CONSTRUCTED WETLANDS

OPPORTUNITIES
FOR
LOCAL AUTHORITIES

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In September 2006 the International Water Association held an *International Conference on Wetland Systems for Water Pollution Control* in Lisbon. This conference, attended by over 300 delegates from around the world, has inspired the following observations and comment.

WETLANDS

Natural wetlands are found throughout the world; in lowlands (raised bogs, marshes and fens), upland (blanket bogs) and coastal areas (salt marches). The bio-geo-chemical processes found in these natural wetland systems have always provided environmental services that were greater than their relative area might suggest, treating, recycling and assimilating intercepted materials from the natural catchments which flow into the wetlands.

By constructing wetlands man has learnt to use the very special conditions of the wetland environment to deal with man-made pollution. Constructed wetlands fall into two main categories:

- Subsurface water flow wetlands
- Surface water flow wetlands

Constructed Wetlands Worldwide

Constructed wetlands have been used for dealing with sewage and industrial water-based waste since the 1960s. There are a large number of installations worldwide with the number growing each year. In the UK alone there are approximately 1,100 constructed wetlands. About half of them are used as add-on tertiary treatment systems for existing treatment plants. In some instances they receive storm water overflow during heavy rainfall events.

"Reed Bed" Constructed Wetlands

Constructed wetlands are widely used to treat sewage from communities of less than 12,000 population equivalent though notable larger ones exist e.g. Atlanta, Georgia, USA and Melbourne, Australia. About 99% of constructed wetlands in use at present are classified as:

(a) Subsurface horizontal-flow wetlands
(b) Vertical-flow wetlands

These wetlands are generally heavily engineered and are often referred to as "reed bed" type constructed wetlands with an emphasis on using a minimum footprint of land. In most instances pumps are used to feed the wetlands, though gravity and automatic siphons are also used. Clogging, due to the voids in the substrate gravels becoming filled with residual sludges, is frequently a significant drawback to these systems demanding relatively high maintenance and operational life. Usually a single plant species, (the common reed *Phragmites australis),* is used and consequently ancillary benefits for amenity and nature are limited. In contrast surface-flow type wetlands, if adequately sized and planted with a wide variety of plants, would appear to provide the most effective and least maintenance demanding performance. These systems generally require a larger footprint of land.

"Reed bed" type constructed wetlands are good at removing COD, BOD and, suspended solids (SS). They are not so effective at removing nitrogen, phosphorus compounds and in some instances pathogens. This is due to the high hydraulic loading rates and low retention times that can be as low as 10 hours, as well as the absence of denitrifying environments and assimilative area for phosphorus retention.

Integrated Constructed Wetlands
In Ireland over the past 10 years, the National Parks and Wildlife Service of DEHLG has been uniquely developing a more robust and sustainable approach to the use of constructed wetlands. Categorised as surface-flow type wetlands they are similar to natural free surface water wetlands. Their holistic approach termed 'Integrated Constructed Wetland' (ICW) has been successfully applied to deal with a range of effluent types - farmyard runoff, industrial waste and sewage. Although this constructed wetland initiative originated and has been developed in the Anne Valley catchment of South Co. Waterford it now has much wider application in a number of Local Authorities, including Dublin City.

The concept is based upon the free surface-flow of water through a series of sequential-linked shallow ponds vegetated with a range of emergent plant species. While the footprint of the ponds is relatively larger than that usually used for similar hydraulic loadings in "reed bed" type systems they are generally less costly to build, easier to maintain and consistently deliver better quality water. An ICW has a long retention time of up to 90-100 days and it can be designed in many instances to have zero surface discharge. It's diversity of plant species facilitates microbial and animal diversity and is generally more appealing for recreation and amenity. Due to the slow movement of water through the ponds suspended matter is deposited, and there is adequate time for both aerobic and anaerobic digestion of organic matter. There is good reduction of nitrates and phosphates which can be greater than 95%. Reduction of fecal indicators is of the order of 99% due to the long retention times and the complex ecology of the aquatic system. ICWs may also remove endocrine disrupters such as estrogen and testosterone which are poorly removed with conventional wastewater treatment systems.

Integrated Constructed Wetlands in Ireland
Currently in Ireland a small number of ICWs are being used for treating farmyard runoff, municipal sewage, industrial waste and polluted surface water. The results from ICWs studied in Ireland are very encouraging.

In Waterford's Anne Valley catchment, circa 80% of the farms have ICWs. The sewage from Dunhill village in the catchment was originally treated solely using a septic tank and its effluent did not meet its discharge requirements. With the addition of an ICW the effluent to the stream now meets the discharge requirements of the Urban Wastewater Directive. Fifteen years ago the Anne River was heavily polluted and was bereft of aquatic life. Now there is an established run of sea-trout in the river.

In Dublin the St. Helena stream from Finglas flows into an amenity pond in Tolka Valley Park. The pond was heavily polluted with a permanent scum on top and no plant or fish life. Seven years ago an ICW, consisting of three cells, was constructed upstream of the pond. The discharge into the pond is now crystal clear. The pond supports all forms of plants, fish and birds.

Opportunities for ICWs in Local Authorities

Where land is available there are many opportunities for Local Authorities to use ICWs.

- ICWs can be added onto existing communal septic tanks/ treatment plants to improve the effluent
- ICWs can be used as an alternative to new conventional treatment plants
- In rural areas where there are problems with individual septic tanks ICWs could be used to treat the effluent from the tanks on an individual basis or on a community basis where the effluent is pumped or discharged by gravity to a common ICW.
- ICWs can be used to treat land fill leachate
- Sludge from conventional treatment plants could be discharged directly onto constructed wetlands without the need for any dewatering, although further research is required on this topic.
- ICWs can be used to treat the pollutants in surface water runoff from roads and motorways before being discharged into rivers and streams.
- In urban areas ICWs could be incorporated into parks and open spaces as part of Sustainable Drainage Systems (SuDS).

Advantages of ICWs

The advantages for Local Authorities are:-

- Most Local Authorities have problems with maintenance. All conventional waste treatment plants need a medium to high level of maintenance. At times this is not available in the smaller plants. ICWs need a minimum amount of maintenance, with suggestions that it can be as little as 1/20 of that of a conventional wastewater treatment plant maintenance.
- ICWs have low running costs - often it is only dependent upon gravity flow.
- ICWs are cheap to construct at about 1/10 to 1/5 of a conventional wastewater treatment plant.
- ICWs can accommodate shock loadings without affecting the operation of the system.

- ICWs with proper design can be allowed to flood during an extreme event and recover immediately after the event.
- As part of the landscape ICWs can accommodate a large variety of plant species and fauna, especially encouraging a diversity of birdlife.
- By connecting existing single unit septic tanks to a communal ICW, subsurface pollution could be reduced or eliminated.
- ICWs have a very high level of environmental safety as they comprise a number of sequential bunded shallow ponds.
- ICWs have the advantage over conventional treatment plants in that they exploit ambient energy thus limiting the need for imported energy and the production of carbon gasses. Indeed ICWs are capable of capturing and storing significant large amounts of carbon as biomass and detritus thus providing an additional environmental service.

Disadvantages of ICWs

The disadvantages for Local authorities are:-

- ICWs require larger land areas than for conventional treatment systems – to treat domestic sewage about 20 sq. metres per person is required.
- Land may be expensive especially if the Local Authority is interested in acquiring it. However, leasing land and contracting land services may reduce this cost. Nevertheless, even with expensive land costs, an ICW, on a whole life cost basis, could still be cost competitive with a conventional wastewater treatment plant.
- While there is no limit to the size of an ICW and the population it may serve, it does require access to extra suitable land if loading is to be increased.
- Connecting all existing single septic tanks to an ICW could be problematic if all the residents do not buy into the system.

Small Rural Developments

ICW offers an attractive low cost method for draining a cluster of new houses in a small rural community where the Local Authority would like to encourage the building of a number of houses. Each house would construct a separate septic tank within the curtilage of the site and discharge to a common ICW. The Local Authority would take the ICW and the gravity sewer / rising main in charge leaving each householder responsible for maintaining the septic tank and any associated pumping system.

Overseas Aid

From a national perspective Ireland could develop the ICW technology as part of its overseas aid to developing countries where water quality management is of high priority. ICWs would only need a low level of local expertise and no mechanical input.

Water Framework Directive

The Water Framework Directive(WFD) was adopted into Irish law in December 2003. It provides a comprehensive framework for water quality management across the EU. It requires that a holistic view is taken of water and how it sustains life. It is about the protection of all waters including rivers, lakes, coastal waters - bays, inlets, estuaries and groundwater. The aim is to achieve good status for all our water by 2015.

Among its key objectives the WFD aims to:

- Maintain ”high status” of waters where it exists, prevent any deterioration in the existing status of waters and achieve at least “good status” in relation to all waters by 2015.
- Manage water bodies in a way that protects ecosystems and habitats.

To achieve the “good status” in all water bodies ICWs could play a significant role in reducing the pollutants and nutrients being discharged into the water bodies. The results from National Parks and Wildlife Service work in the Anne Valley Project are a good example of how the farming community together with a rural village community can bring a river to good ecological status.

Guidance Document for Design and Construction of ICWs

The Department of Agriculture & Food set up a Technical Working Group to produce a guidance document for the design and construction of ICWs on farms. The basic template for the guidance document has been formulated. With the completion of some further studies into percolation from the ICW into the subsoil the guidance document will soon be published. This guidance document will then be used as a template for development of Guidance Documents for municipal and industrial types of ICWs.

Conclusions and Recommendations

The Integrated Constructed Wetland (ICW) concept has been developed over the past twelve years in Ireland. Its development has been on the basis of continuing assessment and readjustment until the required level of treatment was achieved. There are no known failures but lessons have been learnt so as to further improve the concept and its application. The concept continues to receive research funding to improve it even further. The DEHLG and the National Parks and Wildlife Service have to be commended for their work in developing the ICW system. The DEHLG is committed to continuing development and research of the ICW concept and in particular its application to a greater number of scenarios.

The development of this approach to water management has particular relevance within the River Basin District framework and achieving the objectives of the Water Framework Directive. Support through sustained provisioning of resources for research and development and willingness to trial the concept amongst a wider range of Local Authorities are essential. The preparation of Guidance Documents that facilitate the appropriate application of the concept in the management of an array of effluents is particularly urgent.