

Nutrient reduction in agricultural runoff using PhosphoReduc filter media for P and N removal



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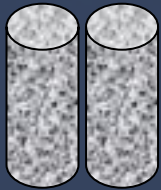
Outline

- Setup design
- Test media
- Instrumentation/analysis
- Significance
- Conclusions

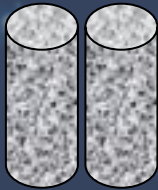


Setup design

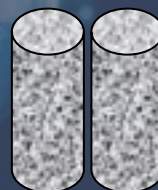
7 °C
22.3 hrs HRT
10 mL/min



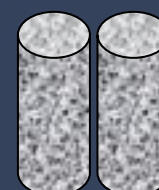
7 °C
7.5 hrs HRT
30 mL/min



17 °C
22.3 hrs HRT
10 mL/min



17 °C
7.5 hrs HRT
30 mL/min



Media: Steel Slag (porosity of ~ 43.5%)

Media volume: ~ 31

Temperature: 7 °C and 17 °C

HRT: ~ 7.5hrs and ~ 22.3hrs

Flow rate: 10 mL/min and 30 mL/min

Influent concentration: 57mg of KH_2PO_4 /L of water (40 mg of PO_4 /L)

11mg of $\text{CH}_4\text{N}_2\text{O}$ /L of water (5 mg of N/L)

Effluent concentration: Claimed.

P and N = 0 mg for the first 2 weeks

Thereafter P and N removal efficiency reduces in the effluent

Setup design



- Temperature controlled room
- Tested flow rates
- Steel slag in column
- Fresh water supply
- 10 samples per day (8 from column effluent, 2 from 600L reservoir)

Test Media

- Steel slag
- Waste material from steel manufacturing
- High in CaO and FeO
- pH reducing



Test parameters

- P: Total P and Phosphate
- N: Total N, Nitrate and Nitrite
- Acidity: pH, mV and temperature

Instrumentation/analysis: pH meter

WaterPro measurements

pH

mV

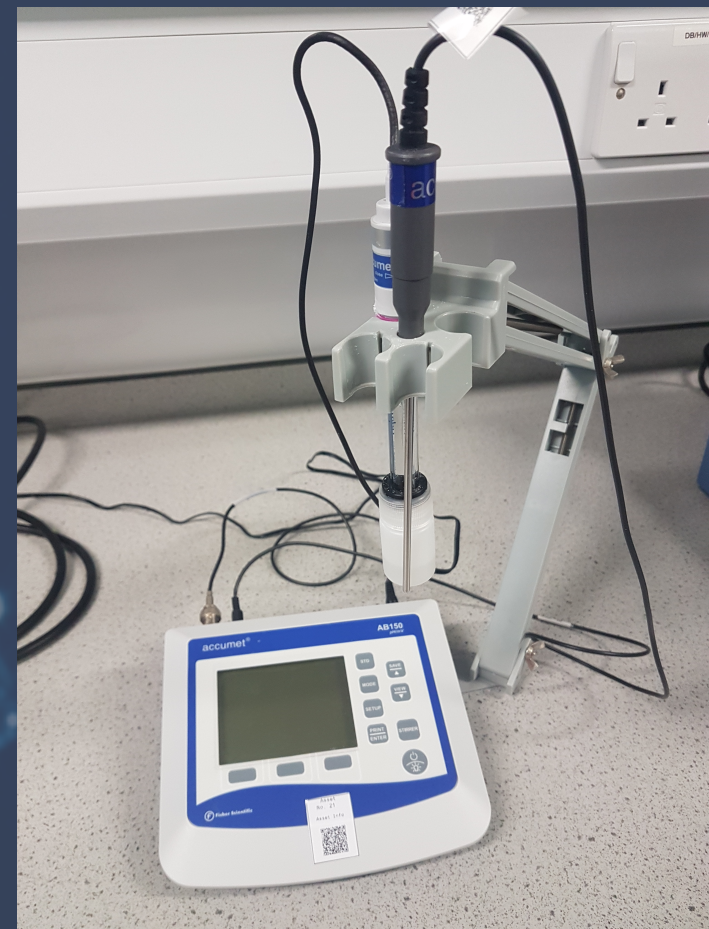
Temperature

Accuracy:

pH Accuracy: ± 0.002 pH

mV Accuracy: ± 0.2 mV or ± 0.05 %, whichever is greater

Temperature Accuracy: $\pm 0.3^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$)



Instrumentation/analysis: Gallery plus

WaterPro measurements

Total Phosphate

Phosphorous

Total Nitrate

Capabilities

Two measurement techniques:

1. Photometric
2. Electrochemical



Instrumentation/analysis: Ion Chromatography

WaterPro measurements

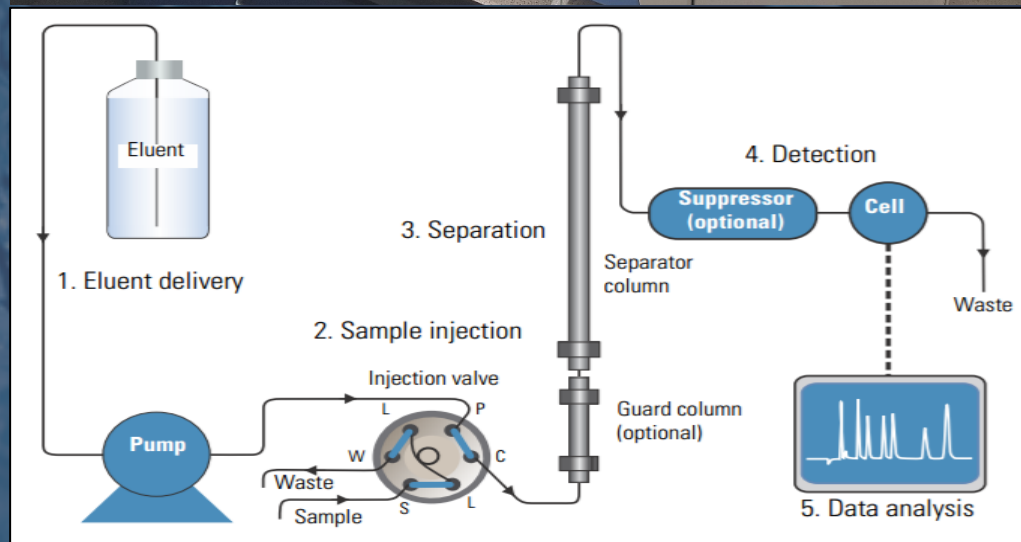
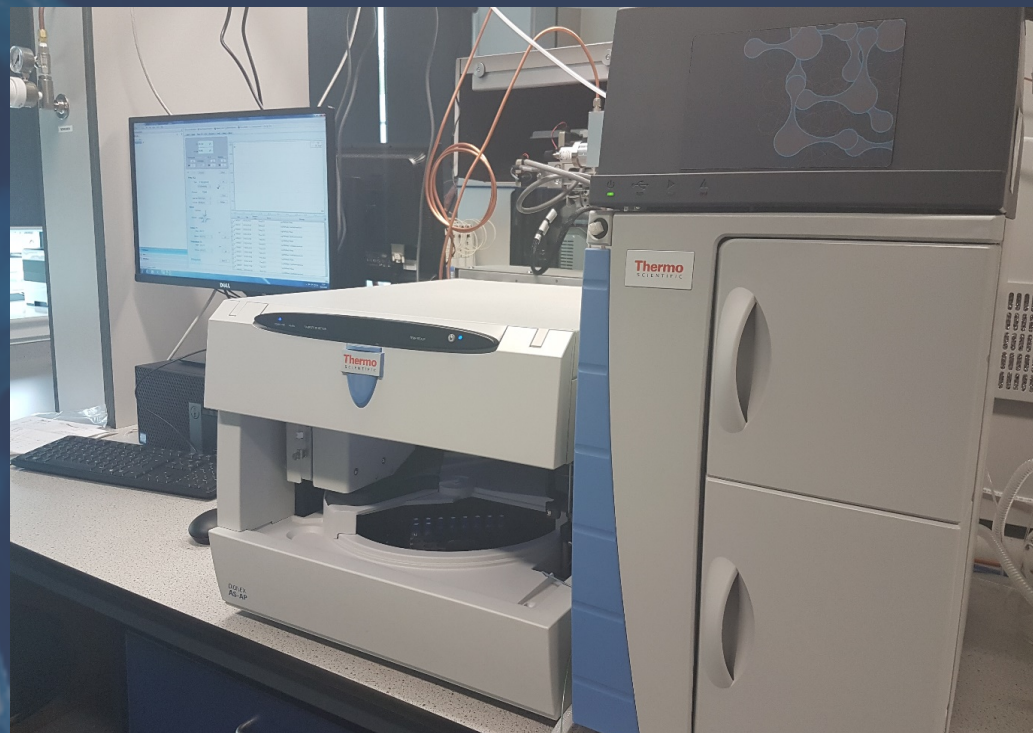
NO_3

NO_2

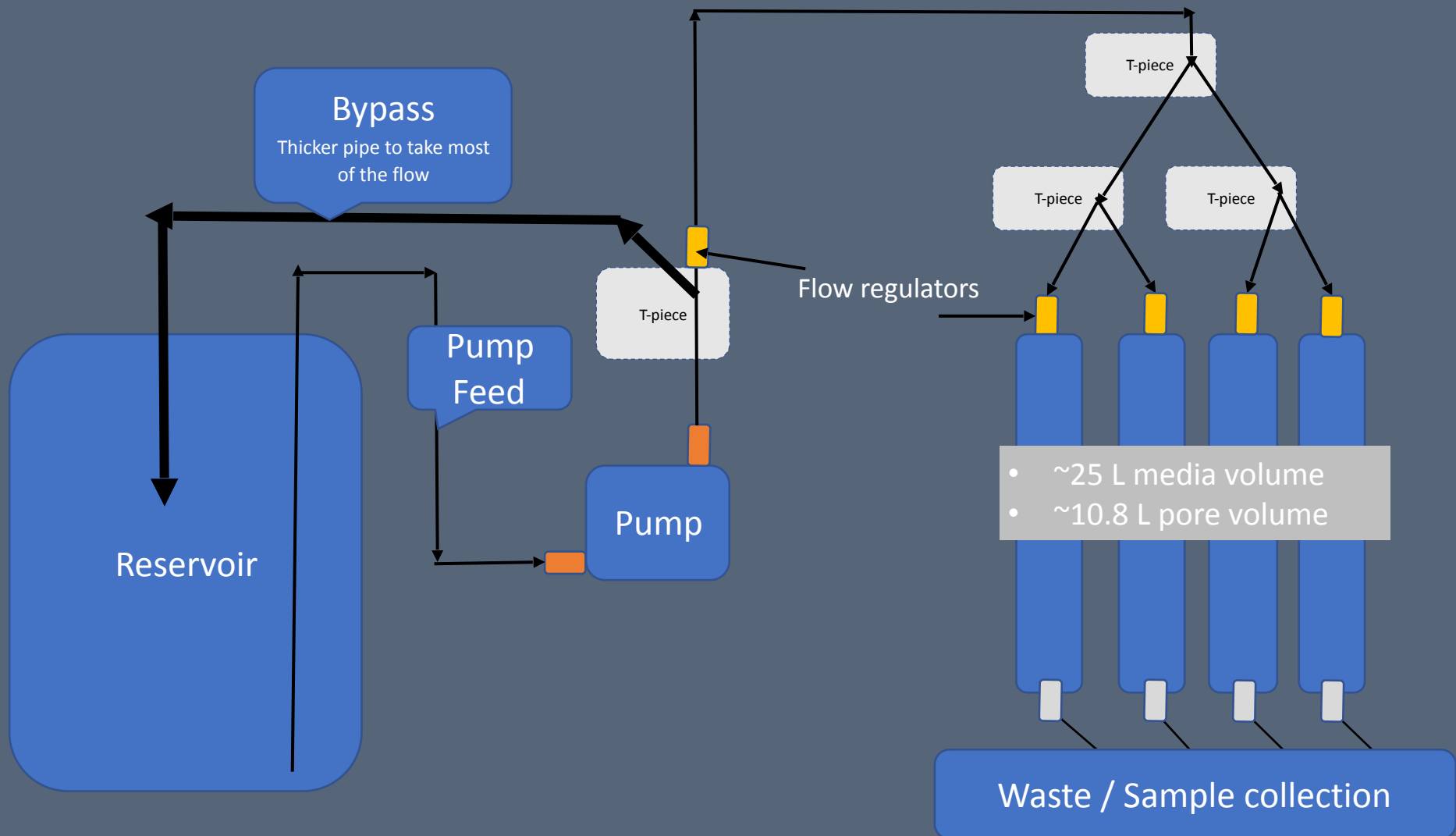
PO_4

Capabilities:

Anion, Cation and organic acids



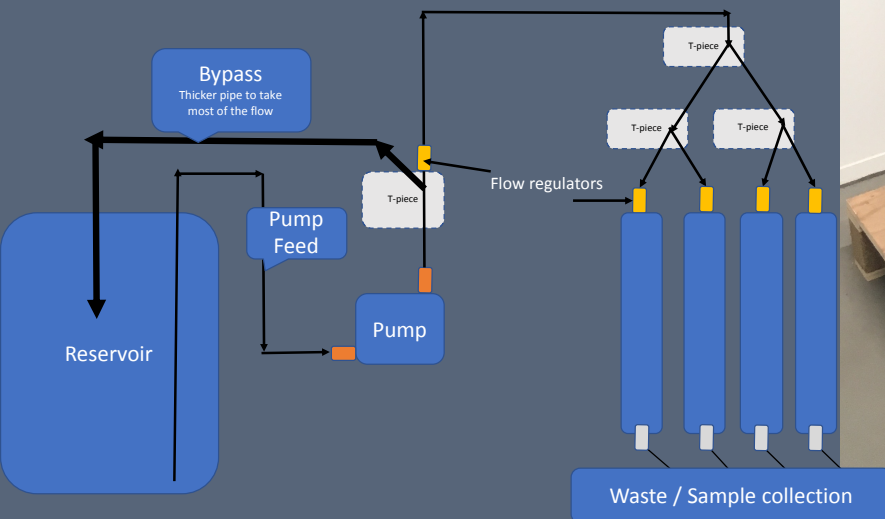
Test rig schematic



Test rig operation

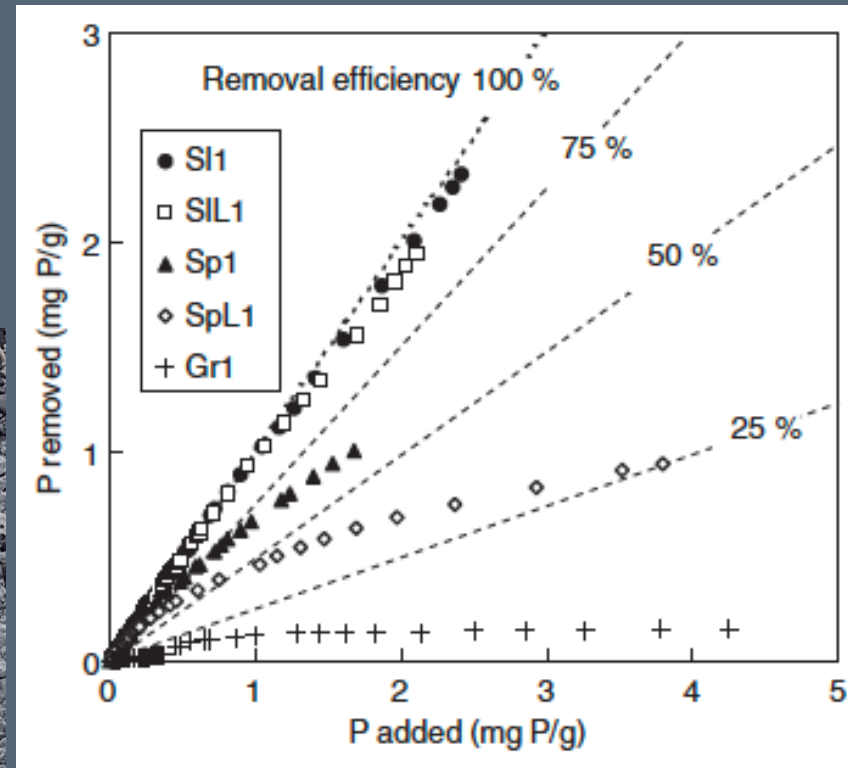
Two setups:

- 7 °C and 17 °C
- 18 and 6 hours HRT
- 10 and 30 ml/min
- duplicates



Test Media: PhosphoReduc

- Steel slag
- Waste material
- High in CaO and FeO
- pH reducing



Parameter	Treatment efficiency	Benefits to the environment
Phosphorus	up to 95%	No energy requirements
Ecoli.	up to 90%	Small footprint
Solids	up to 90%	Life span 20 years ?

Analytical approach

Analyte

Total P

Total N

NO_3^-

NO_2^-

PO_4

DOC

Method

Gallery Nutrient Analyser

Gallery Nutrient Analyser

Ion Chromatography

Ion Chromatography

Ion Chromatography

DOC Analyser

Nutrient Recovery:

Potential for nutrient recovery:

P sorbing material used in filters to reduce P from waste streams has potential to act as a slow release P fertilizer, however the mechanism for recovery is still unclear.



Conclusions:

- EAF Steel slag offers promise for P and N removal from agricultural runoff
- Nutrient recovery methods have not been confirmed
- There is potential for small scale units to be installed as temporary measures in streams to reduce P under special circumstances.
- Literature shows that there should be no leaching of other contaminants from the EAF steel slag, however this has not been confirmed.
- Longer tests are required to show how the system performs long term as effectiveness reduces over time (from near 100% to 80% within two weeks)
- Potential for clogging of filter with consequent reduction in efficiency.

Testing at Heriot-Watt University will continue