Nelson Environmental Inc.

Wisconsin WasteWater Operators' Association, Inc.

Upgrading Lagoons to Remove Ammonia, Nitrogen, and Phosphorus *nutrient removal in cold-climate lagoon systems

October 7, 2015
3:15 – 4:00pm
Session M
Room Tamboti / Aloes-wood

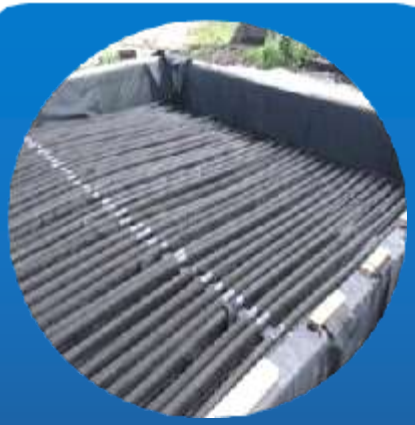
optAER™ Treatment Processes

Aerated Lagoons

BOD & TSS Removal

SAGR

Nitrification
BOD/TSS Polishing
Partial Disinfection



ANSAGR

and/or Effluent Recycle

Denitrification

optTPhos

Tertiary Filtration

TP Removal

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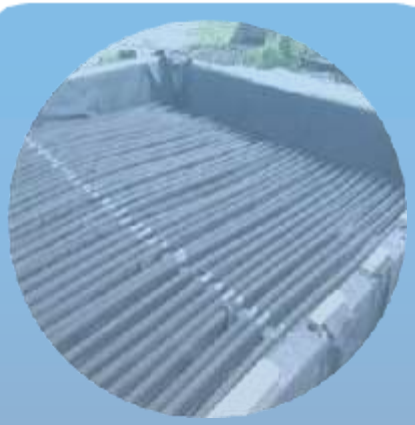

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OPTAER™ lagoon aeration components

Pre-Fabricated Building

PD Blowers

Buried Main Air Supply

Floating Laterals

Self-Tensioning Assembly

Fine & Coarse Bubble Aeration

Baffle Curtain

OPTAER™ fine bubble aeration

Excellent **oxygen transfer** rate at a wide range of airflows

Specifically designed for **cold climate** lagoon applications

OPTAER™ coarse bubble aeration

Specifically designed for **cold climate** lagoon applications

The diffusers consist of an **HDPE air distribution body with 9 air release orifices**, which are designed to minimize backpressure and the potential for fouling

self-tensioning devices

Cables are fastened to **anchors** at the tops of the berm

Allows for **expansion and contraction** of laterals and water level fluctuations

float/sink lateral system

Dry Install

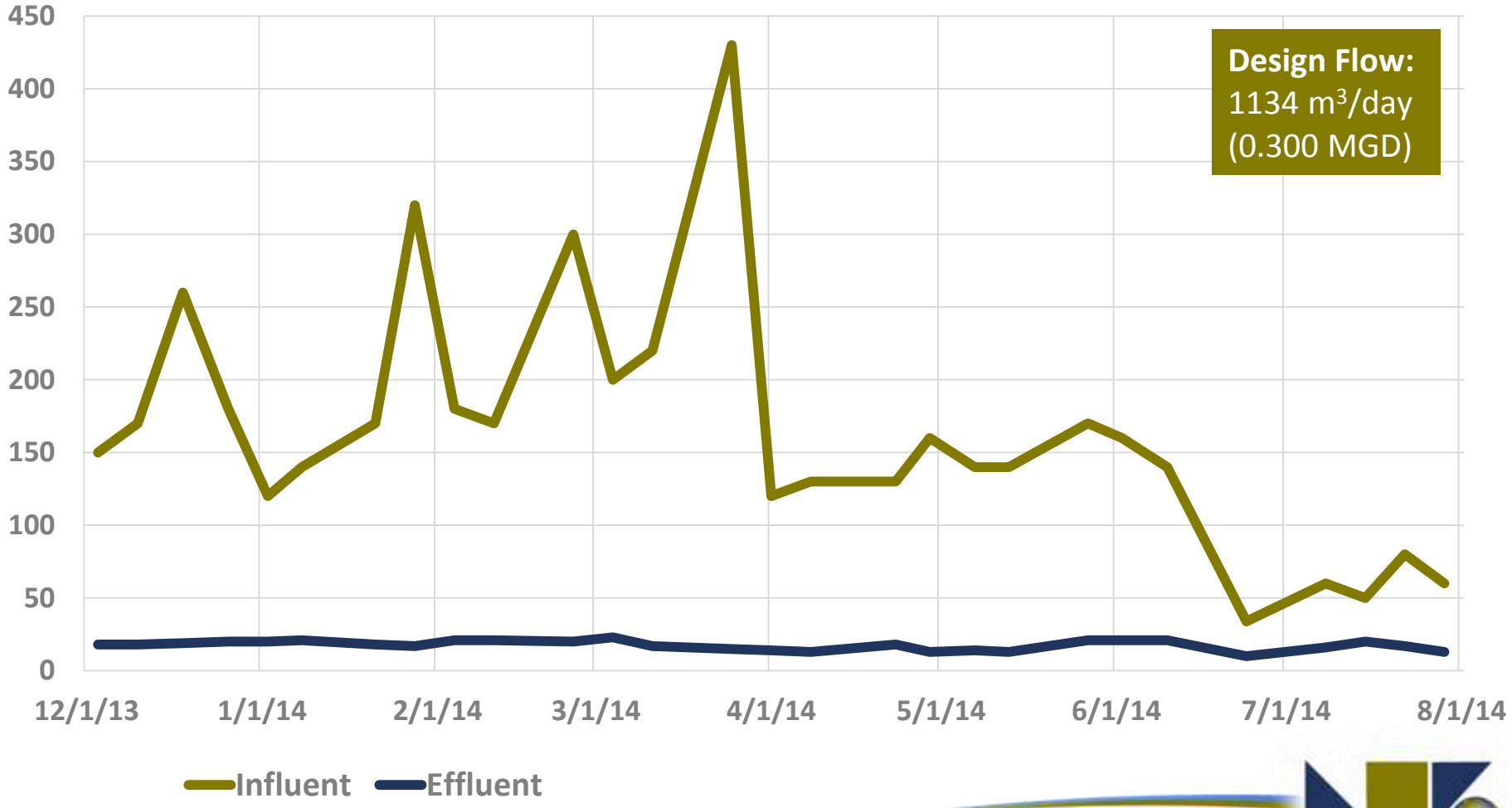
Wet Install

OPTAER™

Complete Mix Cell

Kingsley, Iowa

Lagoon $cBOD_5$ (mg/L)



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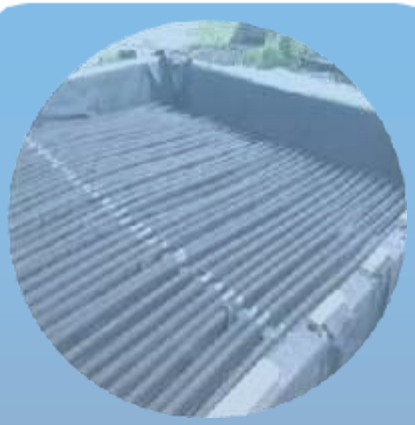

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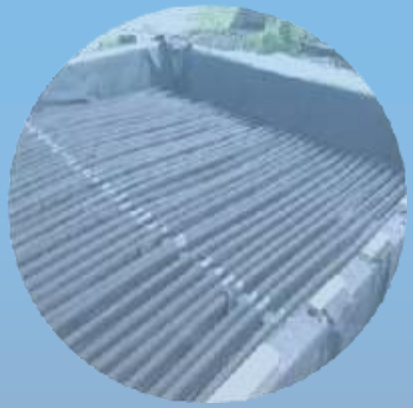

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OPTPhos

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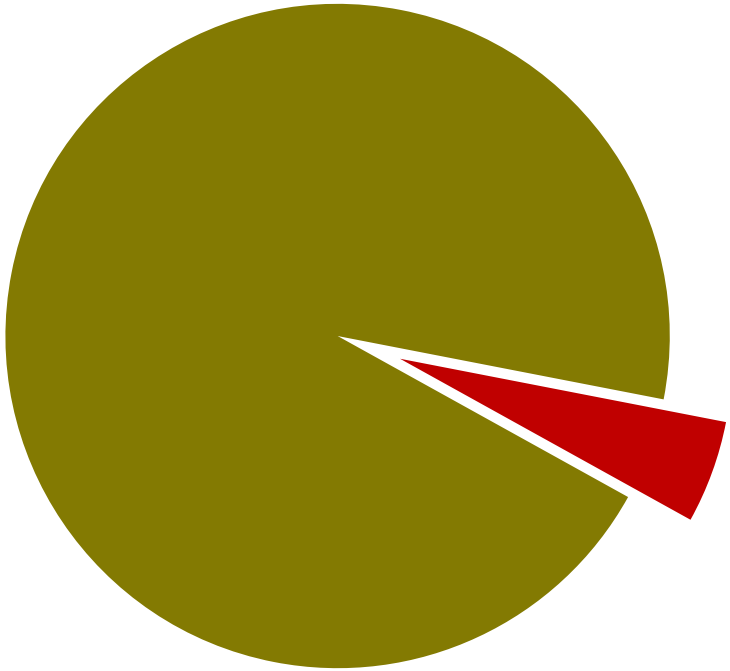
TP Removal

why is removing ammonia important?

Terminology



NH_4^+ (Ammonium)

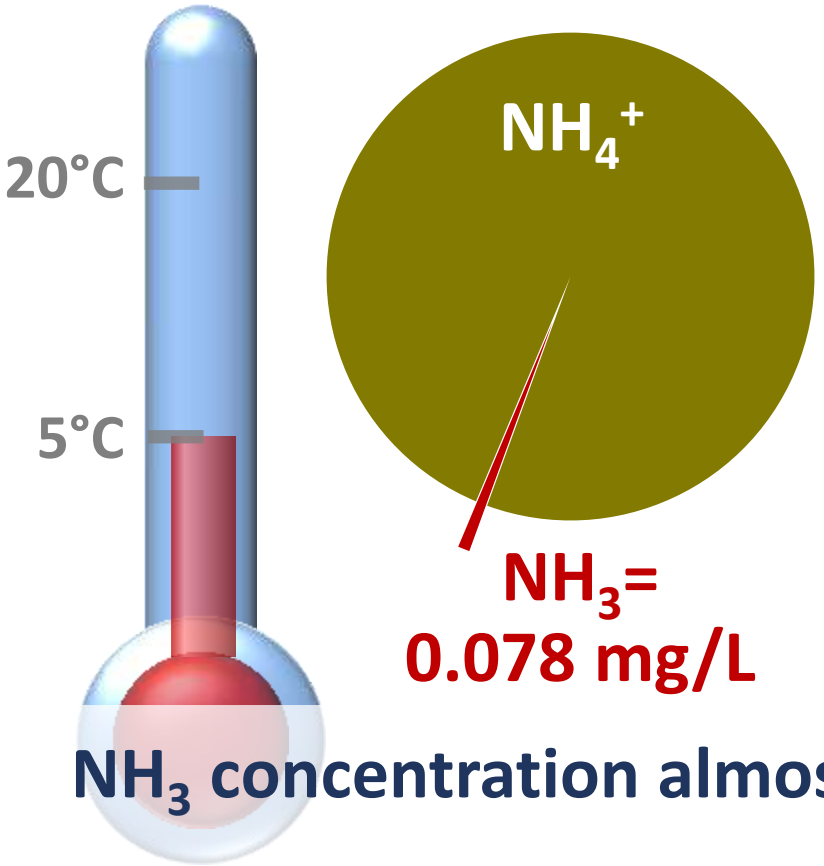
\+ NH_3 (Ammonia/Un-ionized)

TAN (Total Ammonia)

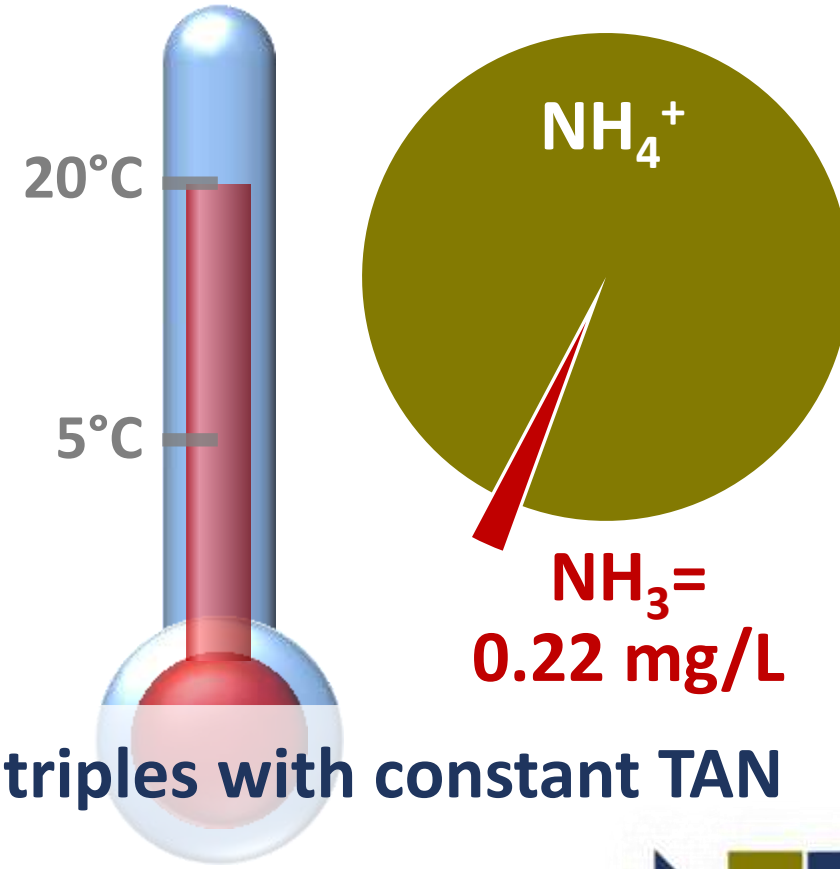
0.1 mg/L NH_3 is generally considered "non-toxic"

why is removing ammonia important?

Assuming TAN=10 mg/L and pH=7.8



NH_3= 0.078 mg/L

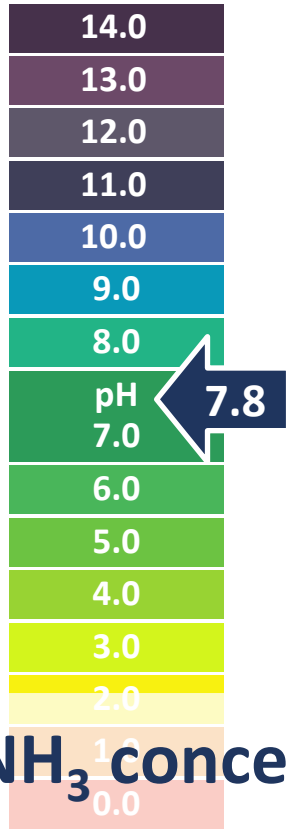


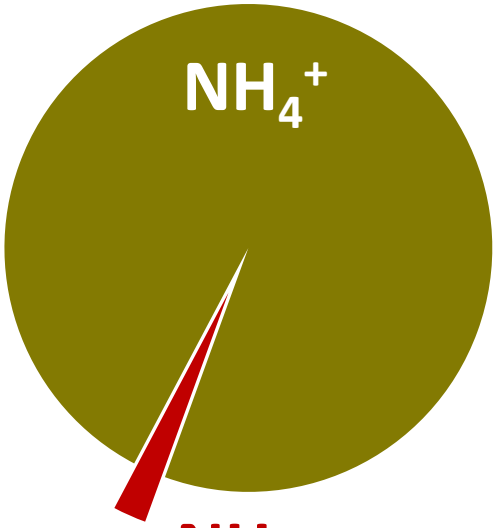
NH_3= 0.22 mg/L

NH_3 concentration almost triples with constant TAN

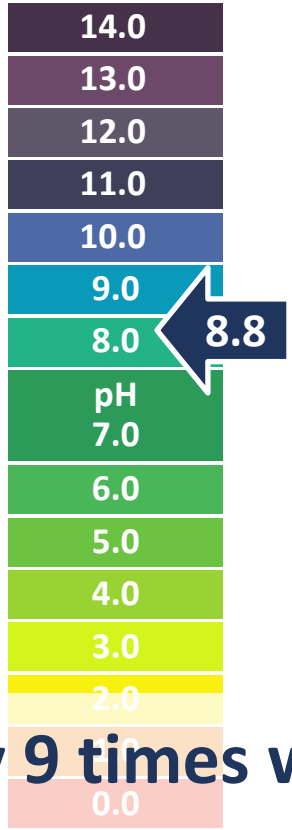
why is removing ammonia important?

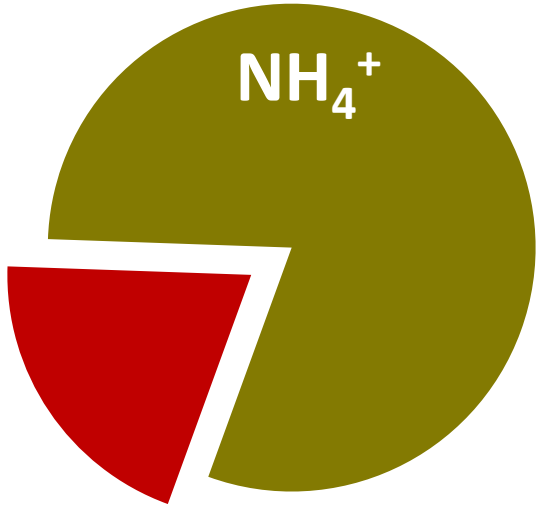
Assuming TAN=10 mg/L and water is 20°C





NH_3= 0.22 mg/L





NH_3= 2.00 mg/L

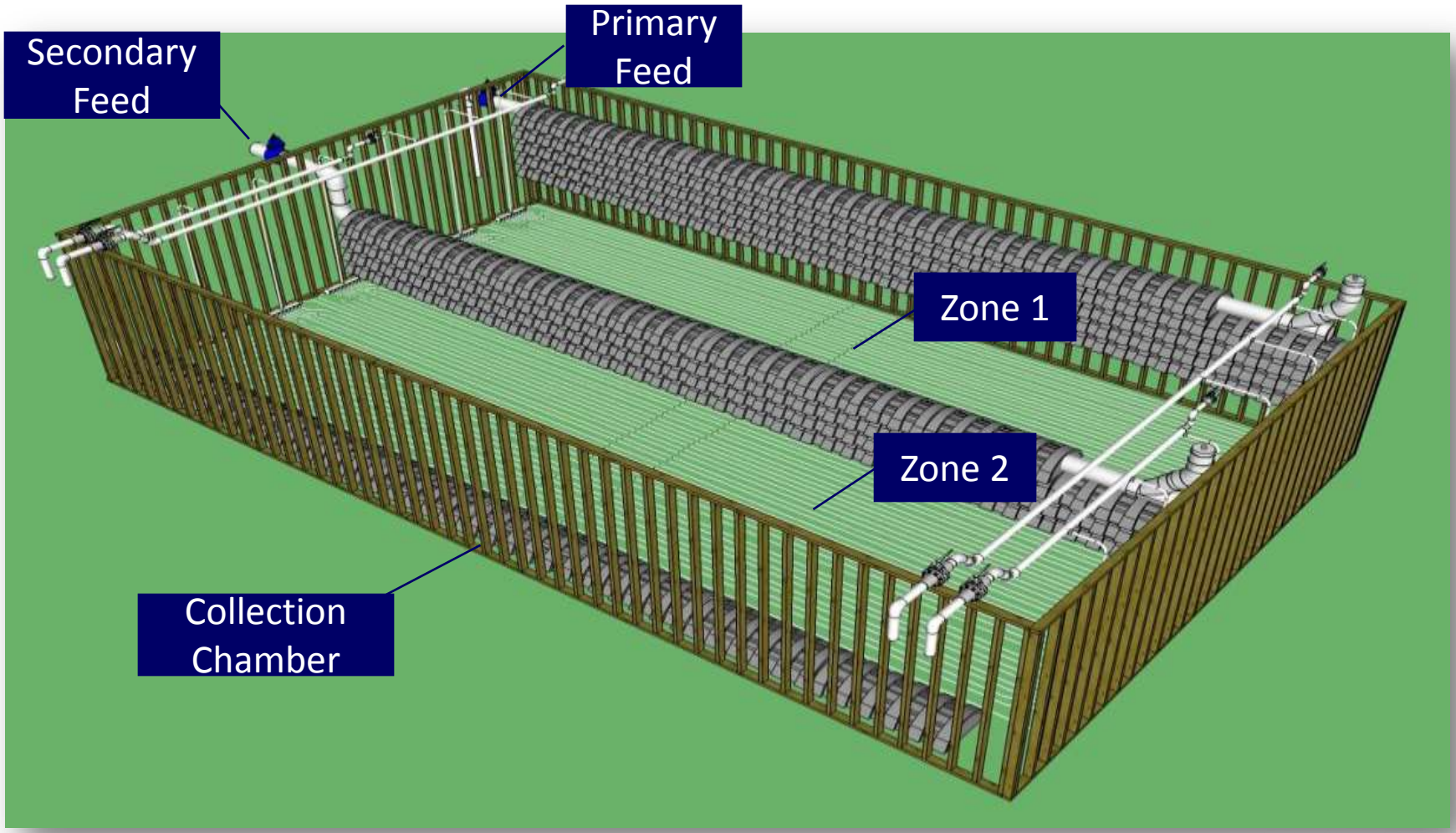
NH_3 concentration increases by 9 times with constant TAN

what is a SAGR

Fully aerated **coarse gravel** bed reactor

- Water flows through the substrate **horizontally**
- Stable dense rock media which is **not susceptible** to temperature shock
- Designed for **cold water treatment**, the SAGR removes ammonia through nitrification and provides BOD/TSS polishing & partial disinfection

Submerged Attached Growth Reactor



SAGR performance data

University of Manitoba Third Party Winter Operation Verification Data
(January 13 – April 21, 2010)

Parameters	SAGR Influent Averages (mg/L)	SAGR Effluent Averages (mg/L)	Removal
cBOD	47	2.1	95.5%
TSS	30	1.3	95.7%
TAN	24.9	0.12	99.5%
TKN	32.5	1.8	94.5%
FC (cfu/100mL)	253,000	13.5	99.99%
Average water temperature (°C)	0.3	1.0	

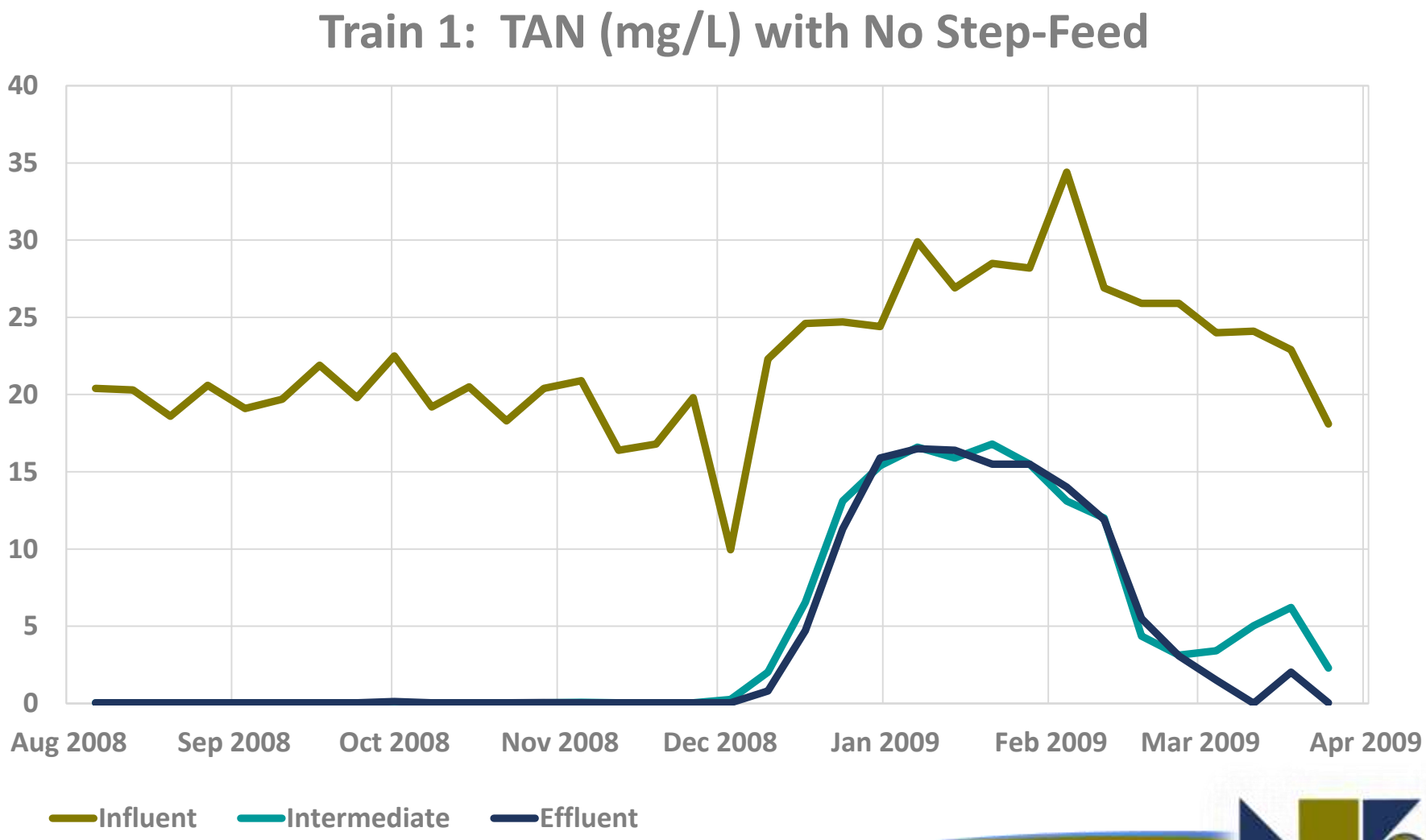
what makes the SAGR so effective?

Built-in temperature buffering: Rock media stabilizes biomass temperature during rapid water cool down

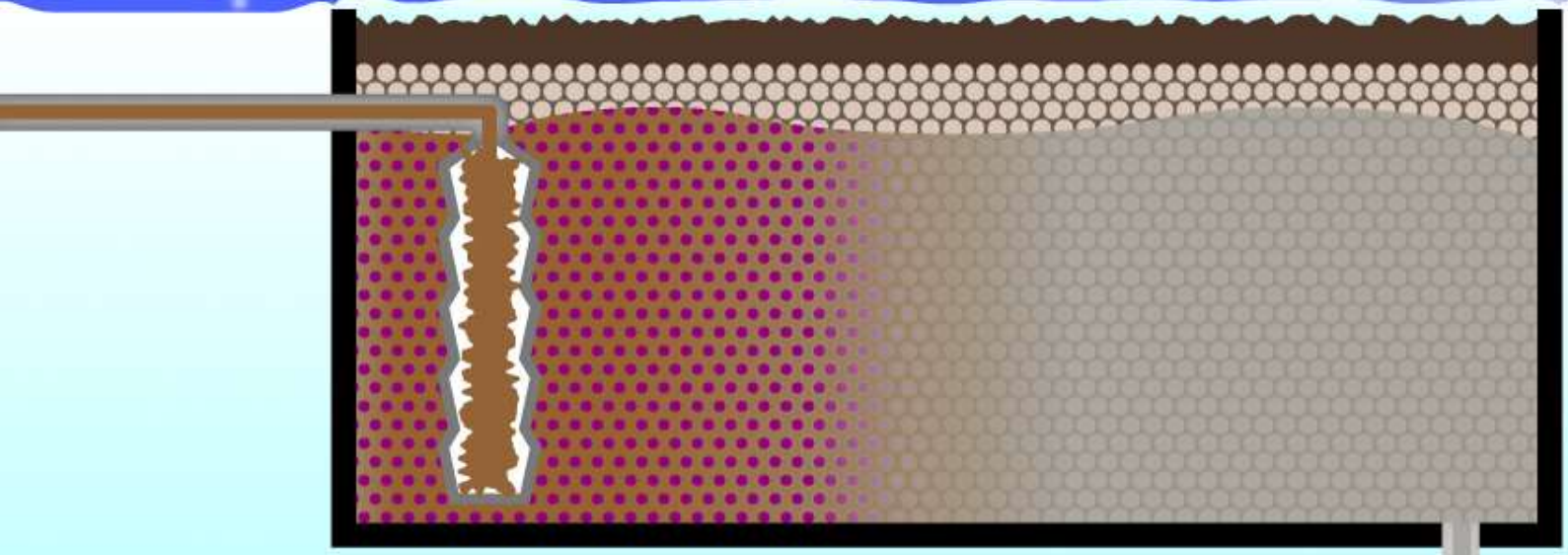
Non-turbulent environment: Allows nitrifier retention throughout the winter which eliminates the need to grow replacement nitrifiers.

Step-Feed: Prebuild and store excessive nitrifiers prior to water temperatures dropping below 1°C. The excess nitrifiers are needed once water temperatures drop and biomass growth slows.

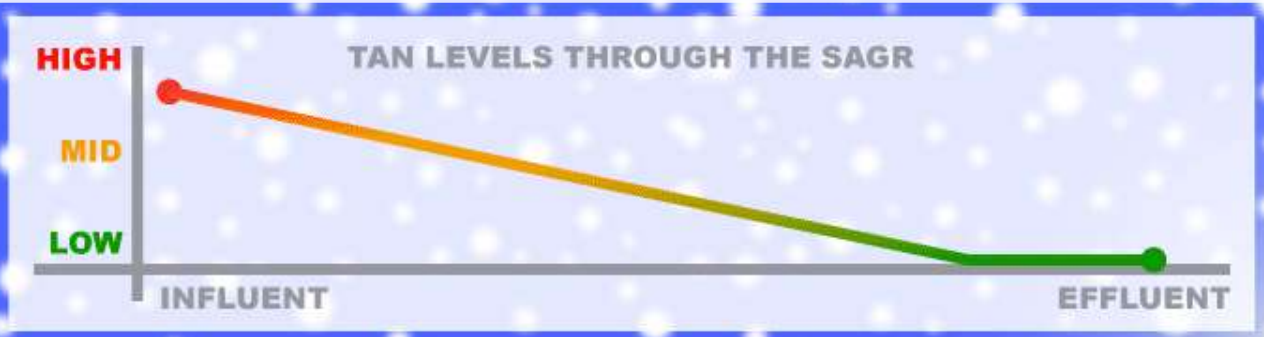
SAGR demonstration site: Steinbach MB

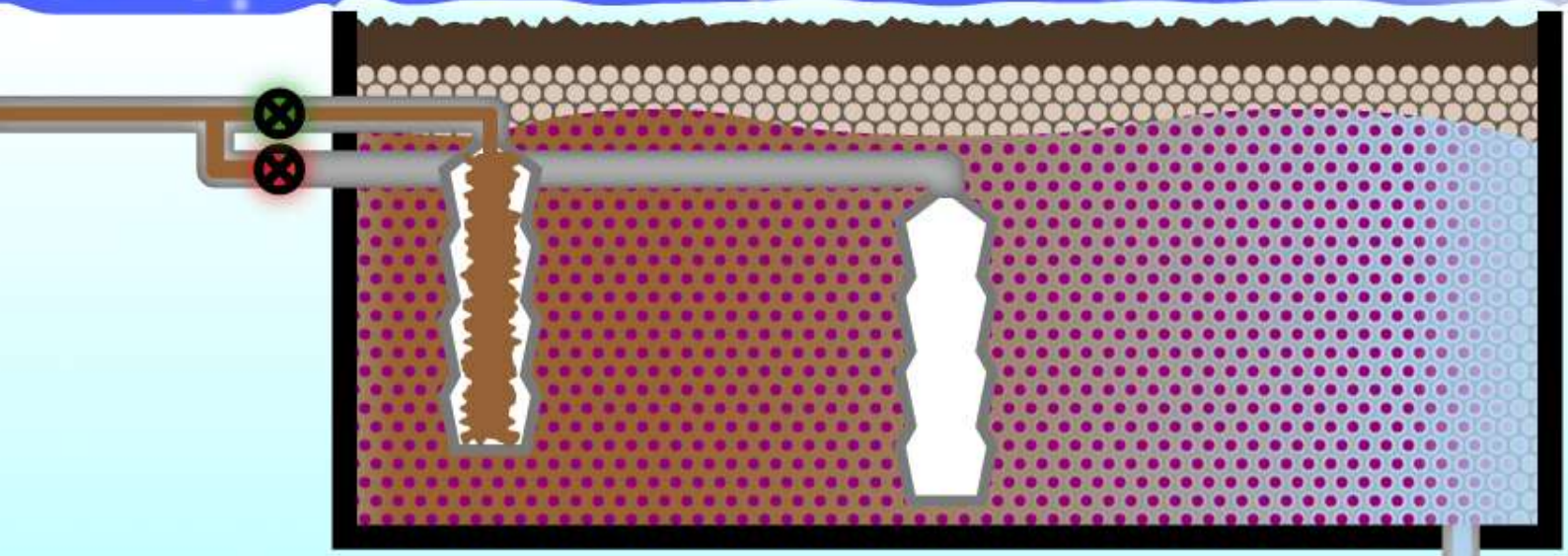


SAGR without step-feed: winter



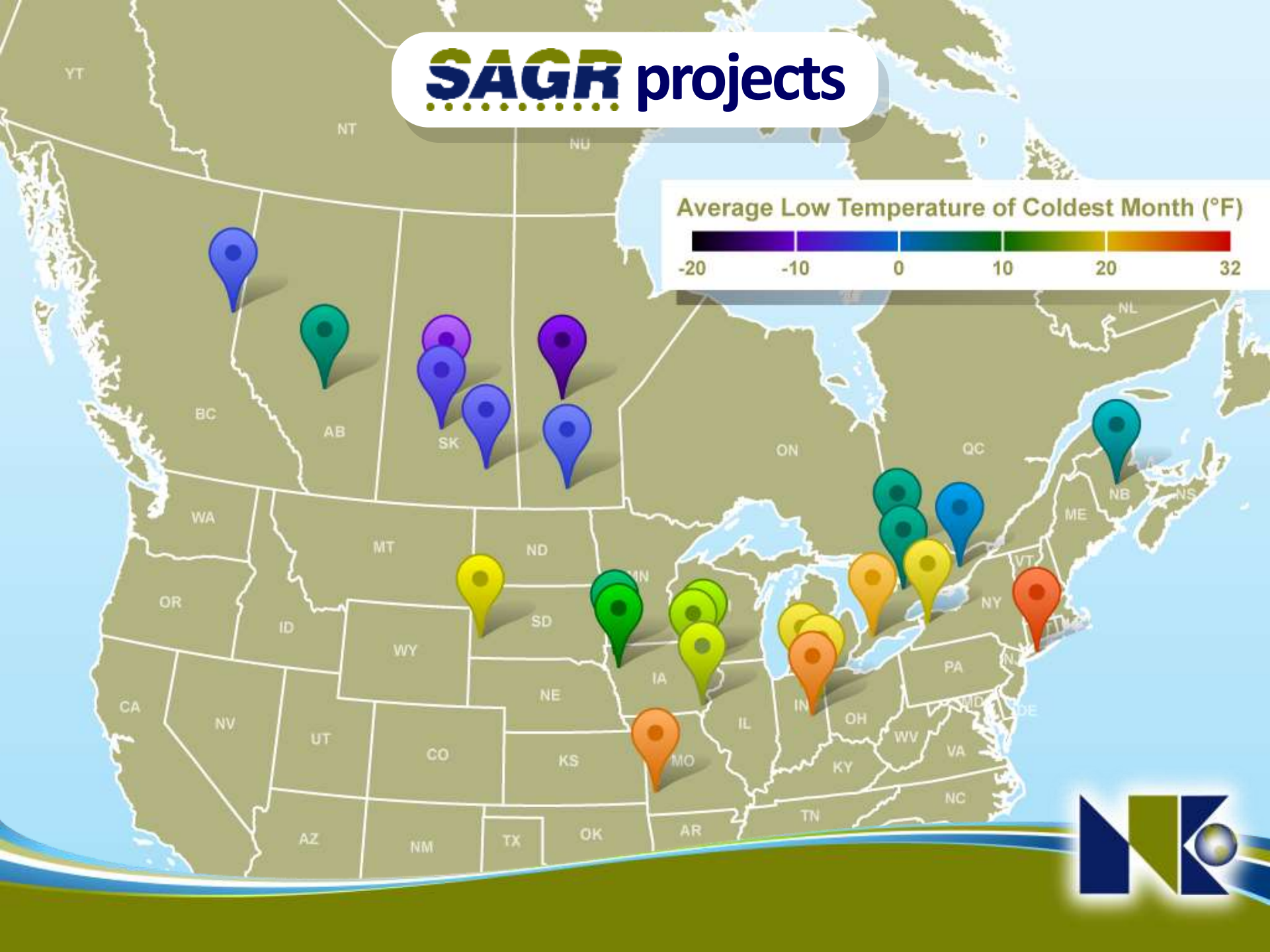
SAGR with step-feed: winter





SAGR projects

SAGR projects



optAer™ Treatment Processes

Aerated Lagoons

BOD & TSS Removal

SAGR

Nitrification
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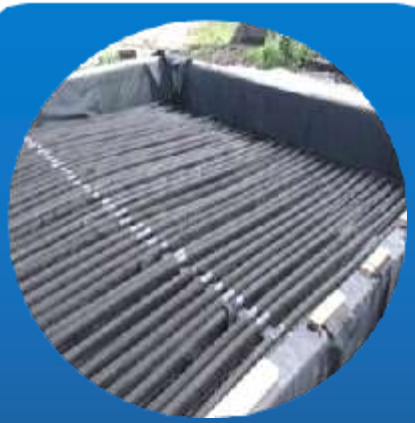
Partial Disinfection



ANSAGR

and/or Effluent Recycle

Denitrification

optTPhos

Tertiary Filtration

TP Removal

what is an ANSAGR

Anoxic Submerged Attached Growth Reactor

- Total Nitrogen removal system (de-nitrification)
- Cloth-based media
- Designed for cold water TN treatment.

Effluent quality:

TN: <10 mg/L

ANSAGR performance data

Blumenort MB Total Nitrogen Demo
November 2014 – March 2015

Parameters	SAGR Influent Avgs (mg/L)	ANSAGR Influent Avgs (mg/L)	ANSAGR Effluent Avgs (mg/L)	Removal
TIN	37.6	39.8	6.2	83.5%
Nitrates & Nitrites	4.6	39.5	6.0	84.7%
TKN	42.6	4.7	5.6	86.9%
TAN	33.0	0.2	0.2	99.3%
Avg water temp (°C)	0.5	0.9	1.7	

Operating at 130% of design flow and load

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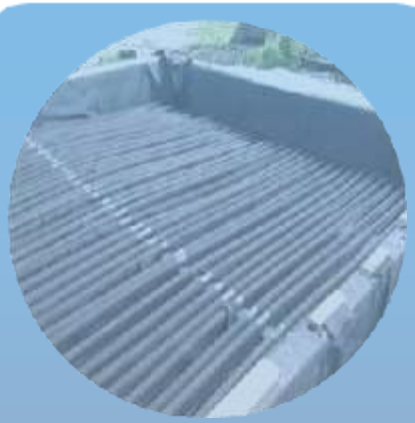

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optTPhos

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opTPhos Phosphorus Removal

TOTAL PHOSPHORUS REMOVAL

- **Rapid mix tank** for chemical dispersion and contact.
- **Slow mix tanks** for coagulation and flocculation.
- Small footprint, high performance tertiary cloth disk filters **or** settling in the lagoon.

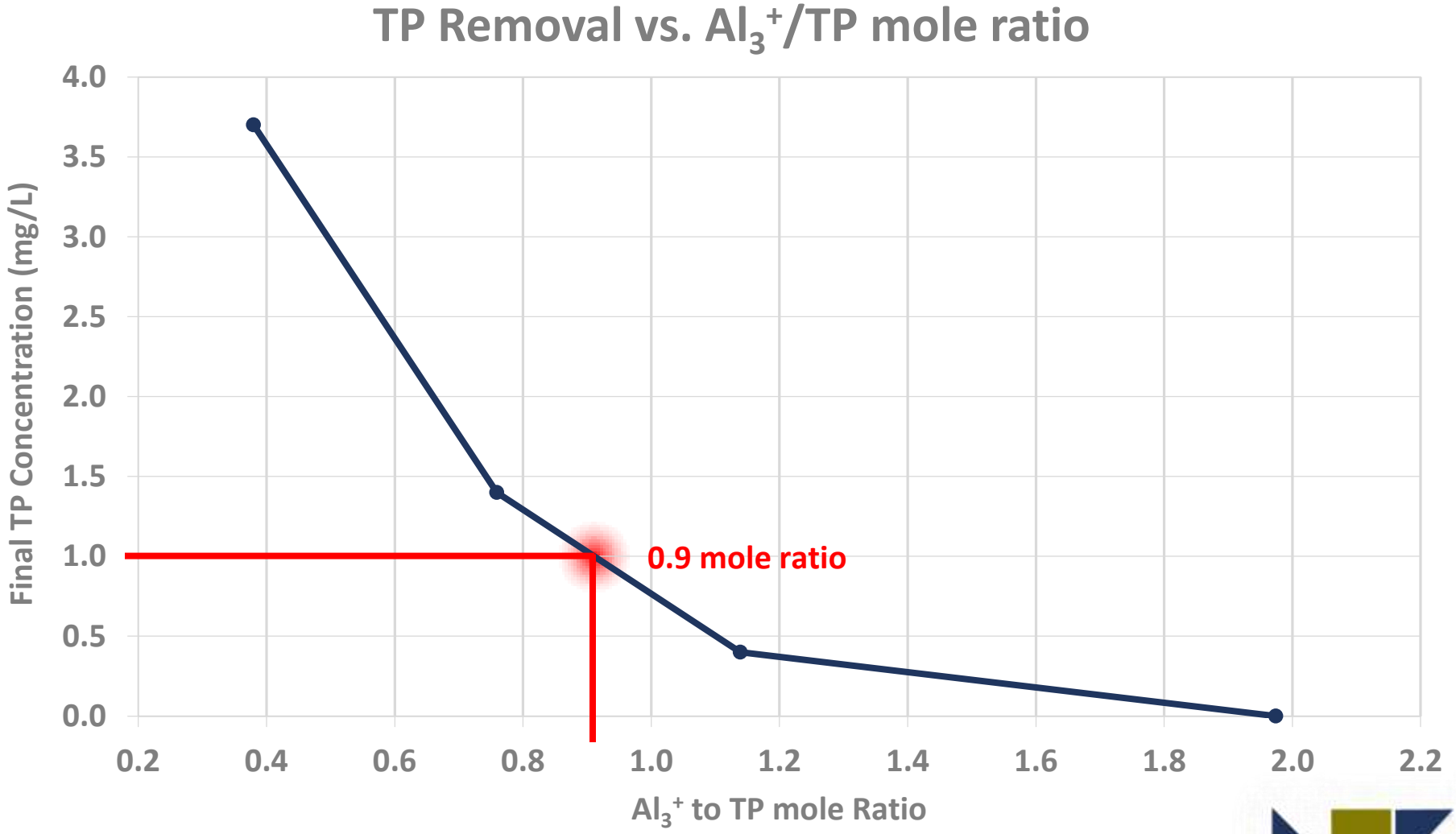
opTPhos

TOTAL PHOSPHORUS REMOVAL

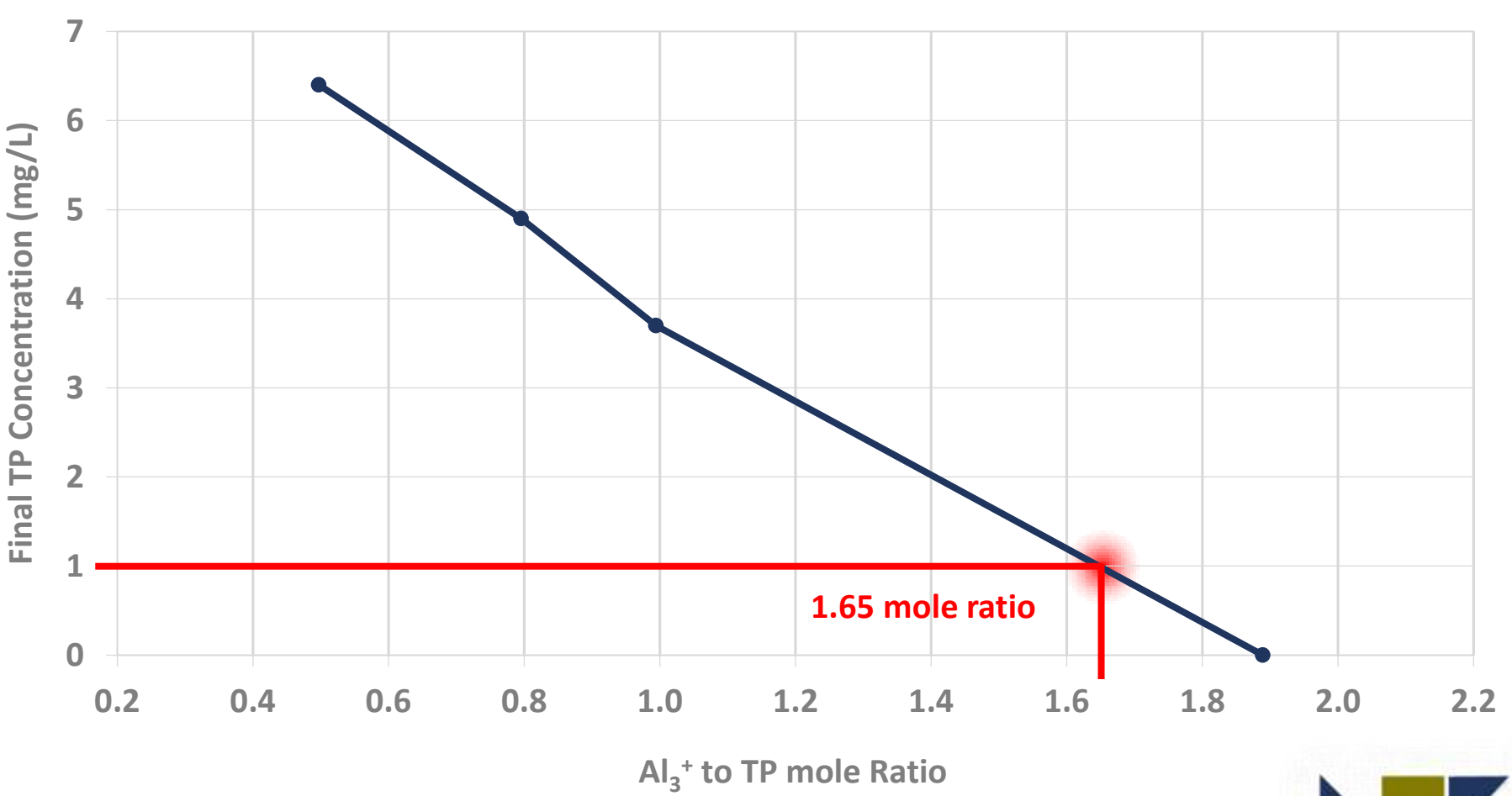
Tertiary Disk Filter

- **Smart Design:** user-friendly system on a small footprint
- **Flexible sizing:** for both small and large flow applications
- **High Performance:** can remove suspended solids to less than 5 mg/L, with low backwash

opTPhos alum jar testing at 18°C



opTPhos alum jar testing at 0.5°C



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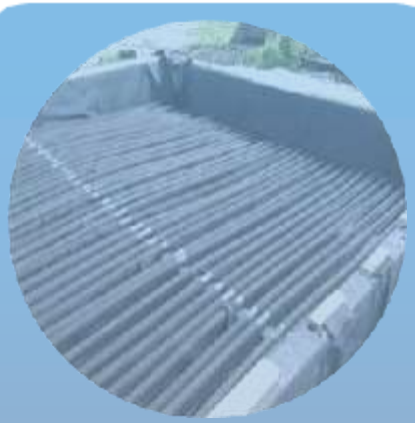

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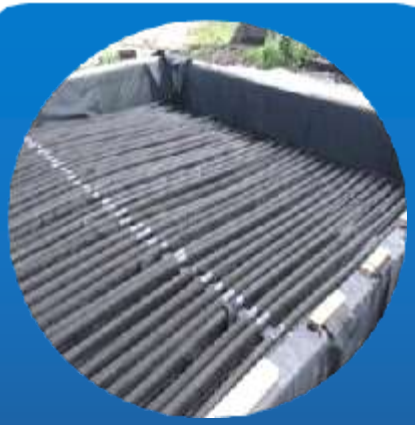

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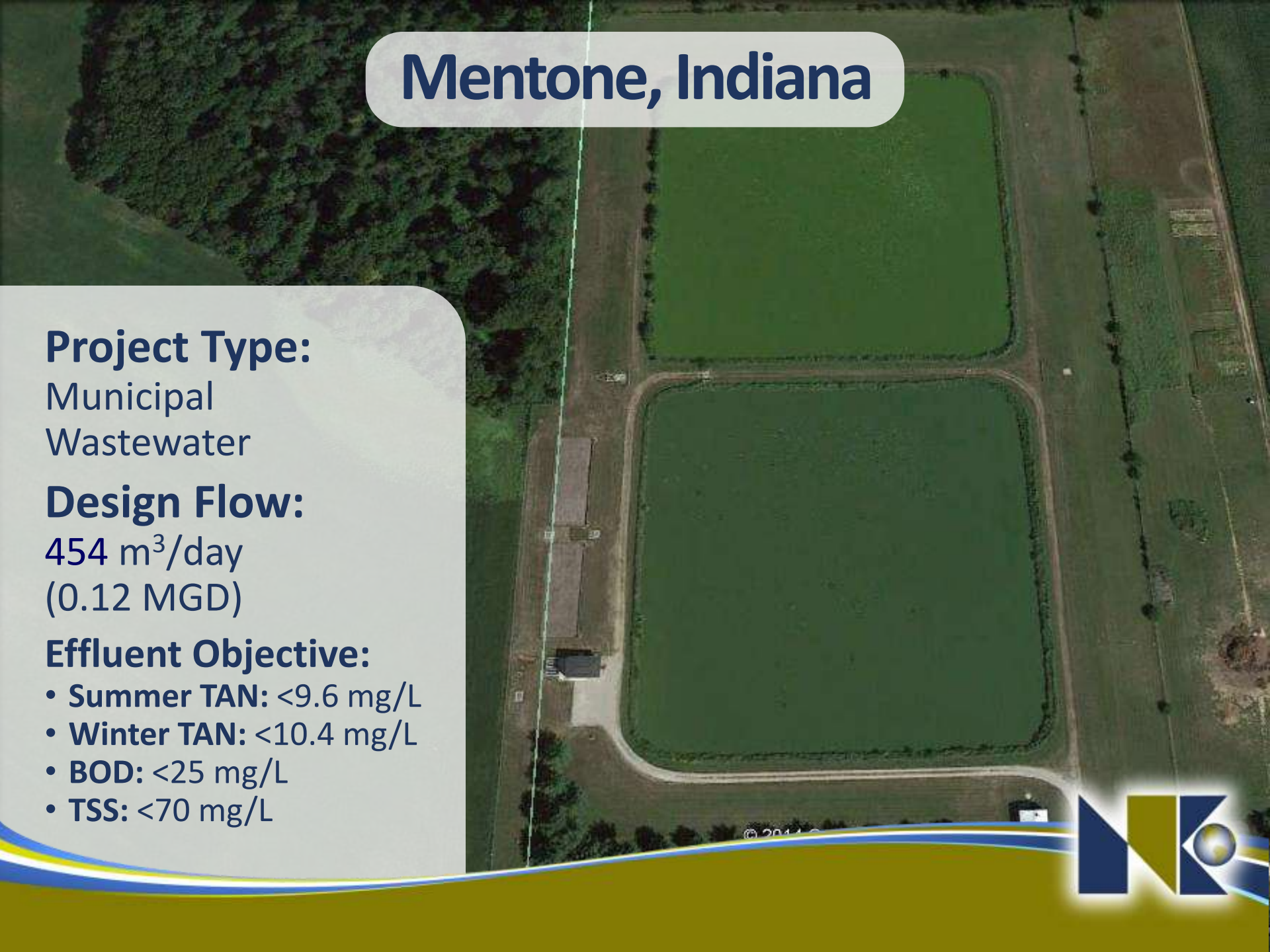
Mentone, Indiana



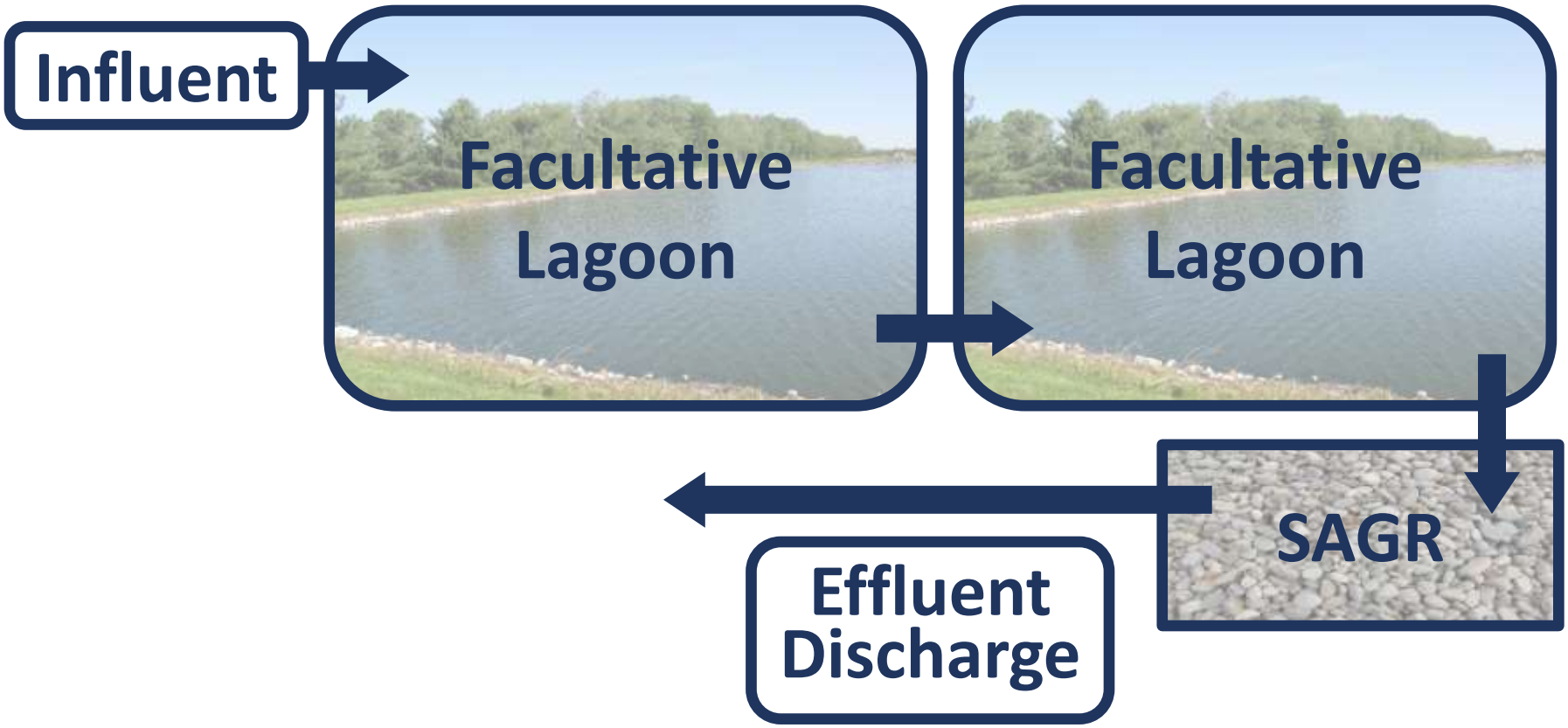
Project Type:
Municipal Wastewater

Design Flow:
454 m^3/day
(0.12 MGD)

Effluent Objective:

- **Summer TAN:** <9.6 mg/L
- **Winter TAN:** <10.4 mg/L
- **BOD:** <25 mg/L
- **TSS:** <70 mg/L

Mentone, Indiana



Mentone, Indiana

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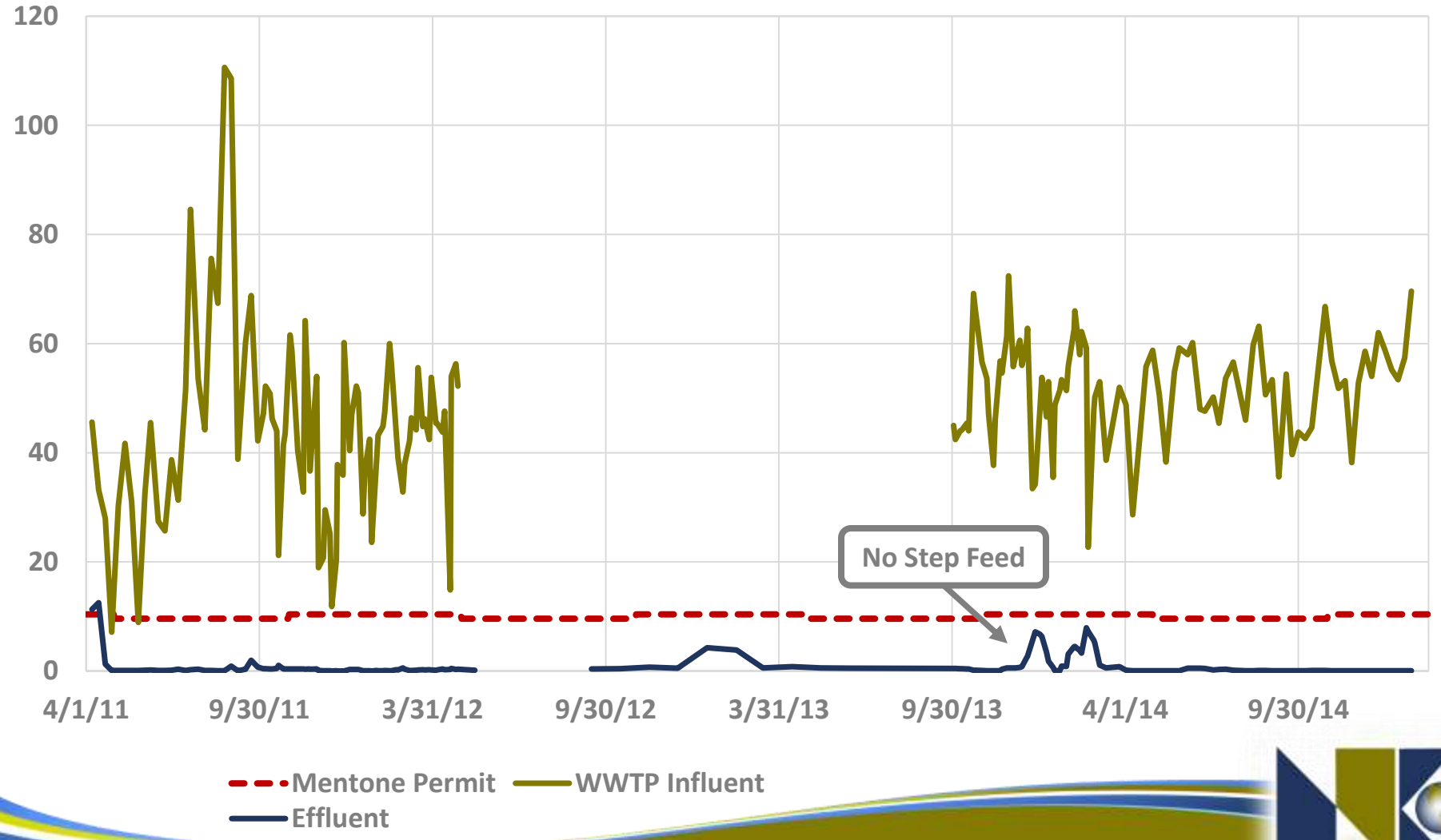
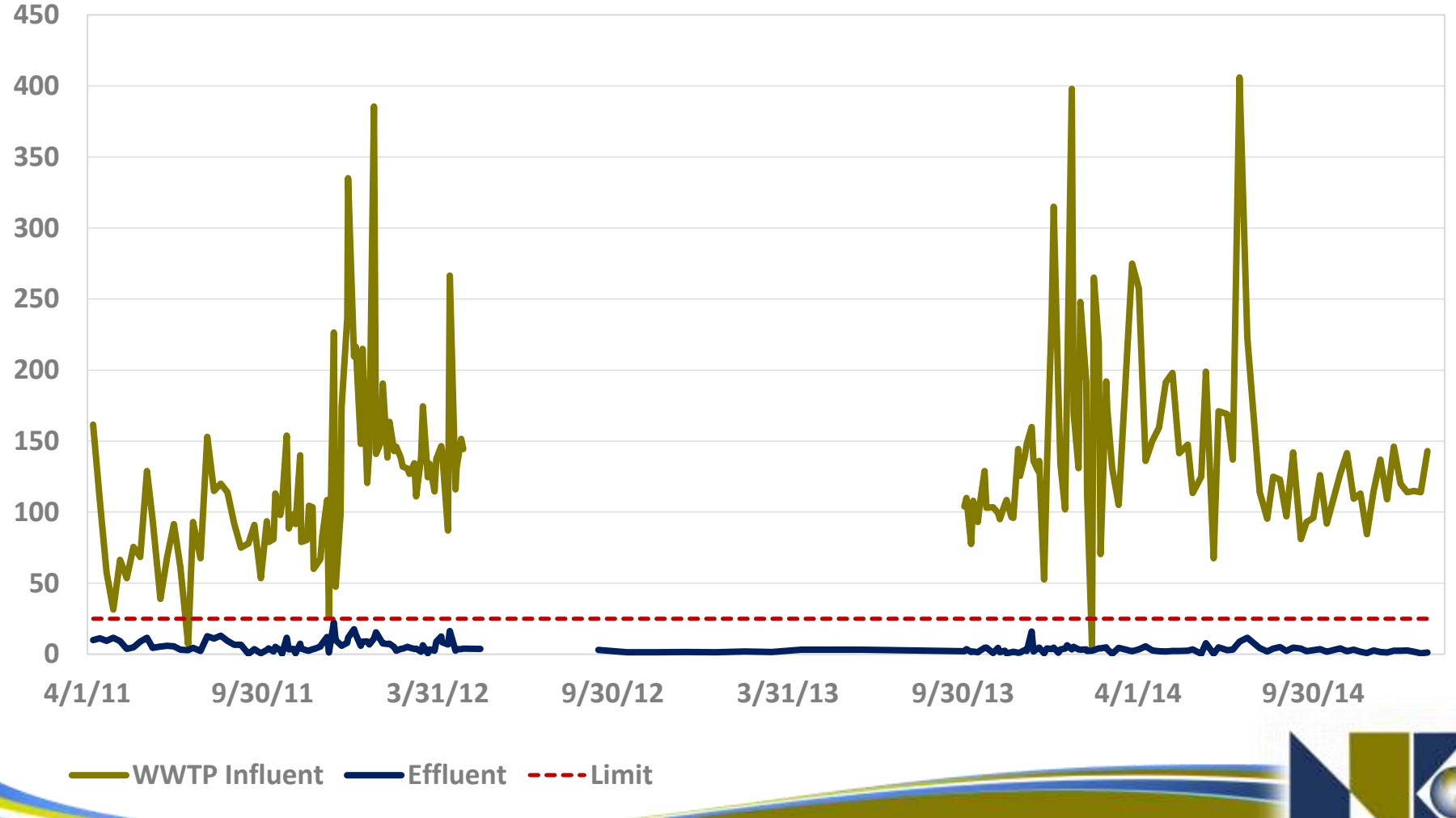
SAGR TAN (mg/L)



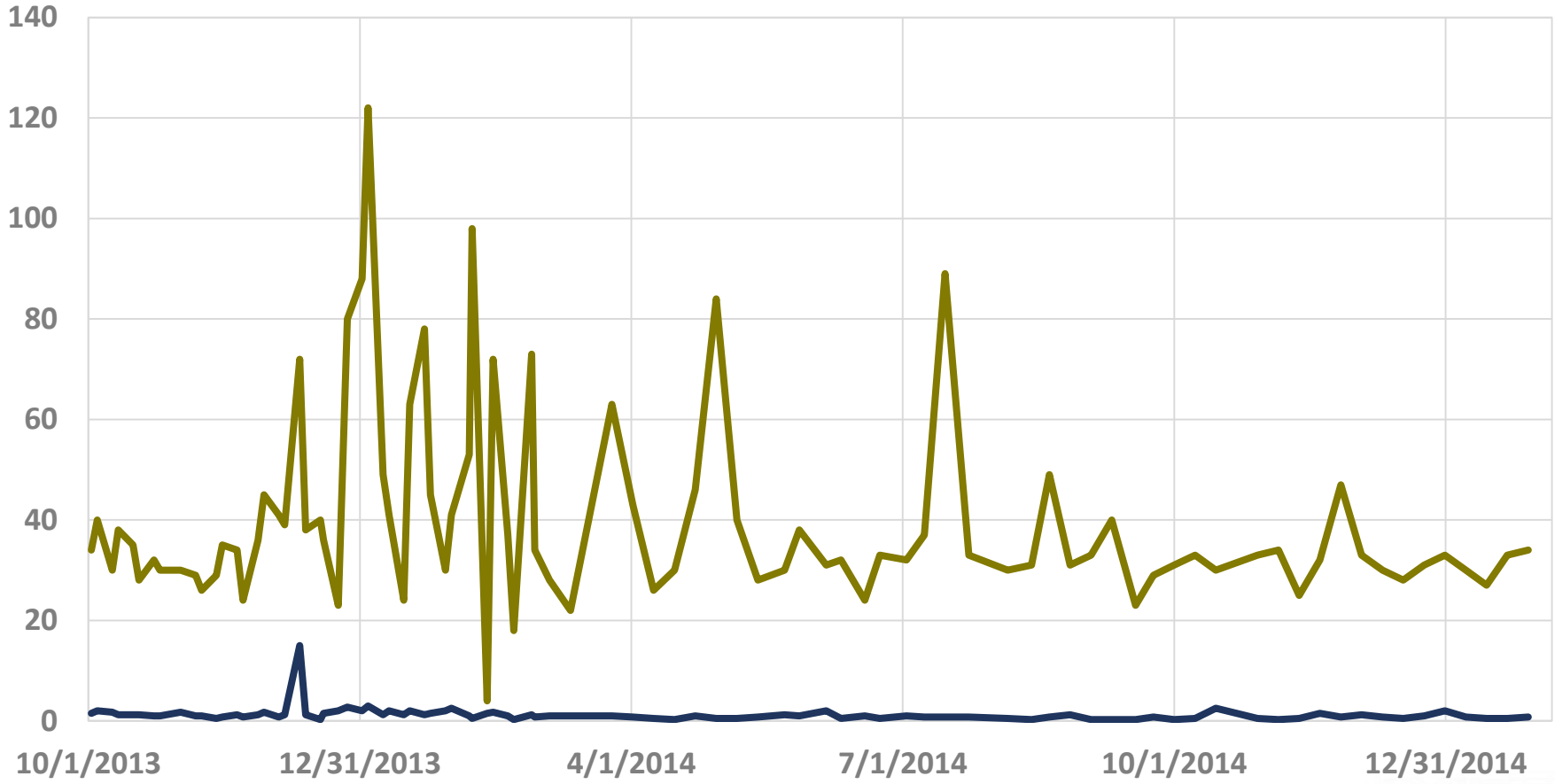
Mentone, Indiana

SAGR $cBOD_5$ (mg/L)



Mentone, Indiana

SAGR TSS (mg/L)



Kennard, Indiana

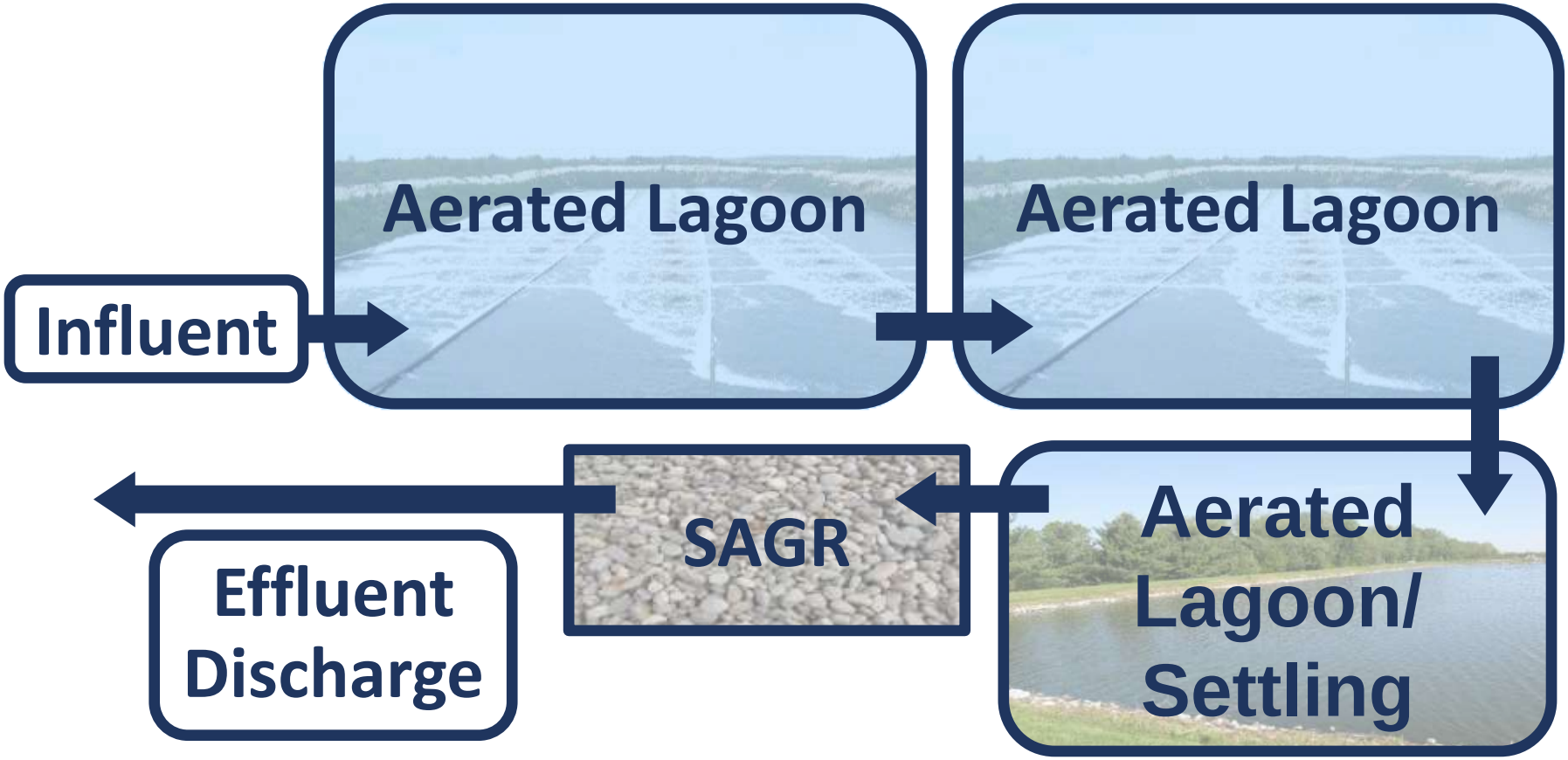
Project Type:
Municipal Wastewater

Design Flow:
378 m^3/day
(0.100 MGD)

Effluent Objective:

- **Summer TAN:** <1.5 mg/L
- **Winter TAN:** <3.0 mg/L
- **BOD:** <10 mg/L
- **TSS:** <12 mg/L

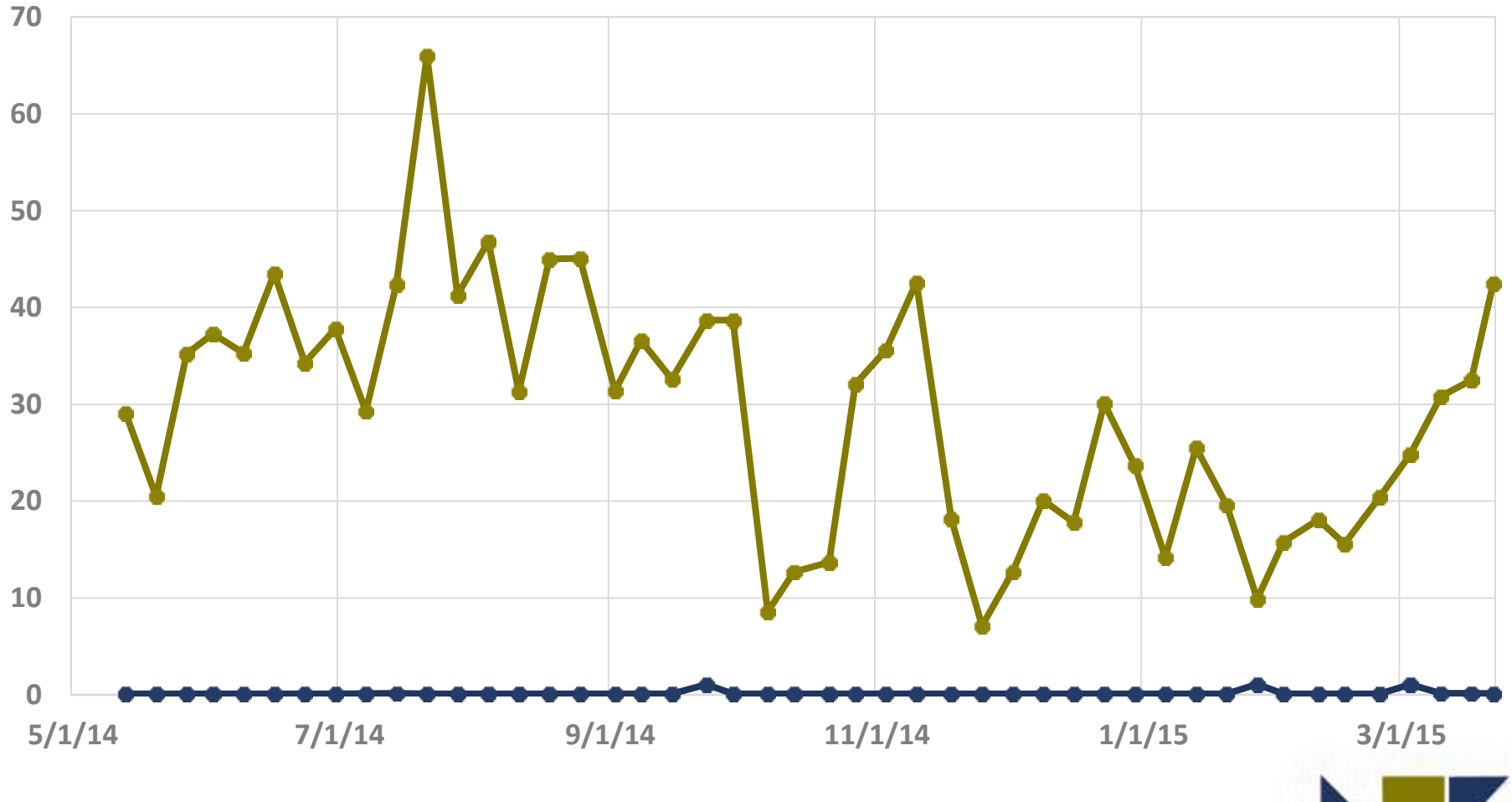
Kennard, Indiana



Kennard, Indiana

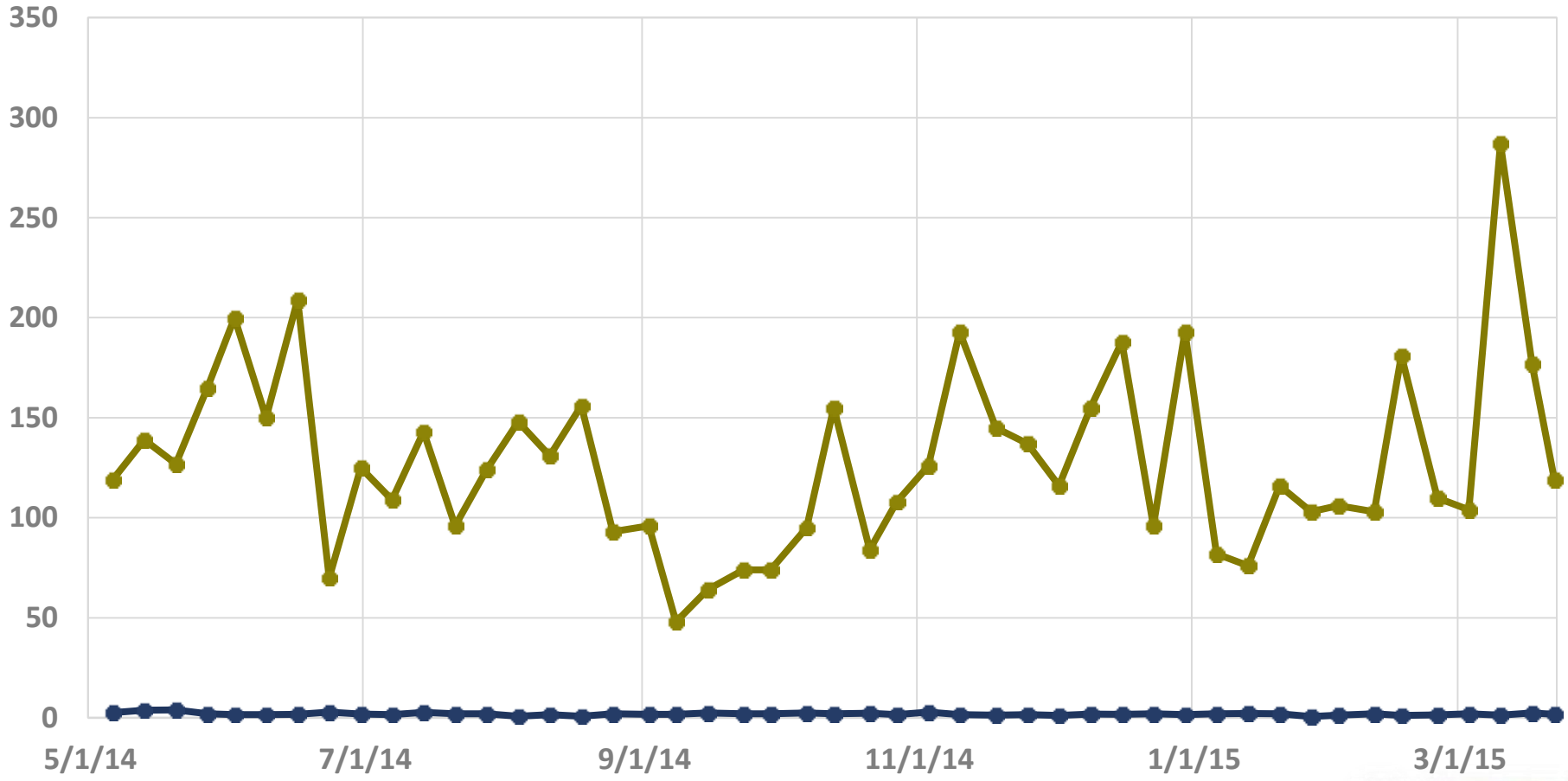
Kennard, Indiana

SAGR TAN (mg/L)



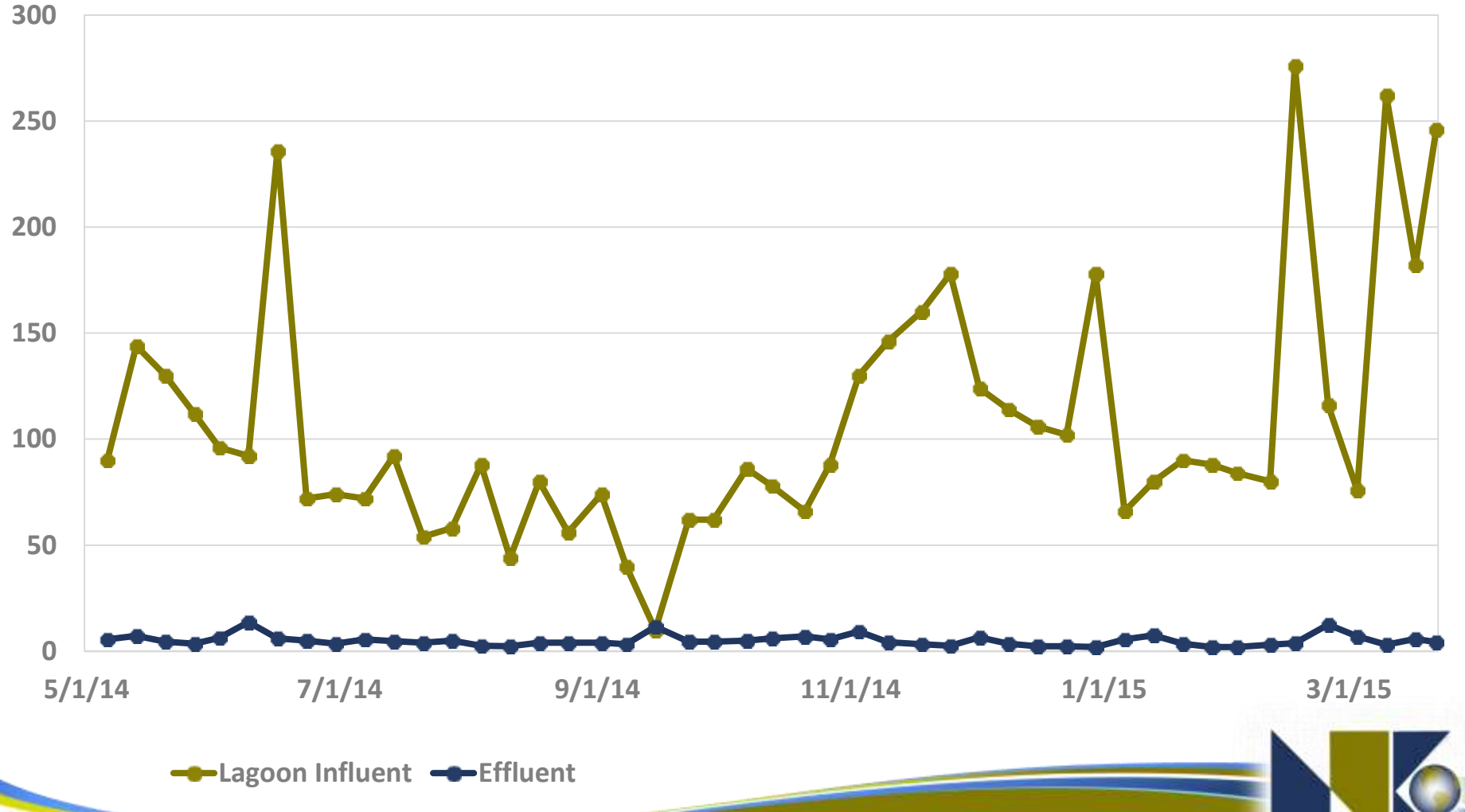
Kennard, Indiana

SAGR BOD (mg/L)



Kennard, Indiana

SAGR TSS (mg/L)



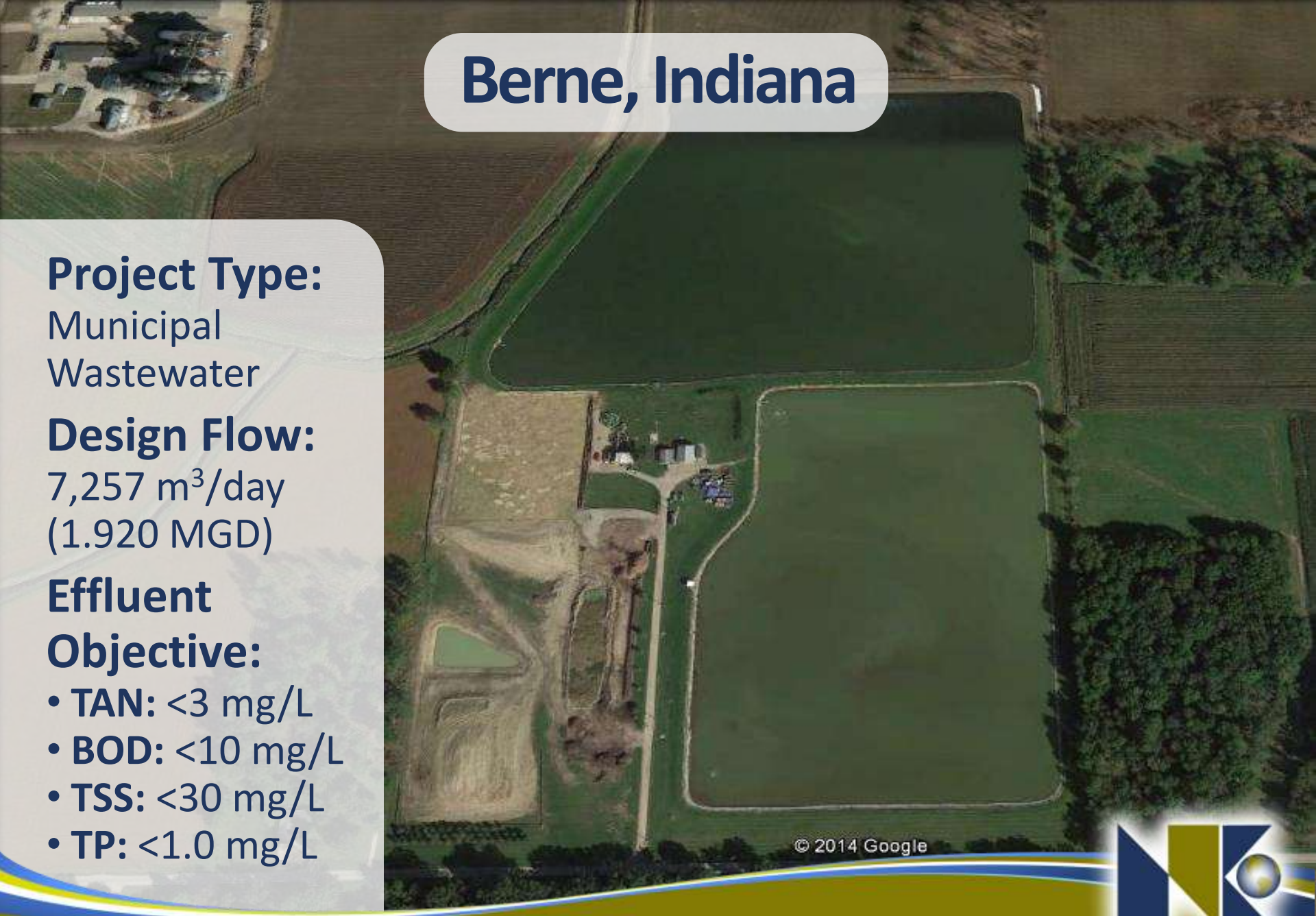
Berne, Indiana

Project Type:
Municipal Wastewater

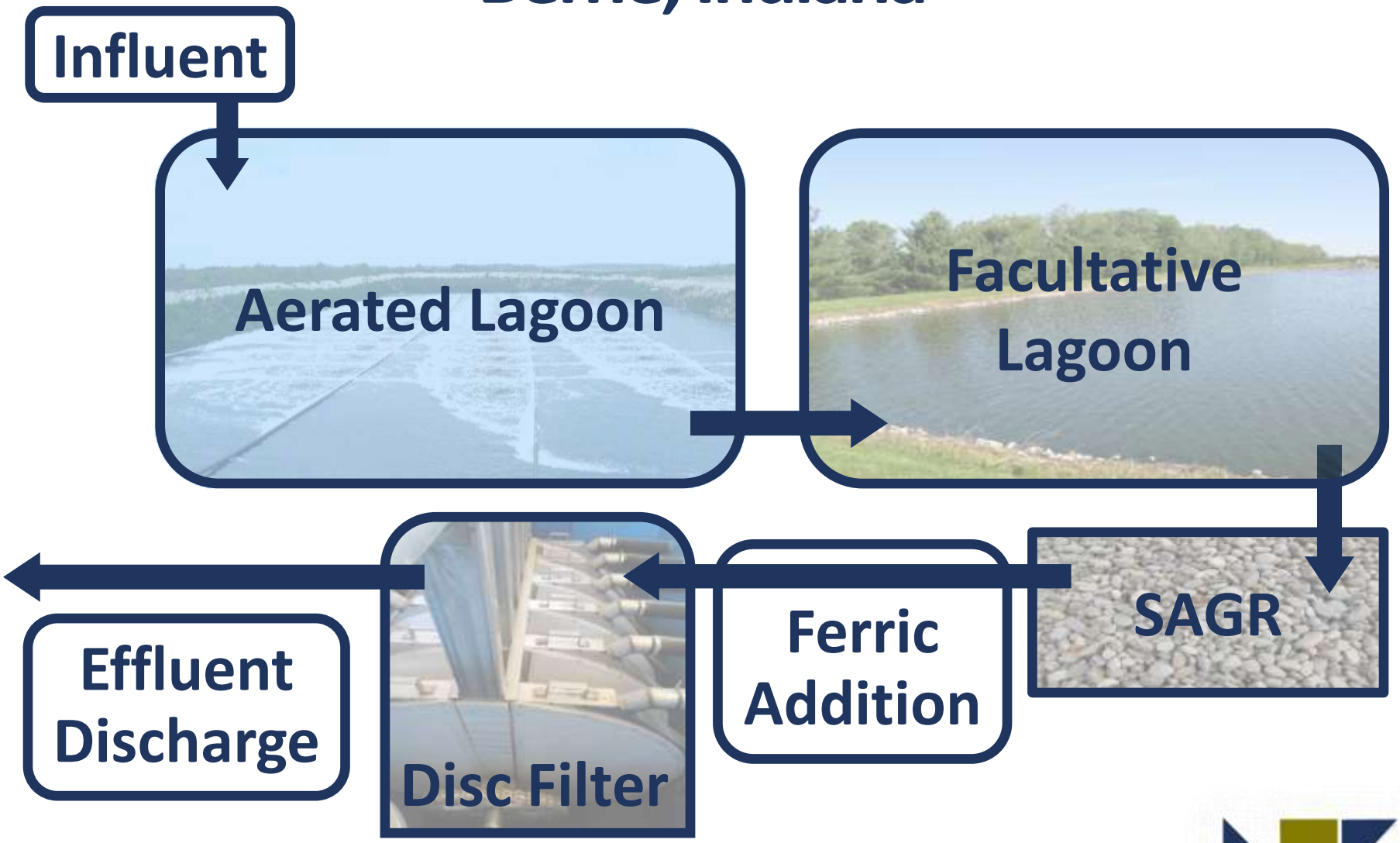
Design Flow:
7,257 m^3/day
(1.920 MGD)

Effluent Objective:

- **TAN:** <3 mg/L
- **BOD:** <10 mg/L
- **TSS:** <30 mg/L
- **TP:** <1.0 mg/L



Berne, Indiana



Sundridge, Ontario

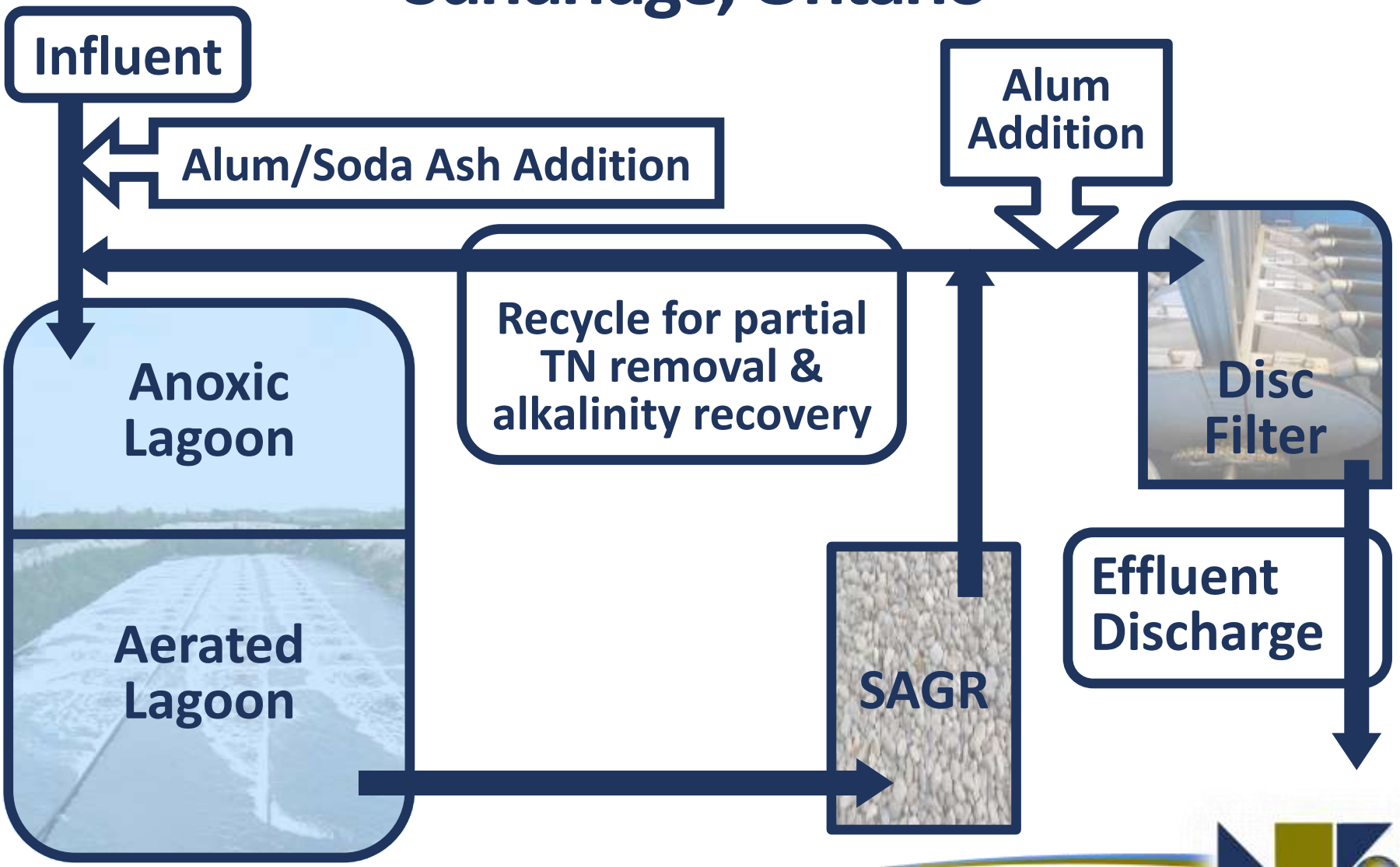
Project Type:
Municipal Wastewater

Design Flow:
1,192 m^3/day (0.315 MGD)

Effluent Objective:

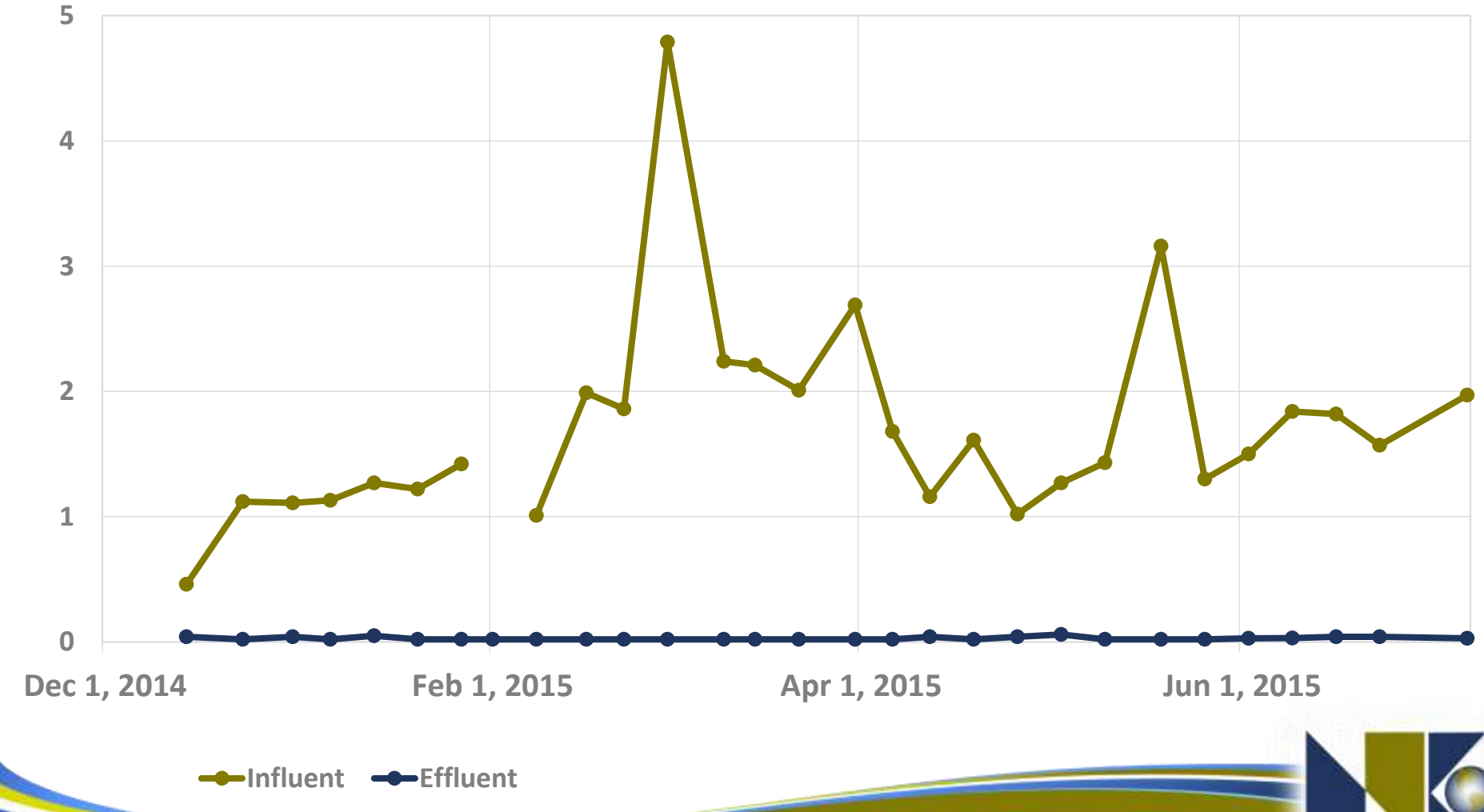
- **TP:** <0.27 mg/L

Sundridge, Ontario

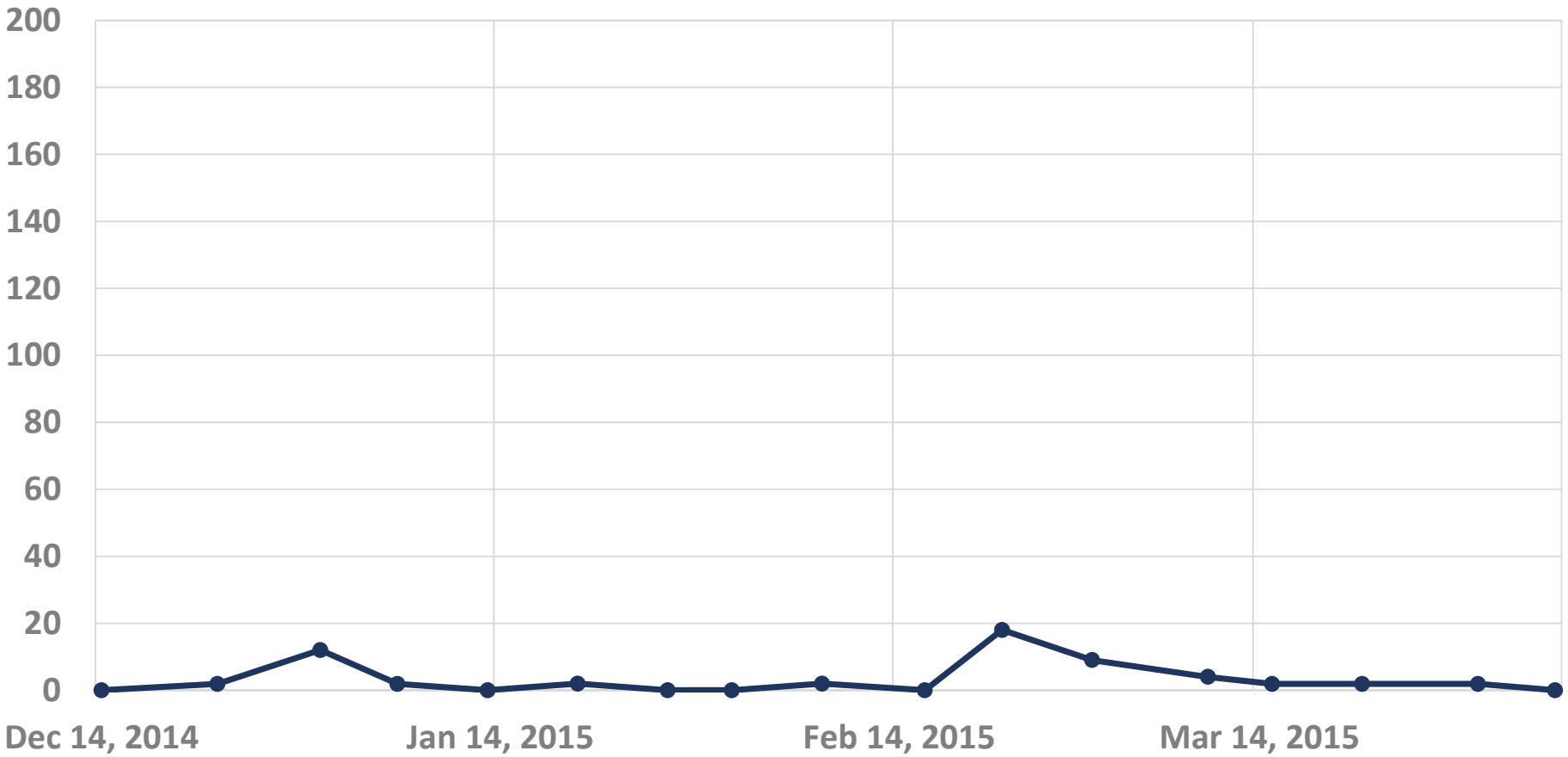


Sundridge, Ontario

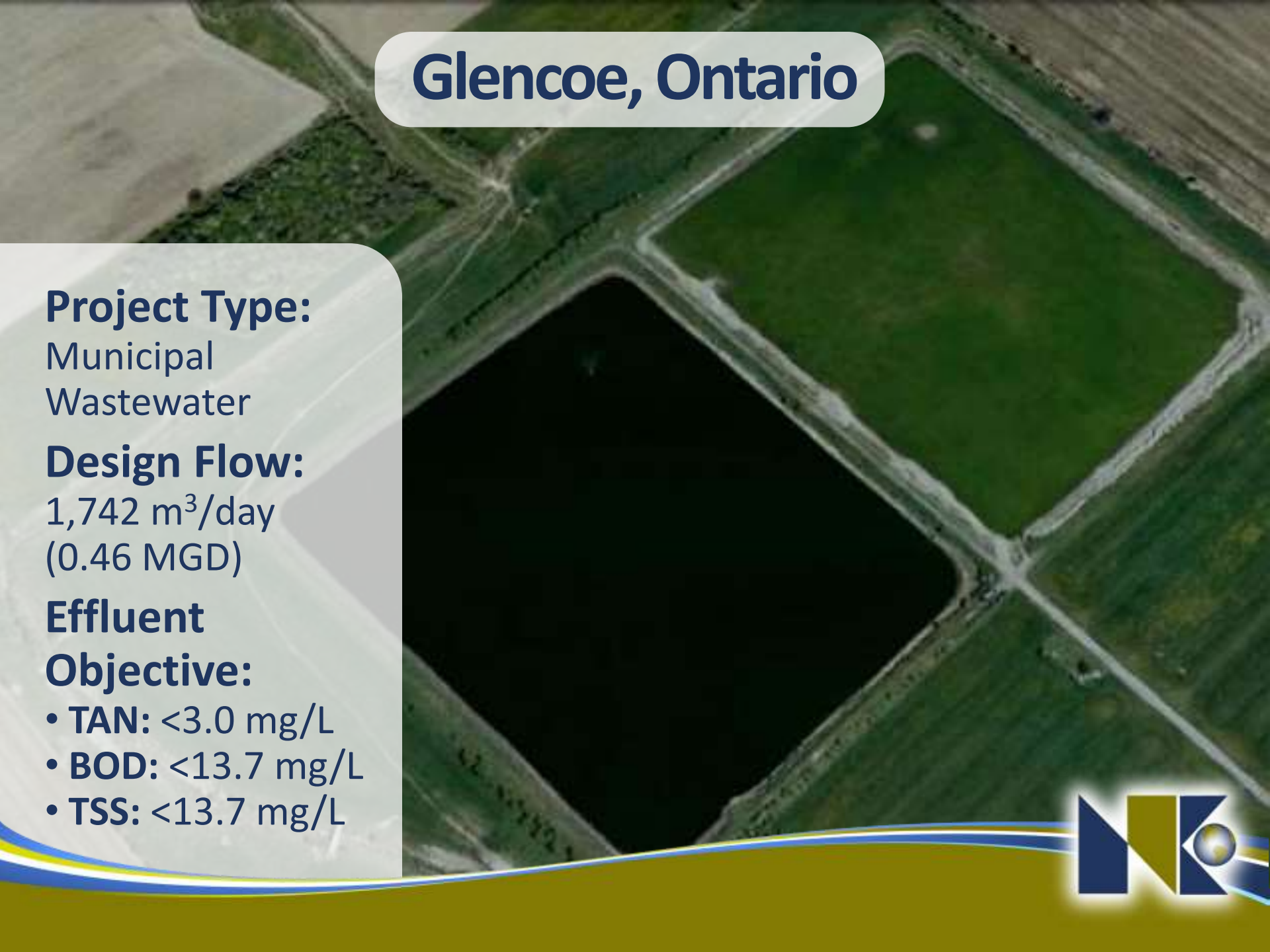
opTPhos® Total Phosphorus (mg/L)



Sundridge, Ontario



Glencoe, Ontario



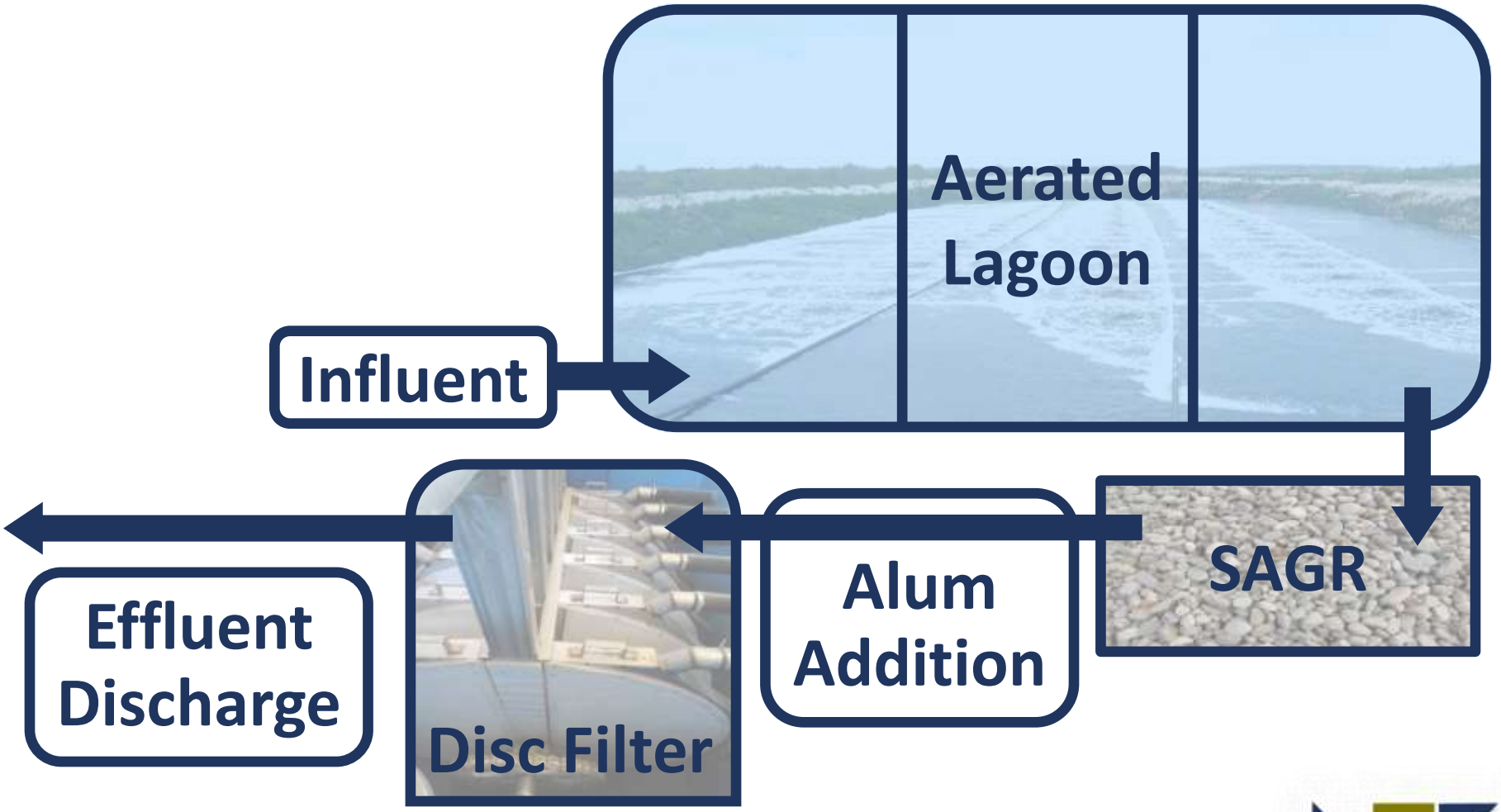
Project Type:
Municipal Wastewater

Design Flow:
1,742 m^3/day (0.46 MGD)

Effluent Objective:

- **TAN:** <3.0 mg/L
- **BOD:** <13.7 mg/L
- **TSS:** <13.7 mg/L

Glencoe, Ontario



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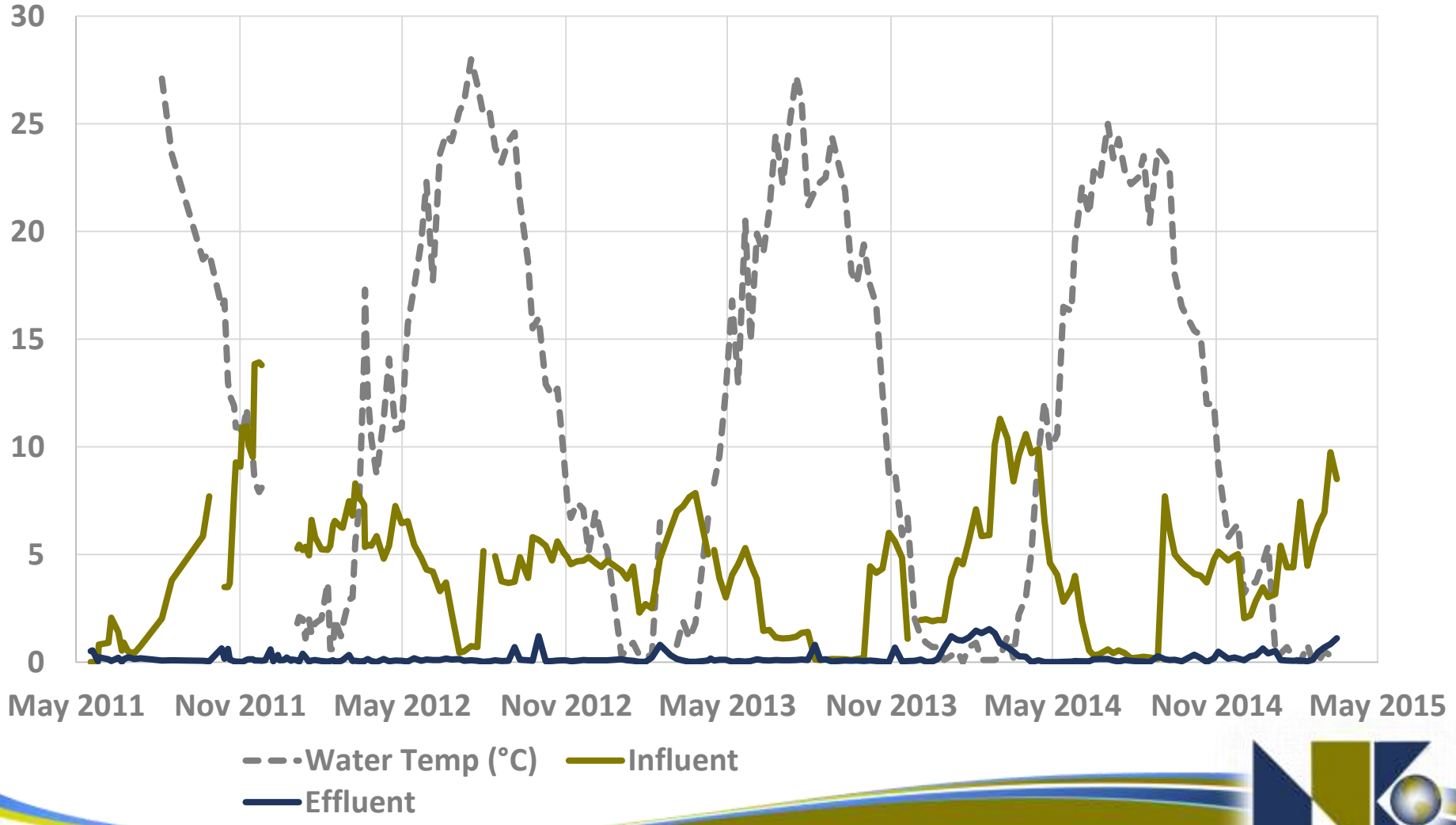
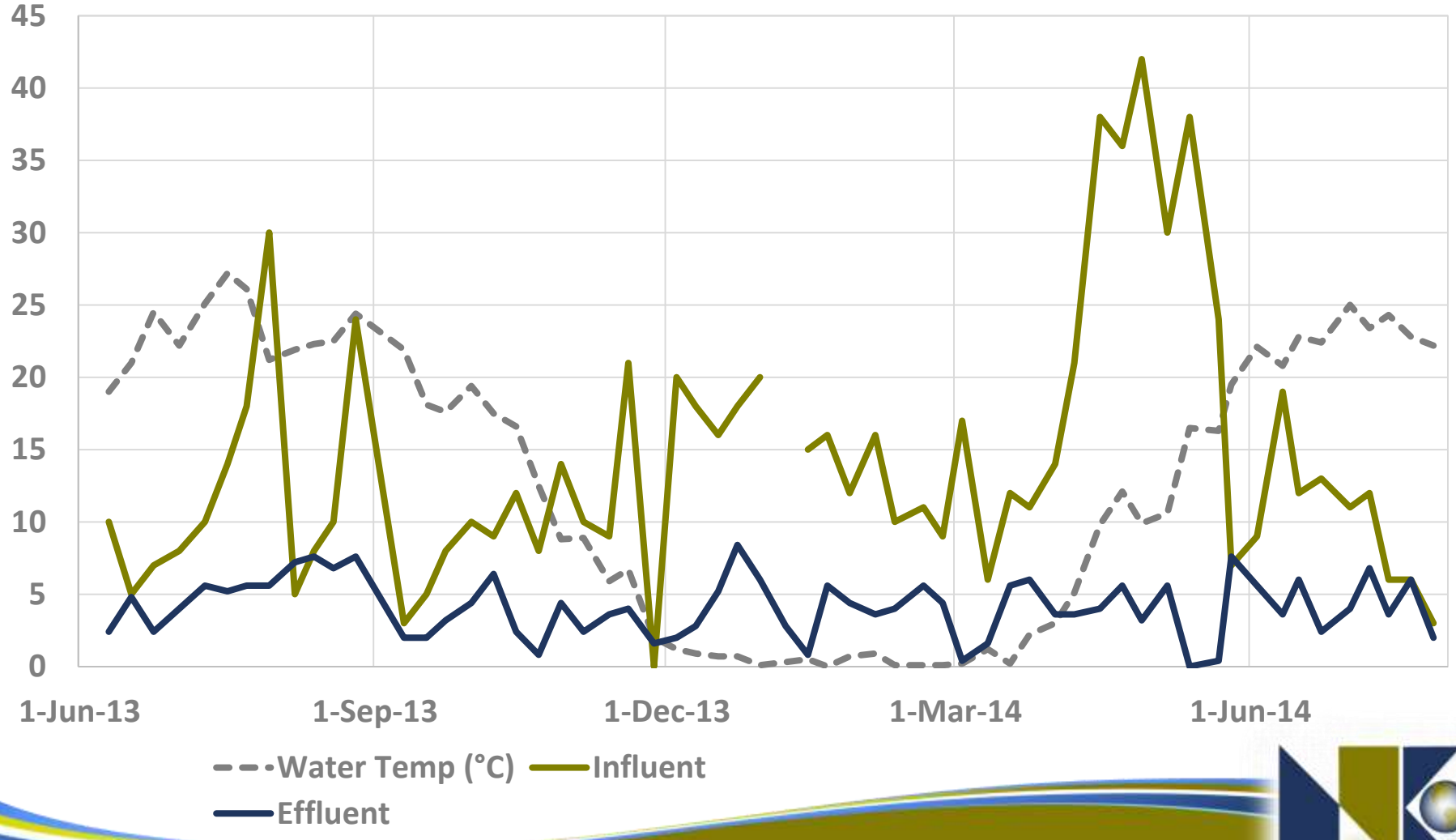


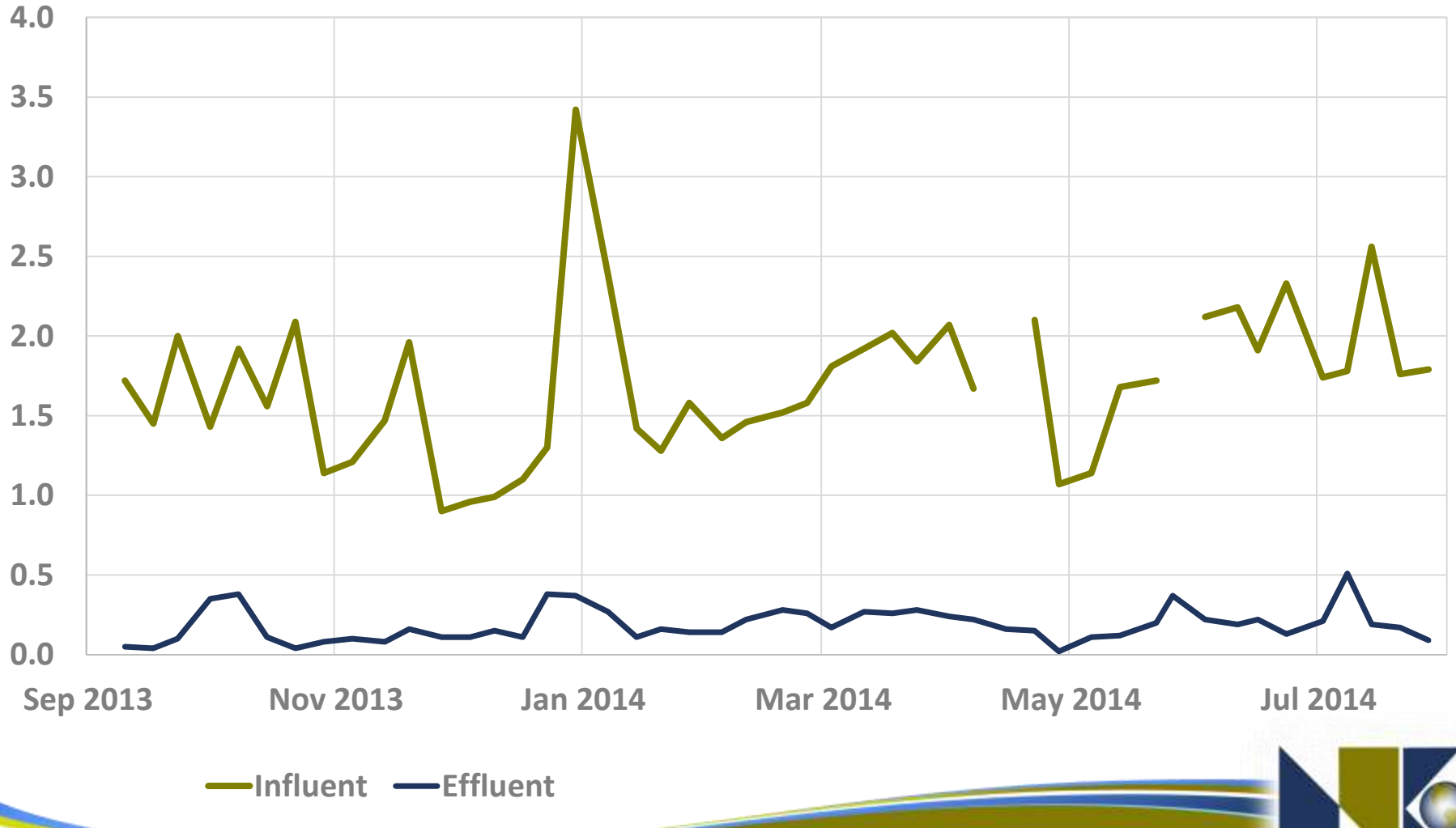
Glencoe, Ontario

SAGR TSS (mg/L)



Glencoe, Ontario

Total Phosphorus (mg/L)



SAGR process provides nitrification to <1mg/L ammonia at 100% design flow

Consistent BOD/TSS <5/10 mg/L (lower with tertiary filtration)

Systems can handle significant variation in incoming water quality without upset

Specifically designed for cold water applications

Your lagoons are likely paid for so use them

Questions?

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