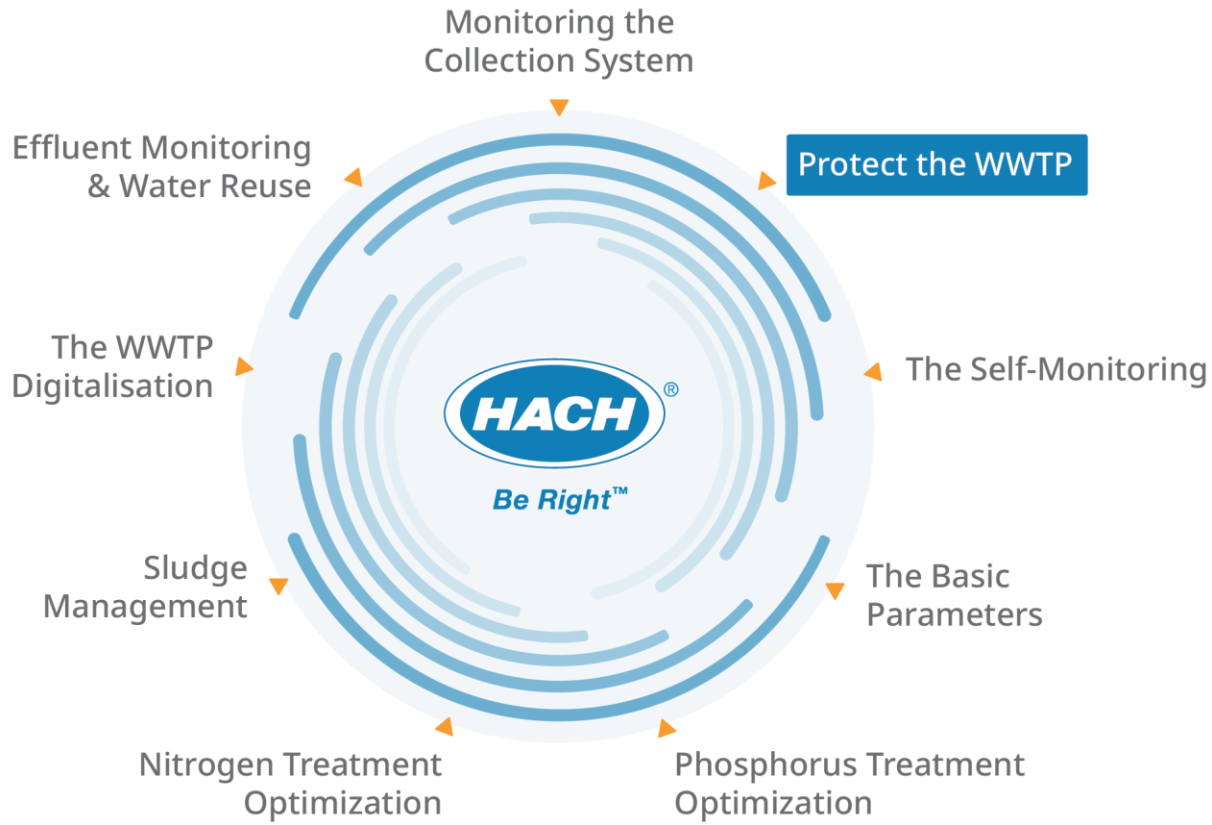
# HACH's answers to wastewater challenges

# PART VI: Protect the WWTP


Monitoring the Collection System
Protect the WWTP
The Self-Monitoring
The Basic Parameters
Phosphorus Treatment Optimization
Nitrogen Treatment Optimization
Sludge Management
The WWTP Digitalisation
Effluent Monitoring & Water Reuse
HACH
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# Speakers

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Product Application Manager

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Application Development Manager

# Agenda

1. Introduction on unexpected inlets and their consequences
2. The watch dog solutions
3. The inlet load monitoring solutions
4. Toxicity monitoring

EUROPEAN BIOSOLIDS & BIORESOURCES CONFERENCE & EXHIBITION
16 - 17 November 2021
St James' Park, Newcastle UK / Online
AquaEnviro

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# Introduction

# Standard influents of muni WWTP

# Standard influents of muni WWTP (dry weather)

**Total Nitrogen**

12 - 15g N /PE

70 - 80 mg NGL/L

**Total Phosphorus**

1,5 - 3g PT /PE

8 - 15 mg PT/L

**Organic Matter**

120g COD / PE

600 - 750 mg COD/L

**SS**

90 g SS/PE

250 -270 mg SS/L

**pH**

6,5 - 8,5

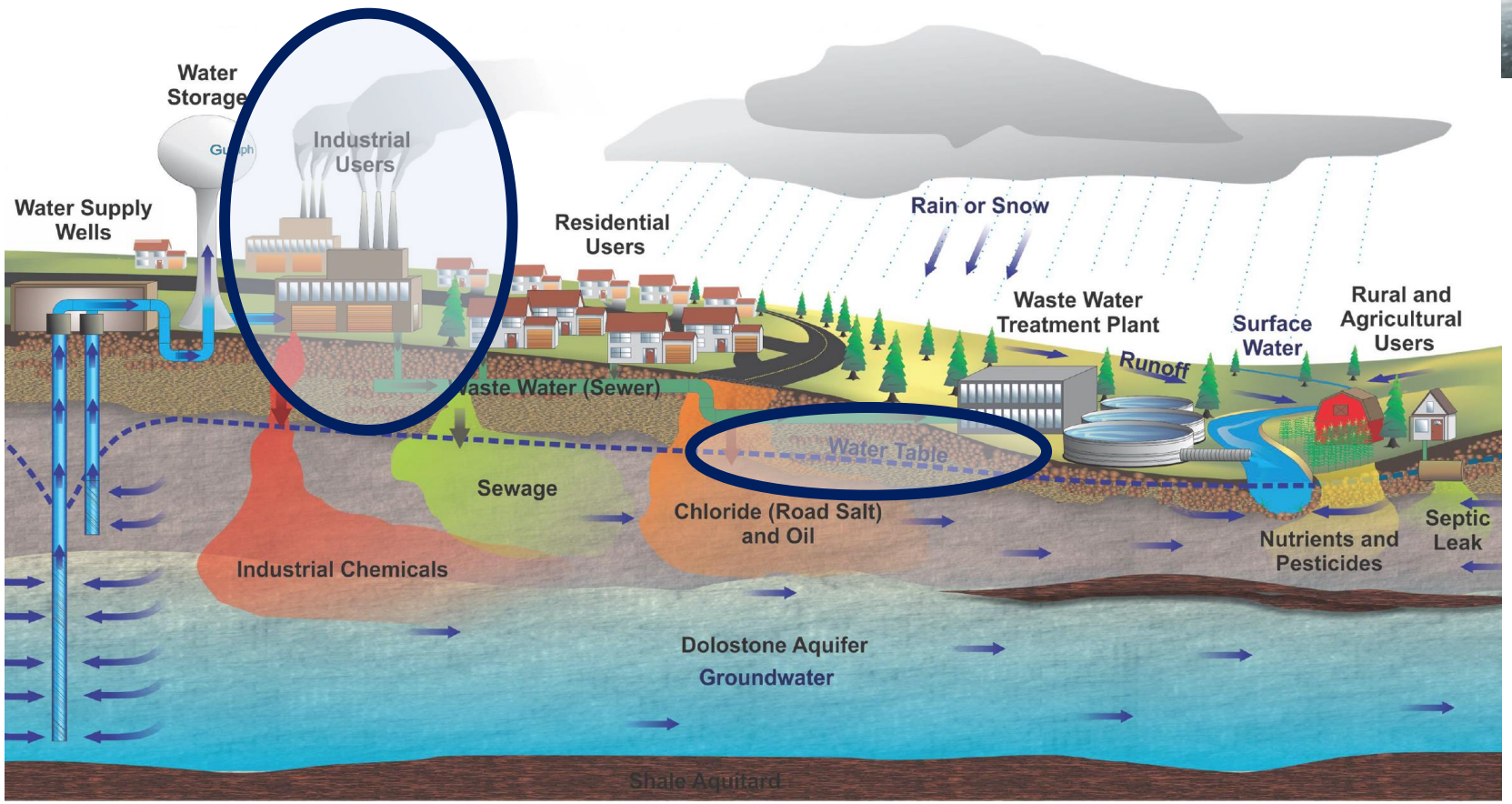
**Conductivity**

500 - 1500µS/cm

# The unexpected discharges

Industries

Clean water infiltration




See water intrusion

# Consequences of unexpected discharges

These influents may be toxic or may represent high pollution loads

1/ Consequences on plant performances and compliance
2/ Biology disruption
3/ Time and resource consuming for laboratory monitoring & treatment settings adaptation

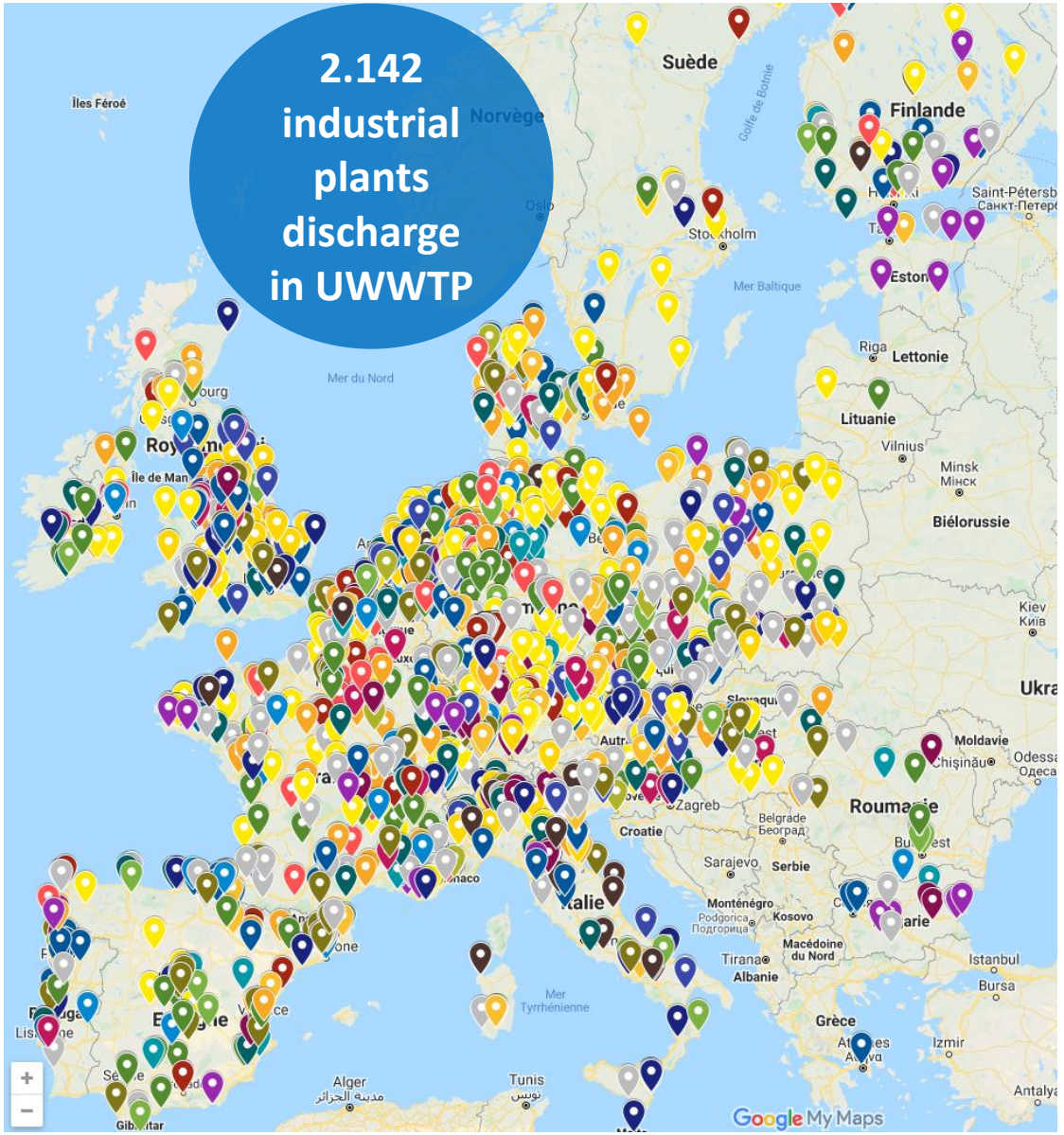
# Zoom on industrial discharges to UWWTPs

| % of industrial sites that discharge into UWWTPs | Number of Member States | Member States |
|---|---|---|
| =<20% | 4 (15%) | France, Portugal, Romania, Spain |
| >20-35% | 2 (7%) | Croatia, Finland |
| >35%-50% | 1 (4%) | Slovenia |
| =>50% | 8 (30%) | Austria, Belgium, Czech Republic, Germany, Lithuania, Luxemburg, Malta. Netherlands |
| Unknown | 12 (44%) | Bulgaria, Cyprus, Denmark, Estonia, Greece, Hungary, Ireland, Italy, Latvia, Poland, Slovakia, Sweden |

Source : Stakeholder Conference on the revision of the UWWTD – 26/10/2021

# Zoom on industrial discharges to UWWTPs

- Treatment and processing of milk
- Chemical installations for the production on an...
- Installations for surface treatment of metals a...
- Treatment and processing intended for the pro...
- Slaughterhouses
- Landfills (excluding landfills of inert waste and ...
- Installations for the recovery or disposal of haz...
- Industrial plants for the production of paper an...
- Treatment and processing intended for the pro...
- Installations using a chemical or biological pro...
- Plants for the pre-treatment (operations such a...
- Treatment and processing intended for the pro...
- Chemical installations for the production on an...
- Installations for the surface treatment of subst...
- Chemical installations for the production on an...
- Thermal power stations and other combustion ...
- Installations for the disposal of non-hazardous...
- Urban waste-water treatment plants
- Installations for the incineration of non-hazard...
- Installation for the smelting, including the alloy...
- Autre/Pas de données



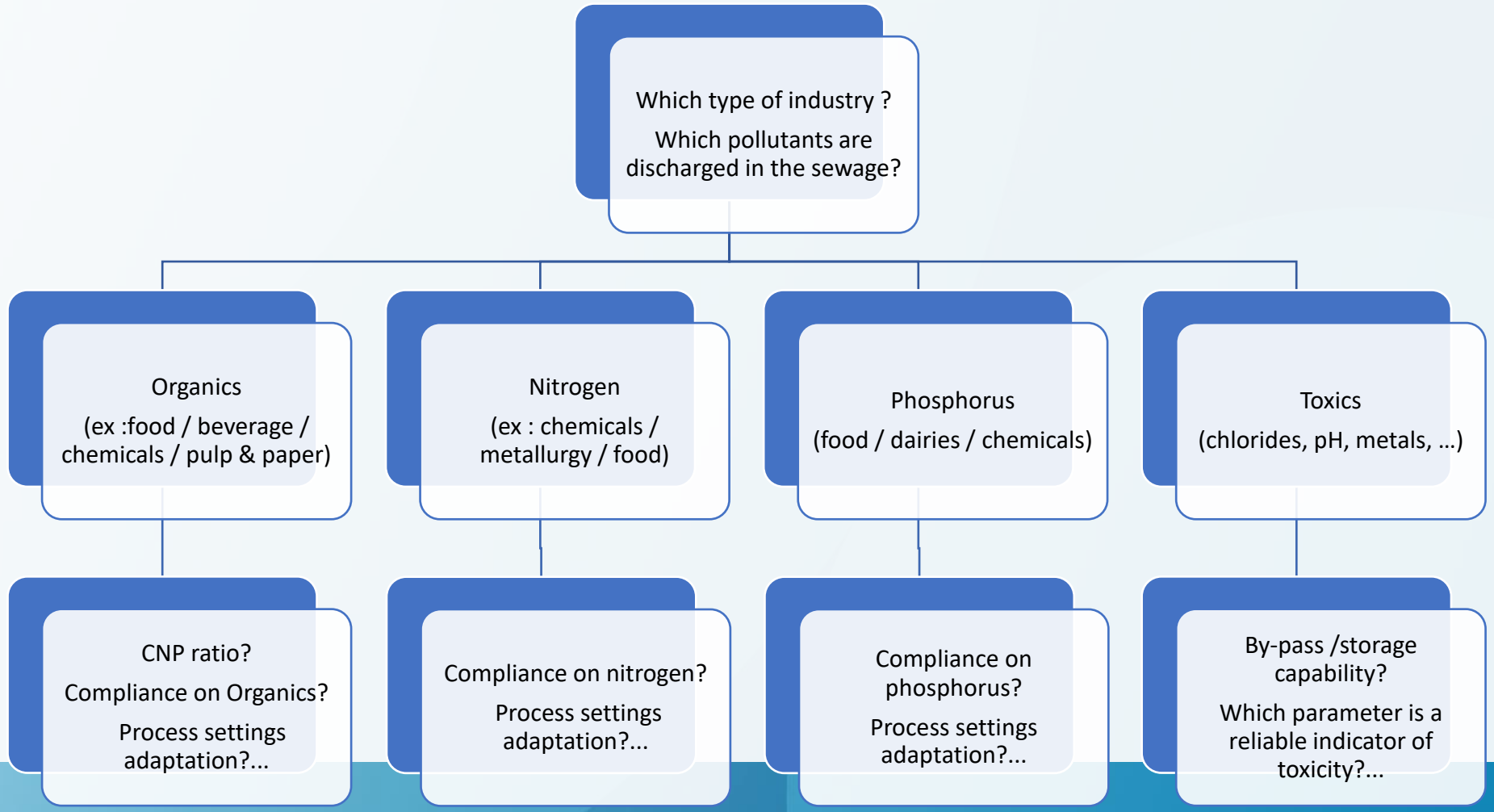

**465**
plants discharge more than 100.000kgTOC/year

**136**
**plants discharge more than 50.000kgTN/year**

**83**
plants discharge more than 10.000kgP/year

Source :E-PRTR database – Pollution transfer

# Which parameters? Which impact for the UWWTP?



# Overview of the solutions for Inlet monitoring

Samplers

"watch-dog" parameters

Solids


E-Chems

Advanced parameters

EZ Toxicity


Biotector TN/TP

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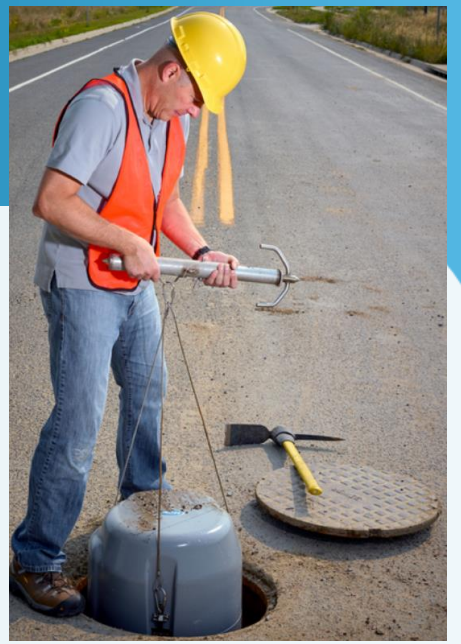
# Poll

# The watch dog solutions

# Sampling and field testing

**Automatic samplers (H2S resistant)**

**Portable samplers for occasional campaign**



# Laboratory solution for inlet monitoring

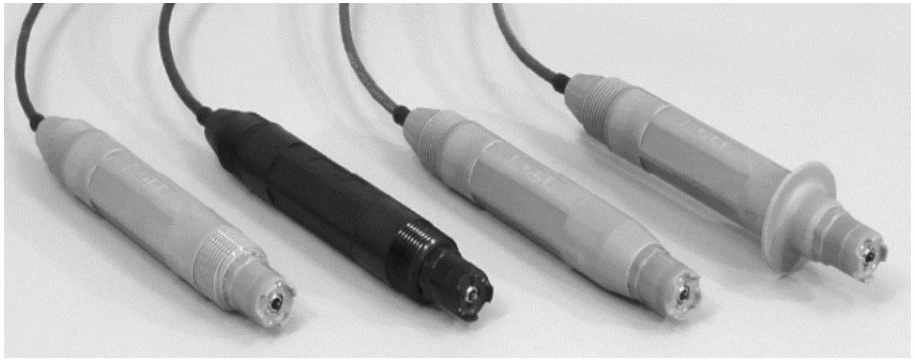
**Cuvette tests**

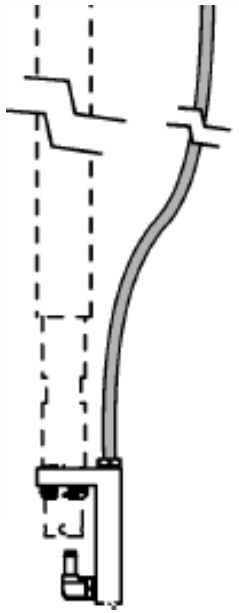
| Cuvette tests adapted to influent monitoring |
|---|
| COD / TOC / COD for sample with high chloride load |
| TN/$NH_4$/$NO_2$/ $NO_3$ |
| TP/$PO_4$ |
| Chloride |
| Trace metals (Cu, Zn, Cd, Hg, Pb…) |


**Heating blocks**

**Spectro-photometer**

# Electrochemical measurements: pH, T°C and ORP





- Help to identify abnormal situations, progressive drift or sudden change
- Potential indicator of an industrial discharge
- A non adapted pH can lead to treatment limitations (ex : coagulation, flocculation, biological treatment..)
- Low ORP values illustrate anaerobic conditions of the network

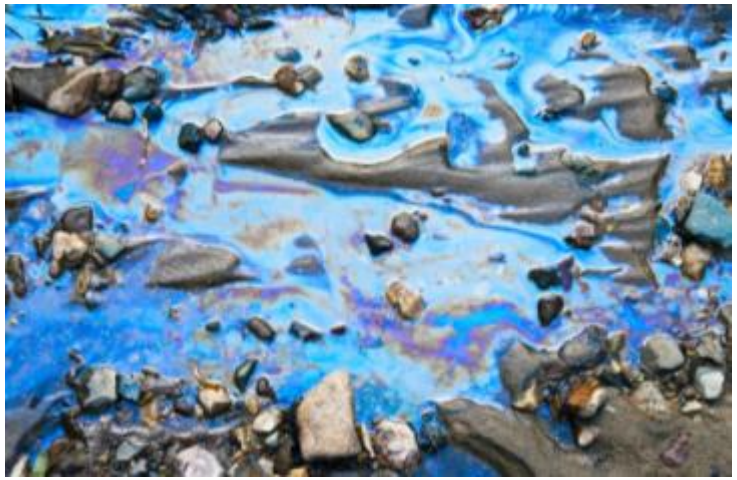
# Electrochemical measurements: conductivity

- Allow observation of sudden change or progressive drift of inlet conditions
- Indicator of possible impact of industrial discharges (ex : salting industries)
- Indicator of see water intrusion or runflow water intrusion after a snowy episode
- A high salinity can lead to bacteria lyse and compete biology up-set

# Solids measurements

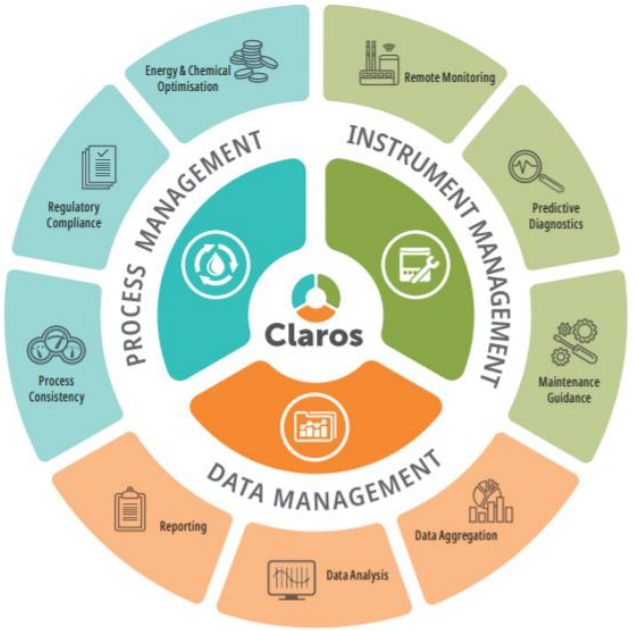
- Allow observation of sudden change or progressive drift of inlet conditions
- Indicator of possible impact of industrial discharges

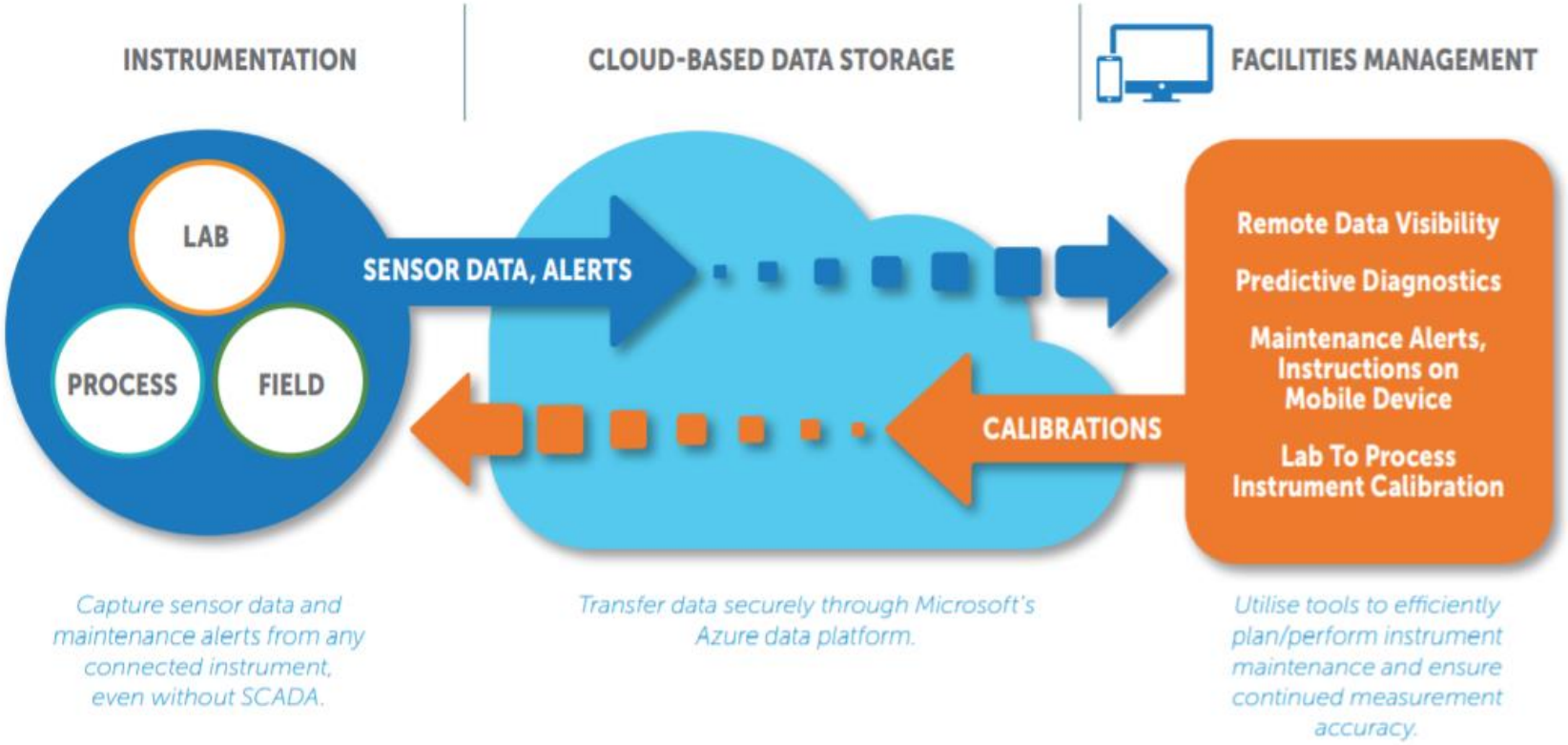
# Hydrocarbons measurements



- Detect Polycyclic Aromatic Hydrocarbons pollution
- Fluorescence probe for detection of even small mineral oil traces

# Claros instrument management - Overview



# Claros instrument management - Overview



Key functionalities

- Remote visibility
- Device viewer
- Alerts
- Maintenance instructions
- Instrument calibrations

# The inlet load monitoring solutions

# Influent monitoring solutions

- TOC online measurement up to 20.000 mg/L
- B7000i for TOC only and up to 6 channels
- B7000 TOC TN TP for combined measurement of TOC and nutrients and up to 3 channels

**Applications: Municipal and industrial wastewater**


**Biotector B7000 Series**

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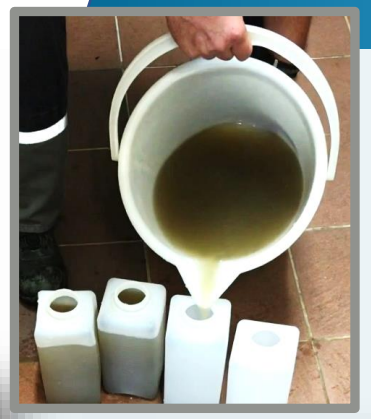
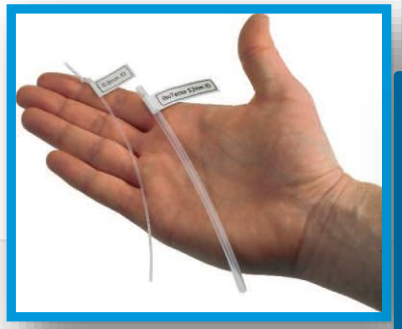
# TOC measurement with BioTector

- Large sample volume - representative
- Optimal accuracy
- Large sample tubes – no filtration needed
- Particles up to 2 mm ok






**TSAO Technology**

**Very strong basic digestion**

- Automatic cleaning of sample lines
- 6 months maintenance interval
- Low operation and maintenance costs
- High up-time (MCert. 99.86%)

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# Method: TSAO (Two stage advanced oxidation)

## TIC Sparging

- Addition of acid and sparging of inorganic carbon (TIC)

## 1st Base Oxidation Phase

- Addition of base and ozone for oxidation via $OH^{\bullet}$ Radicals

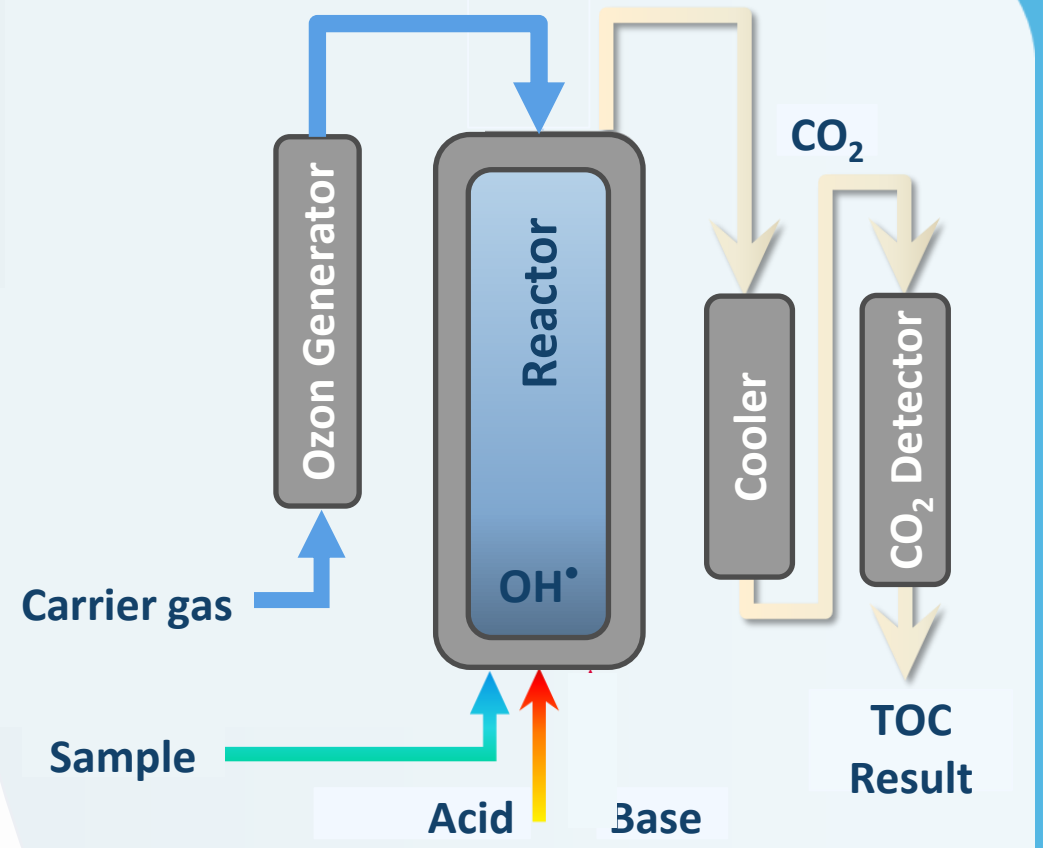
## 2nd TOC Phase

- Addition of catalyst and acid to complete oxidation and sparge all $CO_2$

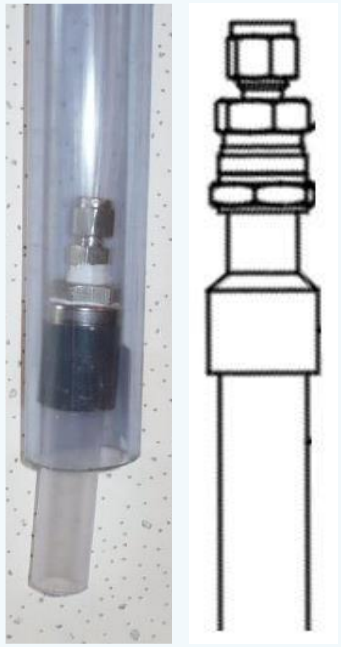
## Nutrient Measurement

- **TN:** direct photometric measurement of nitrate in fully oxidized sample.

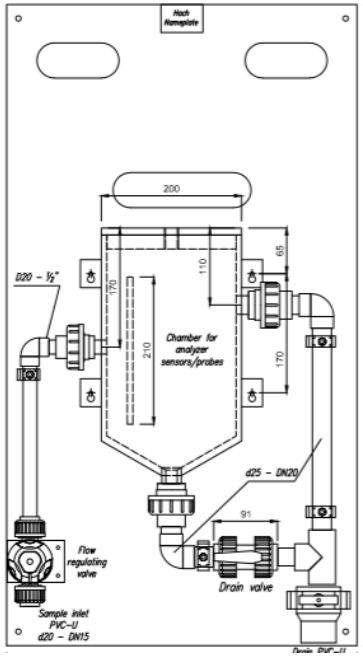
- **TP:** colorimetric analysis of Phosphate with standard Vanado-molybdo-phosphoric-acid method after oxidation



# Biotector sampling systems



Sand trap
Sampling from tank




Overflow vessel
Water with particulates

Flow through sand trap
Flowing sample

Venturi Sampler
Far away or dirty samples

# Case Study – Wastewater Treatment Plant Oijen, NL

## Starting Point

- WWTP Oijen: sewage from 350.000 inhabitants + industries
- No nutrient analyzers for influent or effluent monitoring.
- Unpredictable spikes from industries

Third-party lab testing for nutrients

Exceedance of phosphate discharge limits

Process upsets
-> costly remediation

# Case Study – Wastewater Treatment Plant Oijen, NL

## Solution

- 2 Hach BioTector B7000 TOC/TN/TP analyzer at plant inlet and outlet
- Influent monitoring for insights into mix of industrial and municipal WW
- Identify frequent spikes and react.
- Find root cause for not meeting effluent limits. (process or external discharges?)

# Case Study – Wastewater Treatment Plant Oijen, NL

## Benefit

- Hach BioTector TOC/TN/TP analyzer alerts plant managers to spikes
- Fast tracking of industrial pollutants possible

No high cost for process restoring after disturbance

Plant has been complying ever since the BioTector units were installed.

# Toxicity monitoring

# Influent Toxicity Issues in Wastewater Treatment Plants

## Definition of toxicity (in water)

**Toxicity is a non-specific parameter that allows for monitoring and protection of WWTP bacteria by alerting the plant to changes that show toxic substance inhibition in plant influent**

1. Respiration inhibition: when toxicity of influents threatens the metabolic ability of the activated sludge.
2. Nitrification inhibition: when nitrifying bacteria no longer can convert ammonia-nitrogen to nitrate or nitrite.
3. Shock loads: when a high strength waste upsets the microbial culture of the plant.

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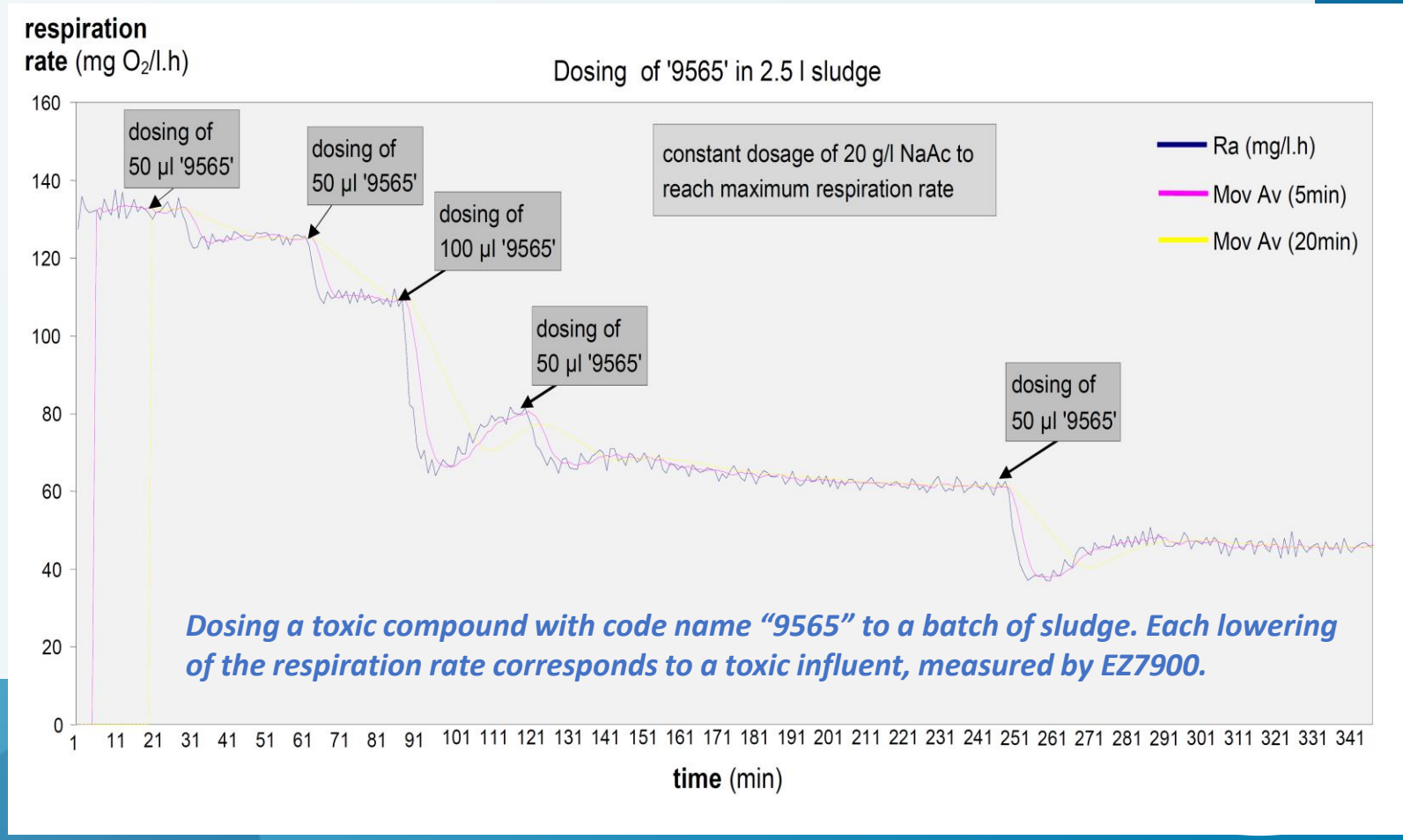
# Poll

# Toxicity & respirometry for WWTP protection

**Activated sludge used in the treatment plant is a mixture of bacteria and microorganisms that can degrade effluent quality, while doing this they consume oxygen / respire**

*Toxic influent → respiration ↘ → Metabolic rate ↘ → BOD/COD removal ↘*

- Respirometry is a valuable technology for monitoring toxicity, and control of the activated sludge process.
- Respirometry allows a quick assessment of the metabolic condition of microorganisms in the activated sludge.
- The respiration rate reflects the metabolic condition of bacteria




*Dosing a toxic compound with code name "9565" to a batch of sludge. Each lowering of the respiration rate corresponds to a toxic influent, measured by EZ7900.*

# Respirometry – How?

- A respirometer is an instrument designed for measurement of the respiration rate or oxygen consumption rate:

$$Respiration\ rate\ = \frac{Mass\ of\ oxygen\ (mg)}{unit\ of\ volume\ (l)\ x\ time(h)}$$

- The respiration rate is measured directly by the measurement of the DO probe in the liquid.

- Method based respiration of activated sludge (related to the oxygen uptake rate (OUR) test)

# Respirometry – In the laboratory

- The technique is mainly focused solely on the measurement of the Biochemical Oxygen Demand (BOD) of wastewater.


**HQd and LBOD101 probe**

- Automatic monitoring of BOD5

**BOD Direct Plus**

**BOD TRAK II**

# EZ7900 Series : Respirometry on-line

The ER7900 is respiration analyzer able to monitor **acute** and **chronic** toxicity on-line

- Measurement of the respiration rate by means of a single dissolved oxygen electrode
- With 15 min cycle time, it’s an early Warning System
- Standard smart automatic features (cleaning,…)

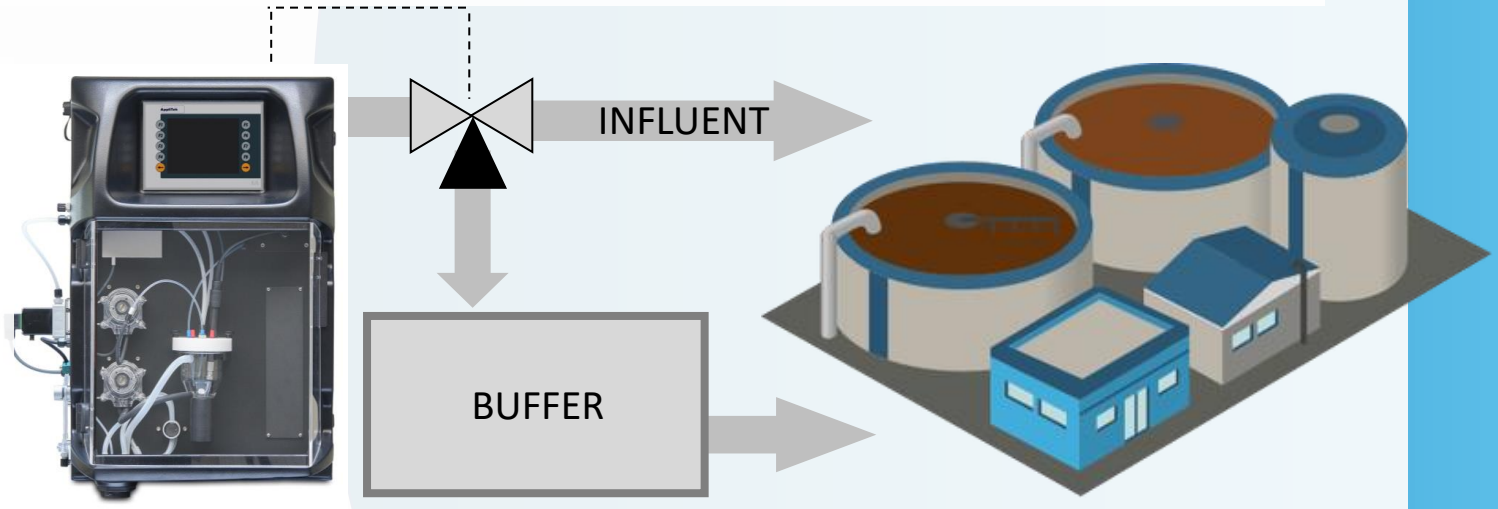
- Multi-stream analysis available with each stream results communicated through individual analogue outputs or modbus
- Standard 4 – 20 mA output with alarm processing through the panel PC.

# EZ7900 Series – Unique selling point

Measurements are carried out on **real sludge, freshly sampled** from the actual WWTP by means of a dedicated filtration unit.

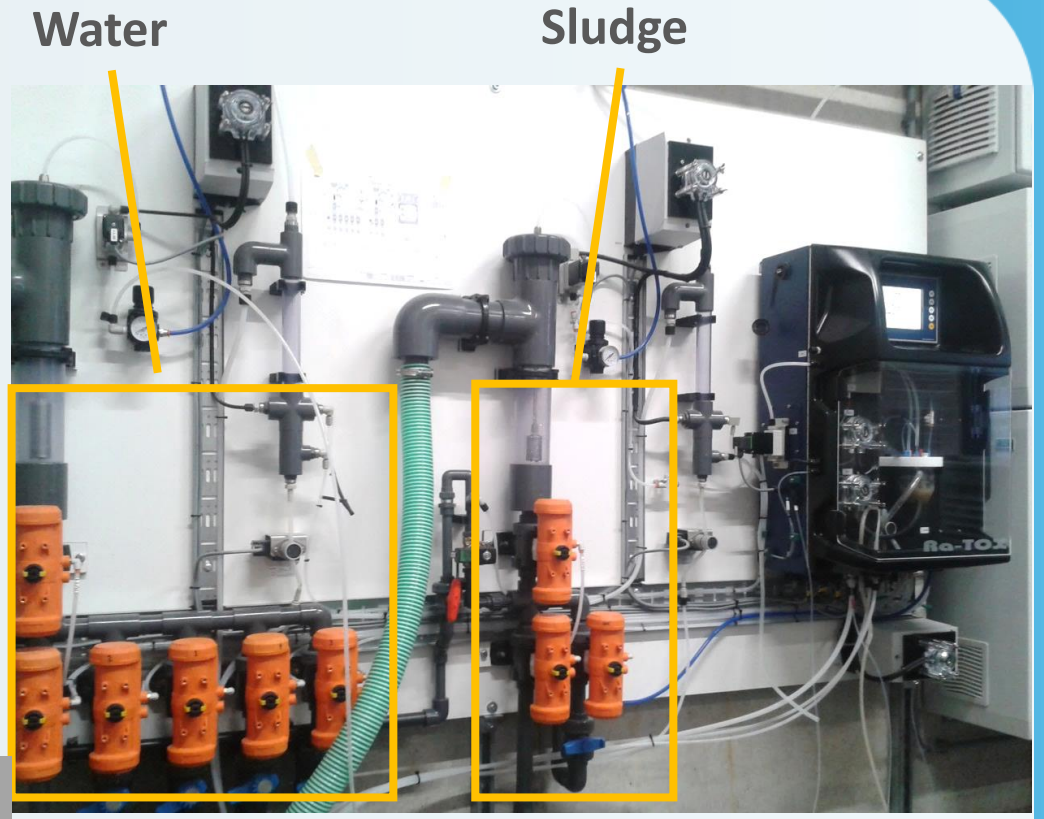
This has the following advantages:

- Dynamic changes in biomass viability are taken into account.
- Measurement at same conditions as the WWTP (pH, Temperature)
- Provide early warning to toxic events or chronic toxicity caused by cleaning agents or shock loads
- Allows operators to take corrective actions to protect the viability of the wastewater treatment plant



# EZ9100: filtration & preconditioning modules

- Sampling with EZ9100 external filtration system
- 2 adequate sample modules:
  - ✓ EZ9110 for water inlet (500µm filtration)
  - ✓ EZ9120 for sludge (1000µm)
- Multi-stream analysis available (typically 2-4 sample streams influent)
- Sample selection controlled by the analyzer
- Results of each stream can be communicated through individual analogue outputs or Modbus
- Automatic cleaning features




Sampling with EZ9100 external filtration system

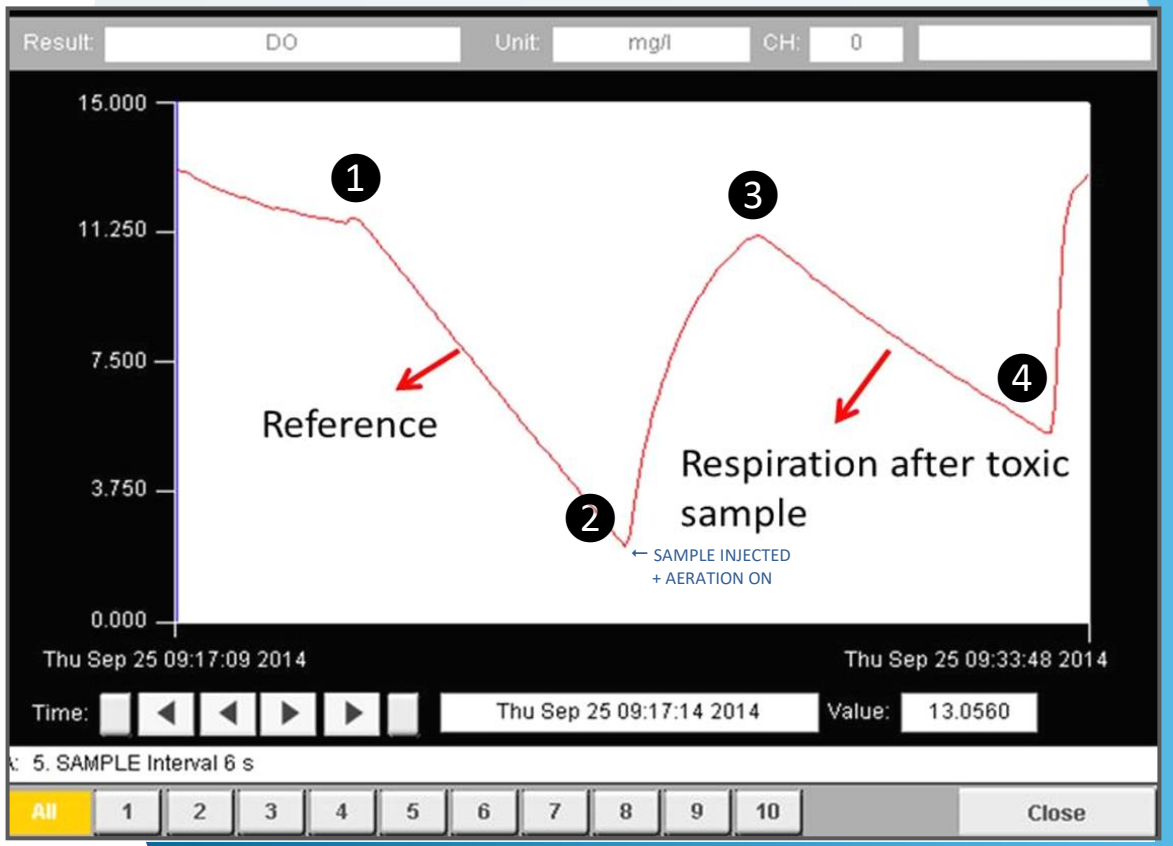
# EZ7900 Series – analysis procedure

**Toxicity calculation: 2 steps**

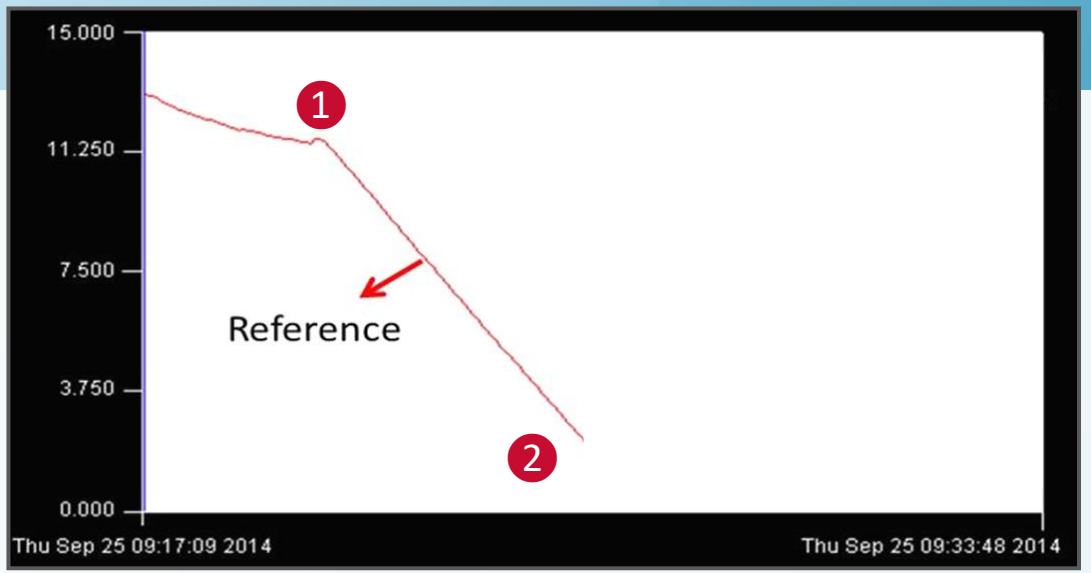
1. Respiration rate **REF** ( Chronic ) = $\frac{\textbf{Oxygene } 1 - \textbf{Oxygene } 2}{\textbf{Time}}$

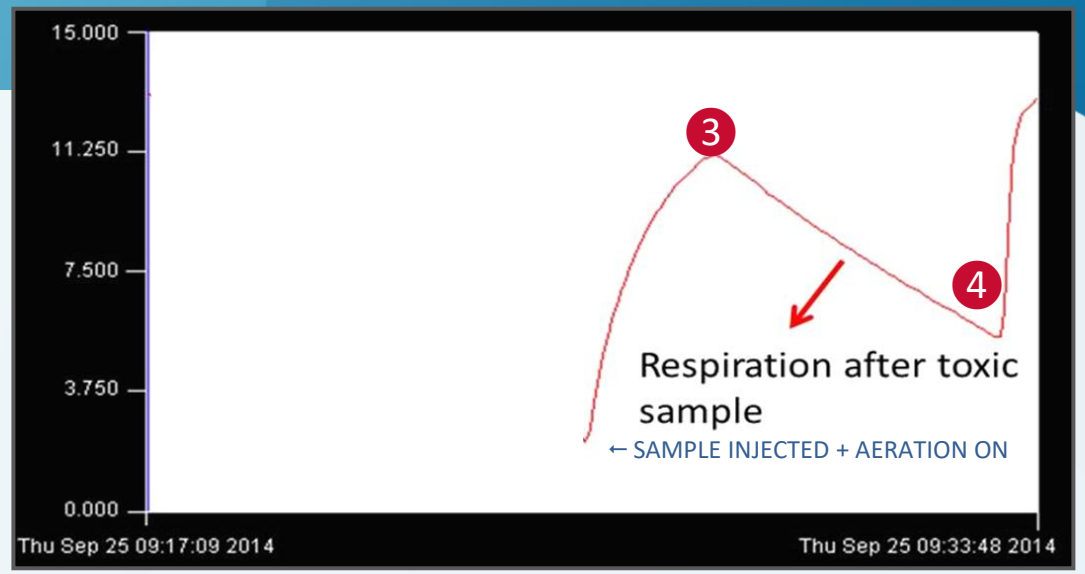
2. Respiration rate **TOX** ( Acute ) = $\frac{\textbf{Oxygene } 3 - \textbf{Oxygene } 4}{\textbf{Time}}$

$$\textbf{Toxicity } (\%) = \frac{\textbf{R.R. REF} - \textbf{R.R. TOX}}{\textbf{R.R. REF}} \textbf{ x 100}$$



# EZ7900 Series – analysis procedure




## Step 1: Reference measurement (R.R. REF)

- Analysis vessel is filled with sludge

1 Analyzer aerates sludge and adds nutrient buffer (NaAc)

- Aeration stops $O_2$ consumption in sludge is measured

2 Respiration rate for "healthy" sludge is calculated

**Respiration rate REF = (Oxygen 1 – Oxygen 2 / time)**

## Step 2: Toxicity measurement (R.R. TOX)

3 Wastewater influent added to vessel and aerated

- Aeration stops and second $O_2$ consumption value measured
- Respiration rate for wastewater sample calculated

4 Calculation of respiration rate and toxicity index made

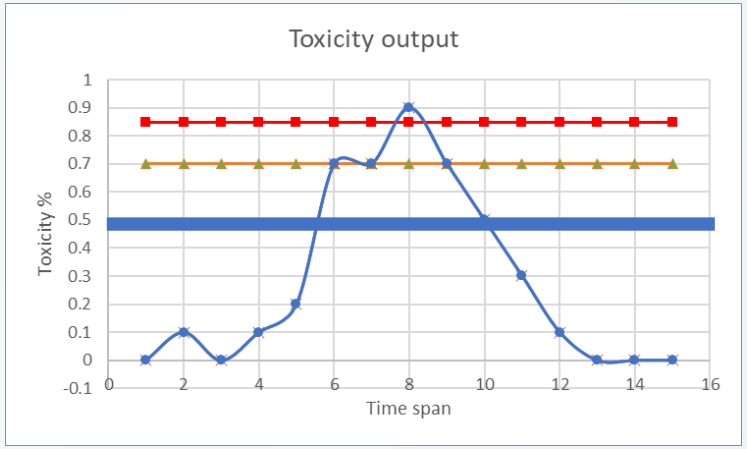
- Filters, analyzer, and $O_2$ probe are auto flushed & rinsed

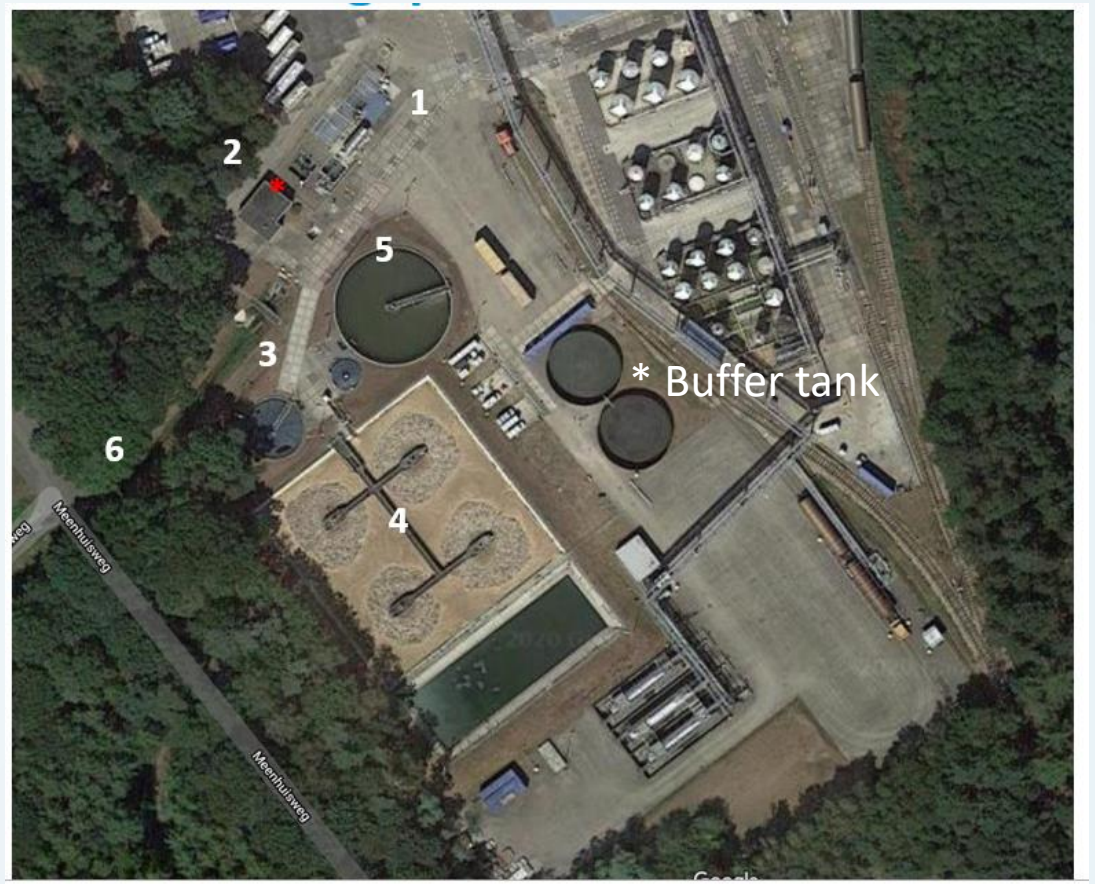
**Respiration rate TOX = (Oxygen 3 – Oxygen 4 / time)**

**Toxicity (% inhibition) = (R.R. REF –R.R. TOX )/R.R. REF x 100**

# Case study : toxicity measurement on a WWTP

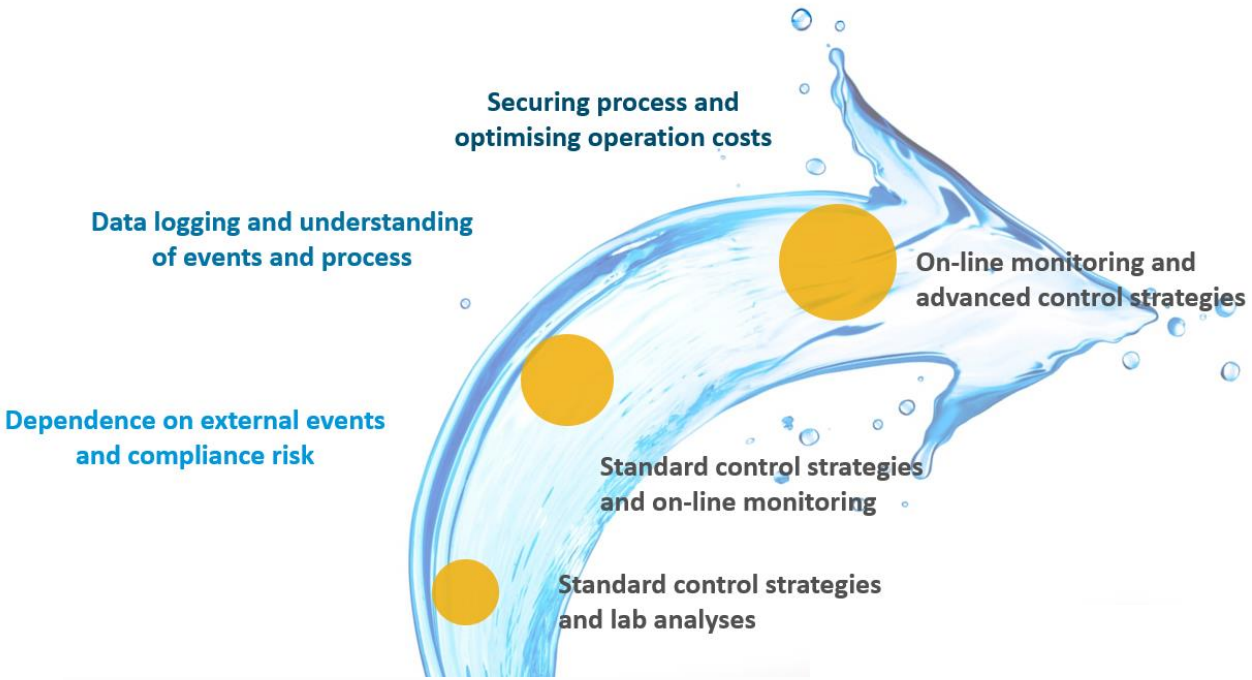
1. Inlet and pH Adjustment
2. House of Analysis
3. Pre - Clarifier
4. Aerated Zone
5. Final - Clarifier
6. Effluent



# Conclusion

# Gain insight into your wastewater treatment facility




**Influent monitoring** helps to:

- Better anticipate peak loads
- Better adapt settings to load variations
- Ensure compliance
- Protect the plant
- Optimize operational costs

# Questions

# Thank you!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