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STORMWATER: TOWARDS WATER SENSITIVE CITIES

The Emerging Crisis of Water in Southern Australia

South Australia takes around half of its water supply in an average year from the River Murray. The concept of an 'average year' is now looking somewhat academic, as Adelaide has drawn nearly 90 per cent of its requirements from the River Murray in recent years as the State and the whole of South Eastern Australia has been gripped by drought.

While we refer to the condition of recent years as a 'drought', we know that it is the worst drought in 117 years of recorded history; and that there is emerging and clear evidence that climate change may be having a lasting and devastating impact on the supply of water into the system. For example, the last three years have seen only 20 per cent of long-term average inflows into the river system, and we are advised that every one degree of warming will further reduce run-off into the basin by 20 per cent. Clear evidence of the crisis that is emerging can be seen in the Lower Lakes in South Australia, where an environmental catastrophe is imminent.

After decades of mismanagement and over-use, the Murray-Darling system is proving to be an unreliable source of water in serious decline. Some 85 per cent of all water in the system is now drawn for urban or agricultural use, and there has been precious little left for the natural environmental needs of the system. And while the needs of urban areas can be managed by measures such as desalination and stormwater recycling (the subject of this paper), the future of the many rural and regional communities in the Murray-Darling Basin is under serious threat from the rapid decline in available water for irrigation.

Not surprisingly, providing security of water supply for the community and moving towards more water sensitive cities is emerging as a key electoral issue in South Australia and elsewhere.

The Salisbury Journey in Stormwater Harvesting

There is some extraordinary work being done by Local Governments around Australia in the development of innovative and creative solutions to issues of sustainability, and this paper describes the work that has been pioneered at the City of Salisbury in northern Adelaide – work that demonstrates the potential of Local Government to contribute significantly to a major public policy issue. The approach that has been taken, however, did not deliberately set out to recycle stormwater, but has been an emerging journey of discovery with shifting goals that has both shaped the debate in South Australia and contributed significantly to the culture of the organisation.

The plain on which Salisbury is located is characteristically flat, and in order to develop the area for housing during the 1970's, it was necessary for Council to create stormwater detention basins to hold flood waters back. A strong conservation ethos in Council during that period led to several of these basins being planted in such a way as to create habitat for bird life and passive recreation opportunities for users.

Salisbury has a relatively dry climate, and, before European settlement, the several creeks that flow across the plains rarely reached the sea, flowing instead into marshlands behind sand dunes or mangrove forests. Since the development of the City of Adelaide, those creeks have been largely channelled into the sea, carrying silt and other pollutants that have effectively destroyed much of the sea grass meadows and aquatic environment of the metropolitan coast.

The area where Salisbury touches the coast is not open sea, but an important estuary, the Barker Inlet, which is characterised by extensive mangrove forests that are of enormous ecological significance in the Adelaide region, being the breeding ground of much of the fishery in Gulf St Vincent and the Southern Ocean. For years, this estuary has been treated as a dumping ground, taking not only stormwater and its accompanying pollutants, but also much of the effluent discharge from Adelaide's major waste water treatment plant, thermal pollution from power stations, and other assorted waste from a range of industries. In 1993, Salisbury Council held a public summit on the looming environmental crisis in the Inlet, and decided itself to set a vision of ensuring that no further stormwater pollution would flow from Salisbury into the estuary. This became a major driver for Council's developing focus on stormwater detention.

At about the same time, and in connection with Council's interest in the development of the detention basins (or 'wetlands' as they were becoming known) as conservation habitats, we were carefully monitoring the water they contained, for pesticides and herbicides, in order to improve upstream management practices. We were surprised to find from this process that the quality of the water, as it left the wetlands, was significantly improved to that of the stormwater that was flowing in. Heavy metals washed from the roads, adsorbed to fine clay particles, were settling out after only a few hours, while the macrophyte reed beds were facilitating removal of most of the nutrient load and the action of sunlight was killing harmful pathogens in the water.

As an aside, it is important to understand that, even in Adelaide – the driest city in Australia – the water that falls in precipitation is roughly equivalent to the total annual consumption of the City[1]. So there was a significant volume of water that was being captured by these wetlands, and a real opportunity to use that water to offset the Council's costs of water for irrigation. But the problem was one of seasonality of rainfall, for Adelaide receives most of its rain in the three months of winter, and virtually none in the hot dry summers when the water is needed.

In considering this problem, staff at Salisbury working closely with staff of the State Government's Mines and Energy Department, came up with the idea of storing the water underground during winter, and so in 1994, our first bore was sunk, pumping water 200 metres into a natural aquifer, and re-drawing the water through the same bore head in summer for irrigation of surrounding parklands.

This trial was successful, and quickly led to further bores in other areas. Injection to the bores is licensed by the EPA, who demand guarantees of water quality before water can be directed into the aquifer – guarantees that have always been met through the effective management of the wetlands that feed them. Permits and extraction from the

[1] Much of that water flows into the sea where, as has been noted, it causes significant damage to the marine environment; and at the same time we take most of our needs from the Murray, treat it and transport it at great expense, and then use 90 per cent of it to flush our toilets, to irrigate our gardens, or in industry. Hardly a system that would be designed by a rational man!

bores is closely monitored by the Department of Water Land and Biodiversity (DWLBC) to ensure continued sustainable management of this crucial resource.

These early trials were soon followed by experimental supplies to industry. One such experiment with the major wool scouring firm, G H Michell, led to the development of a major wetland system on the Parafield Airport that supplies water directly to the Michell plant 24 hours a day for wool washing, and has the capacity to recycle the rinse water from that plant through the same wetland system.

Where are we today?

As noted, the original goals were fundamentally about the creation of habitat and the protection of the environment of the Barker Inlet (apart from the need for stormwater detention and the desirability of creating a pleasant environment for passive recreation). So how have the wetlands performed?

The Council has now developed over 50 wetlands, and has promoted the development of wetlands in all new subdivisions, on large industrial sites, along major transport routes, and in many of its reserves. Most of these have become havens for birdlife. In one large wetland at Greenfields, for example, there are over 180 species of bird nesting, including several rare species and even one new species discovered since the wetland was built in 1994. Through the Council's wetland development program, Salisbury has developed as one of the richest avifauna areas in urban Australia, patronised and nurtured by many ornithological groups.

From the point of view of the discharge of stormwater into the Barker Inlet estuarine environment, the results have also been pleasing, although not yet complete. Of the 33Gl[2] that presently flows through the city annually, our wetland systems are successfully capturing and storing around 5GL, a figure that we expect to increase to around 14GL within the next five years. It will never be possible to fully capture all run-off, especially peak flows, but the program is making a difference. The mangrove forests that were previously suffering from sediment loads have been performing well in recent years, and the attention that we have drawn to the problem has been instrumental in the establishment of the area as a Dolphin Protection Sanctuary.

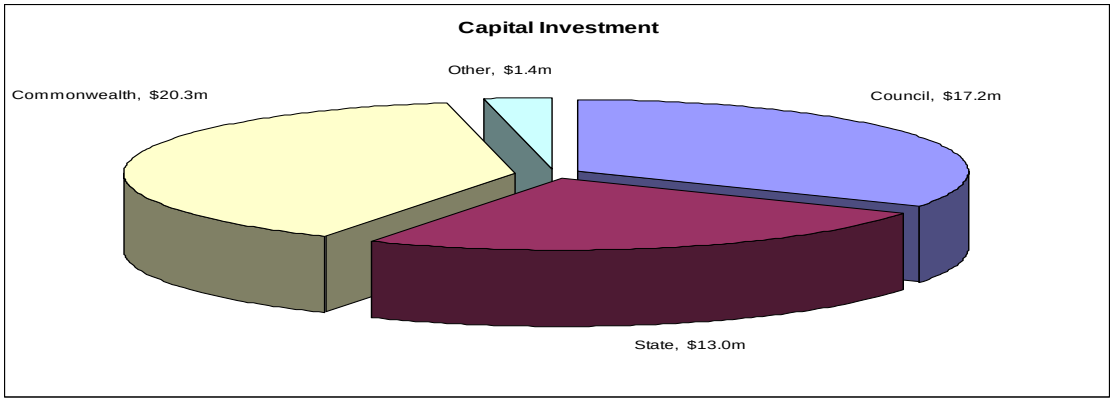
Together with our neighbouring Local Governments in northern Adelaide – Tea Tree Gully and Playford – Council has received considerable funding in the development of this program from successive Commonwealth Governments. This program is overseen by a joint Council subsidiary – Waterproofing Northern Adelaide Regional Subsidiary (WNARS) – which has been specifically established to handle our joint accountabilities to the Commonwealth for the implementation of the stormwater recycling initiatives in each of the three cities.

Business Model

Total investment in the program in Salisbury to date has been nearly $52 million, of which the Council has contributed $17.2 million; the Commonwealth Government $20.3 million; the State (principally through its land development agency and connected with its

[2] GL represents Gigalitres. A Gigalitre is one billion litres.

responsibilities as a land owner) $13 million; and others, mainly industrial users $1.4 million.



As noted above, we are presently capturing around 5GL of a potential flow through the city of 33GL, a figure that we plan to increase to 14GL within five years. However, despite severe water restrictions and a strong demand for alternative water supplies, we are presently only selling some 1.5GL of the water that we can make available. The principal constraint to further sales is the distribution system for the recycled water, which is in three principal forms:

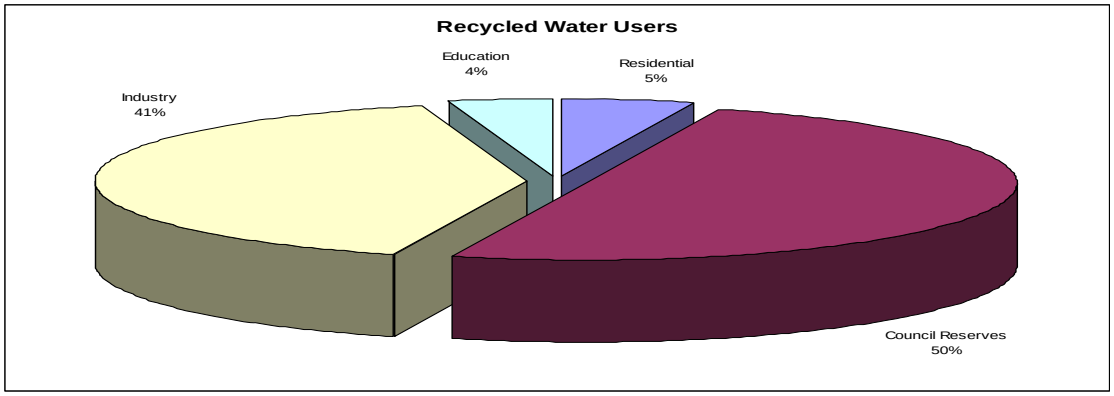
- **Direct customer connection:** Larger industrial users will frequently construct a direct connection from one of our bores to their plant in order to receive a supply. They pay for this connection themselves, as part of a negotiated contract and price with the Council.

- **Connection to a reticulated network:** As part of the Council's long-term capital works program, inter-connecting pipework between wetland systems is being constructed to enable customers to connect as part of their contract for supply. Council is also presently examining the potential for a city-wide distribution network that will enable residential properties throughout the city to connect in the future.

- **Water trading:** Within the Adelaide Plains Prescribed area, it is possible for water trading to occur, wherein the credits that Council earns from injection of water into the aquifer can be used by a customer often several kilometres away to draw from the same aquifer. Council has developed several contracts of supply using this technique which, of course, requires no direct supply infrastructure.

Using these different approaches, Council is now selling its recycled water to its own parks and gardens service; to a wide range of industrial users; to schools and other institutions; and to new residential subdivisions, where the developer is able to offset the mandatory State requirement for rainwater tanks in every property by the installation of a secondary pipe supply for garden watering and toilet flushing (see chart below). Of particular note is the secondary water supply through the new suburb of Mawson Lakes – a community of 10,000 residents, a university and around 5,000 employees in several

high-technology businesses. This supply is through a combination of recycled stormwater with treated wastewater brought from Adelaide's principal waste water treatment plant some 13kms to the north. The blended fresh stormwater is able to reduce the overall salinity that would otherwise make the treated wastewater unusable for irrigation.



In taking these initiatives, Salisbury Council has been concerned not to mix its core responsibilities as a Local Government authority for the management of stormwater and flooding with the emerging commercial imperatives relating to the cleansing, capture, recycling and sale of what we refer to as 'reWater'. We have been especially concerned to clearly isolate the full costs and financial benefits of recycling and, through transparent accounting, to ensure that risks are understood and managed and that our ratepayer's funds are not put at risk.

To achieve this separation, Council has created a Business Unit, which is a 'virtual' unit of the Council that has no staff, but which purchases staff time – whether engineering, finance or whatever – from the Council operations and to which all debt servicing costs, and asset renewal and customer revenues are applied. The Water Business Unit (WBU) maintains a separate balance sheet and profit and loss statement and reports its progress to Council through a board of management comprising senior personnel from the Council and chaired by the City Manager. In due course, it may be appropriate to further develop this structure into a special subsidiary of the Council.

In considering new projects, the WBU board carefully examines the business case for each initiative, including the prospective revenues and risks, the costs for supply and the nature of customer contracts on which the initiative depends. In general, it would expect any such initiative to achieve a positive cash flow including all outgoings and depreciation within around seven years. At the present stage, and notwithstanding a customer base of only 1.5GL, it is expected that the WBU will achieve a positive overall net position within five years, and in the longer term has the potential to be a significant revenue earner for the Council.

Potential of Stormwater Recycling in Adelaide

As part of its funding agreement with the Commonwealth, the Waterproofing Northern Adelaide Regional Subsidary (WNARS) was required to present its views regarding the potential of the stormwater recycling model for metropolitan Adelaide, and in late 2008 it

made a submission on this matter into the development of Adelaide's Water Security Plan.

This submission drew attention to the very good quality aquifers that lie beneath Adelaide, and that presently contain some 18,000GLl of variable quality water. While Adelaide consumes a little over 200GL every year and draws on average around 80Gl of that from the River Murray (closer to 180GL in a dry year), some 160GL still flows off the City every year in stormwater runoff and a further 70GL in wastewater. Quite apart from the damage this does to the marine environment and the River Murray, it seems a dreadful waste of potentially usable water.

Instead, WNARS pointed to the potential to capture at least 106GL from the surface streams in metropolitan Adelaide; another 50GL from recycling wastewater and in doing so to reduce Adelaide's total take on the River Murray to zero. Of course, this will be even more possible now that a commitment has been made to increase the capacity of the proposed desalination plant to 100GL. This program, we believe, can be achieved for the investment of around $400 million.

The challenge, of course, as we have found in Salisbury, is in the distribution of the water thus created. Given that only a tiny fraction of the water that we use is consumed, our aim should be (on both environmental and economic grounds) to produce fit-for-purpose water that can be directed as required, to appropriate uses. Yet the costs of developing a secondary pipe network through our suburbs may be prohibitive, and this will require considerable further research.

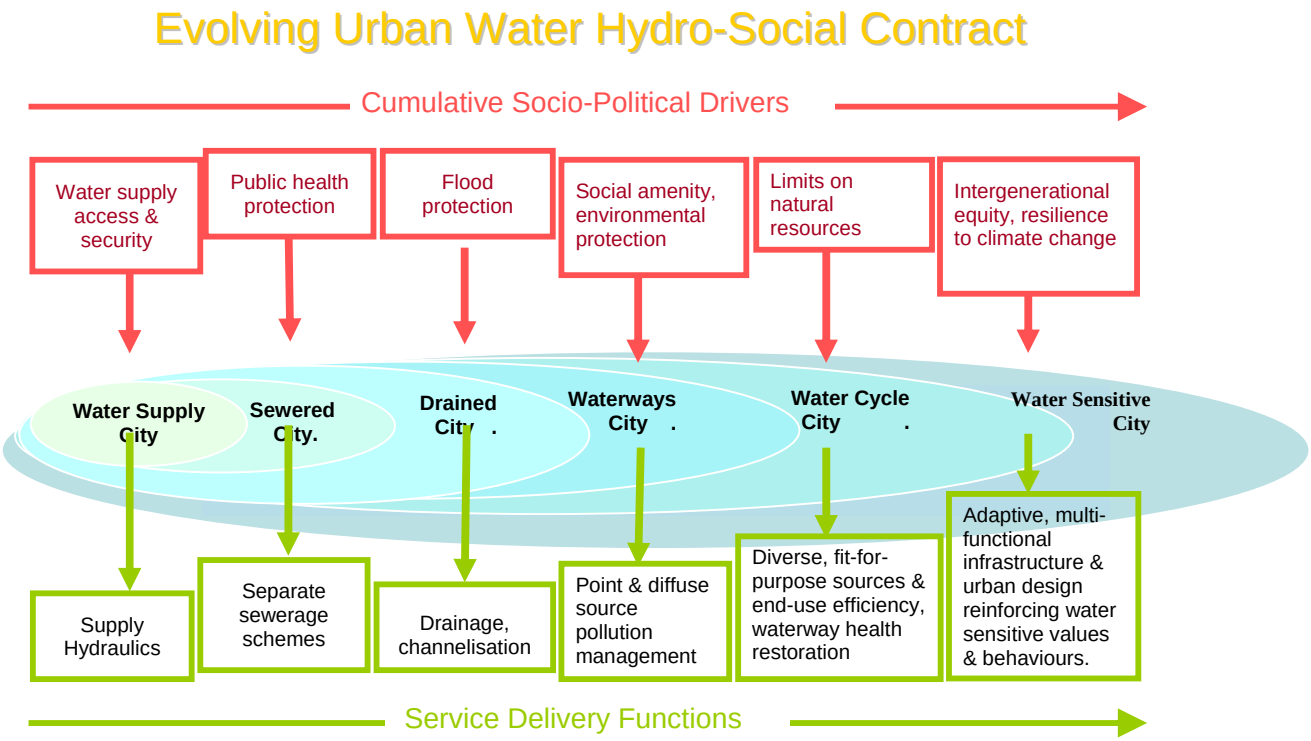
A further challenge in this model is the institutional structure within which it is managed. Local Government is responsible for stormwater and surface flows, and there will emerge a real question as to whether local or centralised governance models will manage such a system.

Towards Water Sensitive Cities

Water is a precious commodity and a key element in our efforts to create a sustainable environment in our cities. Local Government has a central and creative role to play in our efforts to achieve sustainability through the moderation of demand for water and, as noted in this paper, to improve security of supply for both human and environmental needs. But our attitudes to water and its management have changed over the years and will continue to change as new demands are placed upon us.

In her work at the Monash University National Urban Water Governance program, Rebekkah Brown and her colleagues have succinctly summarised these changes in their 'Urban Water Transitions Framework', represented diagrammatically below[3].

[3] Brown, R., Keath, N. and Wong, T., 'Transitioning to Water Sensitive Cities: Historical, Current and Future Transition States', Paper presented to 11th Int. Conference on Urban Drainage, Edinburgh, 2008.



In this model, Brown et al identify six distinct, yet cumulative transitional stages in the development of urban water management in Australian cities.

1. *The Water Supply City*

   This State commenced with colonisation as an imperative for urban settlement, and involved the damming and extraction of large supplies of water for human consumption. The availability of water was seen as a public right, with cheap and equitable access for all, and with the delivery of safe, cheap, and (as presumed) limitless water volume from a benign environment to a rapidly growing urban population.

2. *The Sewered City*

   From the mid to late 1800's (and even later in some areas), there was a strong drive to achieve fully sewered cities. Strongly driven by the need for improved standards of public health, these programs were generally extremely expensive because of the extremely stochastic nature of Australian rainfall.

3. *The Drained City*

The drive to adequately drain Australian cities has been largely a post Second World War program, associated with the growth of our urban areas and the need to make usable land that would otherwise be flood prone. It became a key focus of local government engineers in the 1960's and beyond, and a major cost for many local governments before cost sharing with the development industry.

4. *The Waterways City*

   The 'waterways city' is a term applied by Brown to a change in perception about urban waterways and a fundamental shift in the concept of service delivery as applied in earlier city states. Associated with the upsurge of community interest in environmental issues from the late 1970's onwards, this concept is derived from concerns about pollution and especially diffuse pollution from stormwater and waste water, both in streams and in outflows to the marine environment. In considering this city state, I am reminded of the drivers of the Salisbury program, and especially its concern for the outflows into the Barker Inlet as described earlier. But this state also recognised the value of our streams; not only for the habitat they create, but for the opportunities they offer to create recreation and green spaces for the enjoyment of our communities.

   Brown notes in her work that this city state is still not fully established in all Australian cities, and in its implementation will challenge professional disciplines and 'territories', and centralised institutional structures and technologies.

5. *The Water Cycle City*

   The concept of a Water Cycle City represents something of a future state, and is based on the recognition of the need for sustainability. It places an emphasis on water conservation and finding fit-for-purpose diverse water supplies, matched to the most appropriate uses, and in that regard represents many of the elements that our program at Salisbury is striving to achieve. In particular, Brown notes, it challenges established models for water supply and especially recognises the potential for decentralise, rather than traditional centralised, solutions.

6. *The Water Sensitive City*

   Very much a futurist concept, the 'Water Sensitive City' may be taken to represent a goal towards which we should all be striving. In Brown's words, it 'would integrate the normative values of environmental repair and protection, supply security, flood control, public health, amenity, liveability and economic sustainability, amongst others'. It would, she says, be motivated by 'intergenerational equity with regards to natural resources and ecological integrity, as well as by concern that communities and environments are resilient to climate change'. Clearly, such a state would require a highly flexible institutional regime, and the potential for Local Government to take a major role is significant.

Conclusions

In pursuing this program, the City of Salisbury has been on something of a journey of discovery. What began as a flood protection imperative became an environment and conservation initiative and has now become a business. Importantly, in the process, it

has also been an important driver of our City image and marketing, and of a culture of internal innovation and creativity. The initiative has been a constant and regular feature of the media in Adelaide, and enjoys strong public identification well beyond the boundaries of our City. In that regard, it has become a significant source of pride for our Council, its staff, and the community of Salisbury. It could not have been achieved without significant and ongoing support from the Elected Members of Council and the several funding partners, especially the Commonwealth.

Importantly, this program has demonstrated the level of innovation and creativity that can and does come from local government as a sector. This level of innovation is not evident in either State or Federal Governments, and is a clear advantage of local government that is not often recognised, especially by our own sector. Local Government, as evidenced by the work at Salisbury, is in a unique position to identify and drive change agendas on important issues of public policy, and should build on that position to strengthen its hand in broader public policy questions.

In responding to issues of climate change, sustainability, water sensitive cities and water security issues, Brown's model has pointed to a developing tension between centralised and decentralised solutions – between local water solutions and regional or national water solutions. How that tension plays out in the development of locally adapted solution to environmental issues (and, indeed, other areas of public policy), and how local government will play a role in driving the changes that those tensions will demand in coming years is a critical issue for us all.