



Be Right™

PROCESS TECHNOLOGY FOR PLANT OPTIMIZATION

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Great Lakes Region

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WWOA Lake Michigan District
Sturgeon Bay, WI

TREATMENT IS A HIGHLY VARIABLE OPERATION

Operator Questions -

- What to measure – and why?
- Where to measure it?
- Is a daily grab sample representative, good enough?
 - **Hint: It is not**
- Is my plant running as designed?
- Is my instrument giving me correct readings?
- What do I do with the data?
- Do the chemical, power savings matter?
 - **Hint: Absolutely**

TREATMENT IS A BUSINESS

- Retiring workforce - Institutional knowledge is leaving the industry
- Changing Raw Materials
 - Factories come and go
 - Population changes
 - I&I / Pb mitigation
- Budget concerns
- Compliance regulations
- Data management
 - Common Platform / Language
 - Data Security
 - Remote Access



Claros Overview

Instrument Management

Data Management

Process Management

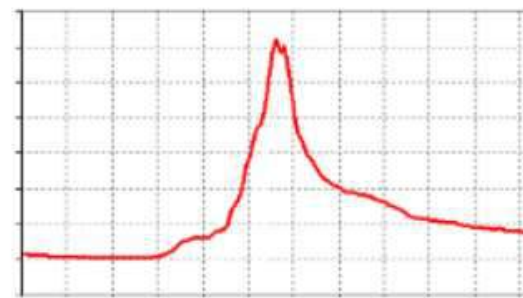
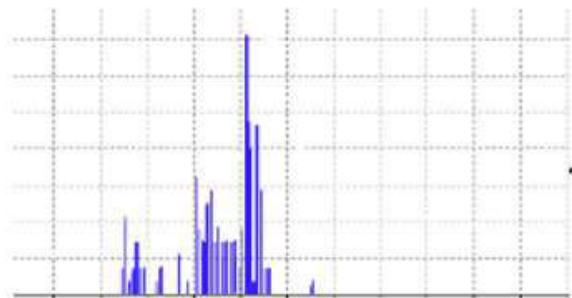
Everyone is being asked to do more with less but how?

WELCOME TO THE AGE OF THE BLACK BOX

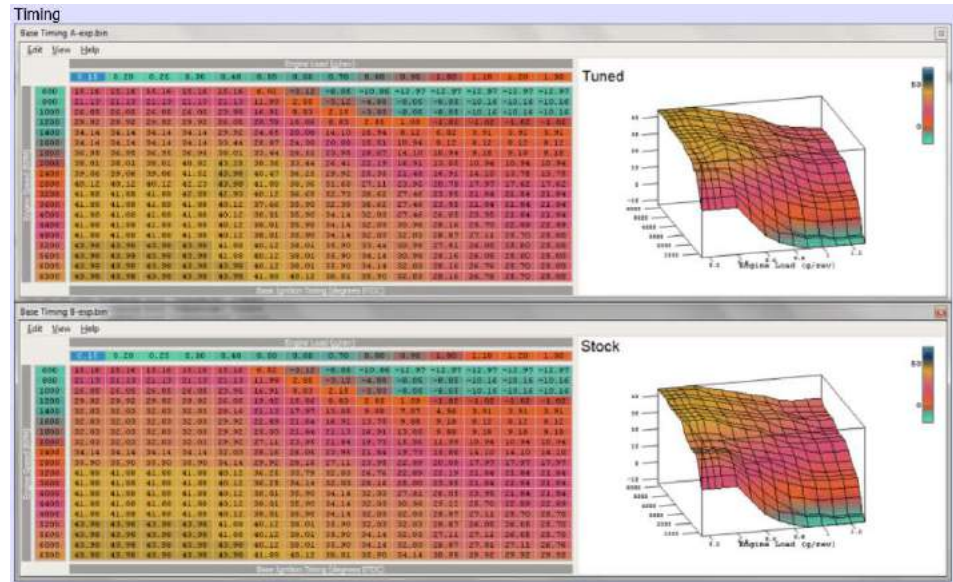
BLACKBOXING:

“The way scientific and technical work is **made invisible by its own success**. When a machine runs efficiently, when a matter of fact is settled, one need focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become.”

INTERNAL COMPLEXITY, EXTERNAL SIMPLICITY



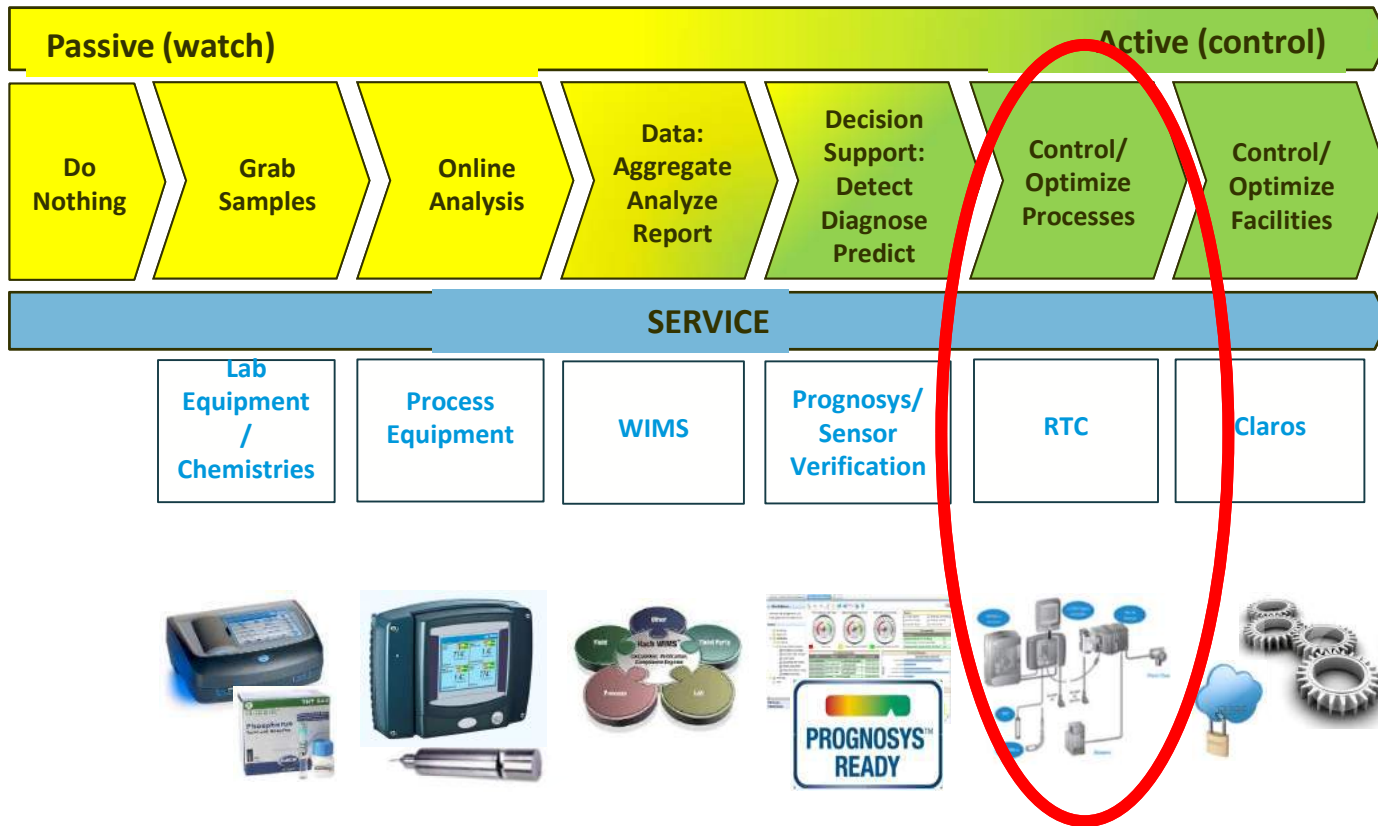
“BLACK BOXES” IN EVERYDAY LIFE



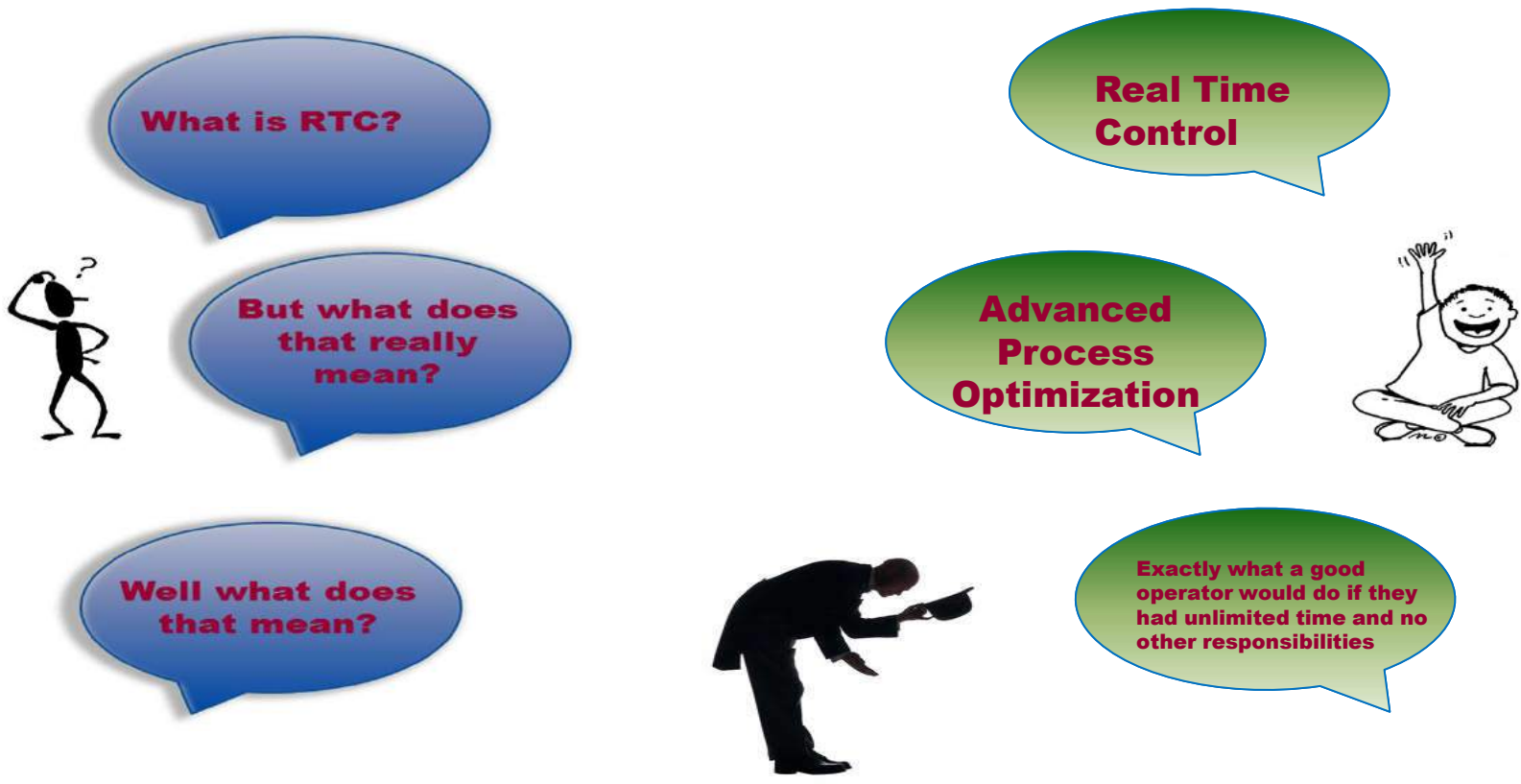
Real world systems:

- Incredibly complex input parameters
- No two days are the same (even minute by minute)
- Critical for Health, Safety, Performance
- Not conceivable to measure by a single person
- Variability in output is ALWAYS negative

WASTEWATER PROCESS CONTINUUM



CLAROS PROCESS MANAGEMENT - REAL TIME CONTROL



WHAT DO WE REALLY MEAN?

“Measurement is the first step that leads to control and eventually to improvement. If you can’t measure something, you can’t understand it. If you can’t understand it, you can’t control it. If you can’t control it, you can’t improve it.”

H. James Harrington

WHY DO WE DO IT?



Is it really all about the money?



WHY DO WE DO IT?



So it's all about the environment then?



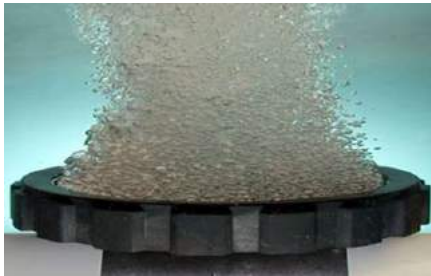
LET'S THINK ABOUT WHERE WE ARE



Compliance is King

*This approach drives avoidance of penalties –
“cost of doing business”, no public visibility of fines*

Therefore, more is better... Isn't it? At what cost?



More air



More chemical



More Capacity

= Robust Compliance



At the cost of energy / labor / chemical wasted

SINGLE TARGET, MANY GOALS

Compliance



So compliance is the only driver?

Efficiency



Sustainability



Environment

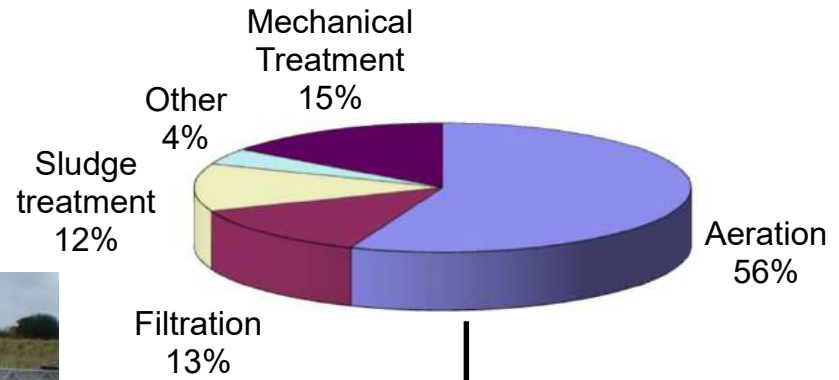


Process stability



ENERGY CONSUMPTION IN BIOLOGICAL WWTP'S

Why target aeration processes?



Offer a large potential for savings

TARGET COST REDUCTION VIA MODEL BASED DESIGN

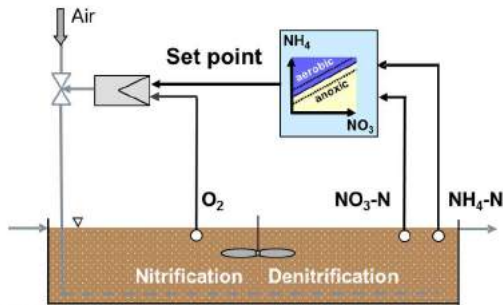
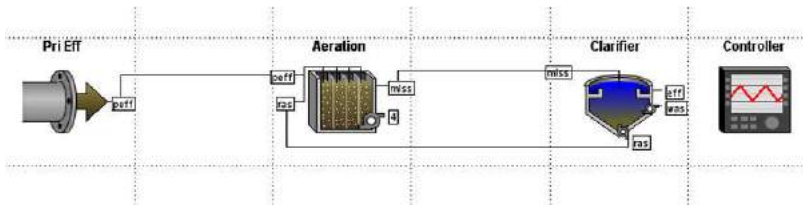


Figure 1: Typical RTC-N/DN installation schematic

Step 1: Identify Process



Step 3: Build Virtual Plant

Table 1: Activated Sludge Model Configuration

Tank	Anoxic	Aerobic	Aerobic	Aerobic	Aerobic	Aerobic
Volume	0.180 MG	0.180 MG	0.180 MG	0.180 MG	0.180 MG	0.180 MG
% of Airflow	0	25	18.8	18.8	18.8	18.8
Primary Effluent	1,200 gpm, TKN:25mg/l, TSS:88 mg/l, BOD:135 mg/l, Temp: 15C					
MLSS	2,850 mg/l					
RAS	1610 gpm from Clarifier to Anoxic Tank					
WAS	21 gpm					
Blower Airflow	1700 SCFM @ 7 psig					

Step 2: Use Good Data

RTC-N/DN Simulation

By allowing the complete aeration basin to go between aerobic and anoxic reduces the amount time aeration is on by 55%, and Total nitrogen in the effluent by 72% with minimal increase of ammonia leaving the aeration basins.

Table 2: Results from the RTC-N/DN-2 Simulation

	Effluent		Aeration	
	Ammonia mg/l	Total Nitrogen mg/l	Power kW/day	Cost @ \$0.10 kWhr \$/yr
Baseline	0.15	7.70	1173	\$42,814
RTC-N/DN	1.23	2.15	532	\$19,418
Reduction	-	72%	55%	\$23,396

Step 4: Actionable results

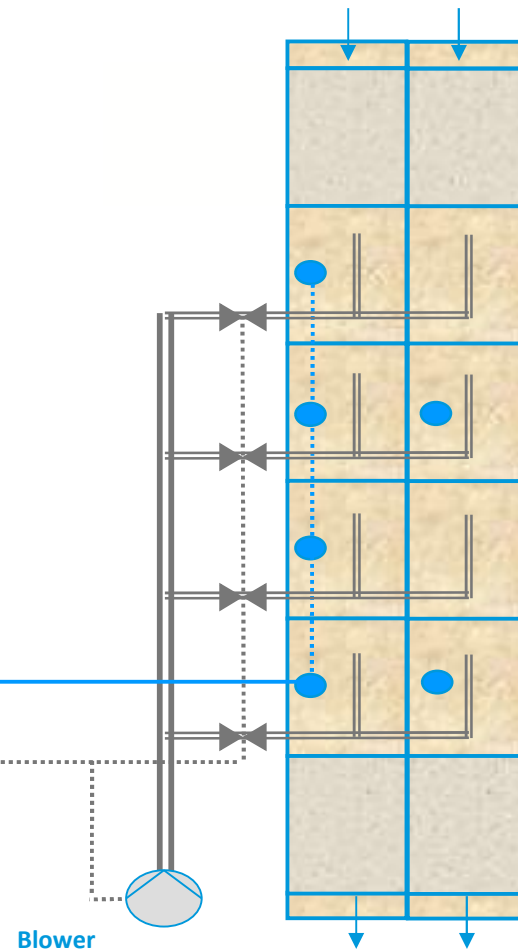
DO SETPOINT CONTROL SYSTEM

Standard Aeration Model

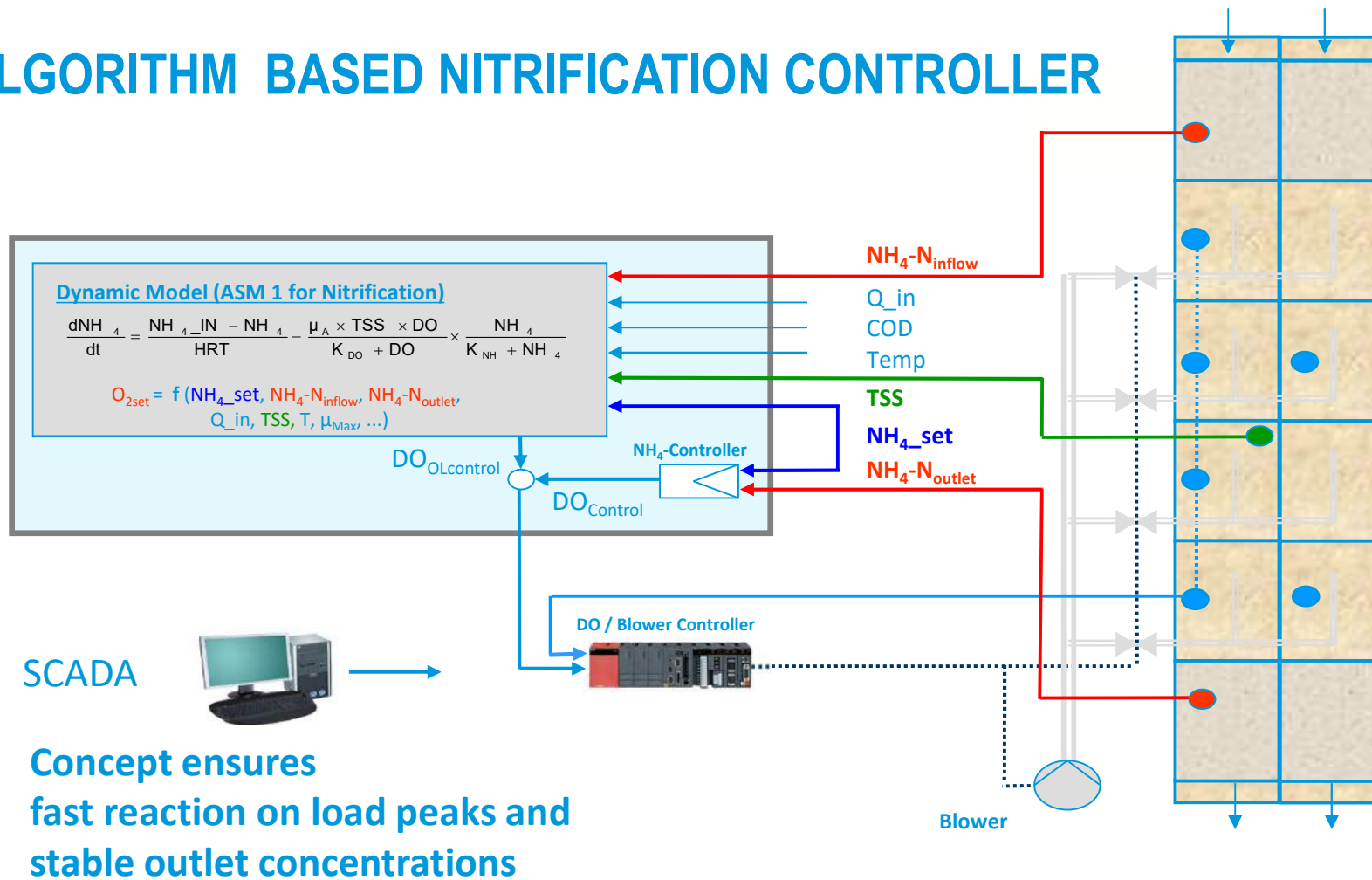
Operator Defined Target

The more we
measure, the more we
can control

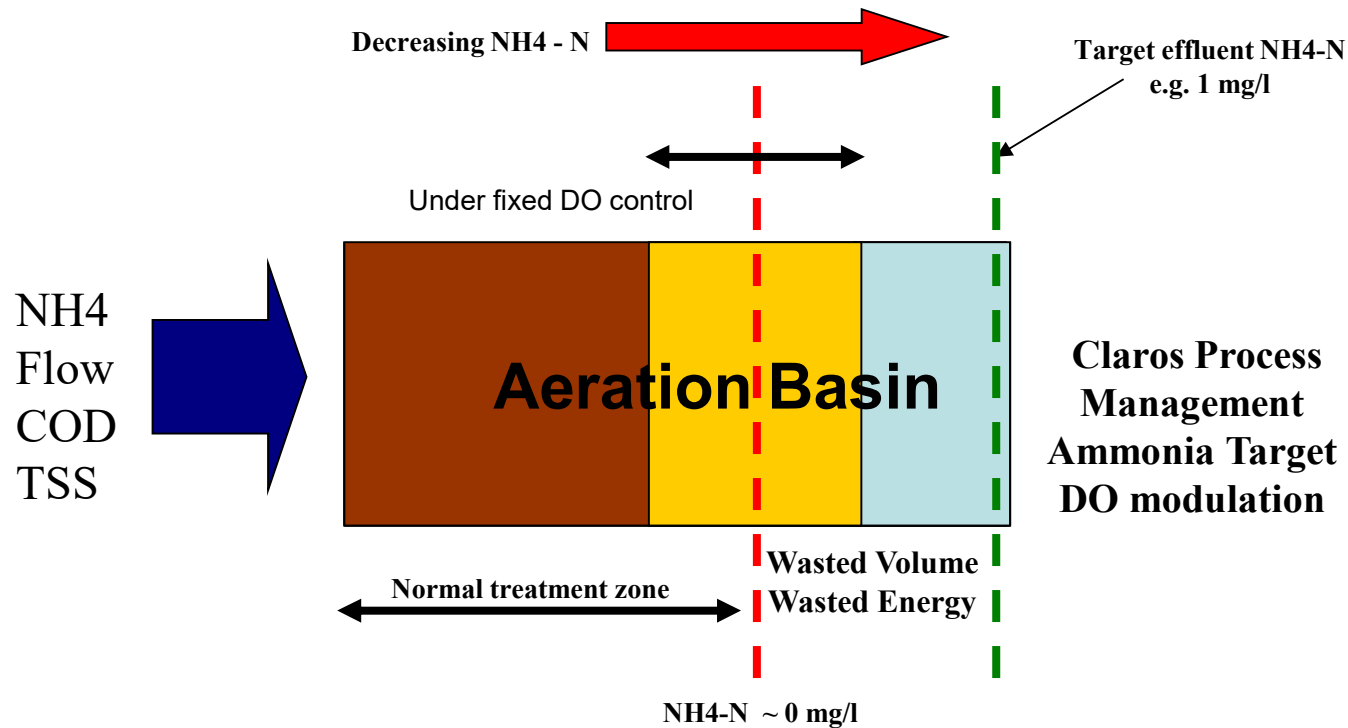
SCADA



ALGORITHM BASED NITRIFICATION CONTROLLER



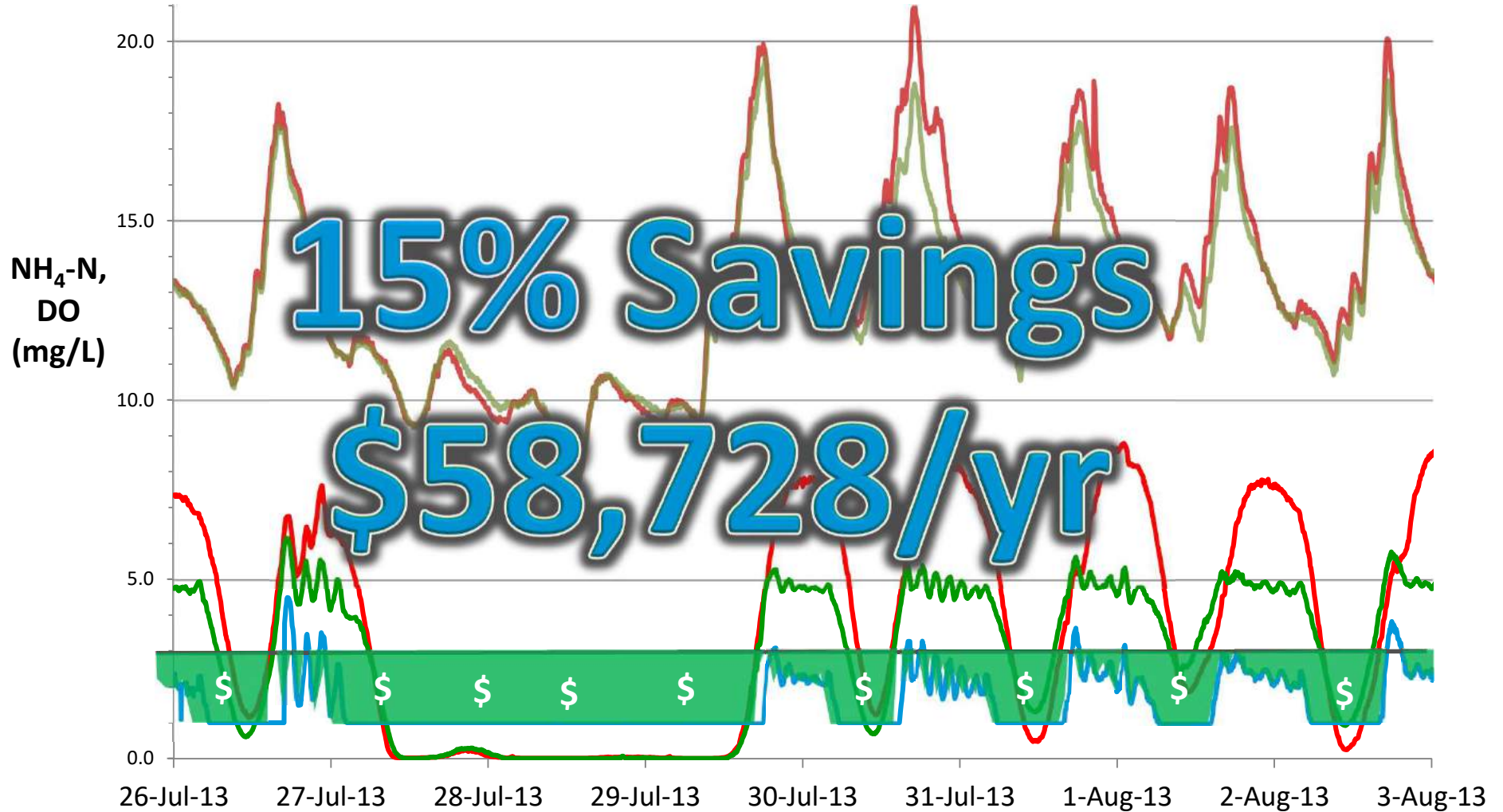
WHY TARGET AN ANALYTICAL INPUT WHEN YOU ARE BEING JUDGED ON A REQUIRED OUTPUT?



ACTUAL PLANT PROCESS DATA

Aeration Tank 1: Manual DO Control

Aeration Tank 2: ABAC Control (23 MGD)



MULTIPLE MODULES FOR PROCESS OPTIMIZATION



The CPM / RTC Umbrella Portfolio

P

N

N/DN

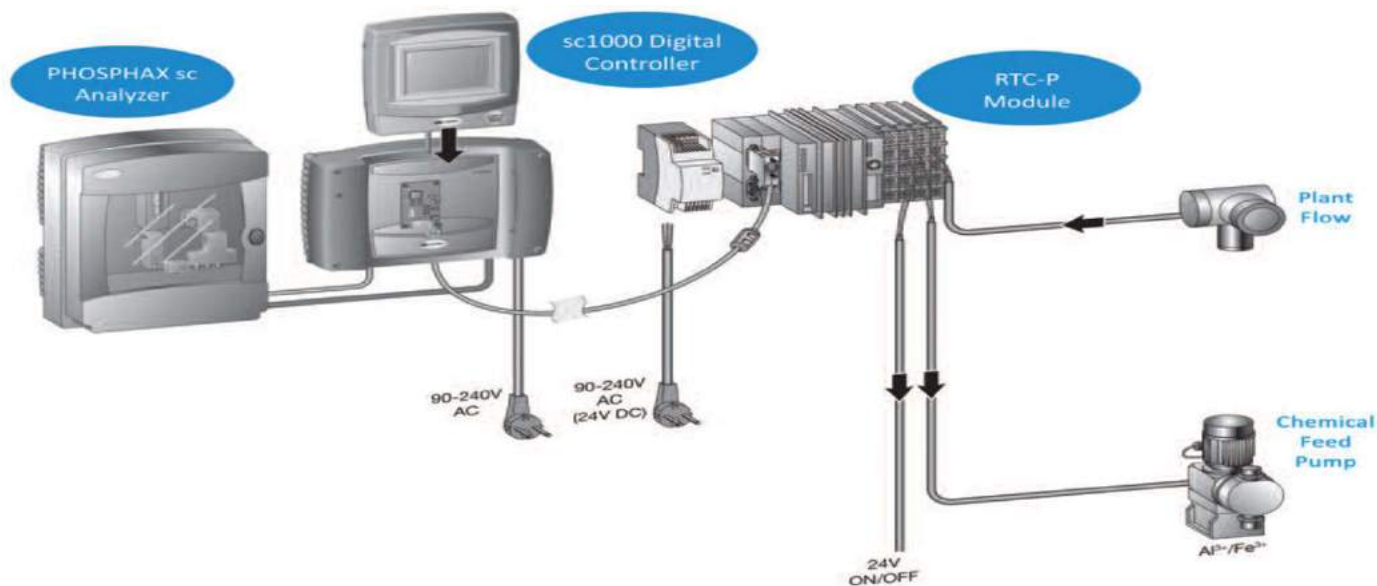
ST

SD

- For Chemical Phosphorus Removal
- Optimizes chemical dosing
- Designed for continuous flow plants
- Ensures compliance
- May reduce chemical cost

WHY HACH'S RTC FOR PHOSPHORUS CONTROL?

- Treatment Process is Optimized
 - Phosphorus load (Flow x Conc.) vs. Chemical effectiveness
- ROI is proven, can prove out cost benefit analysis of Precipitants
- Cost savings can be redirected
- Compliance worries are gone
- Hach offers packaged integration!



RTC-P

Components



**PHOSPHAX sc +
Filtrax**



sc1000

- Controls RTC parameters
- Signal validation
- All communication capabilities



RTC

- Calculates set-points in real time
- Interface for dosing pump
- Install in PLC cabinet



Plant Flow

- Needed to determine loading



Dosing Pump

- Control pump feed of precipitant based on PO_4 concentration

TYPICAL CLAROS PROCESS MANGEMENT INSTALLATION

"If we were high one week, we overfed ferric to make sure the average for the month was below our 1.0 mg/L total phosphorus limit."

The average dose was 300 gpd at 12.5 gph.

Now during months of higher loading, the ferric feed rate may increase from **3 gph to 10 gph.**

"Estimated annual savings of \$50,000 to \$70,000 have more than paid for the system."

Besides affordability, a major benefit was *peace of mind*. Previously, staff worried about whether the plant was over or at its limit for the month. "Now, the RTC controls the dose and I know we will be within our limit,"



Hach Family of Phosphax Analyzers



Phosphax sc HR (High Range)

(1-50 mg/L PO₄-P)
Aeration basin applications
Muni/Industrial WW Inlet



Phosphax sc MR (Medium Range)

(0.05-15 mg/L PO₄-P)
Aeration basin applications
Surface water monitoring
Industrial effluent



Phosphax sc LR (Low Range)

(0.015-2 mg/L PO₄-P)
Aeration basin applications
Surface water monitoring
Industrial effluent

New Photometric Unit

- Lower concentrations of Ortho-P in a sample require a longer measurement path length.

Beer-Lambert Law

Lambert's and Beer's Laws are combined to describe the attenuation of light by a solution. It is easy to see how the two standard photometric quantities can be written in terms of this law.

$$I = I_0 10^{-\epsilon c x}$$

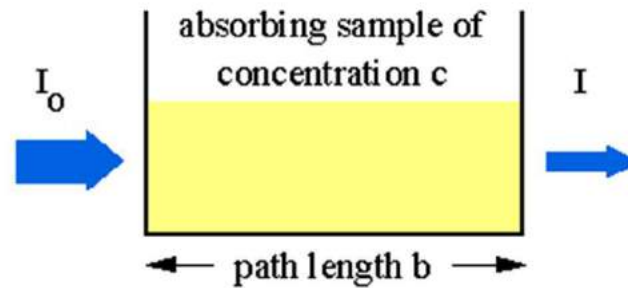
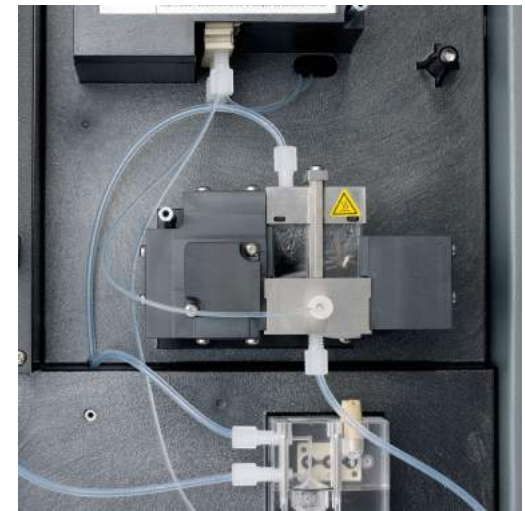
Transmittance

$$T = \frac{I}{I_0}$$
$$T = 10^{-\epsilon c x}$$

Absorbance

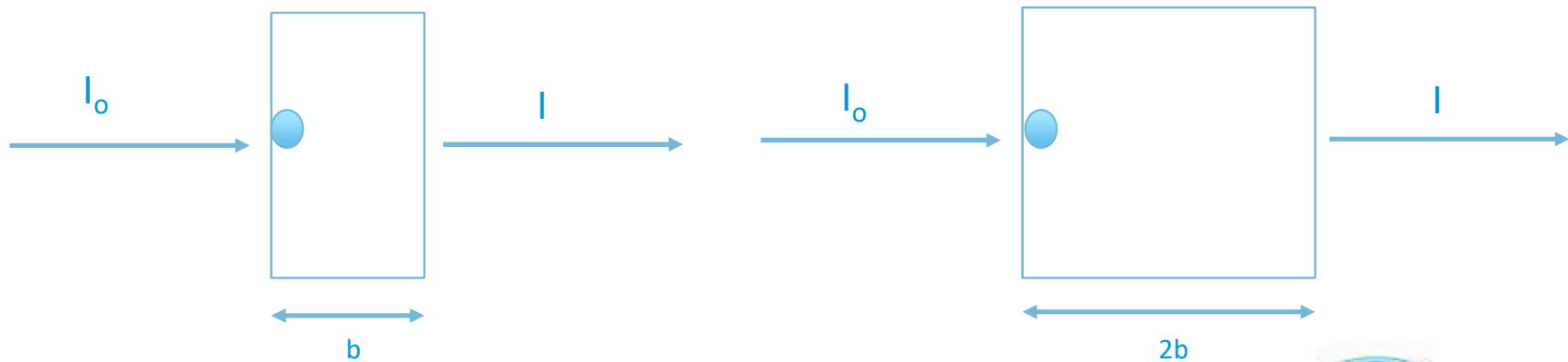
$$A = -\log\left(\frac{I}{I_0}\right) = -\log T$$
$$A = \epsilon c x$$

Phosphax sc MR : b= 18mm
Phosphax sc LR : b= 36mm



New Photometric Unit

- Glass cuvette is expected to last the whole life time of the analyzer- More durable vs plastic cuvette in most analyzers.
- Glass cuvette is less prone to air bubbles compared to plastic cuvette in most analyzers.
- Double path length reduces effect of bubbles, if any.



SAMPLE CONDITIONING

FILTRATION MODULES

- The Filtration Module prepares sample through two ultra-filtration membranes (0.15 μ)
- Modules are immersed in the process tank.
- Peristaltic pump pulls the sample through one filter at a time, allowing for optimal cleaning.
- Unit automatically cleans by forcing vigorous stream of air bubbles against sides of the filter modules.

Filtrax sc



Additional Features, integration and operation



Available in indoor and outdoor versions

- The housing is weatherproof so that the unit can be installed right at the basin, even in the toughest climates.



Claros Enabled

- You can leverage Hach Water Intelligence to collect, manage and analyze data.
- Full Featured “Plug and Play” Digital sc controller.



Zero requirement to cool reagents

- Longer shelf life of reagents.
- Ships with at least a 4-month supply of reagents.



Automatic calibration and cleaning

- Automatic cleaning at customized intervals and automatic zero-calibration at each measuring cycle.
- Low maintenance.

Product Applications



Municipal Effluent



Surface Water Monitoring



Industrial effluent



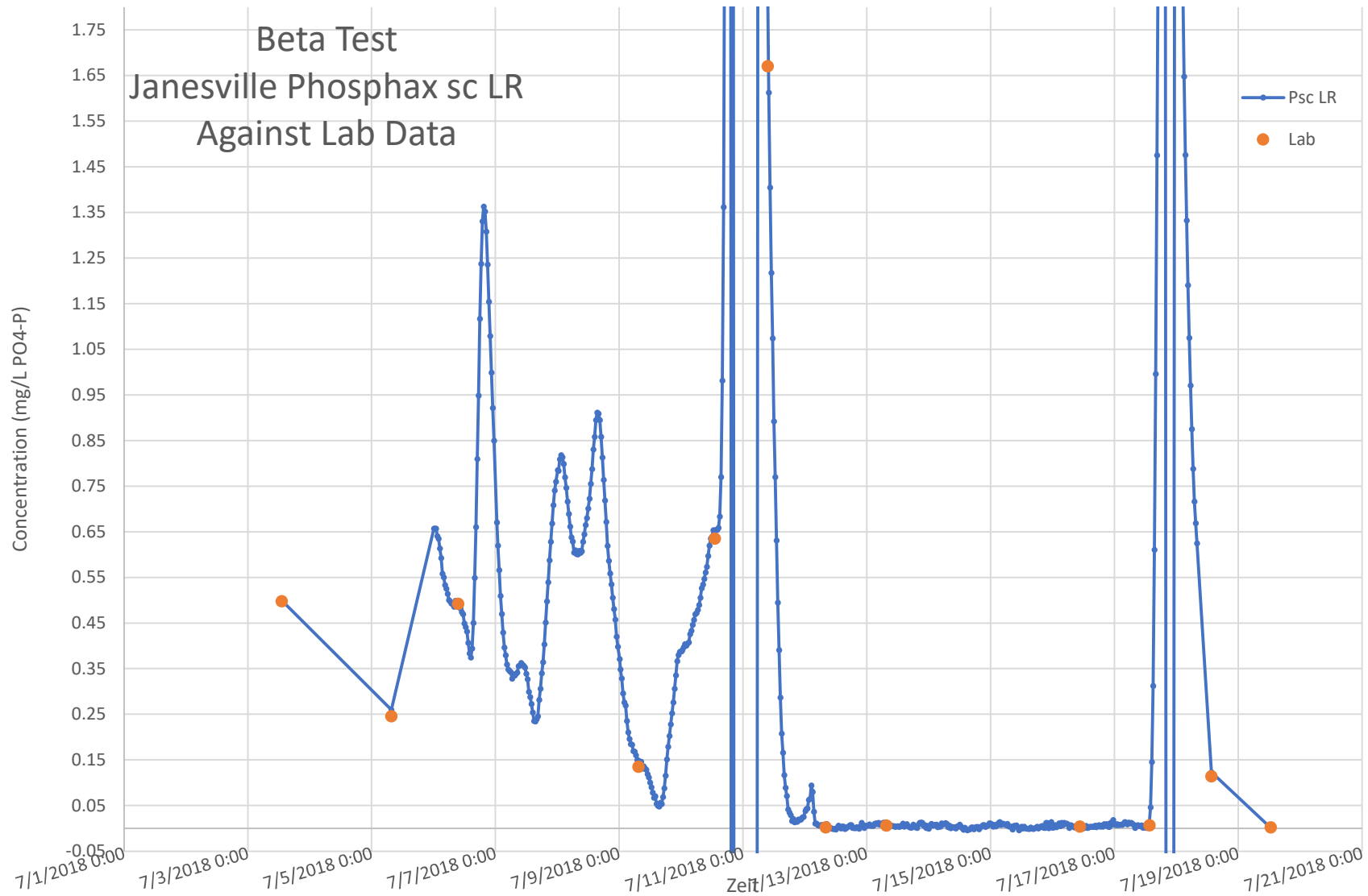
Beta Test Insights



Beta Test Locations



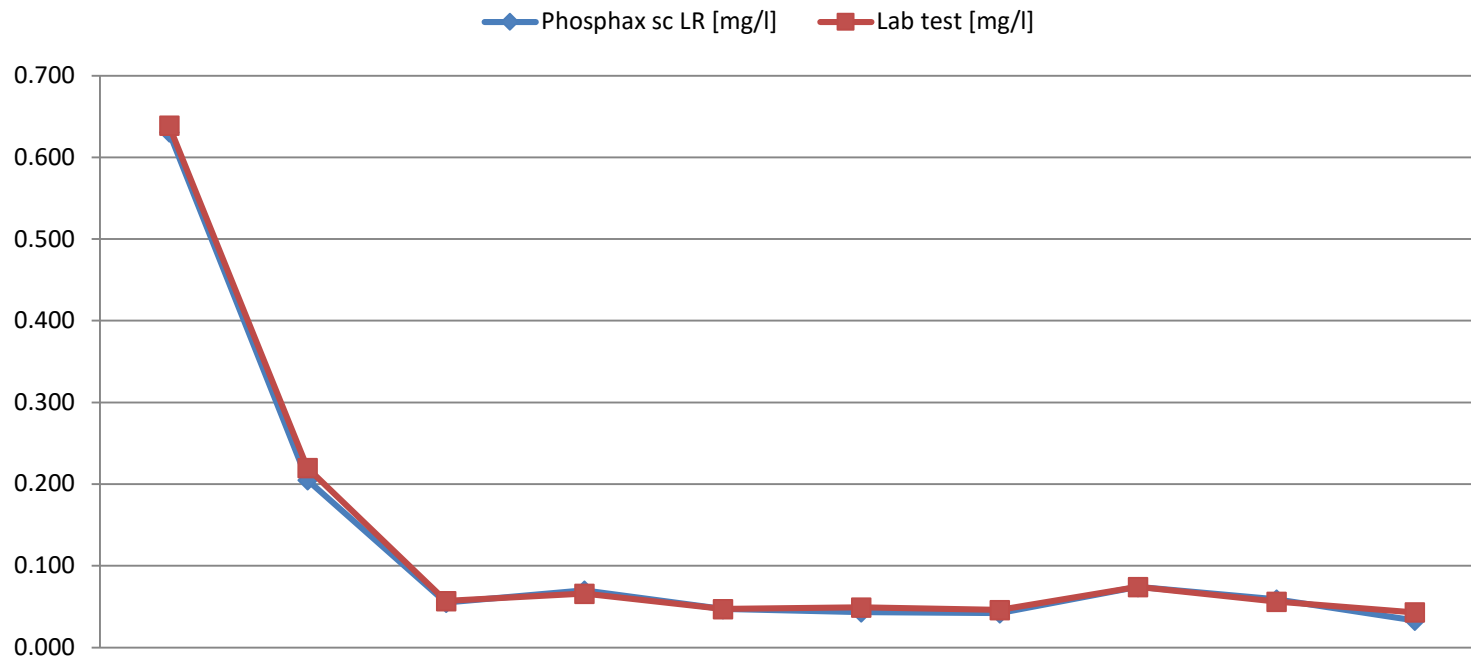
Comparable Lab and Process Results in Very Low Ranges



Company Confidential



Lab vs Process Comparison – an Overlap

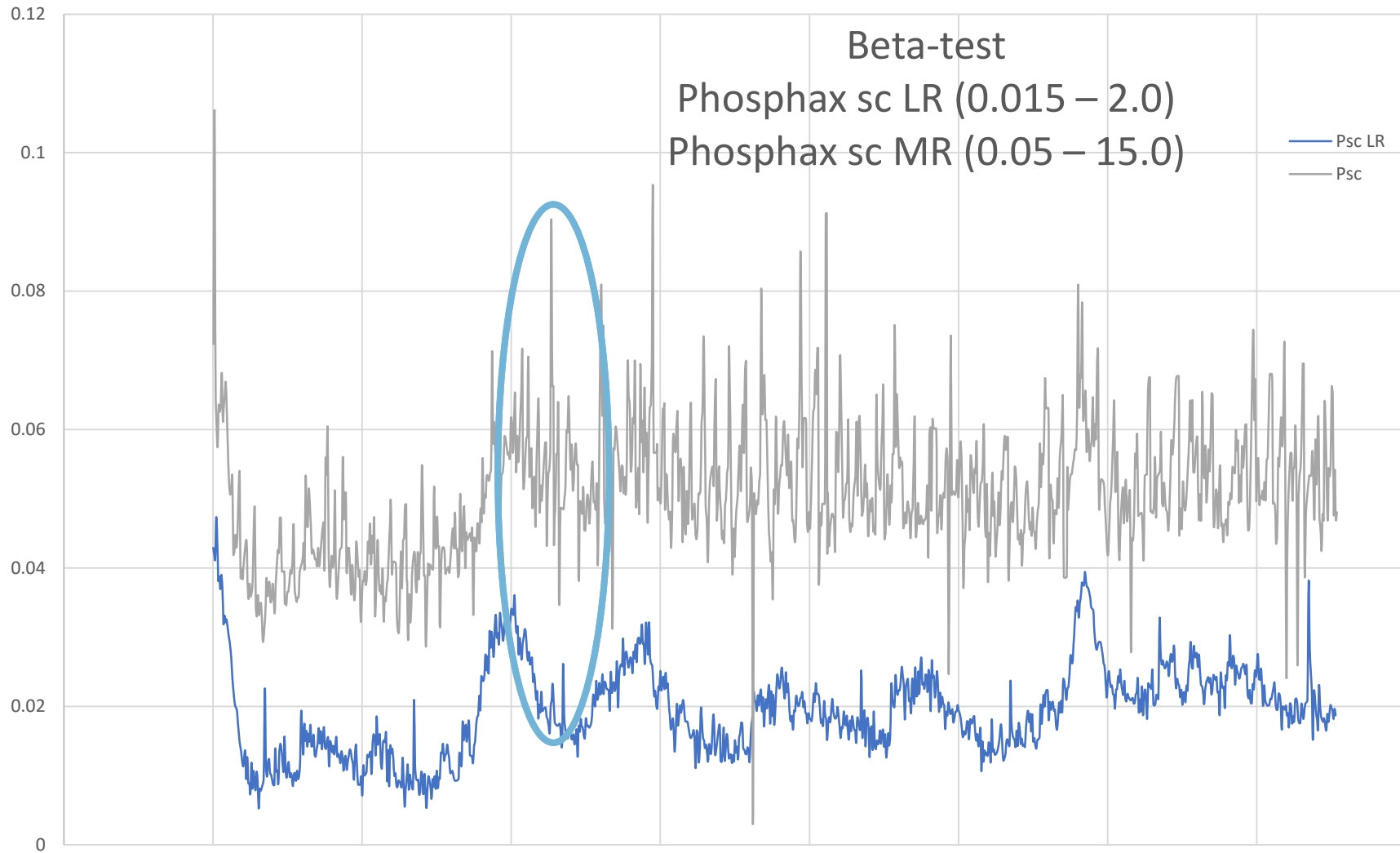


*Lab tests were done using TNT 843 chemistry/LZP269 cuvette and a Hach DR3900/6000 photometer

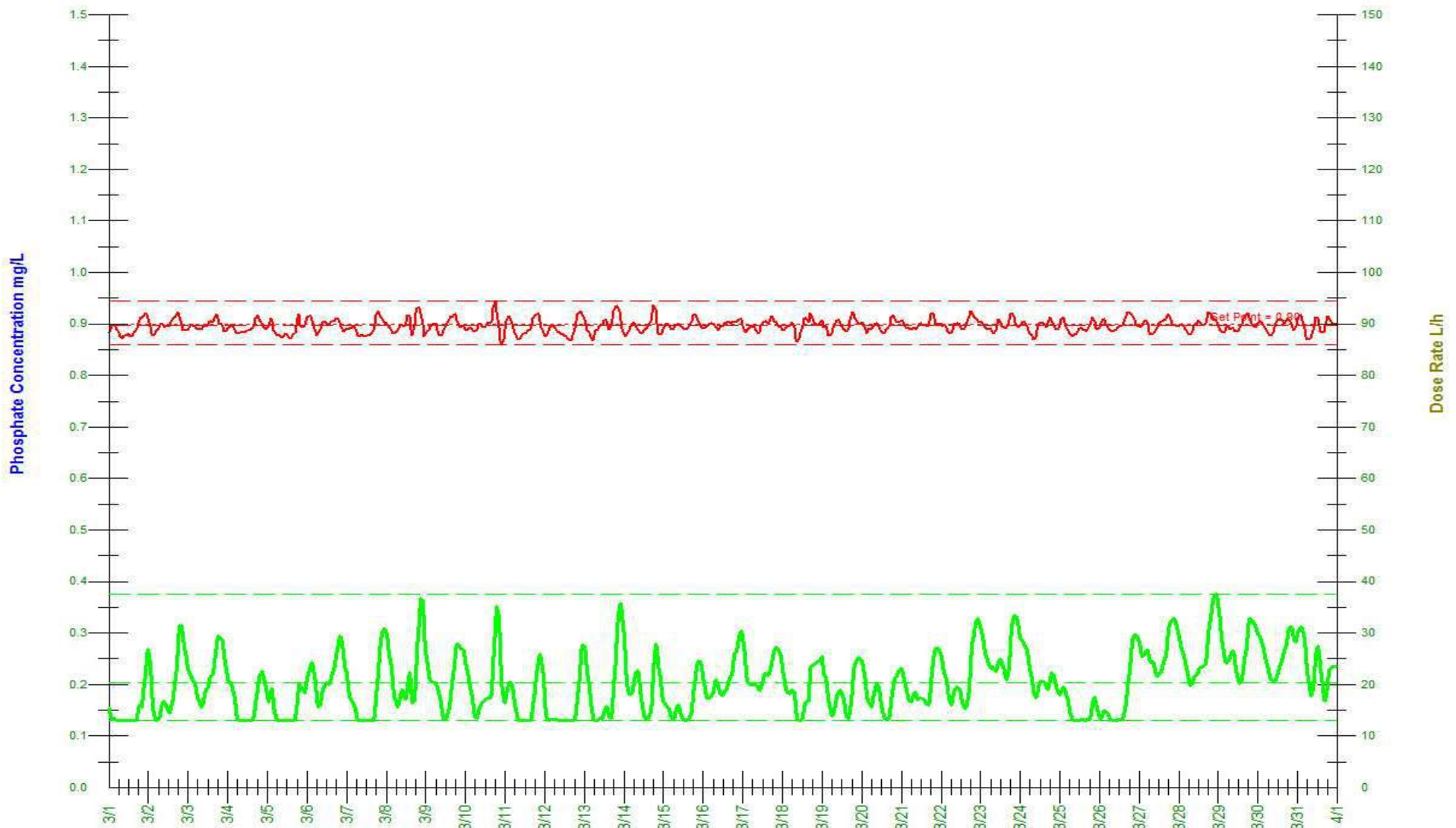
Company Confidential



High Stability/Less Noise of the Measured Values with the New Phosphax sc LR



LIMIT OF 1.0 MG/L SET POINT OF 0.9 MG/L NEVER DEVIATES OUTSIDE OF 0.85 – 0.95

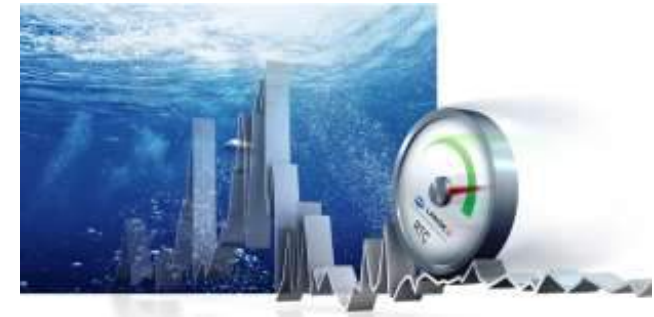




PROCESS MANAGEMENT

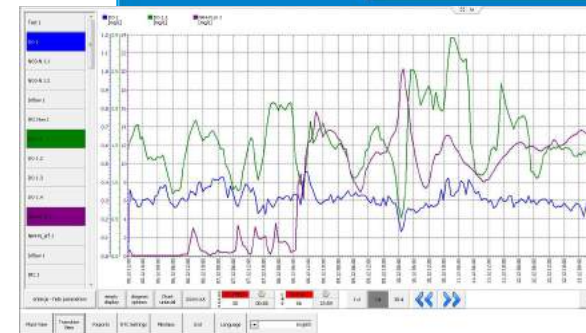
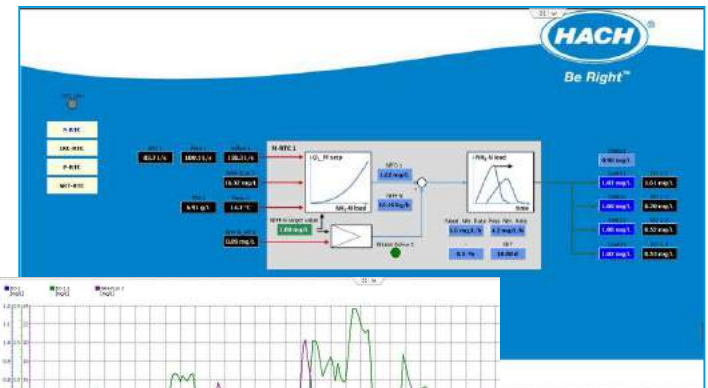
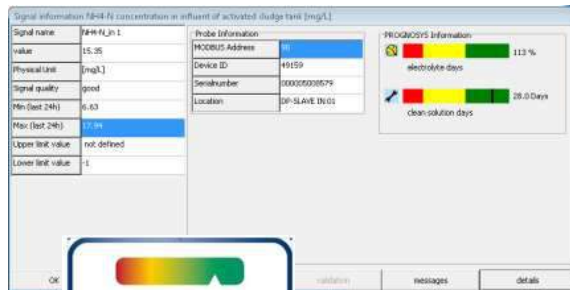
Standardized RTC control modules

- Adapt plant operation to varying load situations and plant performance
 - Improved compliance (minimize risk)
 - Reduced OPEX / Short ROI (economically viable)
 - Improved process transparency



All analytical input signals **validated** by *Instrument Management* / PROGNOSYS®

- High reliability, high uptime

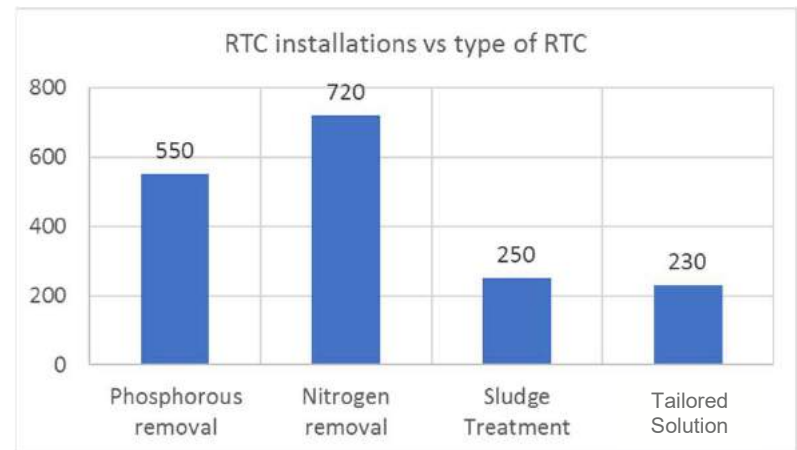




PROCESS MANAGEMENT EXPERIENCE

Large number of installations

- **2150 sites** in EU, US, China operating an CPM
 - 70 % of plants between 2-8 MGD
- **3750 control modules** in operation
- Growing number of industrial CPM



Experienced Global CPM Team

- Growing team of CMP consultants
 - 28 in EU, 5 in US
- Sales & Service NA: 250 associates
- Centralized (US and EU) CMP Service/Commissioning experts providing remote support & monitoring

REAL TIME CONTROL MODULES

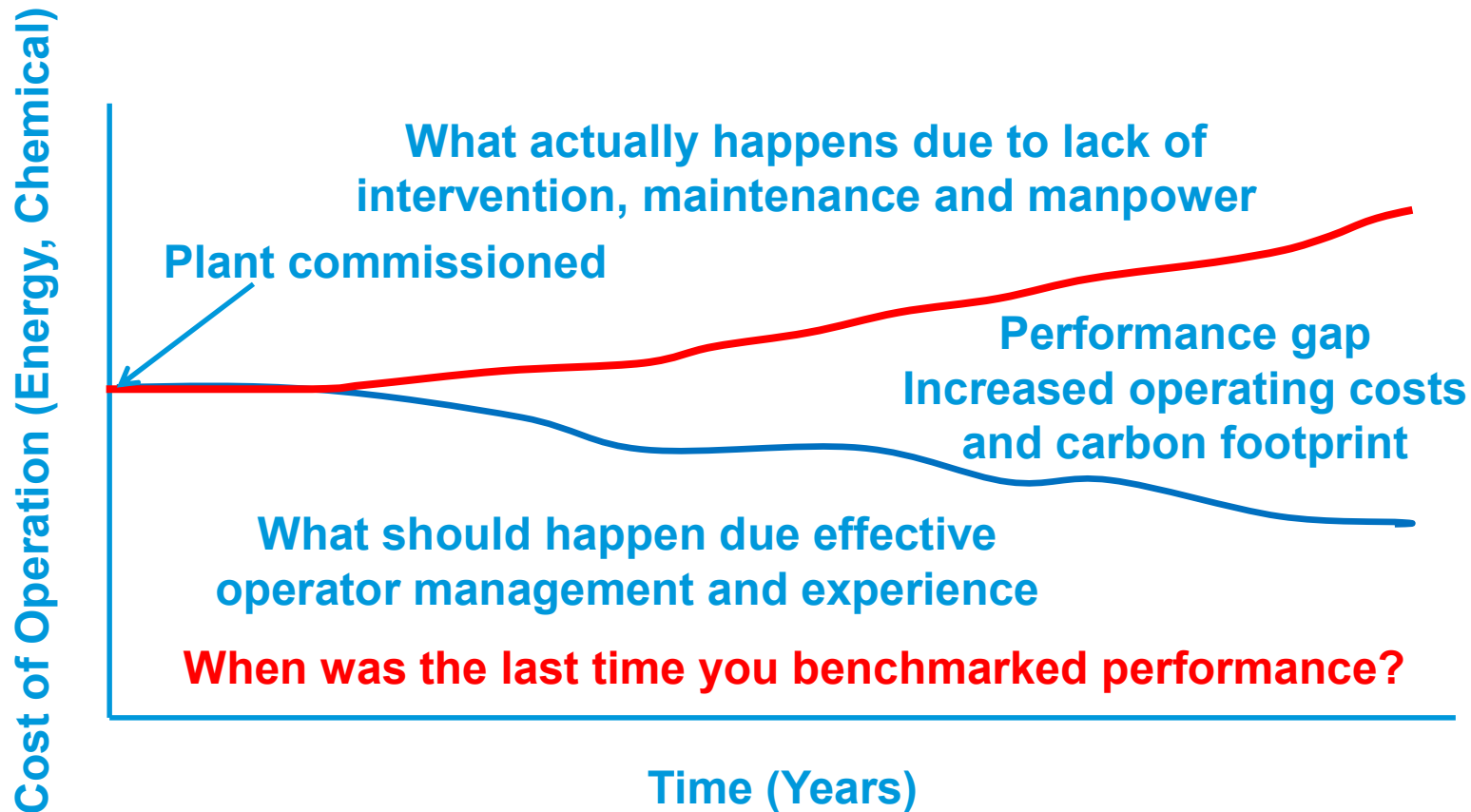
Type	RTC	Application	Compliance	Direct Savings on
Nutrient Removal	P	Chemical P-elimination	P_{tot}	- Precipitant - Sludge treatment /disposal
	N	Nitrification (plug flow)	NH_4-N	- Energy (aeration intensity)
	DN	Denitrification (IRC / Ext. C)	N_{tot}	- Energy (DO recovery, IRC) - External Carbon
	SZ	Swing zone adjustment	N_{tot}	- Energy (aerated volume)
	N/DN	Intermittent denitrification	N_{tot}	- Energy (aeration time/volume, DO recovery)
	OXD	Simultaneous denitrification	NH_4-N	
	DO	Aeration	NH_4-N	- Energy (controlled DO)
	SF	Nitrification (step feed)	NH_4-N	- Energy (aeration intensity)
	MOV	DO Control	NA	- Energy (aeration intensity)
Sludge Mgmt.	SRT	Sludge age	NH_4-N	- Energy (for BOD removal)
	ST	Sludge thickening		- Polymer, - Increased gas yield
	SD	Sludge dewatering		- Polymer - Sludge disposal
Industry	DOS	Nutrient dosing	N_{tot}, P_{tot}, NH_4	- Urea - Phosphoric acid
	DAF*1	Dissolved Air flotation	COD, TSS	- Coagulant, Polymer

AN OPTIMIZED PROCESS SHOULD NOT BE A DREAM, IT SHOULD BE A STANDARD OPERATING PROCEDURE

In the wastewater industry, your plant equipment will be at its most efficient on the day the person who built it gives you the keys

The plant process will be made most efficient by understanding how it responds to what must be treated

Plant Energy Efficiency and Performance over time



Can this primary tank be optimized?



Not until the inlet screens are repaired or replaced

Can this sludge thickener be optimized?



Not until the process piping can adequately handle process flow.



Can this digester's gas production be optimized?



Loss of tank volume due to grit and or solids build up



Can this dosing system be optimized?



Safety

Security

System Reliability



Can this final tank be optimized?



Small problems can become big problems
due to lack of Maintenance

FINAL THOUGHTS....

You can not manage what you do not measure

If you do measure make sure that you KEEP measuring

In other words, clean, maintain and service your instrumentation or your control system will fail

Maintain your assets – control systems only add value on well maintained and well operated plants

It's not all about the money – Optimization helps to drive sustainability, environmental policy, labor efficiency, and compliance



Be Right™