RESEARCH EXTENSION FACT SHEET

A Subsurface Flow Constructed Wetland to Treat Milking Centre Washwaters

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Introduction

Milking centre washwaters include the rinse waters from the milk lines and bulk tank as well as any floor washwaters from milking parlours. The milk lines are cleaned after each milking (typically twice per day), while the bulk tank is cleaned after emptying (typically twice per week). Each cleaning event includes four rinse cycles with water, acid, sanitizer and again with water. The washwater may also include manure and bedding residues from parlour floor rinsing. Milking centre washwaters can be 10-20 times more concentrated than domestic sewage, with organic matter (BOD_5) ranging from 500-4500 mg/L and total suspended solids (TSS) ranging from 200-2000 mg/L. As well, phosphorus and nitrogen, which is contained in milk, manure and sanitizing products, promotes algae and aquatic plant growth, which in excess can be harmful to the environment.

The common methods of managing washwaters are either to add the washwaters to a liquid manure storage or dedicated liquid washwater storage and then land apply the material, or to discharge the washwaters to a septic system [1]. Dairy farms with solid manure practices should not add washwaters to the manure pile and most often must manage the washwaters separately. Conventional septic systems are prone to failure from the high grease content of the washwaters, which can ultimately clog the septic bed.

The subsurface flow constructed wetland (SSFCW) technology has been implemented at several dairy farms in Eastern Ontario and has shown to be effective at reducing washwater concentration to levels suitable for discharge to a septic bed.

System Design

The design flow depends on the number of milking cows. A conservative design flow for milking centre washwater production can be calculated using a value of 20 L/cow/day [1].

The treatment system is comprised of three components: pre-treatment tanks (septic tank and grease trap), SSFCW and septic field. The septic tank and grease traps should have a capacity of 4 and 3 times the design flow, respectively. The SSFCW design should reduce BOD_5 and TSS concentrations to below 200 mg/L for discharge to a septic field. A typical configuration of the SSFCW has a 2:1 length to width ratio, a total depth of 0.7 m and an operating depth of 0.6 m (see Figs. 1 & 2). The wetland surface area will depend upon the design flow. For example, a design flow of 1000 L/d would conservatively require a SSFCW with a surface area of 60 m^2.

The wetland cell is lined with a 30 mil impermeable liner. The liner is extended up the sides of the wetland and is toed into side berms except at the outlet, where the liner forms an overflow weir at 0.6 m depth. This avoids the need to puncture the liner with an outlet pipe. A bed of sand can be placed below the liner if the native soil contains angular rocks.

Dairy Farm Washwater Subsurface Wetland System

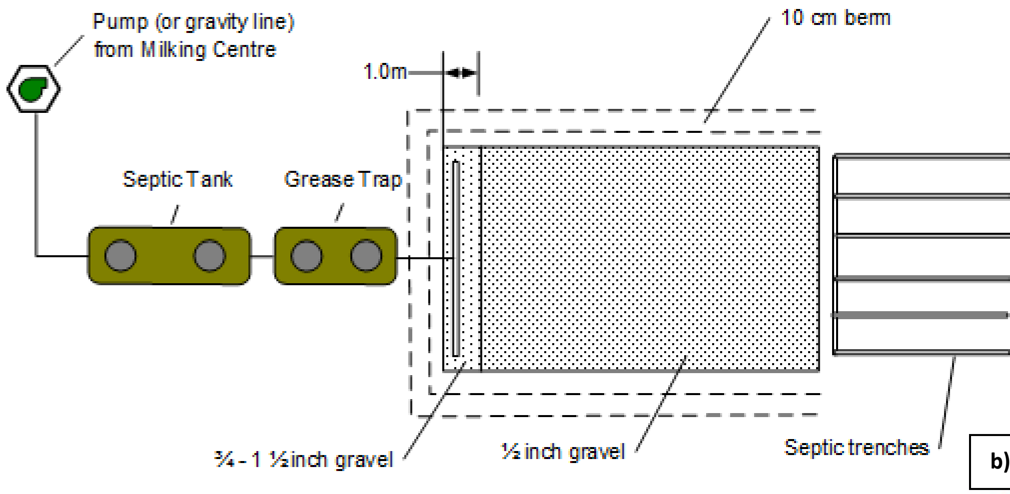

Fig 1. Wetland System Plan View Schematic

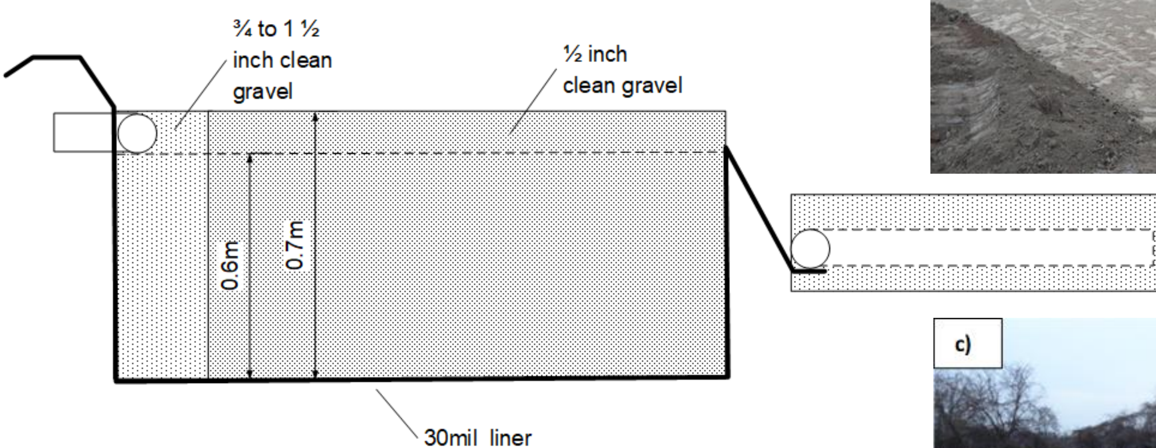

Fig 2. Wetland System Side View Schematic

The first 1.0 m of the SSFCW is filled with 1.0 – 3.8 cm (3/4 – 1 ½ inch) of clean gravel with the remaining area filled with 1.3 cm (½ inch) clean gravel. The inlet pipe consists of a 10 cm (4 inch) perforated PVC pipe laid in the top portion of the gravel. The end caps should not be glued in order to facilitate cleaning. The liner at the wetland outlet directs effluent to the septic field header line. The septic field is designed based on local regulation (e.g. Ontario Building Code - Part 8).

Wetland plants (reeds or cattails) can be transplanted from a nearby ditch at a density of 9 root segments per m^2 or 1 clump of plants per m^2.

Wetland Construction: a) Pre-treatment tanks, b) Excavation with sand base, c) Placement of 30 mil liner, d) Installation of gravel and cattails.

Operation and Maintenance

There are three basic O&M items to consider:

1) Maintain the pump from the milking parlour to the septic tank;

2) Pump out the two pre-treatment tanks on a regular basis (every 3-4 months); and,

3) Cut the grass around the berms.

Pumping out the tanks is easiest with a vacuum pump but a solids handling sewage pump can also be used. The solids can either be pumped directly into a solid manure spreader and land applied or added to the solid manure pile. If solids are allowed to accumulate in the tanks and overflow into the wetland cell then the header pipe and gravel will become clogged and require cleaning or replacement.

The wetland plants do not require any maintenance. They will die off naturally in the fall, creating an insulation layer over the bed, and new shoots will develop in the spring.

System Performance

Long-term system performance from two horizontal SSFCW systems are described in the following figures. The reduction in organic matter and solids are described in Figures 3 and 4, respectively. The combination of pre-treatment tanks and the SSFCW cell perform very well in reducing BOD_5 by 91-97% and TSS by 87-89%. The remaining organic matter and solids meets septic tank effluent quality of < 200 mg/L [2] and can easily be treated in a septic field.

These results demonstrate the importance of reducing both organic matter and solids in order to avoid premature clogging and failure of the septic bed.

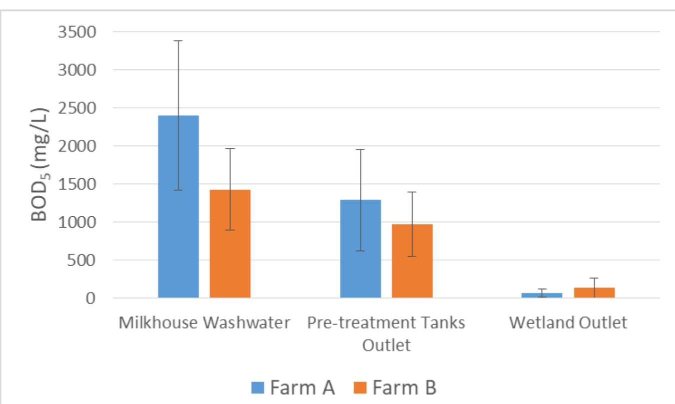

Fig. 3. BOD_5 Concentrations (Avg. ± Std. Dev.)

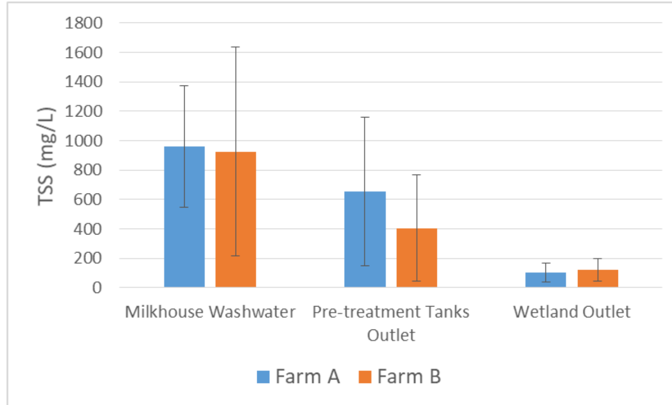

Fig. 4. TSS Concentrations (Avg. ± Std. Dev.)

Nitrogen data is presented in Figure 5. Total Nitrogen (TKN) removal varies from 31 – 48% for the two farm systems. Organic N is removed through sedimentation and filtration, while inorganic ammonium nitrogen for the most part passes through the tanks and wetland cell.

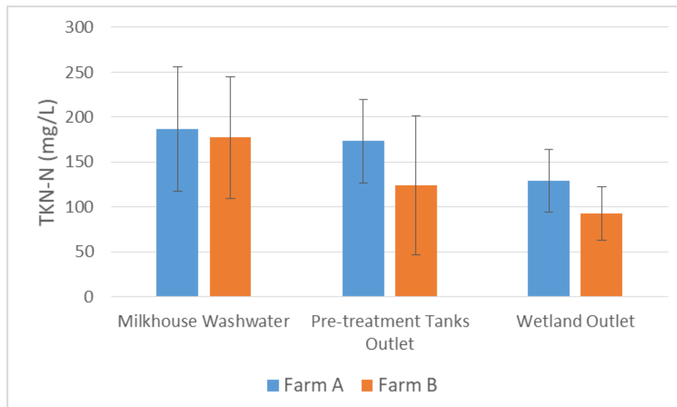

Fig. 5. TKN-N Concentrations (Avg. ± Std. Dev.)

Total Phosphorus (TP) data is presented in Figure 6. Similar results were observed at the two farms with 28-32% TP removal. Almost all of the removal was achieved in the pre-treatment tanks due to the settling of organic phosphorus. The remaining phosphorus is almost entirely in dissolved form which passes through the wetland cell.

On-going research is studying means of enhancing nutrient removal in these systems.

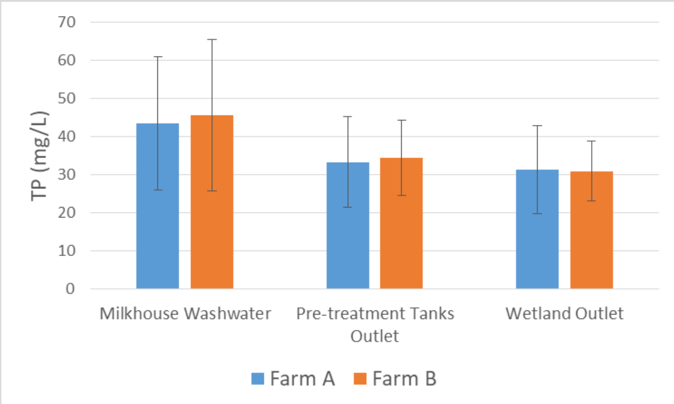

Fig. 6. TP-P Concentration (Avg. ± Std. Dev.)

References

[1] Hawkins, B and Barkes, B. (2014). Fact Sheet - Handling Milking Centre Washwater. AGDEX 720/410. OMAFRA.

[2] Crites and Tchobanoglous. (1998). Small and Decentralized Wastewater Management Systems. McGraw Hill, Toronto, Ontario.

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