

Optimization of Biological Nutrient Removal Wastewater Treatment Systems

ACWA Nutrients Permitting Workshop

June 5, 2018

Jon van Dommelen, P.E.

Ohio EPA

Division of Environmental and Financial Assistance

Compliance Assistance Unit

The Plan

- What goes wrong
- Troubleshooting systems
- Case studies
- Questions and Comments

What goes wrong...

Permit Limits change, and the WWTP doesn't

Land Application of Treated Wastewater Rules Implemented 2014

- WWTPs encouraged to avoid discharging to Waters of the State
- Eased limits since they discharged to impoundments
- WWTPs not designed to meet 10 mg/L TIN in effluent

What goes wrong...

Effluent limits tighten statewide

Tighter TP limits for some dischargers to Ohio River

Nitrate limits on the horizon?

What goes wrong...

Design is important

But often design is by the book (and bacteria can't read)

Inattention to influent waste streams will create havoc with BNR

Especially influents with weak organic loadings

What goes wrong...

Disconnect between design and operation

Design is important

But when design doesn't include operational flexibility,
the hands of the operator are tied

(operators don't get to chose what comes down the pipe)

Troubleshooting Systems

Process Control is an essential

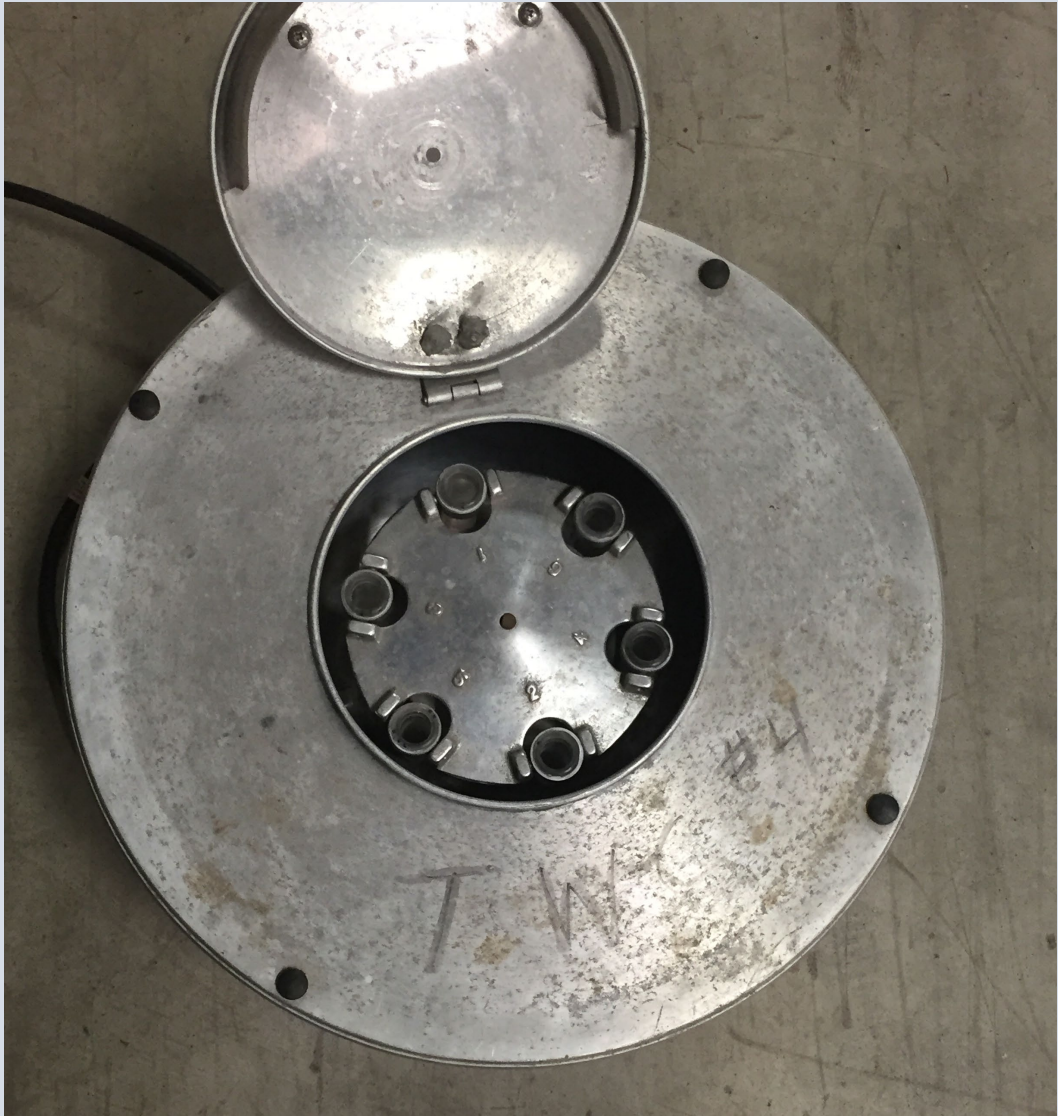
Check the chemical trails that the biology leaves behind

Field test equipment

Grab samples, sometimes lots of grab samples

Cheap, easy, and effective

Troubleshooting Systems



Toubleshooting Systems



Troubleshooting Systems

If the conditions are right, the bacteria will perform

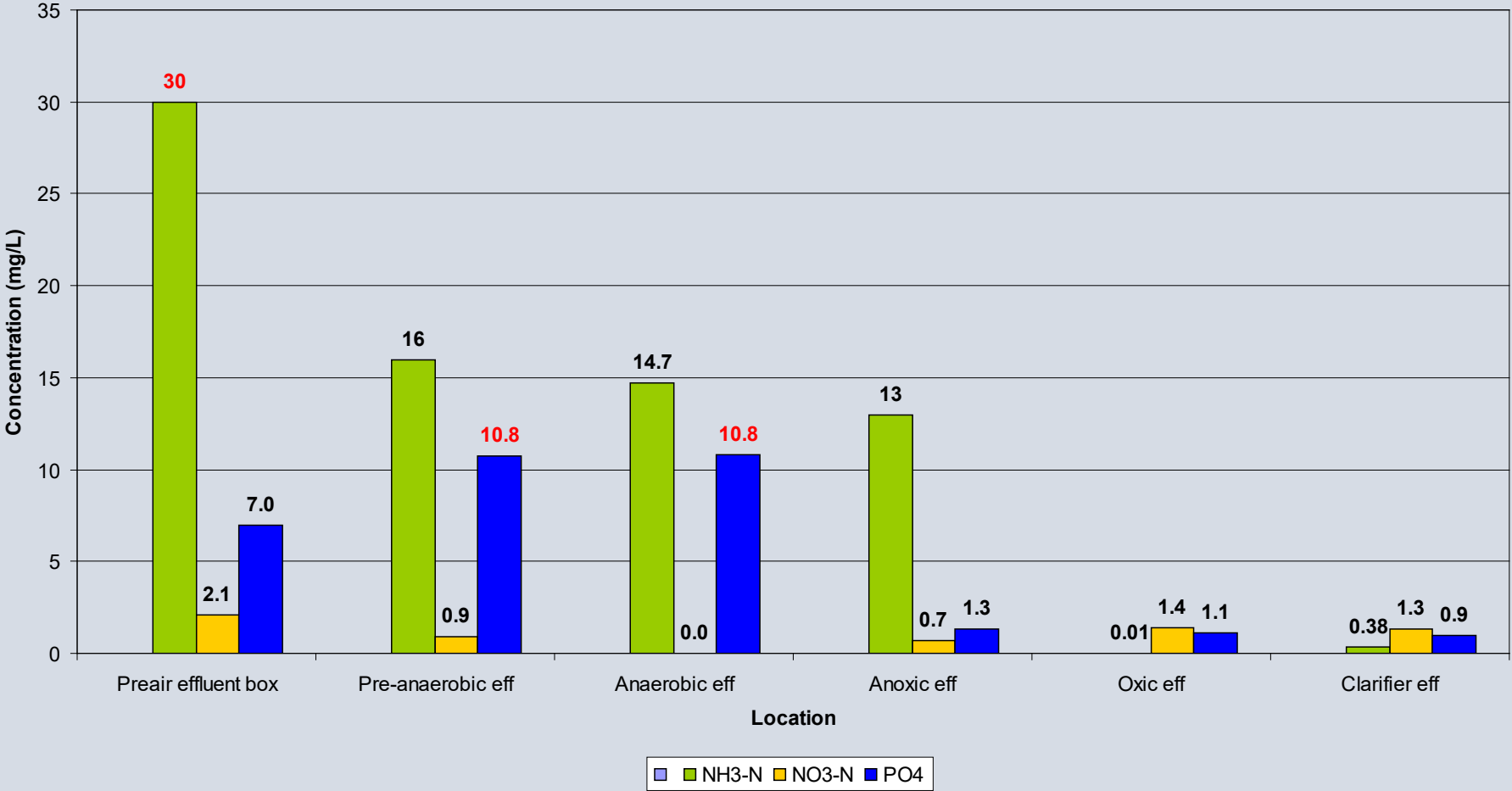
Ammonia, nitrate, and orthophosphate in the inputs to the tanks

Ammonia, nitrate, and orthophosphate in the tanks

Measure, don't guess...

Troubleshooting Systems

Cedarville WWTP
Nutrient Profile
08/24/2004



Case Study: Firestone Trace WWTP

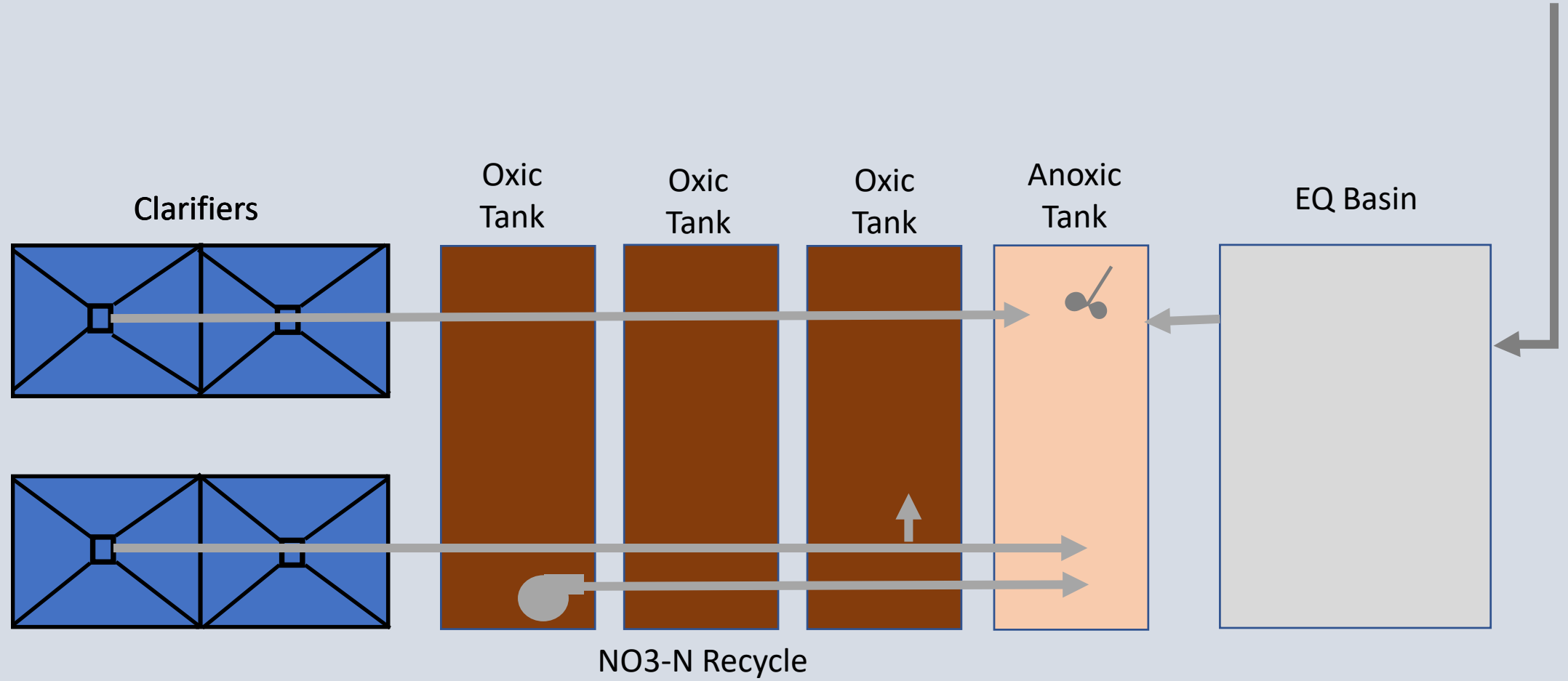








Case Study: Firestone Trace WWTP



Firestone Trace WWTP

We found:

Everything was running full throttle!

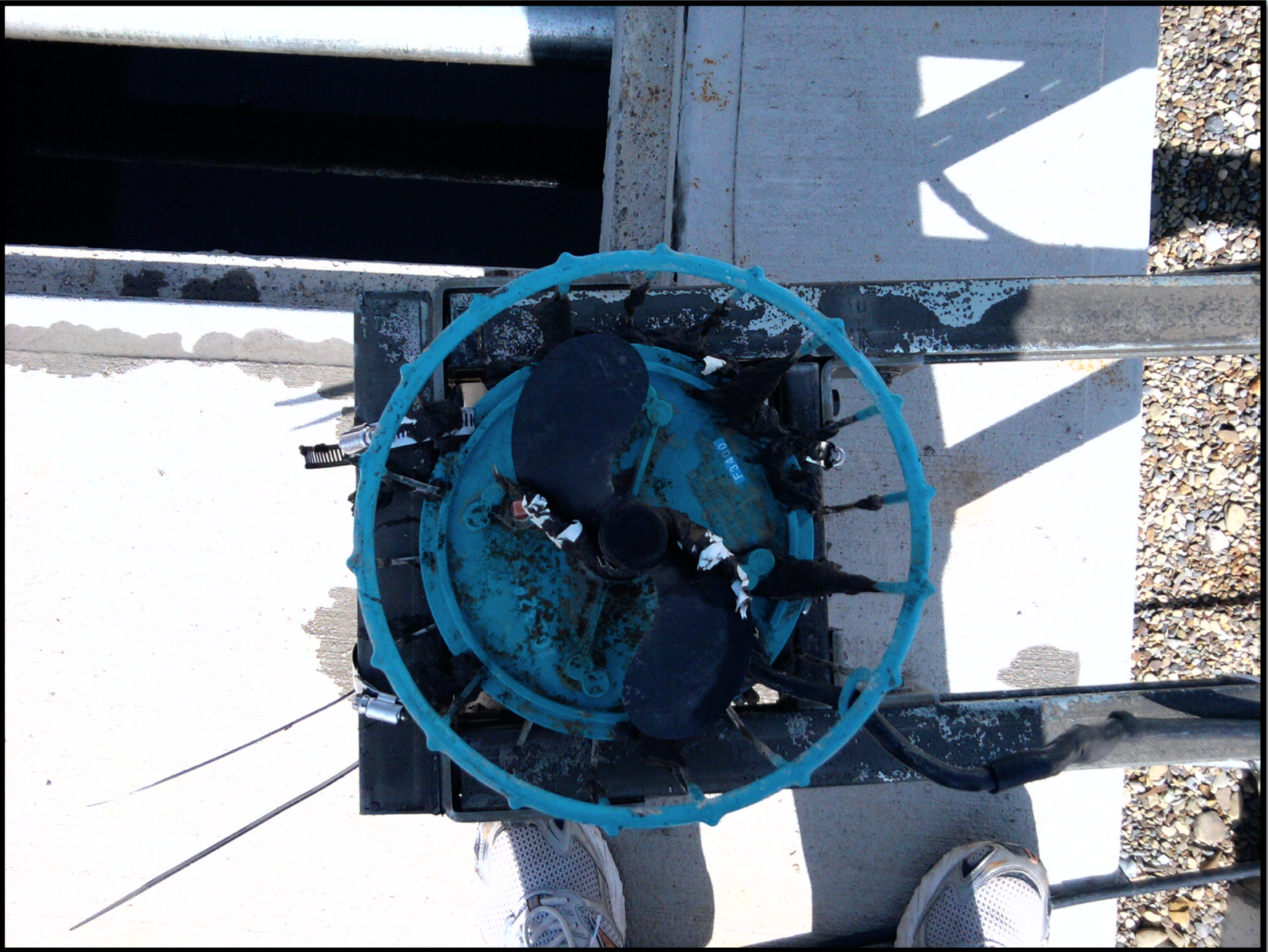
Nitrates are high (anoxic and effluent)

- Turn the Nitrate Recycle Pump down to 15 min ON, 45 min OFF (96 pin timer!)

Influent COD is low

Aeration tanks are very aerobic ($\text{NH}_3\text{-N} \sim 0.00 \text{ mg/L}$)

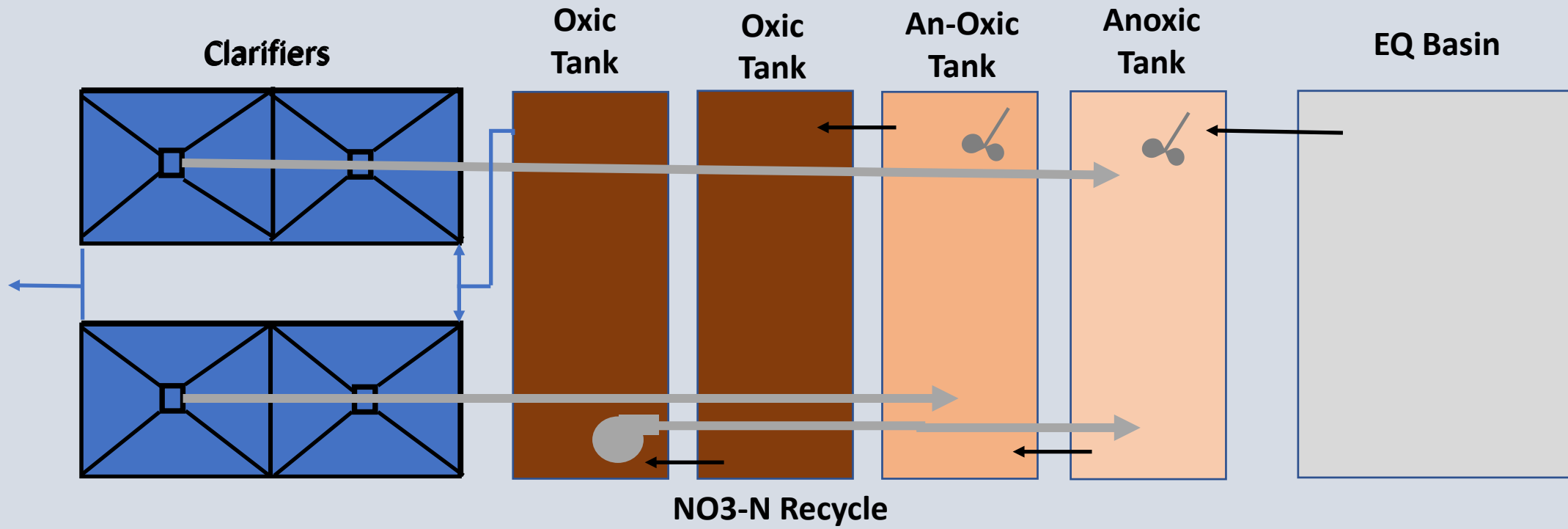
Expand the Anoxic Tank?



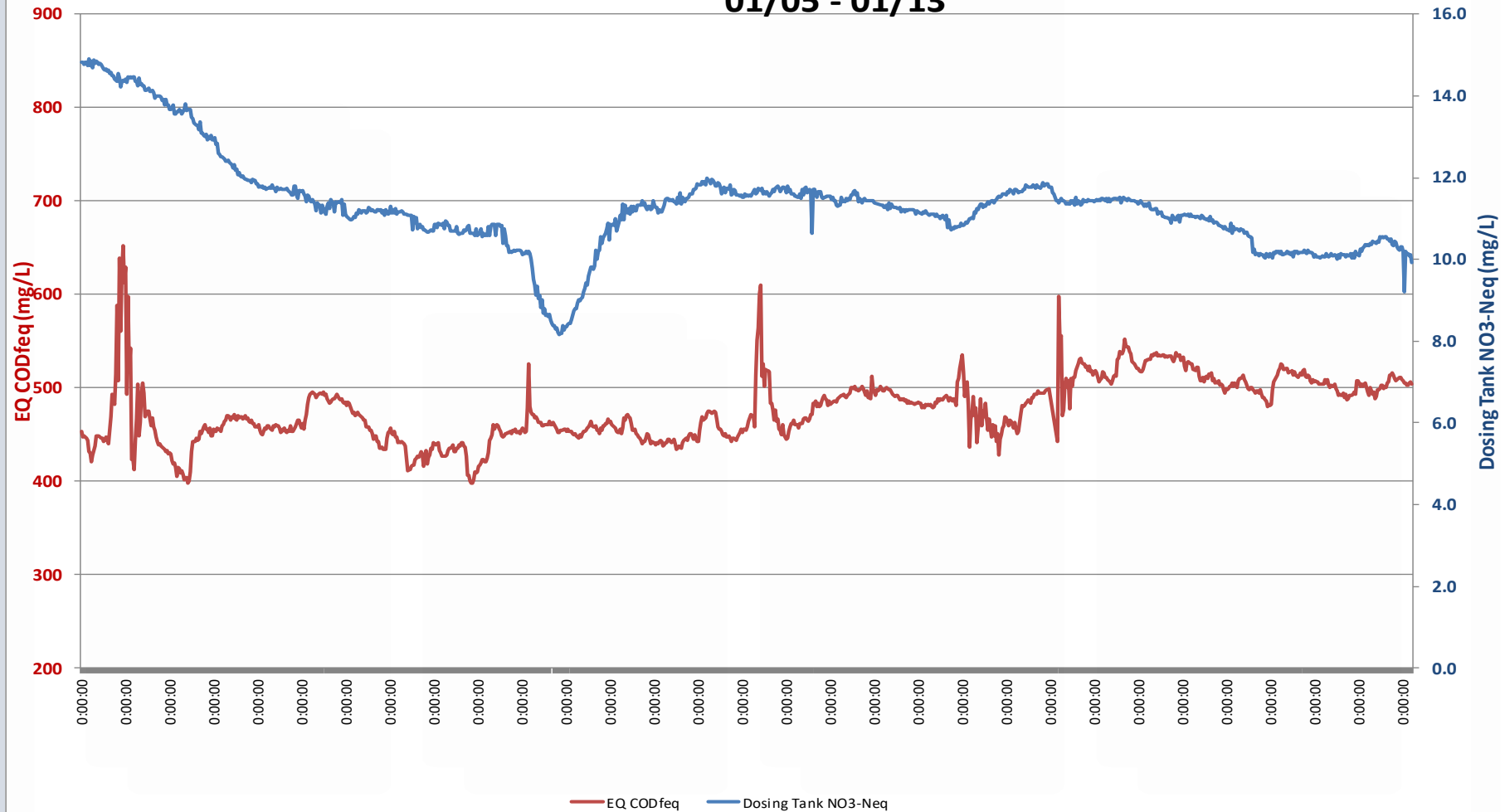




Troubleshooting Systems



Firestone Trace WWTP
s::can Data
01/05 - 01/13



Firestone Trace WWTP

Continued to run with two anoxic tanks for through the summer of 2011

Flirted with Noncompliance for TIN all summer

Pretty certain that carbon was the limiting factor

Firestone Trace WWTP

9/12/2011

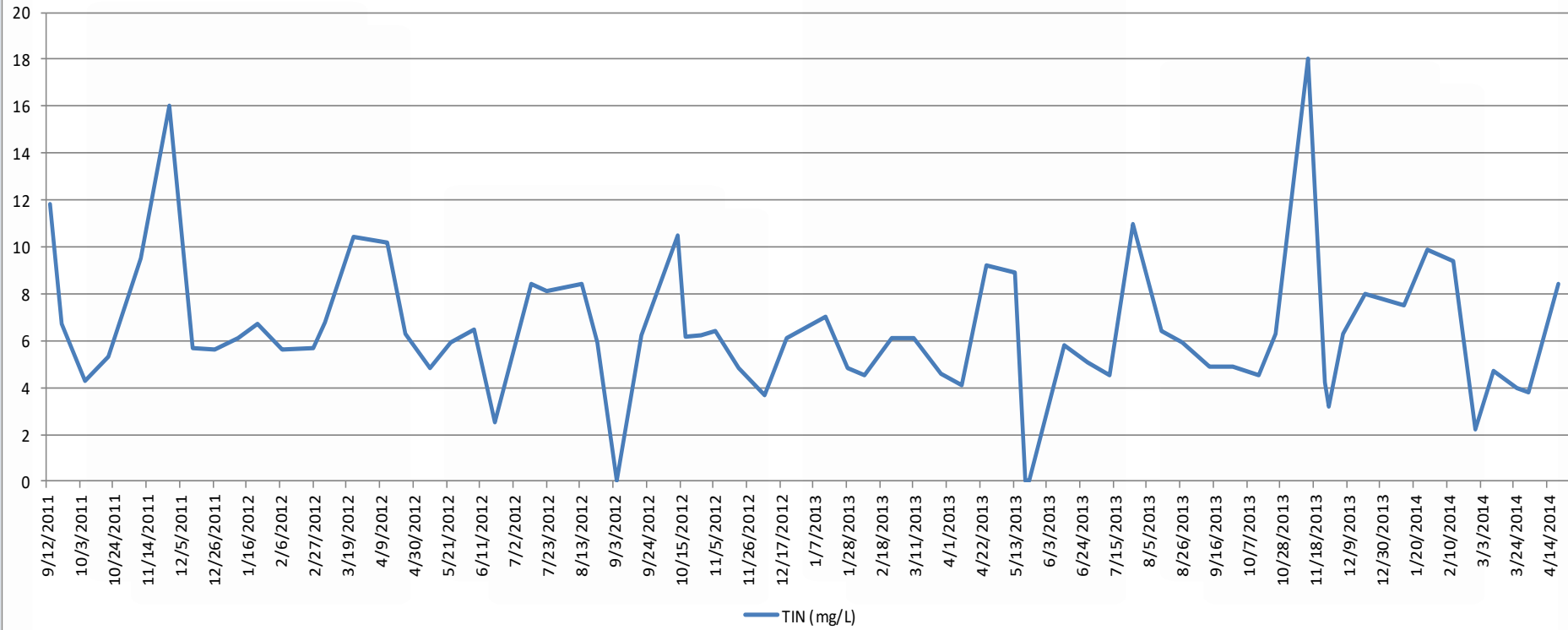
A 55 gallon drum of
Glycerin began to drip
into the Anoxic Tank



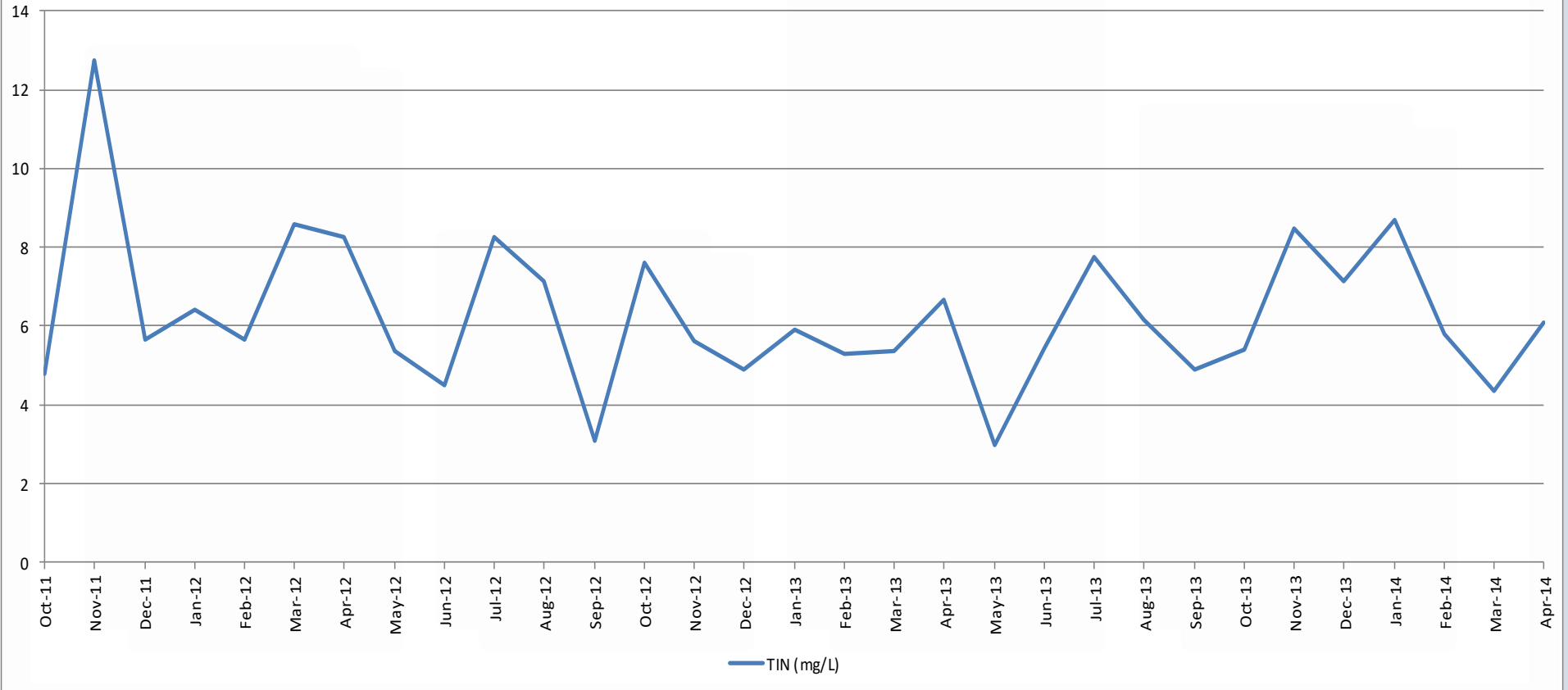




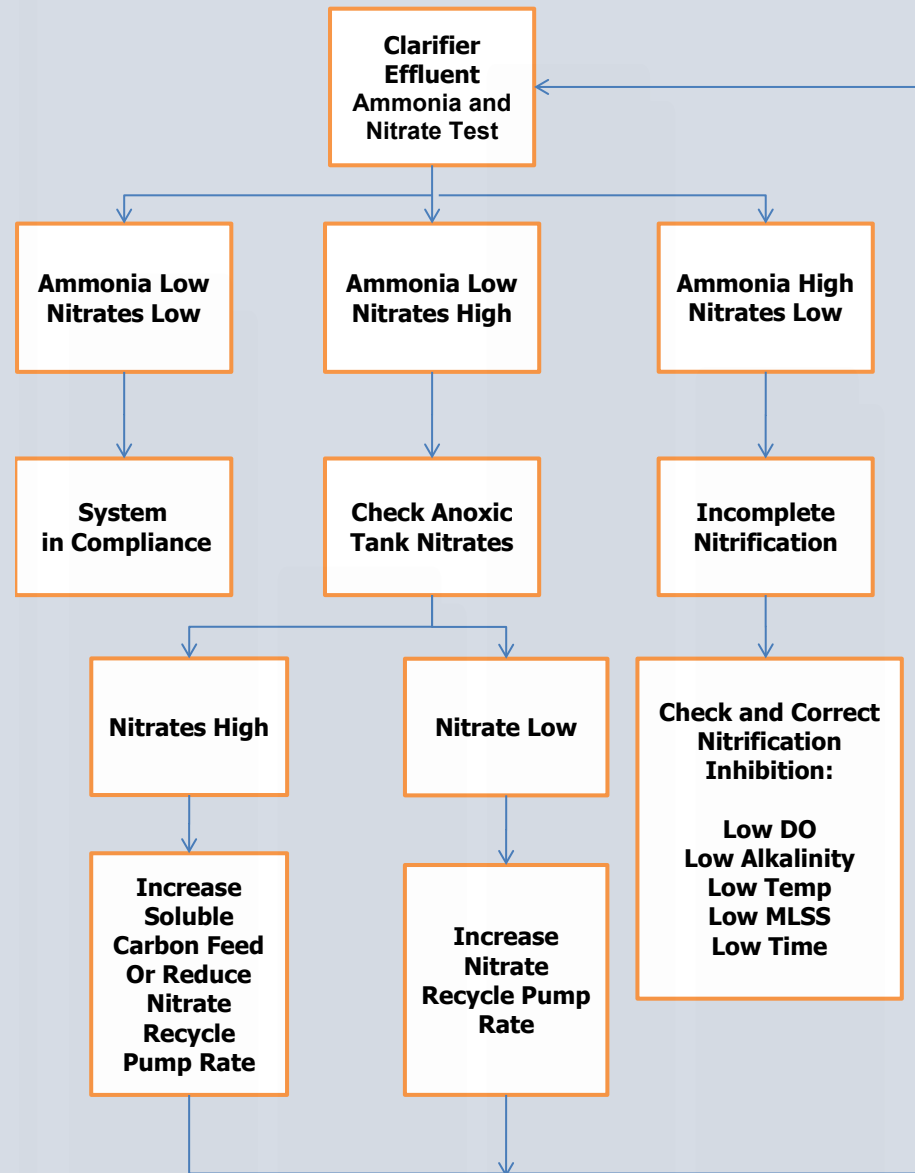
**Firestone Trace WWTP
Effluent Total Inorganic Nitrogen
Individual Samples (2 per month)
9/12/2011 - 4/30/2014**



**Firestone Trace WWTP
Monthly Total Inorganic Nitrogen
9/2011 - 4/2014**



Process Control Flow Chart for Denitrification in Anoxic Tank



Firestone Trace WWTP

Optimize Anoxic Zone

Control Nitrate Recycle

Control Soluble Carbon

Process Control

Anoxic Tank $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$

Aeration Tank $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$

Case Study: Scioto Reserve WWTP

Aeration Tank

RAW

EQ

RAS



Scioto Reserve WWTP

0.423 MDG Design Flow

Operates at 50 % design flow at 100+% of online capacity

Land applies treated wastewater to an impoundment for golf course irrigation

In 2012, rules for land application change and implementation of tight limits begins

Effluent limits required 10 mg/L TIN by April 2014

Scioto Reserve WWTP original design does not provide for denitrification

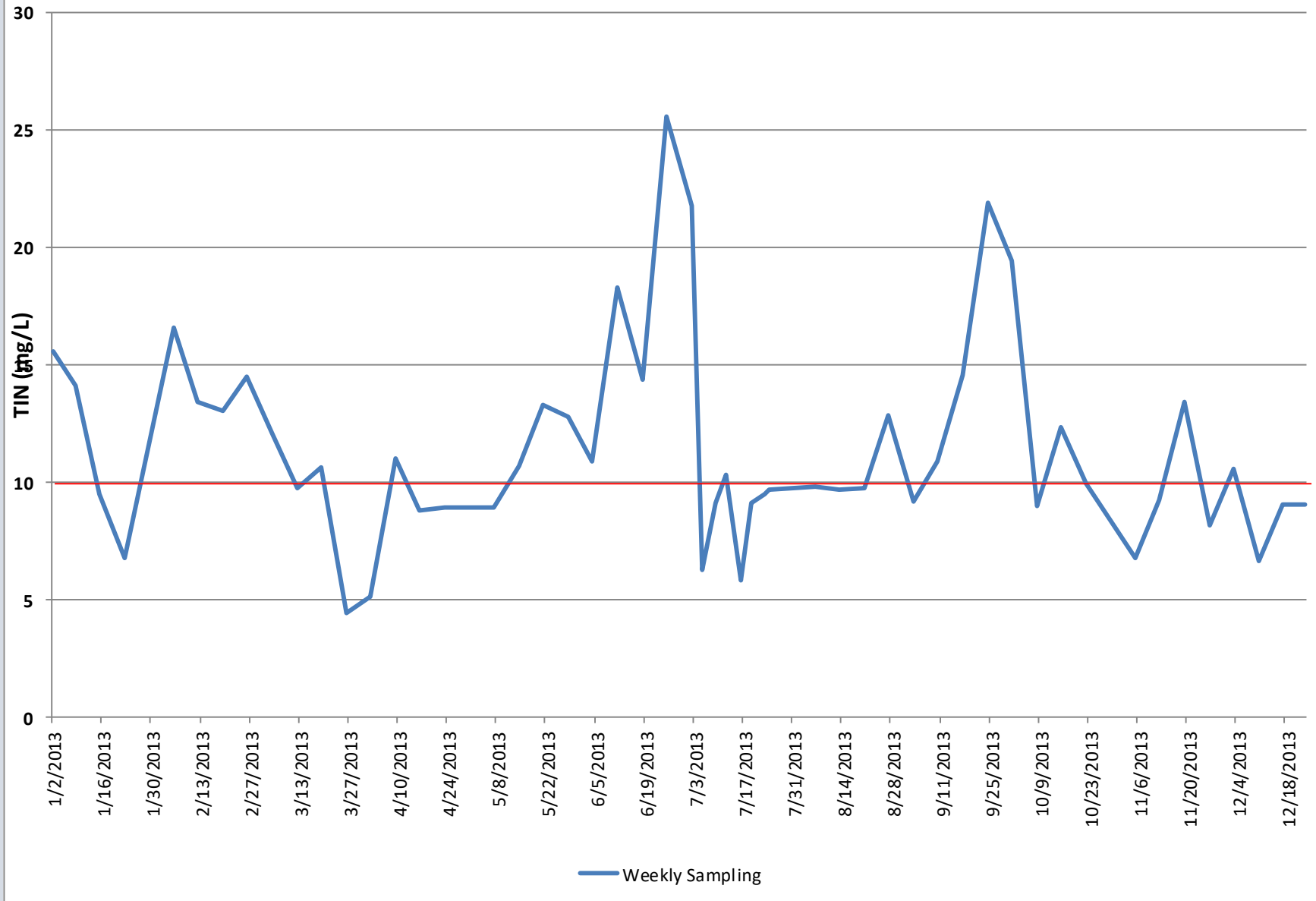
Scioto Reserve WWTP

Initially, tried to ON/OFF blower operation to denitrify in the aeration tanks

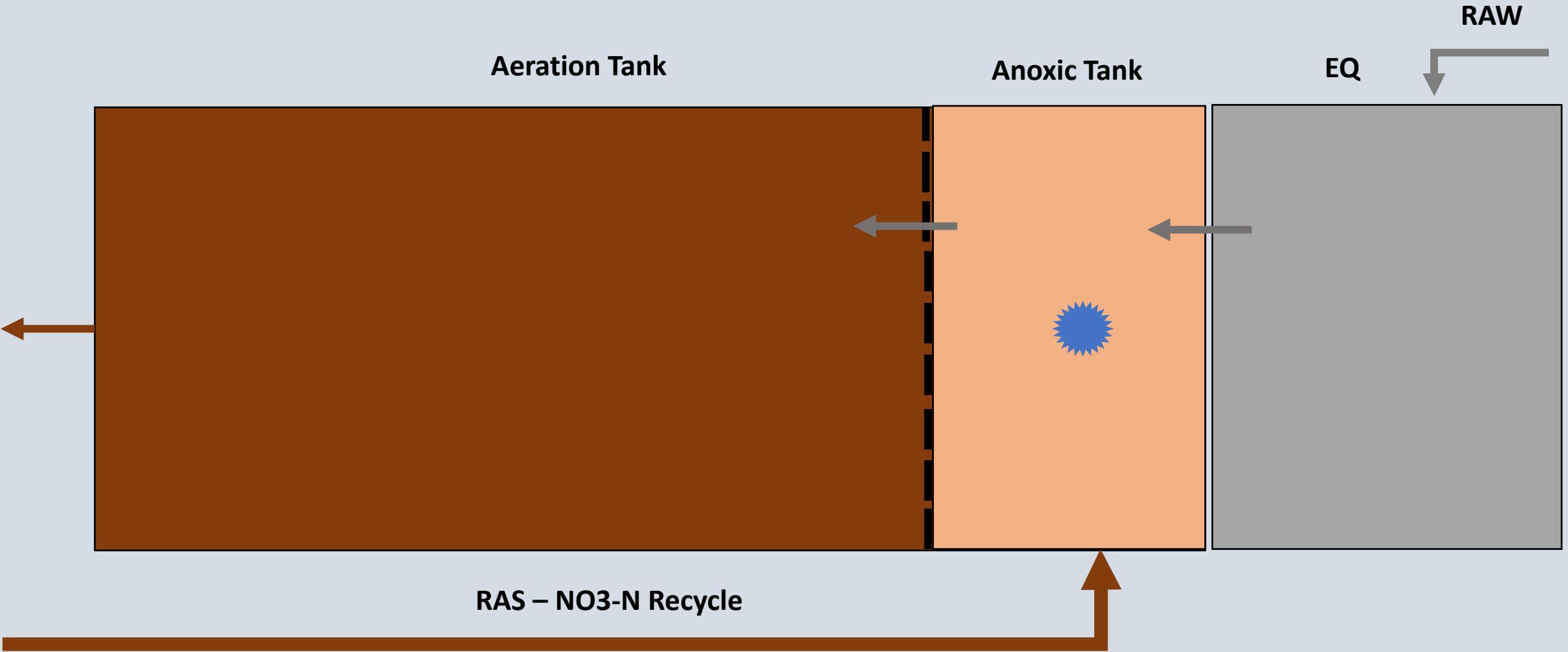
Occasionally TIN would be within permit, but no consistency, no room for safety

December 2013: Drastic measures

Scioto Reserve WWTP Effluent Total Inorganic Nitrogen 2013



Troubleshooting Systems













SLUDGE RETURN

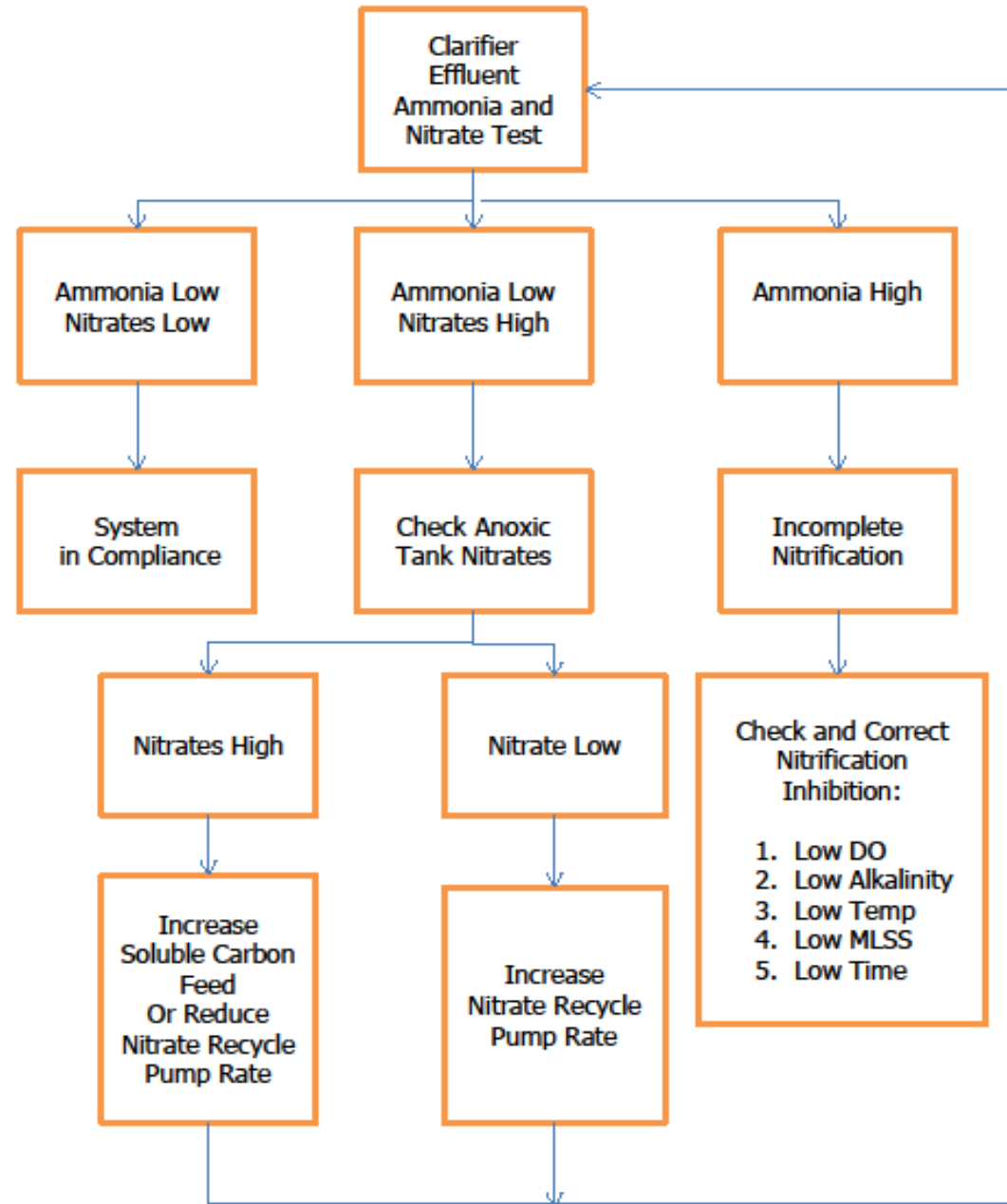
← SKIMMER

SKIMMER →





Process Control Flow Chart for Denitrification in Anoxic Tank








MIO/TC 2020 XT



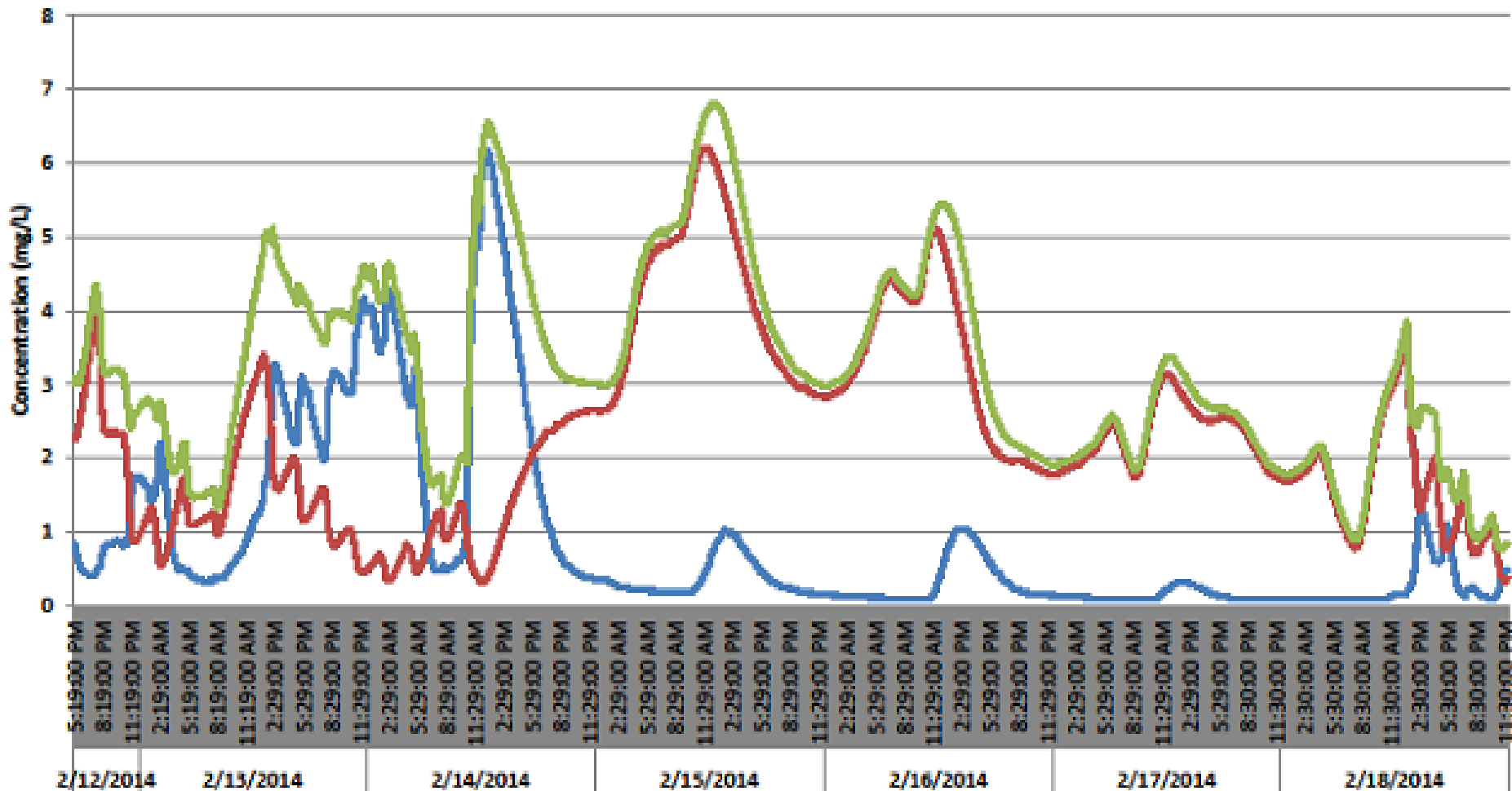
CONTROLLER 24 Apr 2014 14:29   

Values: all sensors 020

01	0.6 mg/l	O2	16.2 °C	AT DO
02	1.5 mg/l	NH4-N	16.2 °C	AT NH3
03	5.5 mg/l	NO3-N	16.2 °C	AT NO3
04	6.58	pH	16.1 °C	AT pH
05	0.1 mg/l	O2	16.0 °C	AX DO
06	6.7 mg/l	NH4-N	16.0 °C	AX NH3
07	4.0 mg/l	NO3-N	16.0 °C	AX NO3
08	6.78	pH	16.1 °C	AX pH

Next sensor , , Display/Options 

Scioto Reserve WWTP VARiON Data 2/12 - 2/18 2014



Tank Parameter
AT - NH4-N AT - NO3-N AT - TIN

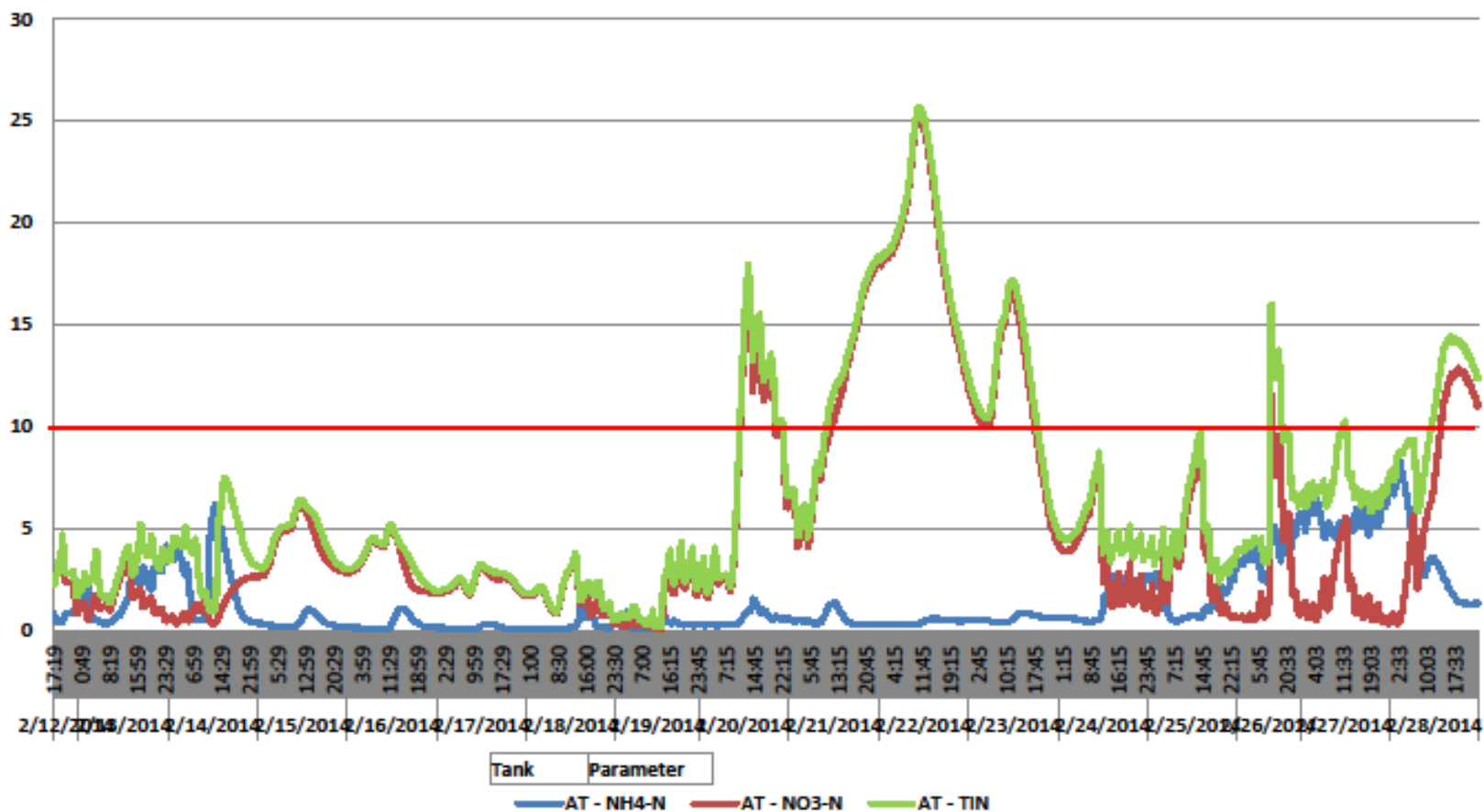
Date Time

Scioto Reserve WWTP

- 1) created a mixed Anoxic Zone
- 2) relied on RAS for nitrate recycle
- 3) relied on raw wastewater for carbon source
- 4) Ran blowers ON/OFF during the week
- 5) Ran full aeration during the weekend
- **TIN < 10 mg/L**

Average of Concentration

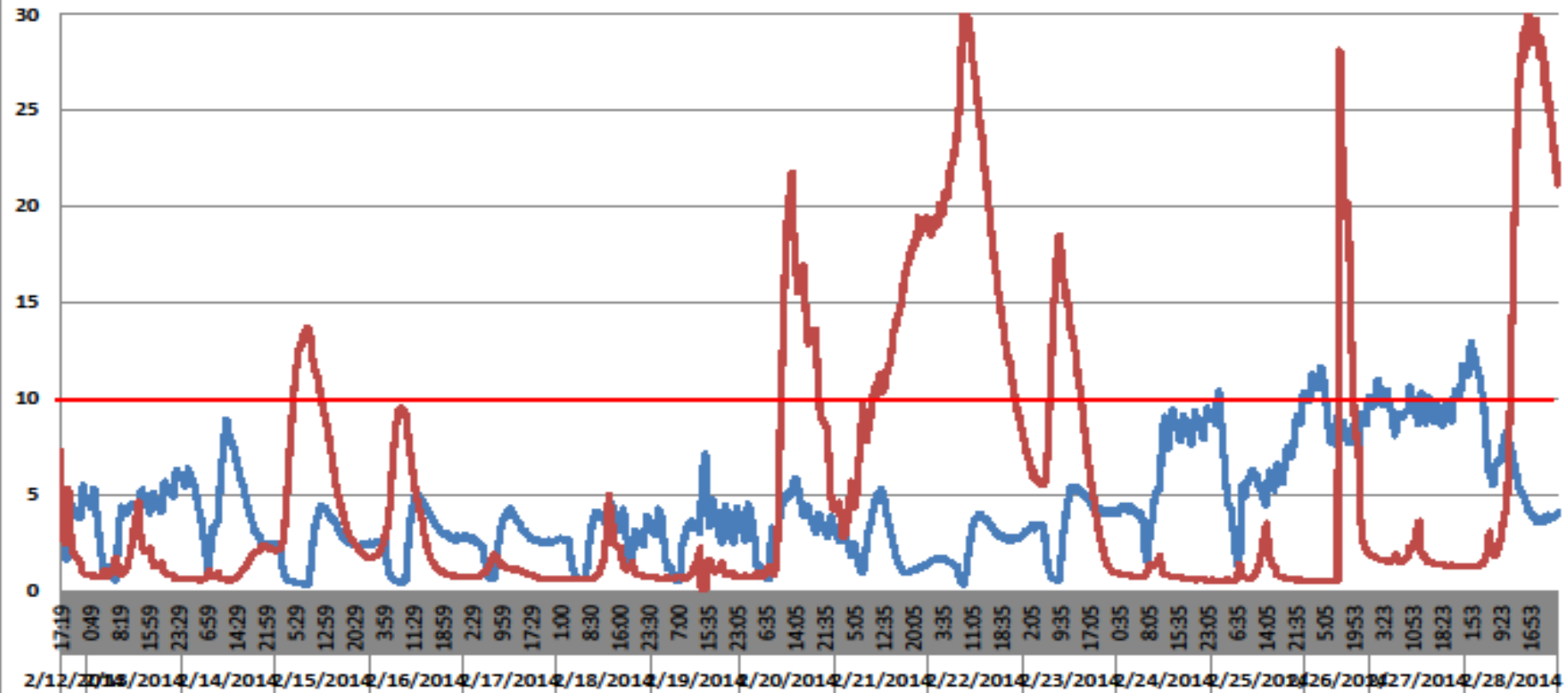
Scioto Reserve WWTP VARiON Data February 2014



Date Time

Average of Concentration

Scioto Reserve WWTP VARiON Data February 2014

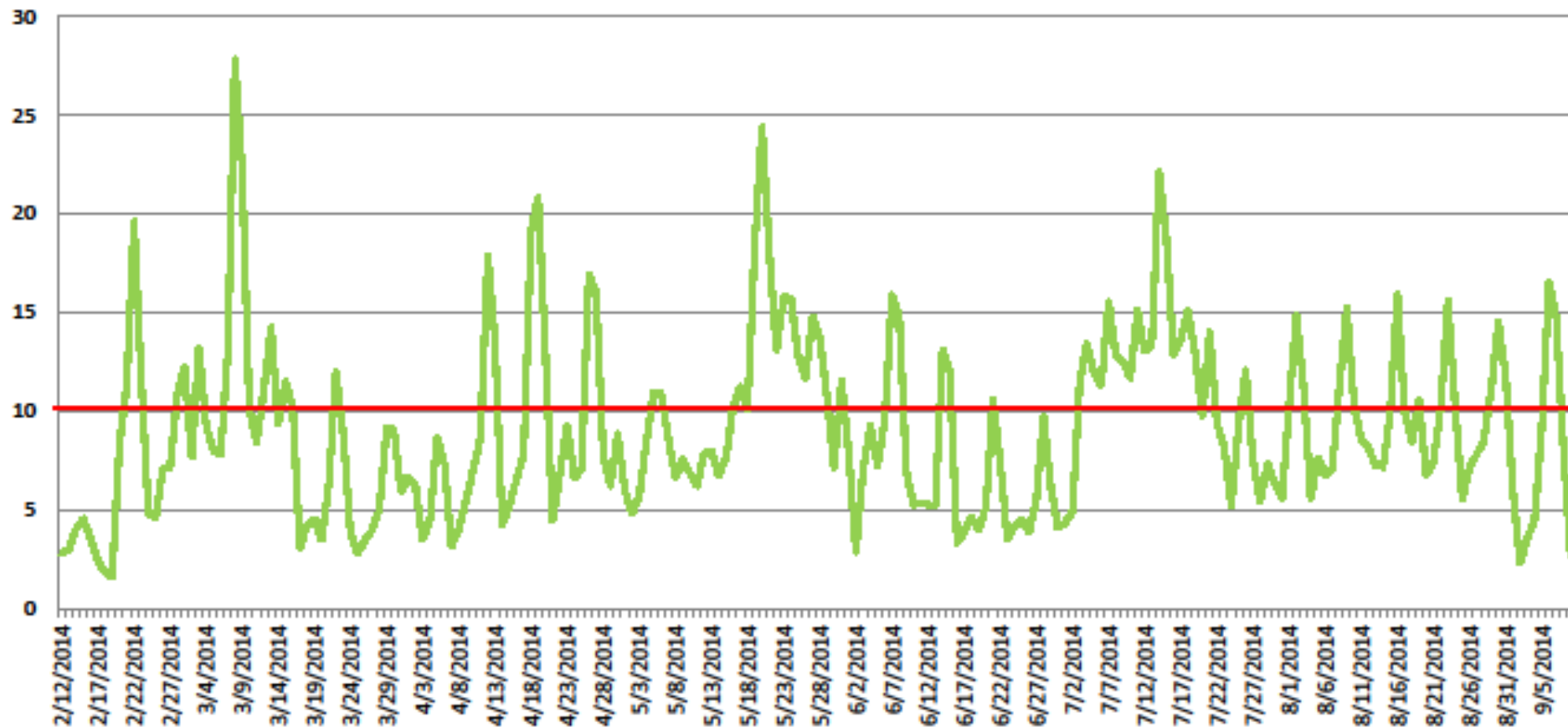


Tank	Parameter
—	ANX - NH4-N
—	ANX - NO3-N

Date	Time
------	------

Average of Concentration

Scioto Reserve WWTP VARiON Data Weekly Sampling TIN February 12 - September 9, 2014

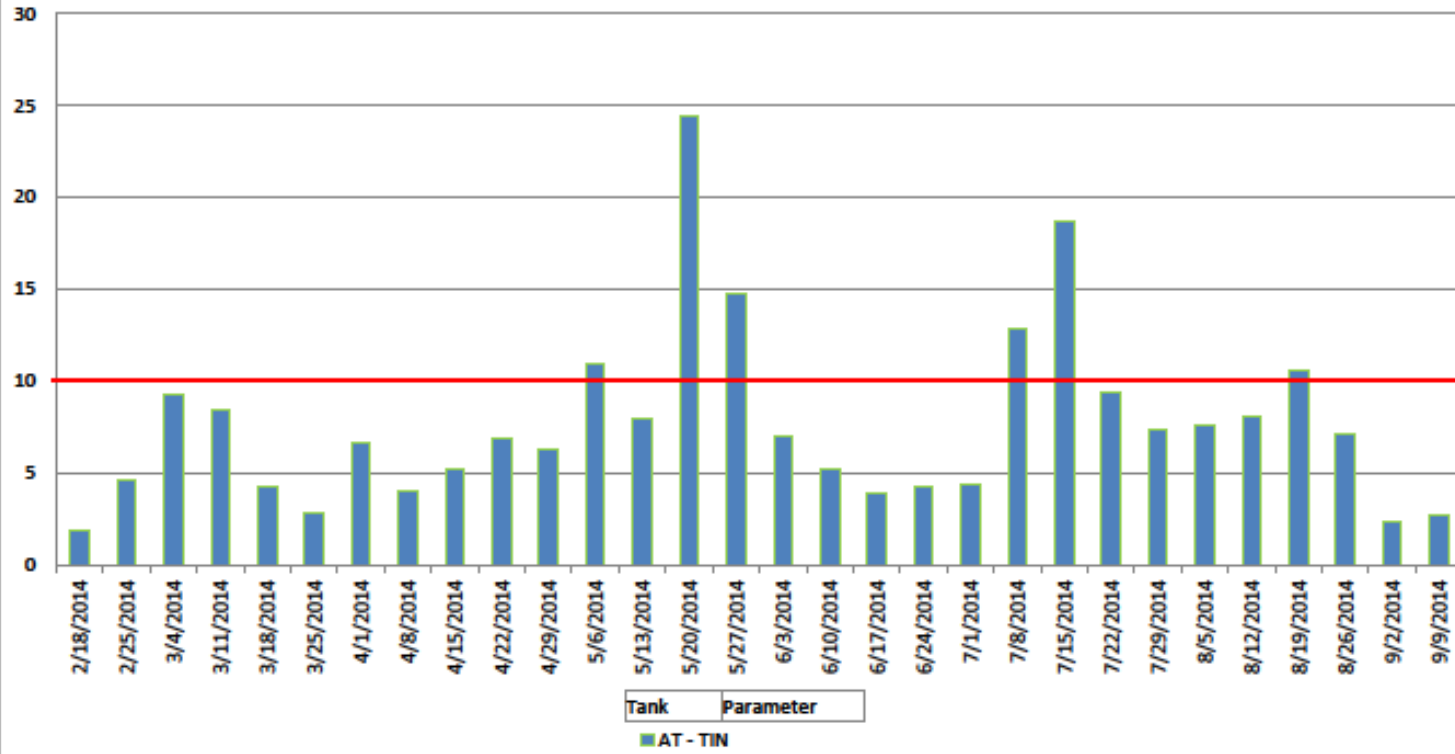


Tank	Parameter
	AT - TIN

Date	Time
------	------

Average of Concentration

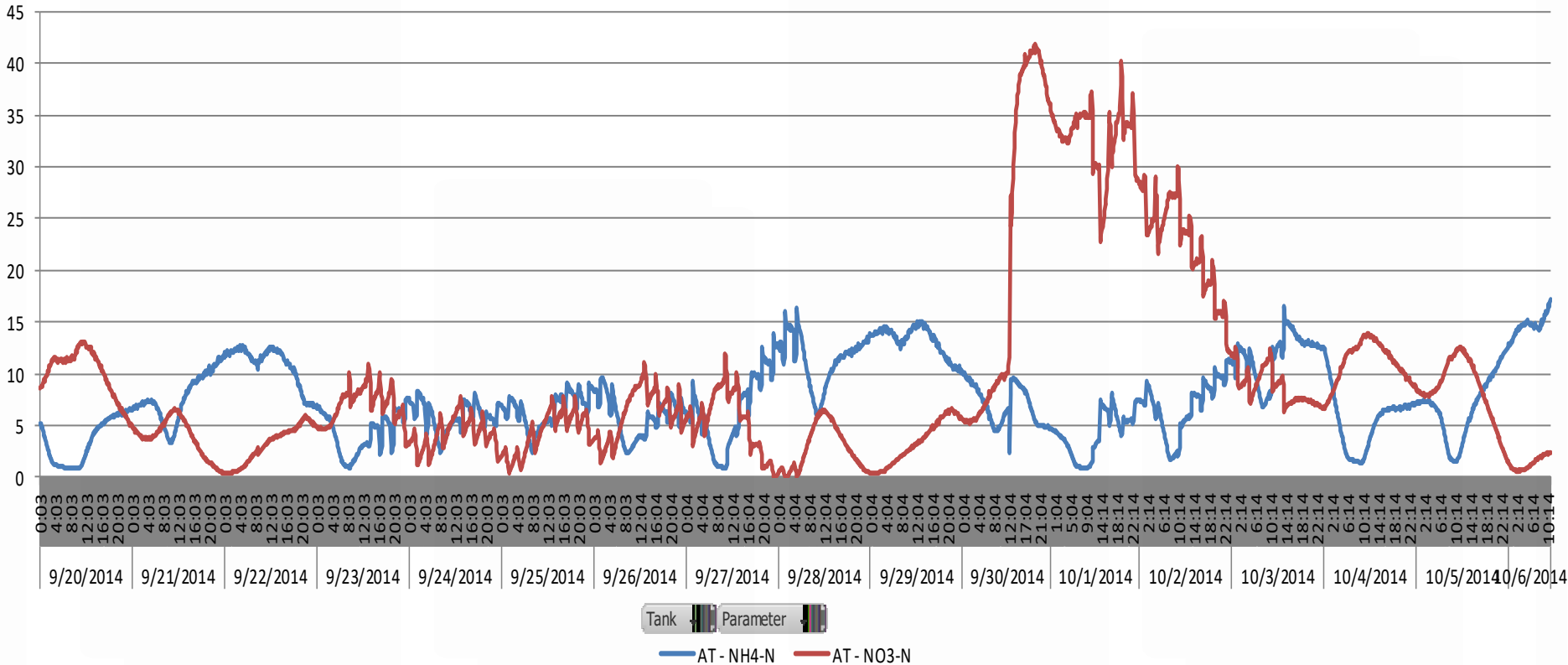
Scioto Reserve WWTP VARiON Data Weekly Sampling TIN February 12 - September 9, 2014



Date Time

Average of Concentration

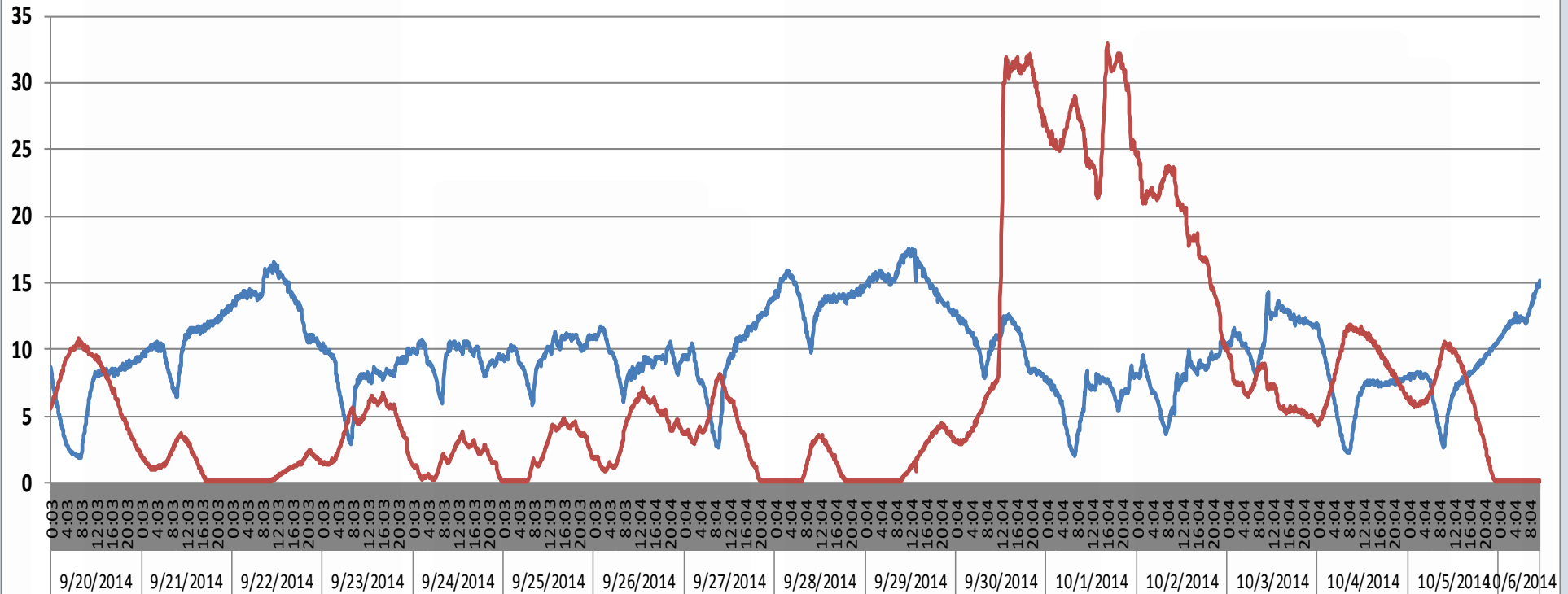
Scioto Reserve WWTP VARiON Data Aeration Tank NH3-N and NO3-N 9/20 - 10/06



Date Time

Average of Concentration

Scioto Reserve WWTP VARiON Data Anoxic Tank NH3-N and NO3-N 9/20 - 10/06

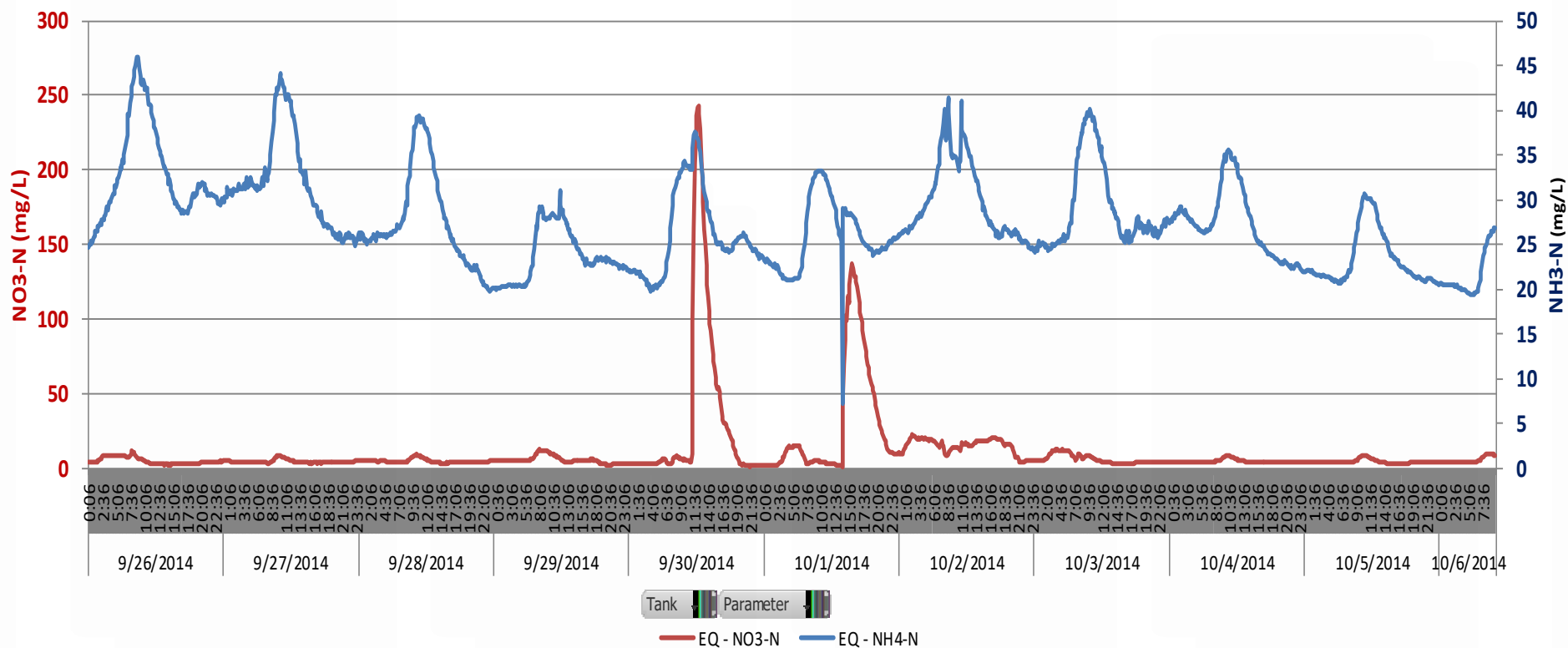


Tank Parameter
— AX - NH4-N — AX - NO3-N

Date Time

Average of Concentration

Scioto Reserve WWTP VARiON Data EQ Tank NH3-N and NO3-N 9/20 - 10/06



Date Time

Troubleshooting Systems: Bradford WWTP

New WWTP came online November 2013

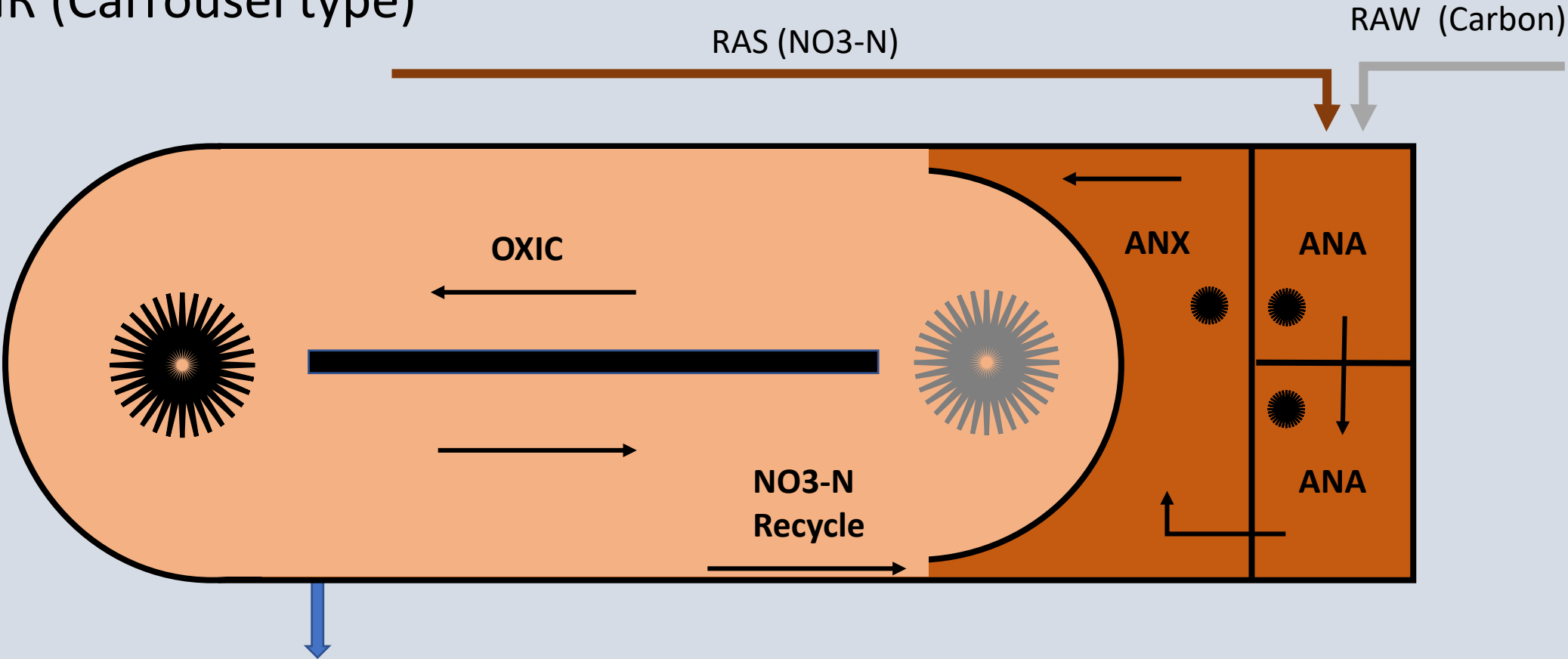
Constructed a Carrousel Type BNR System

Designed for 0.480 MGD

2017 average flow: ~0.550 MGD (big clarifiers!)

Troubleshooting Systems: Bradford WWTP

BNR (Carrousel type)







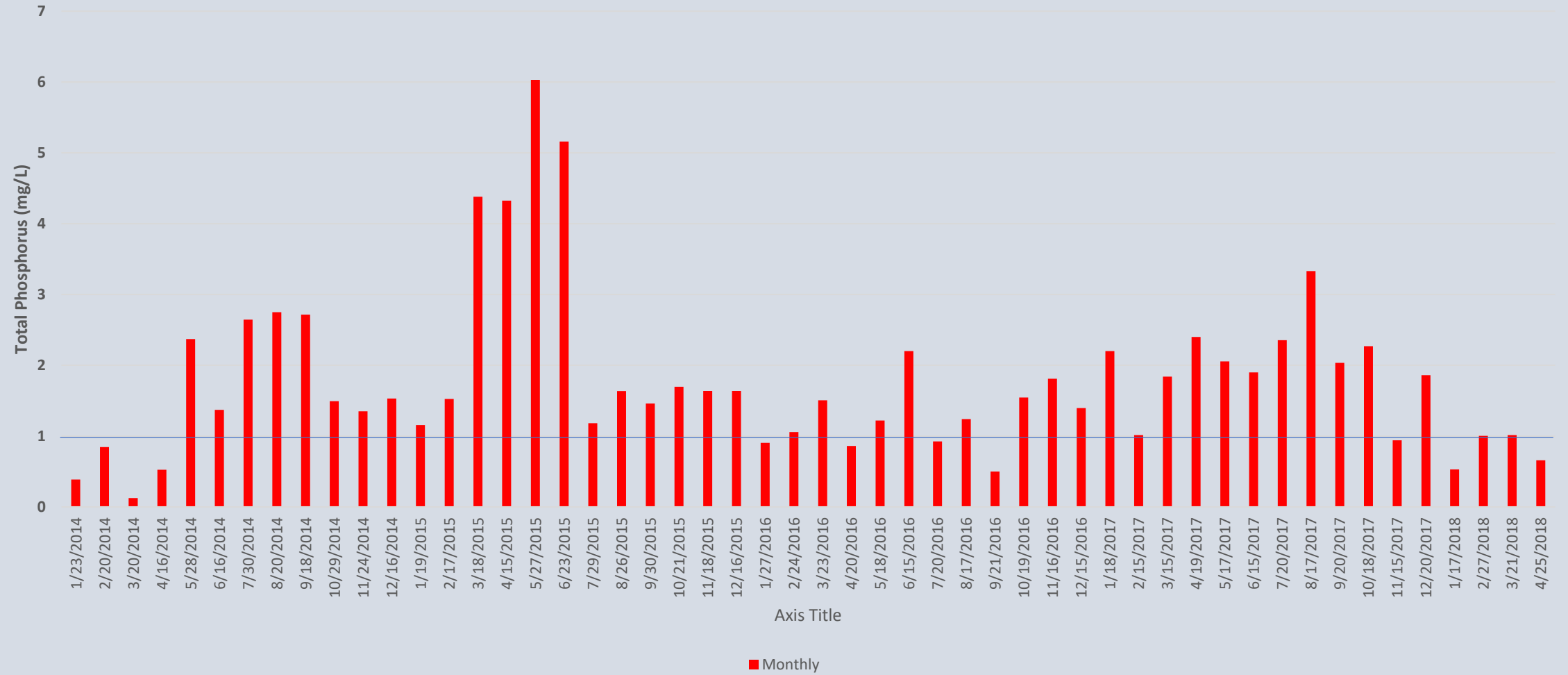








Bradford Wastewater Treatment Plant
Effluent Total Phosphorus
1/1/2014 to 4/25/2018



Nitrate Analysis

Nitrate (mg/L)				
	RAS	Anaerobic	Anoxic	Digester
3/15/2018	14.3	11.9	14.6	
3/19/2018	8.7	12.5	11.9	
3/20/2018	11.6	7.9	11.8	55.9
3/21/2018	11.5	7.5	12.0	
3/22/2018	8.6	8.2	11.1	131.5

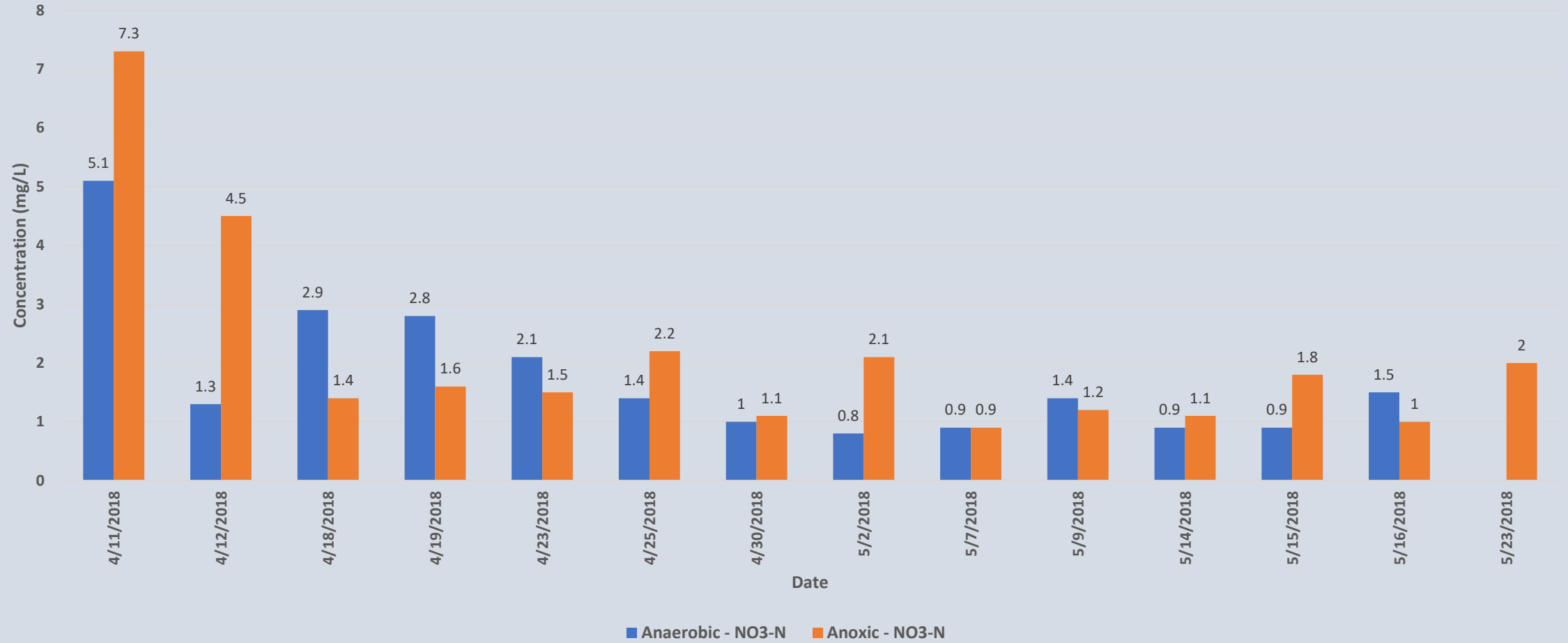
Case Study: Bradford WWTP

Too much Nitrate everywhere

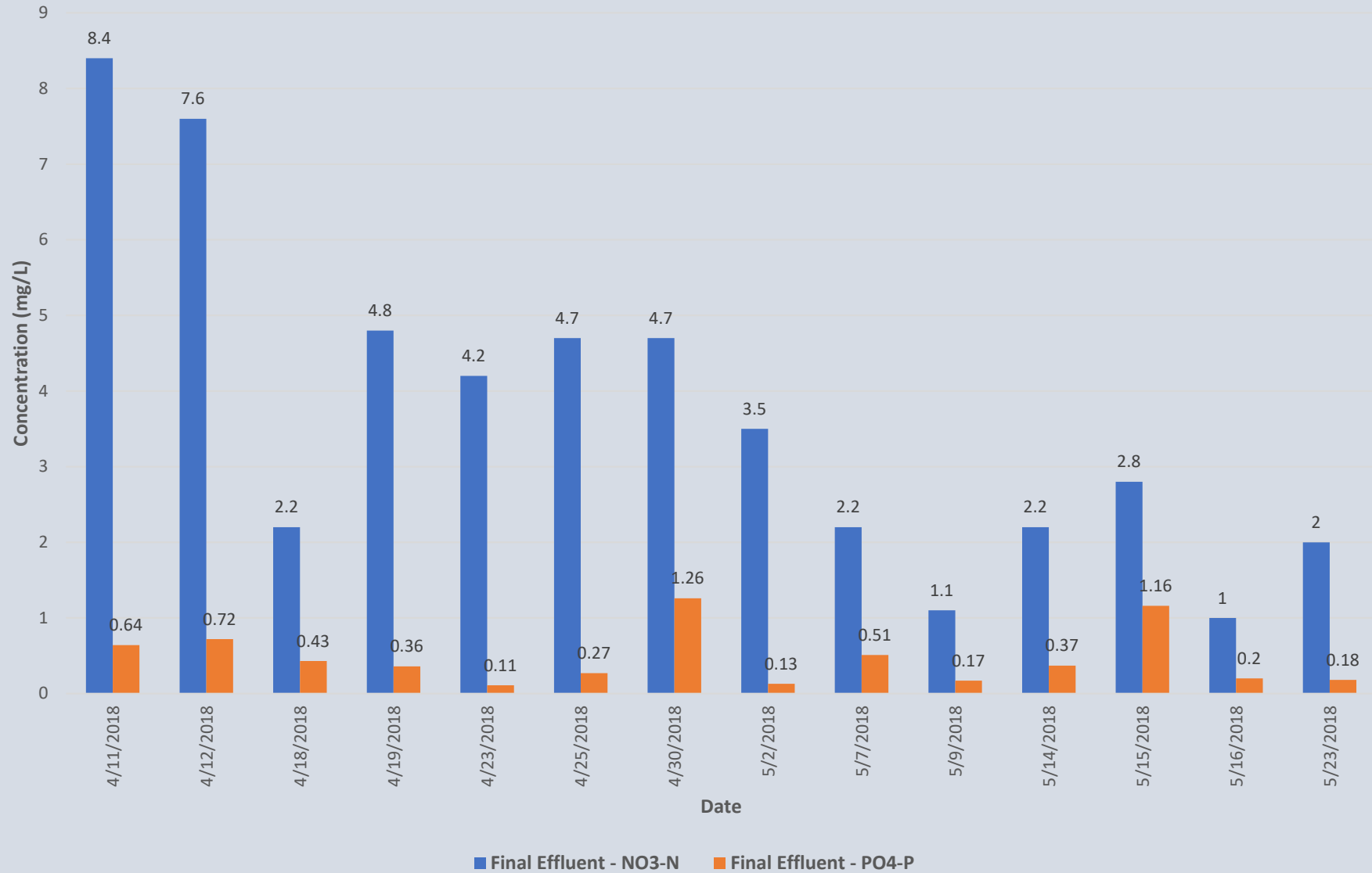
Solution: Manage the Nitrates

- 1) Close the nitrate recycle gate
- 2) Run vertical rotor at 35 hertz
- 3) Turn Anaerobic Zone Mixer OFF for 3 hours, ON for 15 minutes
- 4) Turn Anoxic Zone Mixer OFF for 3 hours, ON for 15 minutes
- 5) Profile Ammonia, Nitrate, and Orthophosphate in each zone

Bradford WWTP
Nutrient Profile
Nitrate Grab Sampling
4/11/2018 - 5/23/2018



Bradford WWTP
Nutrient Profile Grab Sampling
4/11/2018 - 5/23/2018





Case Study: Bradford WWTP

First April sample was high (1.25 mg/L), but the rest of the samples brought the monthly down to 0.66 mg/L

Alum feed was shut down 5/2

May 2018 another consecutive month of compliance for TP

In addition, the village was spending \$800 - \$1200/month for alum previously.

Electricity demand should also be reduced due to mixer turndown

Case Study: Bradford WWTP

Keys to BPR:

Process Control!

- 1) Monitor the nutrients in the Inputs to each zone
- 2) Monitor the nutrients in Internal Recycles (Digester Supernatant)
- 3) If the Chemistry is correct in the zones, the bacterial response will be compliant.
- 4) **Know the chemical environment in each zone of the WWTP.**

Questions?

jon.vandommelen@epa.ohio.gov

614-580-5069