New Primary Bio-filter Achieves High-rate Treatment for Wet Weather Inflows

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NEWEA
WORKING FOR WATER QUALITY

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TOMORROW WATER

TECHNOLOGY PORTFOLIO

BBF
Best Bio-Filtration

PROTEUS

DRACO

vDAF
Vortex Dissolved Air Flotation

AMX
Anammox

FMX
Anti-Fouling Membrane

AAD
Activated Anaerobic Digestion

TREATMENT EQUIPMENT COMPANY
Water and wastewater treated better

TW REPRESENTATION
IN NORTH AMERICA

Wetter (Not Better) Wet Weather

- Climate Change is altering precipitation patterns
  - Less snow, more rain
  - Rain events becoming wetter, longer
  - Rainfall is less predictable seasonally, geographically
  - Combined effect: # of excess WWF events increasing

- Exacerbating Factor: Aging Infrastructure & deferred maintenance

WWF Treatment - Traditional Strategies

- Increase Plant Capacity
- Storage & Equalization (Tunnels/Interceptor)
- Divert & Blend

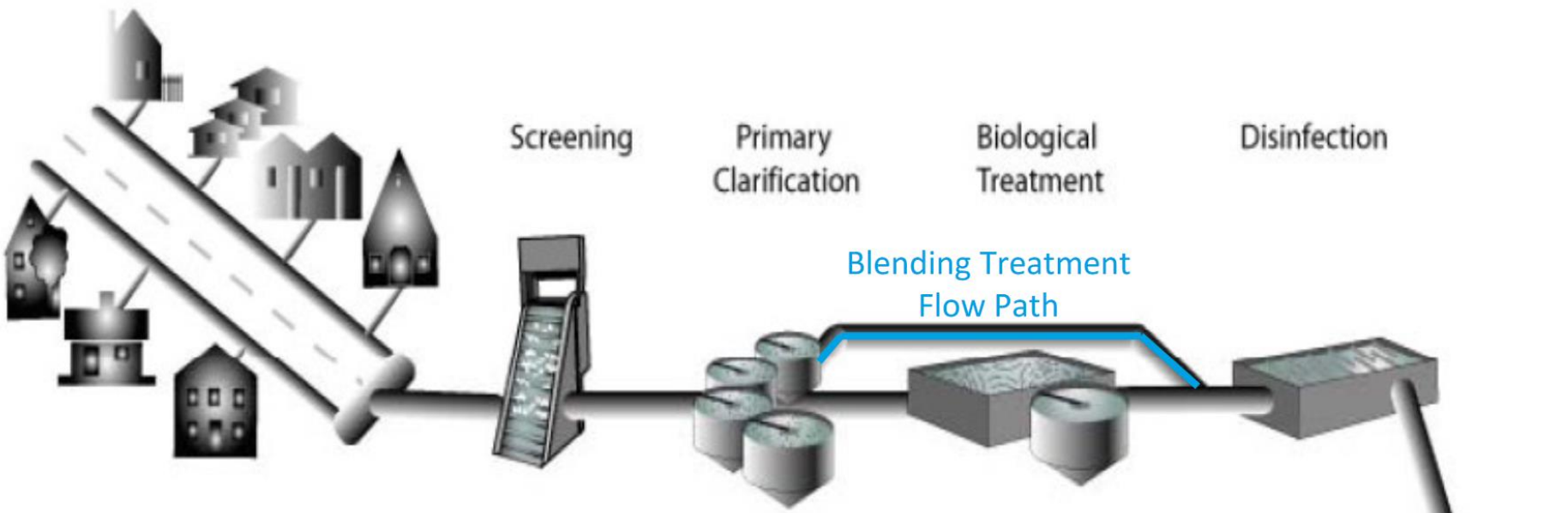
Storage:

- Hold now, treat later
- Achieves full secondary treatment of all flows
- When it's full, it's full
- Large capital investment
- Large Pump Stations
- No added capacity to treatment train
- **Assumes predictability**

Euclid Creek Tunnel, Cleveland, OH

Photo credit: McNally Corp

Blending Scenario



Background diagram from:
U.S. EPA, Sanitary Sewer Overflows and Peak Flows Listening Session, June 30, 2010

WWF Treatment - Traditional Strategies

- Increase Plant Capacity
- Storage & Equalization (Tunnels/Interceptor)
- Divert & Blend
  - Often includes auxiliary settling & disinfection
  - Many facilities meet WQ targets
  - US EPA re-evaluating Blending Rule (ongoing)
  - Some states will not issue blending permits

WWF Treatment – New(ish) Strategies

High-rate filtration

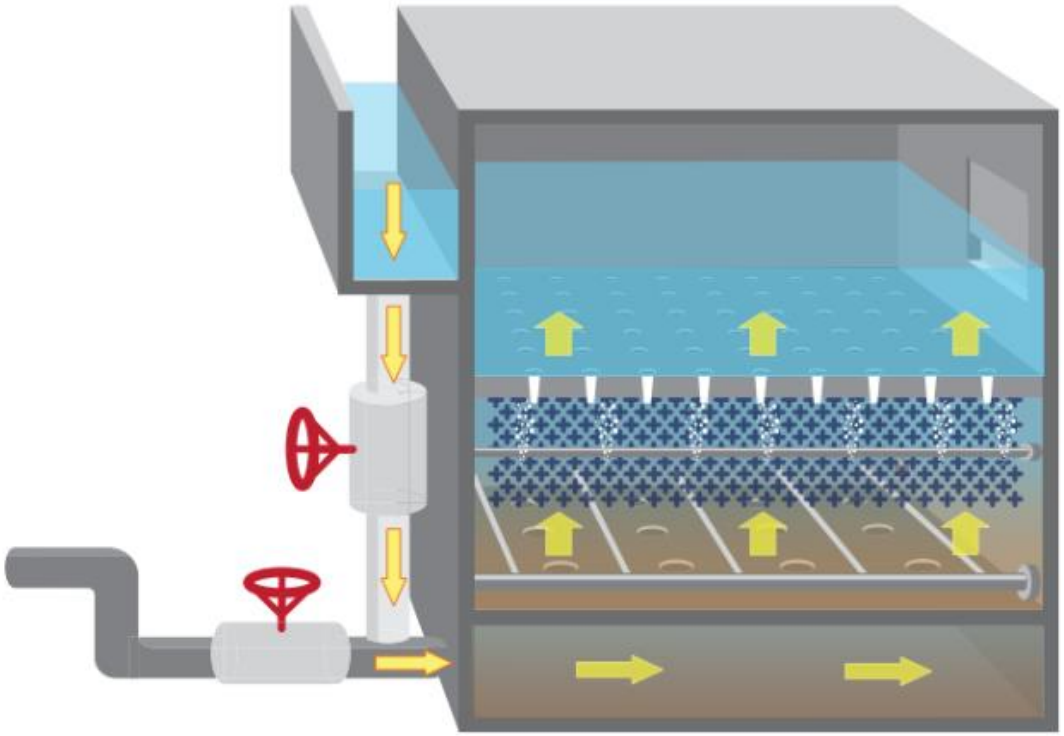
- Treats flows as they arrive
- Removes majority TSS & BOD (particulate)
- Reduces disinfectant demand & microbial risk
- Smallest, most cost-effective auxiliary option

High-rate biological treatment

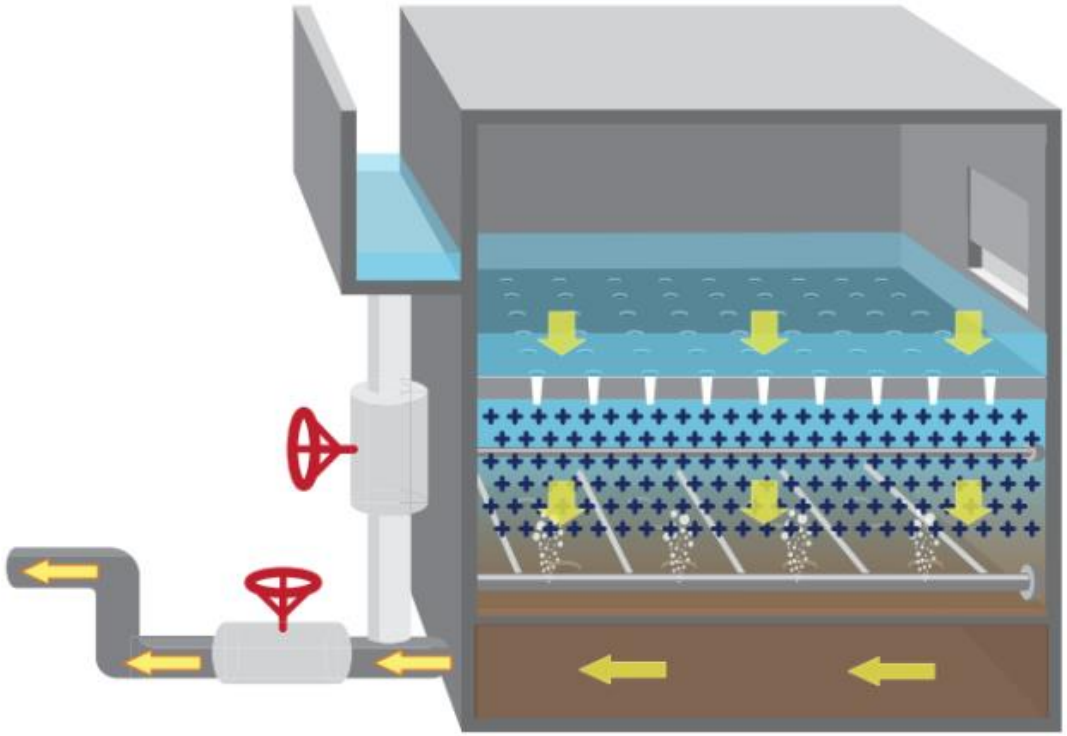
- Removes soluble organics (BOD) as well as particulates
- Contact time adjusted to match dilution
- Requires either dry-weather feeding OR redirection of biological inventory

Proteus Biologically Active Filter

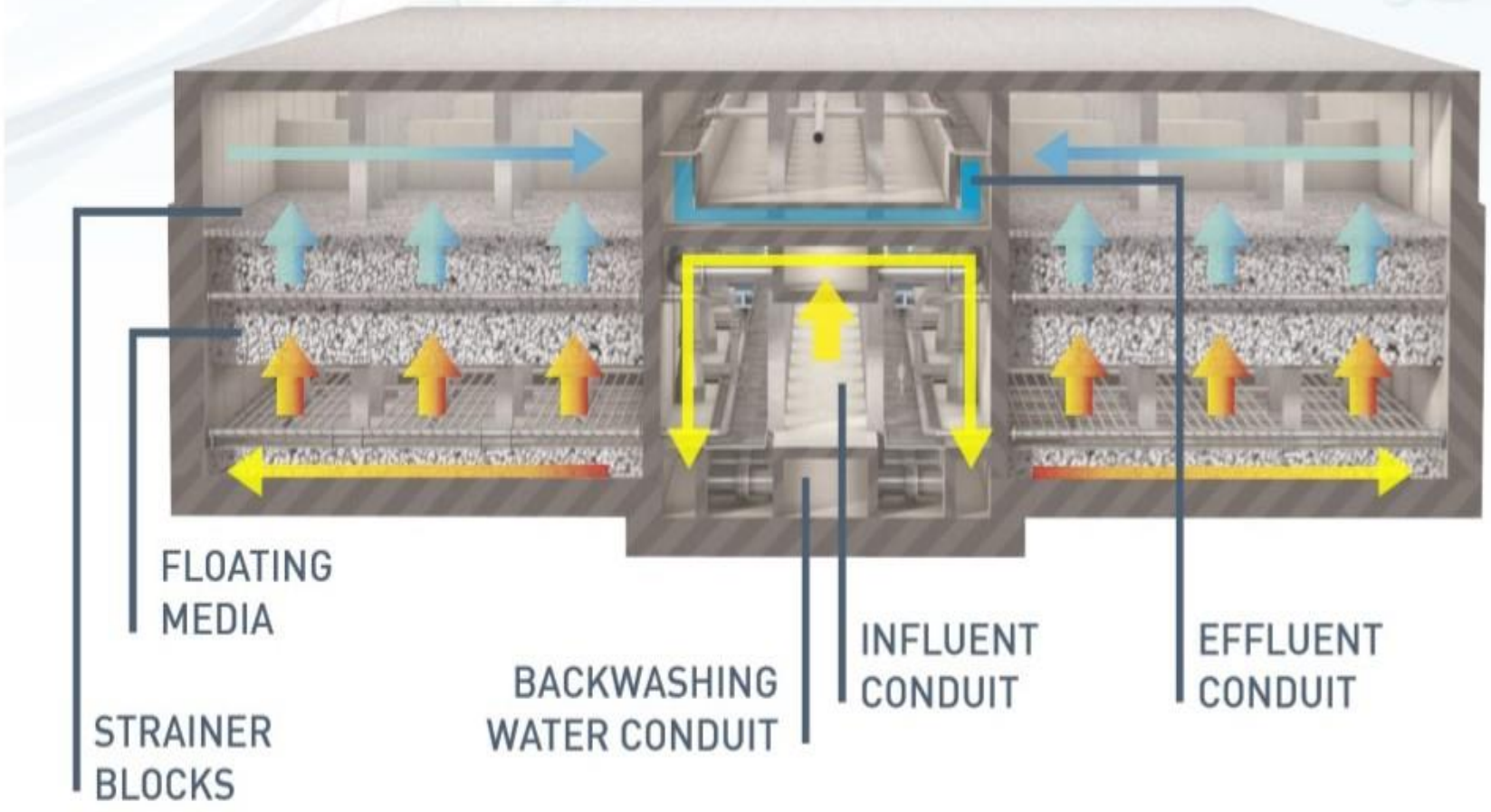
Filtration



Periodic Backwash

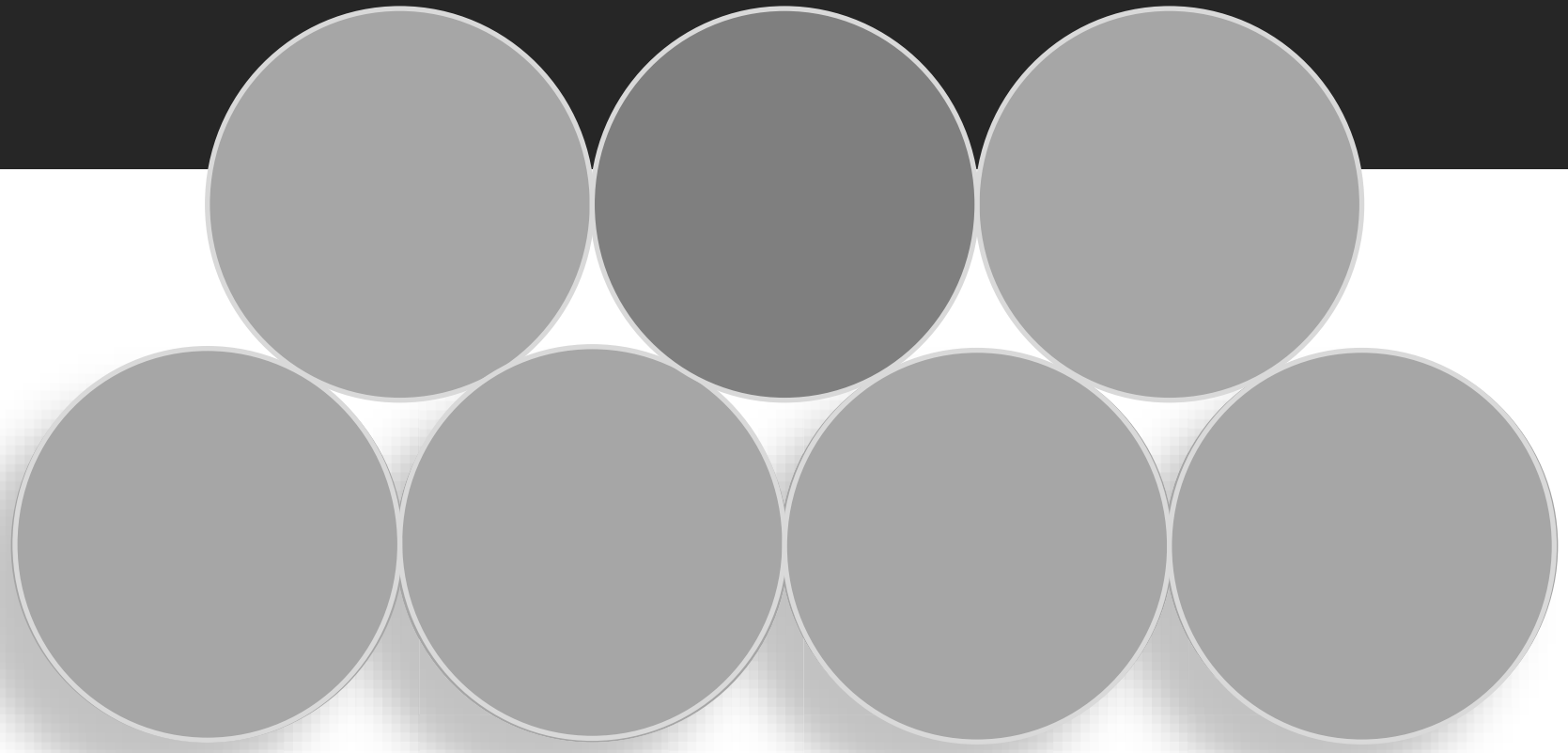


Proteus & Proteus+ BAF



LEGACY MEDIA DESIGN

Spherical Shape
limits surface area and stacking efficiency



NEW MEDIA DESIGN

Cross shape maximizes surface area and packing density

Large void fraction reduces head loss and captures more solids

Floating Media

Void Fraction: 0.4

SS Design Loading Rate: 3 kg/m^3

Develops Biofilm when aerated

Specific Surface Area:

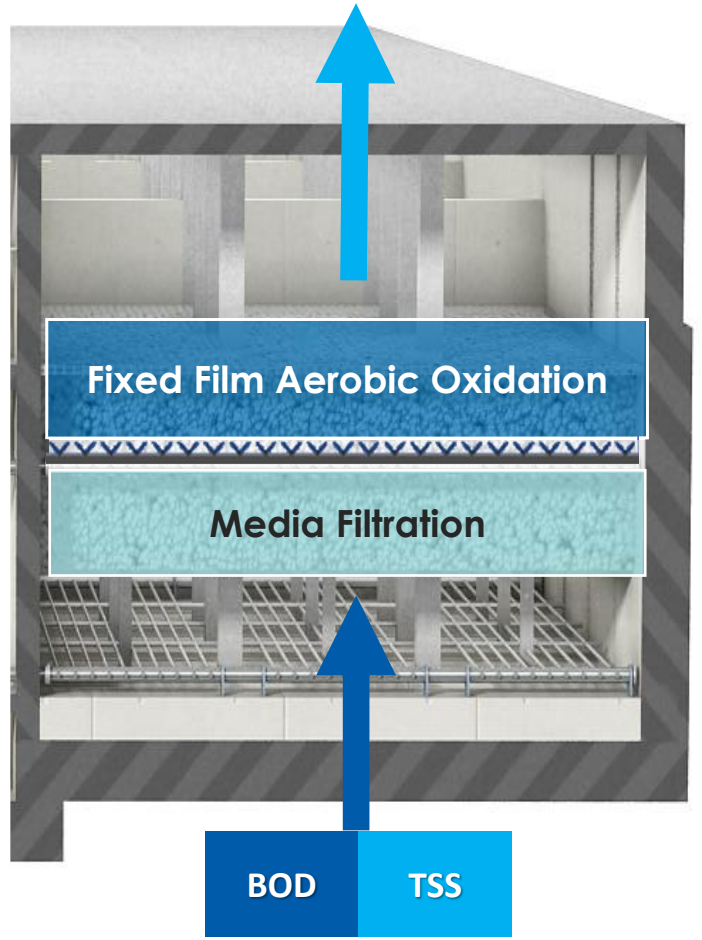
2100 m^2/m^3

Material:

Expanded Polypropylene

PROTEUS+ Biological Filter

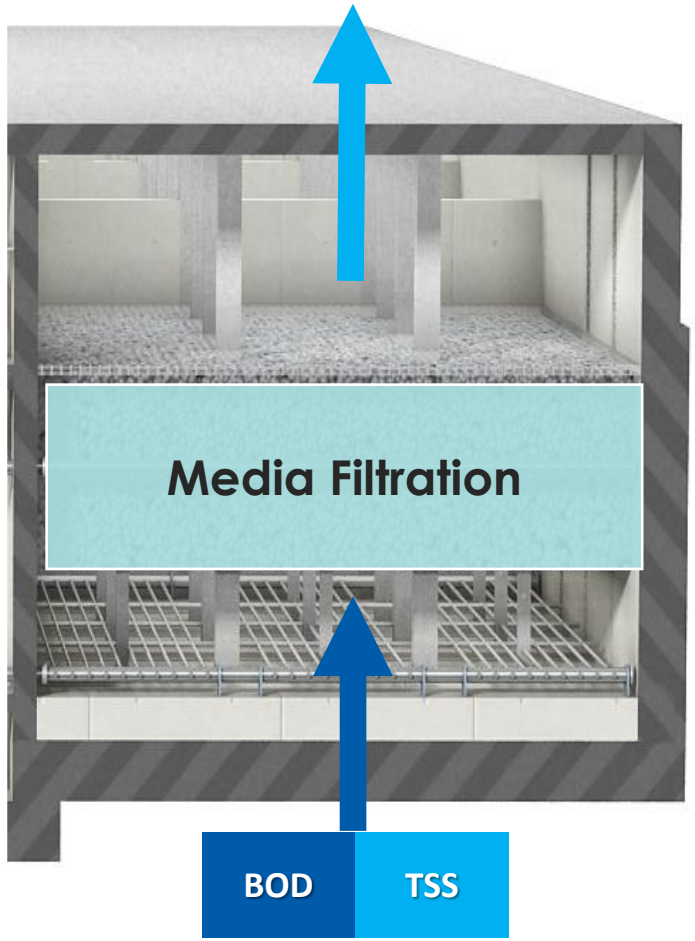
- Process air grid inside media bed
- Grow biofilm on upper layers of media
- Minimum HRT ~ 15min
- Requires air scour during backwash



Wet-Weather Influent

PROTEUS Primary Filter

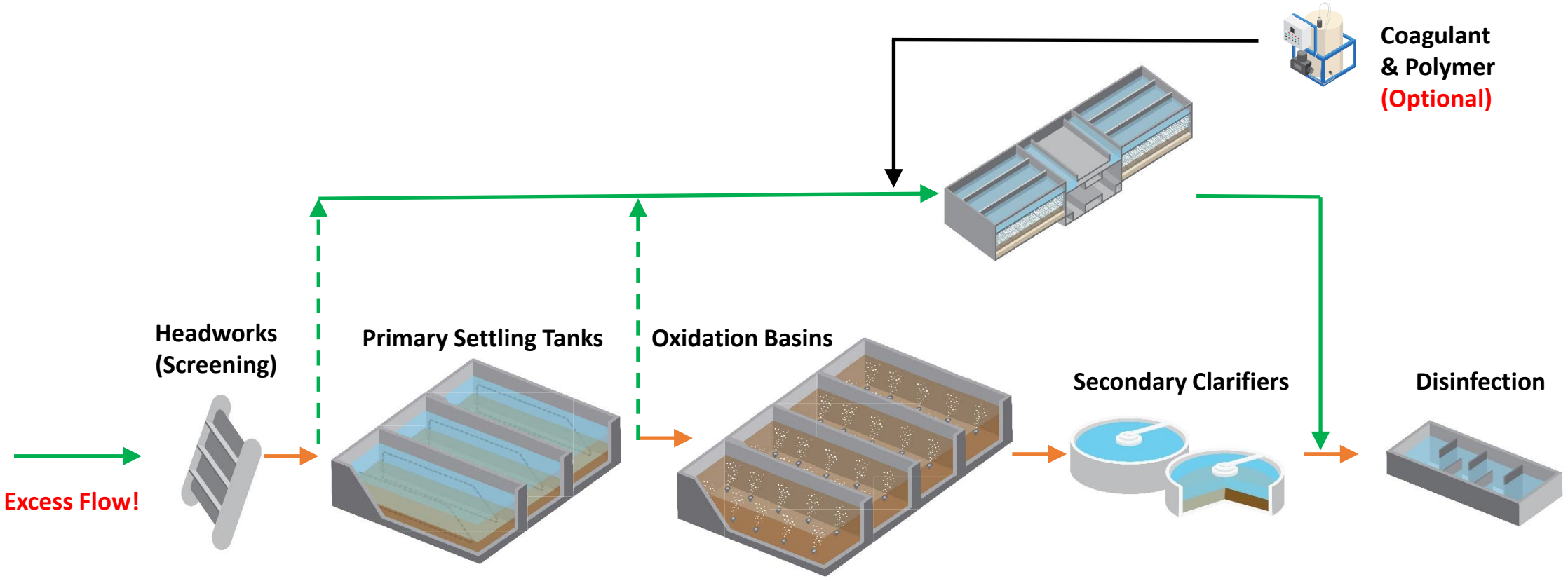
- Fully anoxic media bed (no aeration)
- Developed originally to replace clarifiers
- Minimum HRT ~ 6 min



Wet-Weather Influent

Proteus Applications – Wet Weather

(Auxiliary Treatment)



Full-scale Installations

Jungnang WRF, Seoul, Korea

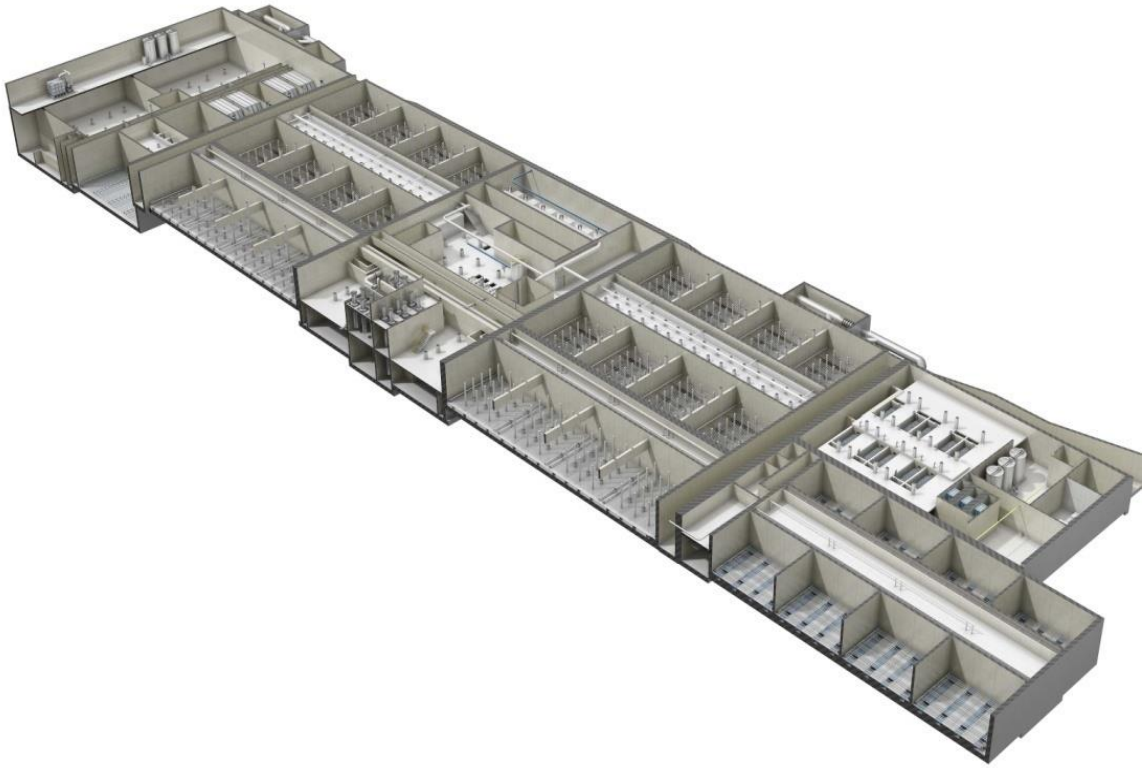
66 MGD Primary Filter

- No Chemicals

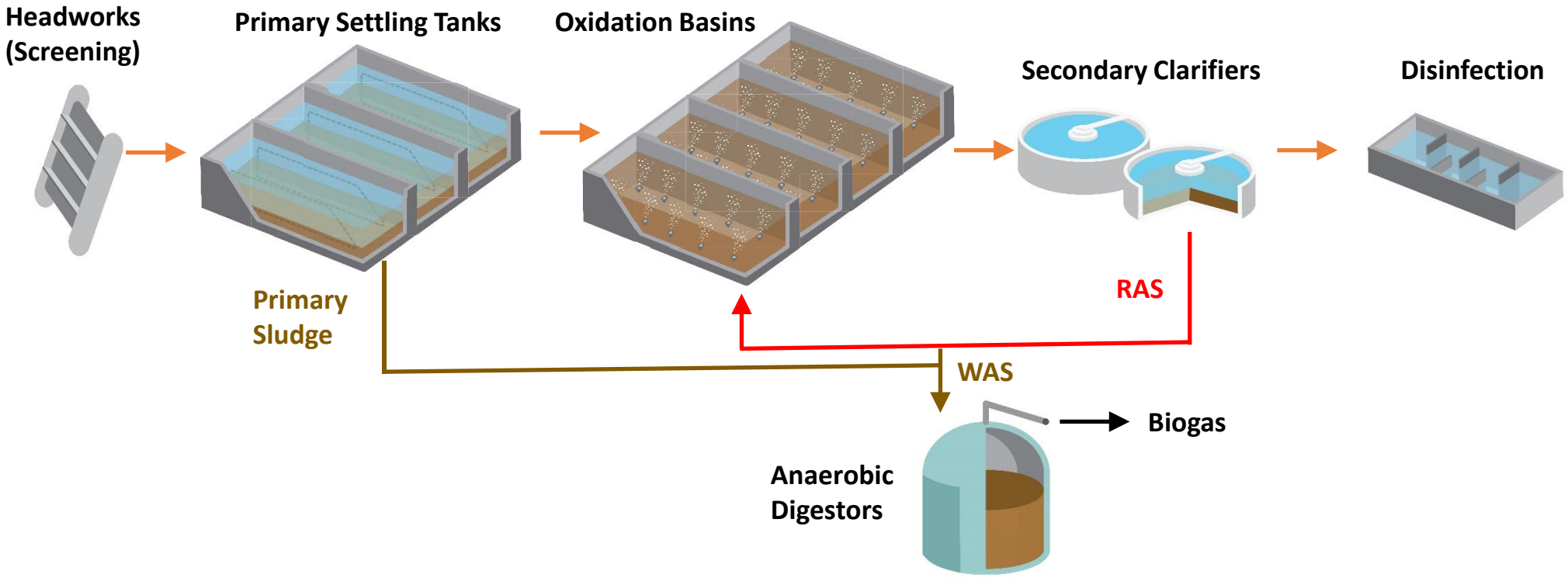
132 MGD WWF Filter

- Chemically Enhanced

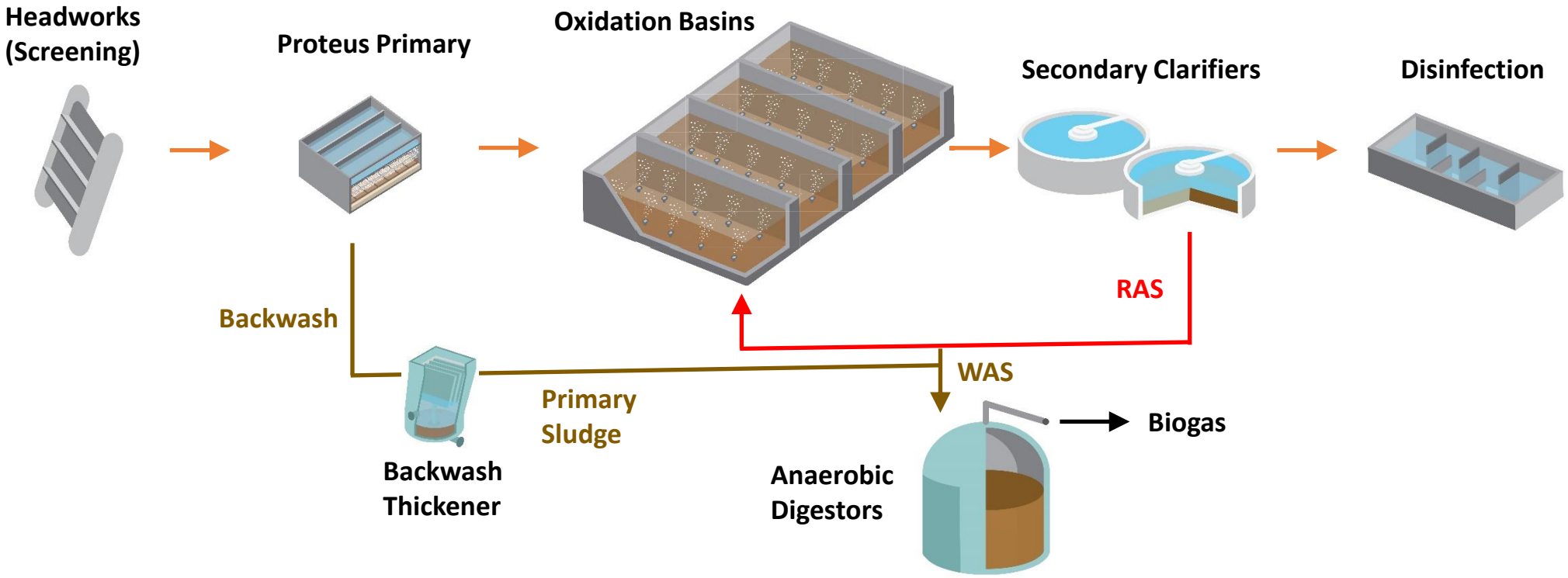
Commissioned 2017



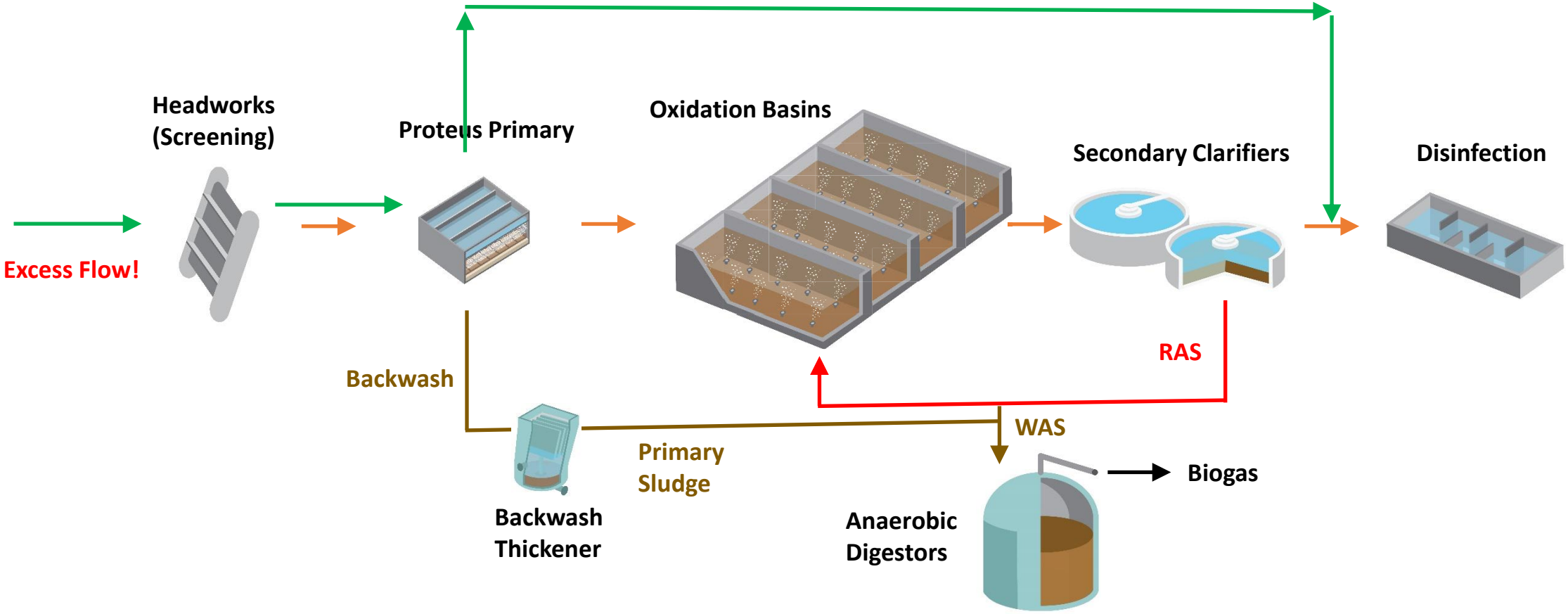
Proteus Applications - Primary



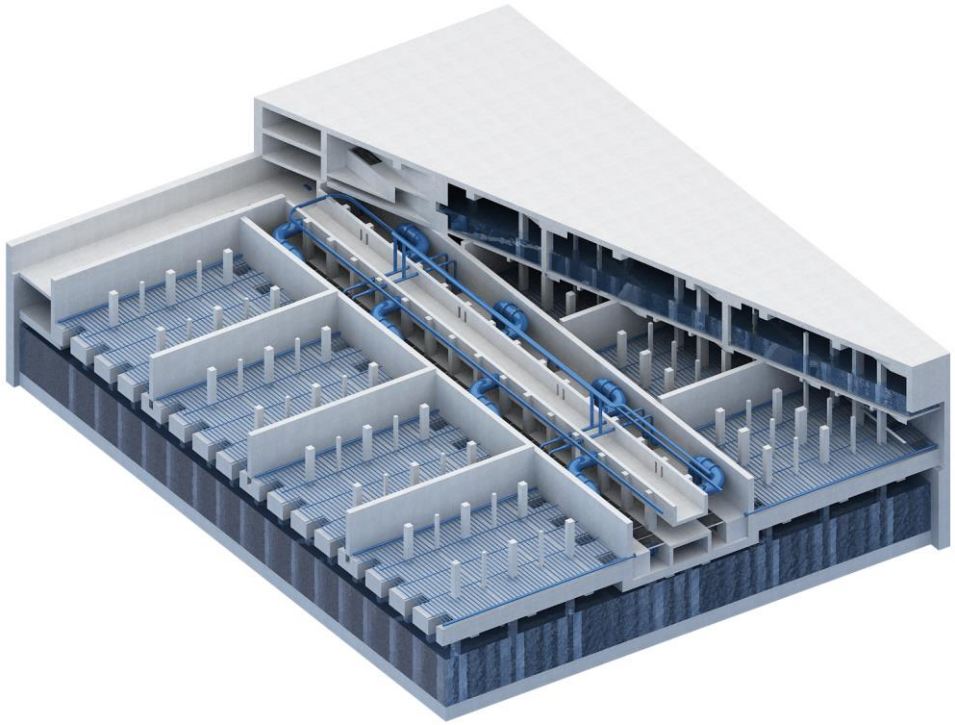
Proteus Applications - Primary



Proteus Applications – Dual-Use



Full-scale Installations



Seonam WRF, Seoul, Korea

95 MGD Primary Filter

- No Chemicals

190 MGD WWF Filter

- Chemically Enhanced

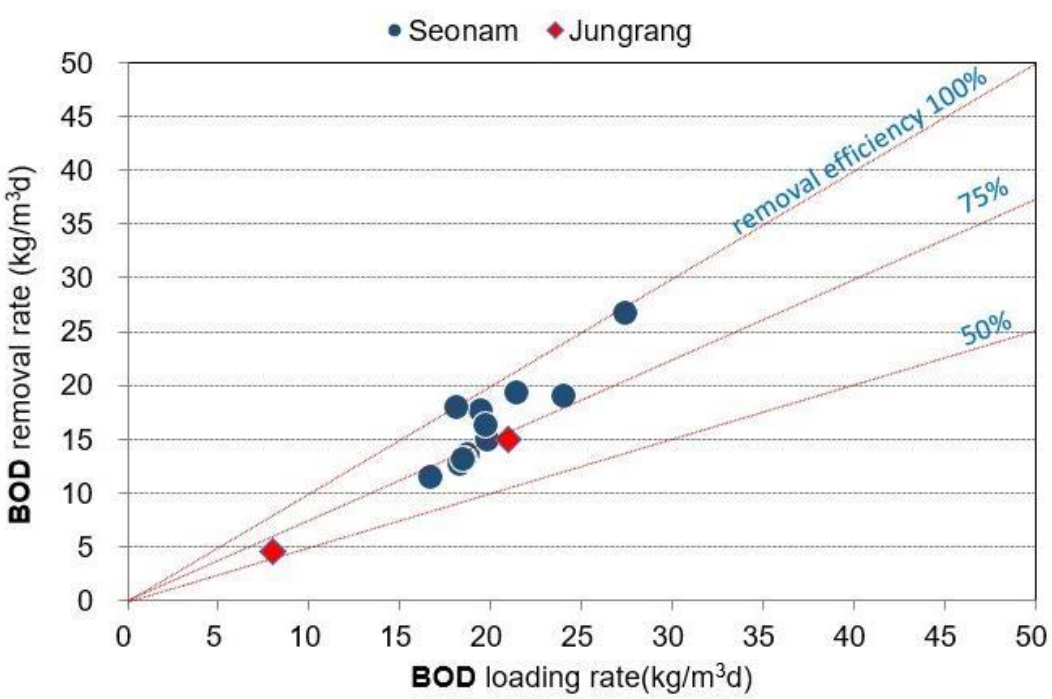
Commissioned 2020

WET WEATHER FILTER PERFORMANCE: 2020

Seonam (190MGD) & Jungnang (132MGD)

TSS

BOD



<u>Average Removals:</u>

Suspended Solids – 93%

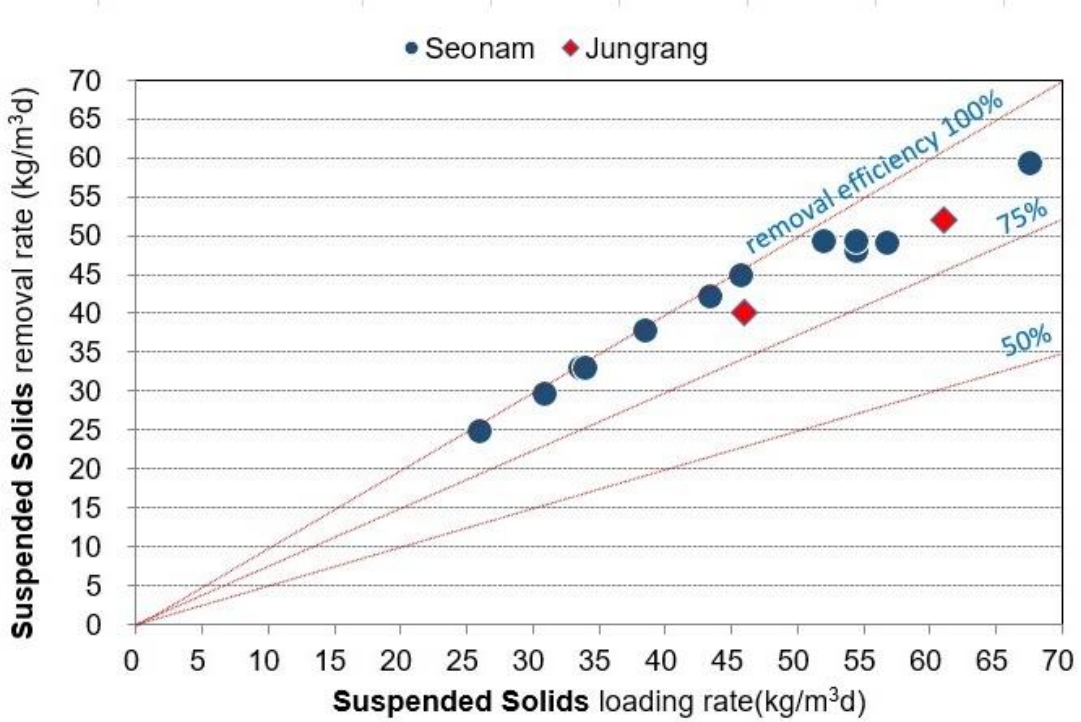
BOD – 81%

(add chem only during peak wet weather flow to boost removals)

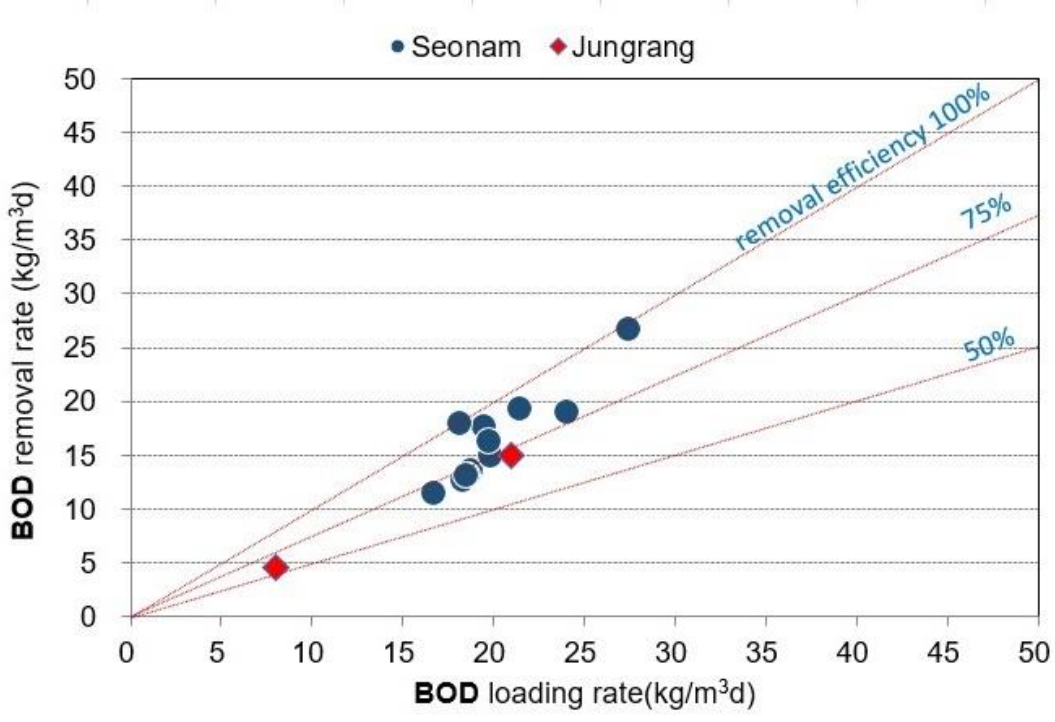
PROTEUS WWF FILTER: 2020 Season

Seonam (190MGD) & Jungnang (132MGD)

TSS



BOD



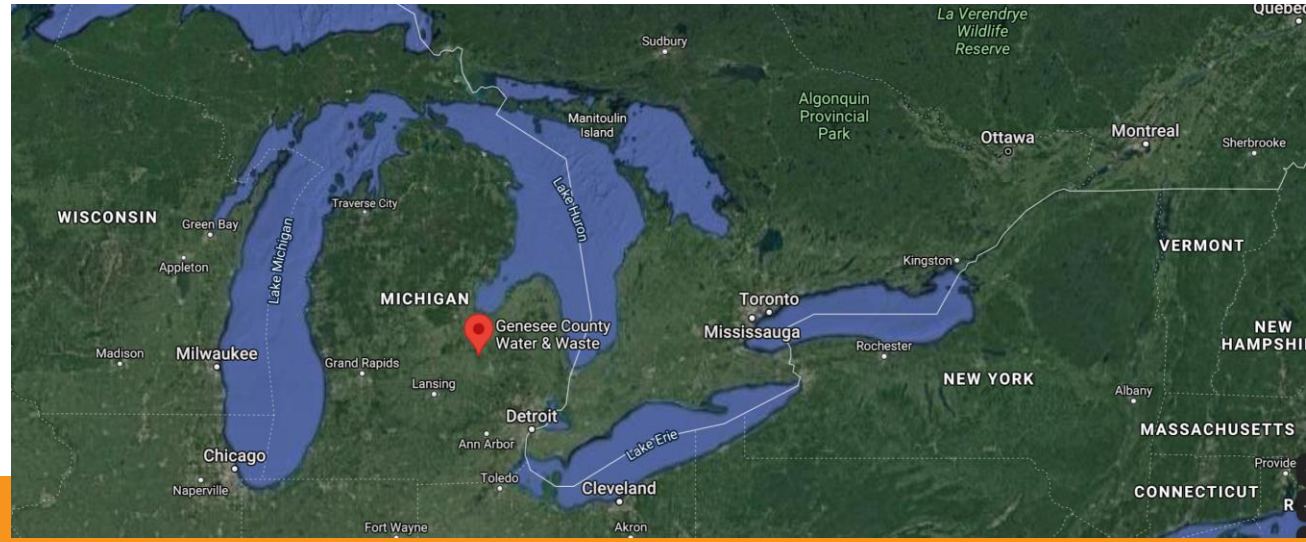
Seonam 2020 Event	Influent (mg/l)	Effluent (mg/l)	Removal %
BOD	86	16	**81%**
SS	191	13	**93%**

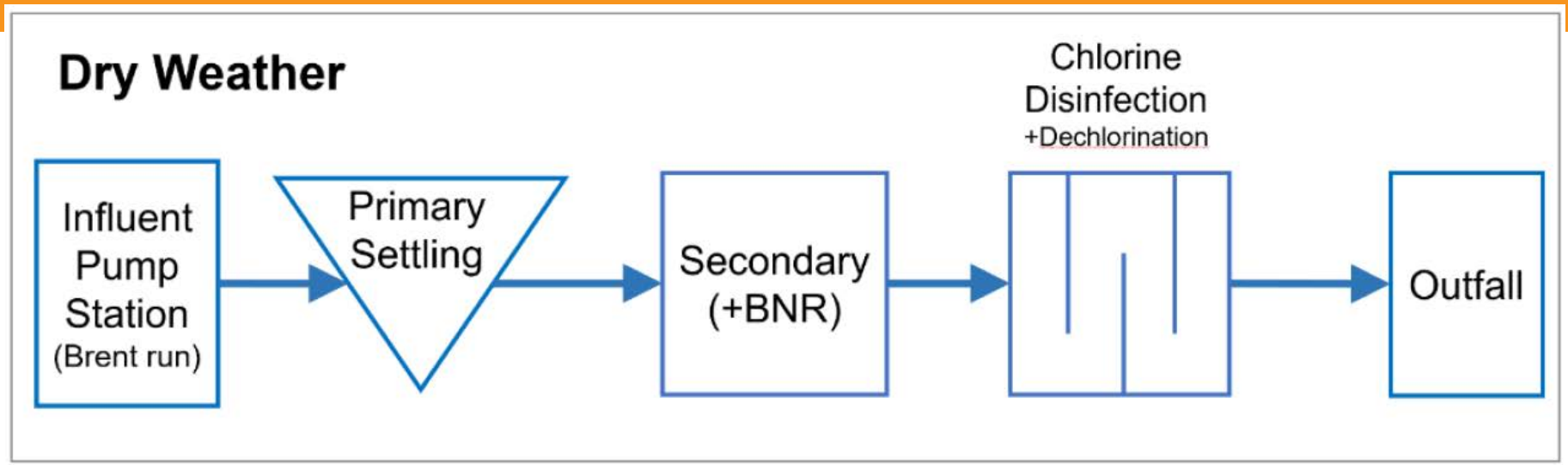
(add chem only during peak wet weather flow to boost removals)

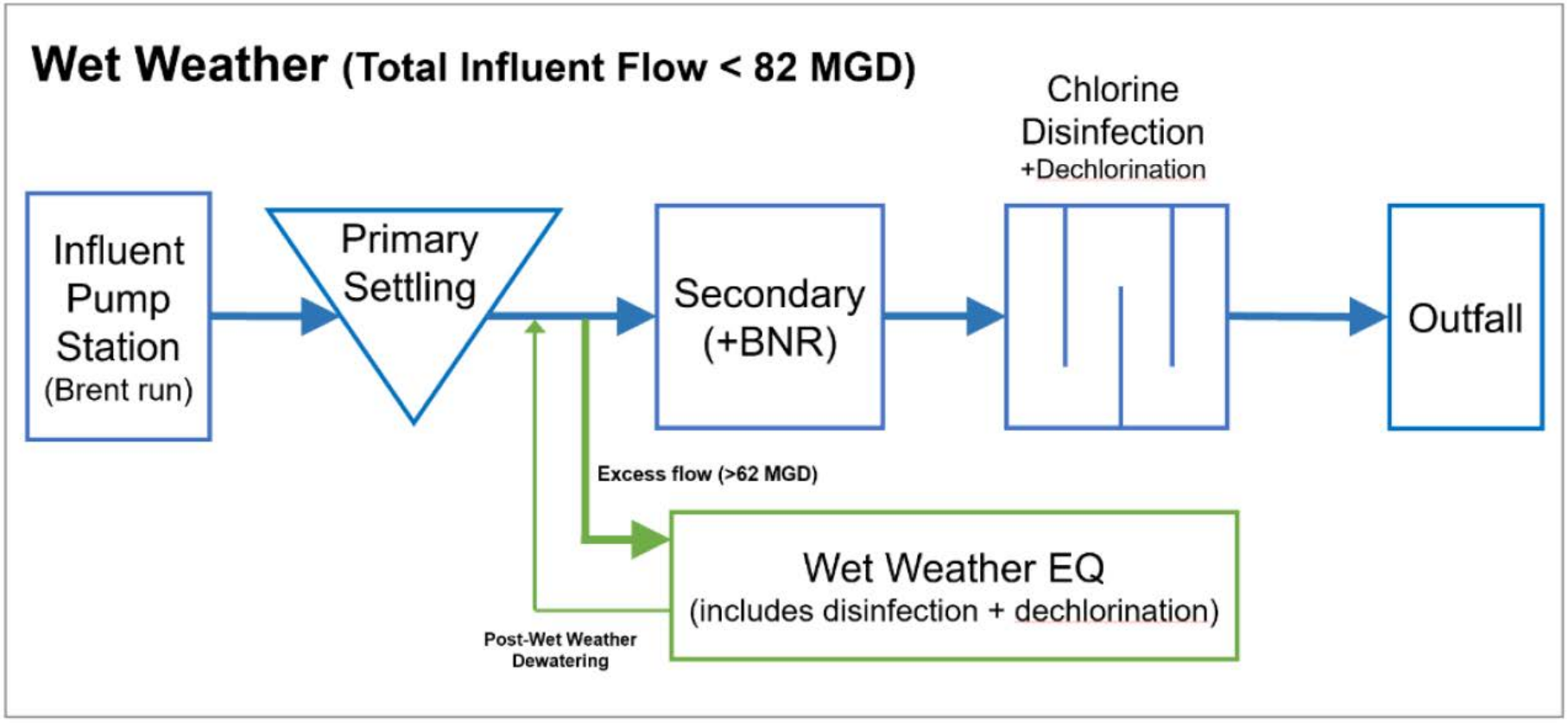
Genesee County, Michigan

Anthony Ragnone Treatment Plant (ARTP)

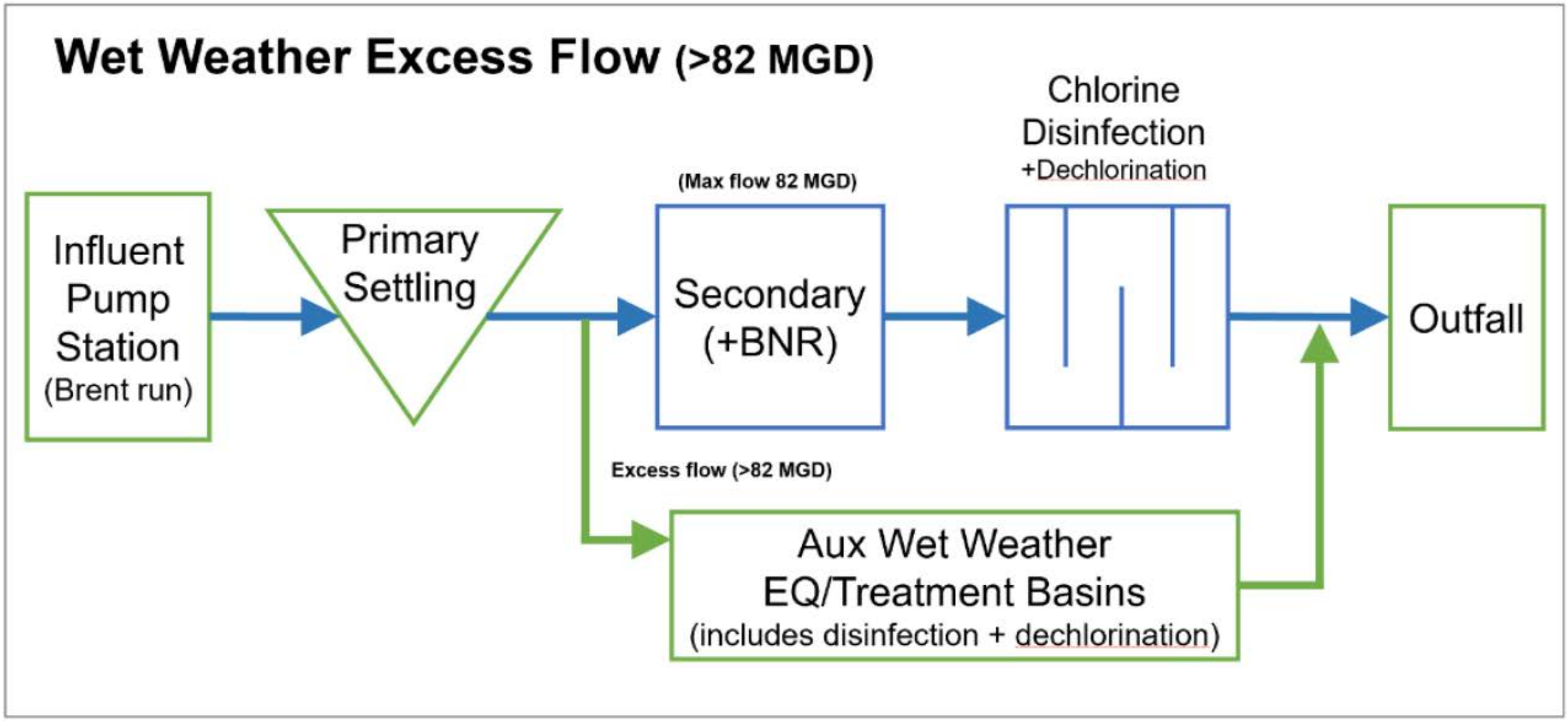
- Annual Average Daily Flow 29 MGD, discharge to Flint River
- Max Day Treatment - Advanced Secondary w/Bio P: 69 MGD
- Excess Flows to WW Auxiliary Treatment ~80 MGD – **Meets current permit**
- ***But***, State of Michigan (EGLE) wants **biological treatment of all flows.**
- Full capacity upgrade to 25 yr/24hr storm (147MGD) **would cost $200M+**



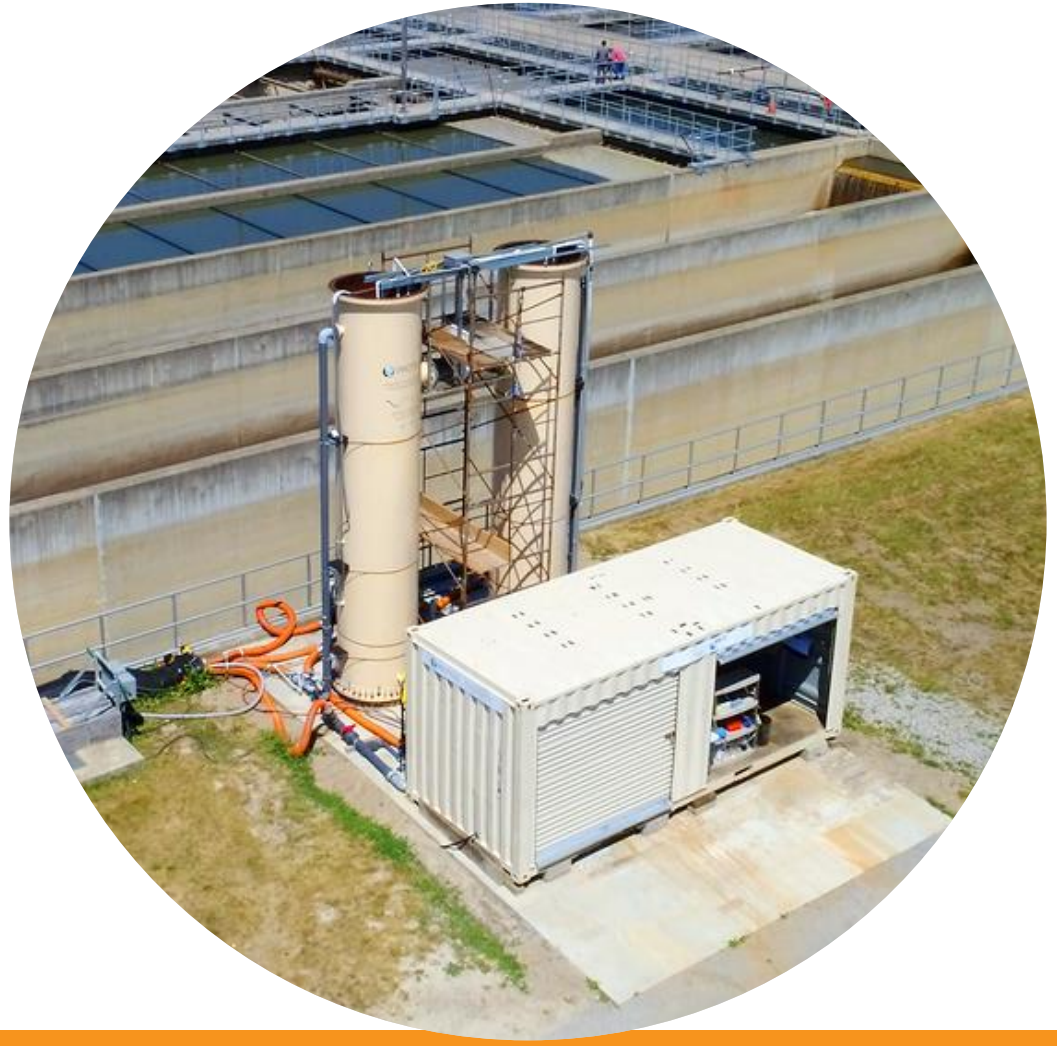




Flow Diagram: Anthony Ragnone WWTP: Genesee County, MI


Wet Weather Excess Flow (>82 MGD)
Influent Pump Station (Brent run)
Primary Settling
(Max flow 82 MGD)
Secondary (+BNR)
Chlorine Disinfection +Dechlorination
Outfall
Excess flow (>82 MGD)
Aux Wet Weather EQ/Treatment Basins (includes disinfection + dechlorination)

Pilot Design

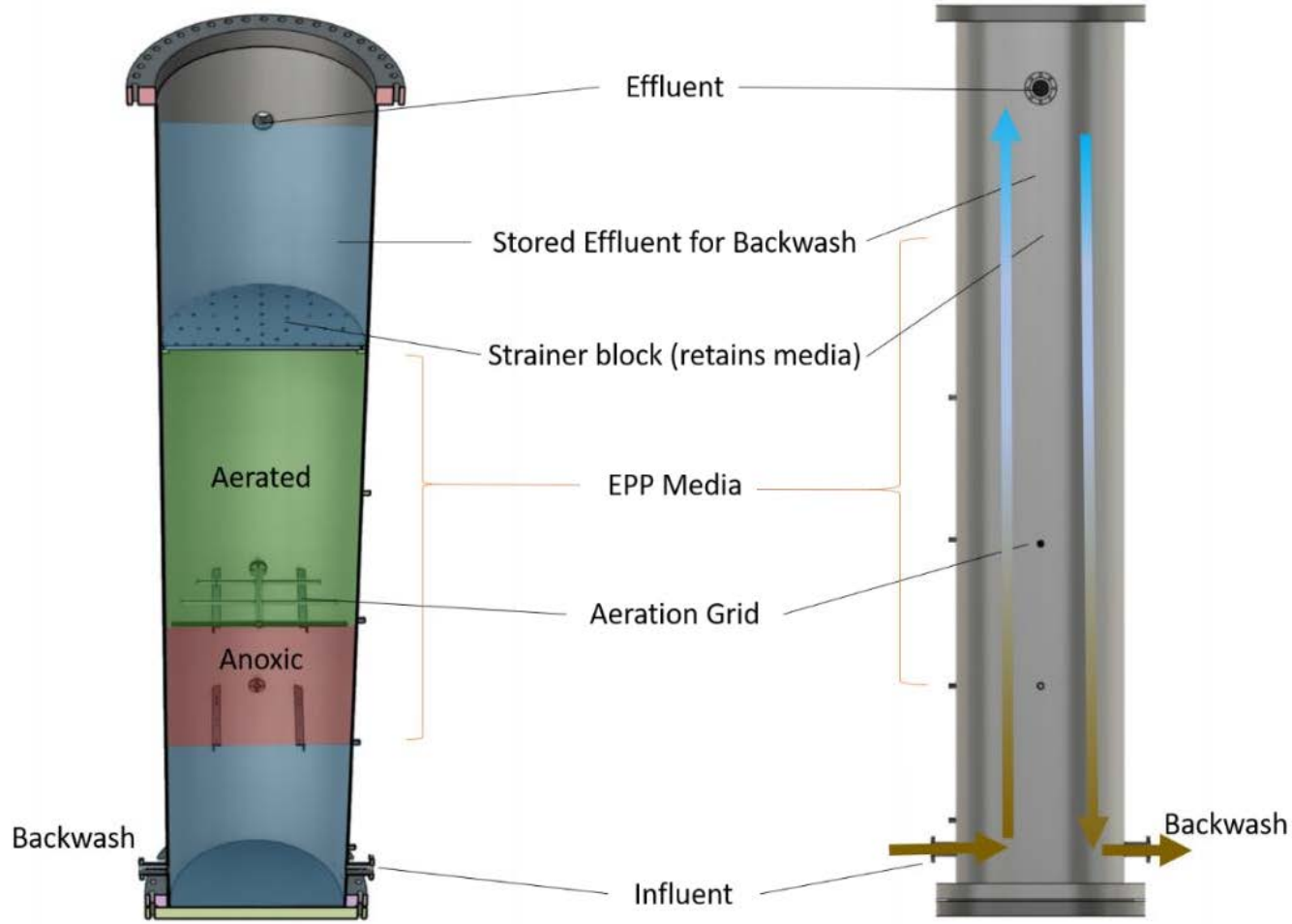


Tower #1: Filtration only

- 2m media depth, no process air

Tower #2: Filtration + Biological

- 3m media depth, process air in media bed



Study Design

Phase 1: Feed **Screened Plant Influent** – 6 months

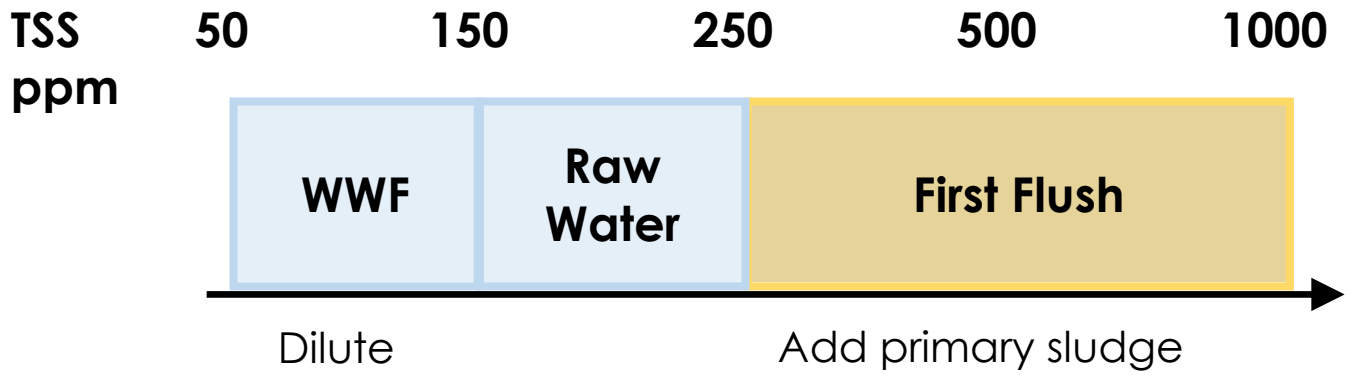
- Change Filtration Rate or Influent TSS Weekly
- Goal: Define performance under many diff conditions

Phase 2: Feed **Primary Effluent** – 5 months

- No TSS adjustment, long runs at same filtration rate
- Goal: Long-term performance with real process influent

Bonus: Minimum feed & starvation tests

- Goal: Reduce carbon requirements for bio system in dry weather



Temperatures

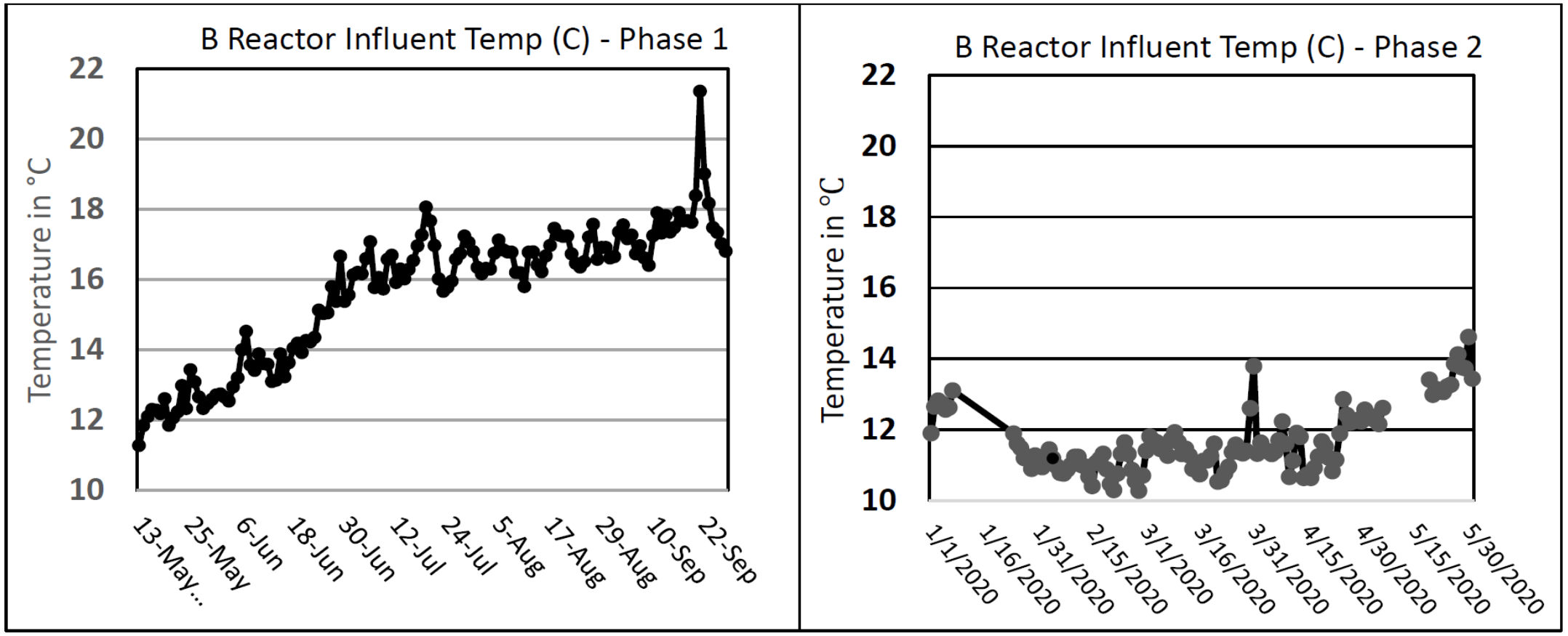


Figure 5: Pilot influent temperatures

Results

Primary Filter

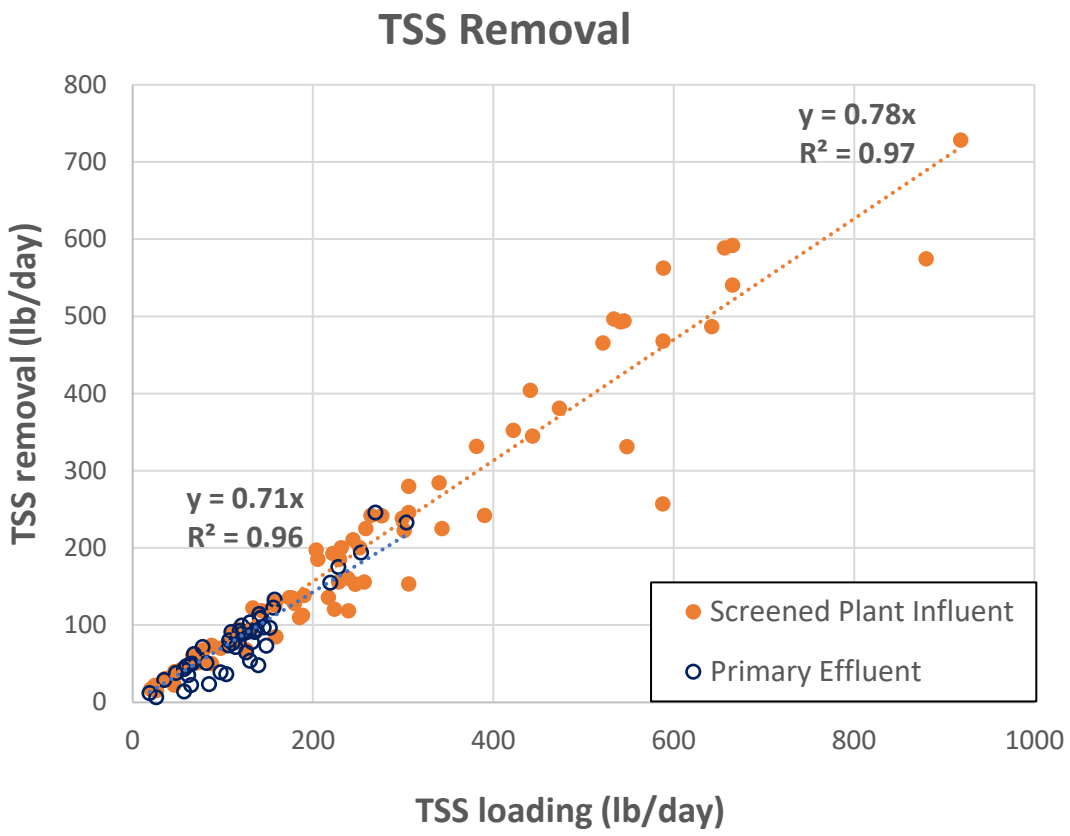
- Filtered up to 133gpm at 15-20 m^3/m^2hr (6.1 - 8.2 gpm/sf)
- Outperformed plant primary clarifiers

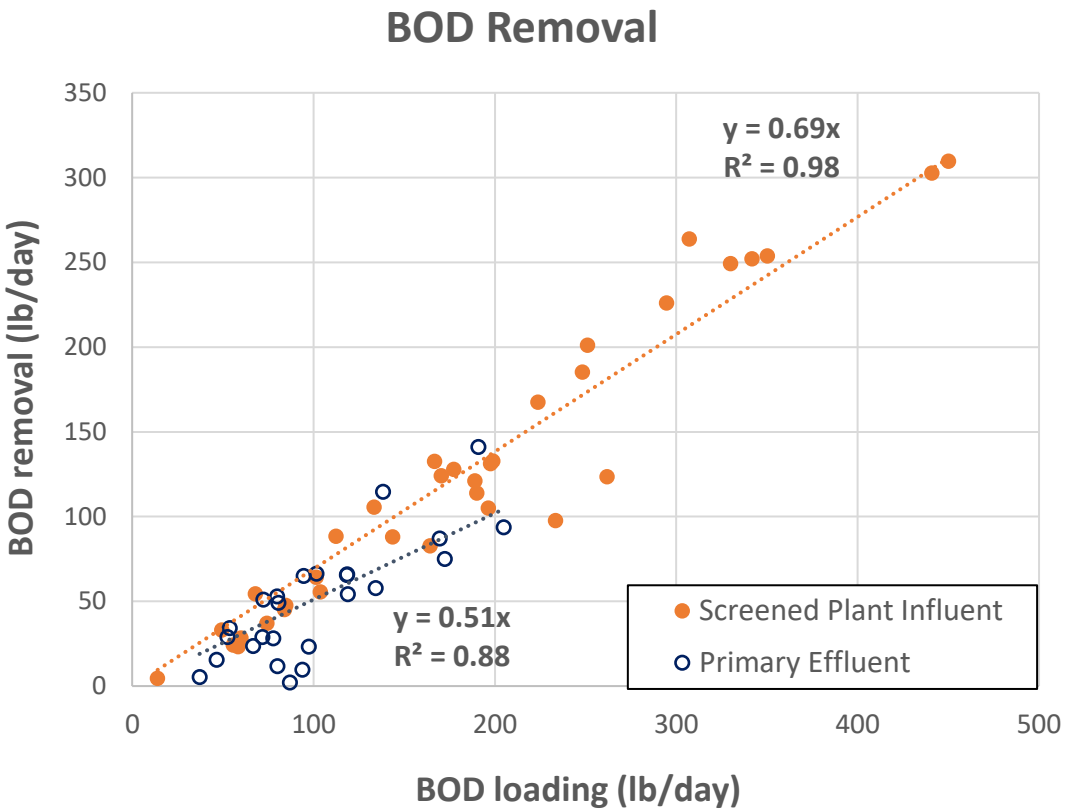
Biological Filter

- Filtered up to 64 gpm at 6-8 m^3/m^2hr (2.4 – 3.3 gpm/sf)
- Optimum 15-20min EBCT
- Better removals than filter alone

Real WWF Event: May 19, 2020

PRIMARY FILTER PERFORMANCE

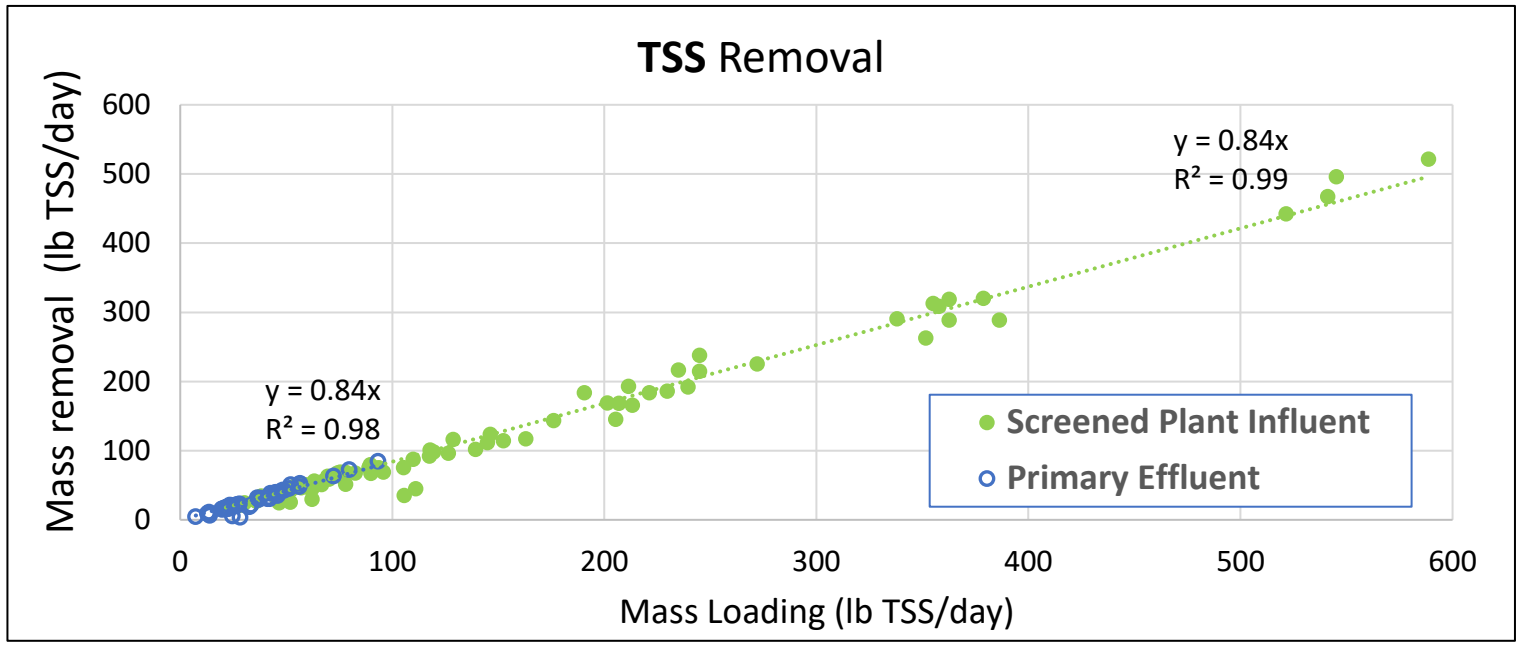




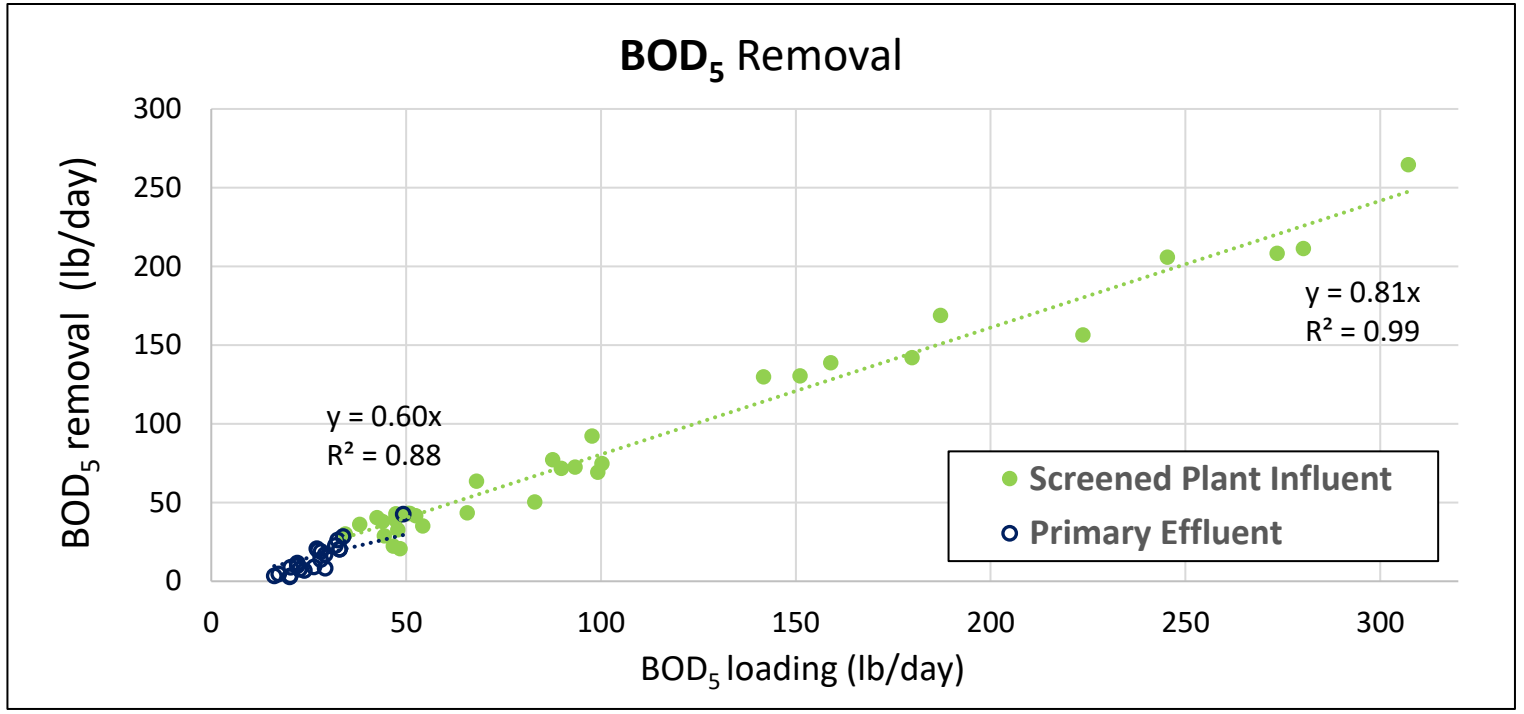
- **78% TSS Removal in plant influent (phase 1), 71% in PE (phase 2)**
- **68% BOD Removal in plant influent, 51% in PE**
- **Hits hydraulic limitation before removal suffers**

BIOLOGICAL FILTER Performance

84% TSS removal
Higher removal than primary filter (78%)



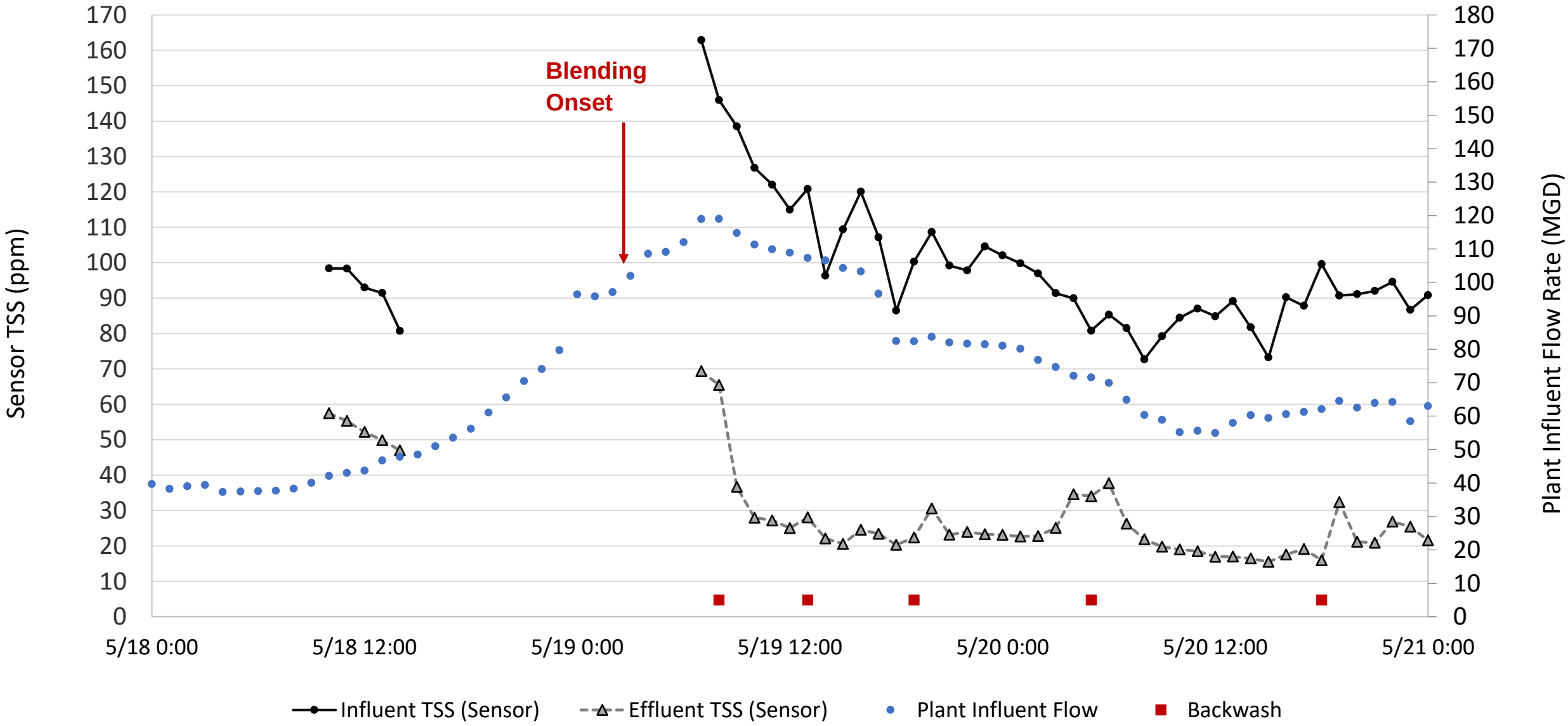
81% BOD Removal at 15-20min EBCT
in plant influent
(79% for COD)
60% for PE



Results Summary

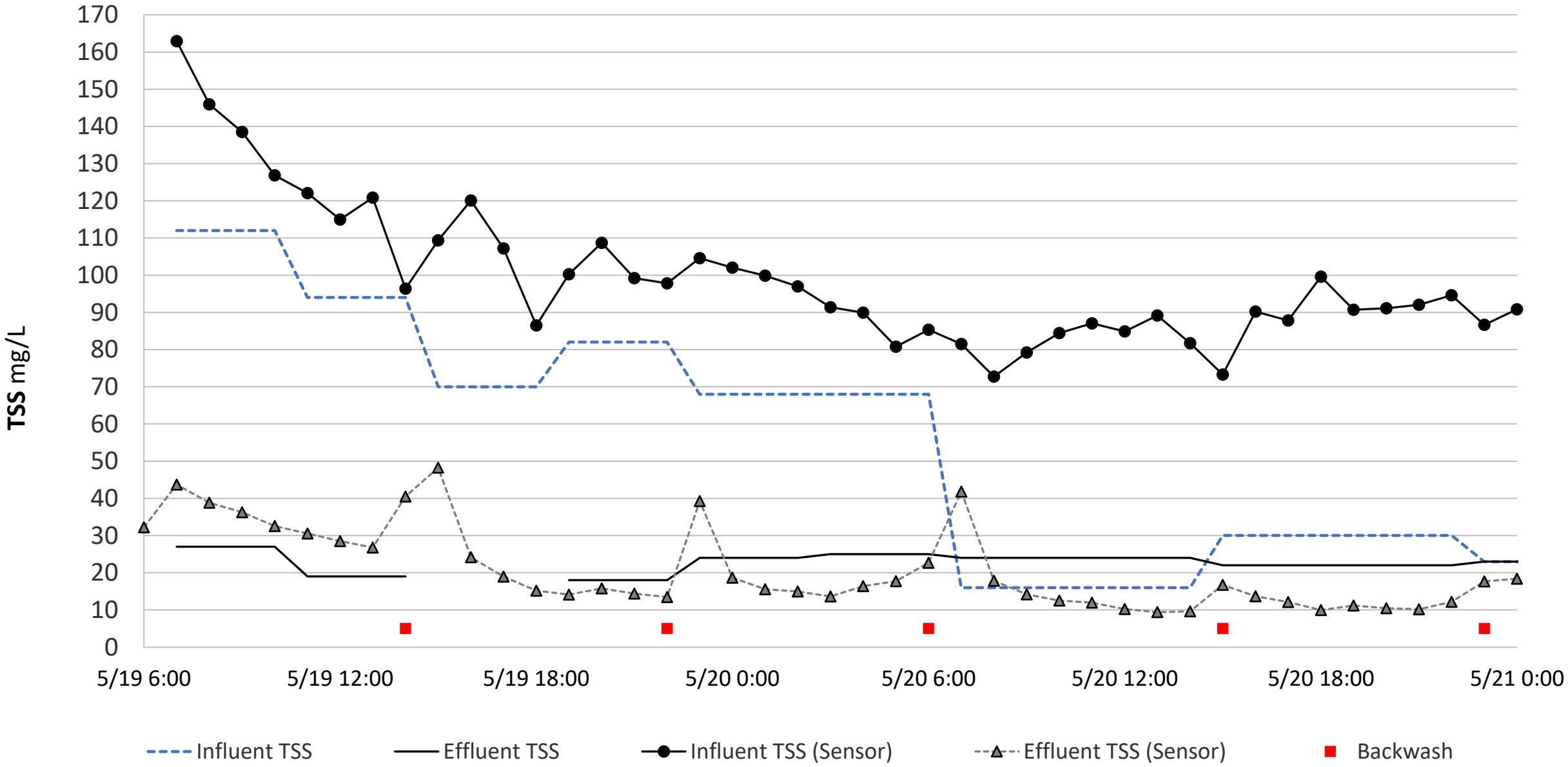
Removal v	Phase 1 (Raw) **Influent** (mg/L)	Phase 2 (PE) **Influent** (mg/L)	**Primary Filter Removal**		**Biological Filter Removal**	
			Raw Water	**Primary Effluent**	**Raw Water**	**Primary Effluent**
TSS	185	76	**78%**	**71%**	**84%**	**84%**
BOD	161	64	**69%**	**51%**	**81%**	**60%**
Total P	5.1	3.2	45%	37%	54%	51%
Fecal Coliform	7.5 CFU/mL	2.3 CFU/mL	51%	NA	79%	45%
Chlorine Demand	0.67	NA	70%	NA	88%	NA

Wet Weather Event **Primary Filter** Performance

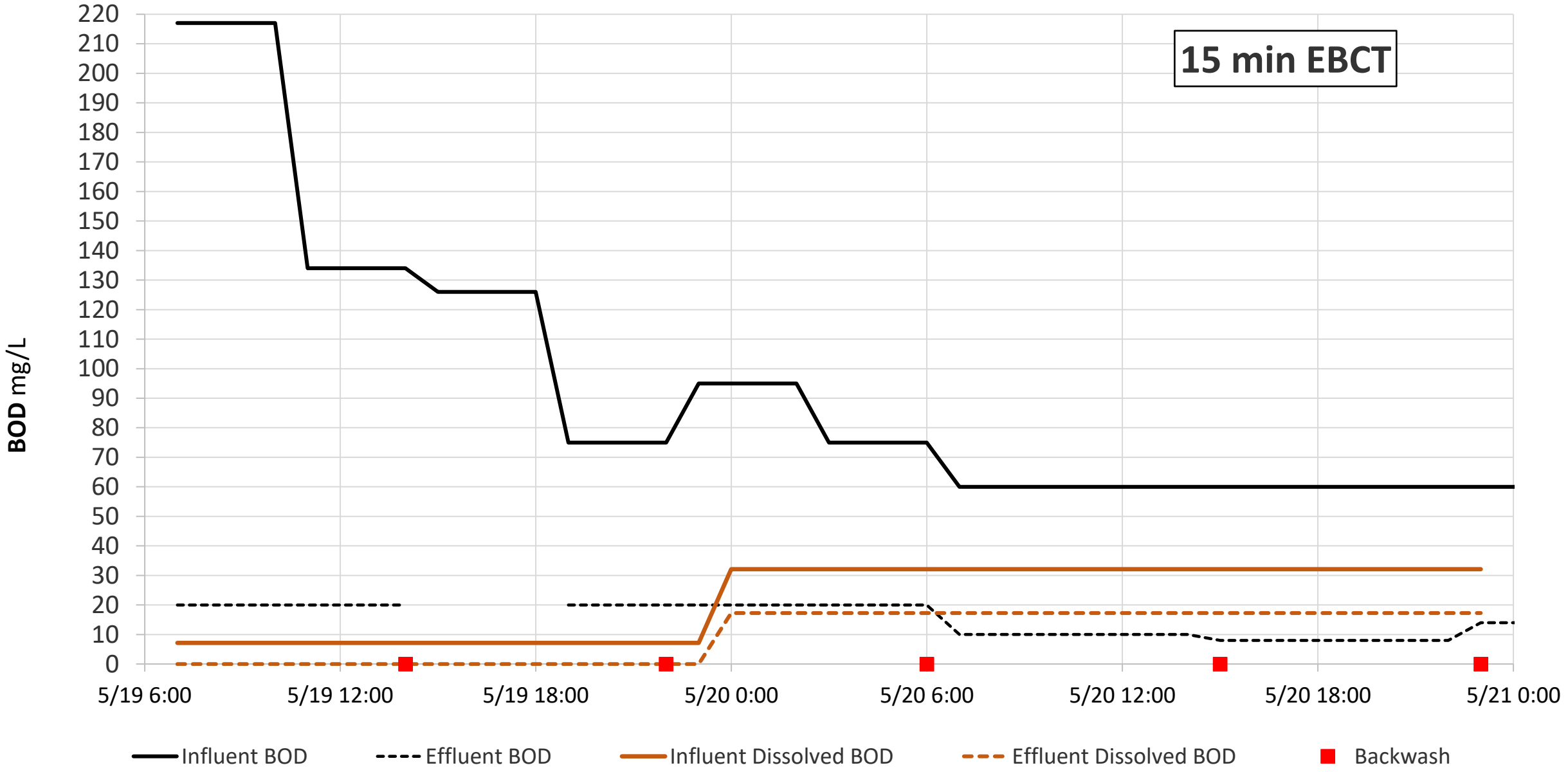


Real WWF Event: May 19, 2020

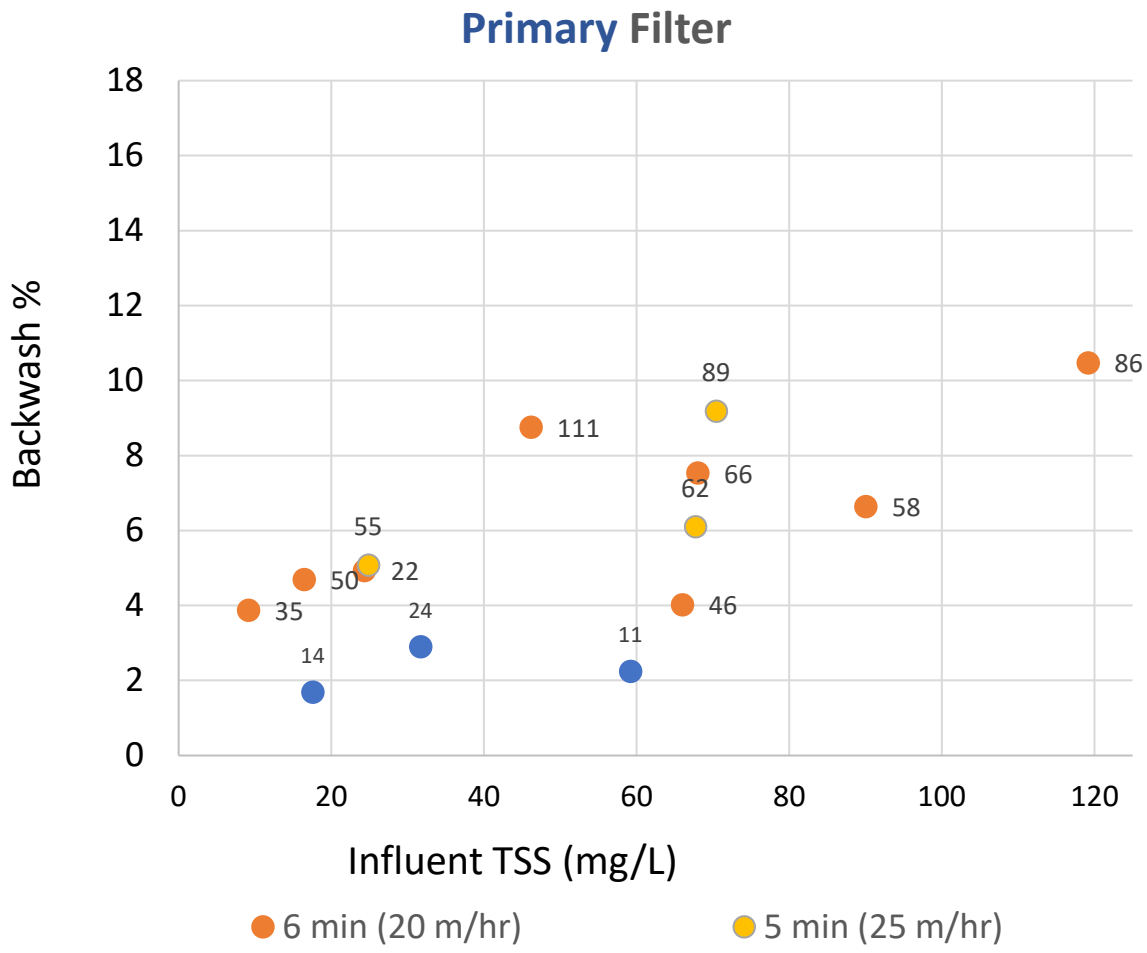
Wet Weather Event **Biological** Filter **TSS** Performance

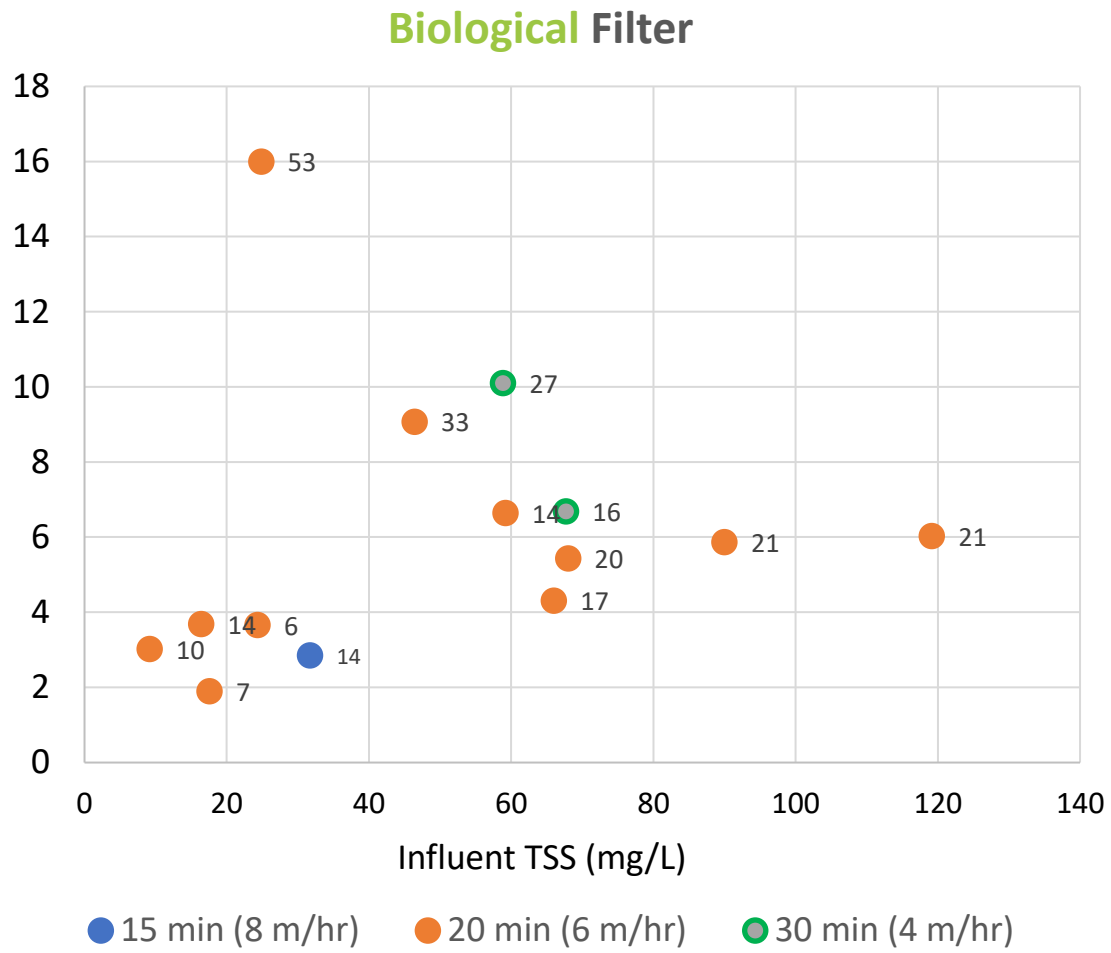


Wet Weather Event **Biological** Filter **BOD** Performance



Backwash: 2-10%, increasing with TSS





*Phase 2 Results

Pilot Conclusions

- New Proteus EPP media effective for advanced primary treatment
- Biological filter effective in reducing TSS & BOD in dilute WWF
- Biological treatment effective at low contact times (15-20min)
- Removal of BOD & TSS also reduces Chlorine demand, fecal coli
- Maintaining biofilm requires some carbon, but not full flow
- Pilot results support full-scale performance, without chemicals

Thank You!

NEWEA
WORKING FOR WATER QUALITY

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