# ATTENUATION OF TRACE ORGANIC CONTAMINANTS DURING SOIL TREATMENT ASSOCIATED WITH ONSITE WASTEWATER TREATMENT SYSTEMS

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Abstract

A quarter of the population in the United States relies on onsite wastewater treatment systems. Many of these same communities also utilize groundwater wells for drinking water. It is important to understand the capabilities and limitations of these systems with respect to Trace Organic Contaminant (TOrC) attenuation. This study is focused on the relationship between septic tank effluent loading rate to soil treatment units and TOrC attenuation. Preliminary results suggest an inverse correlation between loading rate and TOrC removal efficiency.

## Introduction

In the simplest form an Onsite Wastewater Treatment System (OWTS) collects wastewater into an anaerobic septic tank for solids digestion and grease and fat separation. Septic Tank Effluent (STE) is then discharged to a soil treatment unit (STU) before ultimate recharge to local groundwater (McCray et al, 2008). Approximately 25 % of U.S. population use OWTSs, and 35% of new housing developments (Conn et al, 2006). Many of these same communities also rely on groundwater as a drinking water source (Verstraeten et al, 2005). TOrC plumes have been identified beneath some septic tanks indicating that at least in some locations, an anaerobic septic tank and STU is insufficient (Swartz et al, 2006; Carrara et al, 2008). Groundwater can be hydrologically connected to surface water where the impact to aquatic ecosystems is also of concern. Some TOrC have been reported to disrupt endocrine systems. This means that they can affect the growth, behavior, development and reproduction of organisms, and one of the best documented is fish feminization (Barceló and López de Alda, 2008). The objective of this study is to determine how efficiently TOrC are attenuated in STU through biotransformation, specifically, the role of wastewater loading rate on TOrC attenuation.

## Methods

Acrylic columns (30 cm X 8 cm ID) have been packed with sand to represent STU in a series of benchscale experiments. A range of loading rates (30, 12, 8, 4, 2, and 1 cm/day) are being tested to determine the role of STE loading rate on TOrC attenuation. Each experiment consists of three identical columns receiving a specific loading rate applied in four equal doses per day.

To provide consistent water quality experiments are operated with synthetic wastewater (SWW) and a TOrC spike. Bacteria were introduced into the system by operating columns at the appropriate loading rate with raw wastewater for 48 hours. All the columns have been covered with opaque paper to avoid photo-degradation (Figure 1). One column is being operated as an abiotic control to quantify the role of sorption.

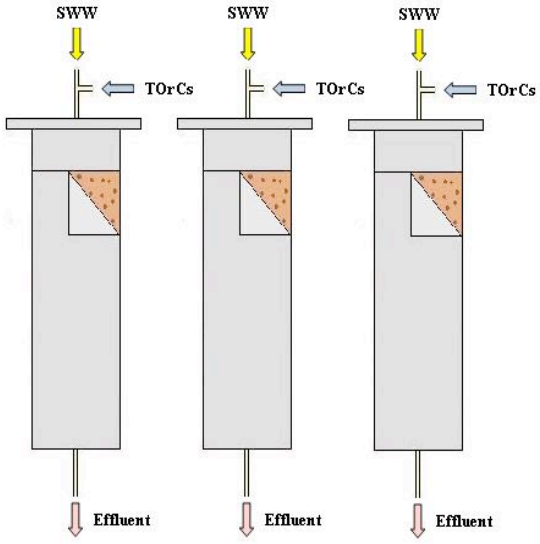


Figure 1: Each loading rate is being tested in triplicate with the TOrC and SWW operated through different pumps.

## Results and Discussion

This work is ongoing but preliminary results shows that the columns are microbiologically active. At 14 and 10 days, respectively for 30 cm/day and 12 cm/day, the nitrifying bacterial community has been established. The transformation of ammonia to nitrate by bacteria activity is shown in figure 2.

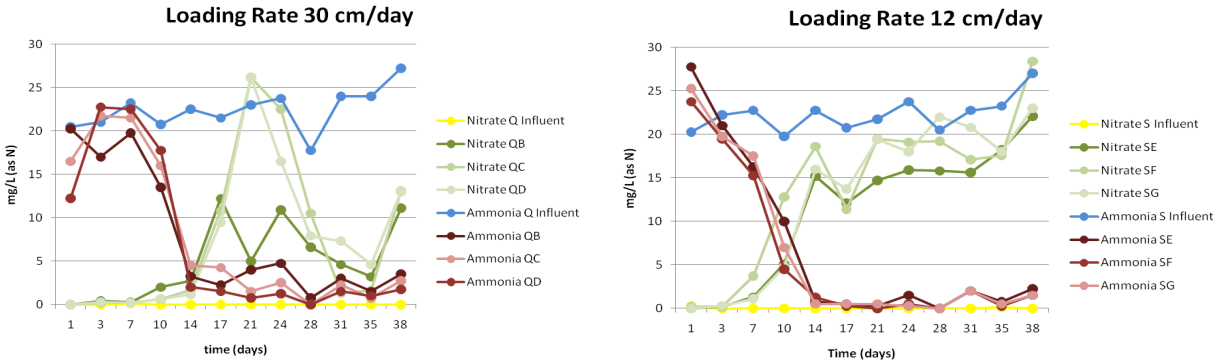


Figure 1: Ammonia and nitrate concentrations reported as mg/L nitrogen for ~40 days of 30 and 12 cm/day loading rate experiments. "Q" and "S" represent the loading rates (30 and 12 cm/day respectively) and "B", "C", "D", "E", "F" and "G" describe each repetition within a loading rate.

TOrC concentrations are 5-7 orders of magnitude lower that DOC concentration in STE (Teerlink and Drewes, 2009). The growth of the microbial community at the infiltrative surface of the STU relies on the DOC available in infiltrating water (Rauch and Drewes, 2005). By 7 days into the experiment DOC removal had reached 50 % in 30 cm/day loading rate and more than 80% in 12 cm/day loading rate.

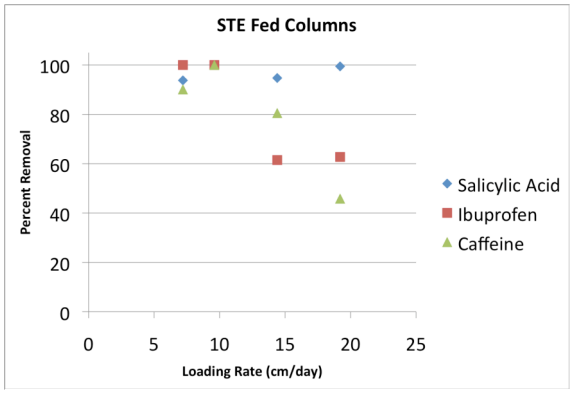


Figure 1: Attenuation efficiency at different loading rates.

TOrC results are not yet available. Results from a previous study, with a limited analytical suite of TOrC, suggest an inverse correlation between loading rate and TOrC attenuation efficiency (Figure 3). Experiments currently underway are targeting a greater number of TOrC (23 compounds).

Redox conditions influence carbon and nitrogen transformation and TOrC attenuation (Grünheid et al, 2005). Under aerobic conditions there is better removal efficiency for many TOrC classes. There are other compounds that need greater residence time or anaerobic conditions. It has been reported that at low concentrations of biodegradable DOC, another community of bacteria could start using TOrCs as a new source of carbon (Rauch-Williams et al, 2010).

## Conclusions

The removal of TOrC during infiltration is function of redox conditions and bacteria community established. Microbial community depends on the rate of DOC loading to the system.
For at least some classes of TOrC there is an inverse relationship between TOrC removal and loading rate. Further experiments with an expanded suite of TOrC will help to elucidate the role of DOC loading rate on TOrC attenuation.

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