



PREDICTIVE ANALYTICS FOR USER LEVEL ASSISTANCE

# PAULA-WWTP®

Monitoring & Control

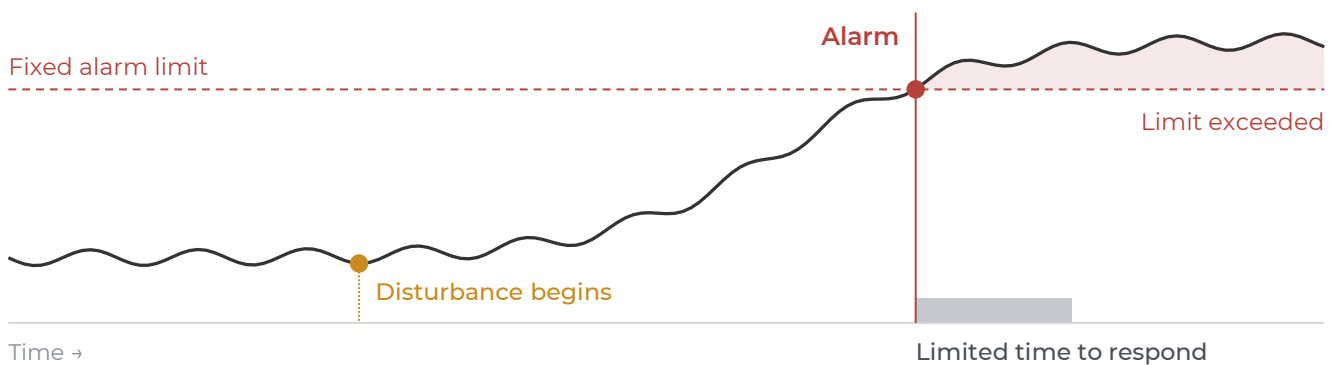
See what is coming.  
Control what happens next.

# By the time an alarm sounds, the process has already changed

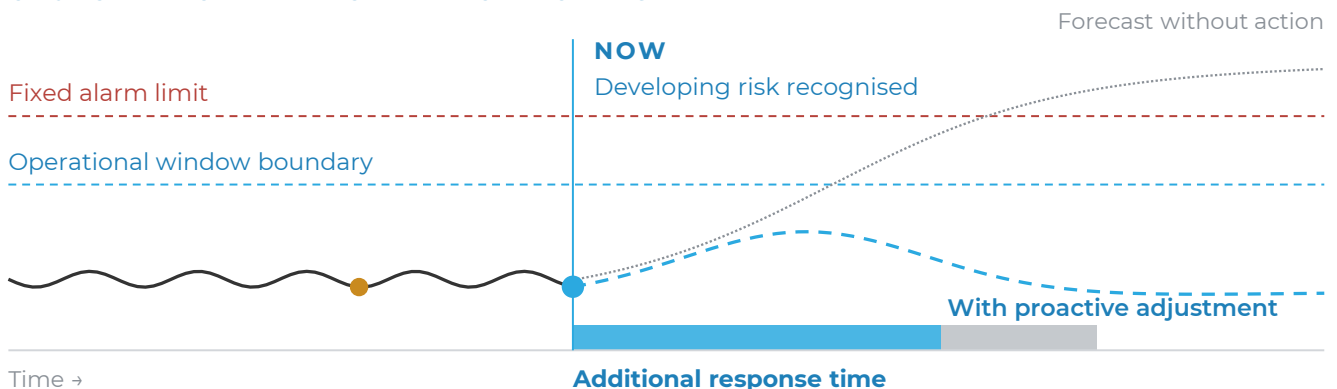
In biological treatment, microbes convert dissolved organic load and nutrients into biosludge. Retention times are long and changes are slow – what comes in today is coming out tomorrow.

Conventional monitoring compares measurements with fixed alarm limits. Operators react once a limit is crossed – often after the biomass is already affected. Without accurate control, plants also tend to run with unnecessary chemical and nutrient buffers.

## CONVENTIONAL MONITORING

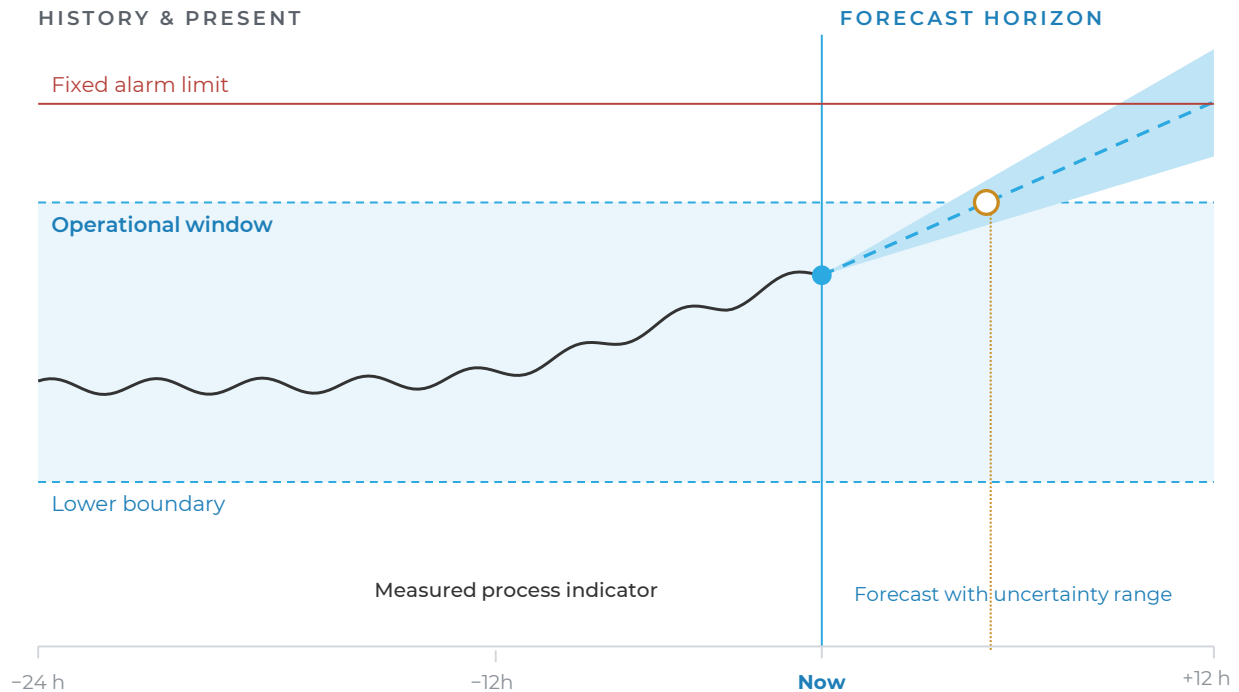


## OBJECTIVE OF PREDICTIVE MONITORING



The further ahead a change can be anticipated, the better operators can prepare for it.

# Past, present and likely future on one timeline



## — Historical data

Mill-specific process history – used to calibrate the models before start-up.

## ● Present state

Online measurements and laboratory analyses, quality-checked and interpreted through engineering calculations.

## — Predicted trend

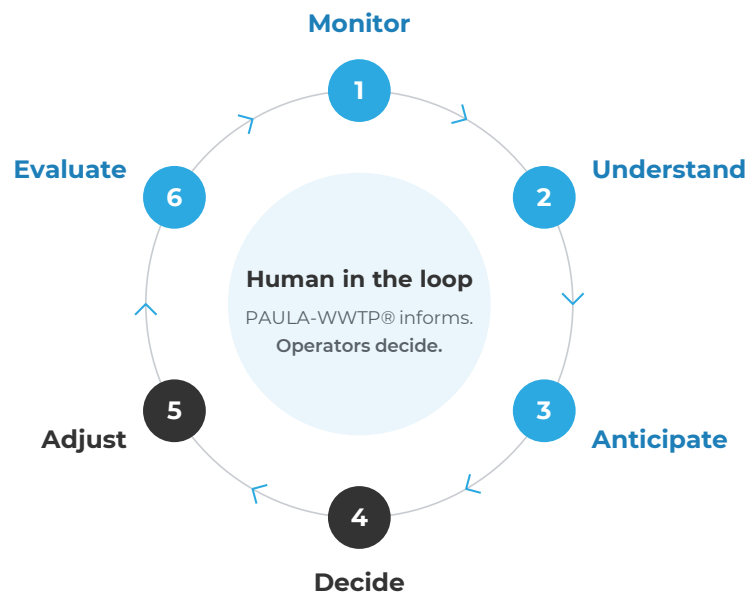
Hybrid-model forecasts. Mill production data reveals incoming load changes before they reach the plant.

## Operational window

Process-specific boundaries that flag risk before a fixed alarm limit is reached.

# Predictions become decisions, made by your operators

PAULA-WWTP® returns calculated recommendations to the mill database and operator screens: nutrient dosing, return sludge ratio, waste activated sludge and sludge retention time.



## PAULA-WWTP® provides

- Forward-looking situational awareness
- Early warnings of developing disturbances
- Recommendations with traceable reasoning

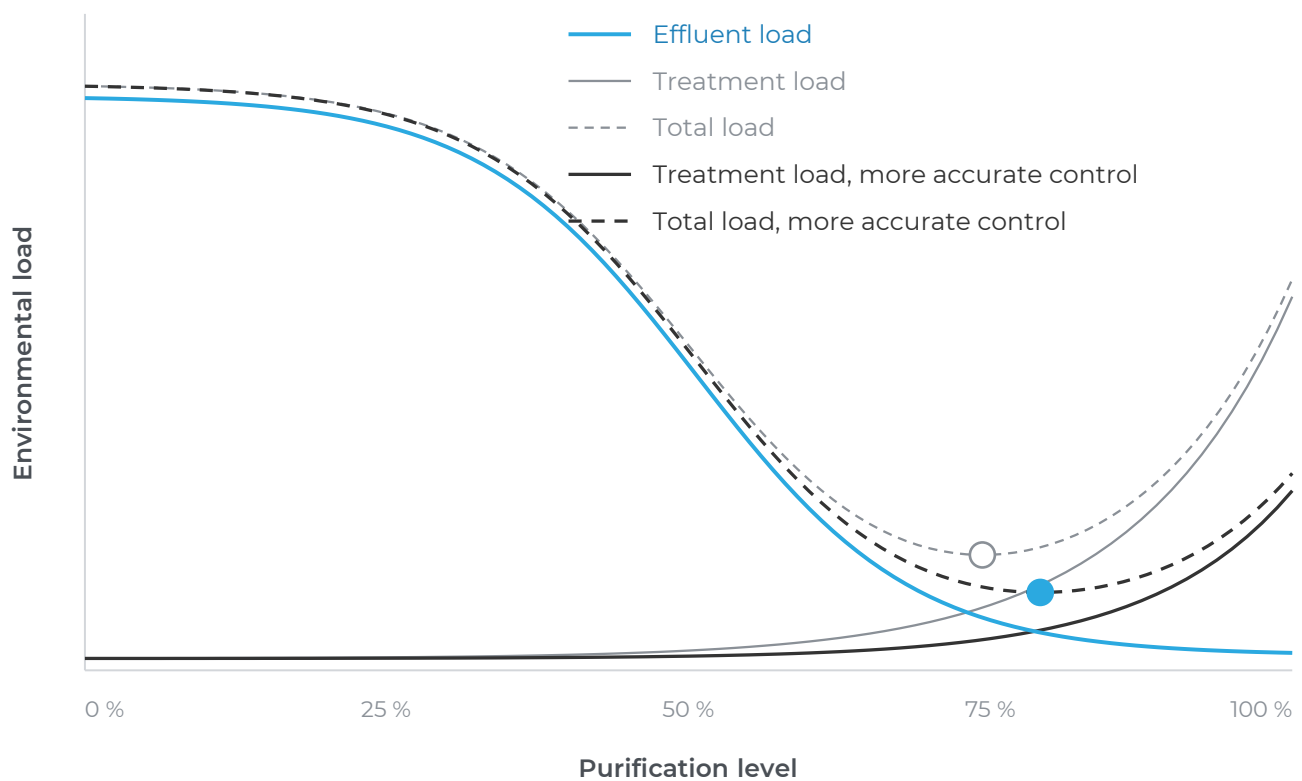
## Plant personnel

- Assess recommendations in context
- Decide on and implement adjustments
- Retain full operational responsibility

**Evaluate closes the loop:** algorithm accuracy is continuously improved from the process response to adjustments and from process simulations.

# Moving the sustainability curve

Treatment performance should be judged by both effluent load and the load caused by treatment itself. More accurate control removes unnecessary buffers – and lowers the total.



Concept adapted from Laukkanen, Dahl & Martikka (2014), Environmental Management and Technology in Industry.



## Resource efficiency

Chemical dosing and energy consumption based on process requirements and biosludge growth.



## Operational reliability

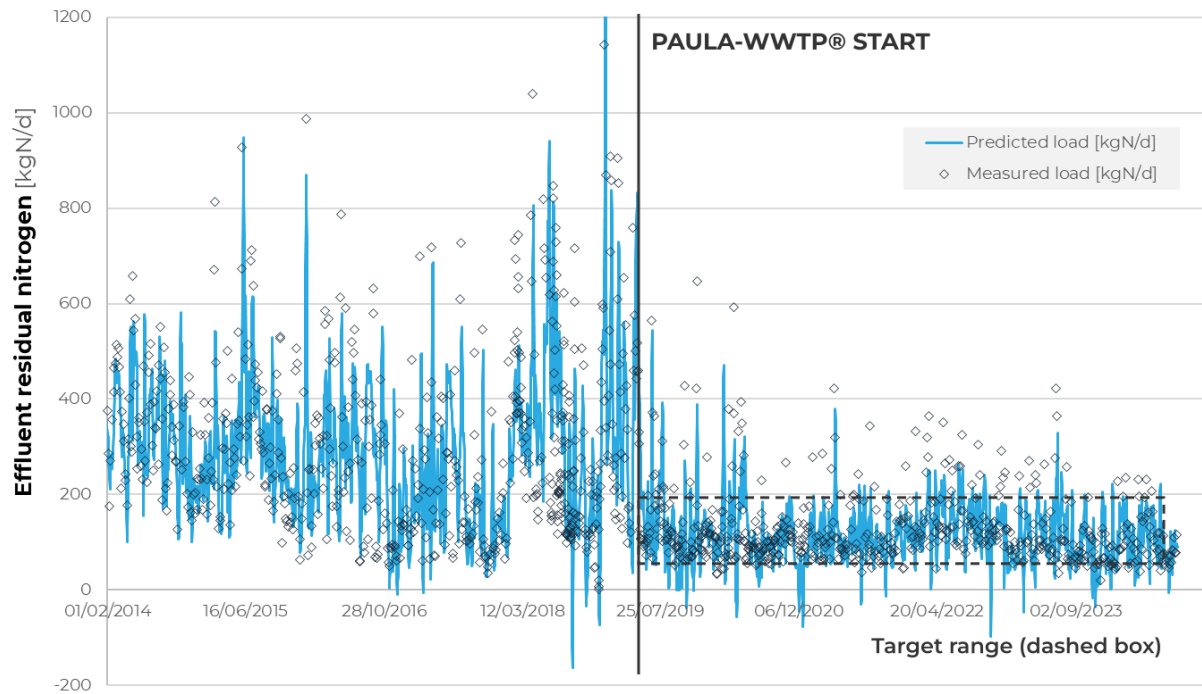
Disturbances anticipated earlier and a more stable activated sludge process.



## Environmental performance

Lower effluent loads, better sludge quality and nutrients matched to real demand.

# Predictive nutrient control in daily operation

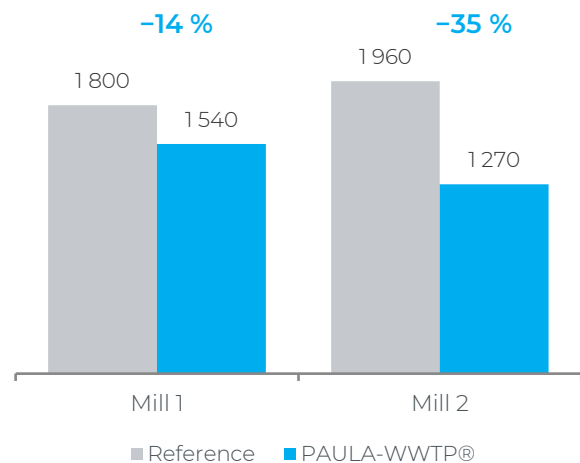


Customer example: effluent residual nitrogen (kgN/d), predicted and measured, 2014–2024.

## Nitrogen held in its target range

After PAULA-WWTP® start, dosing follows predicted demand and residual nitrogen in the effluent stays close to target.

## Urea addition, daily average (kg/d)



## Lower effluent loads in three North European mills

48–68 %

lower total suspended solids load

43–51 %

lower total nitrogen load

12–29 %

lower total phosphorus load

9–32 %

lower COD load

| Mill   | Production | WWTP layout                          | Period    | COD   | TSS   | Ptot  | Ntot  |
|--------|------------|--------------------------------------|-----------|-------|-------|-------|-------|
| Mill A | ECF pulp   | Pre-settler, ASP                     | 4 months  | –22 % | –61 % | –21 % | –49 % |
| Mill B | TMP        | Pre-settler, two-stage ASP, tertiary | 12 months | –32 % | –68 % | –12 % | –43 % |
| Mill C | CTMP, RCF  | Pre-settler, MBBR, ASP, tertiary     | 12 months | –9 %  | –48 % | –29 % | –51 % |

**How the results were measured.** Average final effluent loads per air-dry tonne before and after daily use of the advisory application. Mill operators set adjustments more often and with better timing; sludge settling improved and reported disturbances decreased. Results are mill-specific.

Source: Hannukainen & Toivakainen, O Paper 82(4), 2021.

# Start with a conversation about your plant

Let's discuss opportunities of predictive monitoring and control at your wastewater treatment plant.



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