Sustainability Science
PO Box 11, Canberra City, 2601
ph: +612 6288.0760 f: +612 6287.4489

ACT Legislative Assembly,
Standing Committee on Planning and Environment,
GPO Box 1020
CANBERRA CITY ACT 2601.

Dear Committee Members

Options for ACT investment in maintaining a sustainable water supply in the ACT

The Sustainability Science Team P/L (SST) is an independent research and consulting group established in Canberra in 2002 to analyse and redesign unsustainable systems and replace them with sustainable alternatives- a process we call eco-innovation.

In 2003, SST in conjunction with UC and ANU undertook a comprehensive mapping of water flows into and out of the Australian Capital Territory on the basis of then available data. Land and Water Australia published the results as part of an appendix to a larger report on "Mapping Regional Metabolism: A Decision-support Tool for Natural Resource Management". This mapping showed serious inconsistencies in the available data both for water coming into and out of the ACT and for movements of water through the ACT.

The ACT water systems map was prepared before climate change significantly reduced the quantity and reliability of rainfall and water resources available in the ACT. On current projections this situation is expected to deteriorate further throughout southern Australia including the ACT over the next 10-20 years.

Attached is a submission to your inquiry into investment options for a sustainable water supply for your consideration. You will see that it greatly expands our previous work at the macro-level to consider not only surface flows, but include options for enhancing the ACT's water security through restoring natural and beneficial land management and cloud nucleation processes. In addition, at the micro level, we suggest that local *Autonomous Water Systems* (AWS) will reduce demand from existing storages.

AWSs rely on water use efficiency measures, including the safe recycling of treated water. In our view, the current proposals to mix treated sewage into the ACT's drinking water and natural catchments are not safe and risk imposing unnecessary and unacceptable risks and liabilities on the ACT government and community.

Fortunately safe affordable options are available to the ACT for treating and recycling water that prevent cross-contamination risks. These maintain 100% separate systems for drinking, functional and waste-waters.

The Sustainability Science Team would be pleased to provide further details if requested.

Yours sincerely

Walter Jehne
John Schooneveldt
Directors

SUBMISSION TO THE ACT LEGISLATIVE ASSEMBLY INQUIRY INTO INVESTMENT OPTIONS FOR SUSTINABLE WATER SUPPLIES.

1. The water resources available to the ACT

In the past, average rainfall of 645mm/pa delivered 1,6440 G/l of water to the ACT each year, much of which supported the rich ecology of the ACT's National Parks and rural hinterland. Only a small, and now decreasing proportion of this water finds its ways into the Cotter dams (total capacity 90Gl) for urban use.

In addition to the Cotter system, the ACT has water rights over the Queanbeyan/Molonglo rivers. However these rights are limited in practice by the capacity of Googong dam (125 Gl) and such declining run-off in NSW that feeds this dam.

There are also ground water sources whose capacity is unknown. Such drilling that has occurred has tapped cracked-rock aquifers up to about 100 m and has proven to be a very limited source. The possibility of tapping into very much deeper aquifers in the ACT has, as far as we are aware, not been tested.

There is also the possibility of purchasing water from the Murrumbidgee. The ACT has no water rights over Murrumbidgee flows at the ACT southern border. However, as some 331 Gl are added to this flow from within the ACT, and some 33.7Gl of treated water is added at the lower Molonglo Treatment facility, the ACT does have a claim to at least this proportion of Murrumbidgee water. The ACT is in a strong position here as it does not rely on ocean outfalls and replaces its water in the same river after use.

Recent changes to Murray and Darling Basin arrangements however may limit the reliable supply and use of Murrumbidgee waters by the ACT in competition with many increasing other demands.

Consequently the ACT's water security depends primarily on sustaining and maximizing the reliability and wise use of the water from the Cotter and Queanbeyan catchments, and as a consequence, the ACT needs to pay particular attention to:

- changes to rainfall and inflow into these catchments due to climate change.
- risks of contamination of the natural clean water in the Cotter catchment and any increases in contamination from farming activities in the Queanbeyan catchment
- risks from storing recycled water in the pristine Cotter catchment rather than the already contaminated Googong storage.
- safe recycling and storage of all available water resources.

2. Factors decreasing rainfall over the ACT's water catchments

The rainfall over the ACT catchments comes substantially from westerly frontal rain during winter and from intermittent easterly storms over summer. There is now strong evidence (Bureau of Meteorology, CSIRO) that the quantity and reliability of this rainfall has declined systemically and significantly over the past decades.

This decline in rainfall is consistent over southern Australia and results from the southward displacement and weakening of westerly fronts spiraling from Antarctica. This decline and increasing unreliability in rainfalls should intensify further with climate change.

This decline in rainfall, initially in SW Western Australia and more recently in the Wimmera, Victoria and the ACT have decreased rainfalls by up to 30% in the past 30 years.

Inflows into storages have decreased by up to 60-80% due to water retention in soils and losses via evapo-transpiration. Inflows into ACT water storages in 2006, a drought year, were 7% of normal and totally inadequate to meet current or projected water demands.

The mean annual rainfall runoff into water storages is projected to decline by up to a further 40% over the next 30 years for most of southern Australia.

These declines in rainfall and inflows will limit the ACT's capacity to meet water demands.

Building more or larger dams can not adequately offset this systemic decline in rainfall and dam inflows due to the increased evaporation and less reliable rainfall with climate shifts.

Consequently the ACT has no option but to better use available but decreasing water supplies. Instead of its current single use, 'harvest, pollute and dispose' approach, the ACT has no option but to introduce available, but safe, water recycling options.

3. Options to enhance the ACT's water security by restoring rainfall processes.

While there is more to understand, the available scientific evidence confirms that:

1. The ACT has and will continue to experience significantly lower rainfalls,
2. Partly due to the reduced number and intensity of westerly rain fronts, as well as
3. The reduced nucleation of water vapour in these humid air flows into raindrops.

Whereas the less effective rain fronts are associated with global climate shifts, perhaps half of the ACT's rainfall reduction may be due to changes humans have made to rainfall processes through altering the nucleation of clouds and raindrops as a result of changes to vegetation.

There is clear scientific evidence for this over much of southern Australia and the ACT.

For example the clearing of woodlands west of the rabbit proof fence in SW Western Australian has decrease rainfall 20% relative to that in adjacent still wooded areas to the east that previously received less rain due to being further inland from moist onshore winds.

Such extensive land clearing would have reduced the transpiration of water but also increased the production of dust which serves as nuclei for the condensation of water vapour into cloud micro-droplets and persistent humid hazes. In the absence of adequate larger rain nuclei, from established vegetation, such humid pollutant hazes often persist to significantly:

- warm regional climates through their absorption of both incident solar radiation as well as re-radiated infra red radiation and via the water vapour greenhouse effect, and
- decrease regional rainfalls as water remains suspended as 'humid haze droughts'.

These observations are consistent with CSIRO cloud seeding research which confirmed that:

- the introduction of artificial rain nuclei into such humid air can increase rainfalls, and
- there are now often inadequate natural nuclei making such cloud seeding effective.

These observations are also consistent with our understanding of the micro-physics of cloud nucleation indicating that two different types of nuclei are required sequentially for water vapour to:

- first condense on micro-nuclei to form cloud condensation micro-droplets, and hazes, and then
- coalesce onto larger hygroscopic rain nuclei, from vegetation, to form rain droplets heavy and stable enough to fall out of the clouds as raindrops.

Consequently the levels and types of nuclei released often govern regional haze and rainfalls. Landuse and vegetation changes have greatly affected the natural production of dust, cloud and rain nuclei and hence regional humid hazes and rainfalls.

Land clearing, soil degradation and industrial pollution have all accentuated the production of micro-nuclei and the formation of persist humid hazes.

Such humid brown hazes over large areas of Asia have increased temperatures and respiratory disease as well as decreased monsoon rainfall by up to 40% (Dupont, Pearman). Similar marked increases in dust and haze levels and reduced rainfall were recorded in the Philippines for extended periods following the eruption of Mt Pinatubo (Trenberth, Dai).

However, these cloud nucleation processes can also be managed to increase regional rainfalls.

As demonstrated by the successful cloud seeding experiments in the ACT region, humans can restore and enhance these natural rainfalls processes by introducing suitable hygroscopic rain nuclei into clouds to increase the coalescence and precipitation of humid haze micro-droplets.

While cloud seeding to date has relied on dispersing artificial rain nuclei such as silver iodide into clouds, options may also exist to re-introduce far more effective, safer and cheaper natural biological nuclei back into suitable clouds through strategic re-vegetation approaches. Such re-vegetation strategies may help the ACT to restore and secure not just more secure rainfall and water supplies but also more resilient bio-systems on which the region's climate, water security, sustainability and economy will increasingly depend.

The Sustainability Science Team is able to provide more detailed information, substantiation and strategic plans for how the ACT could utilize such processes to enhance and secure its future rainfall and water security in the face of regional landuse impacts and climate shifts.

4. Buffering the ACT's water security against increased rainfall variability.

While climate shifts as well as human land management practices may have already affected the level of the ACT's rainfall, dam inflows and water supplies; of equal significance in securing the ACT's water needs will be addressing the impact these climate shifts will have on the variability, reliability and effectiveness of that rainfall and dependent water storages.

The increased variability and un-reliability in rainfalls traditionally implies that the ACT will require far larger and more expensive water storages to buffer the reduced and uncertain inflows.

However the climate shift may also make such larger storages, even if they fill up, unrealistic climatically, technically and financially particularly if losses from leakage and evaporation exceed the reduced inflows in a dryer more variable climate.

The larger, often stagnant, storages may also create new water quality and habitat concerns.

Consequently just increasing the ACT's water storage capacity may not be adequate to meet demands and provide adequate water security for the ACT in the future.

Even Sydney, with larger storages and more reliable rainfall, may not be able to supply future water demands as rainfall variability increases and if demands for abundant cheap water remain unrealistic.

Effectively the ACT, and most Australians, have to face reality and be prepared to critically review what are our real water needs, as distinct from current or projected demands, and how these can be best met from the reduced local supplies in safe, equitable and sustainable ways.

We need to face the reality that our current single use linear systems in which we harvest, pollute and disposing of waste water are no longer feasible nor sustainable.

We must adopt intelligent safe water conservation, recovery and recycling approaches. The issue is, not whether, but how to best do this, safely.

5. Ensuring the health and safety of recycled water in the ACT.

In view of the pending lower and less reliable rainfalls, storage limitations and increasing demand, the ACT effectively has no option but to recycle its water resources. However in doing so the ACT must ensure that it does so safely at no risk to public health and safety.

It follows that any risk that drinking water supplies can be contaminated by either; bacterial, viral, hormonal, pharmaceutical or other toxins of danger to human health must be prevented.

Although sophisticated and energy intensive technologies such as membrane filtration and reverse osmosis may be able to normally reduce such potential toxins to acceptable levels, under laboratory conditions, there is no evidence that such technologies can guarantee 100% risk free recycled water under normal and scaled up operational conditions.

Leading ACT and international public health specialists make it clear that there are major, unacceptable and unnecessary risks to community health from mixing treated sewage, even if there are no quality lapses, back into the ACT's natural safe catchments and water supplies.

As such there is no option but to heed warnings from expert health, water management and community leaders that drinking water supplies and catchments must not be contaminated with even treated human sewage while any such risks remain. As these risks do remain returning treated sewage to drinking water supplies is not safe. Nor is it necessary as safe water recycling alternatives exist, that separate water for different uses, to avoid all such risks.

The current and proposed water treatment technologies for the ACT may also accentuate health risks in that they do not remove nutrients adequately from discharges risking the growth of blue green algae downstream and production of dangerous heptatoxins.

Before ACT sewage can be re-used, treatment processes must ensure that they can remove these nutrients and risks of algal growth, not just reduce the numbers of coliform bacteria, pharmaceutical or hormone contaminants to the current single use or disposal standards.

Any proposal to mix even treated sewage into the ACT's drinking water would need to first verify that it can address all risks and liabilities from the inevitability that recycled sewage:

- can contain high levels of ill-defined bio-active contaminants from unknown sources,
- may comprise a high proportion of the inflow to water storages in times of drought,
- may need to be re-used rapidly with minimal opportunity for contaminants to be de-activated by natural bio-detoxification processes due to limited soil and water storage.

Also, if as some claim, that there are no health risks from mixing treated sewage into the ACT's drinking water supply, the authorities advocating this should obtain full independent indemnity cover for all the ACT for any and all future health impact and costs arising from their use of such recycled water. Such an uncapped insurance cover may be impossible to obtain commercially, precisely because the high risks involved make the mixing of treated sewage with drinking water as currently proposed uninsurable, unsafe and irresponsible.

Clearly the ACT needs to adopt water recycling but it needs to do so intelligently and safely. Alternative safe autonomous water recycling options are available to economically meet the ACT's recycling needs while avoiding any risk of such mixing and cross contamination.

As requested, The Sustainability Science Team is able to provide further details on these safe water treatment and recycling technologies and systems for use within the ACT and region.

6. Autonomous water systems to safely meet the ACT's future water recycling needs

While the ACT needs to recycle and more effectively use its limited water resources, it does not follow that the ACT needs to contaminate its drinking water or natural catchments with treated human sewage to do this. Fully safe economical technologies and options are available to recycle water to meet all ACT needs that do not involve mixing treated sewage or any contaminated water with healthy drinking water supplies.

These options simply involve maintaining and recycling the potable, functional and sewage water in separate sealed systems to avoid all risks of cross contaminating water supplies.

Such sealed separate Autonomous Water Systems (AWS) effectively enable::

- The 20% of current water used for potable and personnel hygiene to be provided from filtered rainwater collected and stored either on site or from clean natural catchments.
- The 60% of water used for functional household and garden uses to be supplied from recycled storm and greywater that has been collected, treated and stored in local tanks.
- The 15-20% of water needed for sewage disposal to be sourced from grey/storm water and either biologically treated on site for use as safe sub soil trickle irrigation or fully treated at local or municipal sewage treatment plants as currently.
- Full water quality and risk control to be provided via performance management contracts in fully meeting local health, safety and environmental standards.

Effectively such AWS, by repeatedly and safely re-cycling some 60% of normal functional water demand could decrease current demands for fresh rainwater fivefold, greatly extending the effectiveness of current natural clean water supplies. Such AWS, by also reducing sewage effluent volumes five fold, could also enable effluents to be safely treated and discharged locally in sub soil trickle irrigation systems to enhance local landscapes rather than eutrify downstream catchments.

Separating the three different functional qualities of water will of course require multiple separate sealed storage, pipes and treatment systems. Such multiple systems were previously prohibitively expensive for large centralized water authorities, supply and sewage systems.

However innovative AWS now enable sealed separate water and waste systems to be installed safely and economically at the local level to service clusters of houses or commercial users. By avoiding most of the 80% of the cost of current water systems associated with large trenches and pipes, AWS can be tailor designed economically to safely supply endless safe water to meet most urban, remote and commercial demands; even with lower pending rainfall.

While there are no technical impediments to the widespread adoption of such autonomous water systems in and by the ACT, AWS are innovative. As such they need to overcome numerous; information, attitudinal and structural impediments so that they can be critically evaluated based on their comparative performance and benefits relative to current systems. There may also be major capital and professional investments in maintaining the status quo. However with climate change the status quo may no longer be an option. The ACT may have no choice but to innovate, safely and wisely.

The Sustainability Science Team is able to provide further information on the key features, applications, potential benefits and requirements for AWS. Comparative case studies and evaluations of how tailored AWS can be used to supply ‘endless safe water’ to meet the needs of suburbs and other developments relative to conventional approaches can also be provided.

7. Sustaining the safe supply of water to meet current and future ACT needs.

Based on the above evidence it is clear that climate shifts have already and will further significantly affect the ACT’s rainfall, water resources and water supplies.

To what extent this risks the ACT’s water security depends on how well the ACT can re-design options to manage and meet future water expectations and demand.

Business as usual, the simplistic past approach of harvesting, storing, polluting and then disposing of water in a single one use process is now a very high risk, high cost, non option.

Consequently to secure sustainable supplies of safe water to meet its needs the ACT needs to:

1. Examine alternatives for re-designing water systems and usage to ensure a more natural, cyclic sustainable approach in which water can be safely captured, stored, used, treated and safely re-used at local cluster levels without risking key health imperatives.

2. Examine options for smaller, more local, autonomous multiple pipe supply, treatment and re-use systems that don’t mix incompatible potable and treated waste flows and minimize the 80% of the current capital cost in water distribution pipes and infrastructure.

3. Examine options for securing and enhancing the reliable rainfall received by the ACT by appropriate land management practices to restore and enhance natural rainfall processes.

4. Examine options to better inform the ACT community of the realities and options they face to secure their future water needs including the adoption of full water pricing policies to foster individual and collective responsibility as well as response abilities for effective actions.

5. Ensure that all the above issues and options are objectively reviewed in defining future water strategies for the ACT and that these are not compromised by conflicts of interest by protecting former but no longer relevant status quo approaches and investments.

Options and technologies exist to safely and economically address each of these needs and help secure the safe sustainable supply of water to meet the ACT’s future water needs.

The Sustainability Science Team has extensive experience in the development and application of these technologies and strategies and would be able to provide further detailed information on their relevance to the ACT, as requested.