Stormwater harvesting | Offers a cost-effective water supply option and provides very significant downstream environmental benefits. Propose supply of 60 GL within estimates made by others based on 50% capture. Urgent action required to make this happen at a large scale. | 41 | 60 |
| Existing catchments | Existing catchments are a proven and reliable option. Propose supply of 82 GL after early climate change impacts taken into account and in the interim while larger volumes of wastewater are brought on line. Protection of catchments and reducing system losses a priority. | 35 | 82 |
| Wastewater reuse | Offers a cost-effective water supply option and provides very significant downstream environmental benefits. Propose supply of 15 GL based on 30% recycling with metropolitan areas post demand management. Recommend additional reuse outside of the metropolitan area to further reduce downstream environmental impacts. | 32 | 15 |
| Rainwater tanks | While popular with the community relatively expensive and difficult to manage. Propose supply of 6 GL additional to stormwater harvesting (up to 4 GL from mandated tanks, additional from point of sale legislation and voluntary take-up). | 28 | 6 |
| Groundwater use | Groundwater extraction without recharge is inherently unsustainable. Propose supply of 0 GL unless used as emergency supply or (coupled with stormwater or wastewater reuse). | 26 | 0 |
| Desalination | Reliable source of water regardless of rainfall. However, desalination of seawater is expensive and energy intensive. Useful measure of last resort but not immediate priority. | 22 | 0 |
| River Murray | The River Murray is failing and should not be relied on as a long term supply. Allow for environmental flows and other users. Propose supply of 0 GL per annum (except while in transition to new system). | 19 | 0 |
| Increased storage/Mount Bold expansion | Storage relying on the River Murray and highly sensitive to climate change impacts is not sensible. Propose supply of 0 GL per annum. Redirect investment to other options. | 9 | 0 |
| **Total** | Based on conservative estimates exceeds current water use. | | **227** |
| Current water use | | | 216 |

# 7. Transitioning to a sustainable urban water system

## 7.1 Principles

The authors have found that a very large body of research, discussion and practical experience with alternative urban water systems has been accumulated worldwide, in Australia and here in Adelaide.

The main interest in alternative systems has been driven by the realisation that they offer a potential quantum improvement in efficiency in delivering water services in urban areas. Seeking sustainability has been the goal of many researchers, entrepreneurs and innovative agencies in the face of growing and unsustainable demands for water, dwindling supplies, increasing costs, reducing biodiversity, escalating flood risks and damages, and general degradation to upstream, downstream and in-stream urban environments. 'Total water cycle', 'closing the loop', 'integrated water systems', and 'water sensitive urban design' are all names under which the general movement towards exploration and adoption of the alternative systems travel. Taken together the common theme for moving towards sustainable water supplies in urban areas is water recycling within an integrated multiple objective plan for the city and its water systems.

The workshop report of the US National Science Foundation "Creating Blue Waters in Green Cities" July 2006 is a very comprehensive source of information relevant to this report. The recommendations of the workshop cannot be bettered as recommendations for the future water supplies and water systems for Adelaide. Selected priority recommendations which are particularly relevant to the Adelaide situation are given below.

1. Water is a central and essential organising element in a healthy and sustainable urban eco-system.

2. New approaches are needed to manage urban water systems which should include:
    a. moving towards an integrated system approach based on the total hydrologic cycle that addresses all of the uses and impacts of water in the urban environment;
    b. building multiple benefits into all water projects and programs that contribute to the economic, social and environmental heath of cities; and
    c. promoting new, innovative water systems design concepts that incorporate natural system restoration, replication and enhancement.

3. A cornerstone of a realistic vision of future cities is the decentralisation of wastewater treatment and localisation of drainage networks to provide multiple benefits.

4. Considerations of healthy urban water systems should be incorporated into the 'front-end' of land-use planning and development decisions.

5. Institutional and regulatory barriers should be addressed where they inhibit trialling and adoption of non-traditional, innovative and competitive approaches.

6. Planning and regulating authorities should have skills and resources broad enough to encompass all components of, and interactions between, urban watersheds and receiving aquatic ecosystems and should move towards an integrated system approach addressing all uses and impacts of water.

The importance of integrating urban planning with water systems planning should not be underestimated. If stormwater and wastewater become the main supply sources, as is likely in many parts of the world, urban dwellers will have to recognise that they are inhabiting their own water supply catchments. The same rules and regulations that many city dwelling bureaucrats have imposed on rural dwellers in the name of catchment management will now have to be imposed on themselves and their urban neighbours.

## 7.2 Network considerations

The present water supply system provides one quality of water, drinking quality, via a reticulation network that connects every customer to the single major supply system. A single quality of water is used for all purposes, even though most purposes do not require such a high standard. The potable water that is reticulated is gravity fed from the raw water source catchments to treatment plants located along the eastern side of Adelaide, where it is treated by disinfection, aeration, coagulation and filtration to drinking water quality. This water is then gravity and/or pump fed by an extensive pipe network to each service point.

A common justification for continuing with this system is a claim that it enjoys significant 'economies of scale'. However, CSIRO and others have demonstrated that our present urban water systems, when taken as a whole, do not have significant (if any) economies of scale. While economies of scale exist in individual components, this is largely offset by the need to join the enlarging system together by long lengths of ever increasing diameter pipes. In recognising this, the Productivity Commission also notes that a new generation of smaller scale, but more sustainable systems, based on local stormwater harvesting and wastewater recycling, intrinsically contain large opportunities for 'economies of scope' which will greatly exceed any real or imagined economies of scale [32]. The economies of scope, as defined, are those that accompany the break-up of large monopolies, freeing innovation and enterprise.

If stormwater and wastewater become primary sources of supply, a total re-design of the water systems is called for. This is because both the sources of these supplies and the demands for the services are spatially distributed and the storage and treatment infrastructure can be provided most economically when sited at a small scale within the local urban fabric.

At present, at least 70% of all the capital costs of urban water systems lie in the three sets of pipes and channels that bring water into, or take water back out of, the urban area. If the stormwater that is generated locally can be captured, treated, stored, used for in-house 'first-class' purposes, disposed via the wastewater system, then recaptured and treated again, stored again and re-used again, the off-site pipe networks would be very significantly reduced in size and cost.

In line with the above, several researchers have shown that the savings in the size and length of the import and export pipes and channels can more than counter any increased costs associated with the greater complexity of the decentralised and integrated systems. However, there are two main options in respect to the design of the reticulation systems that will require a decision to be made:

a) Since the existing single pipe system exists, it may be cheapest to treat all additional water to drinking standard and inject it into the pipe network as close to the location as it is harvested.
b) Second class water for garden watering and toilet flushing could be reticulated via a second pipe running in parallel with the existing pipe network. This is the solution provided at Mawson Lakes and Rouse Hill in Sydney.

It is probable that different approaches could be adopted for different locations and for different stages of the progressive restructuring of the system.

A transition to this direction has been already started by some local governments in Adelaide. Longer term transition will require research and cooperation between all levels of government. The main cost reduction strategy will involve the progressive replacement of ageing components of the present 'centralised' water supply, sewerage and drainage systems with a new generation of decentralised, multi-objective water systems.

[32] Productivity Commission "Toward Urban Water Reform"

## 8. Conclusions and Recommendations

Section 6 of this report provides a ranking of the urban water supply options for Adelaide against the sustainability criteria and identifies that a mix of the higher ranking options that could form the basis of a new generation water supply system conforming to sustainability principles and public expectations.

It is concluded that demand management, stormwater harvesting, improved efficiency of existing catchments, wastewater reuse and rainwater tanks can supply all of Adelaide's water requirements with excellent environmental, social and financial outcomes into the foreseeable future.

Desalination and/or increasing reservoir storage do not fit with the sustainable directions outlined.

Climate change is a reality and the focus needs to shift from knee-jerk drought response to long term planning under expectations of a changing climate and future population growth. This is a time of great opportunity to move to more productive and efficient water systems. The State and Federal governments have recognised that Adelaide is facing a water crisis and are prepared to invest in new infrastructure.

It is recommended that the following actions be undertaken in parallel as a matter of the greatest urgency:

- Establish a comprehensive long term demand management program with a residential target of 140 litres/person/day and a commercial/industrial target of 20% improvement in water use efficiency. As part of this, change the pricing structure for water by increasing the volumetric costs and reducing other charges to provide more incentive for users to reduce their demand to meet the overall target levels.
- Undertake an assessment of the capacity of the aquifers beneath Adelaide to support temporary groundwater 'mining', with treatment as necessary, as an emergency water supply, and commence determination of the limits of the aquifers for storing and recovering bulk water harvested from treated stormwater and wastewaters. Research means for exploring and raising the limits, as warranted.
- Commence implementation of a major metropolitan-wide stormwater harvesting program in partnership with local governments and SA Water.
- Identify and pursue strategies for making the total flow of treated wastewater acceptable for urban or peri-urban water supplies in a manner that directly or indirectly reduces the demand by the urban users on non-sustainable water sources by an amount equal to the total of the wastewater flow.
- Provide a single State government department with responsibility for multi-purpose, participatory, total water cycle planning, within the context of the State Water Plan. The Plan to cover the whole gamut of natural and engineered water systems. The department to be responsible for the immediate Water Security investigations.
- Broaden the present Water Security investigations to better define the costs and benefits of the long-term water options for Adelaide using total water cycle principles and judged on sustainability criteria as laid out in this report, but with a greater level of resourcing including:
    - consultation with Local Government and others who have successfully initiated and developed the more sustainable options to date; and
    - a program of information and consultation with the broader community on the implications, benefits and costs of the options as they emerge and progress.
- Put on hold funding proposed for desalination and reservoir storage and redirect to more sustainable options once the above assessments have confirmed the preferred options as feasible.
- Protect and improve existing catchments.
- Prescribe quaternary aquifers to prevent excessive extraction (this will be a specific issue as other sources of water become more scarce).

# Authors

**Richard Clark** has 45 years of experience as a hydrologist and water systems planner. This has included 19 years in the EWS Department, and a further 8 years in the various State government water resources planning departments, before he took up consulting privately under the name Richard Clark and Associates. Over the past 15 years Richard has been involved as water systems performance modeller in the design of most of the 'alternative' water systems in Adelaide including, New Haven Village, Mawson Lakes, Parafield Airport, Morphettville Racecourse, Grange Golf Club.

**Jake Bugden** is the Managing Director of Sustainable Focus. Over the past seven years Sustainable Focus has designed and managed numerous rainwater reuse and water efficiency projects. Jake has worked for a range of companies, NGOs and the Commonwealth government and has extensive project management experience in a range of environmental fields including energy efficiency, water efficiency, treatment and reuse, and the analysis of toxic chemicals. Jake holds a Bachelor of Chemical Engineering (honours) from the University of Adelaide and is a past recipient of the Young South Australian of the Year Environment Award.

**Speech by Paul Davis, Coorong, lakes and Murray Waterkeeper. 1st August 2008**

# Current conditions & environmental impacts in the River Murray and the Coorong, Lakes Alexandrina and Albert Wetland

### Significance of the region & Legislation and Treaty Obligations

We shouldn't have to be here today pleading for Commonwealth intervention to save national icon sites such as the Murray and the Coorong, Lake Alexandrina and Lake Albert Wetland. But we are here, out of necessity, as Government has given us little confidence that it is prepared to take on its full responsibilities and use its extensive powers.

Having signed the Ramsar Convention on wetlands and international agreements with China, Japan and Korea, Australia has a duty to maintain the lakes and the Coorong .

These international obligations have also been incorporated into the Environmental Protection and Biodiversity Conservation Act.

### History of Promises

For more than twenty years, report after report has warned of impending disaster.

Government's have commissioned more reports and pledged to take action but we have little to show for all the talk.

Since 1981 when the Murray Mouth closed for the first time, extractions from the Murray-Darling Basin have increased 300%. Now we have a new national water agreement that is not going to be fully implemented for another 10 years. Not only is it too slow, the new so called independent MDB authority has no real authority at all. It is essentially the old clumsy system re-badged and hyped up..

### Present condition

The impact of successive years of over-allocation, now exacerbated by the drought is obvious to all.

The majority of the Murray wetlands below Lock 1 are now bone dry. Sixty percent (60%) of red gums are dying or have died.

The Lakes, freshwater for 95% of their history, have fallen to the lowest ever level since their formation 1000s of years ago.

Salinity levels in the lakes have risen by more than 500%. In the stretch of river between Clayton and Goolwa salinity is so high marine tube worms are smothering the life out of the turtles, 10,000 have already died.

Hundreds of thousands of freshwater mussels have died.

Wader bird populations are down by more than 95%

The Coorong once an estuary is now a marine environment.

Keystone species of the food chain have been decimated.

The mottled sand crab of the north lagoon is dying under the weight of barnacles.

For the first time acid-sulphate soils have formed in the Lakes. Acid and toxic chemicals threaten to destroy their fresh water ecology.

**Importance of rivers and their wetlands**

Wetlands make up 6% of Earth's land surface and store 20% of its carbon. Given our concerns for climate change, it would be irresponsible to let them die. They produce 25% of the world's food, purify water, recharge aquifers and maintain biodiversity.

Healthy rivers and healthy wetlands are vital for the well-being and prosperity of us all.

We need 375 litres of fresh water into the Lakes now. Despite the denials the water is there.

We need the river to run again.

**Questions to Kevin Rudd, Penny Wong and Peter Garrett**:
Prime Minister, *Will our wetlands survive your time in Government*?

Prime Minister*, How is that Australia can openly criticise Japan for its international whaling activities, yet itself fail to comply with treaty obligations it has with Japan to protect the migratory birds dependent on inflows of freshwater?*