Chapter 32

Development of decentralized systems in Australia

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32.1 INTRODUCTION

Decentralized wastewater systems in Australia developed out of the need to provide sanitation for urban areas not connected to sewers and centralized treatment plants. Initially, combination of domestic septic tank and soil absorption trench were adopted at allotment scale. Over the last two decades, a growing number of aerobic treatment plants (essentially mini activated sludge plants) provided a disinfected effluent suitable for above ground irrigation on a dedicated irrigation area, although sub surface irrigation was often mandated by the regulatory agency (state department or local authority; Beal *et al.* 2005). However, over the last decade all of the capital cities and a number of regional cities have experienced long term drought and severe urban water restrictions. A fundamental re-examination of the linear paradigm of *take* (water) – *make* (use of it) – *waste* (discharge effluent) let to a general acceptance of integrated urban water management (IUWM) concepts. Recycled water is now accepted as a critical component for providing sustainable water services (Diaper *et al.* 2008).

32.2 DRIVERS FOR DECENTRALIZATION

The primary driver in Australia for the uptake of decentralized systems is water scarcity, prompting the need to utilise alternative water sources. Tjandraatmadja *et al.* (2008, 2009) recently conducted two studies to understand the drivers in the Australian context. The studies were conducted in South East Queensland, but we believe that the following drivers are widely applicable to all urban settings across Australia: (1) Overcoming limitations of local water and wastewater services, (2) Deferring infrastructure upgrades, (3) Environmental protection, (4) Showcasing sustainability, (5) Water conservation, (6) Enhancement of local amenity, (7) Technology showcase.

Sustainability is often interpreted by the innovator/developer as reducing the reliance on external (mains) water sources by using a local treatment solution to avoid "long" pumping distances to/from a central treatment plant. Avoided energy use almost ranks as highly as water self sufficiency. Nutrient recycling objectives are usually captured by local irrigation of crops, pasture or amenity horticulture. Deferring infrastructure upgrades is an emerging issue for water/sewerage utilities as there is a strong motivation in avoiding the construction of new or upgraded treatment plants to prevent exceedance of the licenced discharge limits of N and P. Similarly increasing densification in the inner areas of most cities has let to a few examples of limited water mains and sewer capacity driving decentralized sewage applications (Sharma *et al.* 2007).

32.3 OVERVIEW OF DECENTRALIZED SYSTEMS

In most case studies presented here, decentralized water supply and effluent recycling are intermixed. We focus our text on effluent treatment and recycling components. See also Table 32.1 and Tjandraatmadja *et al.* (2009).

32.3.1 Cluster Scale Developments

There are an increasing number of urban developments in Australia where the developer has chosen to install their own "small scale" sewerage system because of regulatory resistance to domestic on site systems, and/or because they wish to demonstrate an environmentally sustainable technology. Examples include Capo de Monte, Payne Road, Sunrise at 1770 and The Ecovillage at Currumbin to name but a few. All of these examples were developed by the private sector with scientists often "tagging on" to quantify their performance and provide objective evidence to separate *green facts* from *greenwash*.

Payne Road (Gardner *et al.* 2006), the first such study, focused on individual and communal rainwater tanks, off peak discharge of sewage to council mains, and on-site use of greywater for a 22 lot development. The greywater was of particular interest as it was treated by the Biolytix vermiculture treatment method (www.biolytix.com) to produce high nutrient effluent for sub surface irrigation. Whilst the treatment system was reliable, the high phosphorus and sodicity load to the $200m^2$ grassed irrigation area indicated that long term (e.g. $\geq$10 years) sustainable irrigation would likely need further treatment (Beal *et al.* 2008a).

The next scale was the community based sewerage system of Capo de Monte (45 lots) and the Ecovillage at Currumbin (144 lots with 100 connected to sewers). Both

Table 32.1 Overview of selected Australian pilot projects.

Project/type	*	Main driver	References	Main technical aspects
Sustainable house				
Michael Mobbs House	SH	Showcase	http://www.abc.net.au/science/planet/house/default.htm	Produces its own power, uses rainwater and reuses sewage
Limited access to reticulated sewerage/water				
Capo de Monte 46 lots	SH	Water scarcity	http://www.capodimonte.com.au/downloads/UDIA%20capo%20sustainability%20award%20submission.pdf	Local wastewater recycling and water supply from rainwater
Payne Road The Gap (Brisbane, Queensland), 22 lots	SH	Limited sewer system capacity	Gardner *et al.* 2006	Individual rainwater tanks with communal tank/mains back up, sewage off peak pumping to council main, greywater reuse
Aurora Development Victoria, 8500 lots	SH	Effluent disposal limitation	http://yourdevelopment.org/casestudy/view/id/13	Local wastewater recycling through dual pipes
Septic Tank Effluent Drainage System in South Australia	SH	Public health	http://www.lga.sa.gov.au/webdata/resources/files/STEDS_Review_Report_Vol_1_LGA_2002_pdf1.pdf. (Palmer *et al.* 1999)	Septic tanks, common effluent drain, lagoon, public park irrigation
Sewer mining				
Sydney Olympic Park New South Wales	A OB	Innovative design	http://www.sydneyolympicpark.com.au/education_and_learning/environment/water/wrams	Non-potable water drived from sewer mining/stormwater reuse
Greywater reuse				
Inkerman Oasis, Melbourne, 245 app.	A	Sustainable development	http://www.yourhome.gov.au/technical/fs75.html	Greywater for toilet flushing and outdoor irrigation

(*Continued*)

Table 32.1 Overview of selected Australian pilot projects (*Continued*).

Project/type	*	Main driver	References	Main technical aspects
Sustainable development and innovative design				
The Currumbin Ecovillage 144 lots	SH	Showcase: Innovative Design	http://theecovillage.com.au/site/index.php/village/index/43/. (Hood *et al* 2010)	Sustainable housing design, rainwater for potable supply and local effluent recycling.
Woodford Folk Festival in South East Queensland	I	Innovative Design	http://www.woodfordfolkfestival.com/main/index.php?cID=2184&menuID=474&apply=&webpage=friends_of_woodford_2009	Recycling of effluent in the complex and for irrigation
Sensitive Receiving Environment				
Sunrise at 1770 (Queensland); 172 lots, 650 ha development,	SH	Effluent disposal limitations	http://www.sunriseat1770.com.au/conservation.html	Pressurised sewer system, local WWTP, effluent reuse at household rainwater for potable use
Rouse Hill (New South Wales) 36000 lots	SH	Effluent disposal limitations	http://www.rhtc.com.au/content.aspx?urlkey=environment	Local WWTP, reclamation plant, dual pipe for Class A + effluent reuse at households
Showcasing sustainability examples				
Council House 2 (CH2) (Victoria) 12500 m^2, 9 story building	OB	Innovative design	http://www.melbourne.vic.gov.au/Environment/CH2/Pages/CH2Ourgreenbuilding.aspx	Energy conservation, self sufficiency in water supply and minimising export of sewage.
Mawson Lakes (South Australia), 8500 lots 4000 lots	SH A OB	Sustainability	http://www.sawater.com.au/SAWater/WhatsNew/MajorProjects/mawson_lakes.htm	Aquifer stormwater storage/ recovery and dual reticulation for recycled effluent and stormwater

* Single Households (SH), Apartments (A), Office Building (OB), Institution (I).

collected combined domestic wastewater and treated it to class A standard at a central facility for reticulation back to households for toilet flushing and external use. The Capo development used immersed membrane bioreactor technology followed by UV and chlorine disinfection, whilst the Currumbin Ecovillage used a communal septic tank followed by an Orenco recirculating fabric filter (http://www.orenco.com/), then UV and chlorine disinfection. Water quality from both systems was quite suitable microbiologically and aesthetically for the intended end uses. As these cluster scale systems were of considerable interest to scale up and replicate in more traditional greenfield developments in Queensland, their robustness to shock loads and greenhouse gas (GHG) footprint were of particular interest. Consequently detailed studies were undertaken and results (Chong *et al.* 2011) showed high system resilience to load variations, but large differences in specific energy consumption (kwh/m^3). This difference tended to even out when greenhouse gas emissions (i.e. methane and nitrous oxide) were taken into account resulting in a GHG footprint of about 7 $kg_{CO2equiv.}{\cdot}m^{-3}$ for both systems, which is much larger than that for a centralized, tertiary sewage treatment and water reclamation plant (Lane *et al.* 2011).

Another type of cluster scale system is the STED/STEP (Septic Tank Effluent Drainage/Pumped) systems which was pioneered in South Australia in 1962 and "reimported" from the USA in the 1970's to provide cost effective sewage services for rural and peri urban communities. The essential features of the scheme are individual household septic tanks which discharge by gravity or pumping into shallow, small bore (≤100 mm diameter) sewers constructed without traditional man holes, with subsequent treatment in a communal facility, usually oxidation lagoons. Over 70% of the effluent is reused for irrigation of agriculture and public open space, with additional filtration and disinfection required for the latter end use (LGASA 2003). There are more than 160 such schemes operating in South Australia, generating about 7000ML$\cdot a^{-1}$ of sewage from over 130,000 people in communities ranging from about 100 EP to 10,000 EP, with the majority in the 500–3000 EP range (LGASA 2003). Their construction cost per allotment is about 1/3 that of conventional sewerage because of simplification in the reticulation and treatment engineering (Palmer *et al.* 1999). Operational costs are similar to conventional sewerage due in part to the cost of sludge removal from the individual septic tanks every 4 years.

We find it surprising that STED/STEPs have not become more popular in other states of Australia. A notable exception is Kinglake West, a rural community north of Melbourne which was largely destroyed in the 2009 bushfire. Here Yarra Valley Water, the local water utility, decided to test a range of innovations for this septic trench serviced community (105 lots) which had previously been earmarked for a sewerage retrofit program. The innovations (see Figure 32.1) included greywater treatment for potable substitution, urine-separating toilets, and a STEP sewerage system (Narangala *et al.* 2010).

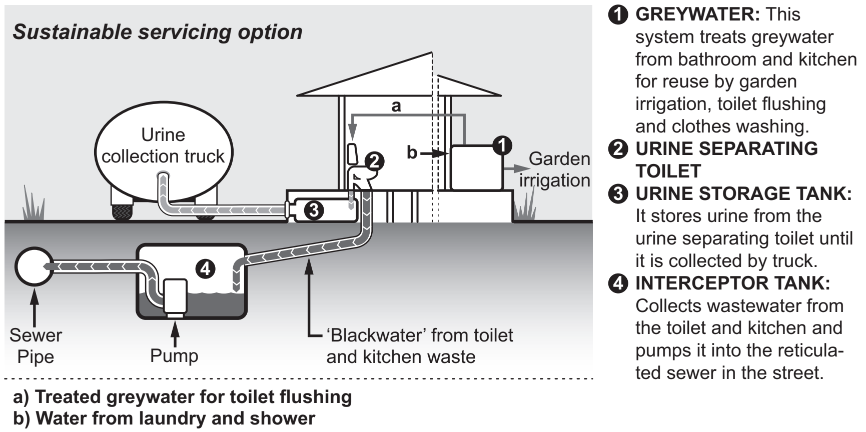

Figure 32.1 Kinglake, Victoria: Greywater reuse system, urine-separating toilets with storage tanks, and a blackwater STEP pumping system (Narangala *et al.* 2010).

32.3.2 Urine-Separating Toilets

The nutrient arguments in favour of urine separation are well known (Larsen and Gujer 1996) but there was essentially no experience with this technology in Australia before a 10 house trial was established the Ecovillage at Currumbin (Beal *et al.* 2008b). Gustavsberg toilets were installed with individual 300 L tanks, which were emptied every 4–6 weeks. After initial serious odour issues, and minor toilet use and cleaning issues were solved, the scheme ran smoothly for over 2 years, with high user acceptance (see e.g. Barton *et al.* 2011). The second stage of the project aimed to reuse the urine for open space and fruit tree irrigation, but research funding ceased before approval for reuse (a microbiological safety issue) was obtained from regulatory agencies.

Kinglake is a more sophisticated example of urine-separating toilets where Wostman EcoFlush USTs have been installed in about 20 dwellings. Urine is collected in a 1000 L subsurface (pressure sewer) vessel and then removed via vacuum truck into individually labelled 1000 L polyethylene "caged" tanks on pallets. After sanitation by extended storage is confirmed by *E.coli* count on each tank, the urine solution is reused on turf pasture (Graeme Julier, pers com.)

32.4 CONCLUSIONS

The original driver for decentralized systems in Australia was the provision of on site sanitation systems in non-sewered urban and peri-urban communities. To a large extent this lack of access to reticulated facilities is still a major driver today, but with the technical evolution into cluster scale (>20 EP) facilities that benefit from centralized management and beneficial reuse such as irrigation.

The real test of decentralized philosophy occurs when developers have the option to choose between a decentralized and centralized system. Apart from the drivers of *green star* building rating (http://www.gbca.org.au/green-star/) and other marketing incentives, we think that cluster scale systems will probably only thrive in situations where access to reticulated sewerage is too expensive. However as externalities are increasingly included into the economic assessment by government regulators (e.g. Productivity Commission 2011), alternatives that reduce demand on natural resources, reduce nutrient discharge, and reduce GHG footprint will be increasingly adopted. It is important that sound biophysical, operational and social acceptance information on alternative technologies is available when the main stream market moves to these "local solutions". We believe that scientifically rigorous documentation of those case studies, built by the innovation pioneers, will be a critical part of the process of informed choice.

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