Examining the potential for reclaimed wastewater irrigation to produce Kentucky Blugrass (*Poa pratensis* L.) sod: how it affects turf quality, soil health, and leachate.

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Rationale:

The volume of water consumption has been increasing yearly around the world and in Canada. Subsequently, wastewater requiring treatment before being released back into the environment has also increased. Wastewater requires substantial inputs of energy and chemicals for decontamination and the resulting effluent is often released into surface water. Depending on the level of treatment, the remaining nutrient load in the wastewater effluent could cause algal blooms leading to low oxygen levels and eutrophication of rivers or lakes. By using processed wastewater for irrigation there is the potential to reduce the remaining nutrients before they can enter a lake or river by using plants as a filter.

Growing sod with reclaimed wastewater is ideal because; a) it is a crop that is not consumed, b) access to the production site can be limited, and c) sod requires plenty of nutrients to grow and has an extensive root system to capture them. Irrigating sod with reclaimed water is currently not common practice in Canada. The purpose of this research was to determine how different types of reclaimed water would suit sod production and how it would affect the soil and turf health as well as the soil microbial community.

The following objectives were to be achieved during the course of this research.

1. Determine the effect of various types of reclaimed water as irrigation sources on turfgrass growth and development
2. Determine the effect of various types of reclaimed water as irrigation sources on soil chemical properties
3. Determine the effect of various types of reclaimed water as irrigation sources on soil microbial ecology
4. Determine what effect, if any, alterations in soil microbial composition have in the ability of the soil to filter common pollutants and chemicals.

Methods:

Two greenhouse experiments and 3 field experiments were conducted examining four types of reclaimed water. The field trials received irrigation supplemental to rainfall in 2010 and a fixed amount regardless of rainfall in 2011.

- Greenhouse experiment 1 – Single Sod Blend with 4 reclaimed waters + control.
- Greenhouse experiment 2 – 2 Factorial, 4 Cultivars/blend and 4 reclaimed waters + control.
- Field Cultivar trial – 2 Factorial, 4 cultivars/blend and 4 reclaimed waters + control.
- Field lysimeter 1 – 1 sod blend, 4 reclaimed waters + control + no water plots.
- Field lysimeter 2 - 1 sod blend, 4 reclaimed waters + control + no water plots.

In the findings section the following acronyms are used to identify the source of the water treatments; CM is from Conestoga Meats, RR is Road Runoff from the Cutten Club, DI is deionized water, GTI is Guelph Turfgrass Institute irrigation water, SEC is secondary water from the Guelph Wastewater Treatment Plant, and finally TERT is Tertiary water from the Guelph Wastewater Treatment Plant.

Findings:

Greenhouse

The highest clipping weight was achieved from the irrigation water coming from the Guelph Wastewater treatment plant treated to the tertiary level for the first greenhouse experiment (figure 1).

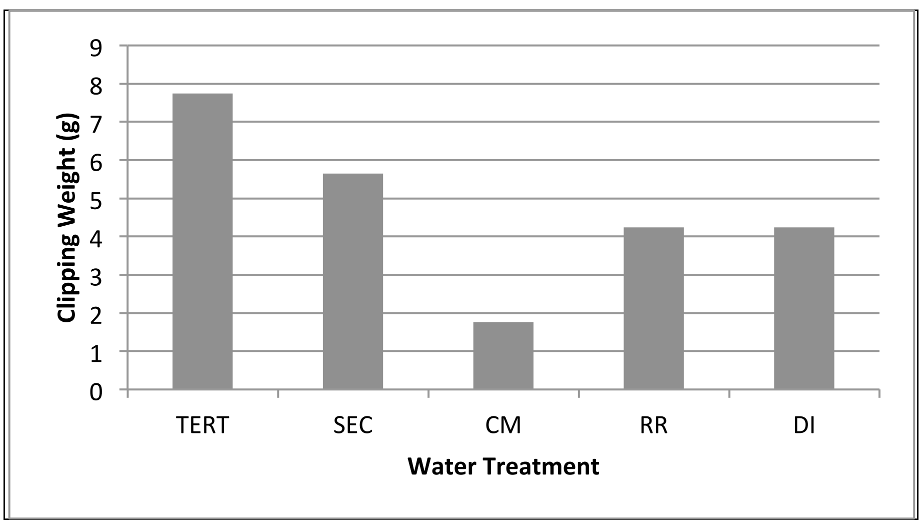

Figure 1 – The total weight of the grass clippings collected during the first greenhouse experiment for each water treatment.

In a second greenhouse experiment, clipping weights were also high for the water coming from the Guelph Wastewater treatment plant (Table 1).

Table 1 - The total weight of the grass clippings collected for the second greenhouse experiment with the columns representing the water treatments and the rows the type of cultivar.

	Reclaimed Water				
Seed Type	CM	TERT	SEC	RR	DI
Avalanche	0.3603	0.5205	0.4649	0.1923	0.1573
Barrister	0.204	0.1968	0.4102	0.1647	0.0359
Moonlight SLT	0.4536	0.2654	0.4586	0.0556	0.1046
Blend	0.1173	0.4232	0.3947	0.1202	0.1508

To assess for potential risks from high levels of nitrate leaching into the groundwater from the applied wastewater, leachate samples were analyzed for nitrate concentration. The highest concentration of nitrate leaching came from the soil columns irrigated with water from Conestoga Meats. The next highest concentrations came from the Guelph Wastewater treatment plant were the secondary and tertiary water behaved similarly and finally the road runoff and control water which also was similar to each other (figure 2).

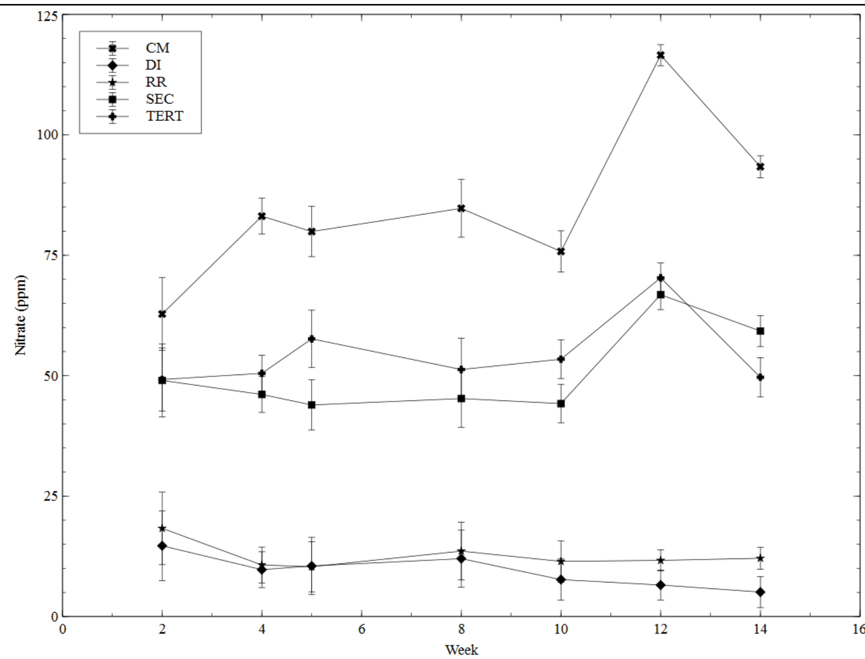

Figure 2 – The concentration of nitrate in the leachate that passed out of the soil columns for the different water treatments during the second greenhouse experiment.

At the end of the second greenhouse experiment, the soil nitrate concentration was examined for differences between treatments. The Conestoga Meats treated soil columns had the highest concentration of nitrate in the soil. The secondary and tertiary had similar concentrations to each other and this was also found for Road Runoff and DI water (figure 3). The type of seed used only had a significant effect for the blend of cultivars in the 0 to 10 cm depth of soil; it did not have an effect in any other seed treatment (figure 3).

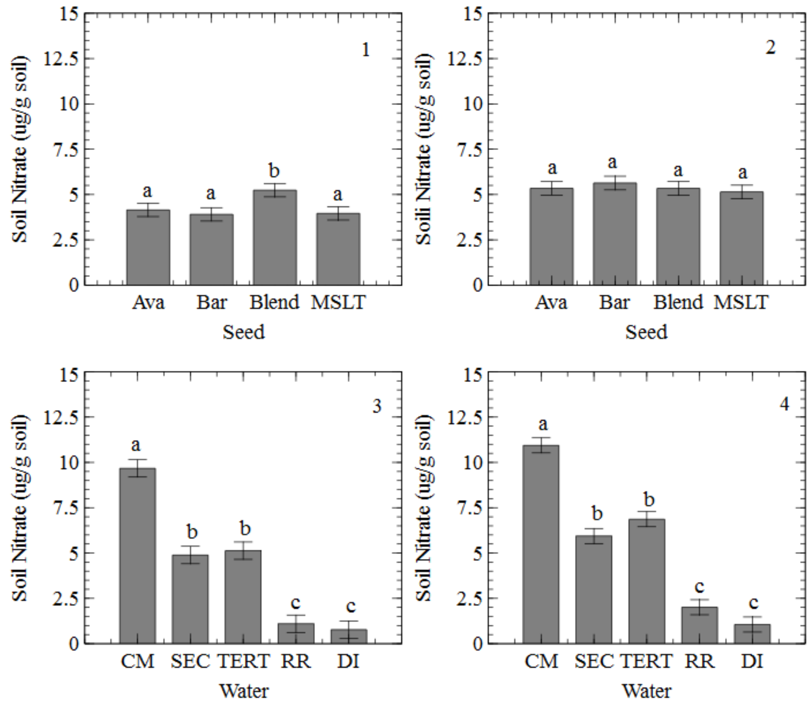

Figure 3 – The concentration of nitrate in the soil at the end of the second greenhouse experiment. The top two graphs show the effect of cultivar type on the soil nitrate concentration, the bottom two graphs show the effect the water treatment had on soil nitrate concentration. Graphs 1 and 3 are for the 0 to 10 cm depth of soil and graph 2 and 4 are the 10 to 30 cm depth. The letters indicate if there is a significant difference between the means with the same letter having no difference.

There were also some instances of E. coli found in the second greenhouse experiments secondary reclaimed water treated soil columns (figure 4).

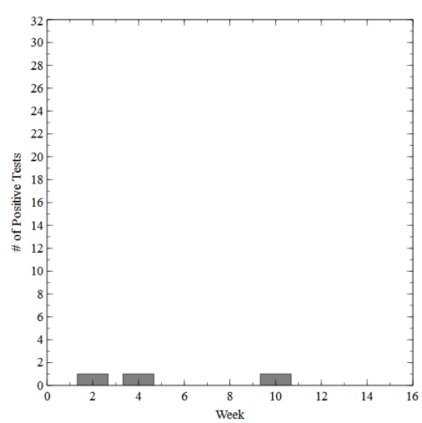

Figure 4 – The number of E. Coli Positive petrifilm™ found for each week of Leachate collection during the course of the second greenhouse experiment.

The NTEP ratings for the overall quality of the turfgrass in the second greenhouse experiment found that in general the control greenhouse de-ionized water had the best quality turfgrass (figure 5).

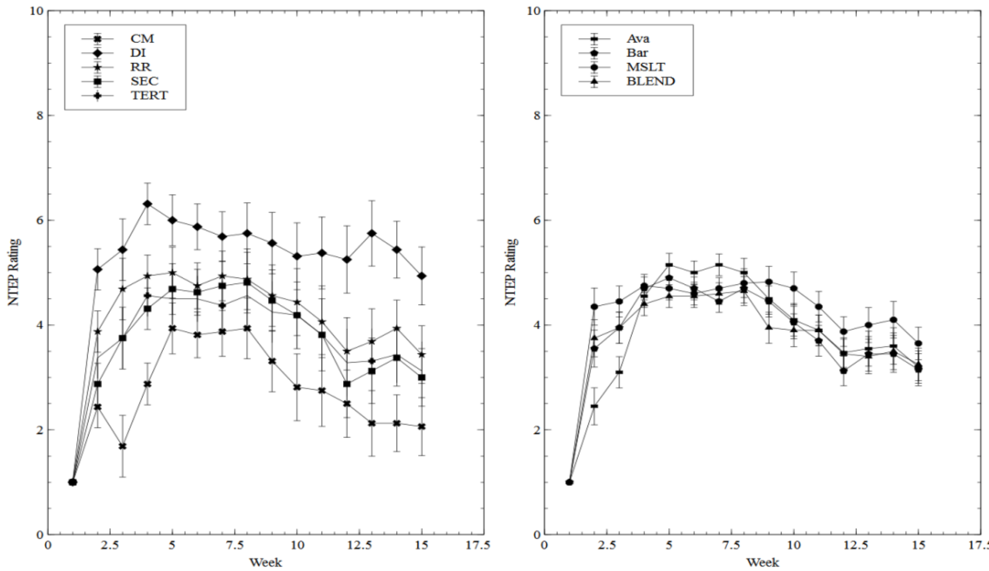

Figure 5 – The quality of the turf growing on the soil columns in the second greenhouse experiment. Quality was assessed using the NTEP rating system with 1 being the lowest quality and 9 being the highest quality. The graph on the left is the response to water treatment and the graph on the right is the response of seed type.

The salinity of the soil in the second greenhouse trial was found to be higher in the case of the Conestoga Meats reclaimed water vs. the other reclaimed waters (figure 6).

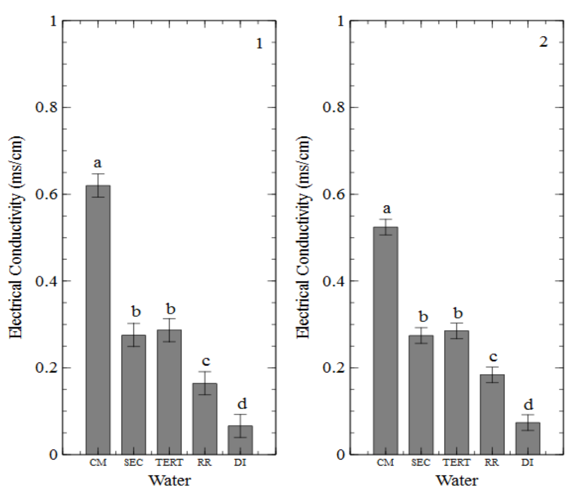

Figure 6 – Salinity of the soil measured at the end of the second greenhouse experiment. The salinity was measured in the 0 to 10 cm depth shown on the left graph

and the 10 to 30 cm depth shown on the right graph. Significant means are indicated by a different letter.

There was a higher amount of salts leaching from the soil of the second greenhouse experiment for the Conestoga Meats treated soil columns compared to the other water treatments (figure 7).

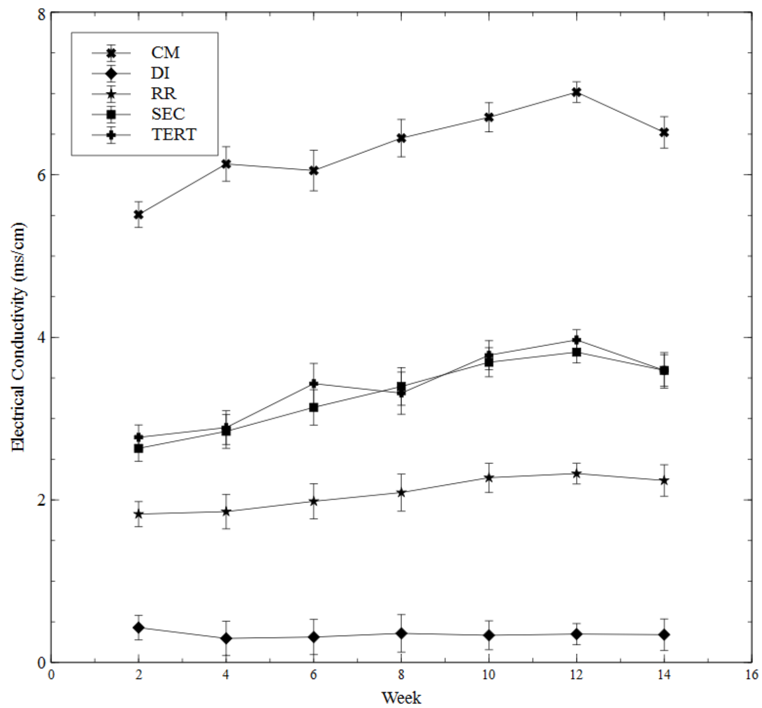

Figure 7 – The salinity of the leachate coming out of the soil columns for the different water treatments measured by electrical conductivity when the second greenhouse experiment was conducted.

In terms of the microbial community, there were no differences seen in the overall numbers in the bacterial community when examined using 16S targeted real time PCR in the second greenhouse experiment for both water (P=0.3855) or seed (P=0.6062).

Field

In the Field experiments for the 2010 season there was no difference in the NTEP ratings for the turfgrass in the cultivar trial. However, there was a difference in the 2011 season for the overall quality of the turfgrass later in the season from the water treatment (figure 8)

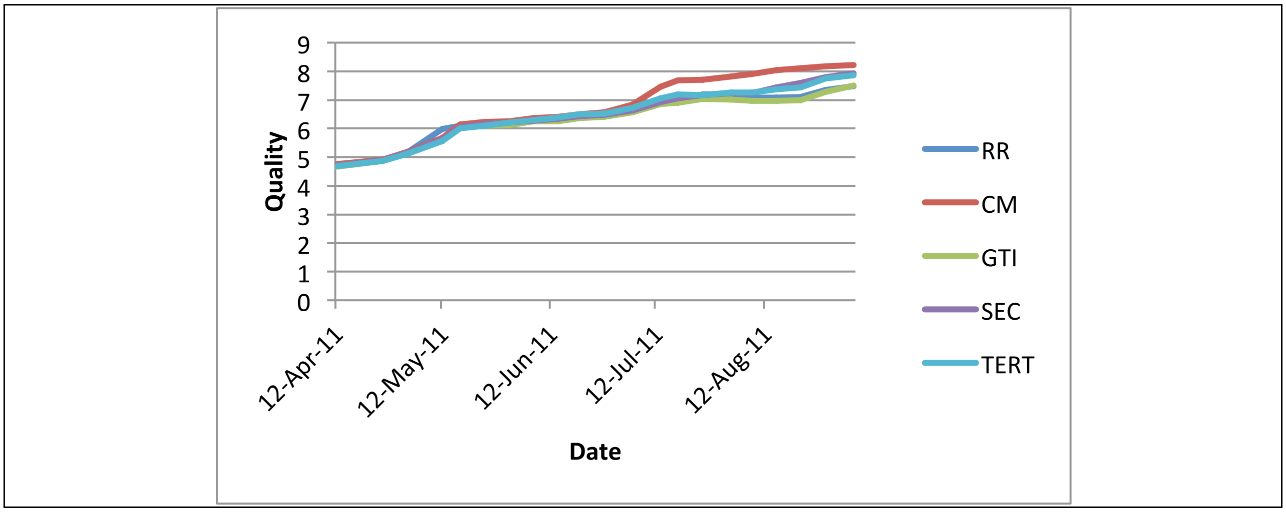

Figure 8 - The quality ratings of the turfgrass in the cultivar trial for the 2011 season for each water treatment. The quality was assessed using the NTEP system that rates 1 as the lowest quality and 9 as the highest quality.

There was no difference in the NDVI measurements taken for the 2010 growing season for the cultivar evaluation trial for the type effect of irrigation water. However, a difference was seen for water treatments affect on NDVI later in the 2011 growing season (figure 9).

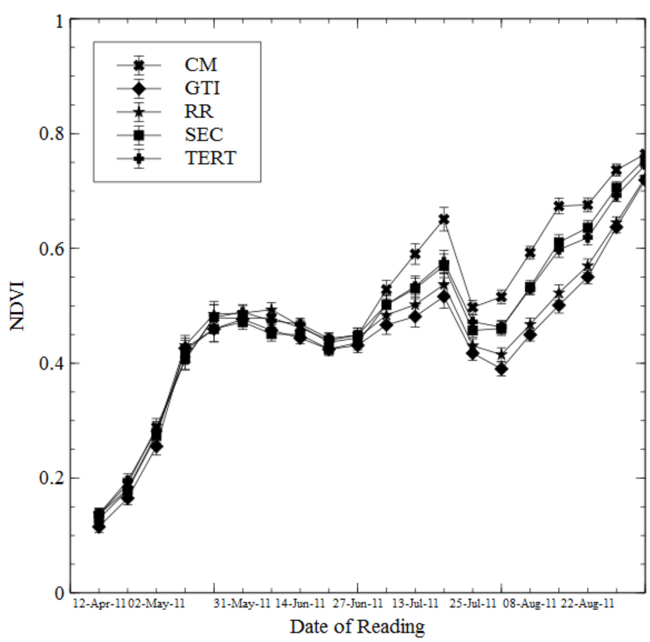

Figure 9 – The affect of reclaimed water irrigation treatments on the NDVI measurements in the cultivar trial for the 2011 season.

The level of nitrates in the soil for the first lysimeter trial was found not to be different when applied supplemental to water in 2010. The 2011 season found that there were differences in the level of nitrates in the soil of the plots when irrigation was applied regardless of rainfall with Conestoga meats having the highest concentration in all but the 0 to 10 depth of the second lysimeter experiment were the no water plot had the highest concentration (figure 10).

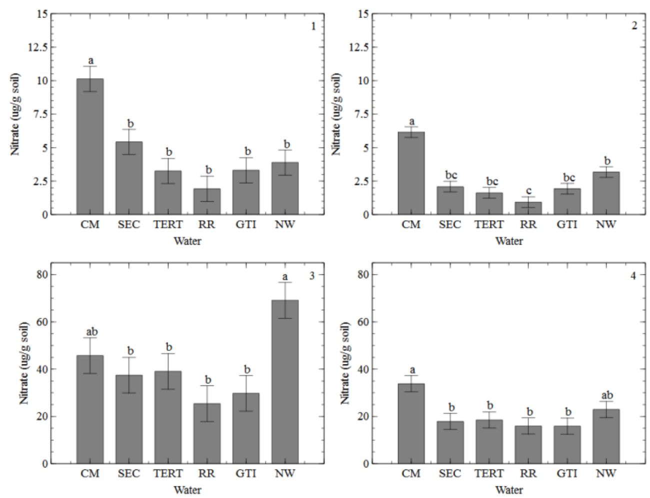

Figure 10 – The concentration of nitrate in the soil at the end of the 2011 season for the first field lysimeter experiment (Top) and the second field lysimeter experiment (bottom). The depths of soil measured are 0 to 10 cm (left) and 10 to 30 cm (right) for both field experiments. Significant means are lettered differently than the other means.

Conclusion

When using reclaimed water for an irrigation source, the quality of the water will vary from one treatment system to another and care must be taken to prevent the reclaimed water from being too high in nitrates and that it is properly treated to remove pathogens as there is potential for them to move through the root zone. However, it is possible to produce a quality sod irrigating with reclaimed water.