

Phosphorus Removal in Oregon

Recovered nutrient from wastewater becomes high value fertilizer.

While phosphorus is essential to sustaining all life, it is paradoxically also a pollutant. Over time, the majority of mined phosphorus enters the ecosystem as waste, leading to excessive nutrient levels in waterways. This over-stimulates algae growth (eutrophication), killing off natural aquatic species by consuming too much oxygen in the water, and damaging waters for consumption and recreation. The increasing accumulation of nutrients such as phosphorus that are discharged into the environment was cited by the United Nations Millennium Ecosystem Assessment in 2005 as one of the most significant environmental challenges facing the planet.

In June 2009, Clean Water Services (CWS, www.cleanwaterservices.org), a water resource management utility in Oregon, opened the first commercial facility in the United States that incorporated the Pearl® Nutrient Recovery Process (Ostara Nutrient Recovery Technologies, www.ostara.com). CWS serves more than 527,000 residents of urban Washington County west of Portland and treats 64 mgd of wastewater on average. The wastewater treatment plants operated by CWS discharge into the sensitive Tualatin River Watershed; hence effective treatment is crucial to ensure its protection and to safeguard the area's economic and environmental vitality.

CWS employed the Pearl process at its Durham Advanced Wastewater Treatment Facility to help meet tight phosphorus discharge regulations (an effluent phosphorus concentration limit of 0.1 mg/L applies during summer months). The Durham Advanced Wastewater Treatment Facility provides wastewater treatment for the cities of Beaverton, Tigard, Sherwood, Tualatin, Durham, and King City, and portions of Clackamas and Multnomah counties, treating a total average flow of 20 mgd.

As is common with biological phosphorus removal facilities, phosphorus and ammonia become heavily concentrated in the sludge handling process where it can cause the formation of stru-



The Durham Advanced Wastewater Treatment Facility is the first commercial facility in the country to incorporate the Pearl® Nutrient Recovery Process from Ostara Nutrient Recovery Technologies.

vite (magnesium ammonium phosphate). Struvite has a consistency similar to concrete and coats pipes and valves, causing blockages much like cholesterol does to an artery. The result is plant inefficiencies, risk of process failure, and costly maintenance. Further, the return of the phosphorus and ammonia back to the main treatment plant increases the nutrient load it has to treat, increasing both capital and operational treatment costs.

Before CWS's partnership with Ostara, biological phosphorus removal and the dosing of aluminum sulphate was used to chemically combine with phosphorus to remove it from the water discharged to the river. Alum dosing is a significant expense at treatment facilities. With the Ostara process removing 20 percent of the phosphorus load to the plant, the biological phosphorus removal became more stable and efficient, resulting in a 23 percent reduction in alum use. While not required by the permit, the Durham facility maintains biological phosphorus removal even during the winter. Both an environmental and economic solution, Ostara was selected by CWS to ensure regulatory compliance, environmental stewardship, address maintenance issues, and provide a revenue stream to the utility.

Before Ostara, all but a minute fraction of the phosphorus at the Durham facility exited the plant by being trucked out in the form of biosolids, which are land applied. Ostara provided CWS with an alternative—phosphorus in the form of Crystal Green® commercial fertilizer.

The nutrient recovery process is based on a proprietary fluidized bed reactor in which magnesium is added to sludge dewatering liquor to precipitate struvite under a controlled chemical reaction. The reactor uses both its unique geometry and up flow velocity to segregate prill (fertilizer pellets) sizes to suit a variety of application needs. Pearl reactors employ a tapered design in which the diameter increases in stages. The larger prills accumulate in the bottom section where up flow velocity is the greatest due to the smaller diameter of the reactor. The magnesium, ammonia, and

phosphorus concentrations are the highest in this zone resulting in the precipitation of struvite on suspended prills. In the next dimensional stage, the velocity is reduced and medium sized prills accumulate. The medium sized prills have more surface area and longer contact time with the reactor liquids so they scavenge unreacted magnesium, ammonia, and phosphorus.

In the largest top section, the velocity is further reduced and fine prills are present. The fine prills have even greater surface area and detention time to capture residual reactants. The process design is focused on precipitating struvite on existing prills rather than on new particle creation, although some new seed nuclei are created. The process is similar to an oyster making a pearl, adding layer upon layer of material on an existing nucleus, resulting in prills that are pure, monolithic struvite crystals. The prills are retained in the process until they have grown to the desired size, and are then removed, dried, classified, and bagged—ready to be sold as fertilizer.

Through the private/public partnership with CWS, Ostara is responsible for the sale and marketing of the Crystal Green fertilizer. CWS receives an agreed payment for every ton of fertilizer that is produced, which not only covers all of the facility's operation and maintenance costs, but also helps to offset the capital cost of the system.

Results and Benefits

After completing a successful pilot project in 2007, Ostara was contracted to deliver a full-scale commercial facility. The system, which employs three Pearl 500 reactors and has the capacity to produce 500 tons of Crystal Green per year, was delivered under an "Engineer, Procure and Construct" contract, in which Ostara provided the full turn-key system and also re-engineered an existing building to house it.

Since the facility became operational one year ago, the nutrient recovery process has provided numerous benefits to the plant. To date the process has reduced centrate phosphorus concentration by an average of 85 percent and ammonia by 15 percent. However, the

ongoing optimization of the process has resulted in recent performance that surpasses the average; for example, in December 2009 the removals were 89 percent and 20 percent, respectively. Removing these nutrient loads has eased the pressure on treatment processes in the main plant, making the whole plant more robust and providing increased flexibility in plant operations. This has consequently reduced the costs associated with alum dosing, and reduced the amount of chemical sludge generated, decreasing dewatering and disposal costs.

Through the course of one year of operations 300 tons of struvite have been generated, representing 76,000 pounds of phosphorus and 34,000 pounds of ammonia recovered from the system. The amount of dry tons of biosolids trucked out of the plant was also reduced by about 12 percent.

As a result of the cost savings derived from reduced chemical alum dosing, reduced maintenance costs, improved plant efficiency, and the income generated from the fertilizer, CWS estimates it will make the projected five-year payback period. Presently, CWS is in the planning and design phase for a system at the larger Rock Creek Advanced Wastewater Treatment plant.

Crystal Green is being marketed to the horticulture (nursery), specialty agriculture, landscape, and turf industries throughout North America and Europe. Several prominent fertilizer distributors in the Pacific Northwest and Eastern United States have added Crystal Green to their product lists, and sales to commercial fertilizer users are ongoing. In spring 2010, a new Crystal Green blend was introduced to the retail market, which debuted at nurseries in Virginia and will be sold in an increasing number of states over the coming months. A Crystal Green fertilizer blend will also be introduced to the Canadian retail market this fall.

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