Campus Greenhouse Effluent Characterization and Treatment Options

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Introduction

Fertilizers and pesticides are periodically applied as part of the growing process of plants in many of Canada's greenhouses.

With a growing concern for the environment, there is a need to minimize the amount of residual pesticides and nutrients that are discharged into the natural environment from greenhouse operations.

Currently, the teaching greenhouse on the Niagara-on-the-Lake campus of Niagara College releases wastewater to a tributary of Six-Mile Creek which, in turn, drains into Lake Ontario.

The Six-Mile creek headwaters that traverse the campus are classified by the MNR as an "important" type 2 fish habitat.

The province of Ontario has set out provincial water quality objectives that determine the amount of a nutrient or chemical that is allowed to be released into the headwaters of a fish habitat.

Aim

One goal of this project is to characterize the volume and composition of wastewater generated by the greenhouse. A second goal is to review various strategies that would eliminate the release of chemicals to Six-Mile Creek.

One option is the construction of a biological treatment system for removal of suspended solids and nutrients prior to water release. Other options include complete recycling within the greenhouse, or stockpiling and re-use of wastewater for outdoor watering needs in summer.

Ultimately, we will implement a strategy eliminating the existing impact on Six-Mile Creek. This may include a biological treatment system, such as a wetland, for removal of contaminants to meet Ontario Water Quality Objectives.

Methods

Cistern Flow Volume Determination

The wastewater flow volume, in cubic meters per day, must be determined in order to size storage and treatment systems.

The clearing out of vermiculite and other suspended particles in order to accurately determine the volume of the greenhouse cistern. Continuous water level monitoring data is used to estimate wastewater flow volumes (Gole 2009).

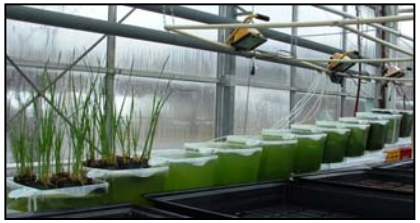
Receiving Watershed: Six Mile Creek

While some nutrient removal is occurring en route to Six Mile Creek in existing ponds and ditches along the flow path, excess nutrients are promoting massive algal growth, contributing to further eutrophication of this aquatic ecosystem.

The determination of the greenhouse effluent ponds storage capacity. Note thick layer of algal biomass on pond. Possible future location of the constructed wetland (Gole 2008).

Biological Test System

A small-scale continuous flow-through system has been constructed in the research greenhouse. Four treatment stages are being tested: (a) sinking and floating solids removal; (b) suspended solids removal; (c) conversion of dissolved nutrients to algal biomass, and (d) biomass removal.



The four-step in-house gravity flow through system (Gole 2009).

Water Characterization for Evaluation of Performance

Evaluation of each treatment stage being tested requires determination of a comprehensive list of parameters, including:

- Total and dissolved nutrients (TKN, nitrate, ammonia, phosphate).
- Suspended solids including algal biomass.

In addition, routine parameters such as pH, conductivity, dissolved oxygen and redox are being measured, since these will help characterize the system (e.g. carbon dioxide depletion; oxygen consumption by decomposition; evaporative losses)

The Ecological Engineering Approach

The biological test system set up in the greenhouse is using solar energy to promote algal growth supported by the elevated dissolved nutrients present in the greenhouse wastewater. The algae is effectively converting the contaminants, in this case nutrients, from a dissolved form into solids that can be skimmed/filtered/settled out of solution.

No other energy or chemical will be required apart from that required to pump wastewater into the system.

The Niagara College teaching greenhouse (Gole 2009).

Path Forward

Nutrients

The monitoring data indicate that nutrient removal has commenced in the test system. An effective technique(s) for passive removal of biomass has to be developed and tested.

Pesticides

Once nutrient removal testing is complete, the same test system could also be used to examine the breakdown/removal of those pesticides more commonly used in the greenhouse.

System Design and Construction

Design parameters developed from the test system can be used to scale up a biological treatment system for treatment of all greenhouse wastewater that meets provincial water quality objectives.

Conclusion

Possible remedial strategies, including biological treatment, for eliminating the impact of the greenhouse wastewater on Six-Mile Creek require at the very least a comprehensive water monitoring data set. The biological test system will provide the specific data required to develop design parameters for treatment system scale-up. Review of other options (e.g. in-house re-use; storage, field application) will require these same data to ultimately select and implement the best strategy.

Acknowledgements

We would like to extend our thanks to Natalee Tokar, (Niagara Research), Jim Thomson (Greenhouse Manager) and Trisha Haynes (Environmental Labs Technician).

Project Supported By: CONII Colleges Ontario Network For Industry Innovation