The pond resurgence

Waste stabilisation ponds – are they valued – are they understood? **Nick Walmsley** explains.

Waste stabilisation ponds (WSPs), or oxidation ponds to some of you, are still one of the most commonly used methods for treating domestic sewage here and overseas. We take them for granted and often don't consider how much value they give our communities.

The Ministry of Health's COSINZ data base reported that, at the year 2000, there were some 176 community wastewater treatment systems incorporating WSPs and this hasn't changed much since. This is over half the total number of community treatment plants. These communities WSP systems range in number between one to eight ponds and service populations from under 100 to over 100,000.

For small to medium sized communities (say up 30,000 population equivalents) ponds are often the sole form of wastewater treatment. For larger communities, there is often a multiple pond system, increasingly with enhancements, to produce a tertiary standard of final effluent quality.

WSPs are also used extensively for waste treatment of dairy farms and piggery effluents as well as agricultural processing wastewater in the likes of meatworks. They have been used with confidence for hundreds of years, yet often the communities that rely on them have inadequate knowledge of how they should be managed and just take them for granted.

For some communities the direct discharge of pond effluents to waterways is becoming less acceptable, for both cultural and water quality impact reasons and often for 'perceived' rather than well understood reasons.

Yet ponds are experiencing resurgence, both here and overseas, due to a mixture of improved understanding of pond biology, maintaining pond health, the development of advanced pond systems, and greater experience and knowledge of retrofit technologies.

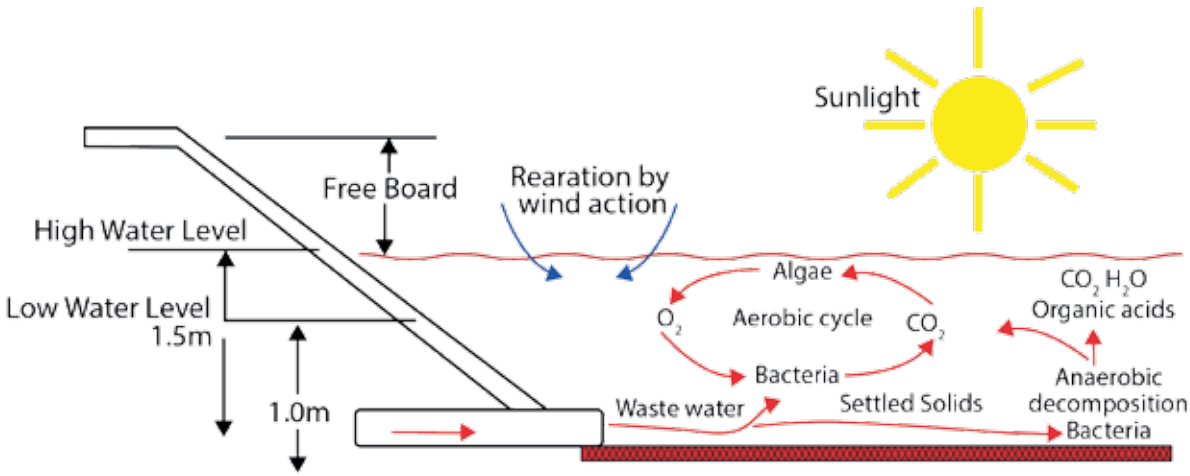
These improvements are able to maintain better quality across the seasons as well as to achieve treatment qualities comparable to mechanised, high rate treatment plants such as activated sludge. Where land is available, ponds also offer significant capital and operating cost advantages when compared with alternative wastewater treatment technologies.

Modern ponds, with enhancements, have an important role to play in wastewater treatment in this country. Ponds are robust, require low energy, are able to cope with hydraulic and organic loading peaks, and can provide buffer storage for downstream processes such as land treatment systems.

Greenhouse gas emissions, especially methane, are an important aspect of the 'environmental footprint' of a wastewater treatment process.

The 2014 National Greenhouse Gas Inventory, using the Intergovernmental Panel on Climate Change (IPCC) 2006 methodology, notes that there is considerable uncertainty in the amount of greenhouse gas emitted from wastewater treatment.

However, the conversion factors proposed by the IPCC indicate that WSPs, which are primarily aerobic or facultative, are likely to emit less greenhouse gases from the whole treatment plant than more mechanical



High Rate Algal Pond.

e.g. activated sludge, systems unless there is substantial energy recovery.

In spite of their apparent simplicity, WSPs require skilled operation and regular attention. A good understanding of how they work and attention to maintenance requirements will make sure the ponds operate reliably.

WSPs are shallow earthen basins in which wastewater is treated biologically. Ponds are able to reduce the level of many contaminants in sewage including biochemical oxygen demand (BOD), suspended solids (SS), ammonia, and a number of microbial faecal indicators (pathogens). Wastewater solids settle to the pond bottom where they partially digest anaerobically and accumulate as sludge.

WSPs use algae and wind action to introduce oxygen to the pond surface waters. The wind and inlet flow momentum will also create currents within the pond which help to mix the wastewater over the full pond area. The quality of outflow (effluent), from a WSP, is very dependent on the action of these currents, and avoidance of short circuiting.

Grazing by microscopic animals, settlement, and sunlight exposure all work to help reduce the levels of faecal indicator and pathogenic microbes in the WSP. This is illustrated in the figure below.

Basic processes at work in a WSP

Dissolved nutrients in the sewage, such as nitrogen and phosphorus, are assimilated along with carbon dioxide, by green algae which are microscopic plants suspended and living in the water.

Like land plants, algae produce oxygen by photosynthesis, during the day. Pond oxygen levels, and some other characteristics, like pH, will therefore change throughout the day and from day to night. The oxygen sustains the aerobic bacteria which feed on and break down the incoming organic waste.

Most algae are good, providing the majority of the aeration of conventional oxidation ponds, as well as nutrient removal. Problem blue-green algae in secondary ponds can be reduced by making sure there is a surface outflow for the effluent, providing mixing to the pond surface and dividing the final pond into cells of no more than two days hydraulic retention.

Knowledge is now available on the key technical issue supporting performance; mixing, hydraulics, the necessary operational skills and that sludge management is always required plus a range of upgrade technologies to modify existing ponds to give cost effective upgrades. However publically available guidance on this can be hard to find.

One of the major advantages of WSPs is they require relatively little operation and maintenance in comparison to more intensive wastewater treatment processes. However, regular and skilled O&M is required to:

- Maintain the health of the pond biology.
- Monitor the efficiency of the WSP process.
- Undertake general housekeeping around the site.
- Maintain the structural integrity of the ponds.
- Collect samples for resource consent compliance.

While WSPs do offer the real advantages of low complexity and operating cost their performance is highly seasonal and we have limited control over the natural biology. Given this disadvantage, there is a natural range of unpredictable performance. WSPs are unlikely to reliably achieve full, year-round nitrification, even after modification. Lack of algal control and overloading are commonly causes for odours.

A few key issues to consider are:

Raw influent screening upstream of a pond system can have several benefits:

- Reduce maintenance requirements through the removal of inorganic matter, which would otherwise float on the pond surface, settle on the embankments or obstruct overflow weirs.
- Protect equipment installed in the pond such as aerators and mixers from jamming and growth media and rock filters from clogging.
- Improve the pond's sludge long-term quality and for potential re-use.

Septage and commercial/industrial discharges can have a significant impact on the health, the treatment capacity and the long-term operation and maintenance needs of a pond system.

A septage discharge not only represents a very high instantaneous load (e.g. 6 m^3 = 600PE) for a pond, but it adds a high percentage of digested, heavy sludge as well as inert solids, such as sand and grit and often also lighter material which can float to the pond surface. Its impact is often underrated but can represent an equivalent load of an additional small village. As such it can make the difference between having to upgrade a pond system to a high-rate plant versus being able to operate a pond over many more years to come.

Anaerobic ponds can significantly improve the treatment capacity of an existing pond system through their capacity of retaining solids, grease and oil and in reducing BOD_5 load. Pretreatment using anaerobic ponds is an excellent opportunity to combat additional organic load to conventional oxidation ponds and reduce the volume of sludge for disposal, and could provide a local energy source (compared with adding aeration).

In modern pond designs the need to use the whole pond volume more efficiently and to create consistent flow conditions has been recognized. The pond inlet design has consequently radically changed. Old plants can easily be modified to improve treatment at the pond's front end through a change of the inlet.

Apart from the use of WSPs as treatment process units, the structures themselves represent a valuable asset as a potential reactor basis for alternative treatment processes. The experience of the Christchurch 2010/11 earthquakes in which practically none of the ponds in the city and the wider region were damaged has shown that treatment ponds can be very resilient structures.

Given the value and versatility of this technology Water New Zealand is updating the WSP Good Practice Guide to enable all utilities to get the most from this asset type. The update will be available later this year. **WNZ**