

Treating farmyard dirty water using constructed wetlands

The Greenmount Campus Constructed Wetland

A constructed wetland was established in 2004 at the Greenmount Campus of CAFRE to treat dirty water from the Campus Dairy Unit. The wetland has offered the opportunity to conduct research in partnership with the Agri-Food and Biosciences Institute (AFBI), The Queen's University of Belfast (QUB) and NIEA. This research has assessed the ability of constructed wetlands to treat dirty water and in particular whether they prevent nutrient pollution.

Since it came into operation, the wetland has successfully treated dirty water from the Dairy Unit. High rates of removal and retention of nutrients have been achieved while the discharge has remained within the Biological Oxygen Demand (BOD) consent value set by the Northern Ireland Environment Agency (NIEA).



The research has shown the wetland is efficient in removing pathogens in the dirty water as well as female hormones (estrogens) excreted by the cows.

How do wetlands work?

Constructed wetlands replicate the bio-filtration action of natural wetlands. Aquatic plants in the wetland quickly develop extensive submerged root systems. These create an environment that supports the removal of nutrients through a combination of biological, chemical and physical processes to extract pollutants from the dirty water.

What size of wetland?

The first step in planning a wetland is to estimate the appropriate area of ponds required to treat the dirty water that is being produced.

- The standard adopted was that the wetland should be at least twice the area of yards and roofs draining water into it.
- Monitoring results suggest that a smaller system would not allow sufficient treatment in winter to comply with the NIEA consent for BOD.
- To keep costs and pond area to a minimum, clean water, especially from roofs, should not be allowed to drain into the wetland.

Wetlands planning and design

Five key assessments are required to determine the suitability of the site:

1. Contact NIEA to apply for a discharge consent under the Water (Northern Ireland) Order 1999 before beginning construction.
2. Contact the Planning Service to determine if planning permission is required.
3. Consult with DARD Countryside Management to determine if permission is required under the Environmental Impact Assessment (Agriculture) Regulations (Northern Ireland) 2007
<http://www.ruralni.gov.uk/EIA>.
4. Undertake a subsoil assessment to determine whether the subsoil can be compacted to form an impermeable base of the pond without the need for an artificial liner.
5. Carry out a topographical survey to map the ground contours and design a pond layout to minimise earthwork movements.

Wetland construction

If the site is suitable and once the necessary permissions have been obtained, the following key steps in the construction of a farm wetland are required to ensure long-term treatment of farmyard dirty water:

1. Site vegetation should be burned off with a suitable herbicide.
2. Strip off the topsoil with a bulldozer for re-use as pond base growth medium.
3. Bulldoze subsoil to the sides of the ponds for bank formation.
4. Form and compact the banks with an excavator.
5. Compact the pond subsoil, with vibrating equipment to ensure an impermeable base.
6. Spread topsoil on the pond base to provide a plant growth medium.

7. Plant the wetland species.
8. Flood the wetland with a controlled supply of water to allow the plants to become established.

Greenmount wetland description

The combined area of the Greenmount Campus five-pond constructed wetland is 1.25 hectares. Using the existing site topography, the ponds were designed to allow water flow through the system by gravity. There is a drop of at least 300 mm between each pond. The first pond has an area of open water that allows sediment to accumulate. The final pond also includes a deeper area into which fish can be introduced. However, to allow wetland plants to thrive, most of the wetland area is no more than 500 mm deep.



Wetland plants

Wetland plant species of an Irish provenance were sourced by tender for the Greenmount wetland. Five native species were planted:

- Common reed (*Phragmites australis*)
- Reed mace sometimes called bulrush (*Typha latifolia*)
- Common sedge (*Carex riraria*)
- Yellow flag (*Iris pseudacorus*)
- Burr reed (*Sparganium erectum*)

Note: Although the *Typha* initially became established after planting, it has suffered severe die-back each summer –

at least where the organic loading is moderate. Therefore this species cannot be recommended.

The ponds were planted in late summer 2004. To assist the plants in becoming established and avoiding the roots drying out, the ponds were flooded to a depth of approximately 100 mm after planting. The plants were allowed to become established under this regime during the summer of 2005 and it was not until November 2005 that dirty water was discharged to the wetland.

Dirty water sources

Three sources of dirty water are directed to the wetland from the Greenmount Campus Dairy Unit:

- Parlour and washings
- Winter runoff from silos
- Dirty yard water



The total surface area of dirty yards and silos directed to the constructed wetland is approximately 6500 m².

Monitoring and maintenance

Monitoring of the wetland has been undertaken on a weekly basis since 2005. This included analyses of water samples of the incoming effluent, the outlet of each pond, the receiving watercourse, and groundwater. Rainfall and flow rates at both the inlet and the outlet from the system were estimated. Base

samples of the soil in each pond were taken and changes in the vegetation mix monitored.

In over five years of operation, the only maintenance required has been the cutting back of plant growth around sampling points.

Research findings

Key findings from the AFBI, CAFRE, and QUB and NIEA research on the Greenmount Campus wetland included:

- Farmyard dirty water can be treated to a BOD of less than the 40 mg/litre NIEA limit, allowing discharge to local watercourses.
- Removal efficiencies measured over four years of operation were: BOD 99%, Total Phosphorus 97%, and Ammonia N 99%.
- Removal rates of faecal coliforms and pathogens such as E. coli in the dirty water exceed 99%. Hormones excreted by the cows do not persist in the wetland.
- For most of the summer months evaporation losses are high and no effluent is discharged from the wetland.
- Constructed wetland size and thus water residence time is a critical factor determining wetland performance.

Discharge consent requirements

As with other industries, using a constructed wetland to treat agricultural dirty water, requires a discharge consent from NIEA under the Water (Northern Ireland) Order 1999. Application fees and annual charges are payable.

- Part of the consent will be a requirement by NIEA to monitor the effluent from the wetland for compliance.
- If a constructed wetland is used on a farm, and found to be causing pollution, or to be non-compliant with

its consent conditions, remedial action will be required and enforcement action may be taken.

- Without a Water Order consent being issued it would be an offence to use a constructed wetland to treat any farm effluent, including dirty water.
- If an unconsented discharge to a waterway or underground strata is found to have occurred, enforcement action by NIEA is likely.

Health and Safety

Constructed Wetlands present a potential hazard, especially to young children. A combination of natural field boundaries and livestock fencing has been used at Greenmount Campus to restrict access to the wetland. During construction, the banks of the ponds were sloped at a shallow angle to ensure easy access out of the ponds, if a person or animal accidentally fell in.



Links to the CAFRE Trail

The landscape development of the wetland has been taken forward to maximise the site potential to deliver additional key environmental messages to the groups visiting the Constructed Wetland project.

The range of native mixed species wildflower meadowland habitats and woodland copses established provide educational facilities (both theoretical and practical) for a wide range of courses including Agriculture, Amenity Horticulture and Rural and Countryside Management. They are also used extensively by the many thousands of visitors (mainly school children) that visit the CAFRE Trail at Greenmount each year.



Further information

Detailed information on wetland construction is available from a joint publication by NIEA and the Scottish Environmental Protection Agency (SEPA) at: www.ni-environment.gov.uk.

Detailed scientific data on the performance of the Greenmount Campus Wetland is available from AFBI at: www.afbini.gov.uk/gru9-farm-effluent-bioremediation.pdf.