



LIFE AT THE WALL

Understanding distribution system biofilms and their impact on water quality

Dr. Katherine Fish (k.fish@sheffield.ac.uk)



The
University
Of
Sheffield.



Sheffield
Water Centre



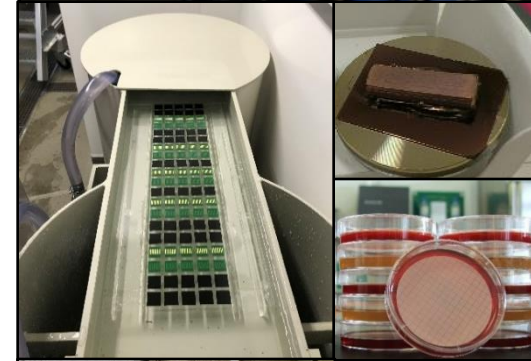
150+ researchers

15+ research groups;

Engineering, sciences, social sciences, management, health



- **Drinking Water Distribution Systems (DWDS)**
- **Microbiology and Bio-engineering**
 - Waste water distribution (sewers)
 - Storm water management/urban drainage
 - Data/analytics
 - Sensors/leakage
 - Engagement and Governance (customers/stakeholders)





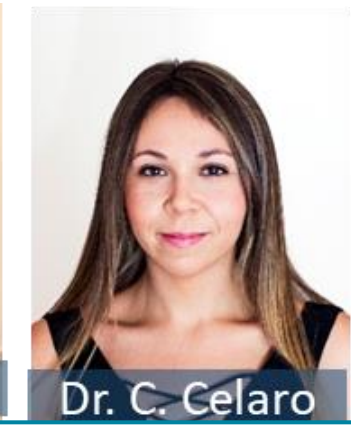
Dr. F. Pick



Mr J. Hook



Ms J. Rogers



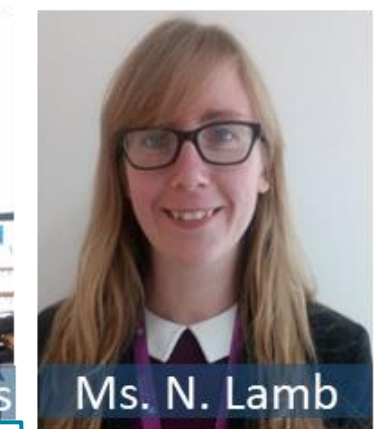
Dr. C. Celaro



Dr. R. Collins



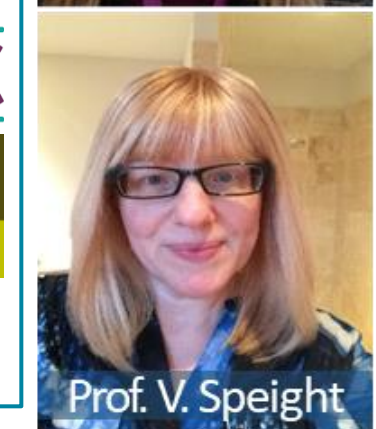
Mr. G. Kyritsakas



Ms. N. Lamb



Prof. J. Boxall



Prof. V. Speight



Dr. I. Sunny



Dr. K. Fish



Ms. C. Genevois



Mr K. Gleeson



Ms. A. Doronina

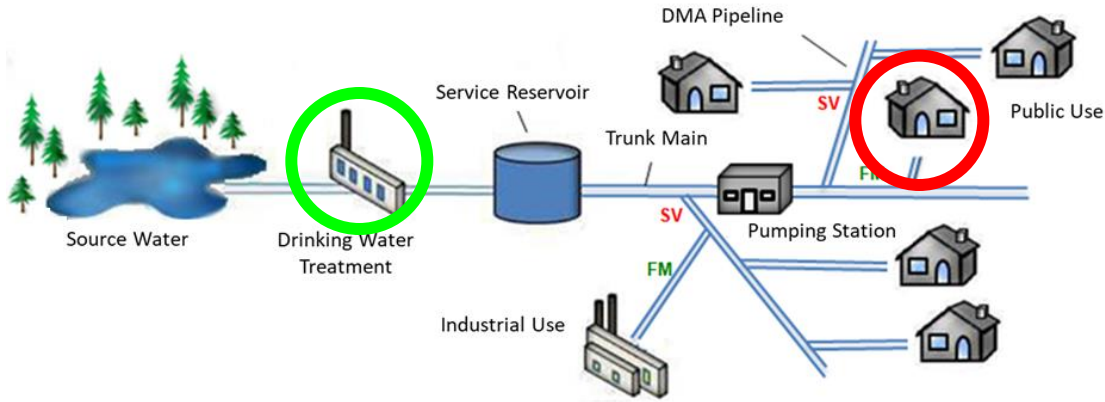


Dr. S. Husband

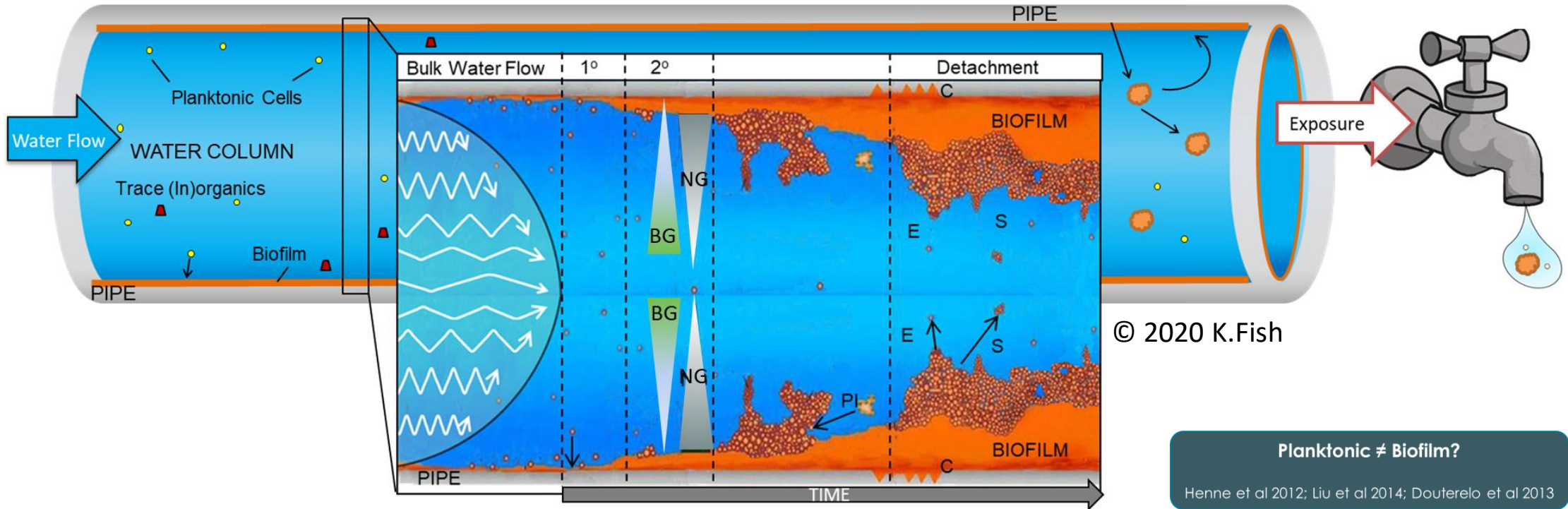


Dr. I. Douterelo

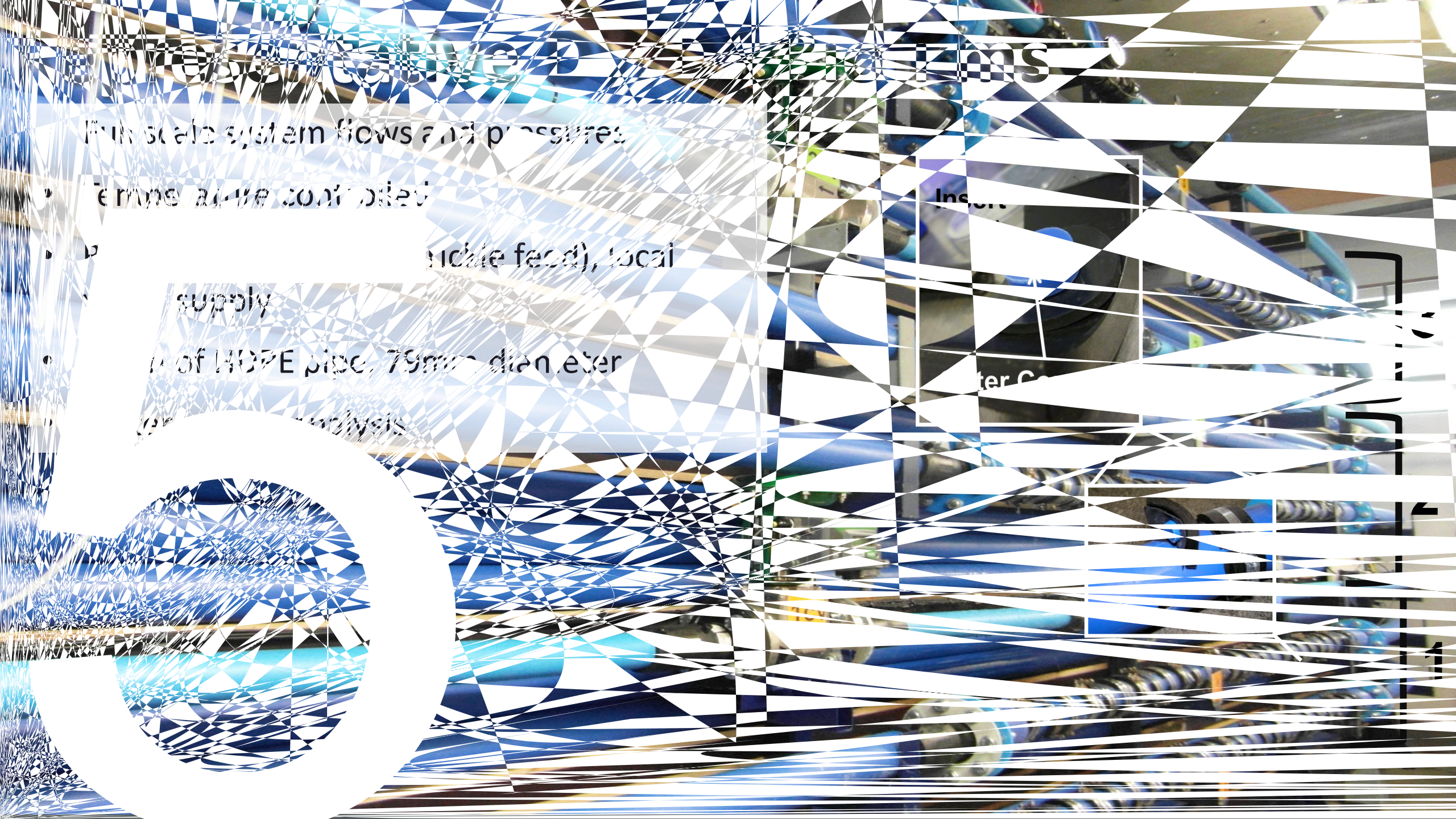
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Complex, extensive, ageing, buried
 England and Wales
 400,000 km pipe
 >1.8 Million affected 2020 (DWI, 2021)



Planktonic ≠ Biofilm?
 Henne et al 2012; Liu et al 2014; Douterelo et al 2013



Control Active Systems

Full scale system flows and pressures

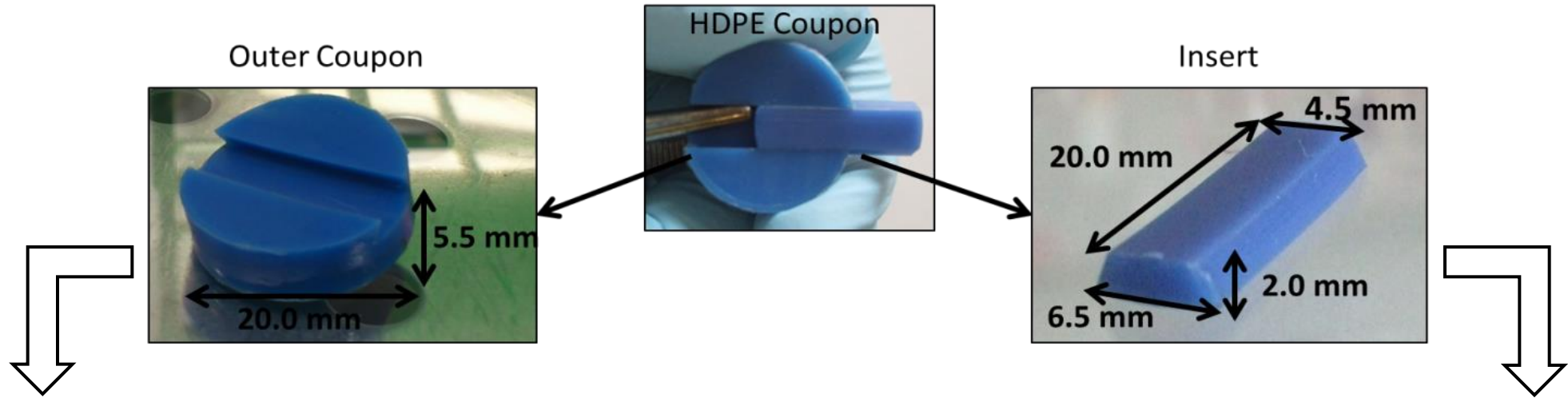
- Temperature controlled
- Pressure controlled (niche feed), local
- Supply
- HDPE pipe, 79mm diameter
- Analysis

Insert

Water Co

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Bacterial and Fungal analysis
(Q-PCR and Illumina)

COMMUNITY

Total and Intact Cell Counts
(Flow cytometry)

Inorganic analysis
(X-Ray fluorescence, Raman microscopy)

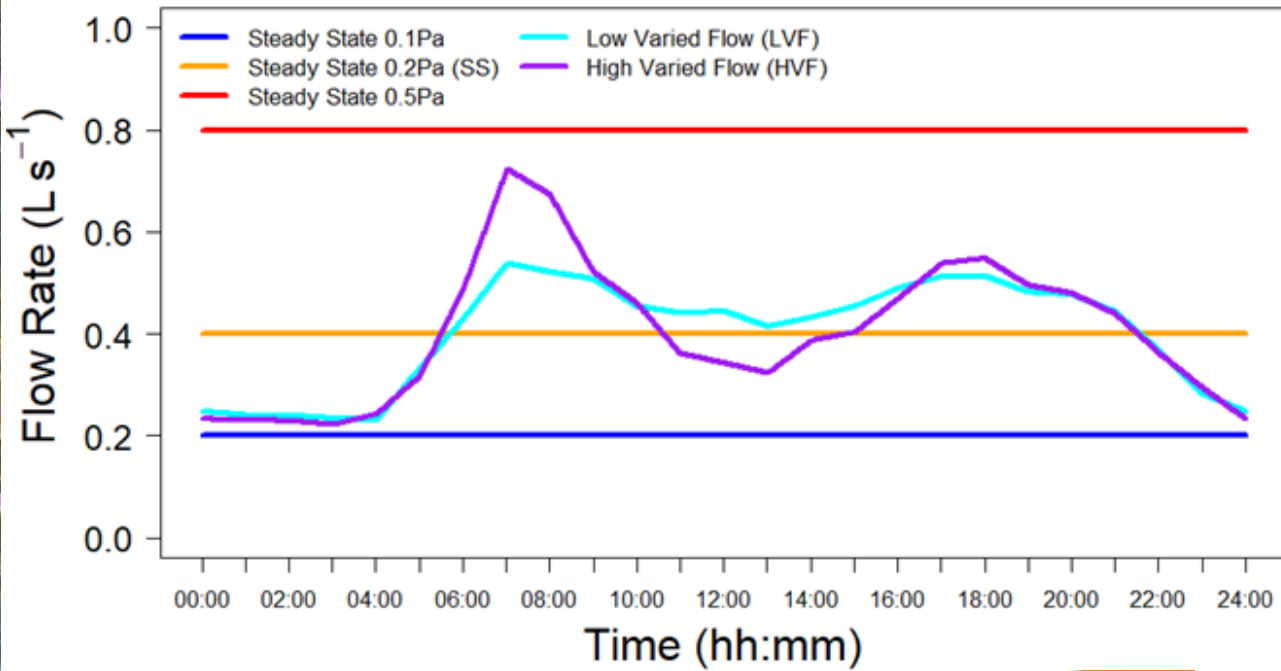
PHYSICAL

Biofilm cells and EPS
Staining and imaging
(Confocal laser scanning microscopy)
Scanning Electron Microscopy

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GROWTH PHASE

(Hydraulics, Temperature, Chlorine, Longevity)

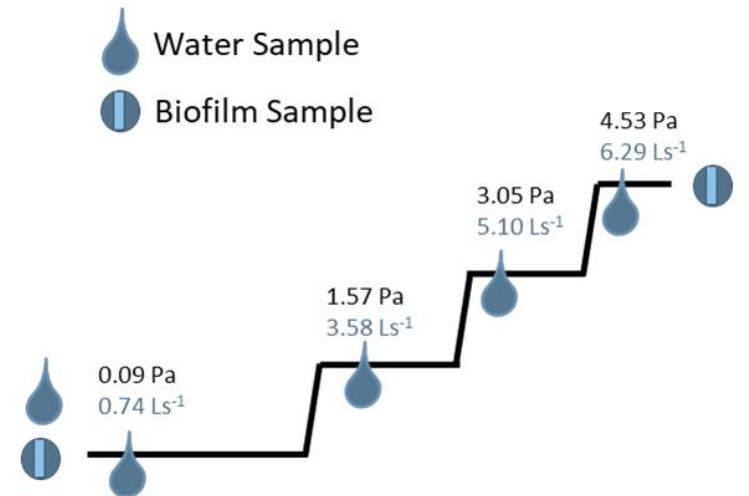


BIOFILM STRUCTURE

Day 28

MOBILISATION PHASE

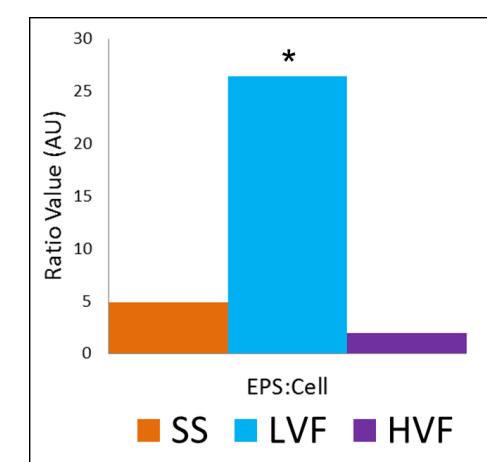
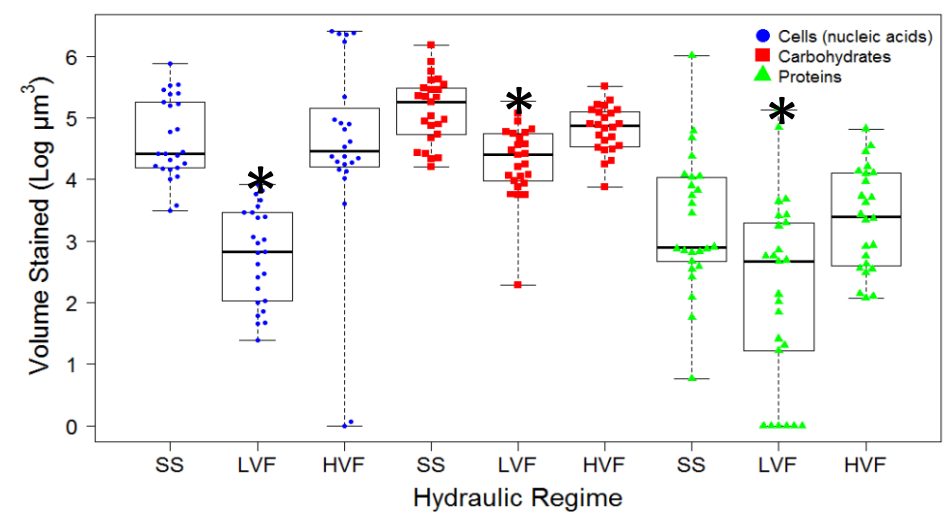
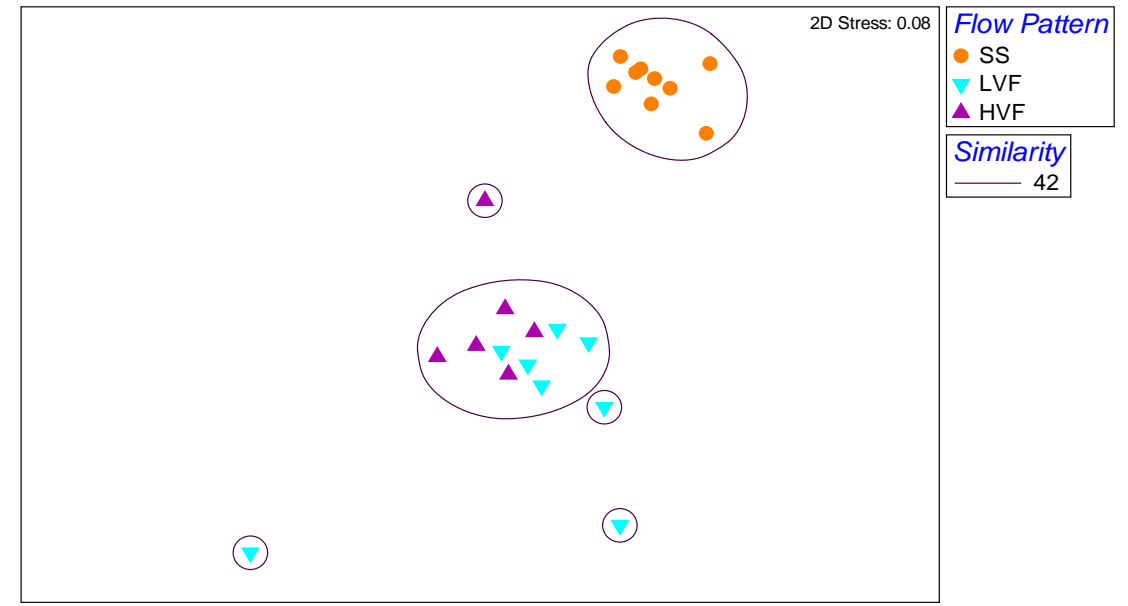
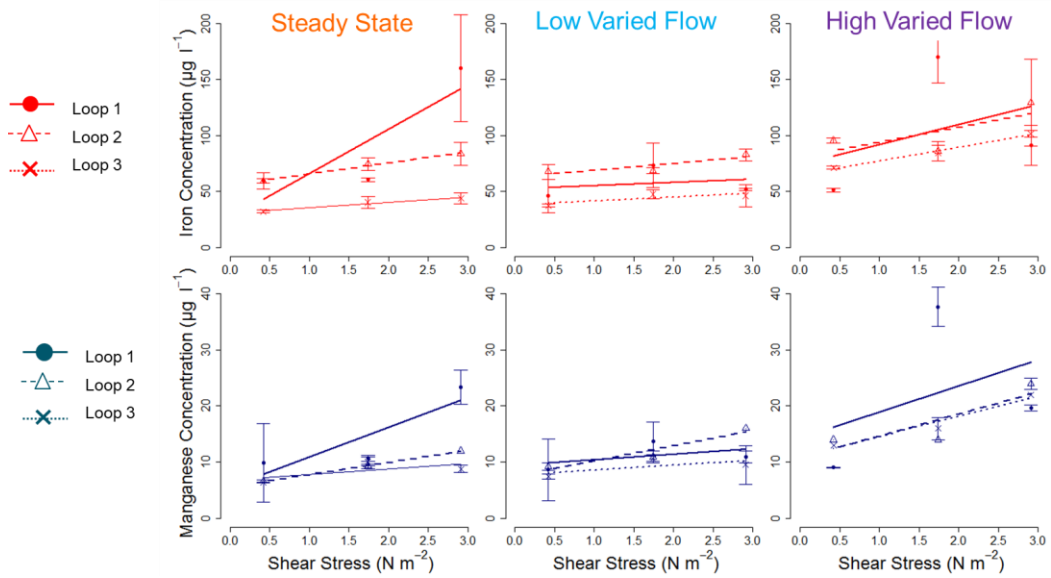
(Response, Intervention impact)

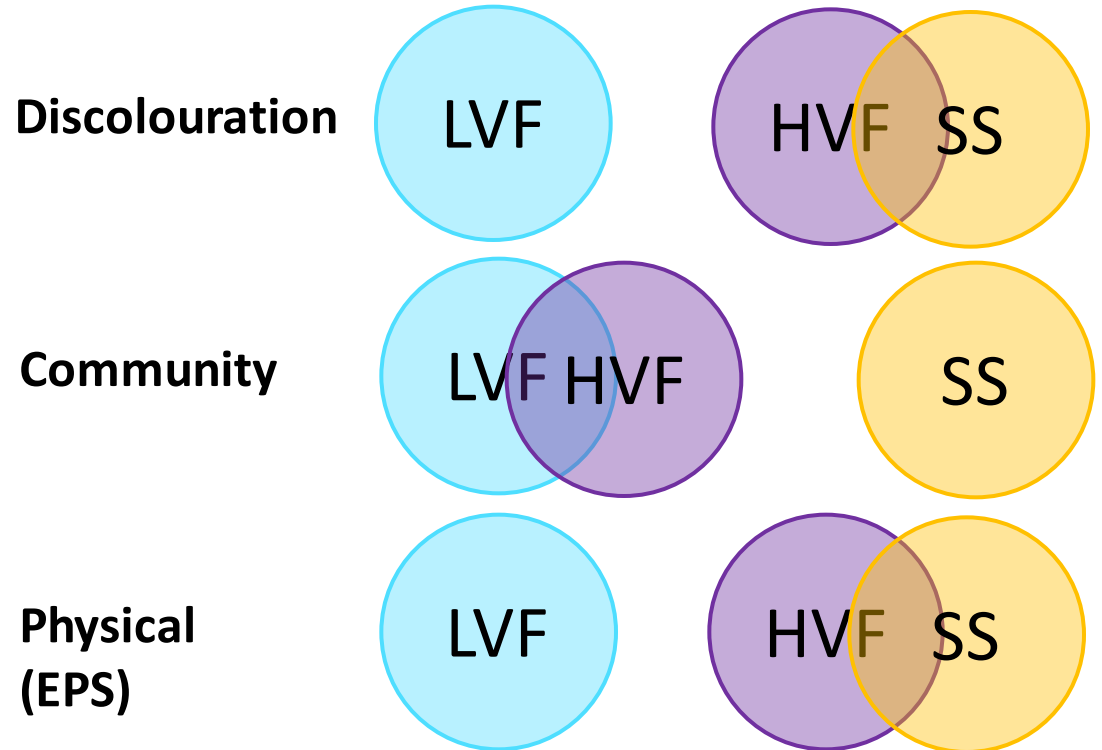


RESPONSE

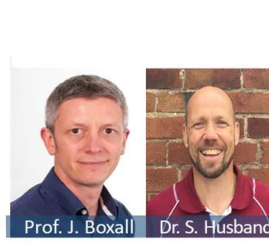
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#PODDS Prediction of Discolouration in Distribution Systems



“PODDS...£15 million saving (current AMP), same customer outcome, lower cost & service risk”

“PODDS... improved service, customer savings, and 90% capital cost reduction, £170/m to £17/m”

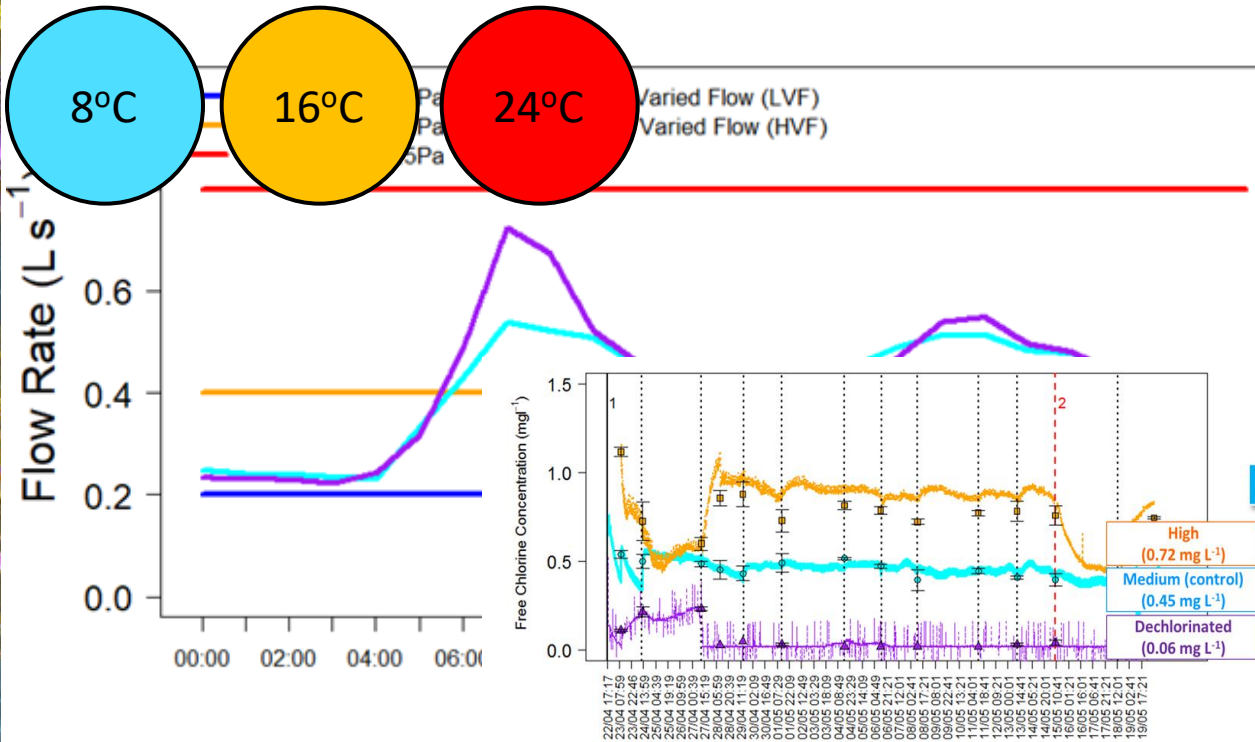


- Hydraulic conditioning occurs
- Physical structure influenced more by hydraulics than community - *monitoring pipeline environment integral to prediction/management*

biofilm of Bacteria

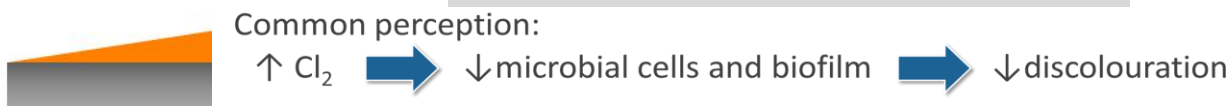
GROWTH PHASE

(Hydraulics, Temperature, Chlorine, Longevity)



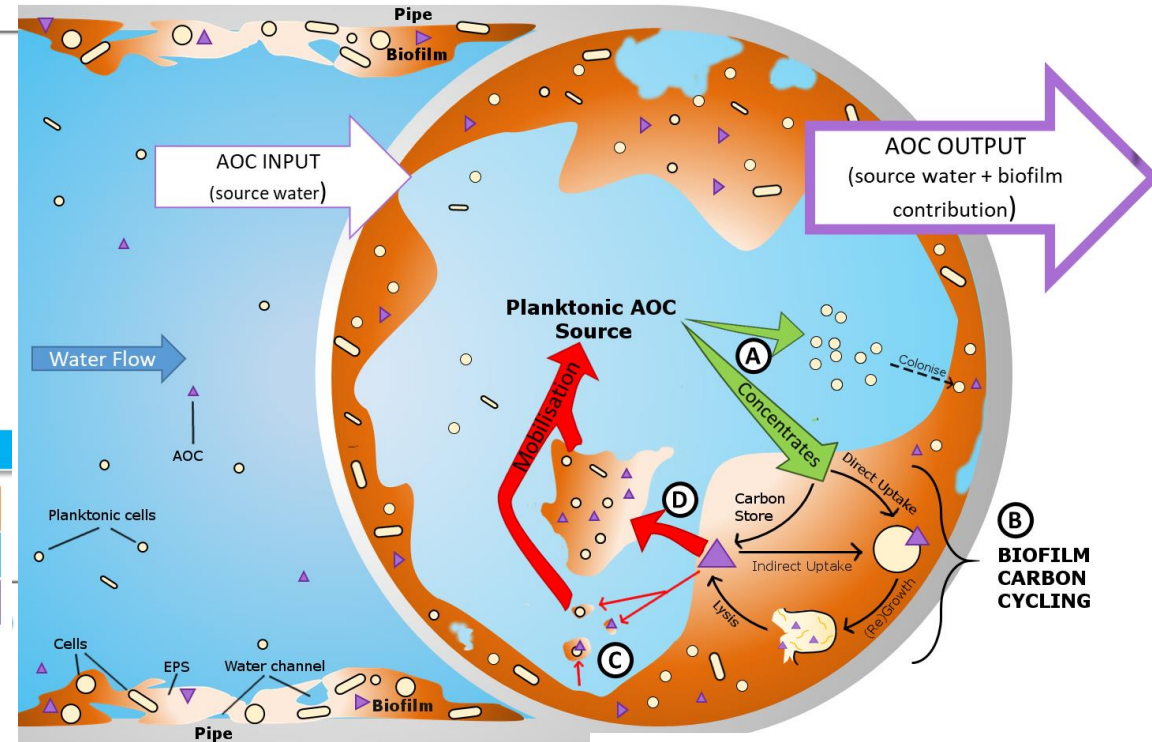
BIOFILM STRUCTURE

Chlorine Residual Concentration



MOBILISATION PHASE

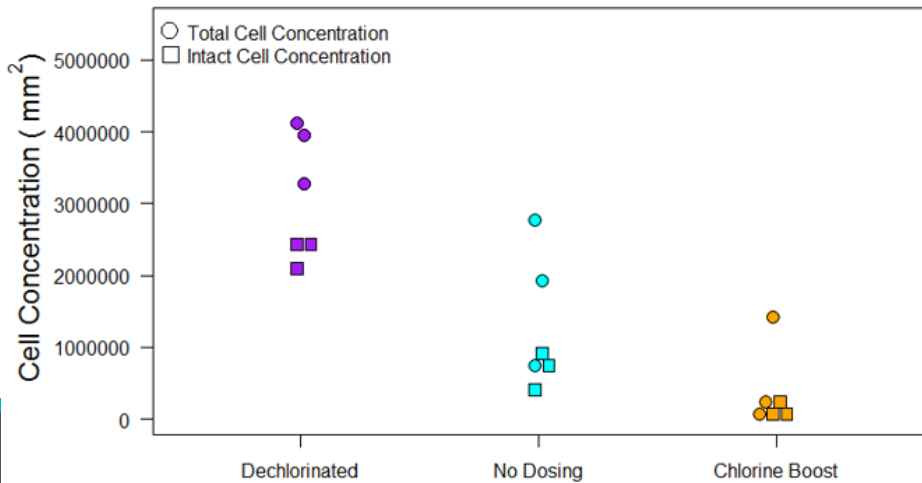
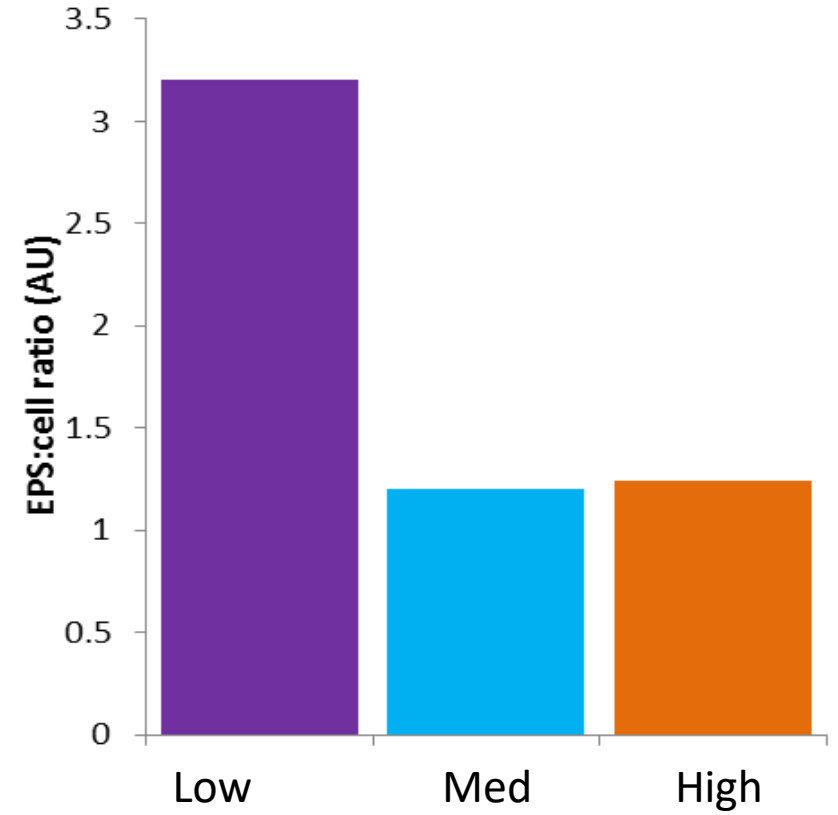
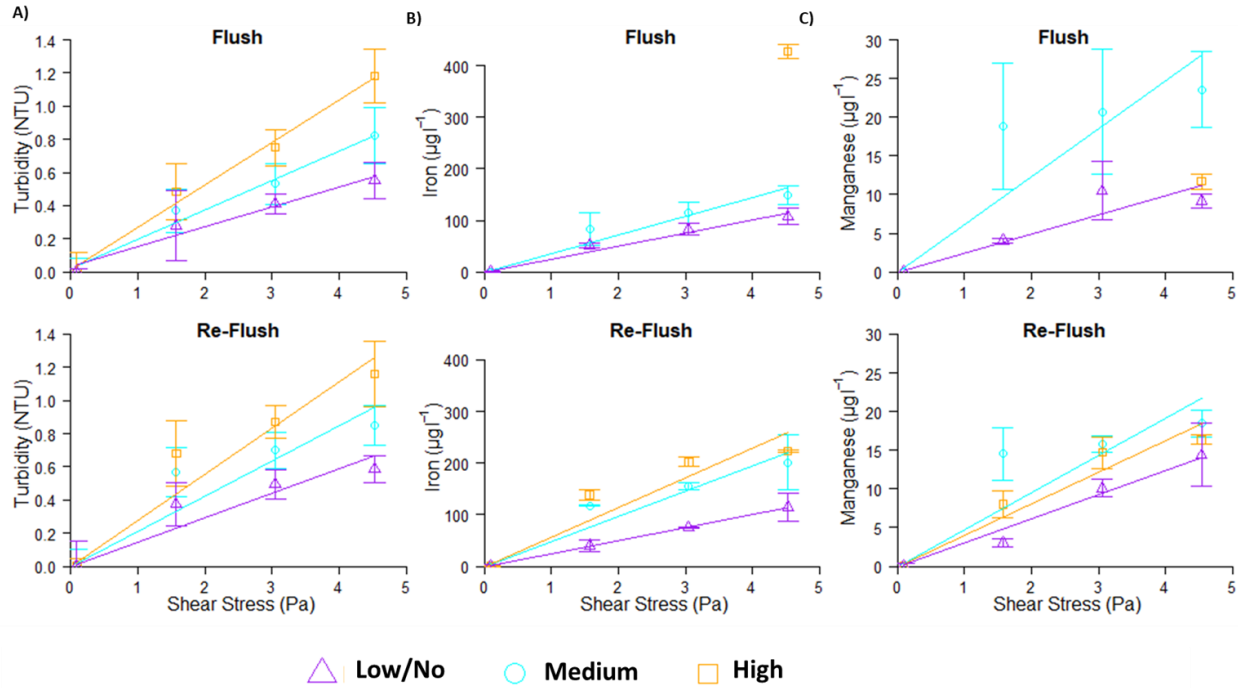
(Response, Intervention impact)



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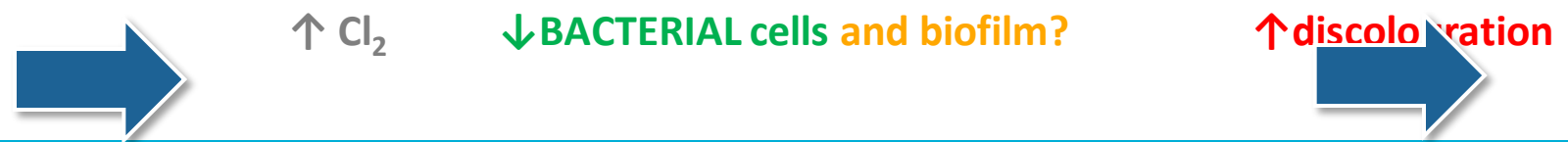


- High chlorine residual = Greatest discolouration ≠ greatest cell mobilisation
- **Selective pressure of chlorine, unique (and complex) impacts**
- Low/No chlorine didn't result in greater WQ degradation

Common perception:



OUR DATA:



- ❖ Holistic, representative biofilm analysis – essential to further understanding interactions
- ❖ We have the ability to test these elements at all scales – essential to develop alternative solutions (monitoring, managing, predicting)
- ❖ Plus collaborative networks to aid in implementing knowledge / innovative solutions

