RECYCLED WATER FOR HORTICULTURE

In South Australia, research was initiated into the use of wastewater from the newly developed Bolivar WasteWater Treatment Plant (WWTP) which became Adelaide's principal Treatment Plant. Studies into the use of treated effluent on a large scale were initiated in the late 1960s using effluent from the Bolivar outfall channel for horticulture and forestry (Matheson 1972, Matheson and Lobban 1973, 1974). As a result, from about 1975, a small group of growers on the Northern Adelaide Plains began accessing secondary treated effluent from the outfall channel with their own infrastructure for horticultural production under Department of Human Services restrictions.

During the 1950s and 1960s, vegetable growers were being displaced by urban expansion in Adelaide's eastern and western suburbs. The Northern Adelaide Plains offered supplies of underground water for irrigation, well drained sandy soils, a mild low frost incidence climate and close proximity to major markets in Adelaide. The advent of turbine pumps enabled efficient extraction of water from these aquifers. By the 1980s, the district had approximately 7,000 ha of irrigated horticulture.

Withdrawal of water from Adelaide Plains aquifers rapidly increased, and it was recognised that extraction was far greater than recharge rates and unsustainable. Legislation was established to license extraction of water (*Underground Waters Preservation Act 1959*) within the region. To enable long term development of horticulture industries on the Northern Adelaide Plains, other water sources would be required.

An Australia-wide study was commissioned in 1977 to strategize the use of reclaimed water (GHD 1977). It recommended:

- A national program of research, demonstration and education.
- An integrated approach to water supply, sewerage and solid waste disposal as an integral part of one planning process.
- Smaller, simpler sewer networks based on regional plants located near opportunities for reuse.
- A major thrust towards irrigation, both landscape and agricultural, with agricultural use reoriented to agricultural gain rather than just as a means of disposal.
- Use for conserving water resources in rivers and streams and recharging aquifers, providing nutrients were controlled.
- The world potable water standards be extended, related to Australian conditions and applied to existing situations of inadvertent use.
- Melbourne offered scope for a variety of reclaimed water uses.
- Assessing the substitution of recycled water for freshwater in Adelaide and inadvertent groundwater recharge in Perth.
- Assessing the elasticity of demand for various uses of water and the real cost of providing for variations in demand.

- Representative studies of the economics of reclaimed water projects, encompassing issues of the definition of the reclaimed water ‘system’, accounting for savings in conventional water supply and waste disposal systems, use of marginal costs rather than average or historical costs, and methods of financing reclaimed water schemes where comparisons over the total ‘system’, including social costs, show this to be economically preferable.
- Development of conceptual models, pilot applications and some full-scale projects, particularly for the ‘interception’ method (‘sewer mining’) and the ‘dual pipe’ supply concept. In a follow-up report for Victoria it was concluded that water deficits would become a problem by 2000 (GHD 1978). There was little immediate response to these recommendations.

At about the time of the release of the Ecologically Sustainable Development Report in 1991, the Australian states began establishing environment protection agencies and authorities. The potential environmental damage from inadequately treated sewage effluent being discharged to oceans, rivers and estuaries was recognised. Regulations were brought in setting standards for discharges. Sewage utilities sought to achieve regulatory standards by improving the composition of effluent discharges to water courses and water bodies, or alternatively, seeking uses for the discharges in the form of saleable recycled water.

To manage its water resources, South Australia developed a Technical Manual (South Australia 2010), prepared with the objectives of minimising demand on the reticulated water supply system; protecting and restoring aquatic and riparian ecosystems and habitats; protecting the scenic, landscape and recreational values of streams; minimising treated wastewater discharges to the natural environment; and integrating water into the landscape to enhance visual, social, cultural, biodiverse and ecological values. It seeks to reduce greenhouse gas emissions by reducing water consumption, increasing rainwater harvesting and “natural” treatment alternatives. The Manual, which lists twelve Water Sensitive Urban Design (WSUD) tools, recognises all water sources in the total water cycle as valuable resources including rainwater (collected from the roof); runoff (including stormwater collected from all impervious surfaces); potable mains water (drinking water); groundwater; and wastewater including greywater (from bathroom taps, showers and laundries); and blackwater (from toilets and kitchen sinks). The South Australian Manual reflects the dry Mediterranean climate, limited catchment water harvesting opportunities and the importance of groundwater for high value agriculture. It includes an emphasis on wastewater and the associated need to meet discharge standards to receiving waters, especially to St Vincent Gulf, adjacent to which Adelaide is built. During the period 1949 to 1995, some 4,000 ha of seagrass was lost along the Adelaide coastline. Seagrass continued to decrease with 720 hectares lost between 1995 and 2002 (South Australia 2003). Mangroves also decreased, even though pollutant loads from treated wastewater discharged into St Vincent Gulf had been reduced.

A major commercial development of the use of recycled water to mitigate marine environmental pollution risks was established in Adelaide, where water from the Bolivar WWTP, was redirected to agricultural production. Adelaide's treated effluent had previously been discharged to Gulf St Vincent. The Adelaide metropolitan WWTPs were required to develop Environmental Improvement Plans to upgrade the quality of the effluents they were discharging to ocean. There was concern that the marine ecosystem was being degraded by the 1,300 t of nitrogen and 200 t of phosphorus in the 40 GL of outflow being discharged from the Bolivar WWTP annually, leading not only to loss of mangroves and seagrass, but also the proliferation of large quantities of macroalgae. The initial response was to plan the building of a biological nutrient removal treatment plant. However, it was also recognised that Northern Adelaide Plains vegetable growers were withdrawing each year a total of 18 GL of groundwater from aquifers that could only sustainably support an annual abstraction of 6 GL/yr. The groundwater cone of depression thus caused was resulting in saltwater being drawn into aquifers from the adjacent gulf, leading to deteriorating irrigation water quality. Bolivar WWTP effluent could be used as a resource to support horticultural irrigation on the Northern Adelaide Plains. The Bolivar plant was converted from trickling filters with secondary sedimentation and lagoon sedimentation to activated sludge. A Dissolved Air Floatation/Filtration (DAFF) plant was installed. The DAFF plant incorporated alum and polymer coagulation, flocculation, dissolved air floatation, granular multi-media filtration and chlorine disinfection. The stabilisation lagoons were retained for their natural biological and toxicological capacity, and as a buffer to minimise water quality deterioration from any abnormal industrial waste discharges. With a total volume of 4 GL, they also provide 2 GL of additional storage to enable more water to be committed for sale in the summer.

The outcome was the Virginia Pipeline Scheme, managed by Water Reticulation Services Virginia (WRSV), a subsidiary of the Tyco Corporation and Earth Tech. This signed up clients for the water and built the water distribution system that delivered the metered recycled water to dams on individual growers' properties, from where they pump out the water through their own irrigation systems. The cost of the $55m project, including the DAFF Plant and the reticulation system was shared between the Commonwealth Government, which contributed $10.8 million from the Building Better Cities funds, $574,000 from Landcare, $7 million from private investors, $7 million from the SA government and the remainder from SAWater. The growers' dams were required to hold three days' supply in case maintenance was required in the supply system. Though not greeted enthusiastically by growers, properties using recycled water were obliged to have signs on fencing reading "Reclaimed water – do not drink". By 1999, access was provided to 15 GL/yr of tertiary treated Class A recycled water suitable for unrestricted horticultural use, including spray irrigation of salad crops (Radcliffe 2004). Produce from the scheme soon gained ready market acceptance. However, the introduction of the ready availability of recycled water was not without impact. Rising water tables were observed in the quaternary aquifers underlying the Northern Adelaide Plains serviced with the reclaimed Bolivar effluent (Zulfic 2002).

To assist growers moving into the use of recycled water, the Department of Agriculture established an extension office at Virginia. A temporary office was established in a caravan next to the Virginia Institute in 1978, followed by a more permanent transportable office in 1980. Subsequently staff were relocated to the Virginia Horticulture Centre in 1996 and continued at this location until 2010. A wide range of support services and industry development activities were delivered to horticulture industries including technical information, financial support in natural disasters, structural adjustment, and access to soil, tissue, disease, pest and other diagnostic services.

Since the late 1990s, the Northern Adelaide Plains has emerged as a national centre for vegetable production in high technology controlled-environment greenhouses. These greenhouses commonly use hydroponic irrigation systems, requiring reverse osmosis equipment for treating irrigation water, enabling irrigation water to be obtained from a greater array of sources.

A similar project followed soon afterwards from the Christies Beach WWTP where the Willunga Basin Water Company, privately funded by growers, provided supplemental irrigation to the groundwater used for wine grape production (Mitchell 2020).
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In April 2018, a major $155.6 M expansion of the Northern Adelaide Plains irrigation area commenced. A project, independent of the Virginia Pipeline Scheme and initiated twenty years earlier, is to provide an additional 12 GL of recycled water from the Bolivar WWTP. The water is to be distributed through a new 28 km water main and distribution infrastructure north of the Gawler River, to underpin an economic development initiative for largescale advanced glasshouse horticulture, nurseries, floriculture, protected orchards and vine crops, premium irrigated field crops, feedlots and intensive poultry businesses. This initiative has clearly identified economic development as a further driver for introduction of recycled water and incorporates local expertise in the use of Managed Aquifer Recharge (MAR) as a management tool within the water cycle.

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Date: 1 January 2022