Background

The Wildfowl & Wetlands Trust (WWT) is a conservation charity that saves wetlands, which are essential for life itself.

In 1999 The Millennium wetland treatment system (WTS) was commissioned, and treats all sewage from the Slimbridge visitor centre, office areas, kitchen, and three residential homes. The system was created not only to remediate effluent, but also to provide habitat which would benefit wildlife and have amenity and educational value.

At the time of construction, WWT Slimbridge attracted some 220,000 visitors per year. This has since remained fairly consistent with 226,923 visitors in the 2014-2015 although visitation fluctuates throughout the year and is highly weather dependent.

Flora and Fauna of Slimbridge Millennium Reedbed

The project

The project was initiated as a proving ground for differing WTS technologies to be integrated into a new multi-component single system. Primarily it was for treating the site's wastewater; second, it aimed to show that these systems could be used effectively to deal with household wastewater to a high enough standard to be discharged to the local watercourse; and third, it aimed to show how such a system could provide benefits to wildlife in the habitats it creates.

The use of this, at the time, state of the art integrated system was a Europe-wide first which acted as a flagship scheme for demonstrating the value of such technology. In addition, few wetland treatment systems had been designed with the creation of wetland habitat for wildlife in mind and even fewer were on display to the general public.

Design

The design incorporates a number of different zones, each performing a different role. This "sequential treatment" design allows close control over water quality as it flows through the system. The facility exists to treat all solids on-site via a "sludge drying bed".

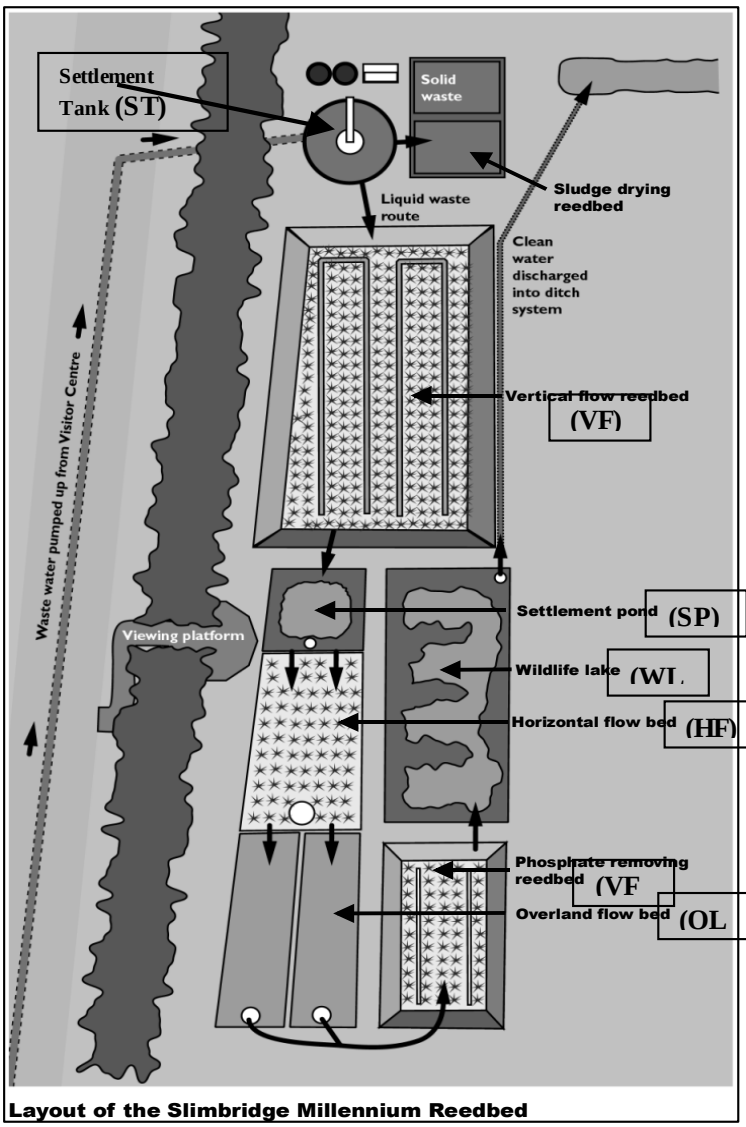
Its sequential components and their roles (in order) are:

1. Settlement tank – solids, and therefore Biological Oxygen Demand (BOD), reduction.
2. Vertical flow reedbed – encourages nitrification through aerobic conditions
3. Settlement pond – further solids reduction.
4. Horizontal sub-surface flow bed – both nitrification and de-nitrification through a mixture of aerobic and anaerobic conditions.
5. Overland flow bed – further mix of nitrification and de-nitrification within a semi-natural wetland habitat.
6. Vertical flow phosphate removal bed – artificial clay substrate planted with Common Reed to adsorb phosphates
7. Wildlife lake – mainly as demonstration of water quality and provision of wildlife habitat.

The sludge drying bed consists of lined beds planted with Common Reed, where settlement tank solids are pumped; excess water feeds into the sequential treatment components.

The system was designed by Dr Chris Weedon at Watercourse Systems Ltd. http://watercoursesystems.co.uk/

Beneath is a detailed image of the layout of the reedbed system.



Layout of the Slimbridge Millennium Reedbed

Cost

The cost of the system was £108,385 with funding provided from BOC foundation and Gloucestershire Environmental Trust, with matching funds secured from the Millennium Commission.

Maintenance

Replacement or flushing of the artificial clay substrate takes place periodically to maintain the treatment efficiency by increasing adsorption sites for phosphorus.

The paths and banks are regularly strimmed and mowed to maintain access. Pipes and other features are checked regularly, but little management is needed of these features.

Other long term maintenance measures include the excavation of the sludge beds on a six-monthly basis, and annual harvesting of the vegetation in all beds. Clearance of any accumulation of sediment from the surface of the vertical bed may also be necessary on occasion.

Maintenance of vertical flow reedbed

Review

Initial monitoring reports (pre 2005) suggested that the Millennium treatment system, on average, removed over 50% of suspended solids, 84% of BOD, and nearly 99% of Ammonia during this period. Over 60% of nitrites and 16% of total phosphorus were also removed. The removal of ammonia was reflected in the much higher concentrations of nitrates in the outflow than in the inflow.

More recent reports suggest that despite periodic fluctuations in visitor numbers and seasonality, the system is still working effectively in terms of BOD and faecal coliform reduction. Ongoing improvements are continuing to further minimise the levels of phosphorus and nitrates being released from the system.

Positive outcomes

Monitoring data shows that the system supports a fantastic diversity of wildlife. The treatment efficiency is evident from the presence of macro-invertebrate species with low pollution tolerance. Unlike most constructed wetlands that are dominated by a few plant species, the Millennium system has been shown to support over a 50 plant species, the wildlife pond at the end of the system being particularly diverse. This shows that biodiversity aims can be effectively incorporated into

constructed wetland designs. The enhanced aesthetics and wildlife of this integrated natural system provides further benefits in terms of education and public enjoyment, which further emphasises the multiple benefits of such systems.

The enhanced environmental protection and habitat creation provided by this system is comparable, in terms of water treatment, to more industrial methods of wastewater treatment that are less sustainable and can have detrimental environmental impacts. The system shows that the needs of human (built environment) and natural systems (biosphere) can be met simultaneously.

In comparison to the cost of standard wastewater treatment options, and considering the normal costs of habitat creation this system also provides, this option is seen not just as viable but as economically favourable.

Room for Improvement

Some modifications to the phosphate bed have since been carried out with the aim of improving the system's Phosphorus-reduction efficiency. This involved planting willow trees, which are harvested on a regular basis and used on the Slimbridge reserve e.g. for building wildlife-watching screens. Further refinement of the system to try to improve the treatment efficiency and longevity of the system is also intended through investigating the use of new low-energy technologies.

Willow planting in the phosphate removing reedbed

Lessons Learnt

Effective use of sequential wetland treatment systems for wastewater treatment is achievable, and can greatly enhance the multiple benefits that can be provided by this approach to wastewater processing.

The input waste type must be carefully considered when dealing with the direct impacts of chemicals on a natural system that is less adaptable than more engineered wastewater treatment methods, for example, by shifting to cleaning products with low phosphorus content.

Recommendations

Despite the fluctuations in reliability of the system, the modular composition of the system means failure of the entire treatment process is unlikely.

Additional consideration of the system's environmental impacts, in the form of waste input (specifically non-biodegradable and high phosphorus chemical cleaning supplies), must be considered carefully so as to minimise any detrimental impacts and ensure the effectiveness of such a system.

There are multiple ways in which wetland treatment systems can be designed to enhance biodiversity, aesthetics and public enjoyment without detrimental impact on treatment efficiency. The use of passive technology can substantially reduce the carbon footprint and running costs compared with more conventional methods. Please contact WWT's specialist wetland consultancy WWT Consulting (http://www.wwtconsulting.co.uk) for expert advice.

Regular monitoring of the performance and other benefits is important in order to best maintain the performance and increase the lifetime of such systems.

Conclusion

It is clear to say that the project has been a huge success right from the start. It has enhanced bio-diversity, proved economically favourable, provided an environmentally friendly system for sewage treatment, improved the visitor experience and much much more.

If you are looking to implement any form of water treatment system WWT certainly are an example to follow.

This case study was compiled in 2016 by Adam Thomas and Fit for the Future with assistance from Anne Harrison

Photo credits throughout go to WWT Slimbridge

Overland flow beds