Digital Twin Based Process Monitoring

Drinking Water Treatment

Abel Heinsbroek - Vitens

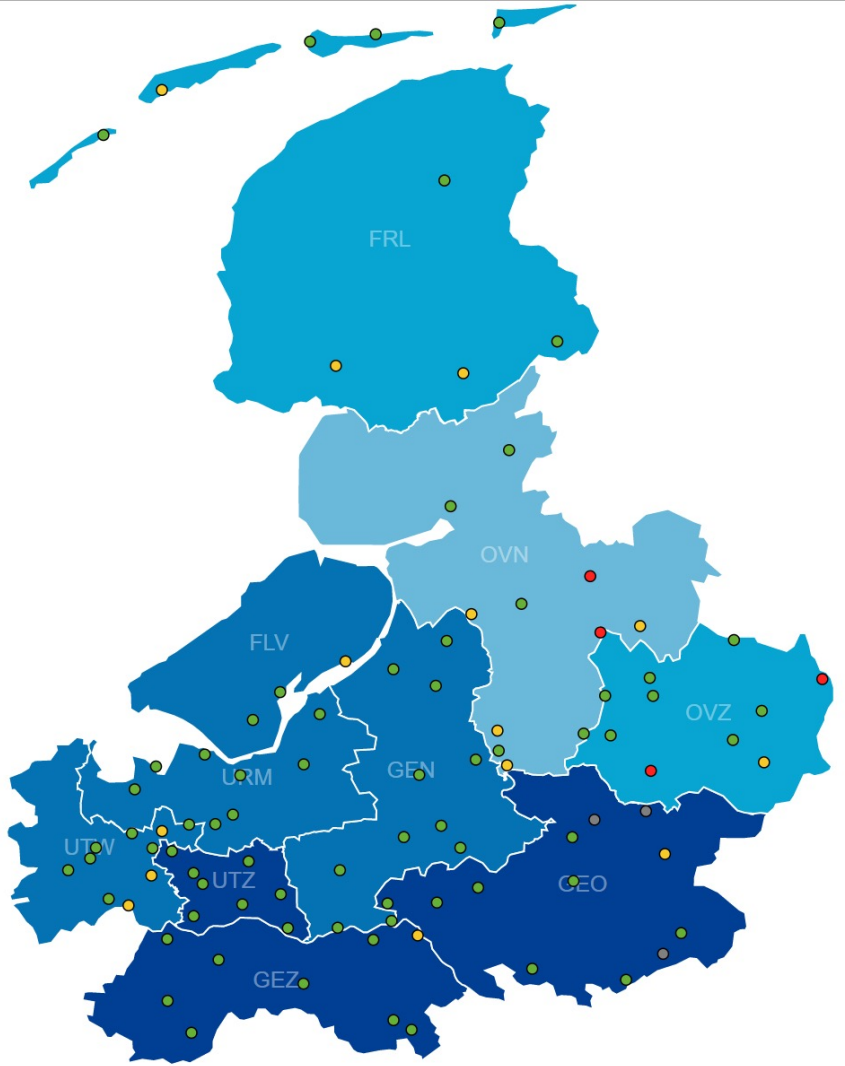
water voor nu en later

Vitens

Introduction

About Vitens

- Largest Dutch drinking water company
- 92 treatment plants
- 350.000.000 m^3 drinking water per year
- Groundwater and Riverbank filtrate
- Large variety in treatment intensity and processes



Background

Operational Challenges driving change

In 10 years time the majority of our experienced process operators will retire.

How do we retain their knowledge?

Large variety between plant operation, lots of specific operator knowledge required per plant

How can we make our system operation more uniform?

We try to control and optimize our treatment plants based on lab measurements

Do we have enough insight into our plant performance?

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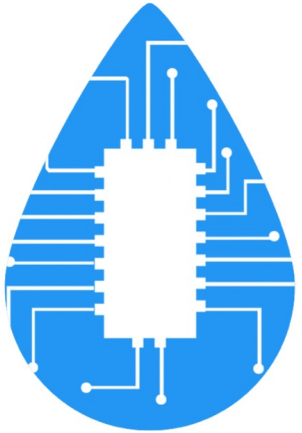
Background

Vitens Digital Strategy

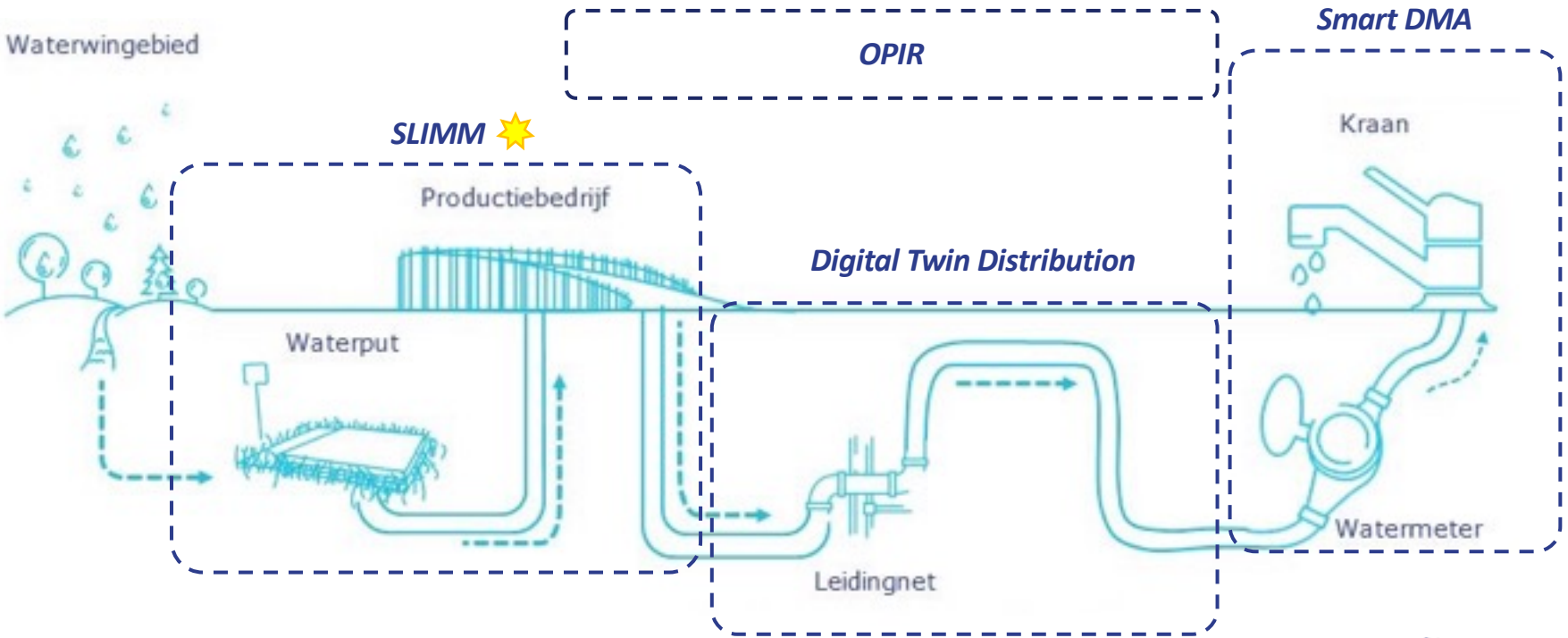
Transition from an experience towards a data-driven operation

- Reduce reliance on scarce operator experience
- Better understanding and monitoring of system performance
- Identify optimization potential
- More stable and predictable operation



Vitens Digital Strategy

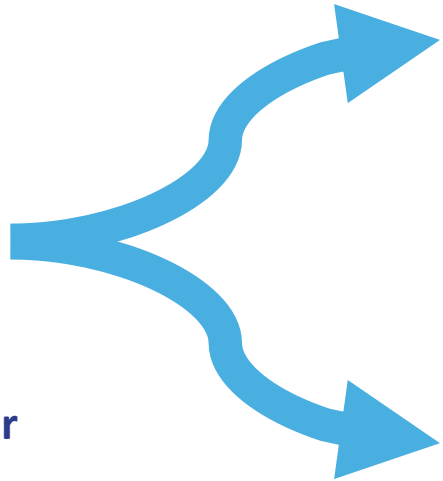
Smart Water Supply

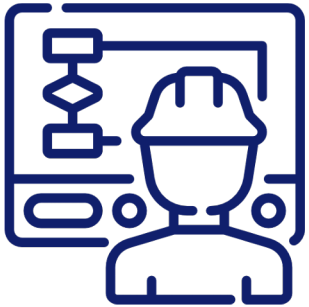


Vitens Digital Strategy

Organizational Changes

Processoperator





Process controller

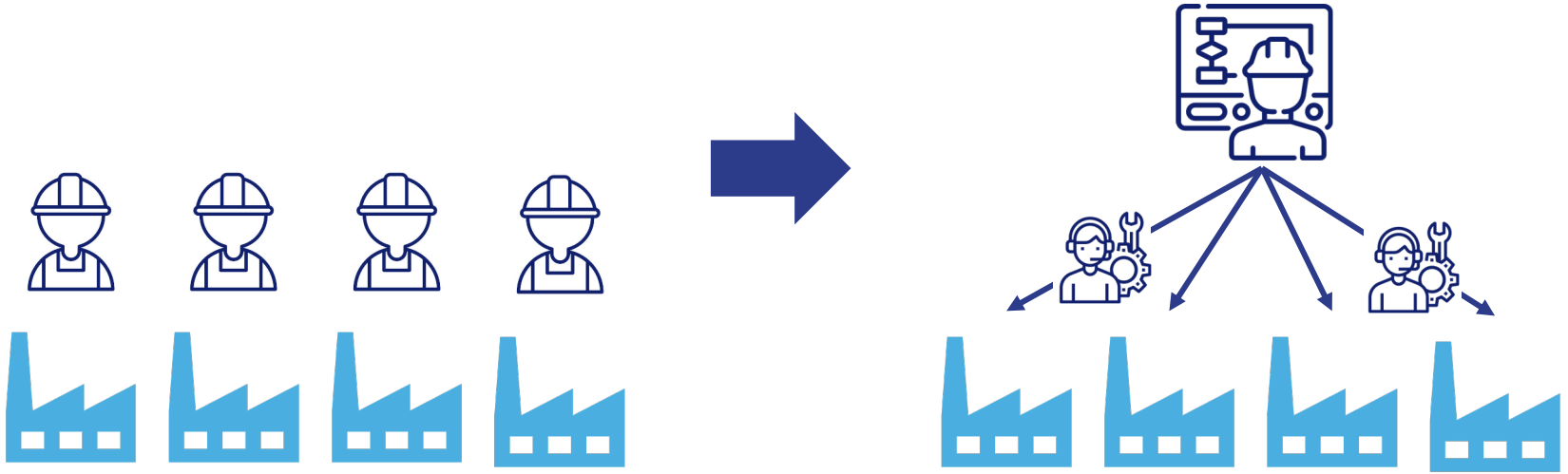
- Quality
- Quantity

Process technician

- Daily operations
- Maintenance

Vitens Digital Strategy

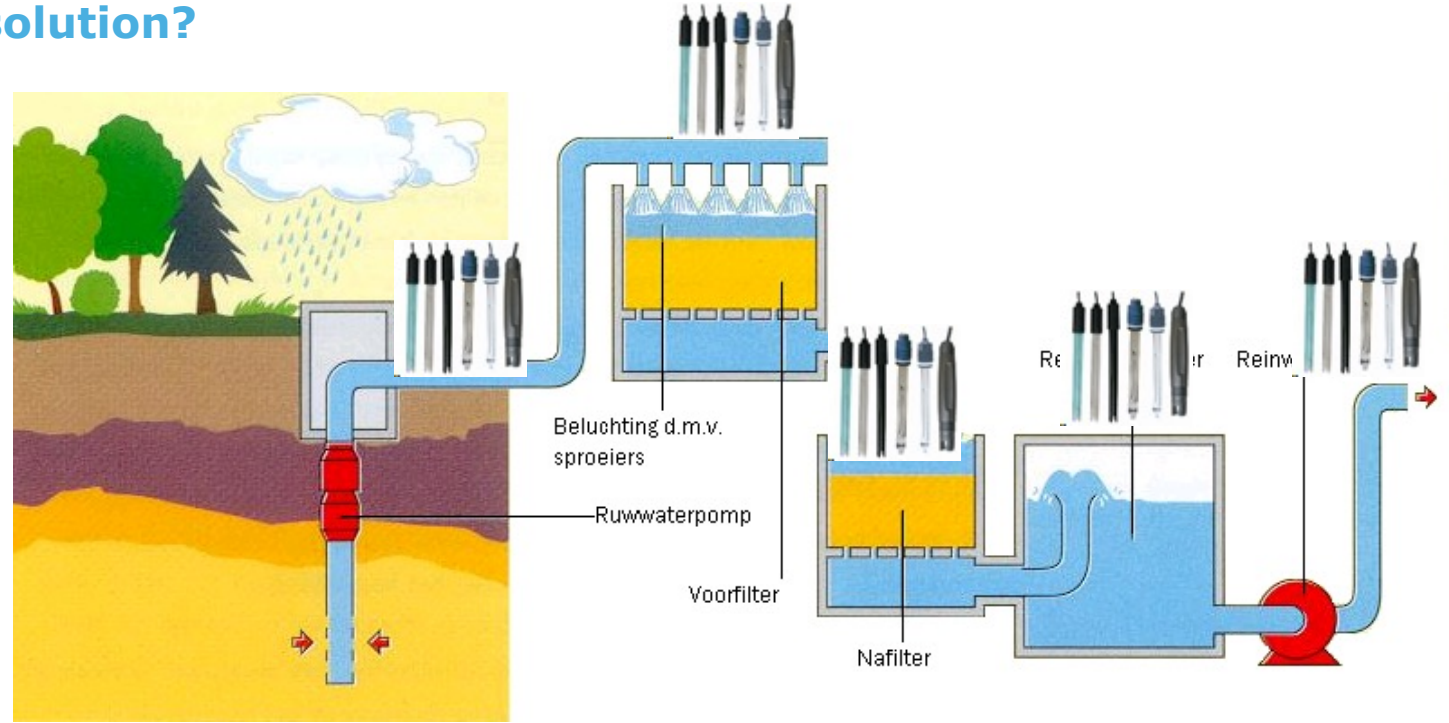
Quality Control



More real-time **quality** data is required

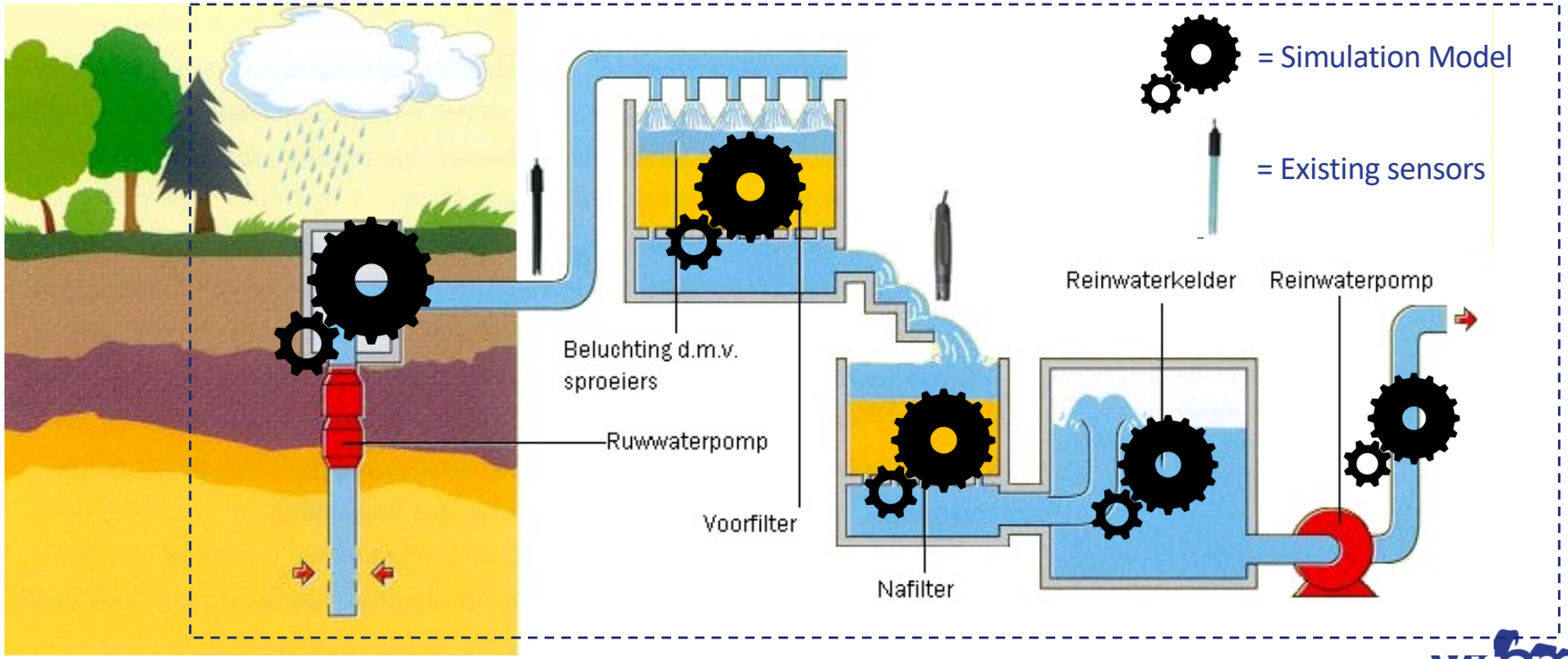
Real-Time data

The solution?



Real-Time data

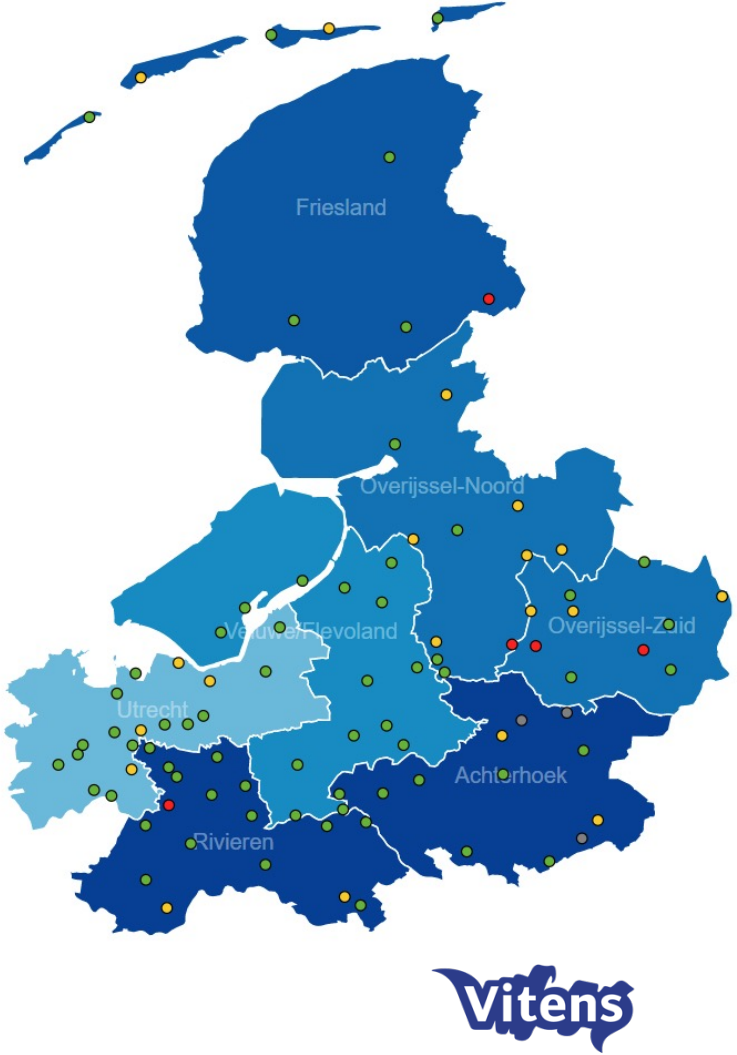
Digital Twin based solution



SLIMM System

Digital Twins in Practise

- In operation since 2016
- Fully developed in-house using open-source components
- Embedded in daily operations
- Real-time digital twin based monitoring and optimization



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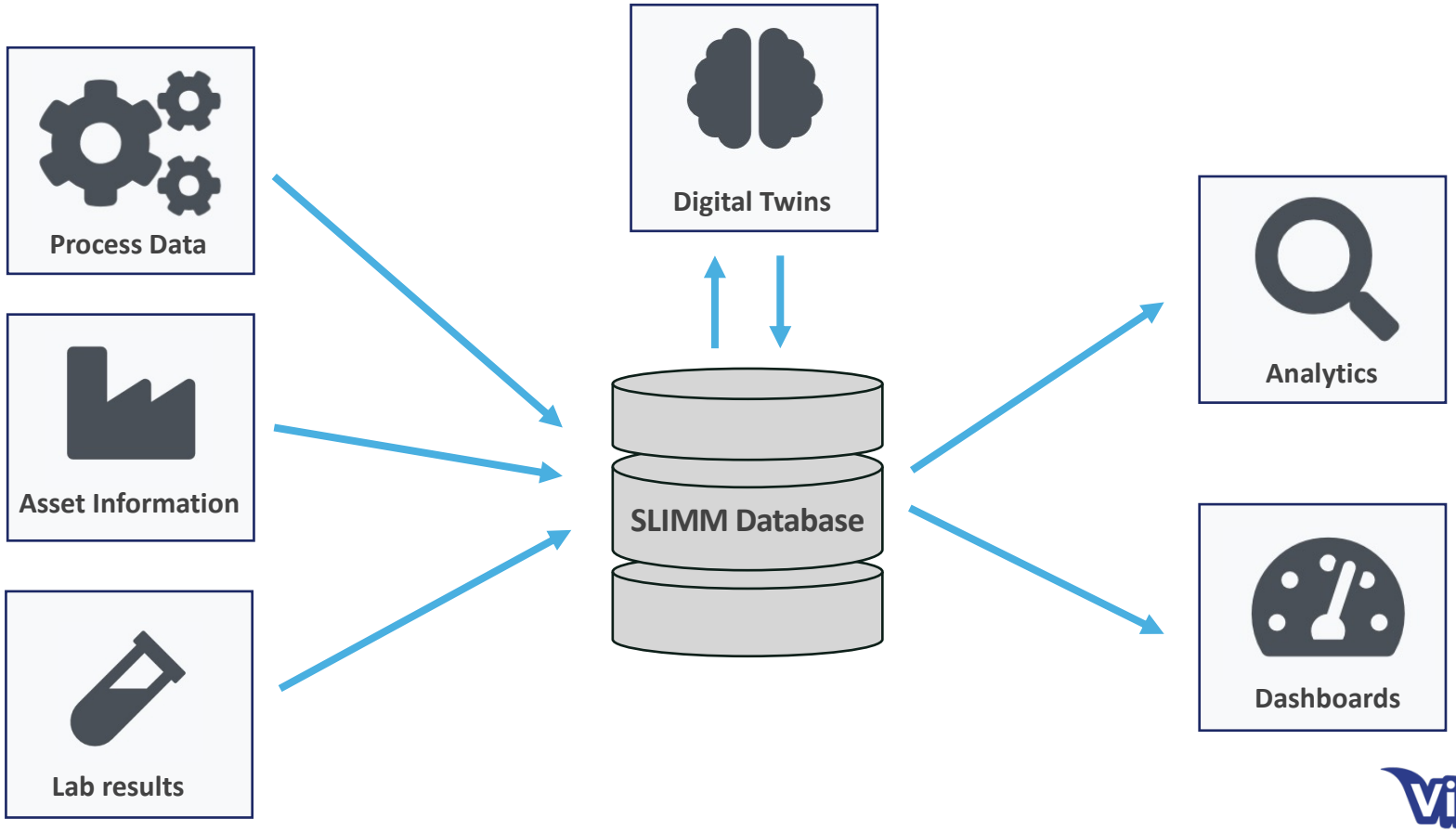
SLIMM System



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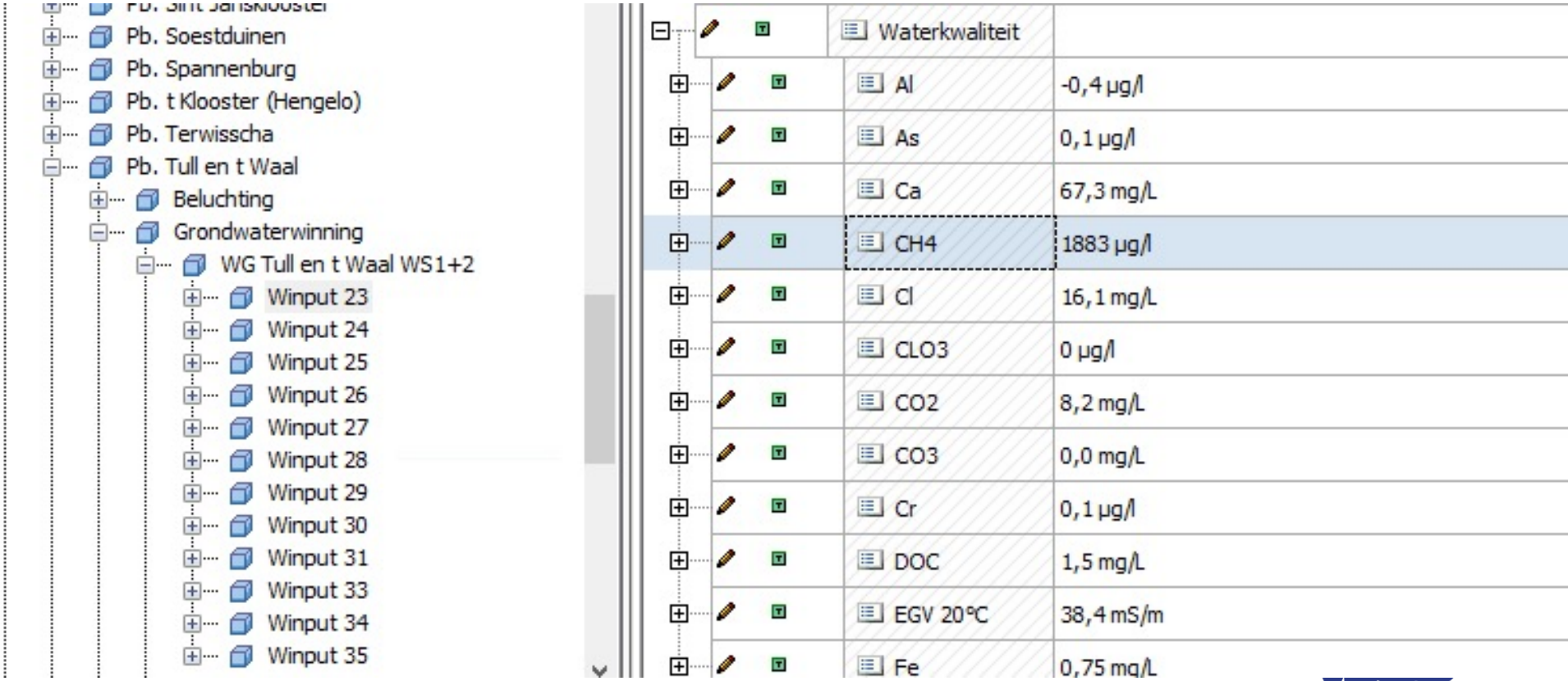
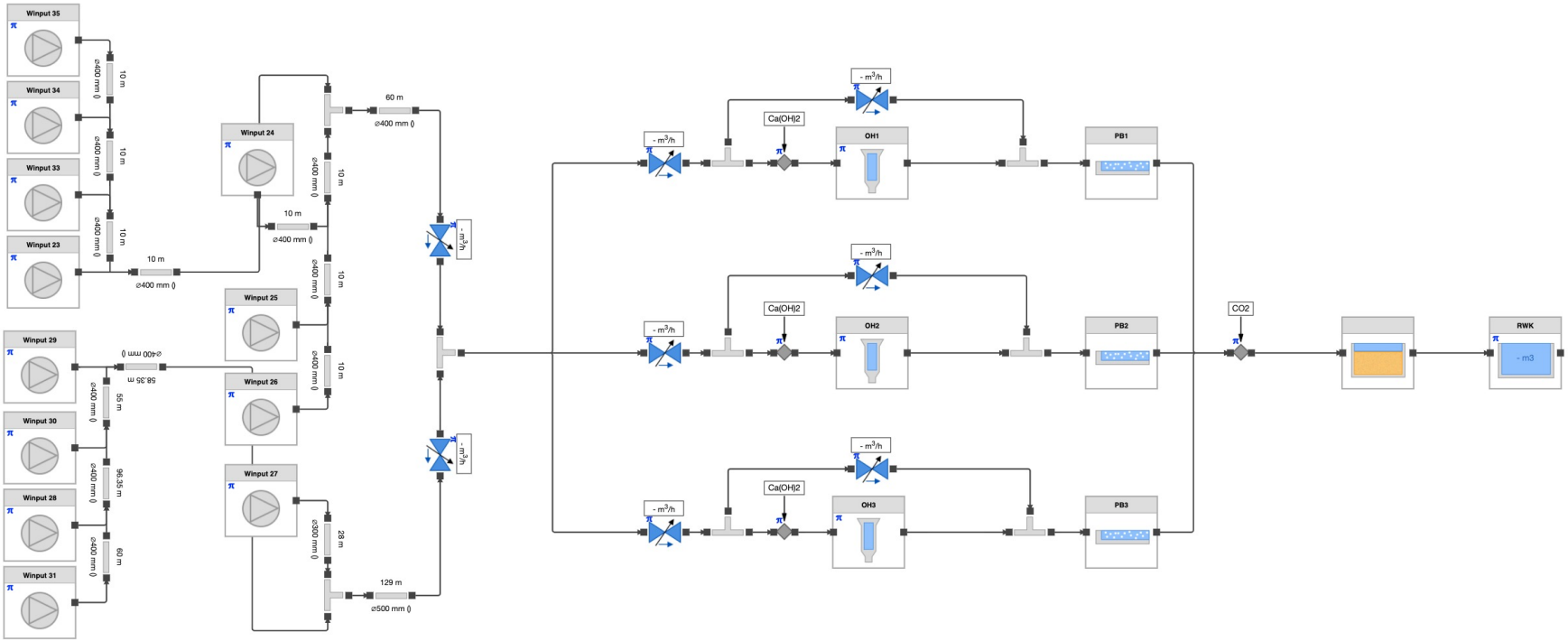
SLIMM Database



Digital Twins



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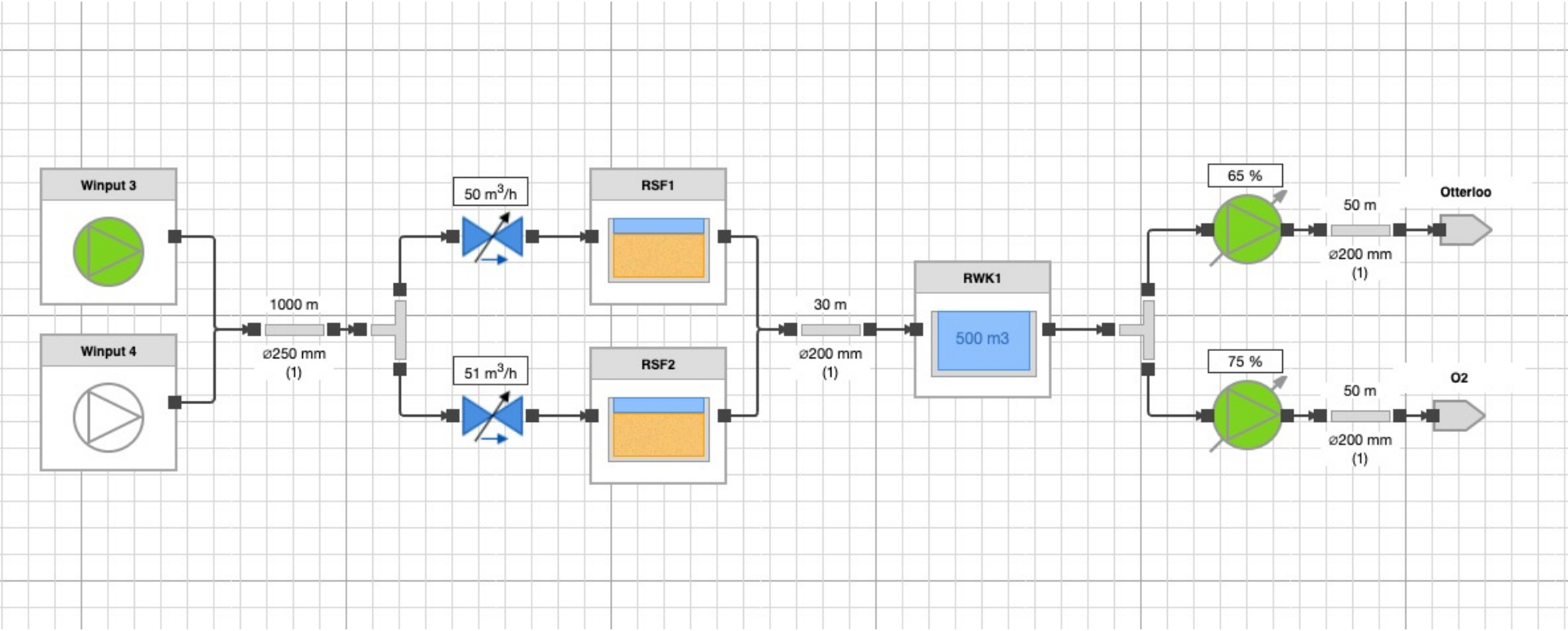
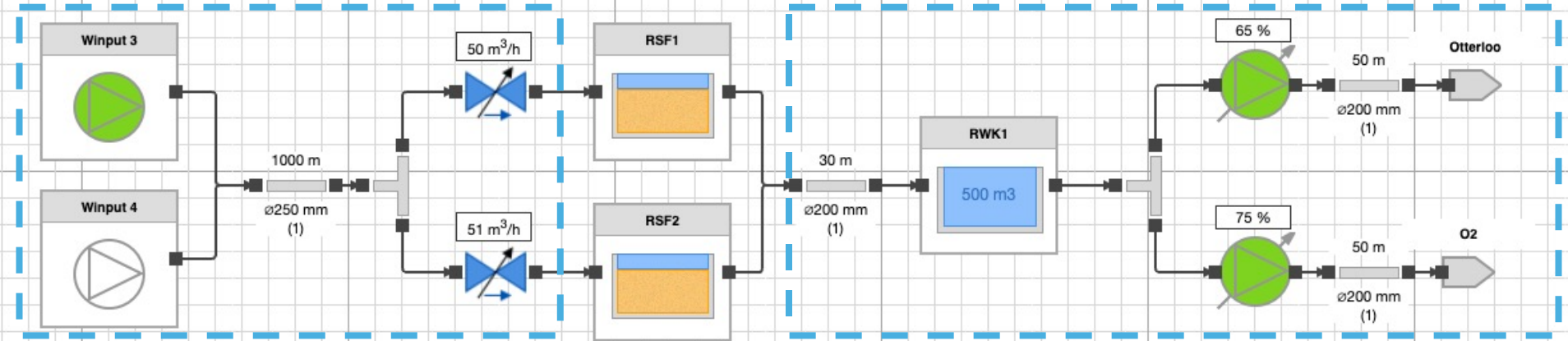
Digital Twins



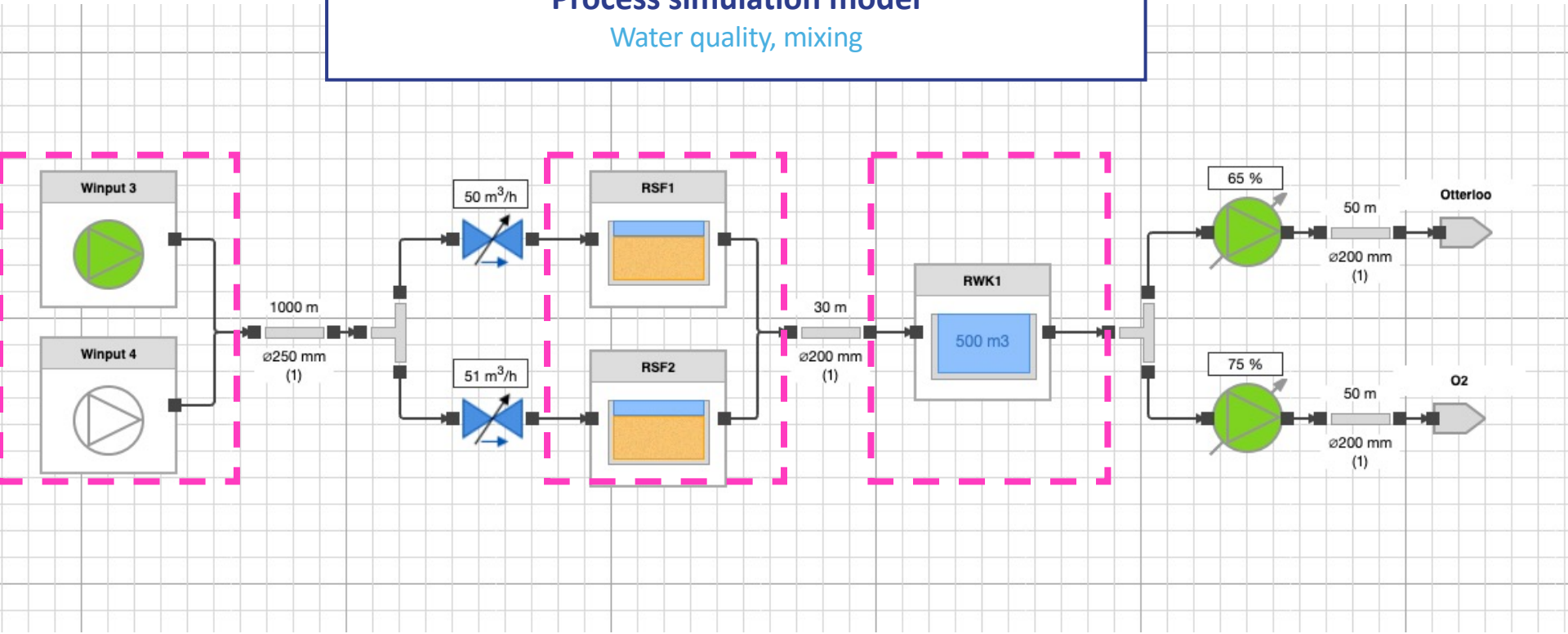
Hydraulic model

Water distribution, residence and travel time



Process simulation model

Water quality, mixing



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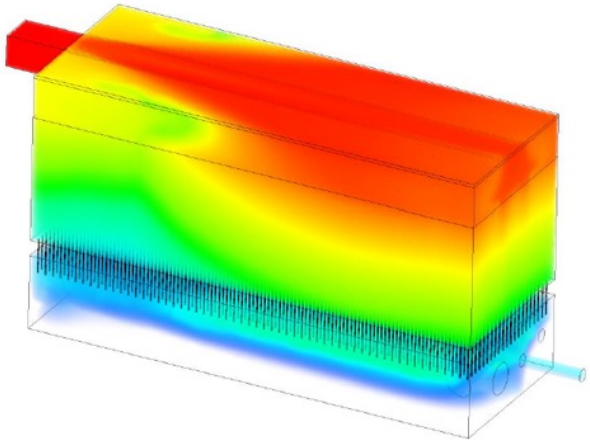


Advanced modelling (CFD)

$$Region\ 4: -\frac{dCa}{dt} = k_S * K_{sp} * SSA_W\ (SR-1)$$

$$Region\ 3: -\frac{dCa}{dt} = k_L * K_{sp} * SSA_W\ (SR-1)$$

$$Region\ 2: -\frac{dCa}{dt} = k_H * K_{sp} * SSA_W\ (SR-1) + A$$

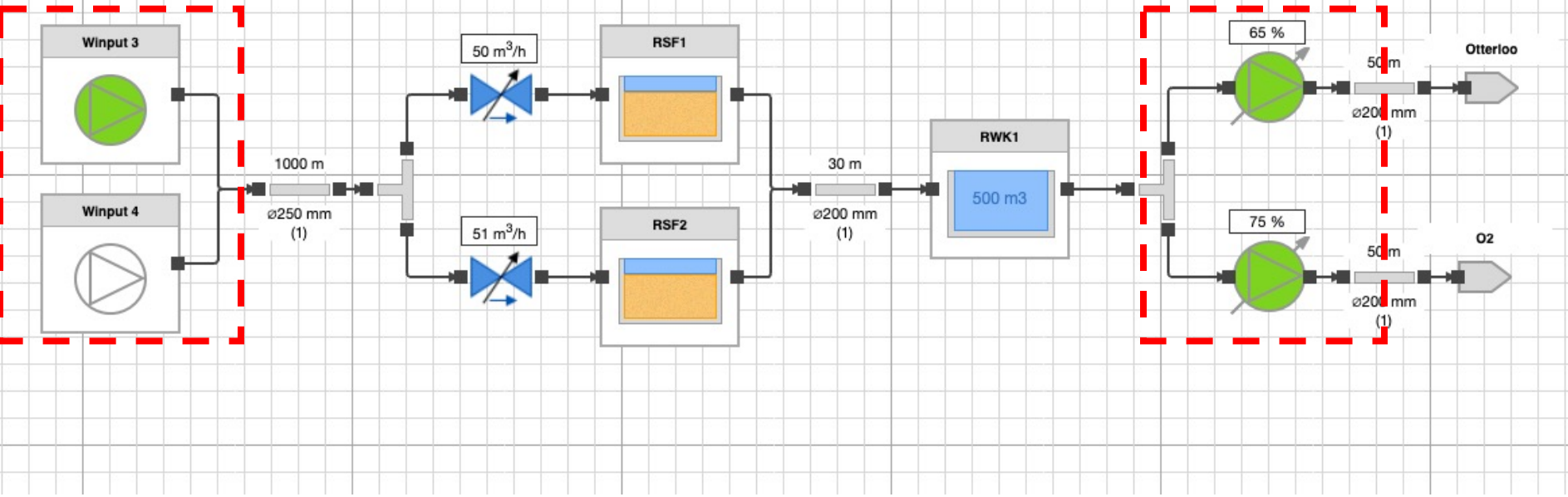
$$Region\ 1: -\frac{dCa}{dt} = k_C * K_{sp} * SSA_W\ (SR-1)$$

Physical/Chemical models

Experimental Validation

Energy model

Power consumption, Pump efficiency



Energy model

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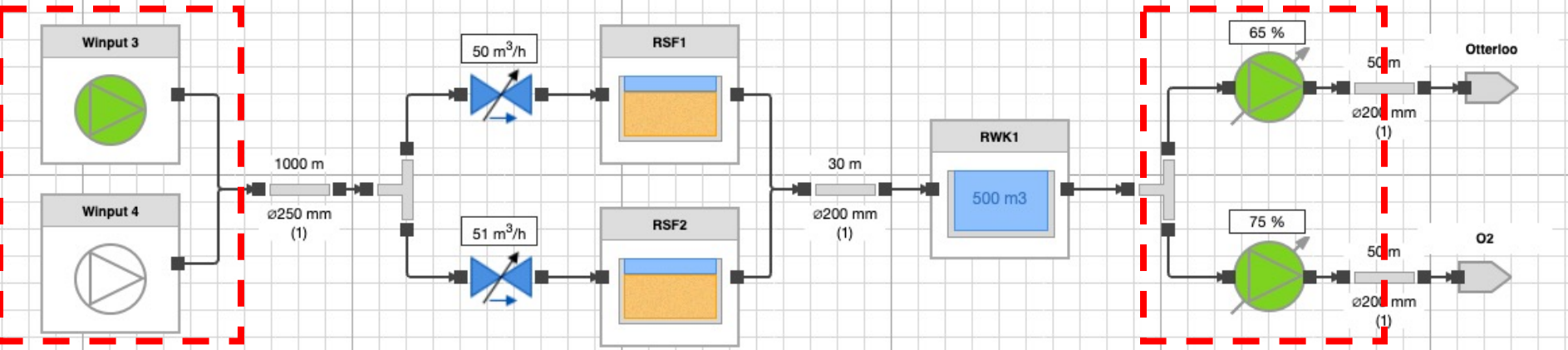
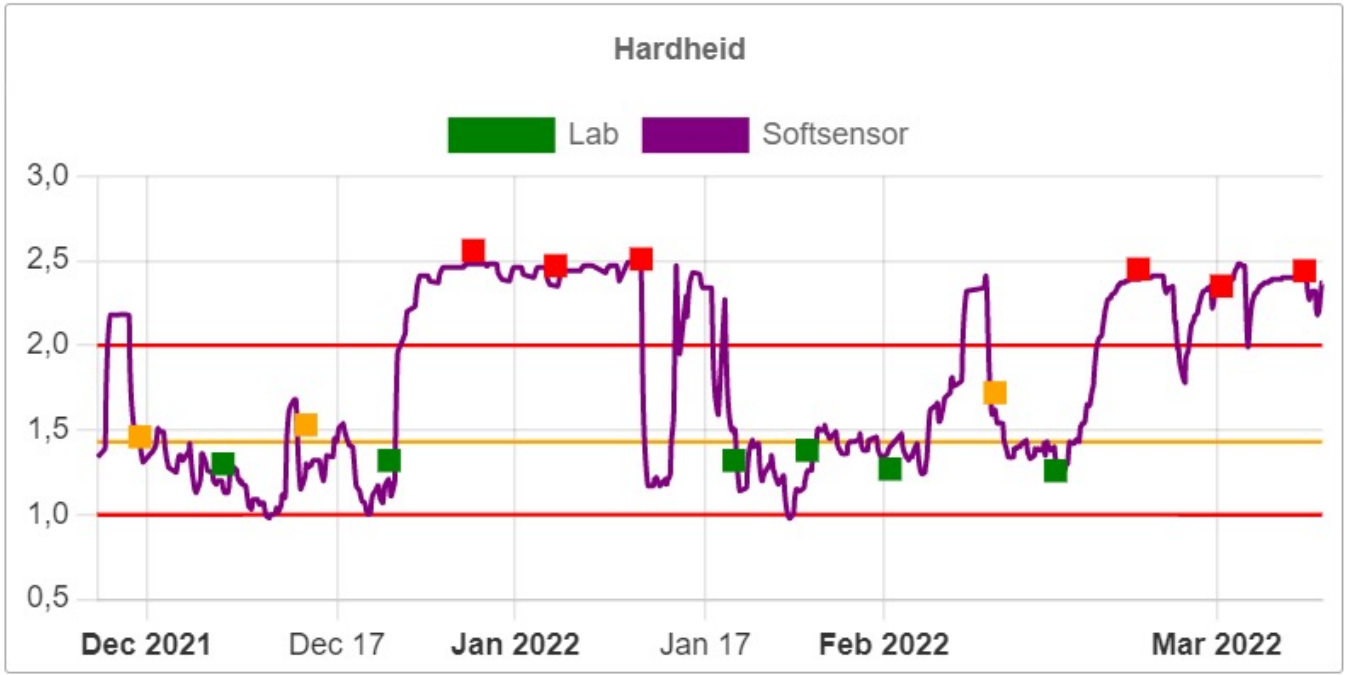


Energy Losses

Best Efficiency Point

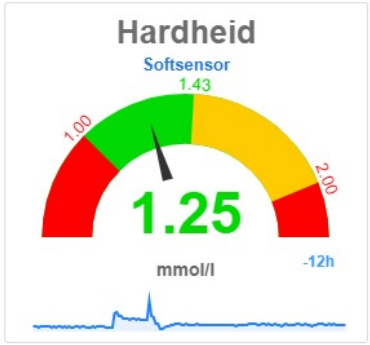
Real time Quality Prediction

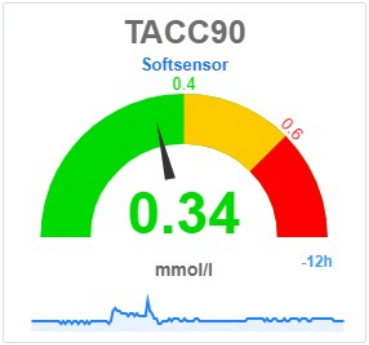
Hardness of produced water

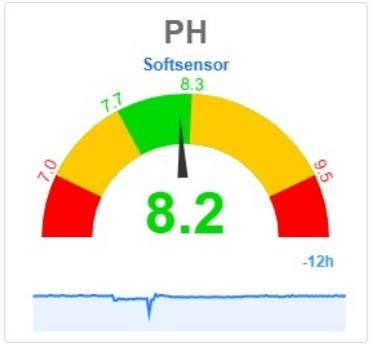


SLIMM Dashboard

Operator Feedback based on Digital Twins



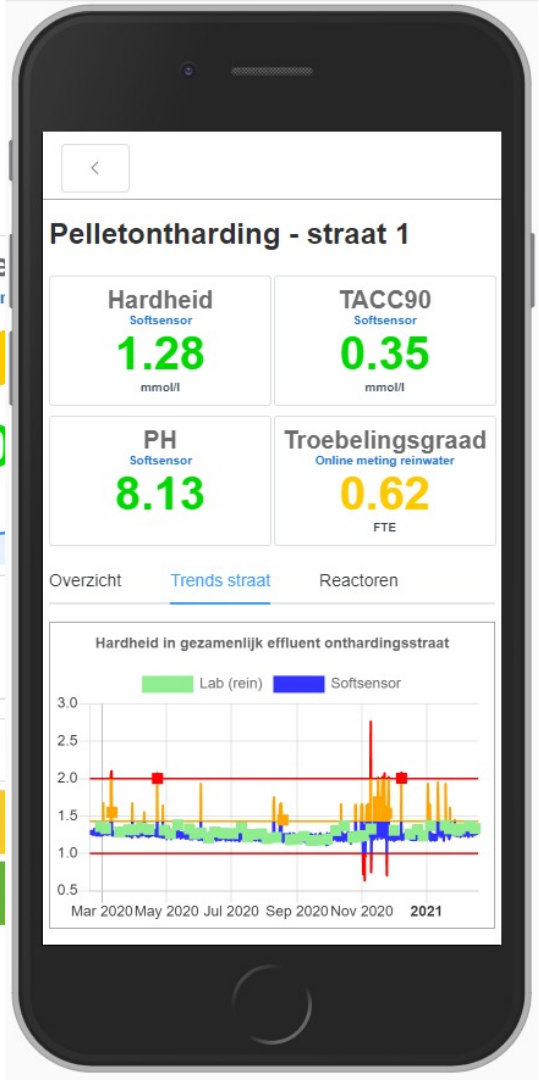




Toon meetwaarden Toon rapportcijfer

Overzicht Trends straat Reactoren

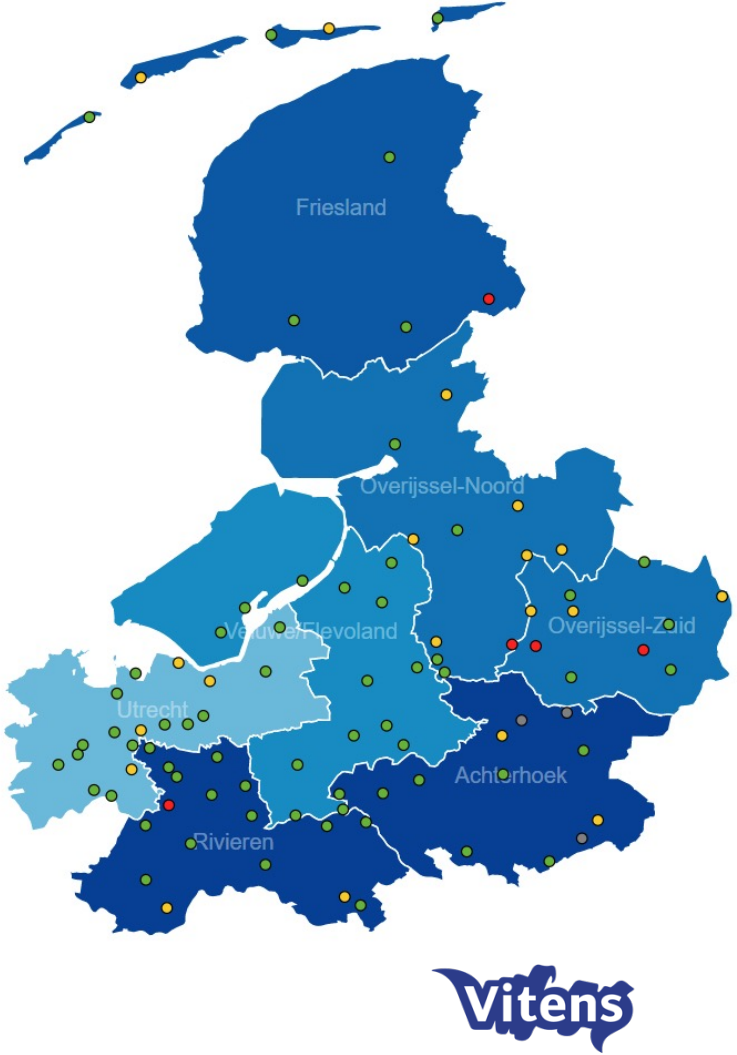
Parameter	Bewaking op	Bron	Proces	Reinwater	Datum	Eenheid	Drempelw.	Grensw.
Hardheid	Softsensor	Lab	-	1.37	4-1-2021	mmol/l	≤ 1.43	≥ 1 ≤ 2
		Softsensor	1.25	1.26	-			
Totaal afzetbaar calciumcarbonaat	Softsensor	Lab	-	0.42	4-1-2021	mmol/l	≤ 0.4	≤ 0.6
		Softsensor	0.34	0.35	-			
		Lab	-	8.08	4-1-2021			



SLIMM System

Overview and outlook

- 40 Digital Twins operational
- Reduction in quality standard exceedance & Faster response time
- Digital Twins used for training and ‘offline’ optimization
- Modules for energy and chemical consumption monitoring
- Integration with Digital Twin Distribution



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