

The Effects of Periodic Abandonment on the Reactivation Period of Biosand Filters on a School Schedule



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PURPOSE

- To evaluate the impact of *reactivation* periods and *pause* periods typical of a school schedule on the microbial reduction, turbidity and flow rate of biosand filters.

INTRODUCTION

BIOSAND FILTERS

- One of the most effective water filtration systems for rural areas in developing countries is the biosand filter (BSF).
- The filters have been widely tested and accepted for daily household use by removing pathogens through mechanical trapping and activity of the biolayer, a diverse microbial community on the upper layer of sand that takes up to thirty days to establish and is disrupted by cleaning or inactivity.



<http://www.clean-water-for-laymen.com/household-water-filter.html>

BIOSAND FILTERS IN SCHOOLS

- BSFs have not been widely implemented in rural schools, where school breaks and weekends are longer than the BSF user guidelines of 1-48 hours. Daily use promotes an active biolayer that removes microbial contamination.
- Research is needed on the effects of pause periods beyond 72 hours and how intermittent use of a typical schools schedule will impact BSF performance.
- A protocol is needed to establish best practices on how to reactivate a BSF after long holidays and vacations.

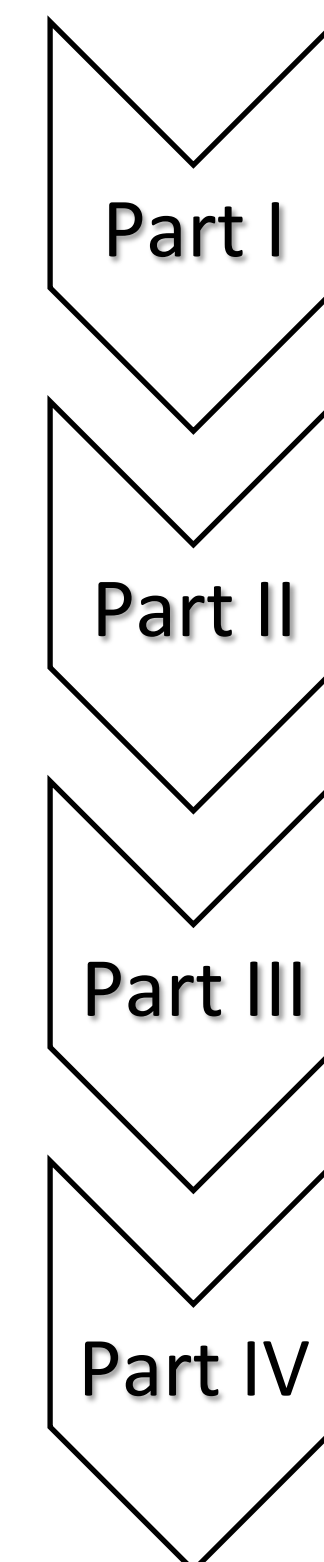
STEM Academy Water Research Laboratory at Bangor High School



- 4 BSFs were installed and maintained on a school schedule in the water research laboratory in Bangor High School's STEM Academy in Bangor, Maine.

METHODS

- Working in collaboration with a nongovernment organization in Honduras, four BSFs were installed, tested, and maintained in the laboratory on a typical school schedule.
- One bucket of source water (20 L) from a local impaired stream was poured through the filter on a continuous schedule or a school schedule.
- Source water and biosand effluent were tested for total coliforms and *E.coli* were using IDEXX Colilert Quanti-Tray/2000 and quantification methods based on the Standard Methods' Most Probable Number (MPN).
- Turbidity measurements were taken with a Hach portable 2000P turbidity meter.

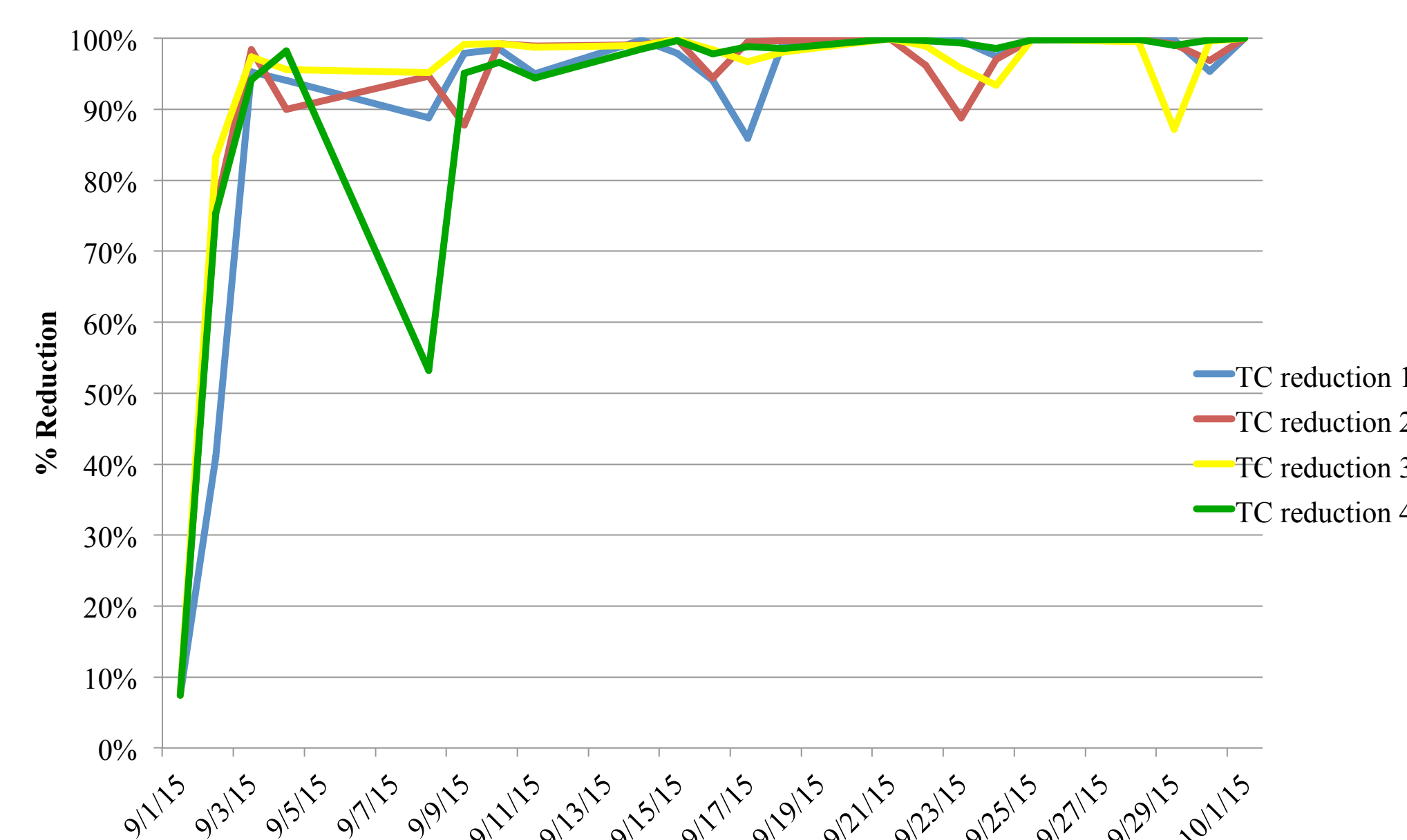


- Flow rate, chemical and microbial measurements were taken during the 30 day activation period of the four filters on a typical school schedule
- Four filters were reactivated for fifteen days on a continuous schedule (seven days a week daily dosing) after a three month school break
- Four filters were activated for fifteen days on a school schedule (no weekend or holiday dosing) after a three month school break.
- A five-day reactivation was conducted by passing varying numbers of buckets of source water through the BSFs daily, one through the first filter, two through the second, three through the third, and four through the fourth.

RESULTS

Part 1: Activation on a School Schedule (Daily Dosing Except Weekends and Holidays)

Total Coliform Percent Reduction (n = 29)

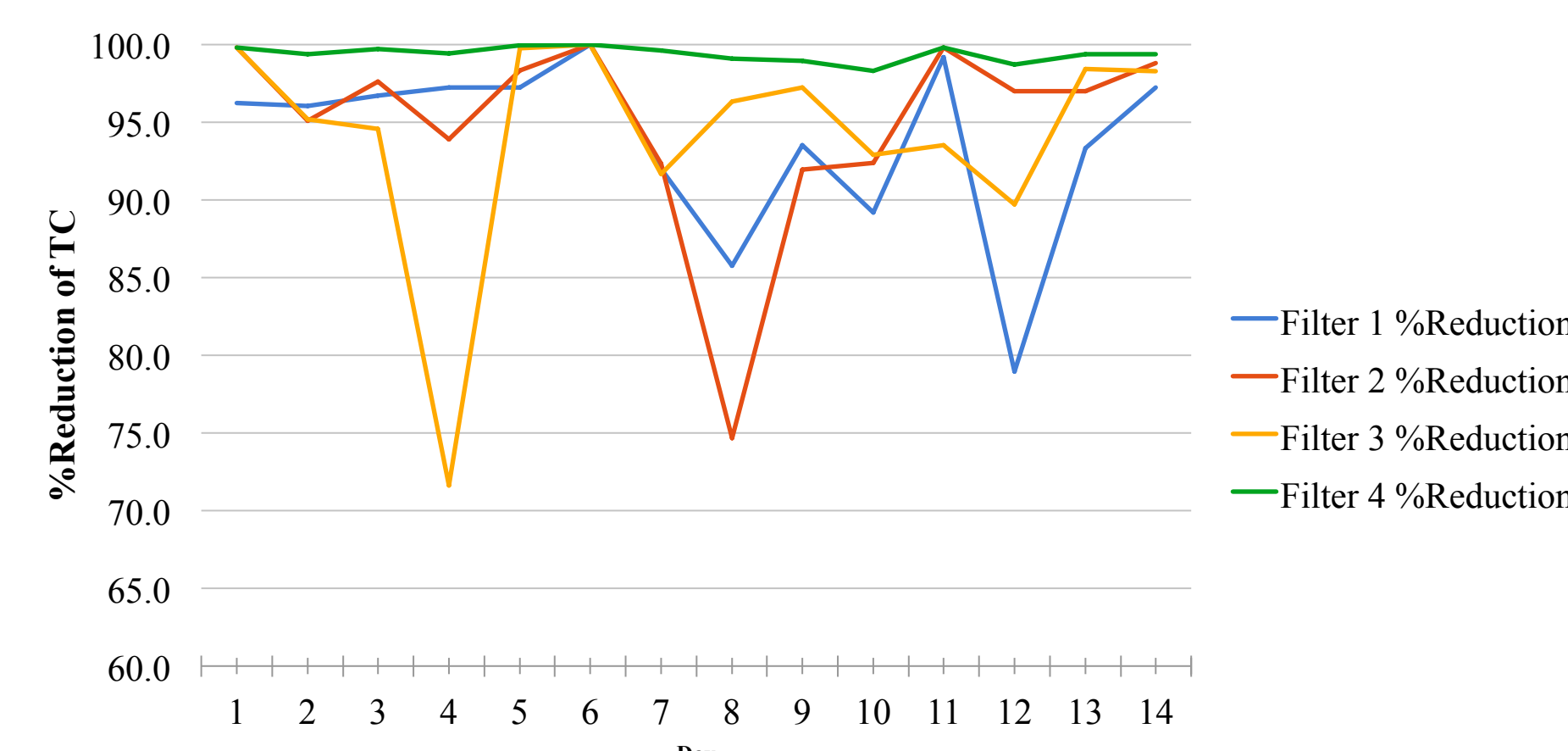


(n = 29)	Filter 1	Filter 2	Filter 3	Filter 4	p value
Total coliforms (% reduction)	92.0	92.4	92.0	87.1	0.72
<i>E. coli</i> (MPN/100 mL)	4.2	4.6	4.9	2.0	0.31
Flow rate (seconds/L)	181	125	244	277	<0.01
Turbidity (NTU)	3.11	1.37	2.84	2.66	0.32

- Filters are statistically similar at the end of activation except for flow rate (<0.01) based on a one-way ANOVA

Part 3: Reactivation on a School Schedule

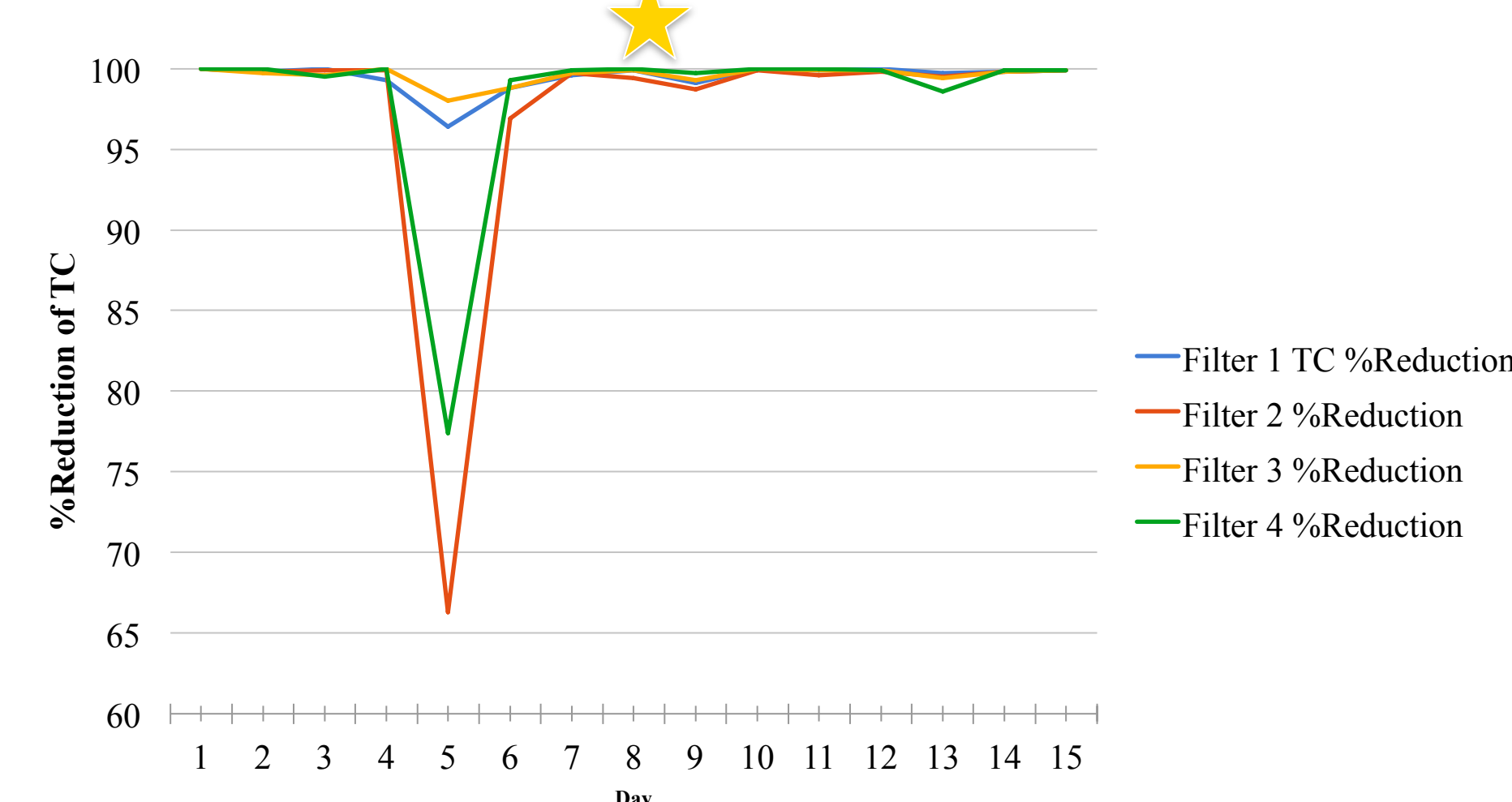
Total Coliform Percent Reduction after 3 month School Break



- Separate fifteen-day reactivation period with pause periods of three days and six days ranged from 40% to 99%, with an average total coliform and *E. coli* reduction of 95.6% (p<0.01) and 92.4% (p<0.01).

Part 2: Reactivation on a Daily Dosing Schedule

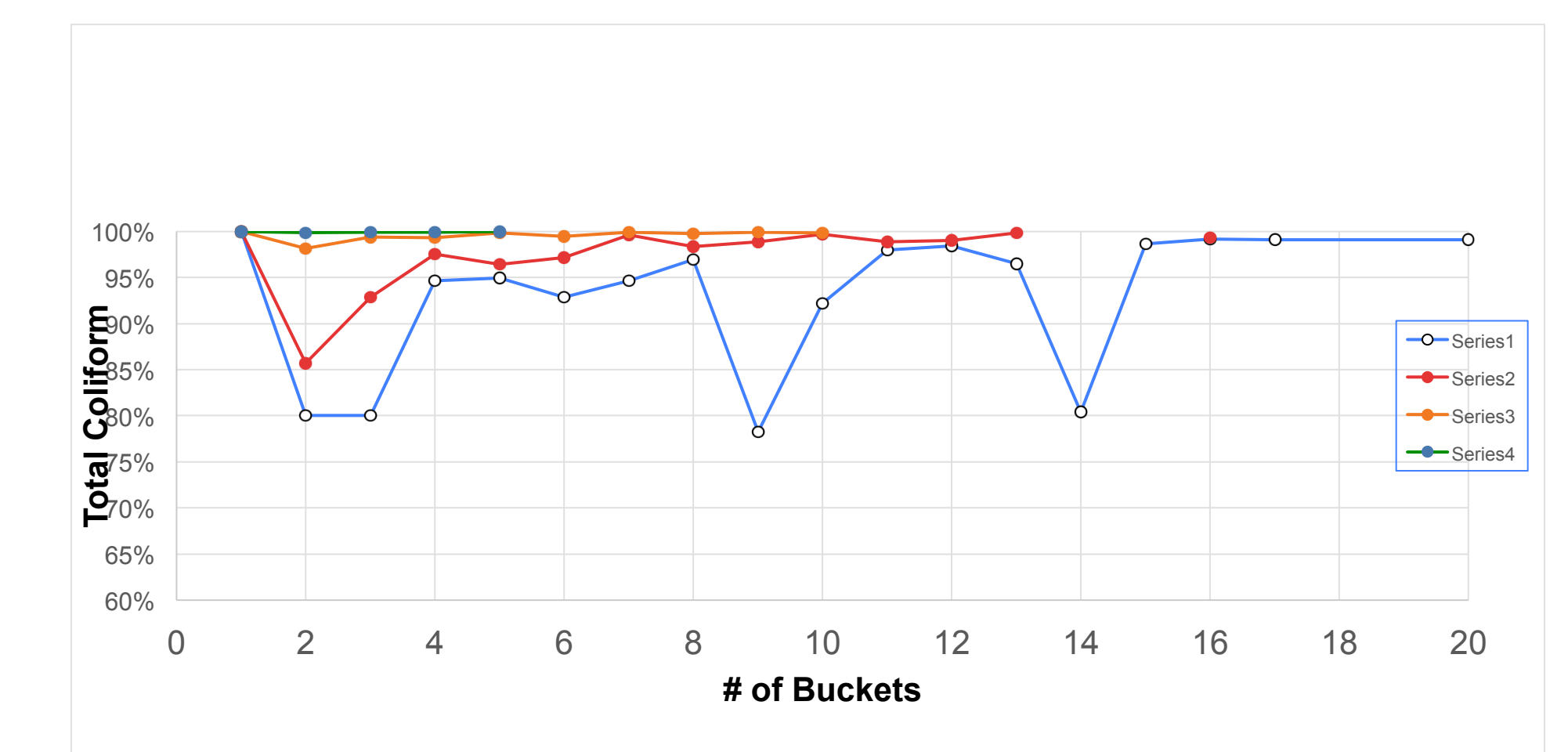
Total Coliform Percent Reduction after 3 month School Break



- Fifteen-day reactivation period with daily dosing resulted in mean total coliform and *E. coli* reduction of 98.6% and 97.4% (n = 56), with the greatest variation in performance during the first five days (p < 0.01).

RESULTS

Part 4: 5 Day Reactivation with one, two three or four buckets of source water



	Filter 1 (n = 18)	Filter 2 (n = 14)	Filter 3 (n = 11)	Filter 4 (n = 4)	p value
Total coliforms (% reduction)	93.0	97.2	99.5	99.9	0.40
<i>E. coli</i> (MPN/100 mL)	4.5	5.2	<1	<1	<0.01
Flow rate (seconds/L)	98	105	162	254	<0.01
Turbidity (% reduction)	39.8	62.4	55.2	67.9	0.14

- Total coliform and turbidity reduction are similar; flow rates and *E. coli* in the effluent are statistically different with different dosing schedules

CONCLUSIONS/RECOMMENDATIONS

- Microbial reduction results from BSF activation on a school schedule were similar to published activation periods with daily dosing in a household setting, suggesting that BSFs can be activated on a school schedule.
- BSF total coliform reduction ranged from 40 % to 99.9 % after the initial activation period, suggesting that BSFs are generally resilient to the inactivity and sporadic dosing typical of a school schedule.
- The length of reactivation appears to be a function of days rather than number of buckets; Increasing the frequency of dosing from one bucket daily to four buckets daily does not shorten the reactivation period.
- More research is needed to determine the long-term impact of frequent reactivation periods, particularly on the flow rate and the microbial performance.
- Safe water storage and treatment options are critical to the use of BSFs in schools due to fluctuating performance of the BSFs after weekends and holidays.

REFERENCES

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