Constructed wetlands: A green alternative to treat both human and animal sewage

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Abstract

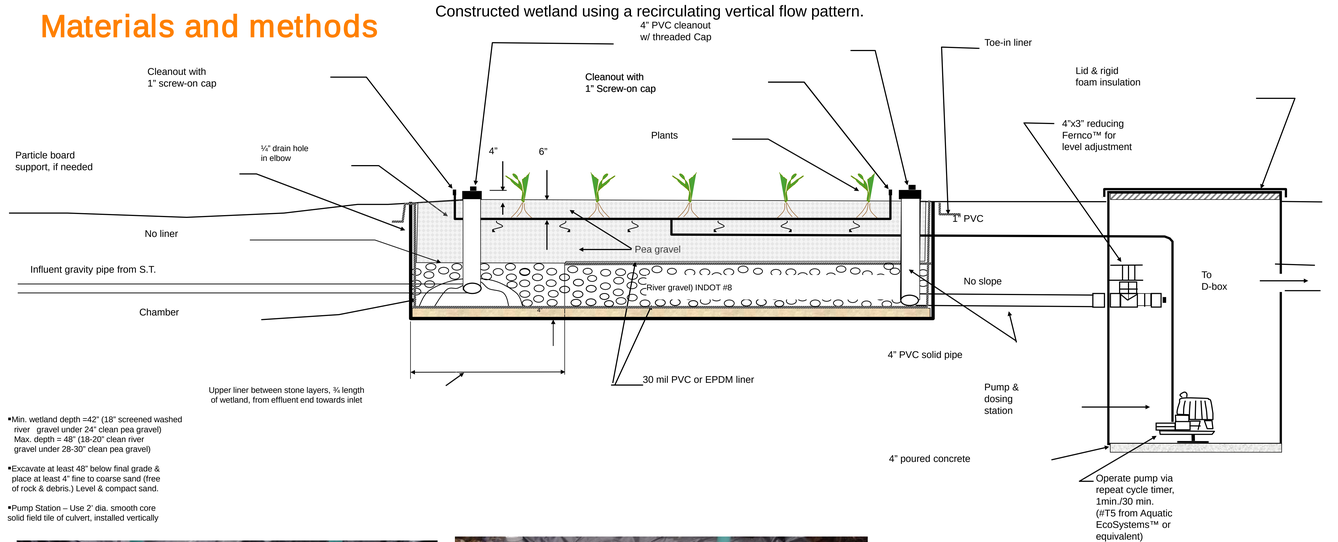
Gravity subsurface constructed wetlands have been used for more than a decade in LaGrange County, Indiana to remove human sewage contaminants that could reach groundwater supplies. Performance of a subsurface constructed wetland (6 m x 6 m; 1.2 m deep) using a recirculating vertical flow to treat sewage from the county animal shelter is examined. The volume of sewage treated was assumed to be approximately 1817 L (480 gallons) per day generated by 18 dog runs, 12 cat cages, 2 isolation rooms and 2 employees. Septic tank versus constructed wetland effluent was periodically analyzed for Biochemical Oxygen Demand (BOD), Total-Nitrogen (TN), Total Kjeldhal Nitrogen (TKN), Total Suspended Solid (TSS), Total Phosphorus (TP), Ammonia-Nitrogen (NH_4^+-N), Nitrate-Nitrogen ($NO_3^=$-N) and Fecal Coliform bacteria (FC). Water analyses collected on-site included temperature, dissolved oxygen, oxygen-reduction potential and pH. The treatment efficiency has been high after 348 day's operation. Average treatment removal efficiencies for BOD, TN, TKN, TSS, TP, NH_4^+-N and FC were 99%, 82%, 94%, 99%, 42%, 98% and 99% respectively. The Nitrate-Nitrogen mean final concentration was 7.6 mg/L, and the dissolved oxygen concentration increased from 1.9 to 5.0 mg/L. Results are promising with respect to using a recirculating vertical-flow constructed wetland as a viable green alternative technology to treat both human and animal sewage.

Introduction

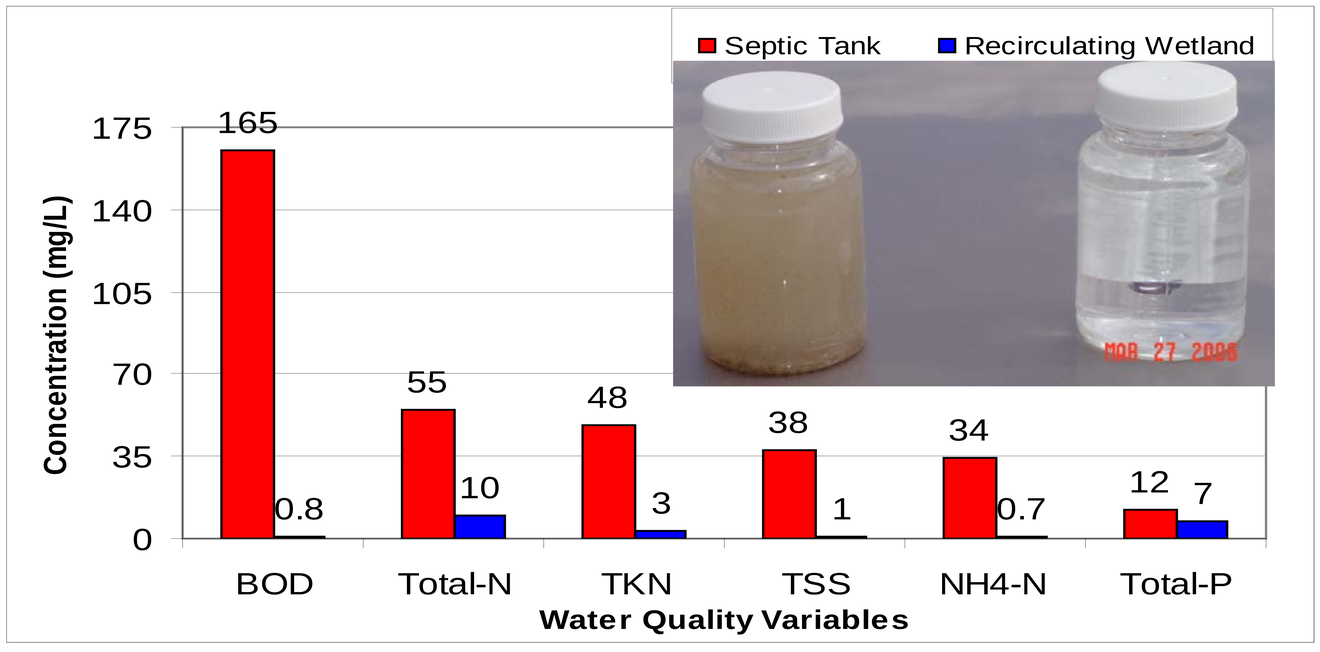
Conventional septic systems are commonly used to treat residential sewage in areas without sanitary sewer. However, they are considered a primary contaminant source for surface or underground water supplies (Whitehill et al. 2003), including residential water wells (Bhardwaj 2003). Horizontal Gravity Flow (HGF) subsurface constructed wetlands have been used for more than a decade in LaGrange County, Indiana to remove human sewage contaminants. Currently, around 200 HGF constructed wetlands are working in LaGrange with daily flow from 150 gallons per day (GPD) to a cluster system handled by the LaGrange County Sewer District for 50,000 GPD. The HGF wetlands provide acceptable removal efficiency for the biological oxygen demand (BOD), total suspended solids (TSS) and fecal coliforms (FC) bacteria, but low efficiency to eliminate nitrogenous compounds because limited oxygen transfer. García et al. (2006) did show that modifying the horizontal and gravity flow to a vertical and recirculating flow the oxidation process of ammonia, which is the predominant form of Nitrogen in septic tank effluents; can achieve low levels plus improving BOD and TSS removal before land application and surface or underground discharge. Performance of a subsurface constructed wetland using a recirculating vertical flow to treat both human and animal sewage from the LaGrange county animal shelter is examined.

Materials and methods

Constructed wetland using a recirculating vertical flow pattern.



Results & Discussion



Like natural wetlands; artificial or constructed wetlands filter out the excess of nutrients and contaminants present in the septic tank sewage by trapping them in the gravel layers and plant roots where microorganisms (bacteria, fungi, etc) digest wastewater down into less harmful substances releasing a biologically purified effluent. The recirculating design creates very favorable conditions especially providing and making available dissolved oxygen to support nitrogen oxidation.

Conclusions

This study shows that the vertical and recirculating flow constructed wetland built in the LaGrange County Animal shelter, Indiana had high treatment efficiency in decomposing organic material (BOD) and removing the particulate material suspended (TSS) in the sewage. Fecal Coliform (*E. coli*) bacteria, which is in indicator that other more dangerous bacteria could be present, was removed up to 99%. The final effluent has low chemical concentration for the different forms of nitrogen present. TKN (Total Kjeldahl Nitrogen which is the sum of Ammonia Nitrogen (NH3) plus organic Nitrogen, such as proteins). TN (Total Nitrogen) is the sum of all nitrogen forms present in the effluent (TKN + NO2- (Nitrite) + NO3- (Nitrate)). The results indicated that a constructed wetland is a viable green alternative technology to pre-treating conventional human and animal septic system effluents before land application and surface or underground discharge. This system was shown to be suitable for residential or commercial projects generating sewage up to 480 gallons per day. Another green practical application for constructed wetlands has been treating agriculture effluents like those generated by poultry and porcine activities. Also, this kind of constructed wetland systems could be easily integrated into the aquaculture activities to treat on-site its effluents before they are finally discharged

Literature cited

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