Responsible water recycling

Decentralized solutions for water reuse

Real-world decentralized water reuse strategies provide additional water supplies to increasing communities worldwide. **Tristian Bounds** and **Jeff Pringle** of Orenco Systems, Inc. and **Pete Muñoz** of Biohabitats report on three projects in Australia and the United States that provide inspiring examples of what can be achieved.

Increasing demands on the planet's limited fresh water supply are a source of immediate concern. In many places, demand exceeds supply. By implementing effective treatment technologies and reuse strategies, the effects of drought and population growth on water supplies can be alleviated. Decentralized water reuse solutions can play a pivotal role in water conservation and management. Properly treating wastewater – both blackwater and greywater – at or near the point of generation relieves pressure on potable water resources and provides many other environmental and economic benefits. Decentralized systems also minimize environmental footprints, increase opportunities for public education and awareness, and provide for a more sustainable future.

The following case studies illustrate real-world examples of decentralized reuse strategies.

Ecovillage in Australia

The Ecovillage at Currumbin was developed on a 110-hectare parcel in the Gold Coast of Australia in 2007. Its founders envisioned a neighborhood with a strong sense of community and a very light environmental footprint. The village was designed to incorporate a variety of sustainable features into its energy, water, and wastewater equipment. The resulting development includes 147 home lots, a café, and a large community center with a swimming pool, kitchen, library, and playground.

Recognition via mainstream and sustainability award programs is a valuable tool to effect change in the development industry, and this facility is one of the most award-winning developments in Australia. In all, the Ecovillage has received more than thirty international, national, state, and local honors. Project developers were especially pleased to receive the Prix d'Excellence Award from the International Real Estate Federation as 2008's "World's Best Environmental Development."

The focus of the project was rooted in sustainability. Some of the constraints during the design phase of the project included providing consistent, high-quality water for non-potable uses, a phased build-out, pleasing aesthetics, and the best environmental footprint possible. With these constraints in mind, the engineers, developers, local council, state government, and equipment suppliers provided solutions to meet Class A+ water quality, with the ability to build out as needed. The constructed system was innovative, aesthetically pleasant, and environmentally sound.

The Ecovillage's wastewater treatment plant consists of five major equipment components:

1. Primary treatment tanks
2. Secondary treatment (AdvanTex®)
3. Odor control via carbon filters
4. Tertiary filtration
5. Disinfection with UV and chlorine.

Six Orenco AdvanTex units treat an average daily flow of 57 cubic meters per day (m^3/day) and can handle up to 114 m^3/day. This high-quality effluent is reused for toilet flushing, car washing, and laundry, helping residents to achieve their goal of water self-sufficiency. The entire system was also outfitted with an Orenco TCOM™ remote telemetry monitoring system, which allows for offsite assistance with daily monitoring and asset management.

The Lloyd EcoDistrict in Portland, Oregon, United States, is one of the first urban neighborhoods to treat and recycle wastewater onsite.
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The facility's performance has been outstanding. Queensland EPA guidelines for Class A+ recycled water for non-potable reuse requires the following:

- Biological oxygen demand (BOD_5) < 10 milligrams per liter (mg/L)
- Total suspended solids (TSS) < 10 mg/L
- Turbidity < 2 Nephelometric Turbidity Units (NTU)
- *E. coli* < 10 colony-forming units (cfu) per 100 milliliters (mL)
- Viruses/pathogens > 5 log removal

Effluent quality at the Ecovillage has consistently outperformed these requirements, with the first 5 years of resulting performance as follows:

- BOD_5 = 3.37 mg/L
- TSS = 1.85 mg/L
- Turbidity < 2 NTU
- *E. coli* < 1 cfu/100 mL
- Viruses/pathogens > 9 log removal

Samples were collected and analyzed by a third party between December 11, 2007, and June 24, 2013. Case study data is courtesy of Innoflow Technologies Ltd. and Orenco Systems, Inc.

The sustainable features of the wastewater treatment facility include:

- The use of polyethylene piping and watertight construction to eliminate infiltration and inflow (I&I)
- Anaerobic solids digestion to minimize solids handling needs
- Packed-bed filter construction in the secondary treatment unit for reduced energy usage
- Nutrient reuse through irrigation
- No unpleasant odor generation
- Low noise
- Low greenhouse gas production
- Pleasing aesthetics
- High-quality reuse water.

Hassalo on 8th (NORM)

The Lloyd neighborhood in Portland, Oregon, USA, is a dense cluster of office buildings with little residential space. The area is served by a combined sewer overflow system in which rainwater is conveyed along with sewage and ultimately treated as wastewater. Hassalo on 8th is a four-block, sustainable urban development in the Lloyd EcoDistrict, the first of several mixed-use developments by American Assets Trust.

The three new residential buildings and existing office building make up the LEED Platinum development that includes many sustainable features including green roofs, a bike hub, access to mass transportation, and numerous other eco-friendly technologies and amenities. It's also one of the first urban neighborhoods to treat and recycle its wastewater on-site.

The on-site wastewater system built in 2016, nicknamed NORM (Natural Organic Recycling Machine), treats and reuses approximately 170 m^3/day from wastewater generated on-site. The system treats wastewater to the state of Oregon's Class A reuse standards for toilet flushing, irrigation, cooling tower makeup, and groundwater recharge. The project lessens the burden on the public utility, staving off costly repairs and infrastructure expansion. This approach garnered considerable support from the City of Portland, as well from as the Oregon Department of Environmental Quality. Through a reduction in one-time sewer development charges (SDC), the development paid for approximately half of the system. The savings in water and sewer fees on top of the SDC will result in an approximate 4-year payback.

Led by Biohabitats in collaboration with GBD Architects, Glumac, and PLACE studio, the system design team used several different treatment elements integrated into the park-like pedestrian corridor of the project. Major treatment elements include trickling filters, constructed wetlands, and microfiltration. Treated water is then disinfected and stored until it is ready to use. Excess, unused treated wastewater is injected into dry wells for crucial groundwater recharge in a largely impervious urban area.

Guidelines for Class A+ recycled water for non-potable reuse for this application require the following:

- Total Nitrogen (TN) < 10 mg/L
- Turbidity < 2 NTU (24-hour average) / < 10 NTU (24-hour max)
- *E. coli* < 2.2 cfu/100 mL (7 day average) / < 23 cfu/100 mL (max).

This system is especially successful because the infrastructure does not just treat water. By integrating the system with natural treatment elements, such as constructed wetlands, the area that houses the system produces multiple benefits. These include: pedestrian circulation, emergency access, landscape, iconic branding, wastewater treatment, education, and increased biodiversity. Case study data is courtesy of Biohabitats, Inc.

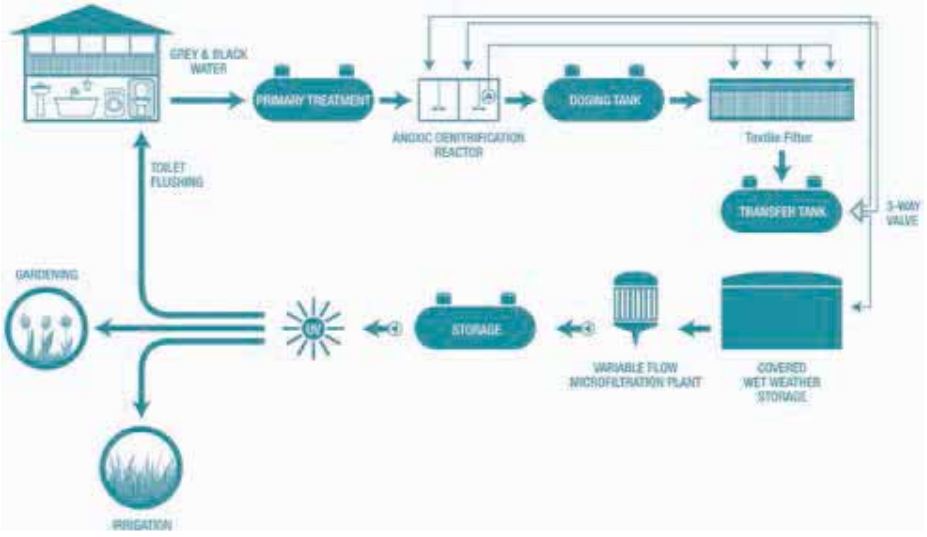
Summit Bechtel Reserve, Mount Hope, West Virginia, USA

The Summit Bechtel Family National Scout Reserve (SBR) is the permanent home of the Boy Scouts of America's (BSA) National Jamboree. The reserve opened in 2013 on a 4,290-hectare site in Mt. Hope, West Virginia, USA. The site was chosen in part because of its location adjacent to the New River Gorge National River, a 28,328-hectare park that's popular for whitewater rafting, mountain biking, rock climbing, and other activities. This location gave the BSA an opportunity to create a model for sustainability and environmental stewardship.

SBR was designed to be zero net energy and zero net carbon by using photovoltaic panels, wind turbines, and fuel cells. Geothermal wells with ground-coupled heat pumps generate chilled and hot water. Rainwater is captured and used, and bathrooms feature composting toilets. Showers use ambient-temperature water and pull chains to reduce water use by up to 50 percent. Passive design strategies take advantage of natural daylight to help heat and cool buildings based on their shape and location. Two of the buildings on-site were designed to meet the Living Building Challenge requirements.

Wastewater designers for the project had several specific requirements. The 336 shower buildings were constructed in groups of three, and each group needed a greywater system capable of treating 7.6 m^3/day. Designers also requested that minimal PVC be used, with components being made of fiberglass and high-density polyethylene (HDPE) wherever possible. And since the camp goes from minimal to full use nearly overnight during a jamboree, it required a treatment system able to cycle from non-use to full treatment capacity in a 24-hour period.

Each greywater system uses a pair of Orenco AdvanTex systems. These treatment units provide a combination recirculation and textile media tank. After biological treatment in the AdvanTex unit, the effluent is pumped through UV disinfection to a pressure tank, where it is



Communities around the world are searching for integrated decentralized water reuse alternatives.

Left: Ecovillage system schematic.
Image provided by Orenco Systems, Inc.

used to flush urinals and toilets. From there, it goes to a septic tank and is sent to the wastewater treatment system. The wastewater is then treated and disinfected before being dispersed into the forest soils for further polishing, which protects water quality and recharges the groundwater.

The treated effluent is required to meet strict criteria:

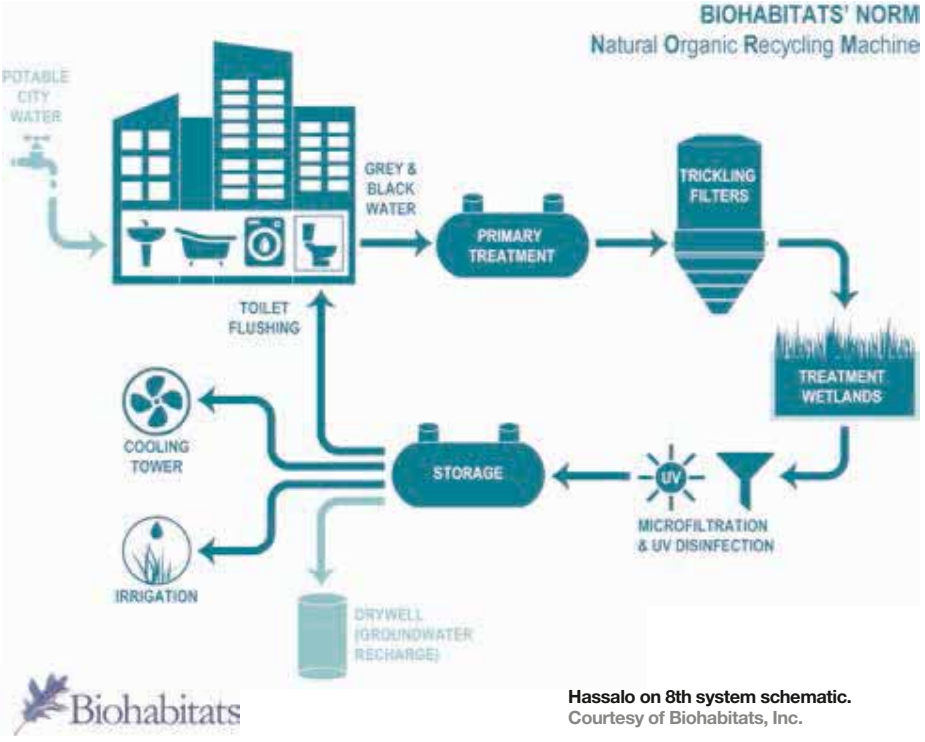
- BOD_5 < 10 mg/L
- TSS < 10 mg/L
- Turbidity < 10 NTU
- *E. coli* < 14 cfu/100 mL.

One of the sustainability goals of the BSA was to treat all wastewater on-site. At the same time, designers had to ensure that the water quality of the New River was protected and not affected by tens of thousands of temporary residents during a jamboree. Energy efficiency was also extremely important. Orenco's packed-bed AdvanTex Treatment Systems met all of the project requirements, including minimal required start-up time and low energy use.

The greywater system at the Summit Bechtel Reserve is designed to treat and reuse more than 757 m^3/day, which saves over 7,571 m^3/day of water during a jamboree. The natural, biological treatment and energy efficiency of the AdvanTex units assist SBR in meeting its goals of sustainability and protecting the nearby New River. The greywater treatment reduces the use of potable water by 30 percent (McCarthy 2012) and saves land area that would be required for disposal if the water were not used twice.

Conclusion

A paradigm shift is underway. As climates shift and populations increase, the need for increased resiliency in our water infrastructure is at the forefront of local, regional, and international conversations. It's becoming widely accepted to collect and treat various kinds of wastewater at or near their source for non-potable reuse. As a result, communities around the world are searching for integrated decentralized water reuse alternatives.



Hassalo on 8th system schematic. Courtesy of Biohabitats, Inc.

Focusing on responsible approaches to water resource management, on providing environmentally beneficial alternatives, and on water solutions that provide a holistic benefit to our communities is critical in this changing environment. This focus will help us educate the engineers of the future, adjust regulations for evolving industry needs, and promote integrated water management – with one unified emphasis on responsible water recycling and the benefits of decentralized solutions for water reuse.

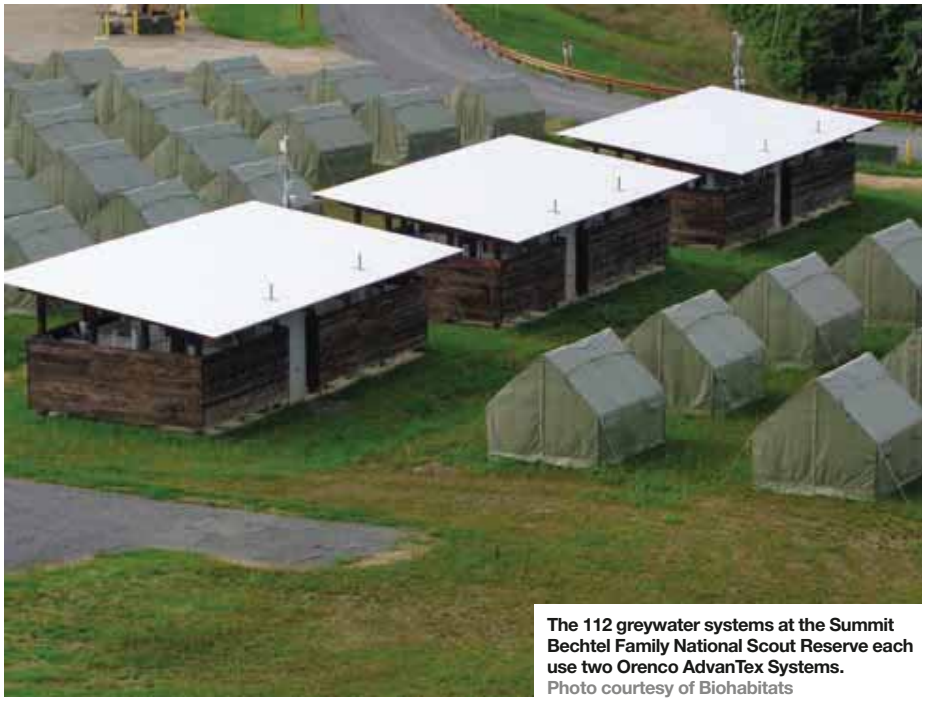
Authors' Note

Research and Development Engineer Tristian Bounds, PE and Account Manager Jeff Pringle of Orenco Systems, Inc. and Senior Engineer Pete Muñoz, PE, LEEP AP of Biohabitats in Portland, Oregon, United States, collaborated on this article, which is based on a paper presented at WEFTEC®, held from September 30 to October 4, 2017 in Chicago, Illinois, USA. Orenco Systems is based in Sutherlin, Oregon.

Reference

McCarthy, Dan. "So What's The Story On Showers?" The Summit Bechtel Reserve. May 16, 2012. http://www.summitbsa.org/so-whats-the-story-on-showers/

Effluent quality in the EcoVillage at Currumbin in Australia consistently outperforms Queensland EPA requirements. Photo by Orenco



The 112 greywater systems at the Summit Bechtel Family National Scout Reserve each use two Orenco AdvanTex Systems. Photo courtesy of Biohabitats