WOODCHIP BIOREACTOR

REMOVING NITRATES FROM DRINKING WATER

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BACKGROUND

- In 1990 the Lower Umatilla Basin was declared a Groundwater Management Area due to high concentrations of nitrate in the well water exceeding 7 mg/L.
- Ingesting high levels of nitrate can lead to serious health problems including death.
- The rural area affected needs a solution for removing nitrate from the drinking water that is effective, reliable, and affordable.

CONSIDERATIONS

- Solution has at least a 10 year lifespan
- No nitrate biproduct
- No additional waste produced by treatment
- Provides access to safe drinking water for vulnerable communities

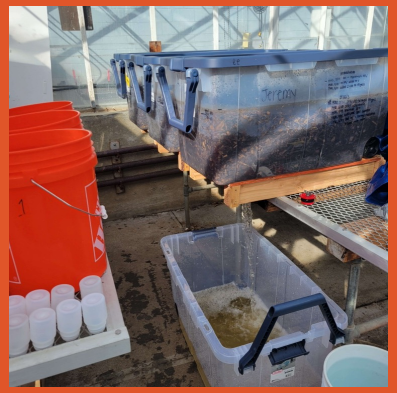

Figure 1: Experimental setup of three prototype woodchip bioreactors

METHODS

- Constructed 3 woodchip bioreactor prototypes using 40 gallon plastic tubs, 20 gallons of arborist woodchips, and a soil sample from 10 cm below the surface.
- Soil was collected from the OSU student farm to inoculate the reactors with denitrifying bacteria.
- The experiment was performed by filling the woodchip bioreactors with 15 gallons of nitrate contaminated water with a concentration of 50 mg/L.
- The nitrate contaminated water was held in the bioreactor for retention times ranging from 4 to 48 hours.
- Effluent samples were collected and nitrate concentration was tested using Hatch Strips and a spectrophotometer.

Figure 2: Collen preparing samples for testing in the spectrophotometer

Figure 3: Brenda adding nitrate solution to a bioreactor before starting retention time

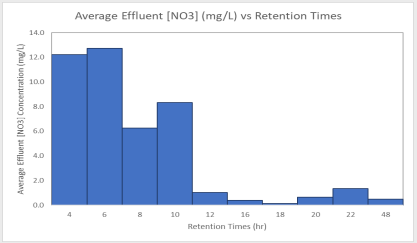

Figure 4: Average effluent nitrate concentration vs RT. An ANOVA test was run between bioreactors that resulted in a p-value of 0.59.

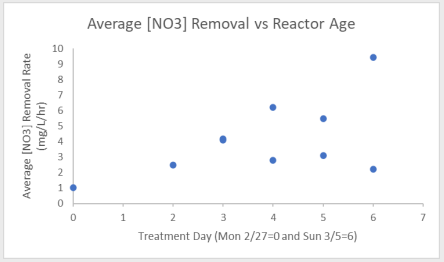

Figure 5: Rate of treatment (mg/L/hr) relative to bioreactor age by day. Rate of treatment was calculated by nitrate concentrations divided by respective RTs.

RESULTS

- The average effluent nitrate concentration consistently dropped below 7 mg/L at a retention time of 10 hours.
- Figure 1 shows an inverse correlation between retention time and nitrate concentrations.
- Trials were not performed in chronological order. Figure 2 shows a relationship between nitrate removal efficiency versus reactor age.
- Hach Test strips used to qualitatively estimate nitrate reductions had an R2 value of 0.619 when compared to lab test results.

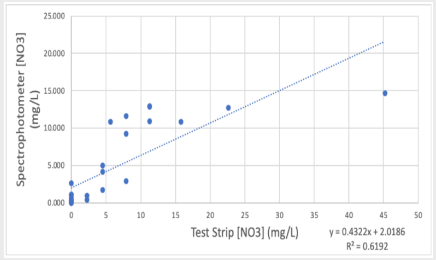

Figure 6: Test strip vs spectrophotometer estimates.

DISCUSSION

- A woodchip bioreactor can effectively remove nitrate from contaminated water.
- The time needed to reduce nitrate concentrations to below 7 mg/L is 8-12 hours.
- Microbial colonies may not be fully matured.
- Hatch test strips provide qualitative results

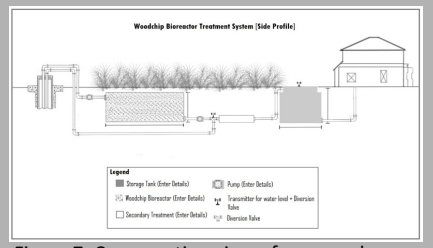

Figure 7: Cross-section view of proposed bioreactor design

CONCLUSION

- We recommend implementing a the woodchip bioreactor for the Umatilla community
- Sizing of the bioreactor is dependent on water use
- Woodchip bioreactors should be used with further water quality treatment

Figure 8: Example construction of a woodchip bioreactor from Illinois Extension

Thank you
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