Optimal design of decentralized constructed wetland treatment system under uncertainties

Abstract

Keywords:

1. Introduction

2. Case study: a decentralized CWs system for municipal wastewater treatment

2.1. Introduction

2.1.1. Mobile, Alabama

With 412,992 people, Mobile County is the second most populated county within the state Alabama in the United States. The population of Mobile County has been steadily increasing (United States Census Bureau (2002)). As populations grow, several fringe communities are created. To manage the wastewater produced by such communities, the traditional approach is to link these fringe communities up with long length large diameter pipes to transport all the wastewater to a single municipal wastewater treatment plant to be processed and then released into nearby water sources. The Mobile Area Water & Sewer System (MAWSS) serves approximately 530 square kilometres in Mobile County (Mobile Area Water & Sewer System (????)), mostly through centralised wastewater treatment facilities. However, annual operations and maintenance costs for such centralised wastewater management systems have been shown to be costlier than decentralised ones, where the wastewater is processed and released within the community (White (????)). Thus, implementation of decentralised wastewater management systems such as constructed wetlands are being considered to manage costs in the long term.

2.1.2. Decentralised constructed wetlands wastewater management

Cost

As urbanised areas grow in size and population, the amount of wastewater produced per day in an urban area increases. A centralised wastewater management system becomes unwieldy and costly to maintain on a large scale. In order to tackle this, decentralised wastewater management systems have been proposed to reduce the distance from the wastewater source to the release point, cutting down on the cost of transporting wastewater to a dedicated facility. Various case studies have conducted a cost-benefit analysis on the implementation of a centralised wastewater management system against a decentralised one and have concluded that the decentralised wastewater management is generally cheaper to maintain (White (????); Prihandrijanti et al. (2008)).

Maintenance

One approach to decentralised wastewater management is the constructed wetlands concept. Essentially, constructed wetlands aim to simulate real wetlands where water flows through and has its nutrients removed via biological processes. In the constructed version, wastewater flows through the wetland to provide the pollutants within as a nutrient source for plant absorption. The end product of wastewater going through these processes is water that meets the standards for release. The use of plants to treat the water allows the procedure of treating wastewater to be more hands off, thus requiring less maintenance.

Factors for success

However, the cost effectiveness of constructed wetlands is based on the assumption that the decentralised sites are in optimal locations and are of suitable sizes to balance the cost of transporting wastewater and building the site. The size of the constructed wetland has to be big enough to serve the amount of wastewater produced, but not too big as the system may collapse due to a lack of nutrients for the plants towards the end of the wetlands. Additionally, the location of the constructed wetlands has to be taken into consideration to determine the shortest distance of pipes required to link the wastewater sources to the treatment area. In order to determine the ideal location and size of constructed wetlands in a defined area, a mathematical model has been developed to represent the problem. Solving this model will give the ideal location and size of constructed wetlands to be designed.

2.2. Objective

This paper aims to determine the optimal configuration (location and size) of constructed wetlands in a specified area in Mobile, Alabama as a case study area.

3. Conclusions

Appendix

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