Ozofractionation of wastewater –

Reducing biological and chemical contaminants including PFAS

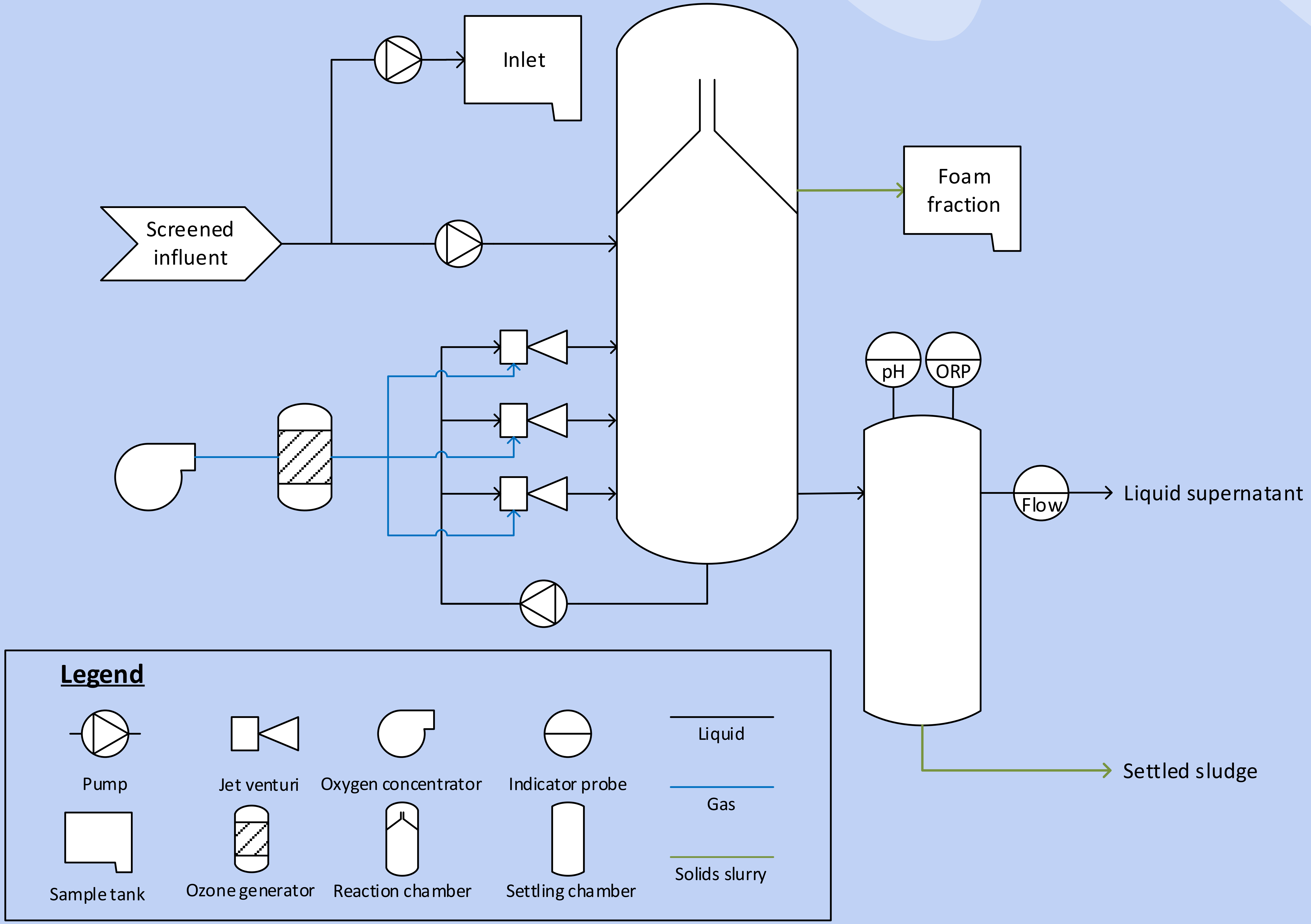
Water. It's Tasmania's thing.

Background

- Ozofractionation – PFAS remediation and acid mine drainage treatment
- Opportunity in municipal wastewater treatment:
    - Concentrate organic load to digestion
    - Reduce load on downstream secondary treatment
    - Conversion from stable to readily biodegradable organic matter
- Strategic targets:
    - Zero nutrients discharged to waterways
    - Increase energy recovery
    - Decrease carbon footprint

Process overview

- Ozone micro-bubbles and foam fractionation
- Ozone-enhanced bubbles:
    - Smaller bubble formation
    - Enhanced attraction of cationic contaminants
    - Direct chemical oxidation
- Contaminants (e.g., PFAS) concentrated to foam fraction
- Venturis for bubble formation and liquid-gas mixing



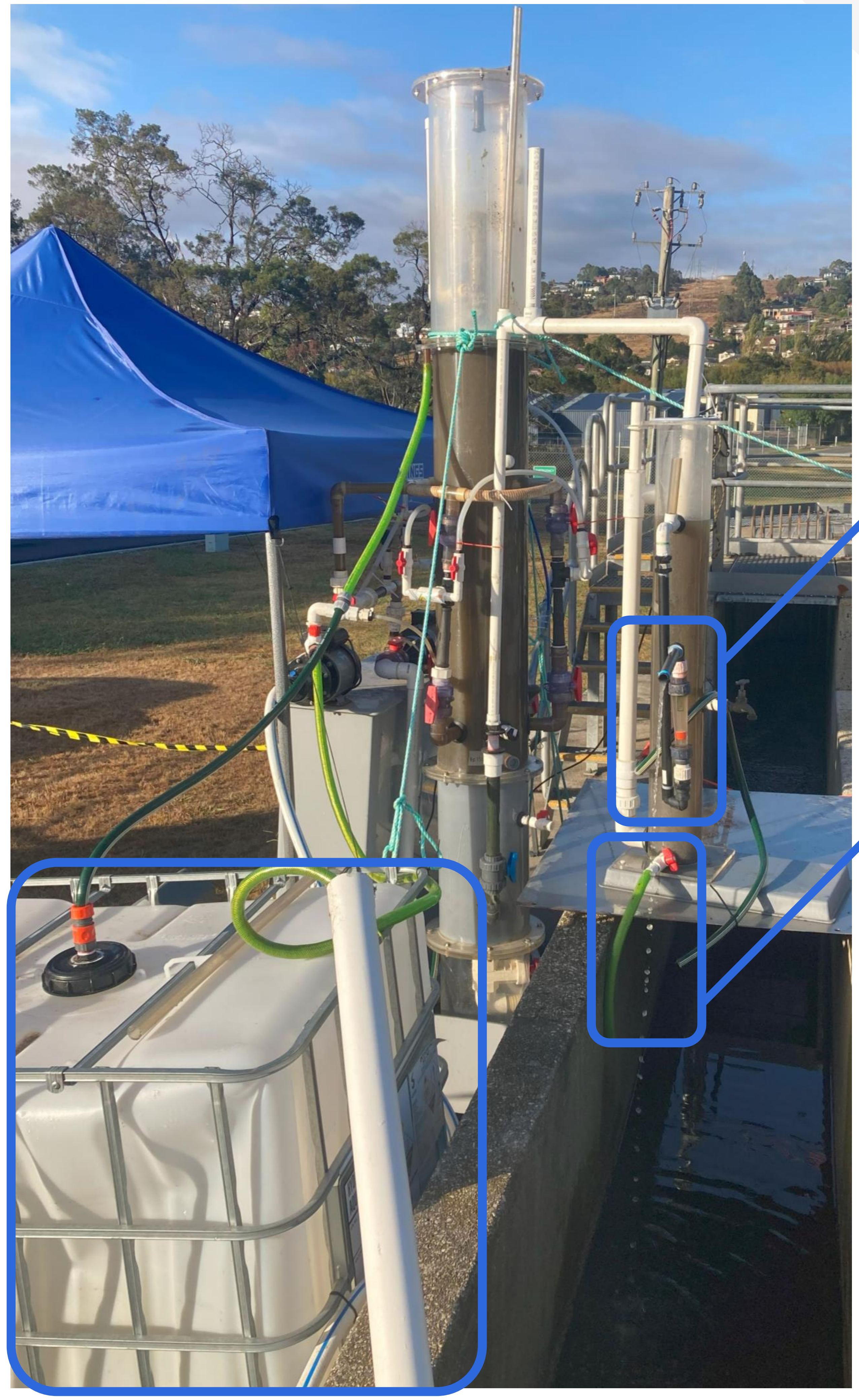
Trial overview

Trial Staging

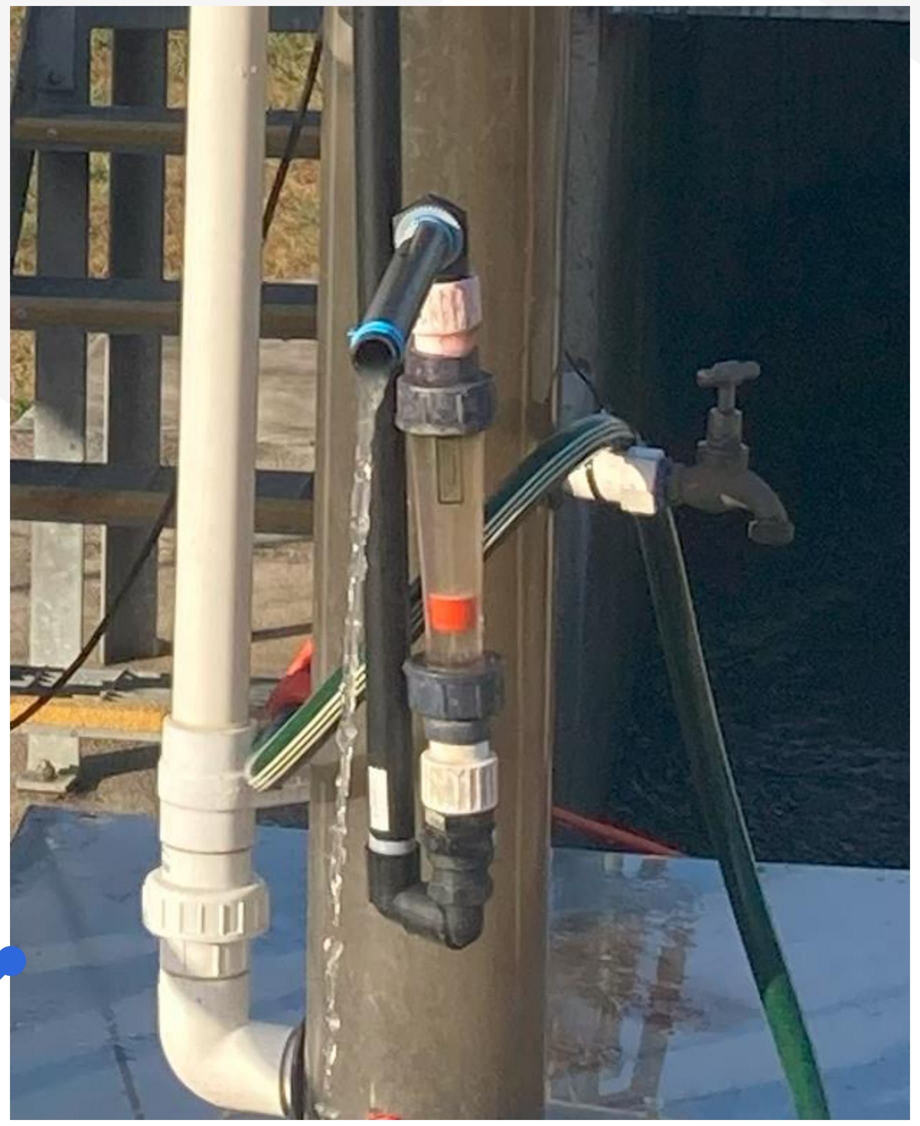
- Phase 1 (2020): Proof of concept
- Phase 2 (2023): Ozone dose study
- Phase 3 (2024): Hydraulic residence study

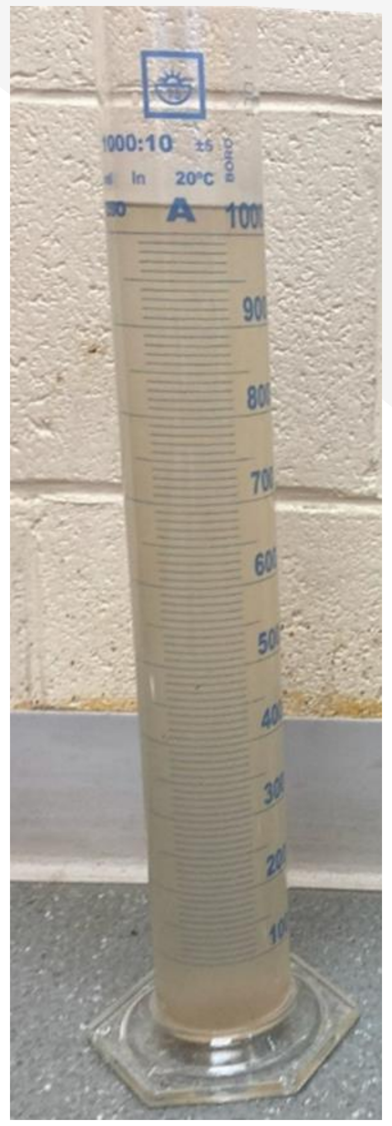
Analysis

- Sample analysis at NATA certified TasWater Selfs Point Laboratory or ALS
- Stream concentrations and mass balance
- Visual comparisons and observations
- Site testing for pH and ORP

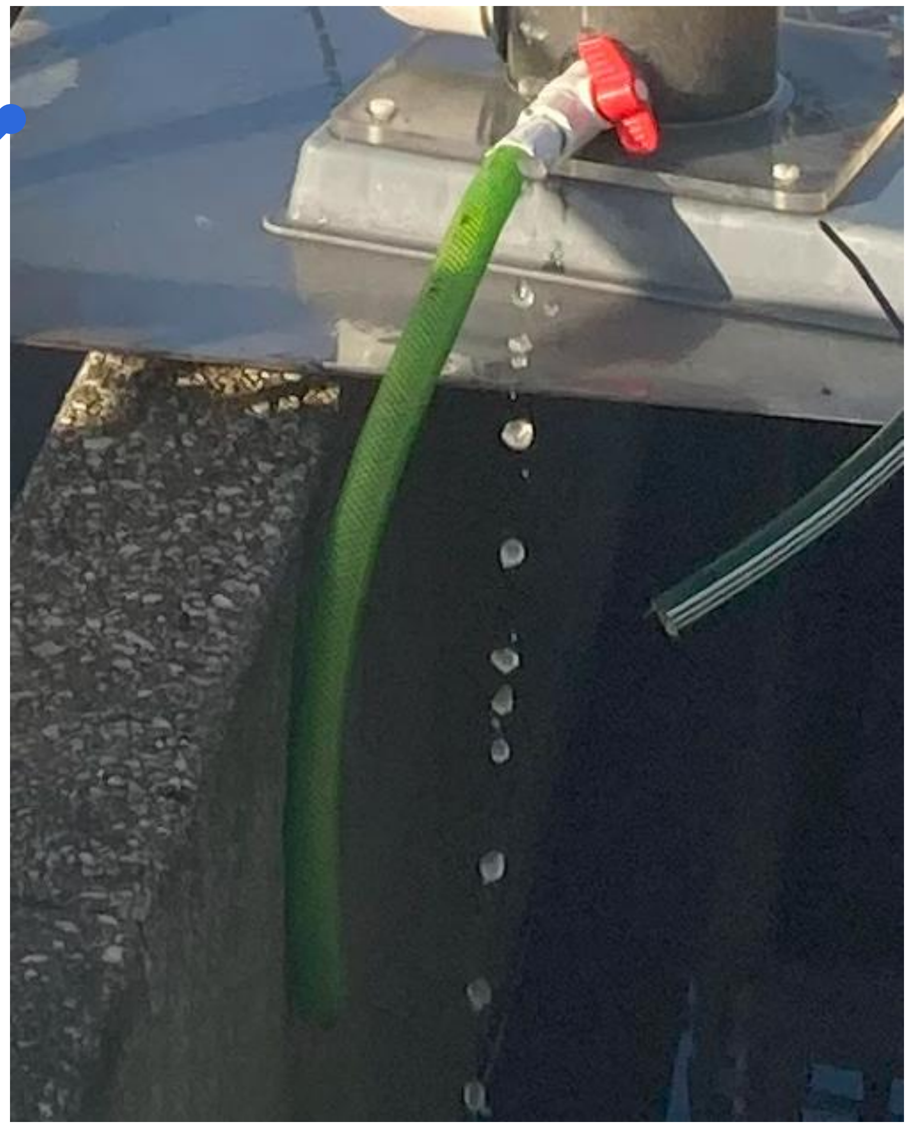


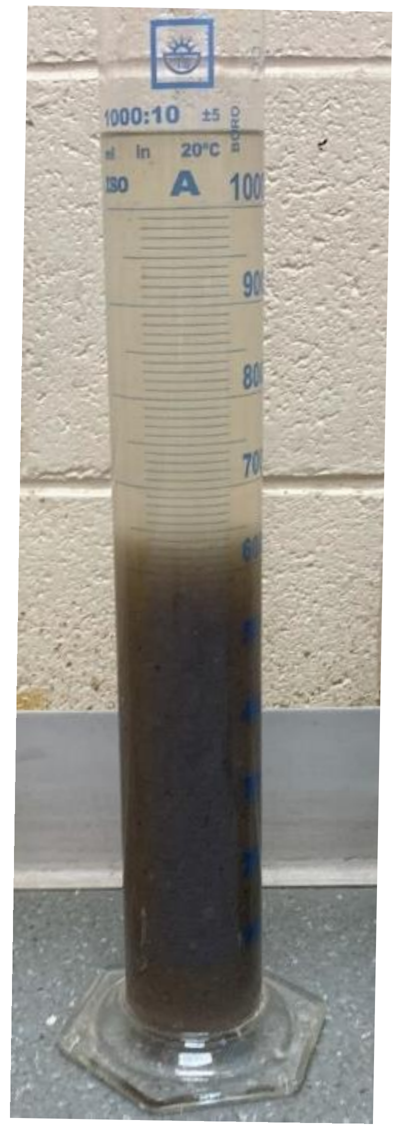
Foam fraction sample





Treated liquid sample





Settled sludge sample

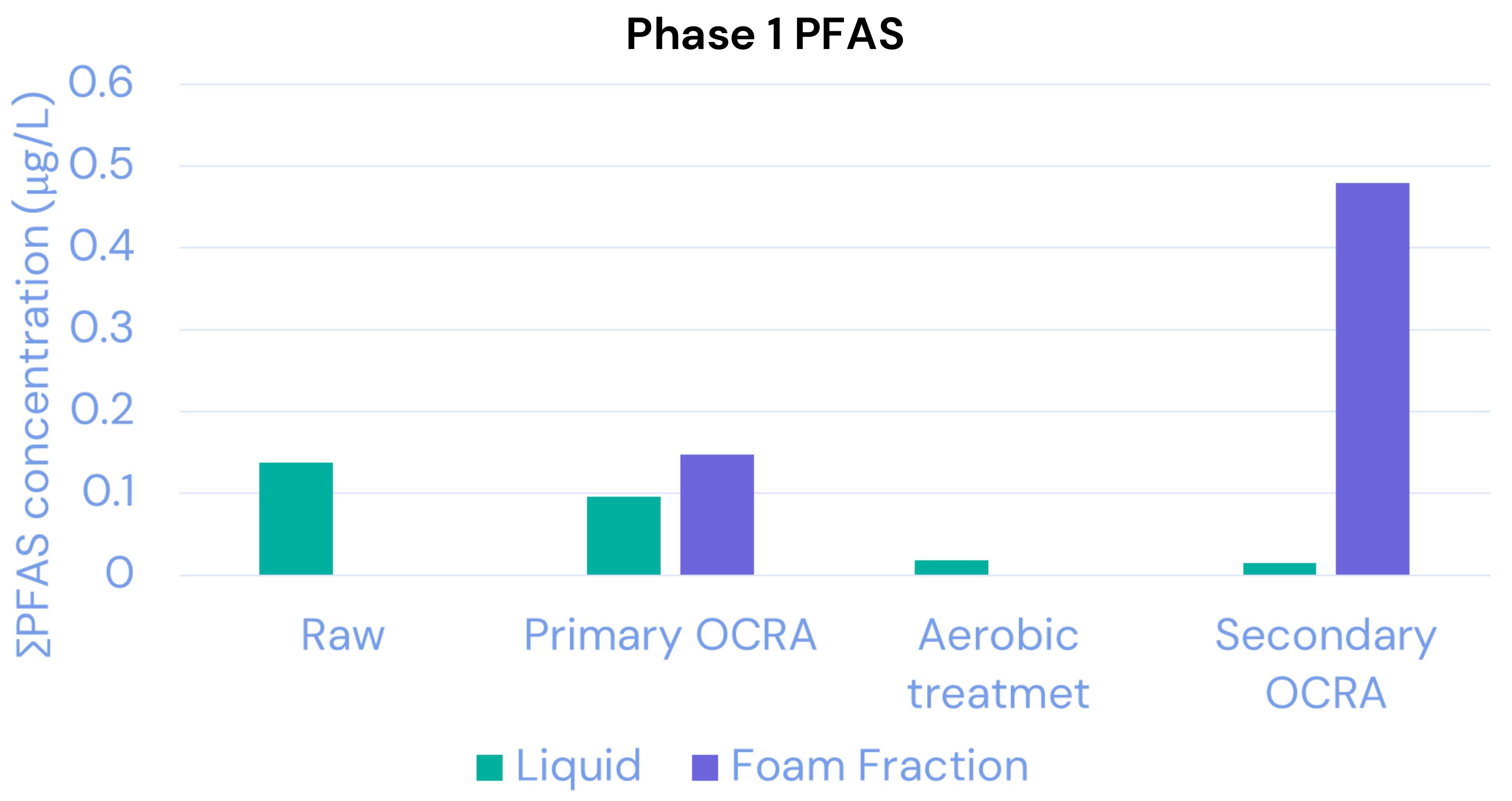
Phase 1 and 2 results

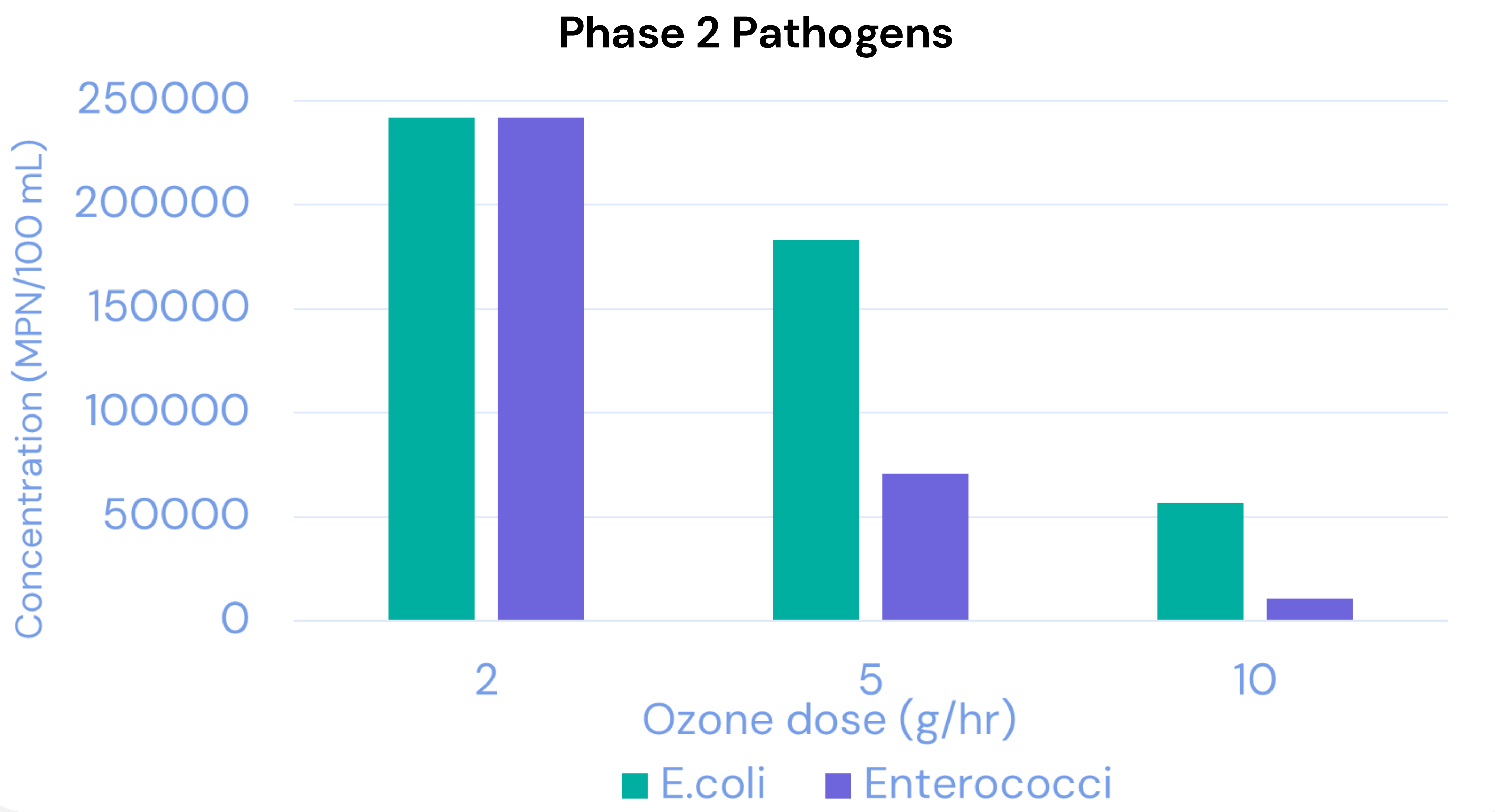
Performance:

- PFOA and PFOS & PFHxS reduced by >99.9%
- HRT 30 mins – ΣPFAS reduction 86%
- Unexpected reduction of pathogens (up to 2 log)

Learnings:

- At high doses ΣPFAS can initially increase – potential liberation from sewage sludge
- Requires further investigation around creation of short chain PFAS
- Low performance TSS (possible impact of algae)
- Observed improvement to settling rate





Phase 3 – BOD and COD

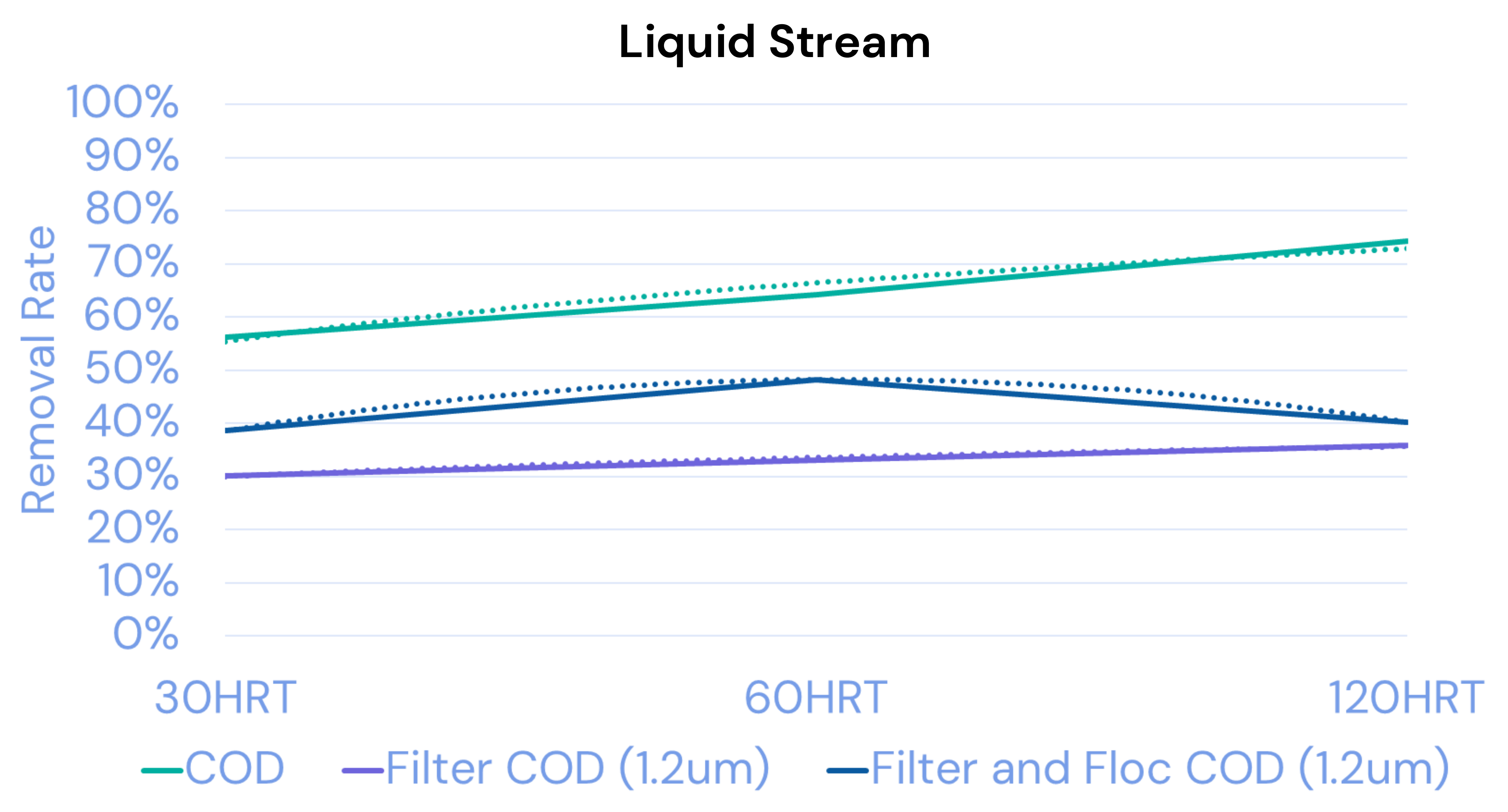
Liquid Stream:

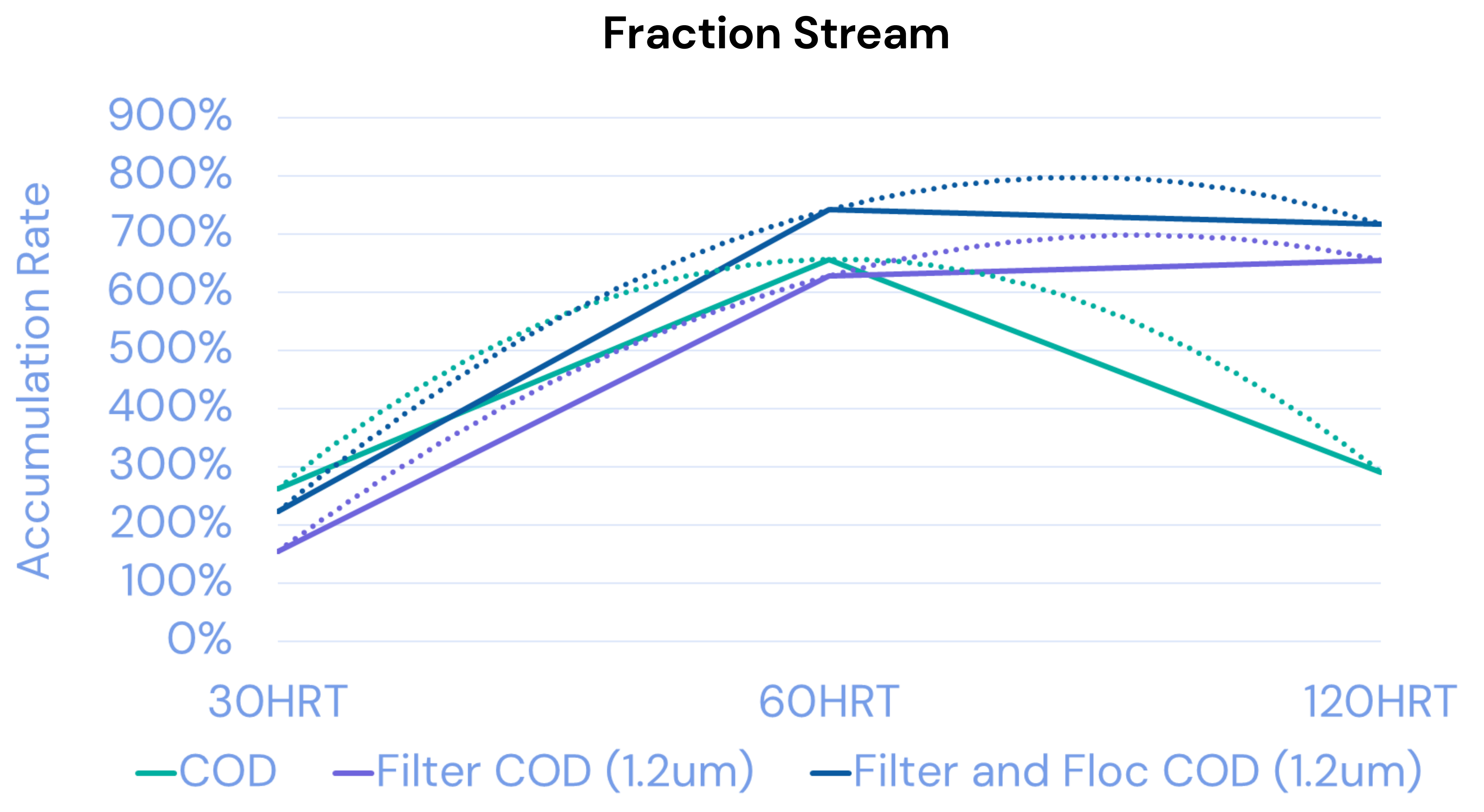
- Outperformed traditional PST (within <15% equivalent HRT) especially for dissolved particulate
- 14% additional reduction downstream COD load = aeration power savings (0.44 kW/kg COD)
- Potential to improve nitrification (lower aerobic loading)

Solids Stream:

- Accumulation in foam fraction and settled sludge
- Balance between maximizing separation while avoiding direct oxidation = 60 min HRT

Parameter	Riverside PST performance	30 HRT	60 HRT	120 HRT
COD	50%	56%	64%	74%
fCOD	10%	30%	33%	36%
ffCOD	-11%	39%	48%	40%
BOD	50%	59%	65%	80%
cBOD	48%	61%	65%	83%
fBOD	-2%	47%	63%	57%





Phase 3 – Solids

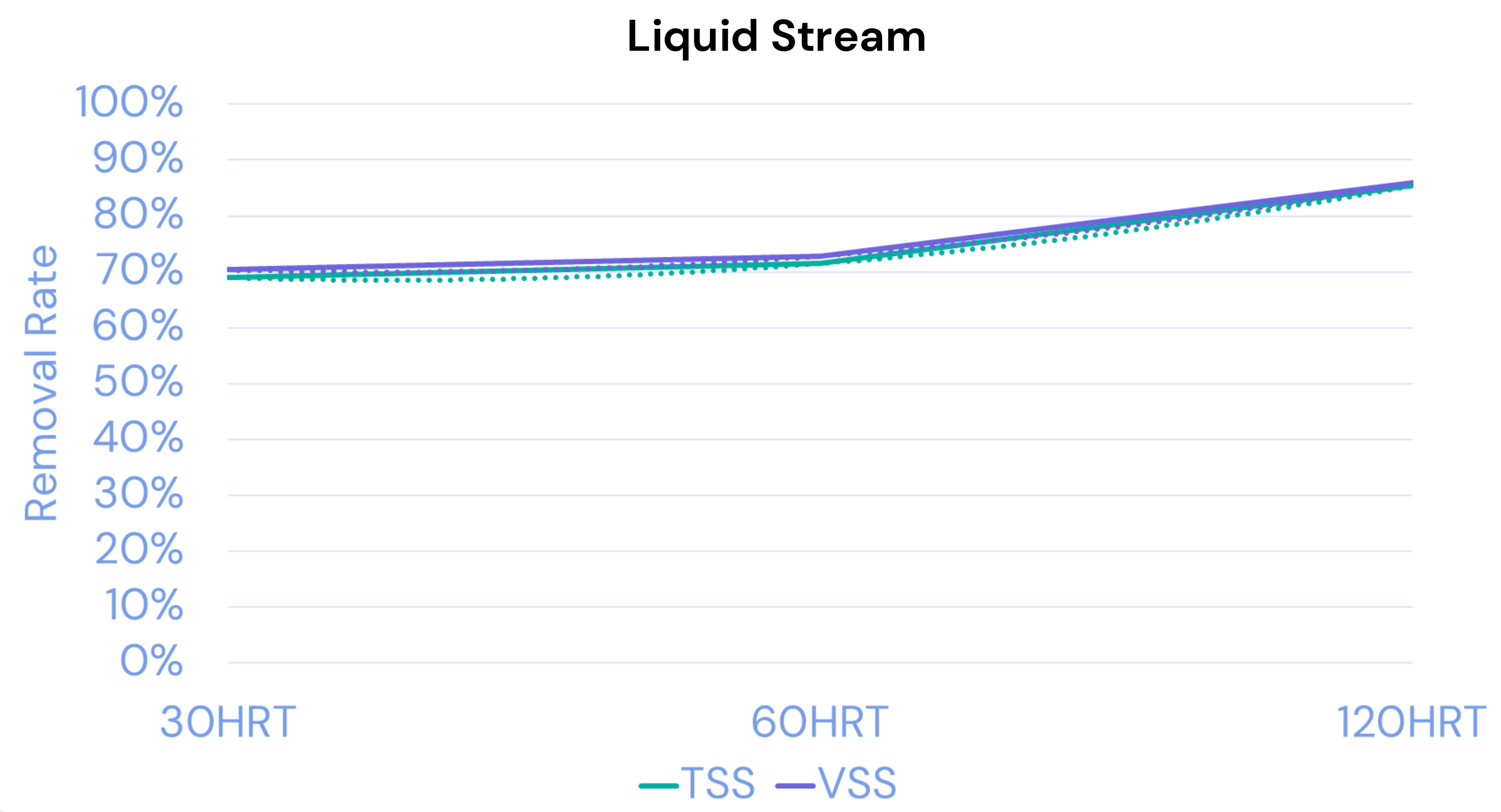
Liquid Stream:

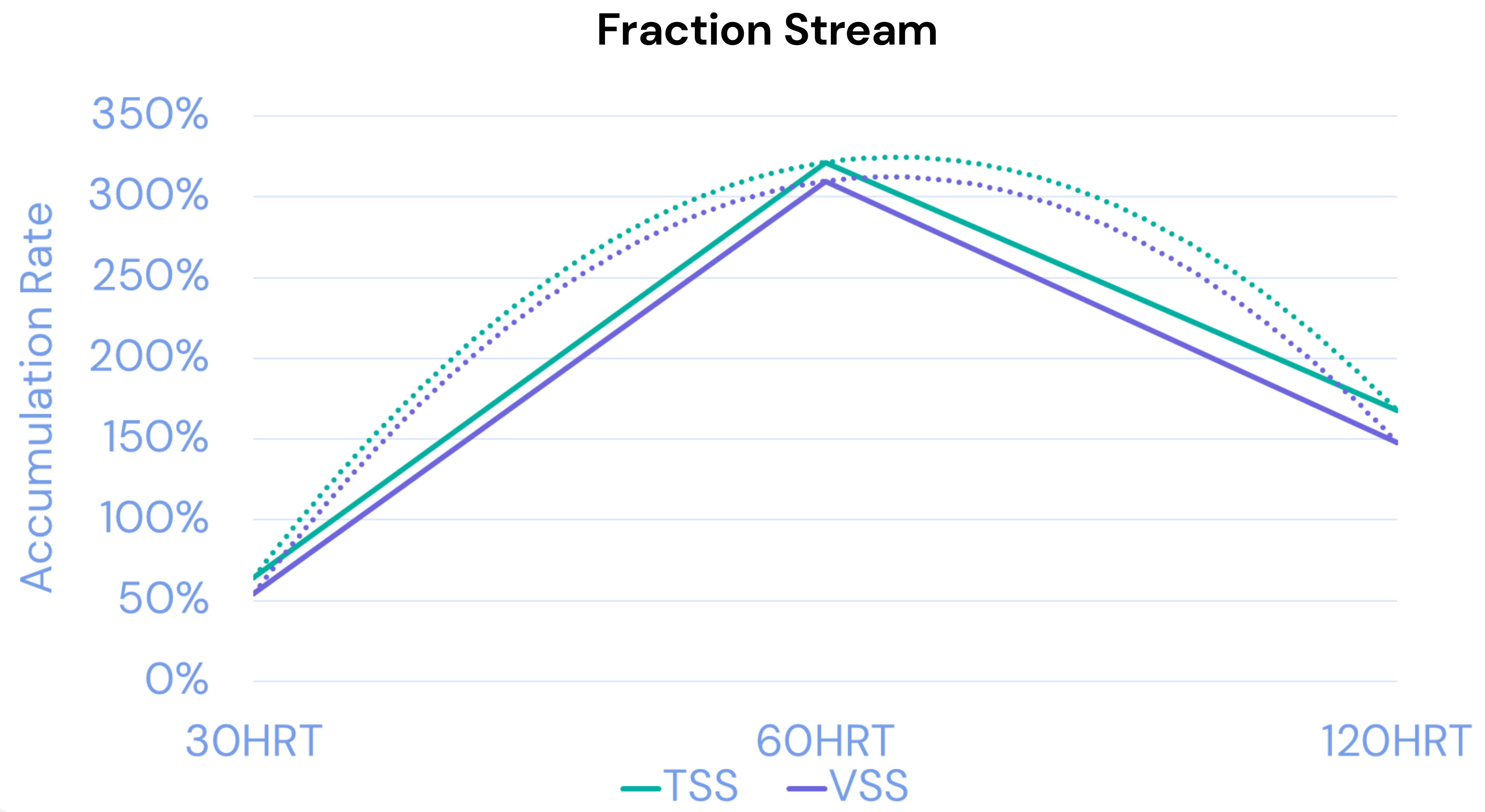
- Outperformed traditional PST at >60 min HRT
- Improve downstream aeration performance/ decrease trickling filter fouling
- 5 minutes settling = 50% higher removal of TSS

Solids Stream:

- Low HRT = improve settling and floc formation ('generation' of TSS)
- High HRT = degradation/ oxidation of suspended particles ('removal' of TSS)
- Elevated VSS% (>90%) for improved digestibility

Parameter	Riverside PST performance	30 HRT	60 HRT	120 HRT
TSS	73%	69%	72%	85%
VSS	74%	70%	74%	86%





Phase 3 – Other

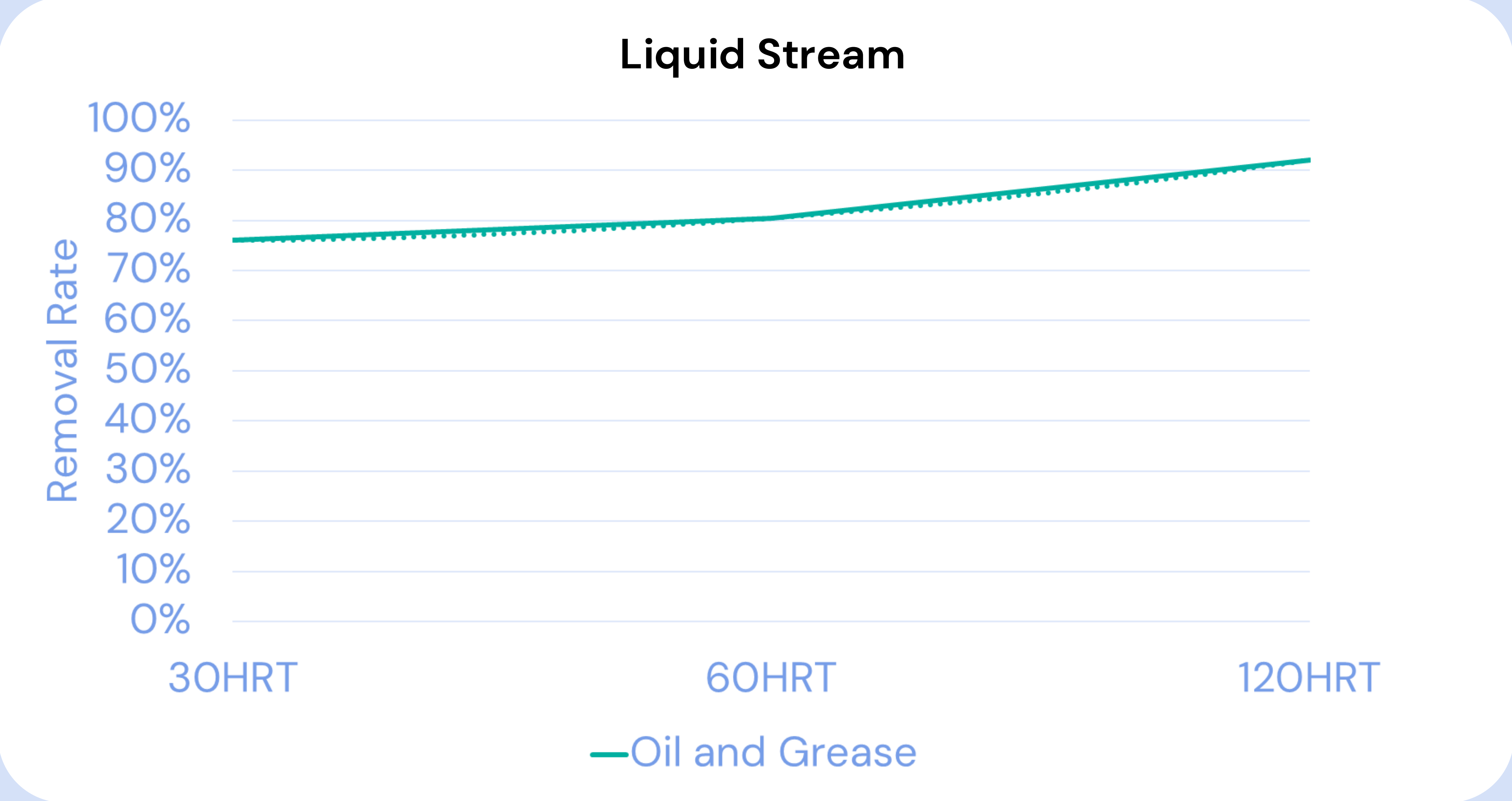
Nutrients:

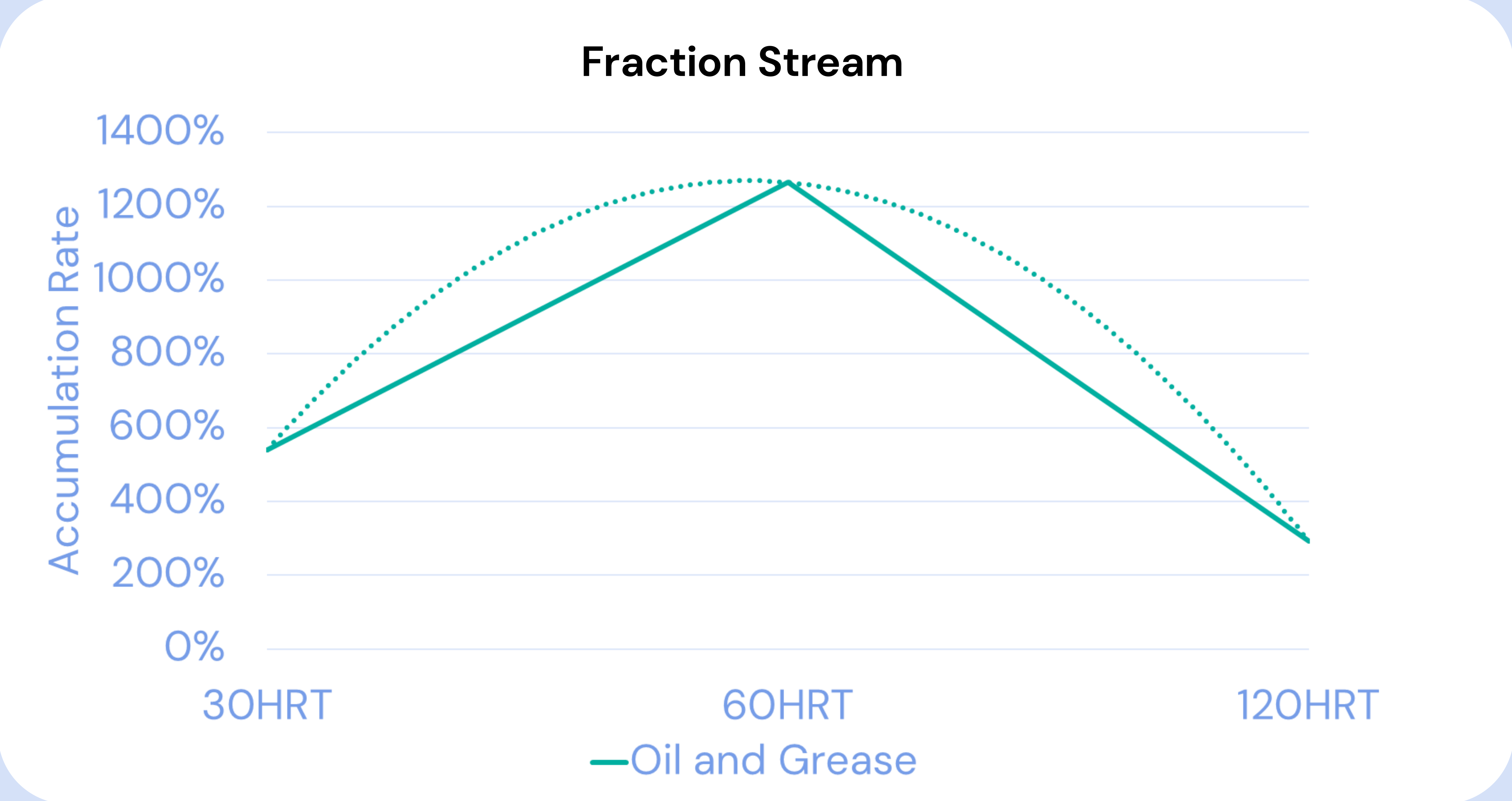
- Limited/ variable treatment (primarily through removal of solids)
- Decrease cBOD5:TKN ratio – impacts to downstream denitrification
- Opportunity for downstream natural systems approach

Oil and Grease:

- High performance consistent with Phase 2
- Peak at 60 HRT

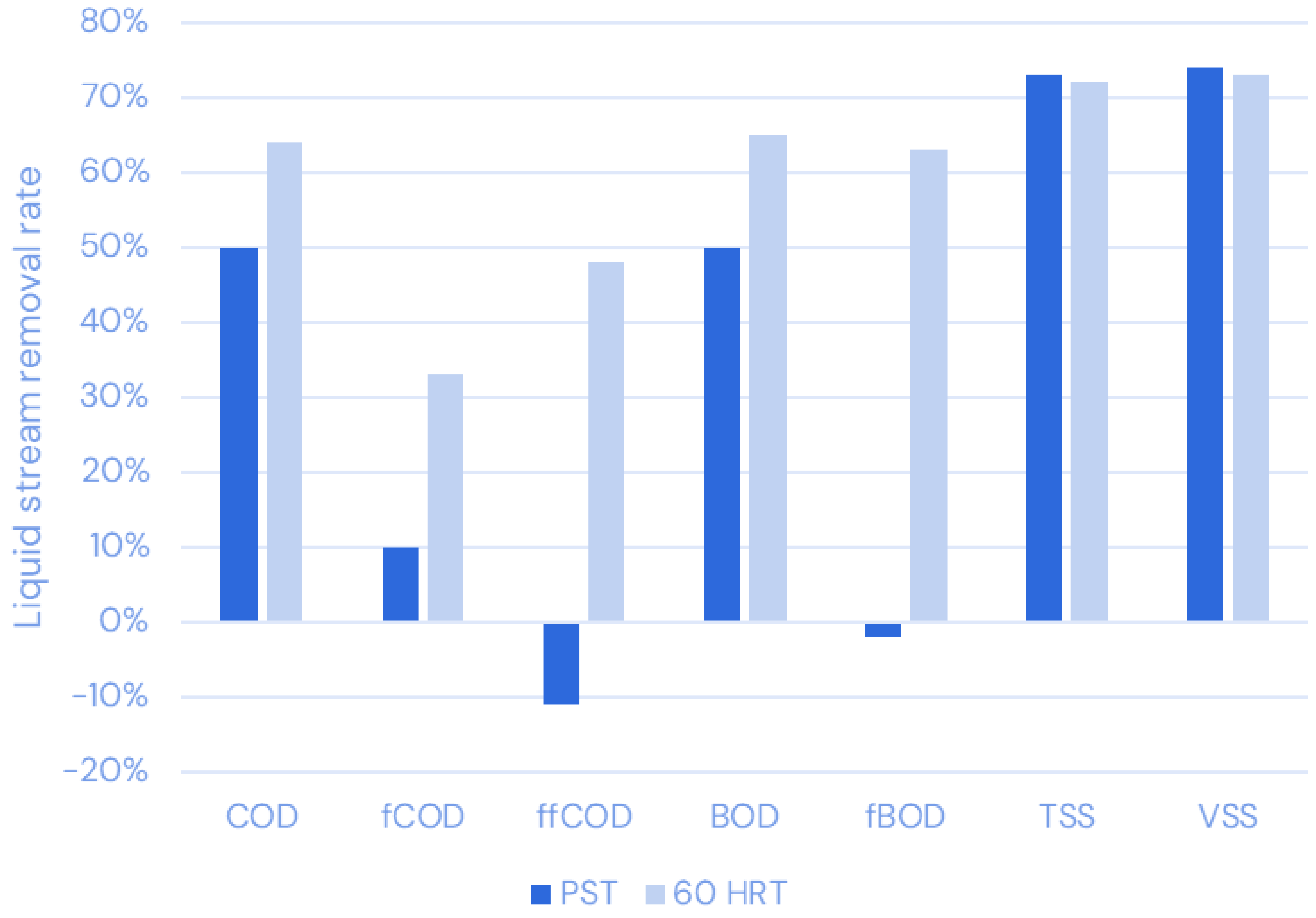
	Expected removal	30 HRT	60 HRT	120 HRT
O&G	20-40%	76%	80%	92%





Conclusion and next steps

- Optimal performance – 60 min @ 2 g/hr ozone dose
- Outperformed traditional sedimentation in 16% tank volume
- Improved partitioning of organics = estimated >40% increase to biogas
- Concentration of PFAS for further treatment



Further research

- Computational modelling and cost-benefit analysis
- Impacts to digester performance and biogas production
- Comprehensive onsite experimental program including details PFAS sampling