

WATER RECYCLING - EXAMPLES FROM OTHER COUNTRIES

Purified recycled water has been used to replenish drinking water supplies in many parts of the world for up to 40 years, including the USA, UK, Singapore and Belgium.

There are both **unplanned** and **planned** uses of purified recycled water occurring throughout the world.

Unplanned indirect reuse is very common and occurs when upstream sewage treatment plants discharge treated wastewater into the water supply from which a region extracts its drinking water.

Planned indirect reuse occurs when the wastewater is treated to drinking water standard, blended into an existing water source such as a dam, reservoir or river, and then treated again before it is delivered to consumers as drinking water.

The proposal for the use of purified recycled water in South East Queensland is based on **planned indirect reuse**.

The process will be world's best practice, underpinned by state-of-the-art technology, similar to that used in Singapore and Orange County.

It will utilise sophisticated management systems and a strong regulatory framework to discharge purified recycled water into Wivenhoe Dam.

Some examples of countries using purified recycled water are provided below. Each example differs, reflecting local opportunities and constraints.

Orange County, USA

For more than 30 years, Orange County in California has supplemented its drinking water supplies with reclaimed water.

Concerned about seawater intrusion into the groundwater basin and needing to reduce reliance on water imported from the Colorado River and Northern California, the Orange County Water District piloted studies in 1965 which investigated the use of reclaimed water to replenish the groundwater basin.

In 1976, Water Factory 21 commenced operation as an advanced water treatment plant. It used both traditional and advanced treatments to produce up to 60 million litres per day of reclaimed water for injection into an underground aquifer, where it was mixed with deep well water in a 1:1 blend. An assessment of results from extensive monitoring in 1992 led the California Department of Health Services to allow 100 percent of the reclaimed water to be injected into the aquifer without prior mixing provided it was treated with reverse osmosis.

In 1997 Orange County decided to expand the system. Called the Groundwater Replenishment (GWR) System, its water treatment involves a dual membrane process consisting of microfiltration, reverse osmosis and advanced oxidation. The GWR System, the largest advanced water purification project of its kind in the world, received final approval in January 2008 to provide northern and central Orange County with a new, locally-controlled source of safe, clean water. The system has the capacity to produce 70 million gallons (265 million litres) per day of near-distilled quality water. Fully operational, it can generate enough pure water to meet the needs of 500,000 people.

For more information on Orange County's scheme, go to www.gwrssystem.com/



Upper Occoquan, USA

The Occoquan Reservoir in Northern Virginia supplies drinking water to nearly one million people living around Washington DC. To cater for a growing population in the 1960s, a number of traditional wastewater treatment plants were constructed in the reservoir's catchment. This was originally an example of unplanned reuse. Over time though, the discharges from these plants caused severe deterioration of water quality.



In 1978, the existing wastewater treatment plants were replaced with an advanced water treatment plant that employed many of Orange County's original Water Factory 21 treatment methods. Purified water from this plant is discharged into Bull Run, which is a tributary of the Occoquan Reservoir. The discharge point is 32km upstream from the water supply intake.

In 1998, the Upper Occoquan Sewage Authority (UOSA) discharged 87 million litres of recycled purified water per day into Bull Run, which was approximately seven percent of the average annual inflow into the Occoquan Reservoir. During low-flow periods, such as the drought experienced in the early 1980s, the UOSA discharge was between 80 to 90 percent of the water entering the reservoir (WEF and AWWA 1998).

The UOSA utilises a multiple barrier treatment process, involving aerobic treatment using activated sludge, high pH lime treatment, recarbonation, sand filtration, upflow carbon adsorption and chlorination. Although the water is discharged to a surface reservoir instead of an aquifer, the treatment processes are less extensive than those employed by Orange County's Groundwater Replenishment System, as no membrane processes are used to produce the purified recycled water for discharge to the Occoquan Reservoir.

An independent testing authority, called the Occoquan Watershed Monitoring Laboratory, ensures independent surveillance of the process and monitors water quality. The monitoring results show purified recycled water to be far cleaner than other sources of surface water inflow into the Occoquan Reservoir.

All advanced water treatment plants have fail-safe features. The UOSA's include:

- backup units for all electrical and mechanical systems;
- three sources of electricity to power the station (including on-site generation);
- storage basins to retain water during emergencies and system failures;
- system monitoring by a distributed control system; and
- mostly computer-controlled processes.

The scheme operated by the UOSA has considerable similarities to South East Queensland's (SEQ) Wivenhoe scheme; however, SEQ's scheme will include a state-of-the-art membrane filtration system.

Montebello, USA

Next to Orange County, in Los Angeles County, the Montebello Forebay Groundwater Recharge Project provides the main source of water to replenish the groundwater basin which underlies the greater Los Angeles metropolitan area. Purified recycled water has been supplementing the groundwater since 1962.



Three major water reclamation plants – San Jose Creek, Pomona and Whittier Narrows – provide the groundwater recharge. Most of their wastewater is from domestic sources, industrial effluents are largely diverted. The wastewater undergoes sedimentation and activated sludge treatment, sand filtration and disinfection with chlorine before recharge of the aquifer. The recycled water constitutes up to 38 percent of the drinking water that reaches the consumer (Sloss et al.1999).

The high quality purified recycled water meets all US drinking water standards for pesticides, heavy metals, minerals, trace organic compounds, microorganisms and radionuclides. After more than 40 years of operation, studies examining health have found no negative impacts from drinking recycled water in this community.

The Montebello scheme applies significantly less water treatment than what is being proposed for Queensland due to the absence of membrane technology.

For more information on Montebello's scheme, go to lacs.org/waswater/wrp/wrp2.htm

Singapore

Singapore has adopted a 'four tap' approach for sustainable and robust water supply. It imports water from Malaysia, collects and treats local surface runoff, desalinates seawater and reuses water through its NEWater scheme.

Results of pilot testing of membranes at Water Factory 21 underpinned the design of Singapore's NEWater 10 million litres per day demonstration plant constructed in 2000.



NEWater exceeds the WHO Drinking Water Guidelines and USEPA Drinking Water Standards. Two plants commissioned by the Singapore Government came online in 2003, producing a combined 72 million litres of purified recycled water per day. These two plants are being expanded to meet the growing demand for NEWater by industries.

In 2004, a third plant producing up to 24 million litres per day was commissioned, and a fourth plant was constructed in 2007. To cope with growing demand, work on the fifth and largest NEWater plant located in Changi recently commenced. This plant will have the capacity to produce up to 50 million gallons (189 million litres) of NEWater a day.

Most of NEWater is supplied to wafer fabrication plants, electronic industries, commercial buildings and other industries for process and other non-potable use because of its high quality. The high purity of NEWater has enabled these industries to save on their operation cost. The wafer fabrication plant operators who require water quality more stringent than for drinking have reported savings of some 20 to 30%. The target is to supply

some 250 million litres per day to the industries by 2011.

Currently, NEWater contributes one percent to the drinking water supply through planned indirect potable use i.e. discharge into existing surface reservoirs where it is mixed with raw reservoir water before treatment at water works before supply to households. This is expected to increase to 2.5 percent by 2011.



The water treatment process involves membrane pre-treatment, reverse osmosis, UV disinfection and chlorination for control of bio-fouling and residual chlorine in NEWater. Unlike Water Factory 21, advanced oxidation is not required as the level of n-nitrosodimethylamine (NDMA) in NEWater is low, at less than 10 parts per trillion. This could be attributed to wastewater mainly from domestic sources and to full secondary wastewater treatment.

Many fail-safe features are incorporated into the NEWater treatment plant, including:

- routine membrane integrity testing and on-line monitoring eg particle counts for MF/UF integrity monitoring and TOC (in parts per billion) for RO integrity monitoring;
- standby units on all critical equipment;
- routine calibration and daily verification of on-line monitoring systems;
- automatic warning systems for abnormal plant conditions;
- automatic plant shutdown;
- real-time computerised data acquisition and trending of operational data; and
- comprehensive staff training on operation and maintenance of NEWater plants.

An international independent External Audit Panel undertakes regular audits of water quality assessment of the ongoing monitoring of data and operational processes. So far, more than 50,000 test results have been collected since 2000 and more than 287 parameters are routinely monitored including the latest USEPA Priority List of Contaminants. This is much more than some 140 parameters listed in WHO and USEPA drinking water standards.

Health risk testing was conducted on fish and mice to check for adverse endocrine and carcinogenic effects. According to a 2002 report reviewed by the Expert Panel, no adverse effects were detected.

An international expert panel has also been convened for South East Queensland's water recycling project to provide independent advice on the regulatory framework and associated technical issues.

For more information on Singapore's scheme, go to pub.gov.sg/NEWater_files/index.html

Veurne-Ambacht, Belgium

Veurne-Ambacht is a tourist region on the coast of Belgium. Its water supply is from the local groundwater basin. The popularity of the area placed the water supply under pressure, with heavy water extraction bringing the threat of seawater intrusion.

Recharging with purified recycled water has prevented this from occurring.

The sewage treatment plant at Wulpen provides treated wastewater to the water treatment plant at Torreele, which produces a total of 2500 million litres of purified recycled water per year. At Torreele water undergoes ultrafiltration, reverse osmosis and ultraviolet disinfection treatment. The treated water is then added to an

infiltration basin where it filters through the sand dunes to the groundwater, which provides the local drinking water supply.

The water takes approximately 40 days to infiltrate from the surface to the groundwater before it is extracted and used for drinking purposes. (Wintgens et al. 2005). The recycled water contributes about 45 percent to the drinking water supply.

For more information on Veurne-Ambacht's scheme, go to www.iwva.be/docs/torrelee_en.pdf

Essex, UK

Essex, the driest county in the UK, has a population of 1.5 million. From 1995-1997, severe droughts led Essex and Suffolk Water to implement a temporary recycling scheme.

The recycling scheme began in 1997. Up to 28 million litres per day of treated wastewater from the Chelmsford Sewage Treatment Works was UV disinfected, mixed with river water and pumped into Hanningfield reservoir.

When the water was extracted from the reservoir, it was subjected to advanced potable water treatment at the Hanningfield treatment works. The treatment involved pre-ozonation, coagulation, settling, lime softening, rapid sand filtration, ozonation, granular activated carbon filtration and chlorination.

In 2003, a 40 million litres per day permanent scheme was implemented. Wastewater undergoes an advanced wastewater treatment process at the Langford recycling plant before the purified recycled water is released into the River Chelmer. The purified recycled water is of better quality than the river water so further dilution in the Hanningfield reservoir is no longer required. The water is extracted 4.5km downstream and subjected to drinking water treatment before it is distributed to consumers. The reclaimed water contributes about 10 percent of the total drinking water supply.

By comparison, purified recycled water which is added to Wivenhoe Dam would travel about 60km down the Brisbane River, or about two days travel, before being extracted at the Mt Crosby pumping station for further treatment.

For more information on Essex's scheme, go to www.eswater.co.uk

More information

For more information, visit the Queensland Water Commission website at qwc.qld.gov.au

If you would like to tell us what else you would like to know about purified recycled water, write to the Queensland Water Commission, PO Box 15087, City East Q 4002. Telephone: 1300 789 906

References

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