Building on Success of Other Reuse Projects

The water cycle—the continuous movement of water from ocean to air and land then back to the ocean—is as old as the earth itself. The basic underlying principle is simple: All water is recycled. There is no new water.

Today, nature cannot keep up with all the water needs because of the increased need for water by people, industry, agriculture and the environment. This is true in many places around the globe, but especially in arid regions like Southern California with its recurring droughts. For many years man has augmented this natural process by purifying wastewater to keep up with increasing demands.

Wherever there is a large city near a river, stream or lake, sewer water is treated for return to the environment. This treated water becomes part of these waterways and is further treated by nature. When humans use the water, it is withdrawn and purified again for use in the drinking water supply. This process has been repeated daily for many years throughout the developed world, including the United States where people receive some of the highest quality water in the world.

The Groundwater Replenishment (GWR) System is a new, planned water purification project unlike previous projects because of its high level of water purification. Using one of the world's most advanced water purification systems, the GWR System will produce water that is very similar to or better than bottled water quality before it is used as a seawater barrier and to augment the groundwater supplies.

The GWR System simply accelerates this natural water-recycling process by purifying highly treated sewer water to drinking water standards, water that otherwise would be returned to the ocean. After undergoing an extensive water purification process, the purified water is naturally filtered again in the groundwater basin.

The GWR System, scheduled to produce water in 2007, is part of an overall plan to help prevent predicted water shortages in Orange County's future. The GWR System is being built, based on more than 25 years of successful sewer water purification experience at Water Factory 21, where water is being produced that meets or surpasses the nation's toughest drinking water standards.

WATER PURIFICATION PROJECTS AROUND THE GLOBE

Orange County, California: Water Factory 21

The most widely recognized and highly regarded water purification program in the water industry worldwide is Water Factory 21, a project built and operated by the Orange County Water District (OCWD).

It was the first project in California to purify sewer water to drinking water standards as a barrier against the intrusion of seawater into a groundwater basin. Since 1976, Water Factory 21 has been protecting the integrity of the large groundwater basin that serves north and central Orange County, while also helping to increase the reliability of the area's water supply.

Water Factory 21 has a design capacity of 15 million gallons of water per day (mgd). The water meets or surpasses all drinking water standards, even before it is blended with water from other supplies in the groundwater basin.

Interest in the state-of-the-art technology employed at Water Factory 21 continues to generate annual visits by hundreds of water industry experts from around the world. Visitors meet with OCWD staff and learn about the latest advances in water purification. These experts are facing the challenges long ago solved by OCWD, including seawater intrusion, groundwater basin management and the need to reuse their water to augment future water supplies.

After more than a quarter century of operation, Water Factory 21 has proven that highly treated sewer water can be successfully purified to drinking water quality and used for injection into groundwater basins.

Los Angeles, California: Montebello Forebay Natural Groundwater Recharge Project
The Water Replenishment District (WRD) of Southern California operates the Montebello Forebay Groundwater Recharge Project, one of the oldest ongoing natural groundwater recharge sewer water projects in the nation. WRD has managed the project, located in southeastern Los Angeles County, since 1962.

The Montebello Project filters an average of 45 million gallons per day of treated sewer water through the ground into the Los Angeles Central groundwater basin. This recycled water, which meets state and federal primary drinking water standards, makes up about 35 percent of the total recharge to the groundwater basin, while imported water purchased from the Metropolitan Water District of Southern California and storm water runoff make up the remainder of the water used to replenish the basin, which provides water for 3.7 million people.

The Montebello Project is important because its long duration—40 years—has allowed numerous health studies that confirm the safety of using sewer water filtered through the ground. A health effects study was conducted in 1976. No measurable health problems were found among the people using the water. There have been peer reviews and other technical reviews of the study, with each concluding the project is safe.

Three epidemiological studies also have been conducted by the Rand Corporation on the Montebello project. In two of the studies, health outcomes were examined for about 900,000 people who receive water naturally filtered by the ground in their drinking water supply and compared to a group of about 700,000 whose water supplies did not include the ground-filtered water. The conclusion reached by the Rand researchers was that there was no association between project water and any ill health effects, such as cancer, mortality, infectious disease or adverse birth outcomes.

Fairfax, Virginia: Upper Occoquan Sewage Authority (UOSA), Millard H. Robbins, Jr. Water Reclamation Plant
After an intensive study conducted in 1970 of water quality problems in the Occoquan Reservoir, a major source of drinking water for Northern Virginia, the Occoquan Policy mandated the creation of a state-of-the-art advanced water reclamation plant to replace the 11 secondary treatment plants discharging to the reservoir. The Policy also mandated the creation of an independent ongoing program of water quality surveillance. The Upper Occoquan Sewage Authority (UOSA) was created to meet the water reclamation mandate of the Policy. The Occoquan Watershed Monitoring Laboratory met the requirement for independent surveillance. The Occoquan Policy included an implicit recognition that indirect reuse of reclaimed water would become the norm in the Occoquan Watershed.

The UOSA plant was created with high reliability, redundancy and treatment efficiency requirements to protect the water supply. UOSA discharges its effluent to its own final effluent reservoir. From this reservoir, the water flows to an unnamed tributary of Bull Run, which is a tributary of the Occoquan Reservoir, about 20 river miles upstream of the water treatment plant intake. During times of normal precipitation, the UOSA effluent makes up about five percent of the total inflows to the reservoir, with percentages much higher during times of drought.

Since UOSA came on-line in 1978 and the 11 secondary wastewater treatment plants were decommissioned, the quality of the water supply has dramatically improved. The quality of the UOSA reclaimed water is generally much higher than that of the receiving stream.

El Paso, Texas: Hueco Bolson Recharge Project
The Hueco Bolson aquifer provides about 40 percent of the municipal water supply needs of El Paso, Texas and the surrounding area. It also supplies 100 percent of the municipal supply for Ciudad Juarez, Mexico and Fort Bliss, Texas. The Hueco Bolson receives limited natural recharge due to the arid climate.

In order to decrease the rate at which the fresh water reserves of the Hueco Bolson were being depleted, El Paso Water Utilities looked to artificially recharge the aquifer using highly treated wastewater effluent. Substantial public comment took place during project development in the mid-1970s. The 10 mgd Fred Hervey Reclamation Plant and the associated Hueco Bolson Recharge Project started full operation in 1985 and have continued treating up to 7.5 mgd of wastewater to drinking water standards for injection. Irrigation and industrial customers were subsequently added to the project.

The Project has generated considerable technical interest. Several U.S. Geological Survey reports have been written based on Project research. The Project was included in the Bureau of Reclamation's High Plains States Groundwater Recharge program in the 1990s.

Scottsdale, Arizona: City of Scottsdale Water Campus

Meeting the water supply demands of a growing city led to the creation of the Water Campus in Scottsdale, Arizona. Since 1998, the Water Campus has produced 12 mgd of tertiary treated wastewater that is used primarily for golf course irrigation. In winter, when irrigation is reduced, 10 mgd undergoes advanced purification at a state-of-the-art membrane water purification facility where microfiltration and reverse osmosis purify the water to meet or surpass drinking water standards before it is used to recharge an aquifer.

The Water Campus is being expanded to 20 mgd, producing more purified water to maintain the water supply in a very arid region.

Los Angeles County-Area, California: West Basin Water Recycling Project

The West Basin Municipal Water District's sewer water purification facility in El Segundo, California, has been on-line since 1995. Purified sewer water provides a variety of benefits for the West Basin service area, including water for irrigation, industrial use and for a seawater barrier.

West Basin uses a combination of imported water and purified wastewater for the one-half mile long seawater barrier that encompasses over 100 injection wells to help protect the District's productive groundwater basin from seawater intrusion. Currently, 7.5 mgd of water that has been purified through a microfiltration and reverse osmosis process provides a high quality water that helps to improve the overall quality of the water mix in the groundwater basin that supplies the region's drinking water requirements. By 2006, the plant will expand to 12.5 mgd.

San Bernardino County, California: Chino Valley Basin

Water recycling is a critical component of the water resources management strategy for the Chino Basin in Southern California. In the past, the Inland Empire Utilities Agency (IEUA) has imported water for the Chino Basin from Northern California to meet its expanding needs.

In an effort to meet growing demand, the IEUA has adopted water rates that provide an incentive for use of recycled water throughout the Chino Basin. IEUA produces some of the nation's highest quality recycled water that can be used for a wide variety of applications, including groundwater recharge, industrial process water, and irrigation of unrestricted access golf courses, freeway landscaping, pasture for animals and food crops. Presently, about 15 percent of the 60 mgd of water currently generated by the agency's four wastewater treatment plants is reused locally each day.

Recycled water is treated through sand filtration and is also exposed to chemical and ultraviolet light for final disinfection. These processes result in high quality water that meets stringent California "Title 22" (water quality) standards.

The water is being served primarily to the cities of Chino, Chino Hills, Rancho Cucagmonga and Ontario. An extensive distribution system is planned in phases over the next 10 years to serve the northern portion of IEUA's service area. This recycling program under development by the agency could offset the additional use of between 30 and 40 million gallons a day of potable water.

Singapore: NEWater Project

The newest indirect potable (drinkable) water purification project in the world is in the city-state of Singapore. The "NEWater" project produced sewer water purified to drinking water standards on a test basis for two years. Before it was fully operational in early 2003, the Prime Minister led the way by drinking the NEWater to show his citizens the high quality and safety of the new purified water. The project uses water purification processes similar to Orange County's Groundwater Replenishment System design.

The NEWater project provides a safe, reliable source of high quality water for Singapore's 4.3 million residents and greatly diminishes the country's dependence on water imported across the channel from Malaysia.

The three-step purification process—microfiltration, reverse osmosis and ultraviolet disinfection—used to produce NEWater results in water that is better than World Health Organization drinking water standards. NEWater also meets or is better than the standards set by the U.S. Environmental Protection Agency, which have become an international benchmark for water quality.

With the purity and safety of NEWater endorsed by an international panel of world-renowned water quality experts, the long-term plan is to add NEWater to Singapore's reservoirs before piping it to residential homes and commercial industrial customers.

Other Indirect Potable (Drinking) Water Reuse Projects in Georgia, Texas and California
Other indirect drinking water reuse projects are operating successfully throughout the United States.

The Clayton County Water Authority operates a land application system that has served the southern metropolitan Atlanta area for more than 20 years. Approximately 15 mgd is treated by this system and discharged into nearby forestlands. The water percolates through the soils and flows into a creek that feeds a water supply reservoir for the area.

In suburban Dallas, since 1987, the North Texas Municipal Water District operates an advanced wastewater treatment plant that has produced up to 24 mgd of water treated for return to the local watershed. The highly treated water flows into a lake providing water to the district's entire service area.

In San Bernardino County, California, the Victor Valley Wastewater Reclamation Authority (VVWRA) treats more than 9 million gallons of sewer water per day. Approximately one-third of the water is placed in nine percolation ponds and is filtered by the ground as it naturally seeps into the groundwater basin. In addition to this recharge activity, two-thirds of the water is treated for release directly into the Mojave River (which is normally dry) and eventually settles into groundwater basins downstream of Victorville. This project is a vital part of the region's groundwater replenishment program since it accounts for more than half of the total down-gradient recharge. Eventually, the VVWRA expects to treat more than 18 million gallons of sewage daily by 2020.

Other projects are in the planning, design and construction stage, including some in Southern California. The Water Replenishment District is constructing a microfiltration, reverse osmosis and ultraviolet light water purification plant in Long Beach. The plant will further purify an initial 3 mgd of sewer water to near distilled water quality, which will exceed state and federal drinking water standards, for the Alamitos seawater intrusion barrier.

Conclusion
As these projects demonstrate, planned indirect use of purified sewer water has been taking place successfully for many years. With the new high-tech membrane water purification technologies—a water purification breakthrough not unlike the computer chip for the communications industry—sewer water purification can produce even safer, higher quality and more reliable water in the future.

The 1998 National Research Institute report states, "Our general conclusion is that planned, indirect potable reuse [water purification] is a viable application of reclaimed [purified] water—but only when there is a careful, thorough, project-specific assessment that includes contaminant monitoring, health and safety testing and system reliability evaluation." The GWR System has all of these safeguards in place and is backed by a natural groundwater purification system in the county's vast groundwater basin, all of which ensures a safe and reliable supply of water for current and future residents of Orange County.

Appendix

Planned Versus Unplanned Indirect Potable Reuse (Water Purification) Projects

Indirect potable reuse—using water a second time as a drinking water supply—occurs on both a planned and unplanned basis.

Orange County's Groundwater Replenishment System represents planned indirect potable reuse, which means that sewer water is purified to an extremely high level, similar to the quality of bottled water. The process includes state-of-the-art technological processes, backed by natural ground filtration as it enters the groundwater basin. The reuse occurs as part of a plan by the Orange County Water District to help prevent future water shortages.

Unplanned indirect potable reuse takes place on nearly every river system throughout the world, including the United States. For instance, water moves from an upstream community to one downstream where the city takes the water out of the river or stream, purifies it, uses it and returns it to the river or stream. Another city downstream extracts the water from the same river or stream, purifies it, uses it and the process repeats. The Mississippi River is an example where this is done repeatedly until the water reaches the ocean. The National Research Council noted in its 1998 report that "…more than two dozen major water utilities use water from rivers that receive wastewater discharges amounting to more than 50 percent of the stream flow during low flow conditions." (*Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies with Reclaimed Water*, 1998, page 2.) So, treated sewer water is already being provided to many, many communities as part of their drinking water.

In the case of Orange County, imported water from the Colorado River and Northern California contains highly treated sewer water and is part of our overall drinking water supply, as is water from the Santa Ana River. Orange County could not exist without these imported water sources, which contain highly treated sewer water.

Using the Colorado River as an example, cities such as Las Vegas take water from the river, run it through water purification plants and provide it to their customers through a sophisticated distribution system. The resulting sewer water is treated to tertiary levels at a wastewater plant and returned to the river. Eventually, some of this water reaches Orange County, where it once again is purified before being distributed to residents for their everyday use.

In contrast, as a planned indirect potable reuse (water purification) project, the members of the Boards of Directors of the two agencies who are overseeing the GWR System made a conscious decision to provide one of the highest levels of purification possible—using microfiltration, reverse osmosis and ultraviolet light and hydrogen peroxide processes. This purification process will ensure the water meets or surpasses all water quality standards. The product of this process is very pure water, similar to bottled water, that will be used to replenish Orange County's groundwater basin.

Indirect Versus Direct Potable Reuse

Indirect potable reuse refers to the discharge of highly purified sewer water into an underground basin or reservoir where it will blend with other water sources and become part of the drinking water supply. There are a number of indirect potable reuse projects in the world, but there are no full-time direct potable reuse projects, or those that discharge purified sewer water directly into the drinking water supply.

How the Groundwater Replenishment System Works

The Groundwater Replenishment System will use state-of-the-art membrane water purification technology, including reverse osmosis, which is used by many bottled water companies, to produce water of near-distilled quality that meets or surpasses state and federal drinking water standards. The water will then be used as another source to replenish Orange County's groundwater basin, along with water from the Colorado River, northern California and the Santa Ana River, providing arid Orange County with a more diverse and necessary water supply.

The GWR System process will begin with highly treated sewer water, which will undergo several additional purification steps that include microfiltration, reverse osmosis, and ultraviolet light and hydrogen peroxide disinfection processes.

After undergoing this additional treatment, water will be used to expand the seawater intrusion barrier that keeps the Pacific Ocean out of the groundwater basin. The water will also be used to replenish the groundwater basin underlying north and central Orange County. The purified water will be pumped to spreading basins and travel the same natural filtering path that rainwater takes through the ground into deep aquifers.

The water is so pure following the treatment process that it cannot be moved in conventional concrete pipes. Stripped of minerals, the purified water, if put in a concrete pipe, would leach the minerals out of the pipe and destroy it. In order to move the purified water, a small amount of minerals must be added back into the water, just like procedures used by bottled water companies, which use the same reverse osmosis purification process.

Once in the basin, the purified water will blend with existing groundwater from the Santa Ana River, Colorado River and northern California, eventually helping to lower the mineral content, or hardness, of Orange County's groundwater.

Treatment Process Explained

Water produced by the Groundwater Replenishment System will be purified using state-of-the-art microfiltration, reverse osmosis and ultraviolet light and hydrogen peroxide treatment techniques. Here is the explanation of these processes:

The first step in the treatment process is microfiltration. This is the same process used to purify food products such as fruit juices, wine and baby foods and to sterilize medicines that cannot be heated. It is also used to produce particle-free water for computer chip manufacturing. It works like a screen to remove small suspended particles, protozoa, bacteria and some viruses from the water. It is an excellent pretreatment for reverse osmosis.

The next, and most widely known process, is reverse osmosis, which is used by many bottled water companies to purify water for their products. It is also used in home and boat water purification systems. Water is forced under high pressure through thin membranes that eliminate salts, viruses, pesticides and most organic compounds, creating near-distilled quality water.

The final safety measure involves ultraviolet (UV) light and hydrogen peroxide treatment. UV light, combined with hydrogen peroxide, is the most effective way to eliminate any remaining organic compounds in water by breaking them down to their most basic elements of carbon dioxide and water. UV with hydrogen peroxide provides a powerful oxidation process that destroys low-molecular weight specially charged or shaped organic compounds and thoroughly disinfects the water prior to its use.

A study completed by an independent group of experts found that water produced by the GWR System is safer and of higher quality than any other current source of water for Orange County. The GWR System can also be replicated in other arid coastal regions of the world and help address the looming global water crisis.