

Priority & Hazardous Occurrence in Domestic Wastewater from Small Scale Systems in Ireland

Valerie McCarthy^{*1}, Patrick Rafferty¹, Mawuli Dzakpasu¹, Brian Kinsella², Antóin Lawlor³, Lisa Jones³, James Chapman³, Ambrose Furey², Vaishali Bane², Ken Forde² & Fiona Regan³

¹Centre for Freshwater Studies, DKIT

²Proteobio, Cork Institute of Technology

³NCSR, Dublin City University, Ireland.



Background

A wide range of household sources may potentially contribute to contaminant loads in domestic wastewater. Typically domestic wastewater is combined and transported as a single waste stream, however, there is considerable variation in the pollutant and pathogen content of wastewater derived from different activities within the home (e.g. toilet flushing, dish washing, bathing etc.). In Ireland, the issue of unsewered wastewater treatment systems often located in rural areas and estimated to number over 400,000, constitutes a significant diffuse risk to both surface & groundwater. DCU & CIT have teamed up with DkIT and their project partners to carry out a preliminary investigation into the levels of priority & hazardous substances in domestic wastewater from a number of single dwelling houses within the Lough Muckno Catchment, Co. Monaghan and an integrated constructed wetland (ICW) on the grounds of the Castle Leslie Estate in Glaslough, Co. Monaghan.

Site Description

Since 2008, the Centre for Freshwater Studies at DkIT have conducted an investigation into the effects of on-site wastewater treatment systems (OSWTS) on surface water quality at several sites within the Lough Muckno Catchment in Co. Monaghan and at the ICW in Glaslough in Co. Monaghan. The primary focus of the project was on systems which are currently in use, regardless of age, type or level of maintenance. The aim was to acquire an understanding of the risk posed by currently installed and operating systems, taking into account the likely effect of factors such as poor maintenance, incorrect installation and operation and the suitability of the system to the site. A series of monitoring wells were installed down-gradient of the OSWTS at each of the study sites in addition to a control monitoring well, which was located outside the predicted path of the effluent plume. The sites were located in areas underlain by clayey glacial till. The GSI subsoil permeability map records the subsoil in the general area as of 'low' permeability, suggesting that run-off usually dominates over infiltration. Sampling has been ongoing at these sites since August 2008 and have been examined for a range of parameters indicative of effluent pollution including, nitrogen, phosphorus and indicator bacteria.



Plate 1: The collection of subsurface water from a monitoring well.



Plate 2: A typical septic tank within the study catchment.

The ICW plant on the grounds of the Castle Leslie Estate in Glaslough, Co. Monaghan was established in 2007 and has a design capacity of 1750 population equivalent (PE). It currently takes pumped wastewater from the nearby village with a loading rate of 800 PE, where it flows by gravity through five vegetated ponds (cells) before discharging directly to the adjacent Mountain River. The performance of the surface flow ICW system in treating primary domestic wastewater is currently being evaluated based on the dynamic water budget and the influent and effluent concentrations of water quality parameters.

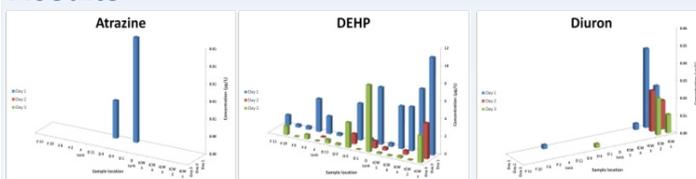


Plate 3: Aerial view of the ICW system on the grounds of the Castle Leslie Estate in Glaslough, Co. Monaghan

Methods

On three occasions between July and August 2011 (13 July, 2 Aug, 10 Aug), subsurface water samples were extracted from monitoring wells at two OSWTS sites (D and F), using a peristaltic pump. Surface water samples were also taken from each of the cells at the ICW system in Glaslough. Grab samples were taken near the inflow of the first cell and the outflow of the remaining four cells. The samples were then isolated and purified using solid-phase extraction (SPE) on Phenomenex Strata-X polymeric cartridges. Analysis of the samples was carried out by liquid chromatography-tandem mass spectrometry (LC-MS/MS) using an Agilent 1100 LC coupled to an Applied Biosystems API 3000 mass spectrometer. Separation of the pesticides was achieved using a Waters XBridge C18 column (150 × 4.6 mm, 3.5µm). The mobile phase flow rate was 300 µL/min and consisted of (A) H₂O:ACN (90:10, v/v) and (B) ACN, both containing 1mM ammonium acetate and 0.01% acetic acid.

Results



The following pesticides were found to be present in collected samples: atrazine, di-ethylhexyl-phthalate (DEHP), diuron, chlorfenvinphos, malathion, mecoprop and pirimiphos-methyl. The graphs above show the concentrations of DEHP and the pesticides Atrazine, present in the tank at Site D & a monitoring well located 22 m from the tank, and Diuron present in most cells of the ICW system on all three sampling dates. Of note was the presence of DEHP, which was found at concentrations between 0.02 - 11.2 µg/L at both the ICW and OSWTS sites, on all sampling dates. At a number of sampling points the concentration is greater than the environmental quality standard (EQS - 1.3 µg/L).

Results and Further Work

Further data analysis on metals and PAHs are on-going. The preliminary results presented here, show the presence of DEHP and a number of pesticides in the OSWTS at Sites D and F, and in numerous cells of the ICW system. At the OSWTS sites there is a general pattern of higher concentration in the tank and the monitoring wells closest to the tank, with declining concentrations with distance. In addition, there were generally higher concentrations of the monitored substances in the first ICW cell with decreasing values in subsequent cells. There is, nevertheless, a high level of variation both in time and between substances, suggesting the need for more long term analyses, which will take into account both temporal and spatial variation.

Acknowledgements

Thank you to Michelle Reilly for sample collection and preparation. Thanks also, to Monaghan County Council, the homeowners and the members of the Churchill and Oram Group Water Scheme for facilitating research activities at these sites.