



HOW A LIVE DIGITAL TWIN OF HUNTER WATER'S SEWAGE NETWORK IS OPTIMISING HYDROGEN SULPHIDE MANAGEMENT

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Coauthored by Claire Williams, Dan Heise, and Ari Shammay

SEPTICITY 101

Why?

Hydrogen Sulphide (H_2S)

- Odourous
Rotten egg gas,
Odour Threshold 0.41 ppb
(Nagata, 2003)
- Toxic (ppm range)
- Corrosive (Sulphuric Acid)
- Naturally forms in
wastewater

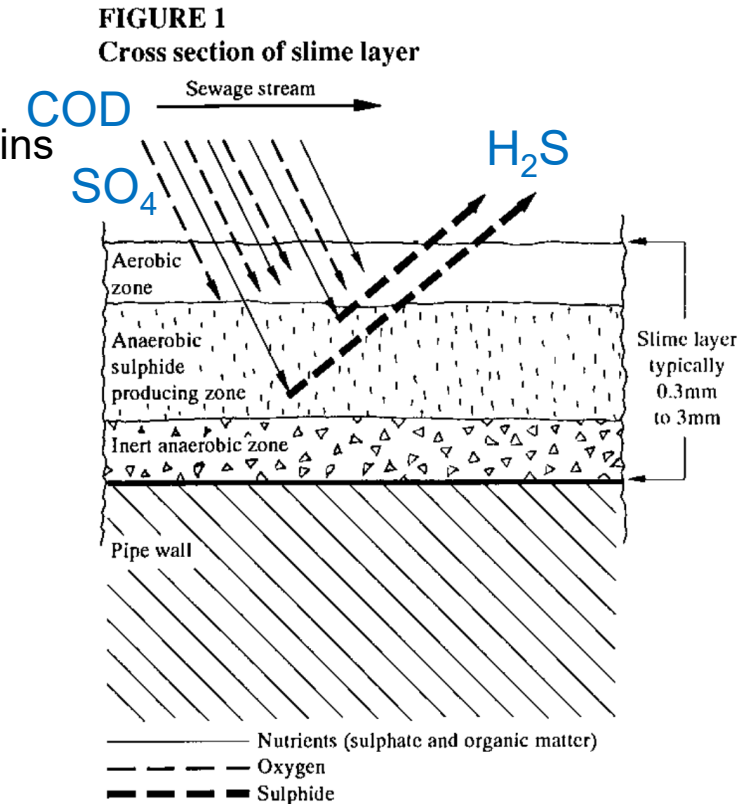
Stantec Photo, Wastewater
Treatment Facility



How?

Primarily in Wastewater Rising Mains
(pumped distribution pipelines)

- Organic material – Oxygen
Demand (COD)
- Sulphate (SO_4) – Detergents,
Source Water
- Pipe Surfaces (for Slime)
- Warm Temperatures
- Time



*The Problem of Hydrogen Sulphide
in Sewers, Pomeroy, 1992*



(but not this location)



DOSING FERROUS CHLORIDE (IRON SALTS)

Ferrous (or Ferric) chemically binds dissolved sulphide

- Dosing is recommended between 2.6 – 6.0 mgFe/mgS
- Typically, a constant mass or concentration (flow-paced)
- Excess dosing can acidify wastewater

Target Ferrous $\text{Fe}^{2+} + \text{HS}^- \rightarrow \text{FeS} + \text{H}^+$

Excess Ferrous $\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$



Black Wastewater (Ferrous)

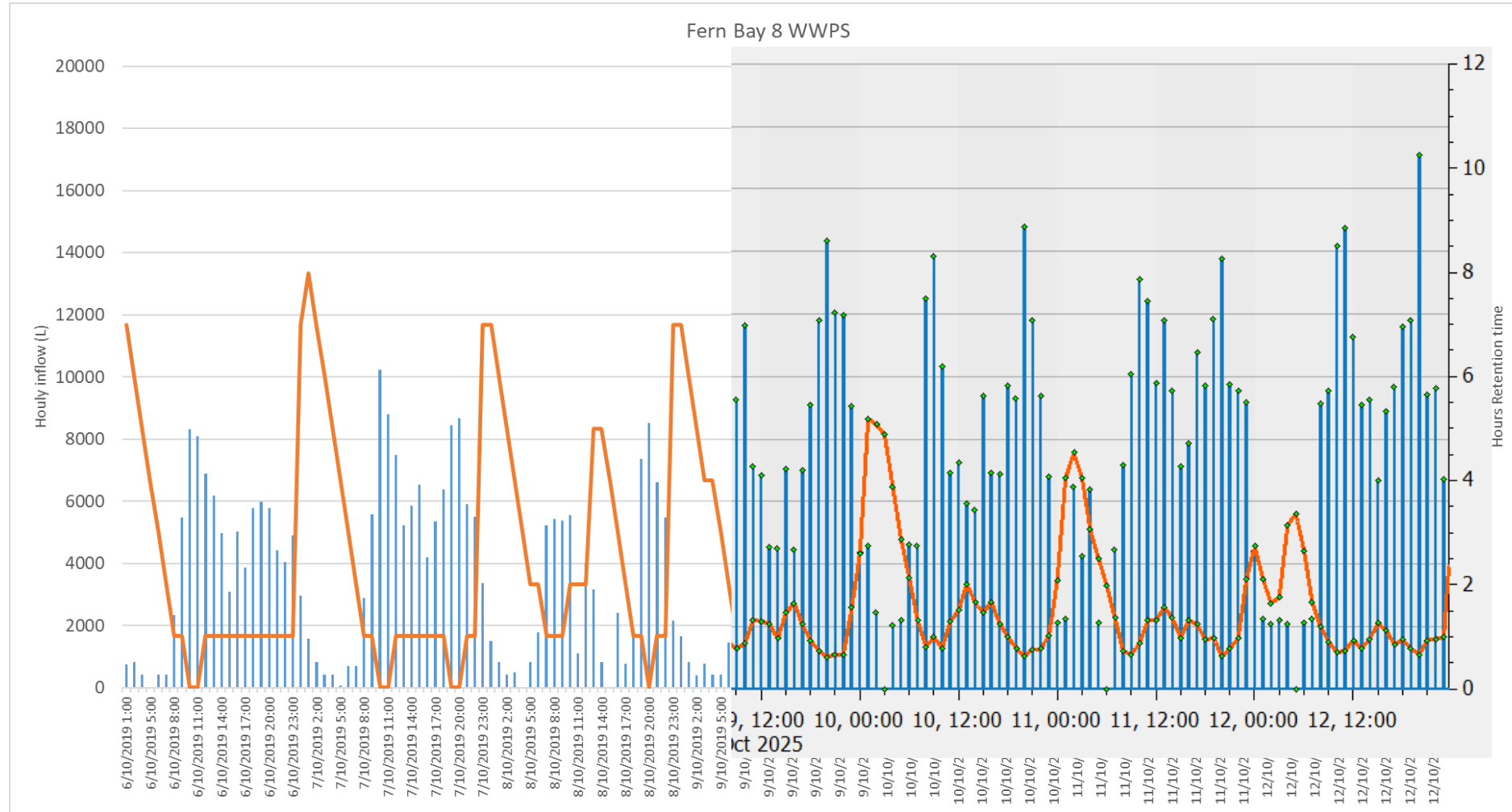
WHY INCORPORATE A DIGITAL TWIN INTO A FERROUS DOSING SYSTEM



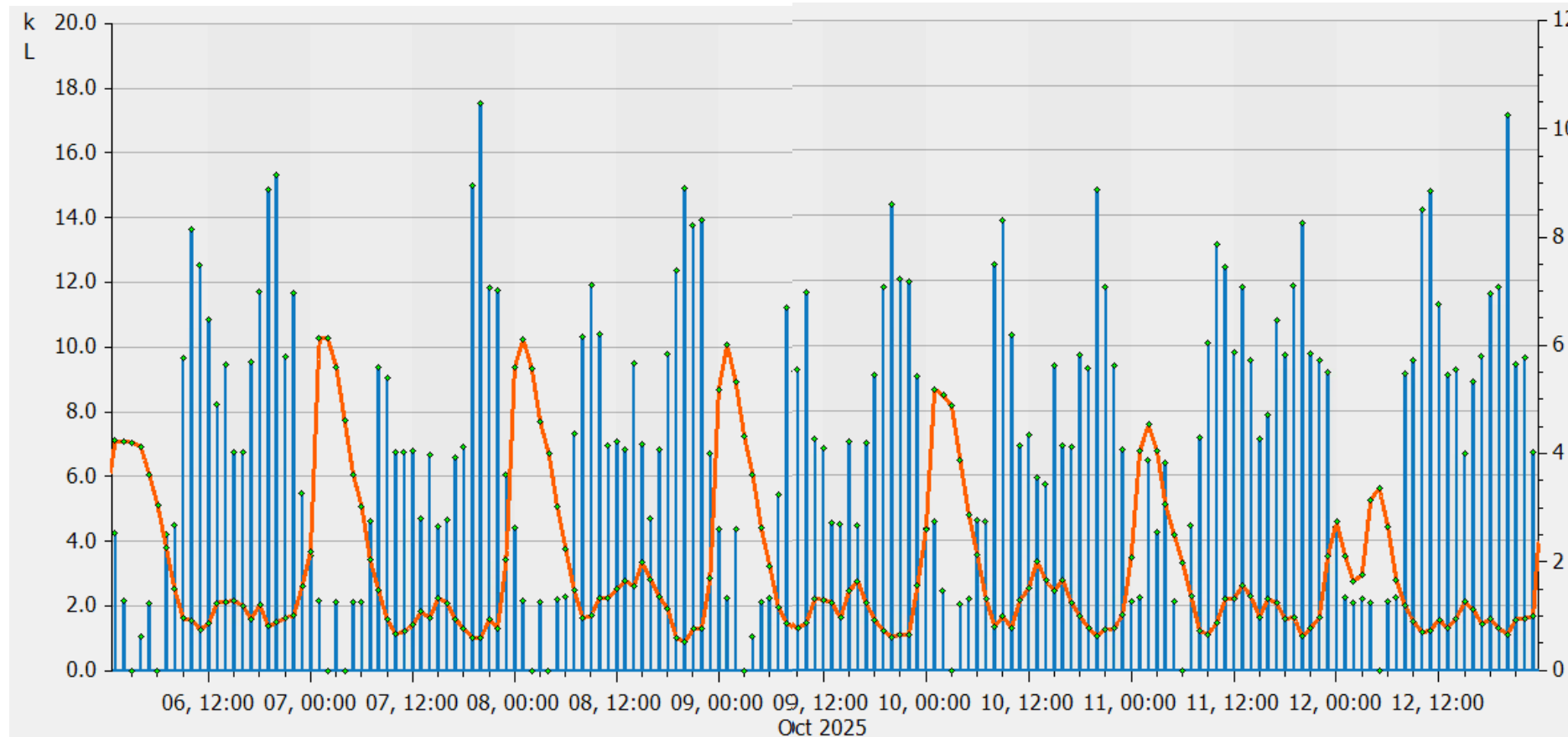
- In 2018 Hunter Water resolved to replace all of its Ferrous Dosing Units with a new standard CDU unit – a blank sheet
 - Concerns about potentially damaging assets in the well from accidental overdosing
 - Clare Williams and Chris Farragher take on the control scheme development
 - A desktop exercise recommended a Digital Twin approach



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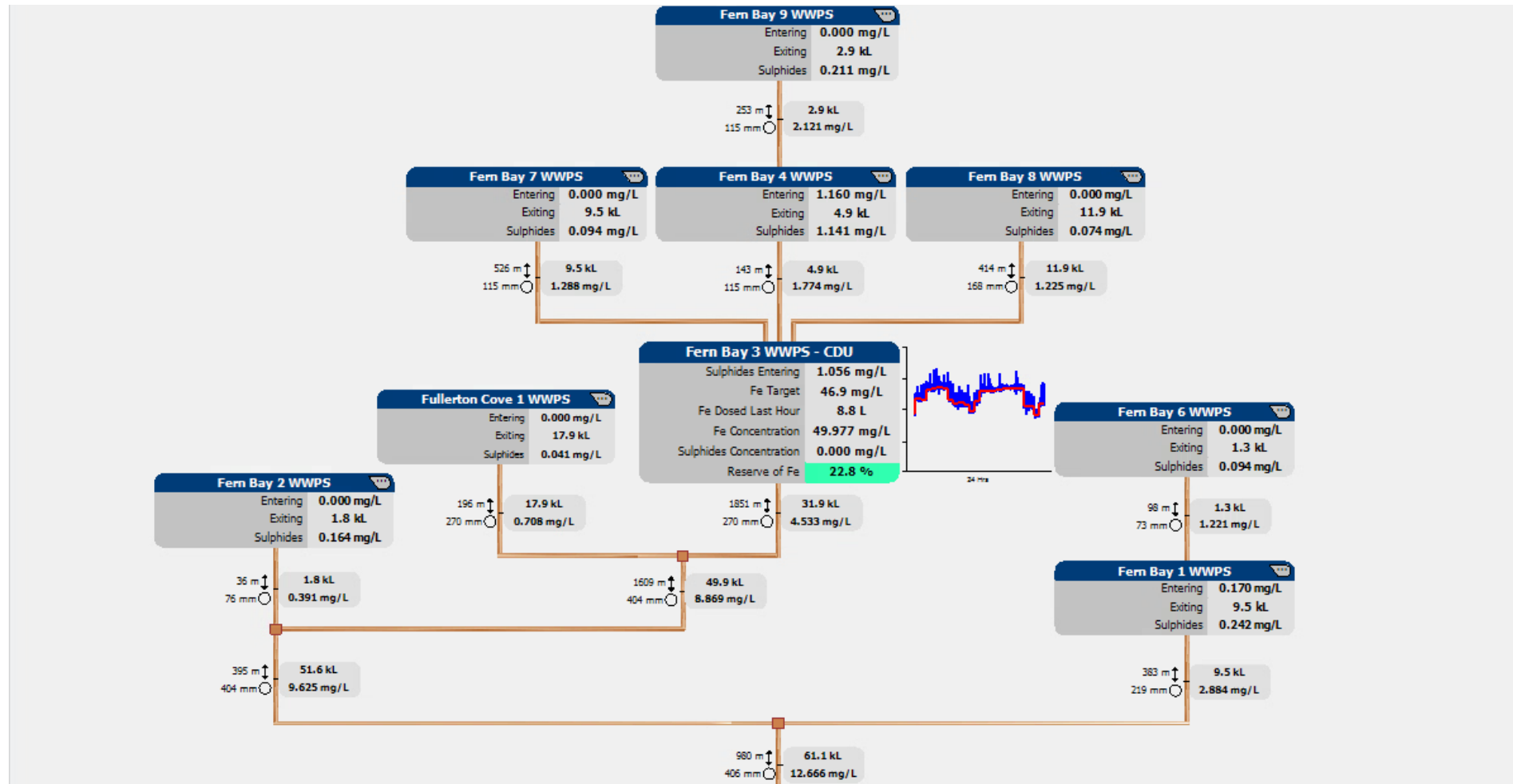


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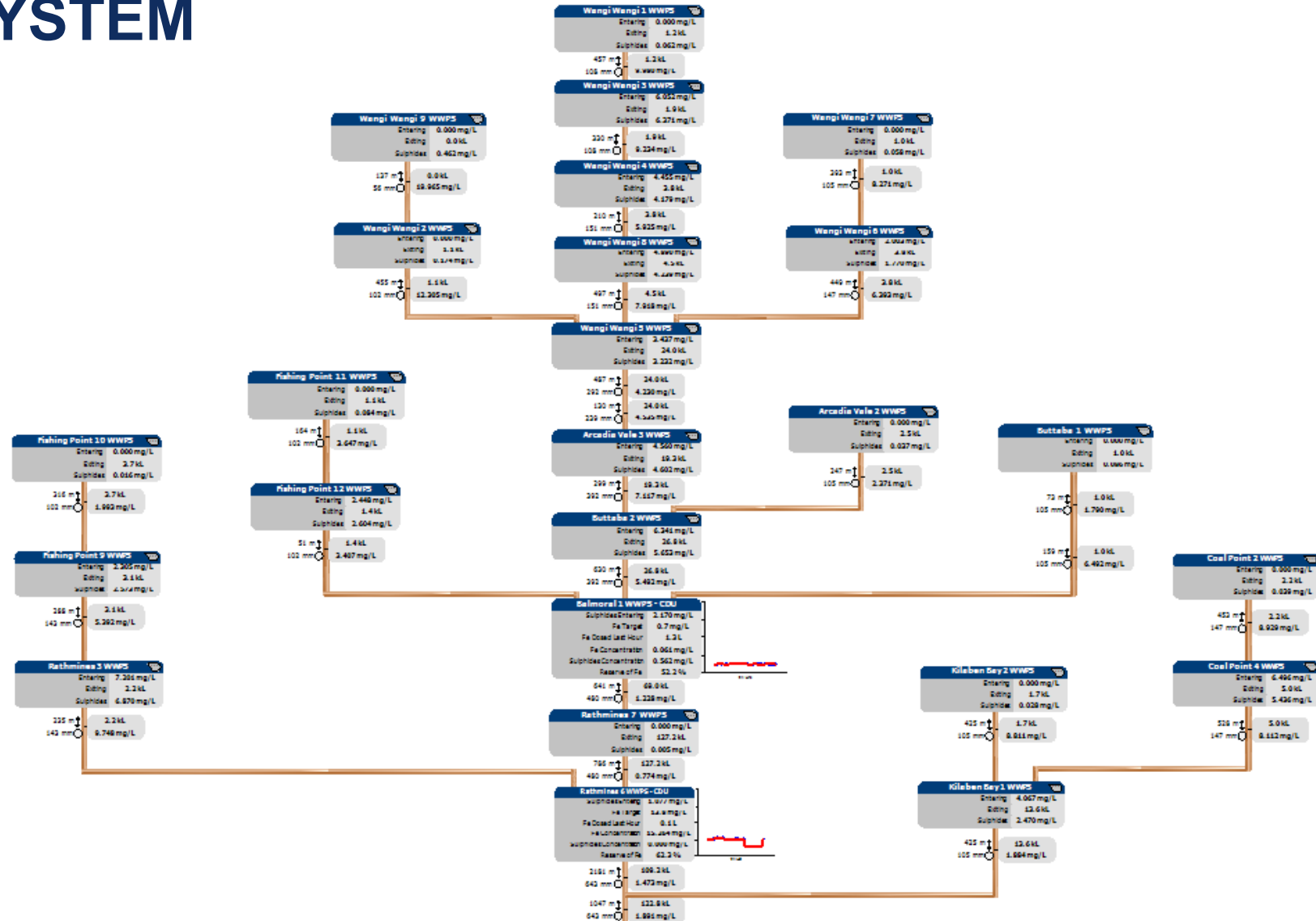
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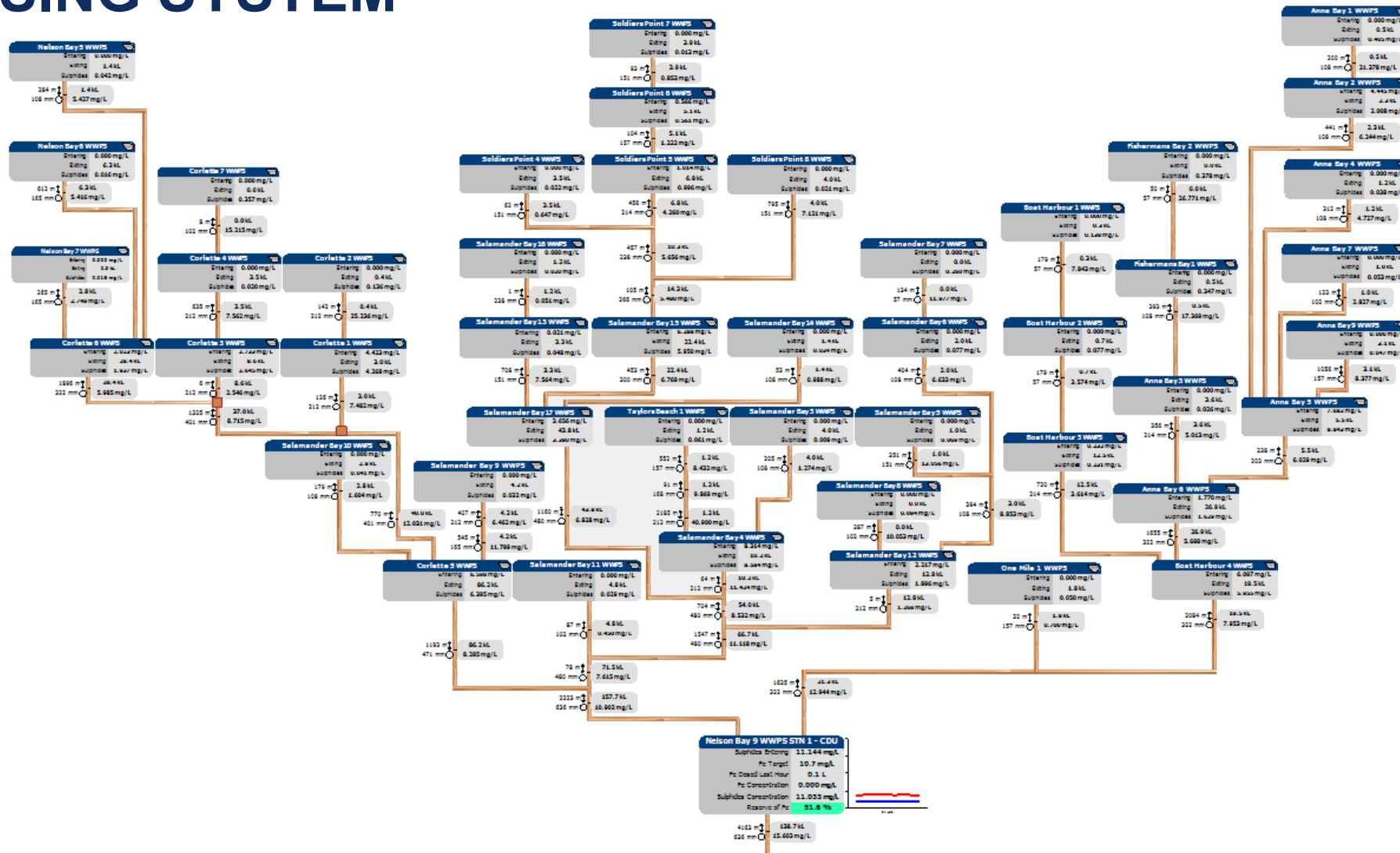
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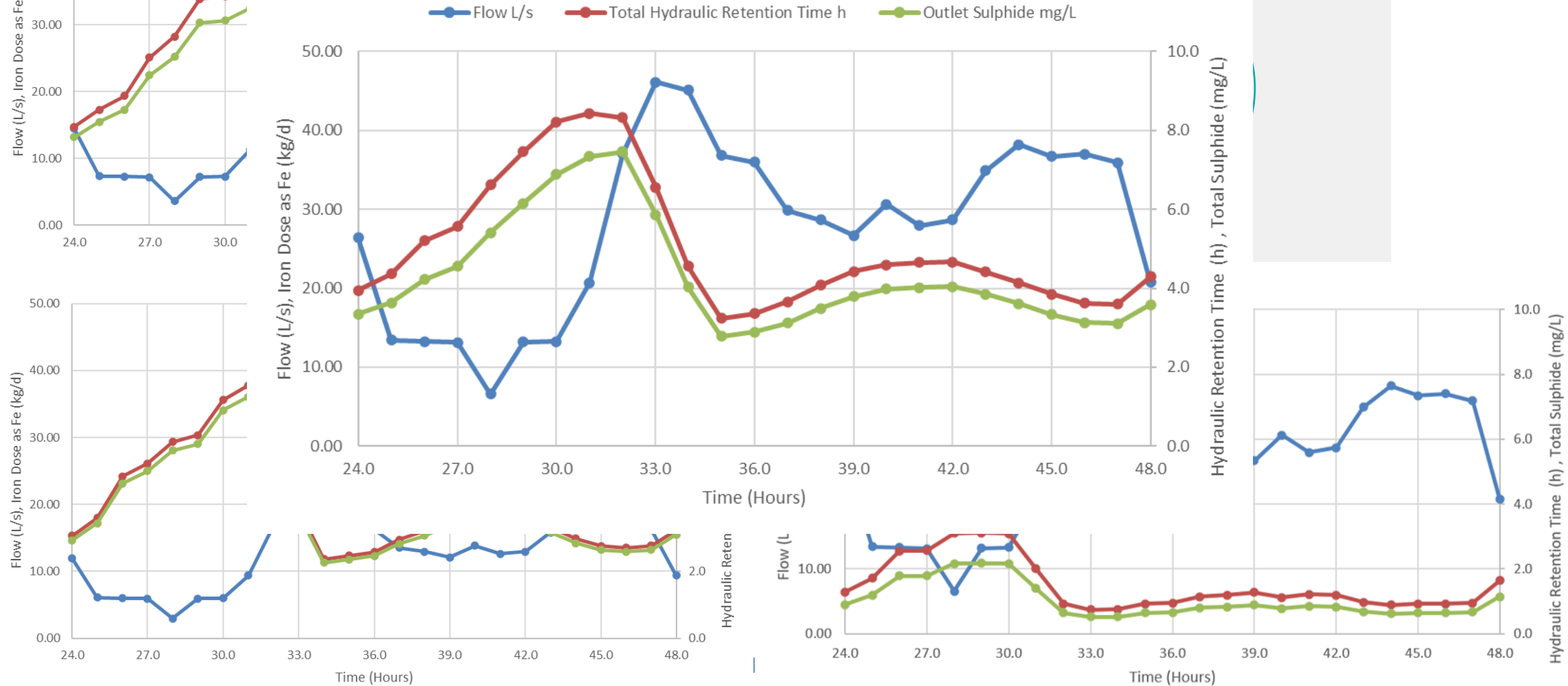
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Let's Build Warners Bay 1



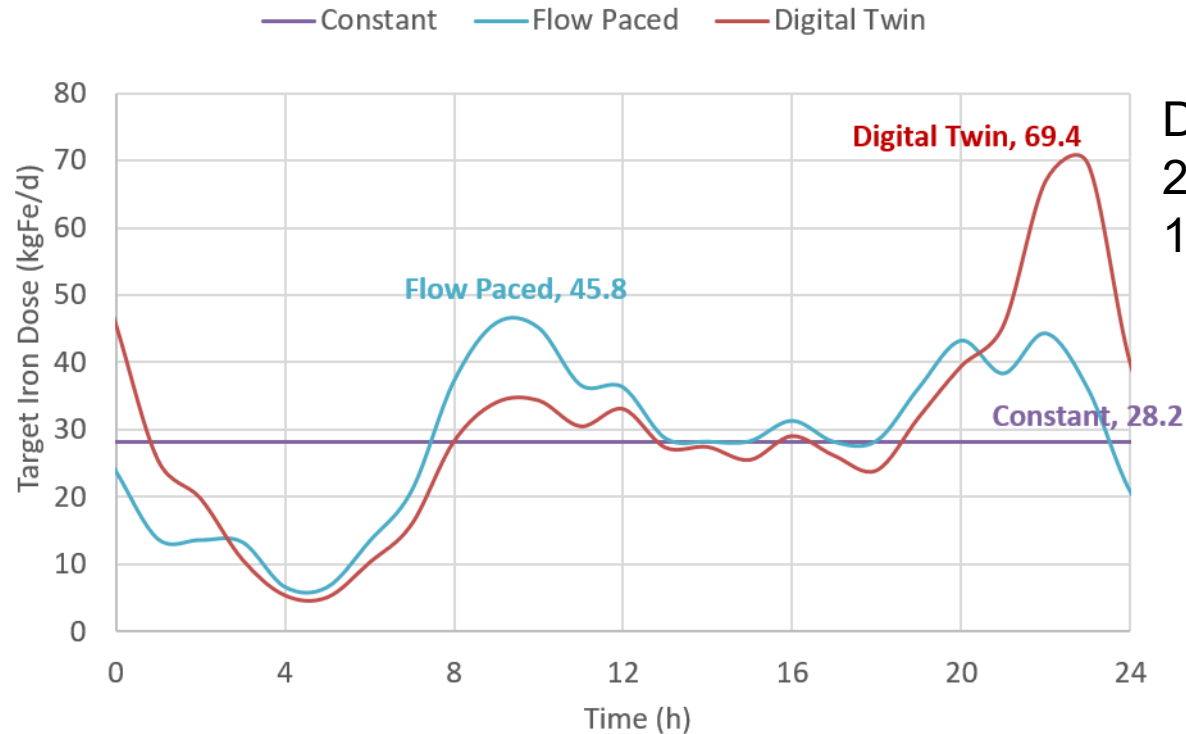
Warners Bay 1 WWPS - CDU

Sulphides Entering	0.000 mg/L
Fe Target	11.2 mg/L
Fe Dosed Last Hour	7.9 L
Fe Concentration	12.034 mg/L
Sulphides Concentration	0.000 mg/L
Reserve of Fe	73.8 %



Let's Compare

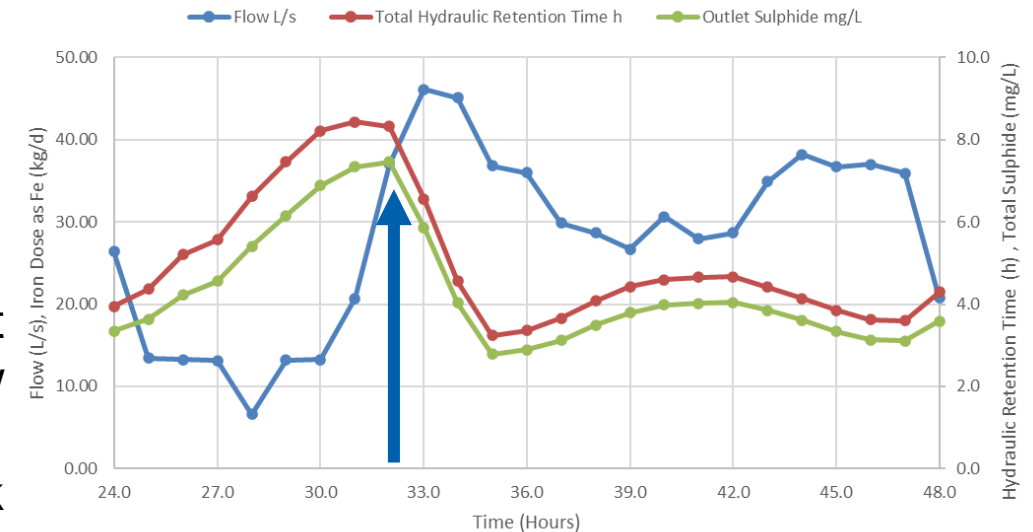
Dosing Methods applying calibrated average requirement of 28.2kgFe/day



Digital Twin applies a peak dose of ~70 kgFe/day
2.5x the average,
1.5x the flow paced peak

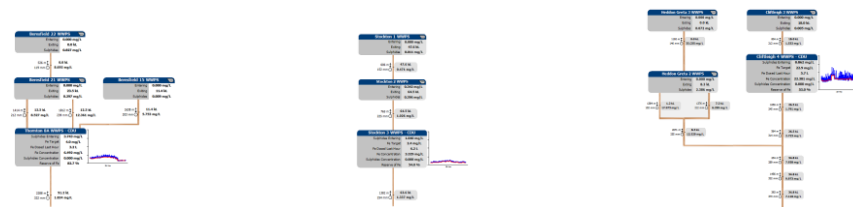
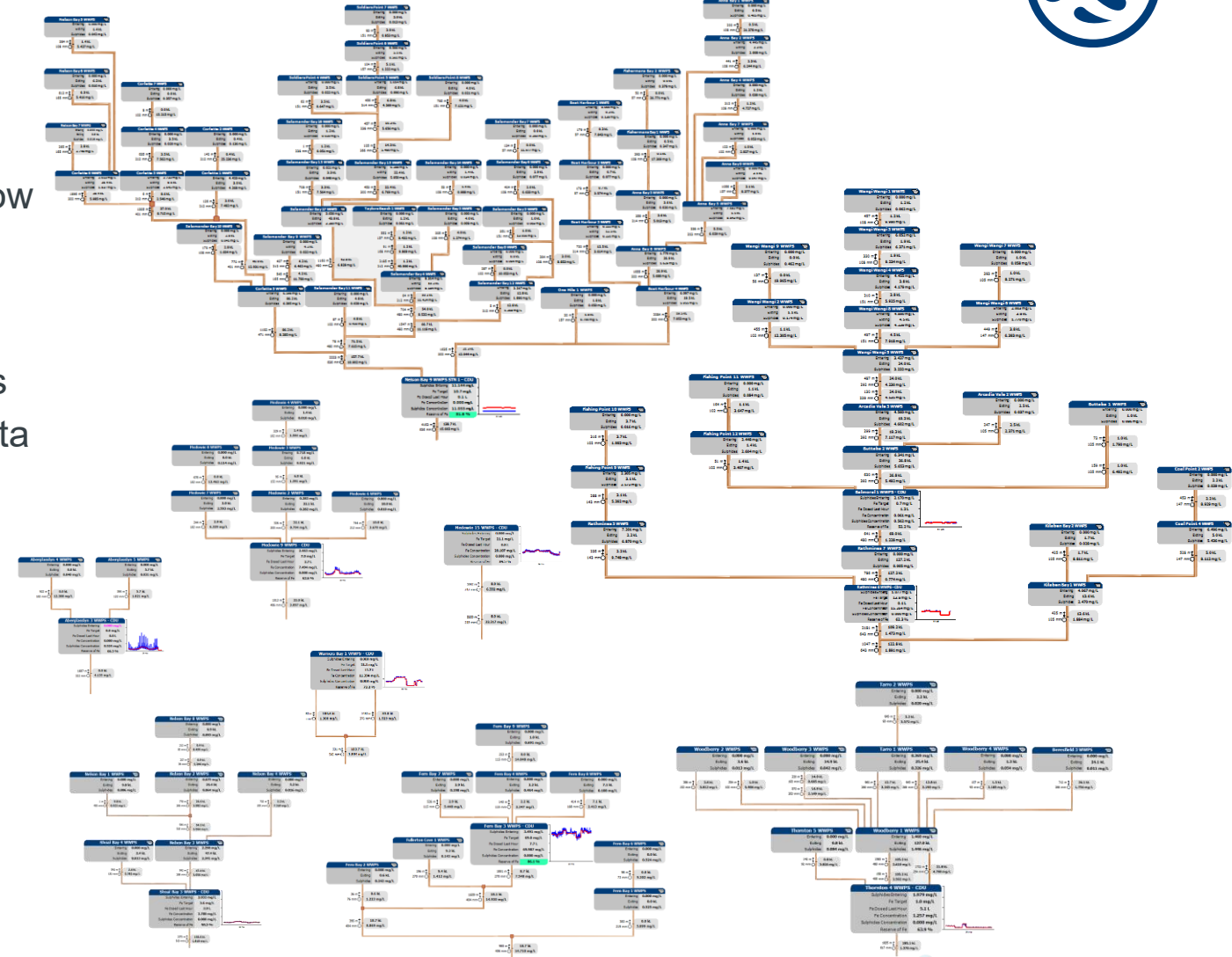
Previous figure: Peak sulphide concentration builds overnight
but is discharged during morning peak flow

Conventional control either overdoses or misses this peak
Simulations and other studies estimate 30-40% more efficient



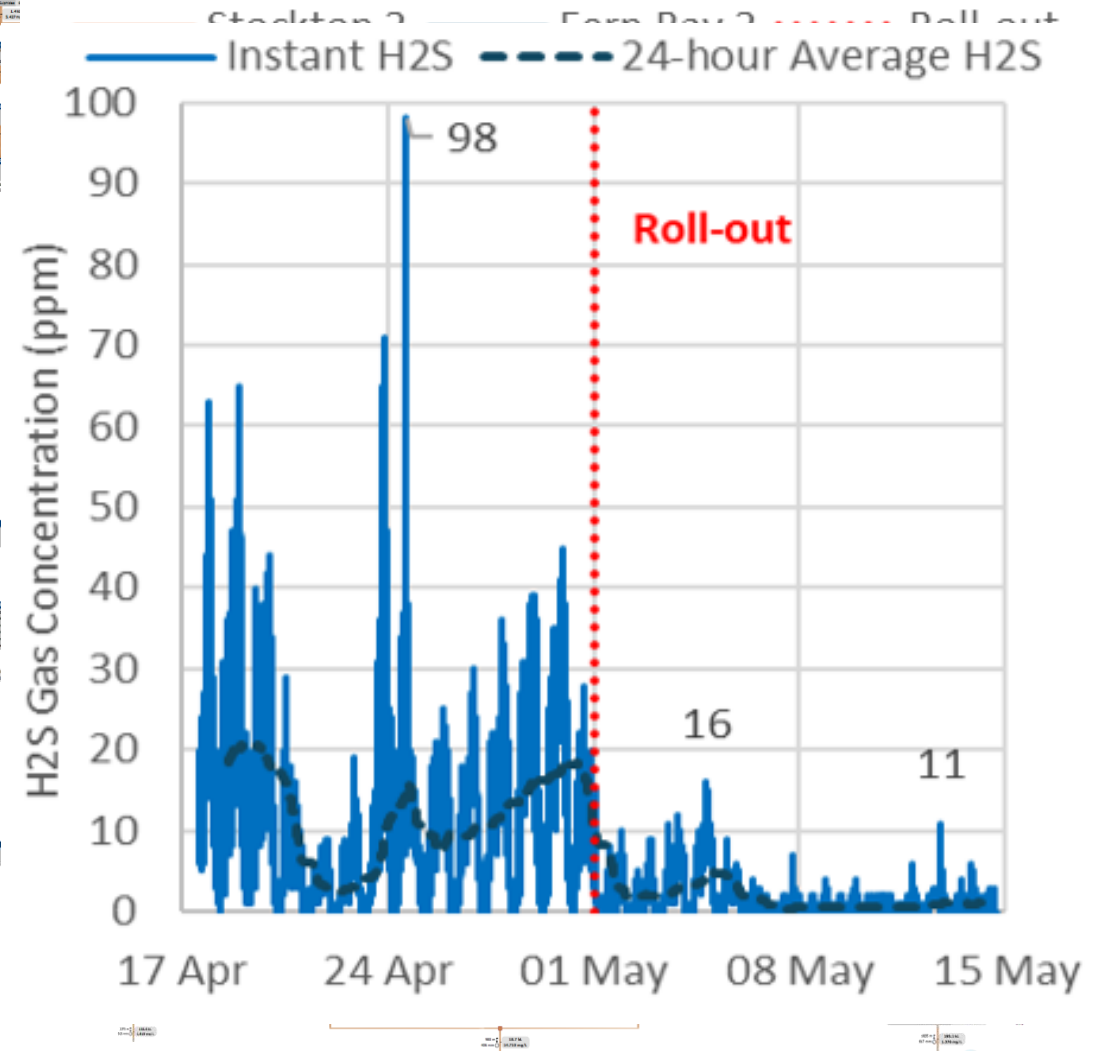
ACHIEVEMENTS OF THE DIGITAL TWIN BASED DOSING SCHEME

- Rolled out in mid 2024 two years after the original flow paced scheme
 - Currently modelling 131 WWPS and their rising mains
 - Controlling the dosing of 13 chemical dosing units
 - Opportunities for operator insights from the data
 - Less need to revisit and recalibrate



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 - Opportunities for operator insights from the data
 - Less need to revisit and recalibrate
 - 12.2% reduction in chemical use
 - \$40,000/annum cost saving
 - At all dosed sites the Digital Twin achieved the same or lower H2S readings at the rising main discharge



TAKEAWAYS

1. Wastewater assets are at risk from Rising Main Septicity
2. Conventional control underestimates this risk
3. This Digital Twin provided modest savings (12%), less odour and much safer assets (up to 7-fold reductions in complaints and H₂S)



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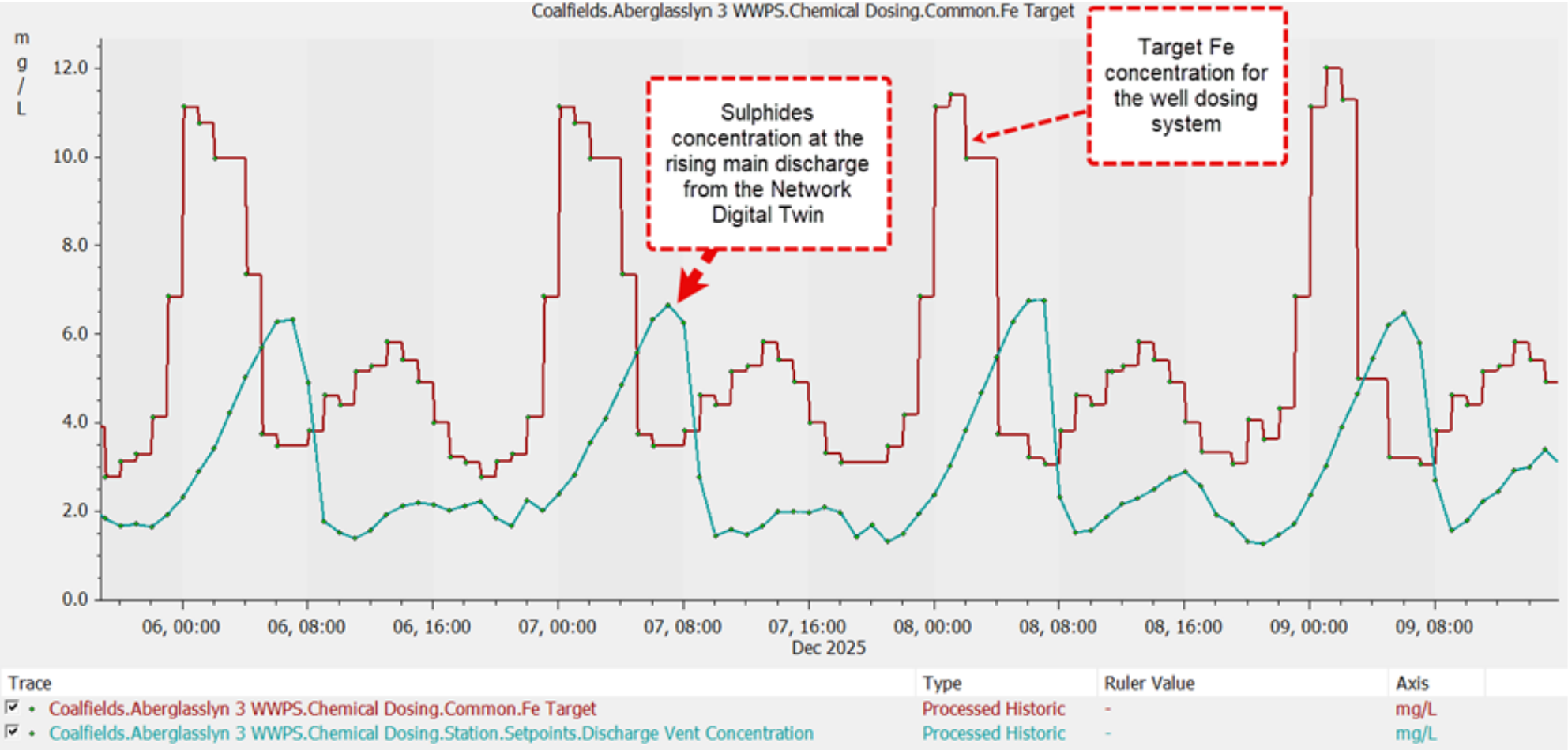
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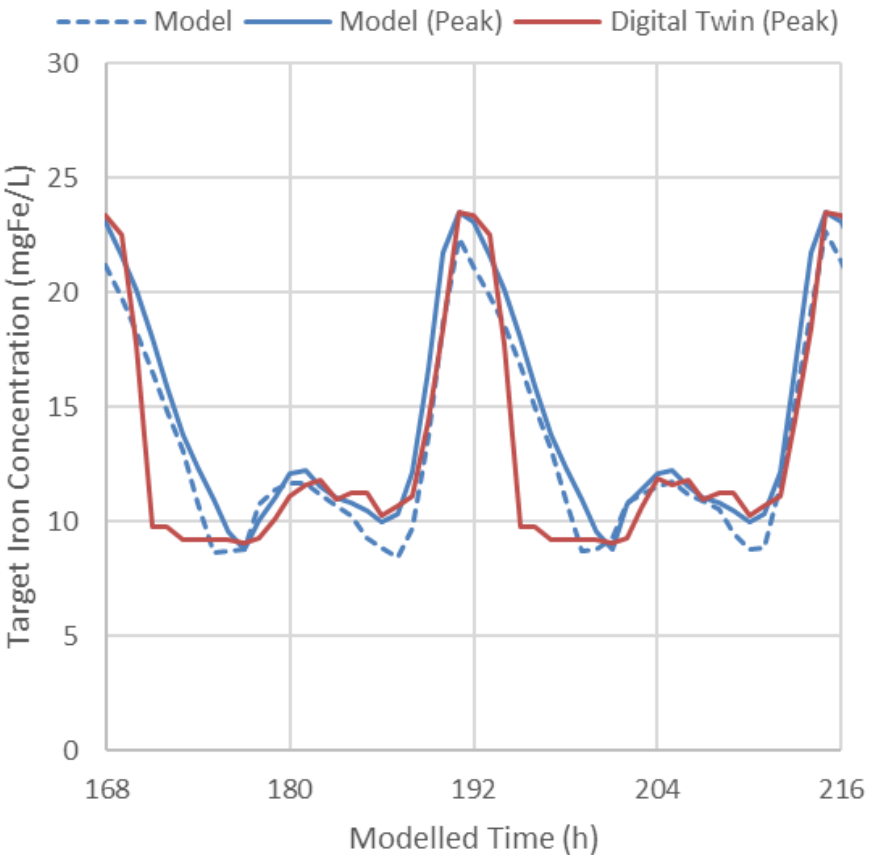
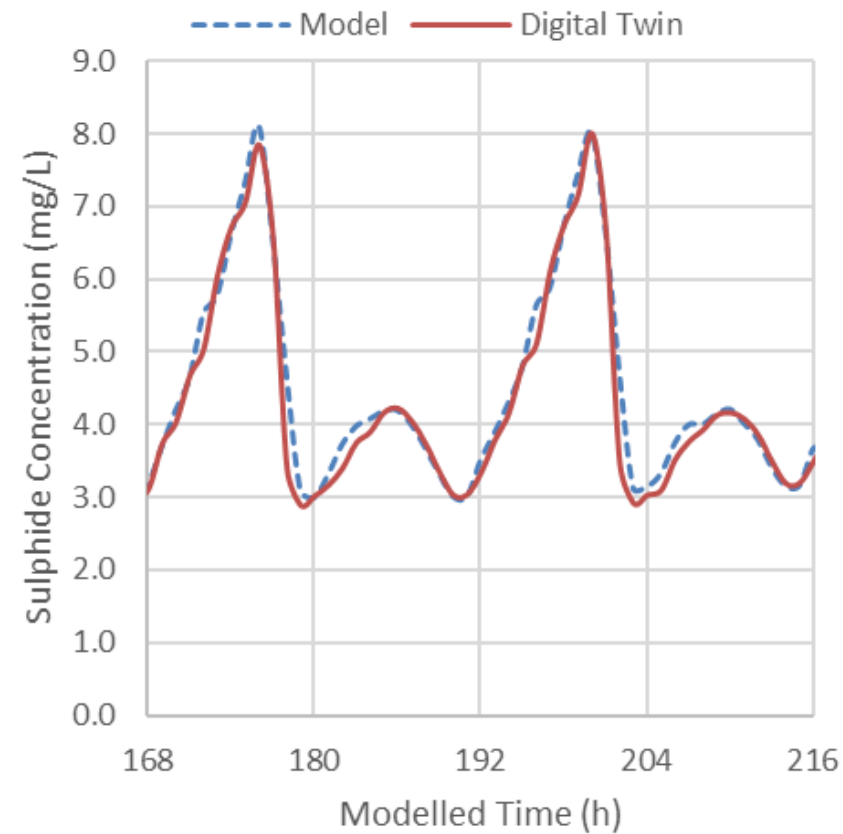


Questions

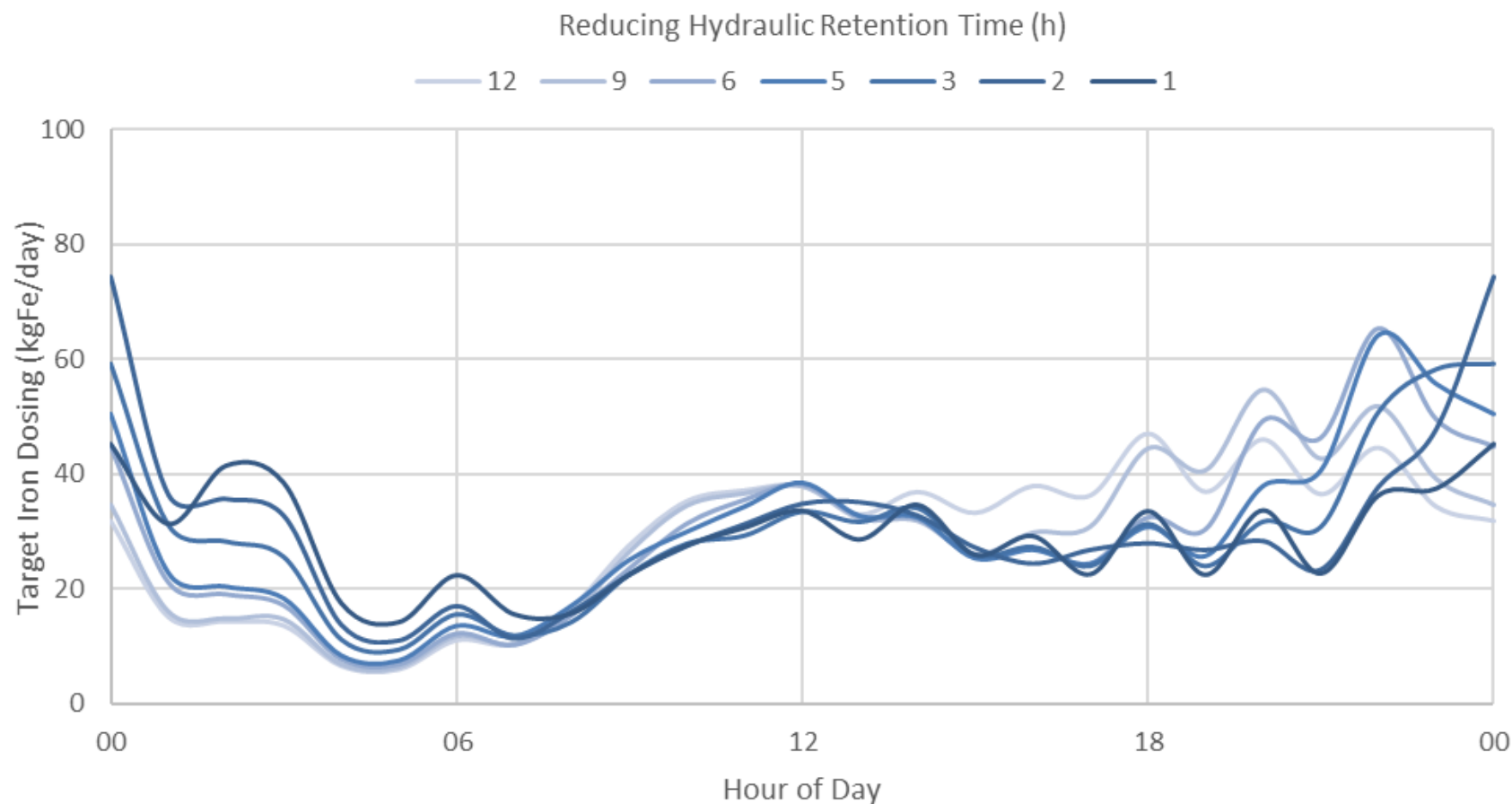
DIGITAL TWIN BEHAVIOUR



DIGITAL TWIN ACCURACY



DOSING PATTERNS FOR ONE SYSTEM



MEDOWIE 9

Medowie 9 WWPS Risng Main Gaseous H2S Readings at the Discharge

