NEWEA
WORKING FOR WATER QUALITY

Development of World's Largest Dual-use High-rate Primary & Wet Weather Flow Filtration Process using Floating Media

Presented by Jon Liberzon

TOMORROW WATER

PROTEUS

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, CSO & SSO events increasing
- Exacerbating Factor: Aging Infrastructure & deferred maintenance

WWF Treatment - Traditional Strategies

1. Increase Plant Capacity to Match Peak Flows
2. Storage & Equalization (Tunnels/Interceptor)

3. Divert & Blend

WWF Treatment - Traditional Strategies

1. Increase Plant Capacity
2. Storage & Equalization (Tunnels/Interceptor)

Bottom line:
Storage can buy you time
but it can't catch every drop.
(Size accordingly)

3. Divert & Blend
   - Only works if you can get all flows to the plant
   - Risk violating permit without auxiliary treatment
   - Blending permits may be hard to get/renew

WWF Treatment - New(er) Strategies

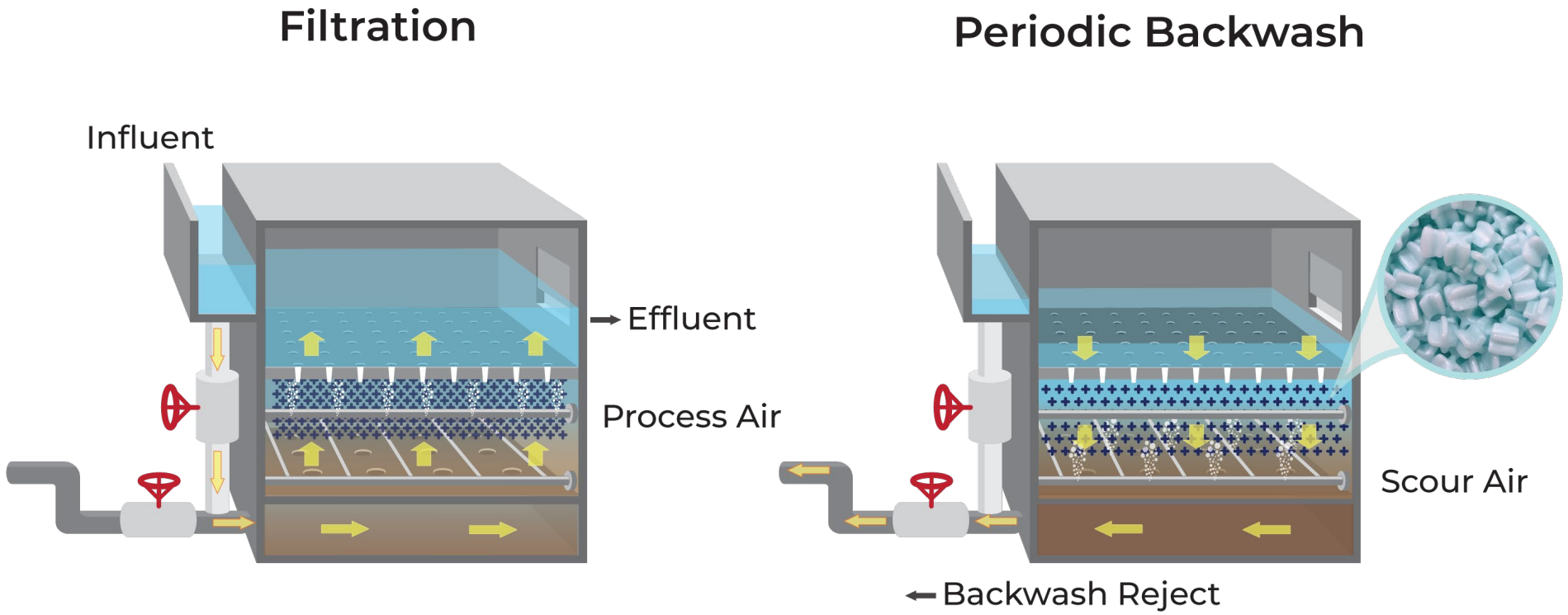
4. Auxiliary High-Rate Treatment

- Physical filtration to remove solids (+ particulate BOD)
- A lot of infrastructure just for rare events

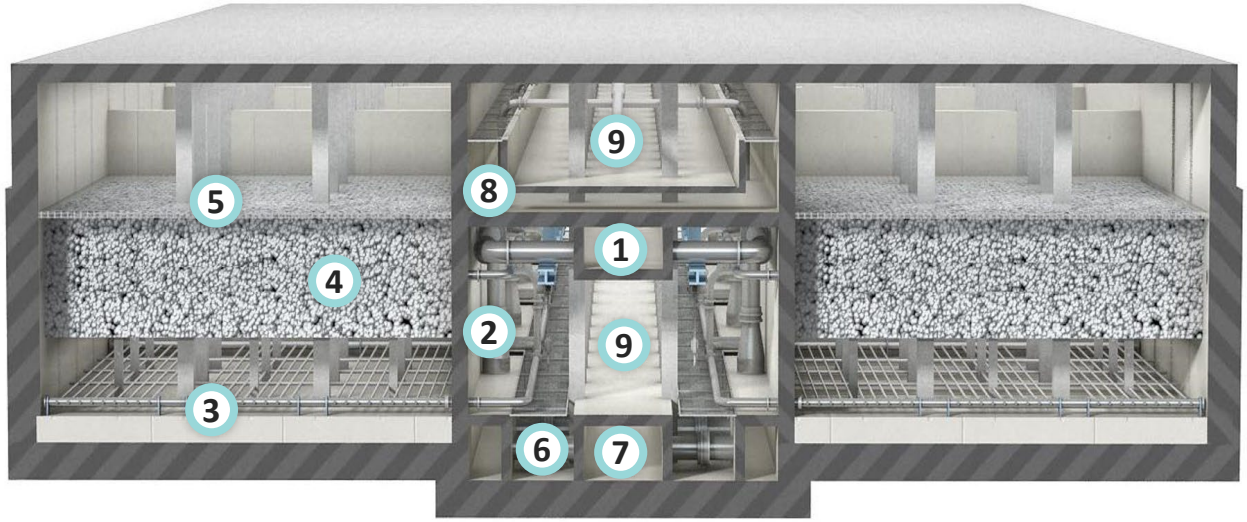
5. Dual-Use Systems: The best of both worlds

- Provides treatment for dry weather flow
- Switch feed or ramp up loading rate to manage WWF
- Still need to get flow to plant

PROTEUS High-rate (Bio)filter

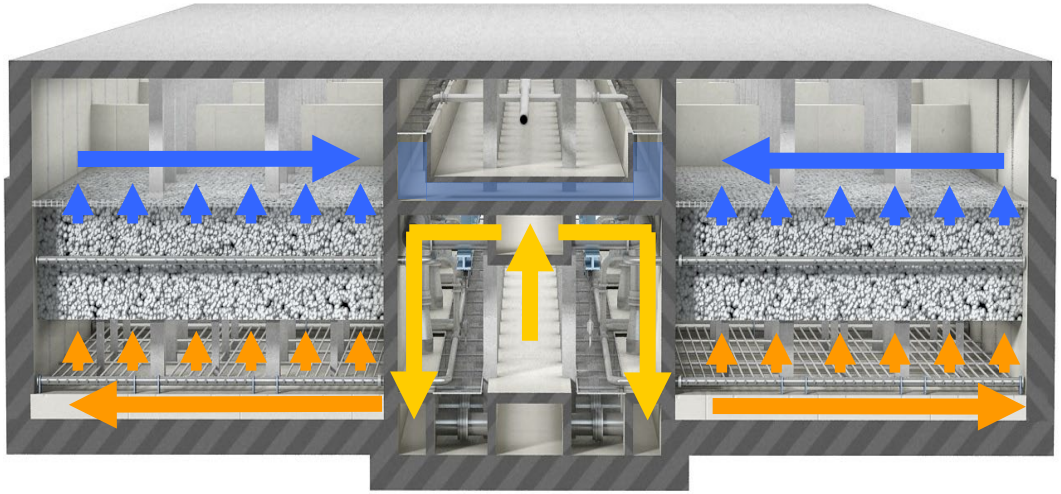


PROTEUS
Structure



1. Influent Conduit
2. Influent Pipes
3. Backwashing Diffuser Pipes
4. Floating Media
5. Strainer Blocks
6. Backwashing Water Drain Pipes
7. Backwashing Water Conduit
8. Effluent Conduit
9. Piping Conduits

PROTEUS
Structure



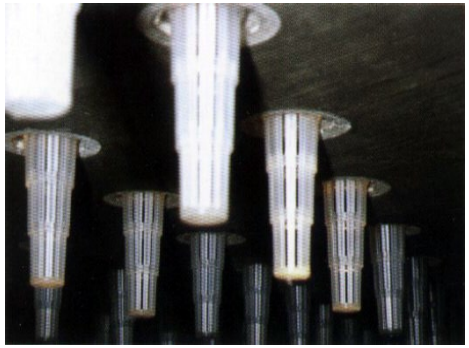
Treats Screened Raw Water Directly Without Clarifiers

Up-flow Biological Aerated Filter

Using Expanded Polypropylene (EPP) as floating media

Components

Concrete strainer block with top-serviceable nozzles completely retains floating media



Flow distribution: Channels w/ 5" aperture or piping manifold

Headworks: standard ¾" bar screen

LEGACY MEDIA

Expanded Polypropylene (EPP)

- Long lifespan

Ovoid Shape

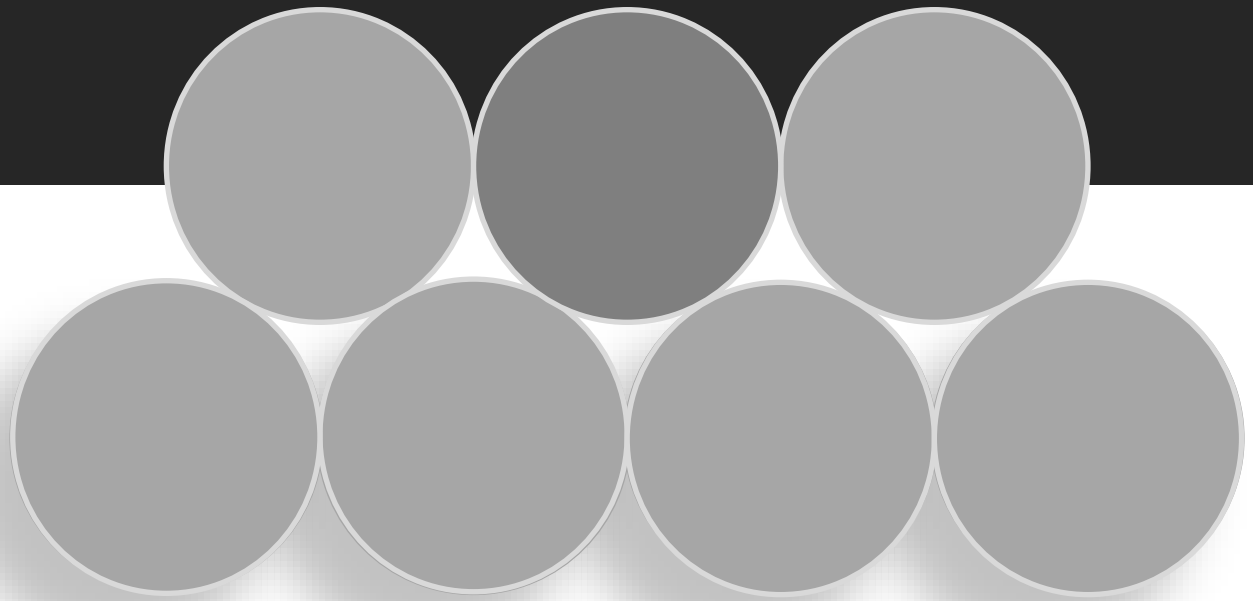
GREAT for Secondary/Tertiary

BUT! – Can’t Handle Raw Water

LEGACY MEDIA DESIGN

Ovoid Shape

Not suitable for high-solids loading



NEW PROTEUS MEDIA DESIGN

Lots of space to trap & hold solids

Complex stacking

Less head loss

>50% more surface area than legacy media

NEW CROSS-SHAPED MEDIA DESIGN

01

High Void Fraction: 0.4

- Low head loss @ high solids

02

High SS Loading: >3 kg/m^3 max (216lb/1000 ft^3)

- Minimizes backwash rate

03

Made With Expanded Polypropylene

- Cost-effective
- Long lifespan (>35 years)

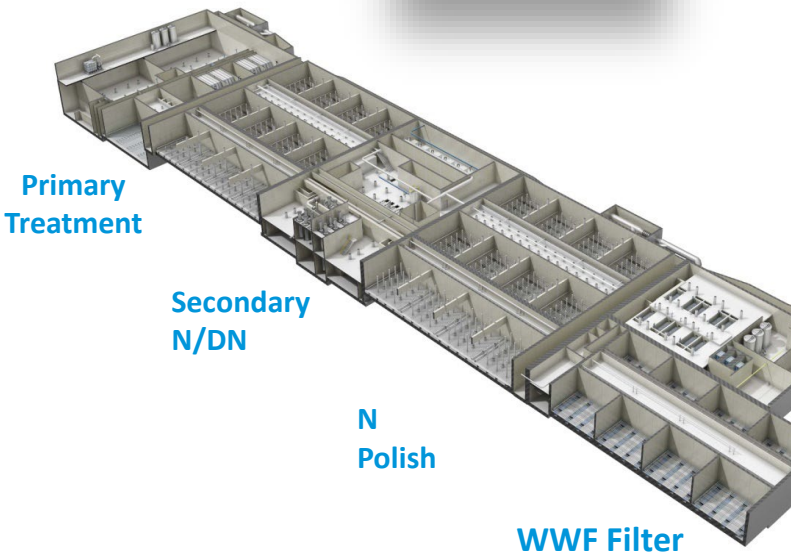
Proteus APPLICATIONS

Legacy BAF:

- Secondary Treatment & BNR
- Tertiary Nitrogen Control
- Groundwater Treatment

New:

- **Advanced Primary Filtration**
- **Wet Weather Flow & CSO Treatment**



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WHY ADVANCED PRIMARY FILTRATION?

FILTER PRIMARY SOLIDS INSTEAD OF SETTLING

80% Footprint Reduction
Over Primary Clarifiers

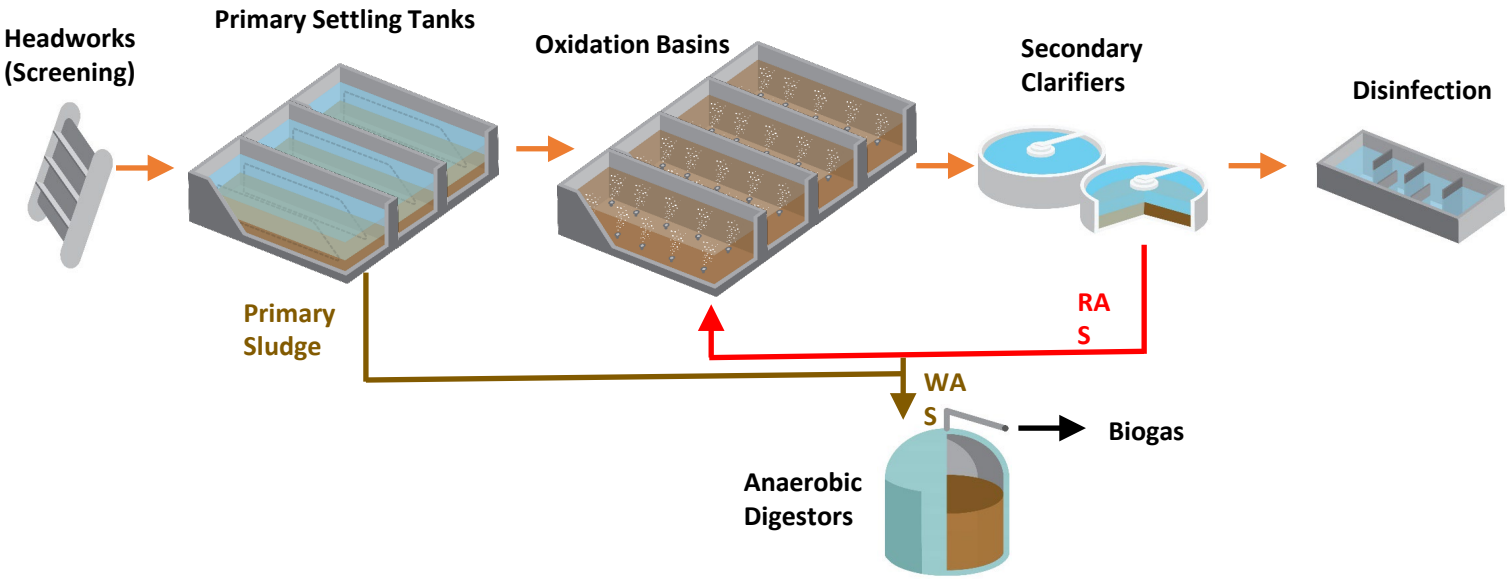
CAPTURE MORE TSS

70-90% Removal
Instead of 30-60% in Clarifiers

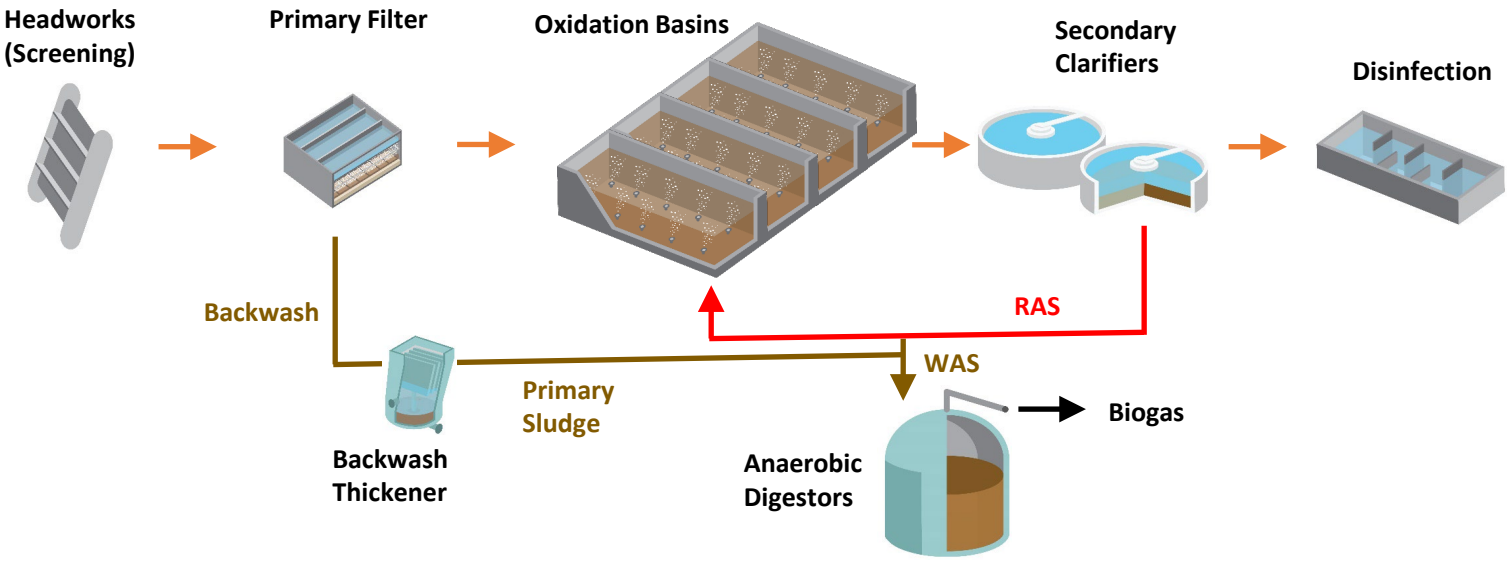
CARBON DIVERSION

Grab More BOD Upstream of Aeration
& Send To Digestors
10-25% Aeration Energy Reduction
10-25% More Secondary Treatment Capacity
20-30% Increase In Gas Production

High-Rate Filter Applications

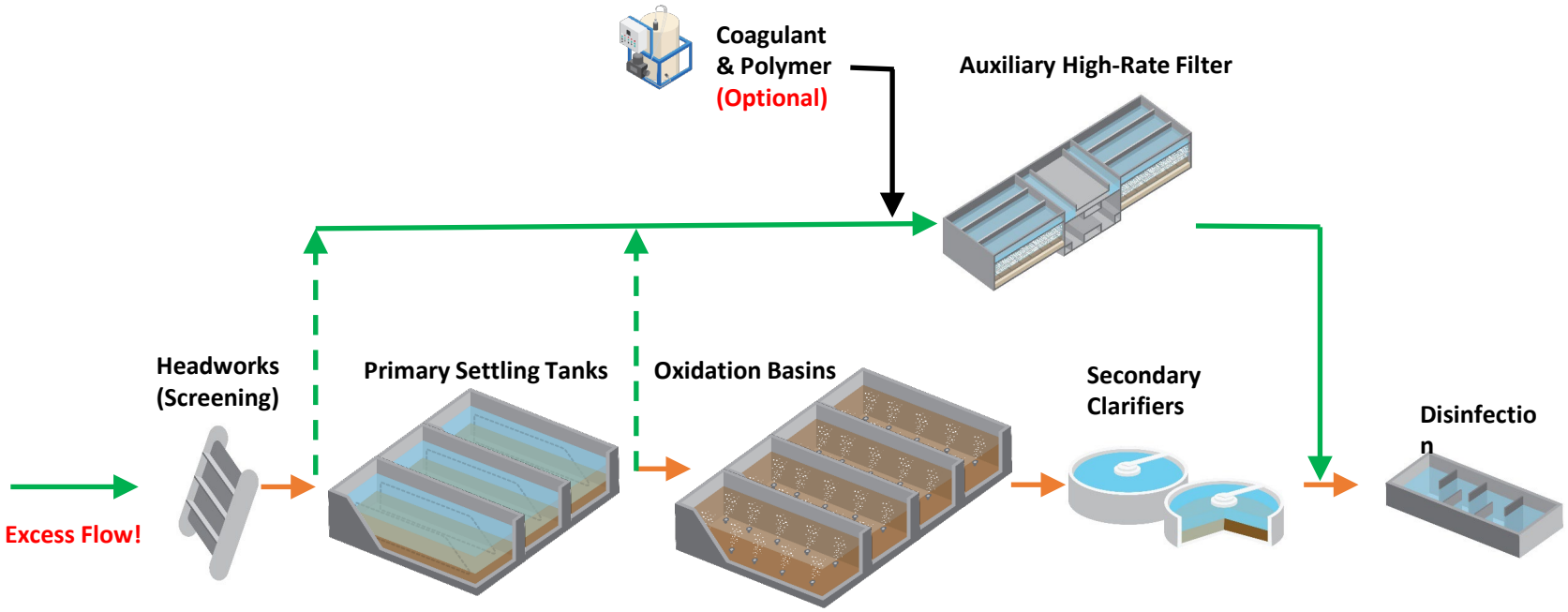


High-Rate Filter Applications - Primary

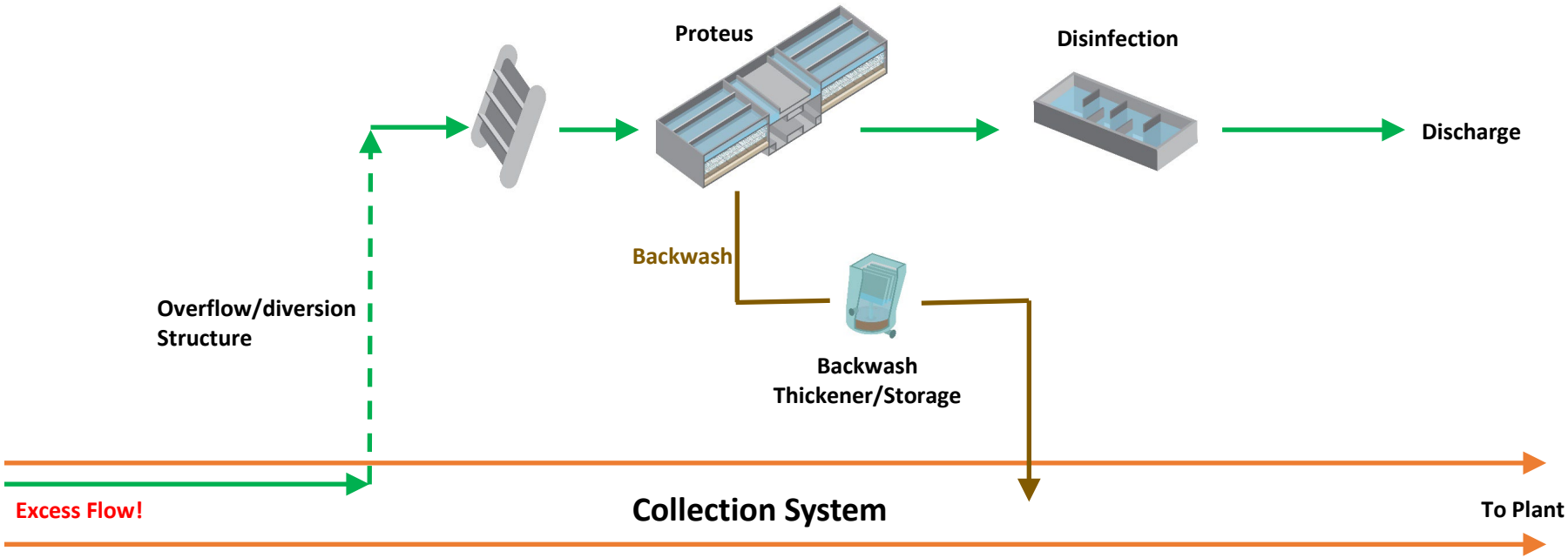


High-Rate Filter Applications – Auxiliary

Wet Weather Treatment

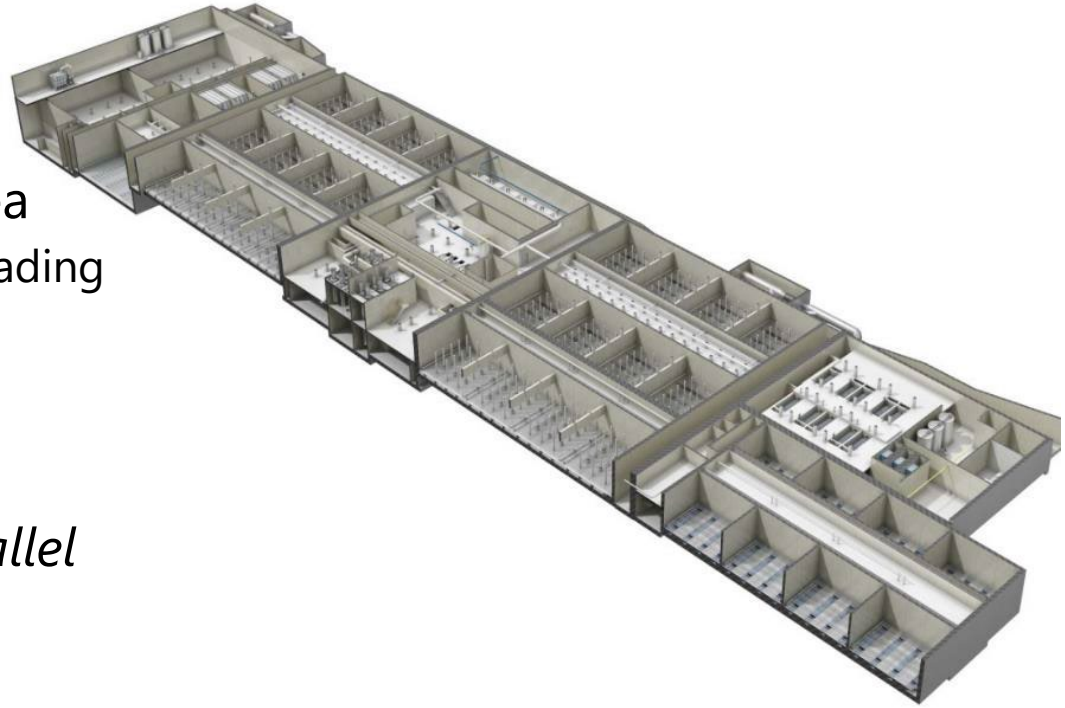


High-Rate Filter Applications – Satellite CSO Treatment

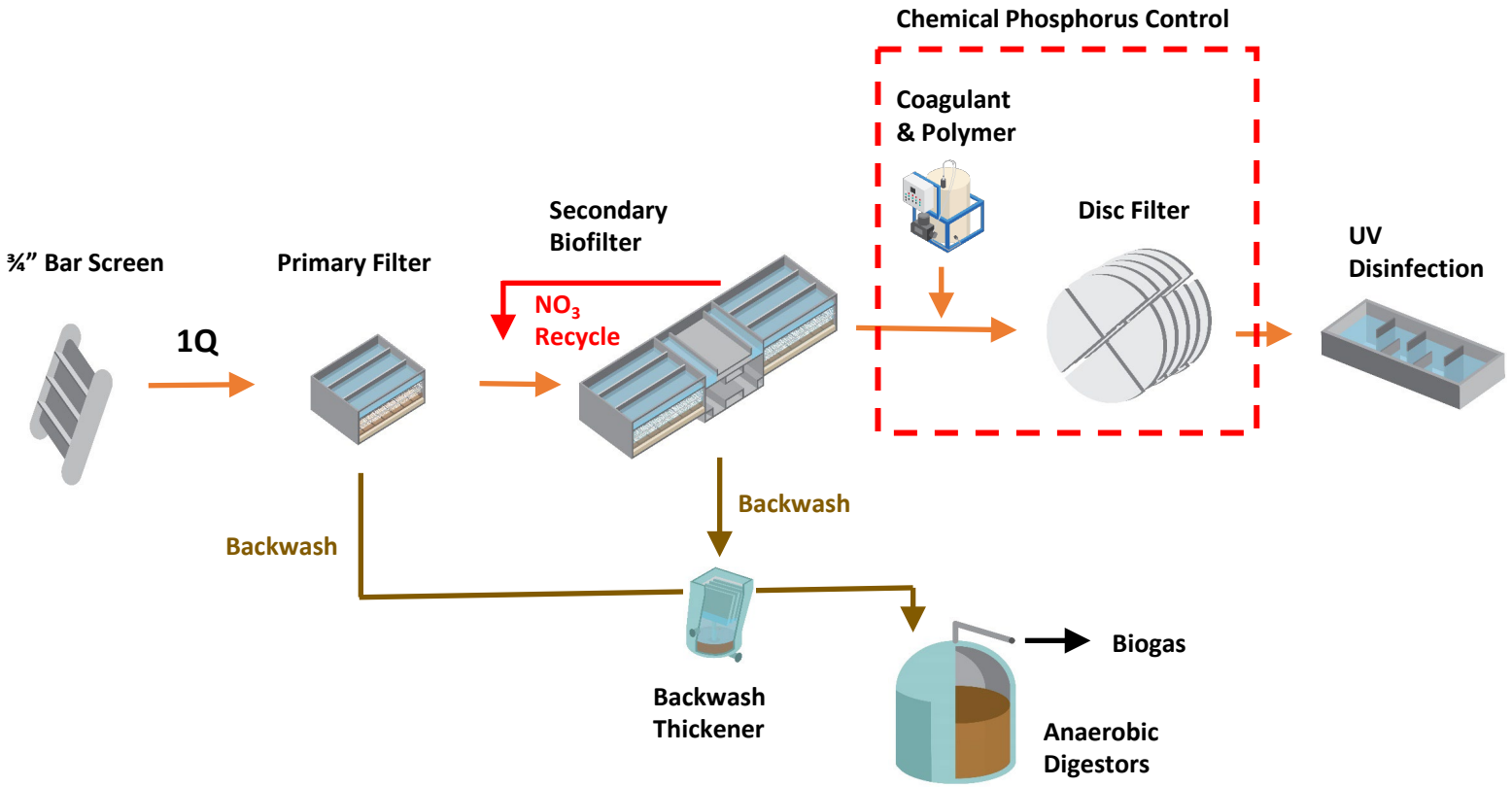


1st FULL-SCALE INSTALLATION

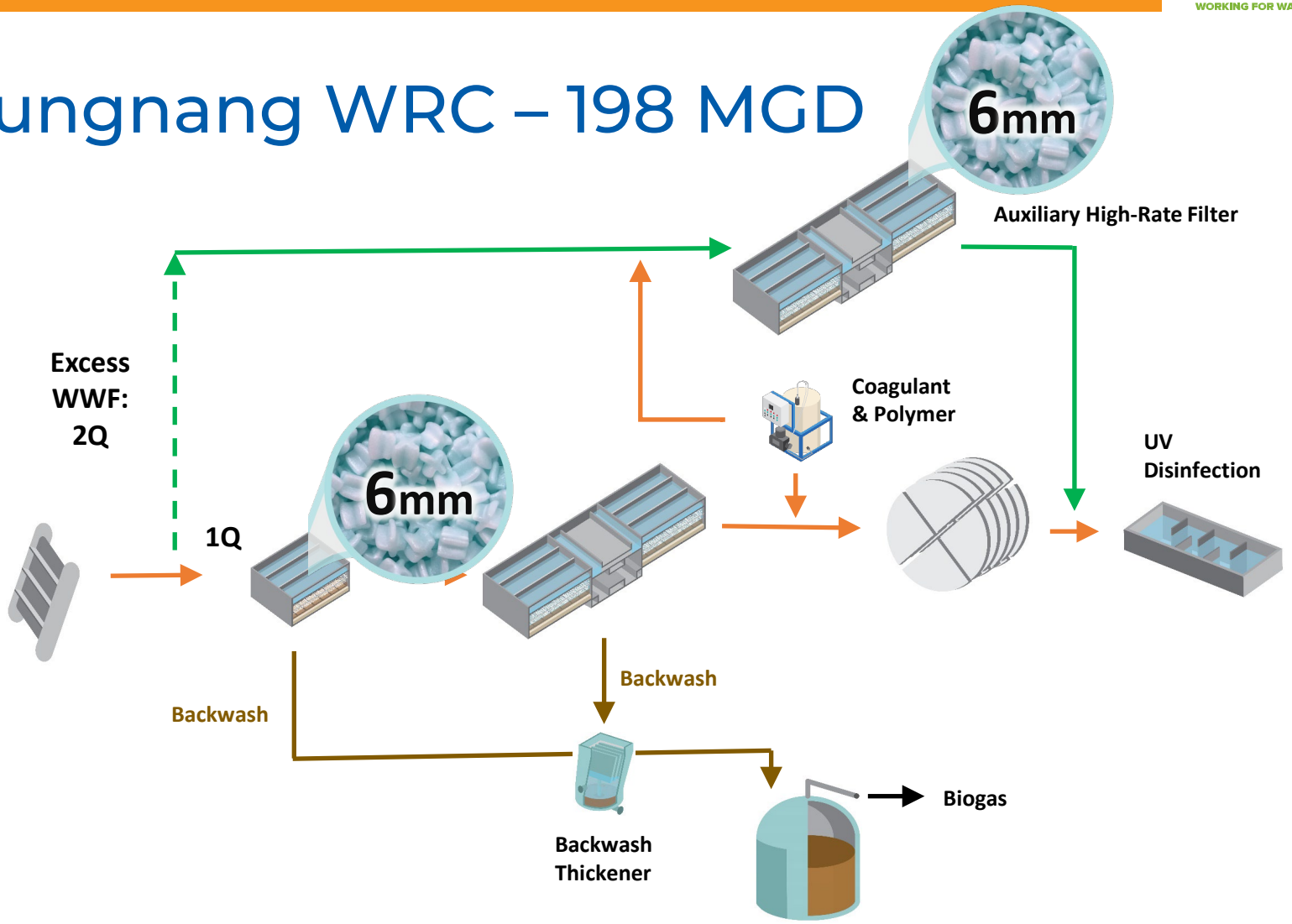
- **Jungnang WRF**, Seoul, Korea
  - Combined sewer with low loading (Inf TSS/BOD = 102/120)
- 66 MGD Primary Filter
- *132 MGD WWF Filter, in parallel with Primary Filter*
- Commissioned 2017



Jungnang WRC – 66MGD



Jungnang WRC – 198 MGD



Jungnang FILTER PERFORMANCE: 2020

		Influent (mg/L)	Effluent (mg/L)	Removal (%)
Dry Weather Primary Treatment 66 MGD	**TSS** Avg (Min-Max)	**101** (35-236)	**45** (13-95)	**56%**
	BOD Avg (Min-Max)	**124** (42-273)	**86** (21-231)	**31%**
Wet Weather Filtration 132 MGD	**TSS** Avg (Min-Max)	**277** (258-297)	**36** (36.0-36.3)	**87%**
	BOD Avg (Min-Max)	**84** (34-134)	**27** (15-39)	**63%**

Simplifies Odor Control

Improves Property Values & Boosts Reinvestment

Reclaims Public Space

Can Build on top

FULLY SUBTERRANEAN TREATMENT SYSTEM

JUNGNANG WRRF

SPRING 2018

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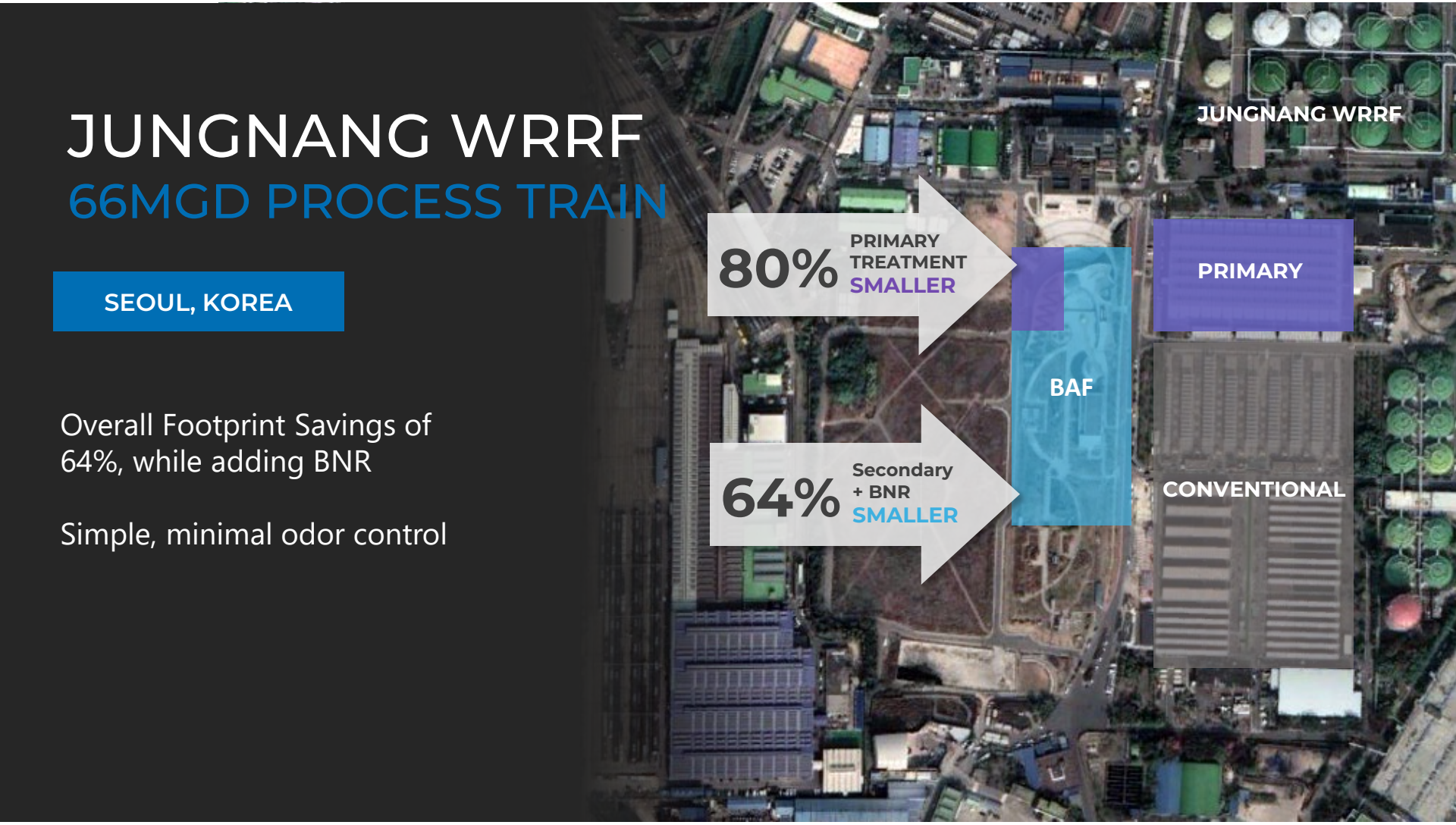
JUNGNANG WRRF

66MGD PROCESS TRAIN

SEOUL, KOREA

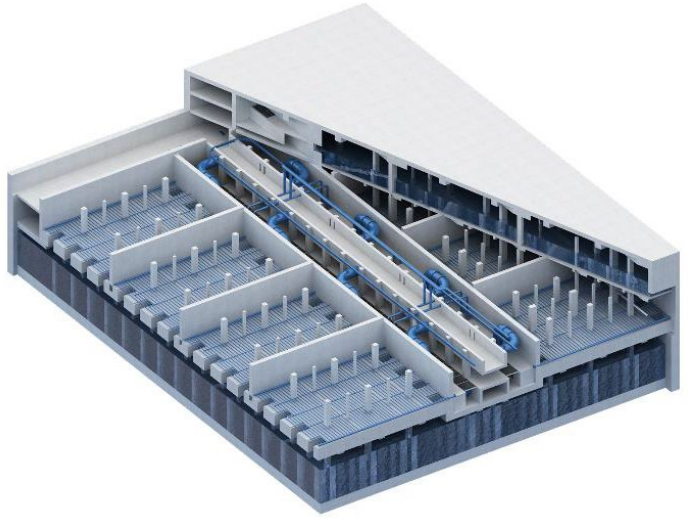
Overall Footprint Savings of 64%, while adding BNR

Simple, minimal odor control



1st DUAL-USE INSTALLATION

- **Seonam WRF**, Seoul, Korea
- 95 MGD Primary Filter
  - No Chemicals
- *190 MGD WWF Filter*
  - Flow velocity simply increased in primary filter
  - Chemically Enhanced
- Commissioned 2020



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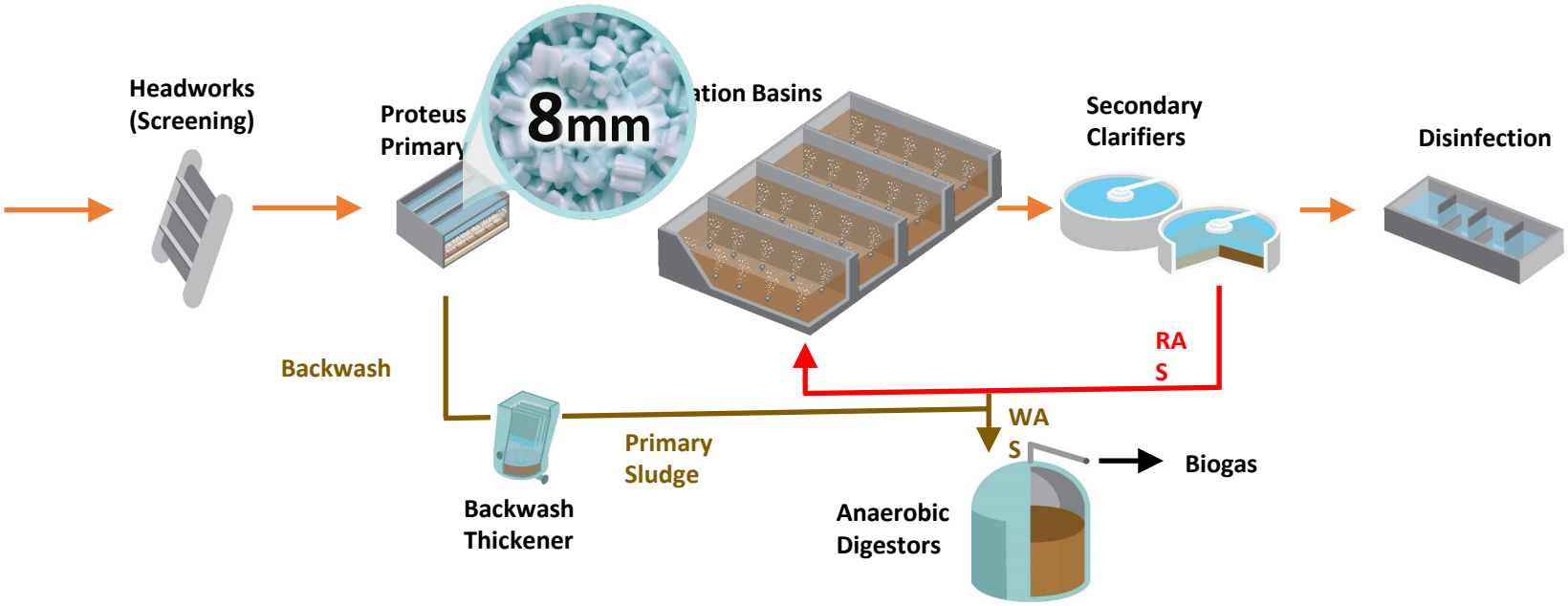
FULLY SUBTERRANEAN TREATMENT SYSTEM

Primary Filtration *without* Carbon Diversion

- Seonam is a denitrifying plant with ***low bioavailable BOD***
- The plant wanted to ***conserve as much BOD as possible***, while capturing large solids, grit, etc.
- Proteus primary filter installed with ***larger 8mm media to reduce the TSS & BOD removal rate*** through primaries, conserving more carbon for downstream denitrification
- WWF requires maximum BOD removal (no BNR)

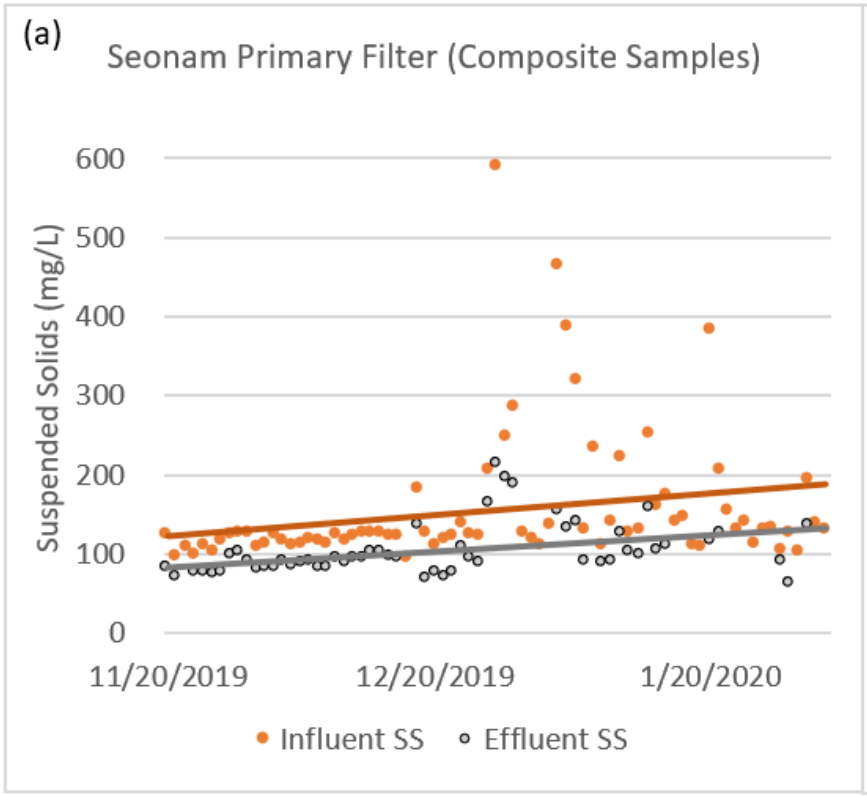
  → Seonam doses PAC & polymer to ***maximize TSS/BOD removal in WWF***

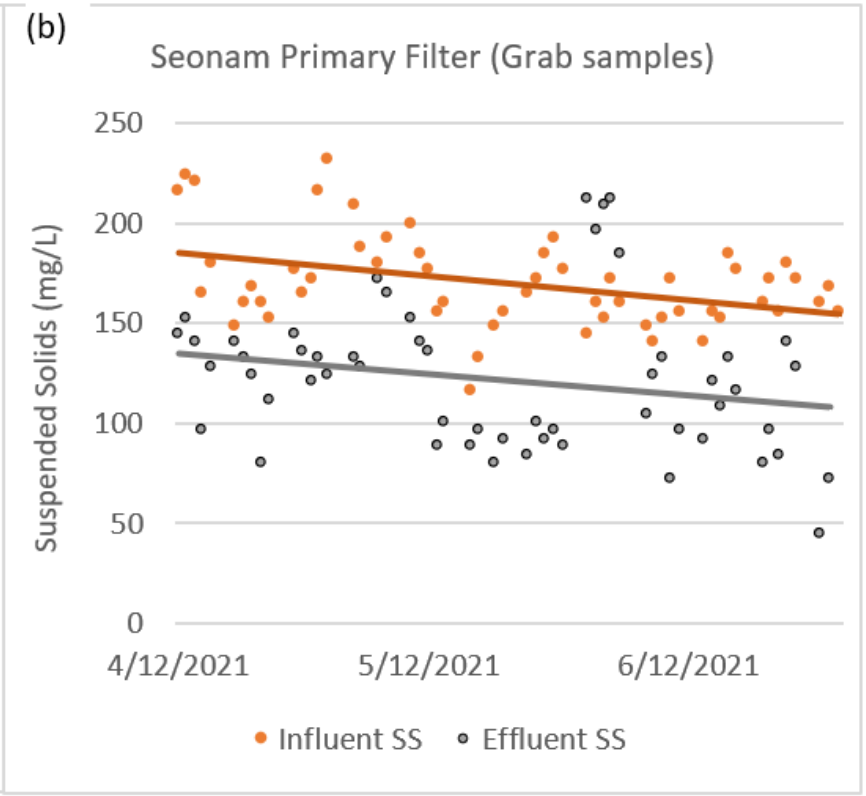
Seonam WRC – 95MGD




Seonam Water Recover Center, Seoul, Korea
Dual-Use
Proteus™ Filter
95 MGD
A2O
Train
Conventional Primary
303 MGD MLE Train
Secondary

SEONAM PRIMARY FILTER PERFORMANCE: 2020

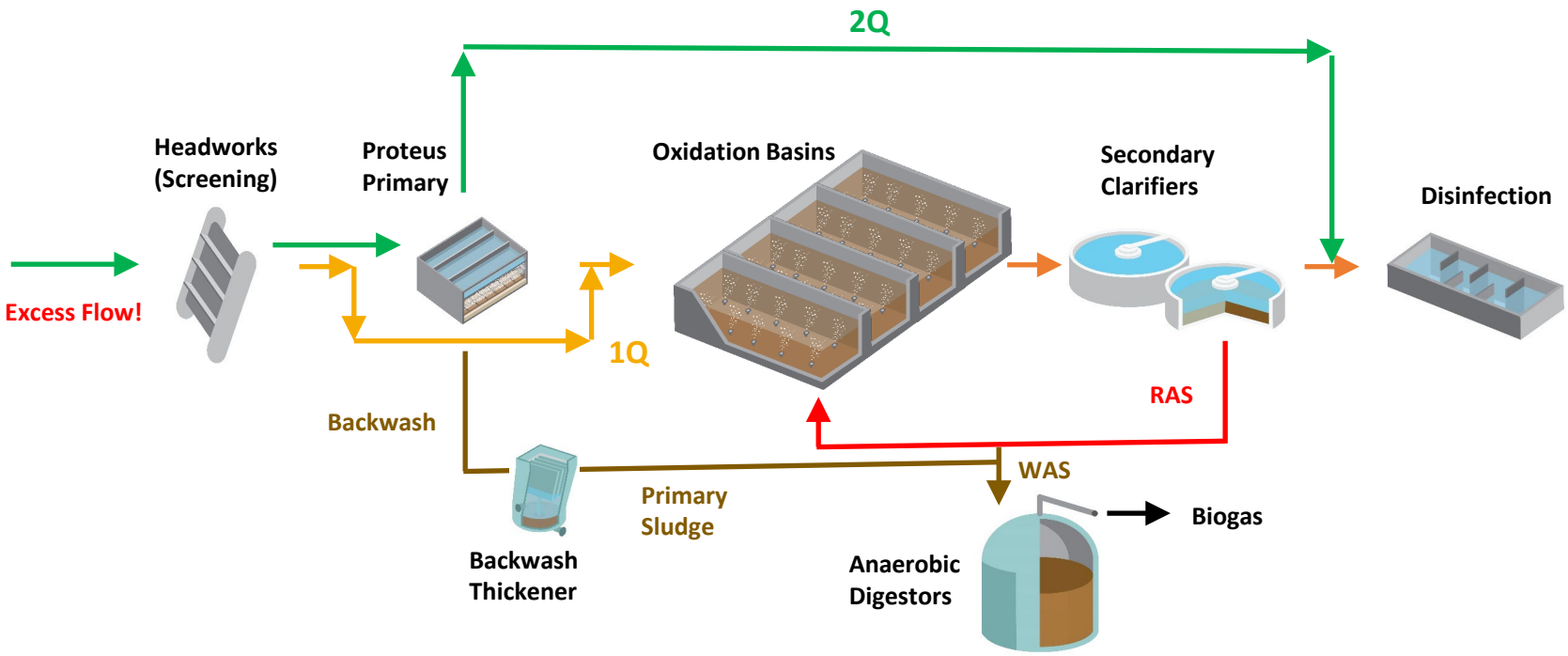




Before Turnover

After Turnover

Seonam WRC – 285 MGD (Dual-Use)



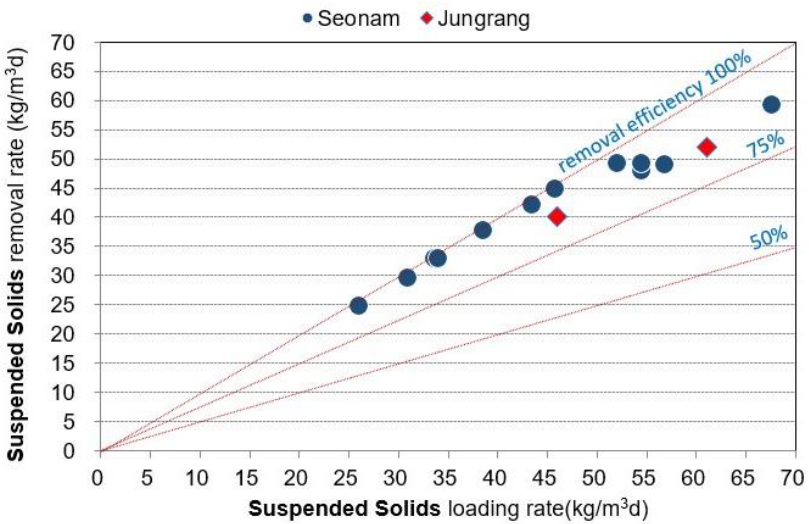
2020 WET WEATHER FILTER PERFORMANCE: Seonam

Event	Q (m3/d)	Influent		Effluent		Removal Efficiency	
		BOD_5 (mg/L)	SS (mg/L)	BOD_5 (mg/L)	SS (mg/L)	BOD	SS
1	720,000	79.8	288.0	21.6	34.8	73%	88%
2	720,000	102.3	242.0	20.7	32.8	80%	86%
3	720,000	116.7	232.0	2.8	27.2	98%	88%
4	720,000	91.5	232.0	9.2	22.0	90%	91%
5	720,000	84.4	222.0	20.6	11.4	76%	95%
6	720,000	78.0	195.0	23.9	3.6	69%	98%
7	720,000	82.8	185.0	7.5	5.4	91%	97%
8	720,000	79.2	164.0	23.2	3.0	71%	98%
9	720,000	77.1	143.0	0.4	2.4	99%	98%
10	720,000	71.1	145.0	21.8	4.1	69%	97%
11	720,000	78.9	111.0	22.4	5.3	72%	95%
12	720,000	84.0	132.0	14.4	5.4	83%	96%
Average		85.5	190.9	15.7	13.1	81%	94%
Max		116.7	288.0	23.9	34.8	99%	98%
Min		71.1	111.0	0.4	2.4	69%	86%

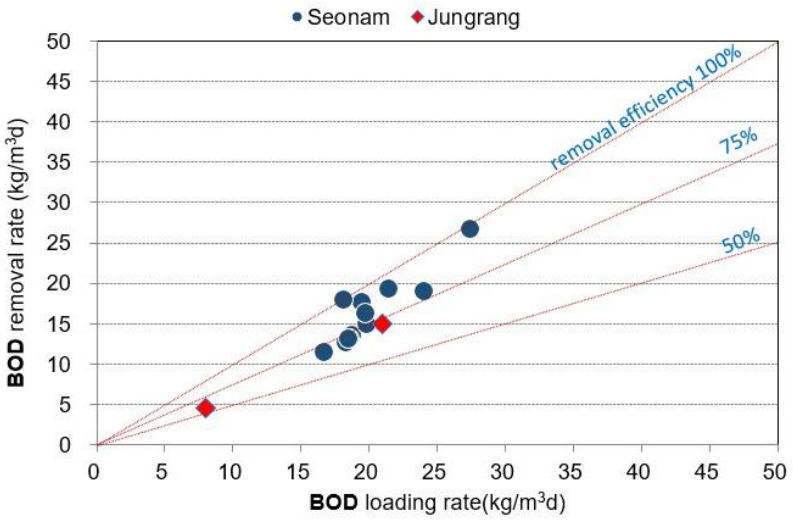
WET WEATHER FILTER PERFORMANCE: 2020

Seonam (190MGD) & Jungnang (132MGD)

TSS



BOD



6mm vs 8mm MEDIA PERFORMANCE

		6mm Removal (Jungnang)	8mm Removal (Seonam)
Dry Weather Primary (no chem)	TSS	56%	32%
	BOD	31%	25%
		N=2	N=12
Wet Weather Filtration (with chem)	TSS	87%	94%
	BOD	63%	81%

- 6mm Media: Remove more carbon in dry weather (carbon diversion)
- 8mm Media: Allow more carbon through primaries for denit
- Wet Weather (w/chem addition): Similar performance

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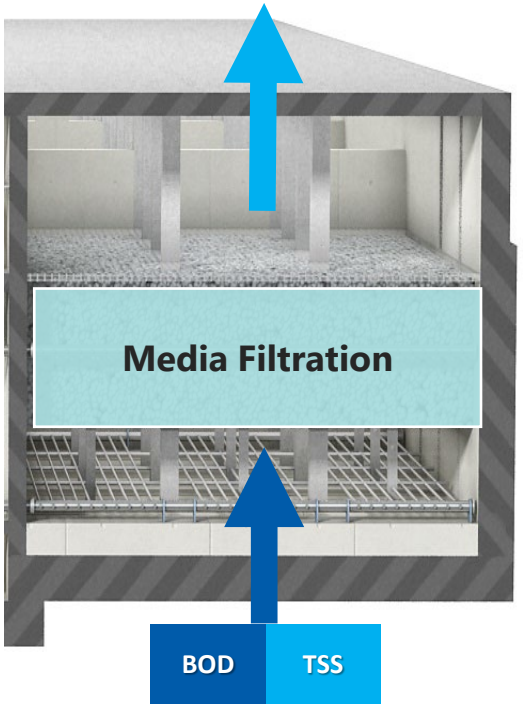


Wet-Weather Influent

PROTEUS Primary Filter

- Fully anoxic media bed (no aeration)
- Developed originally to replace clarifiers
- Minimum HRT ~ 6 min
- Peaking Factor ~2x (with WWF dilution)

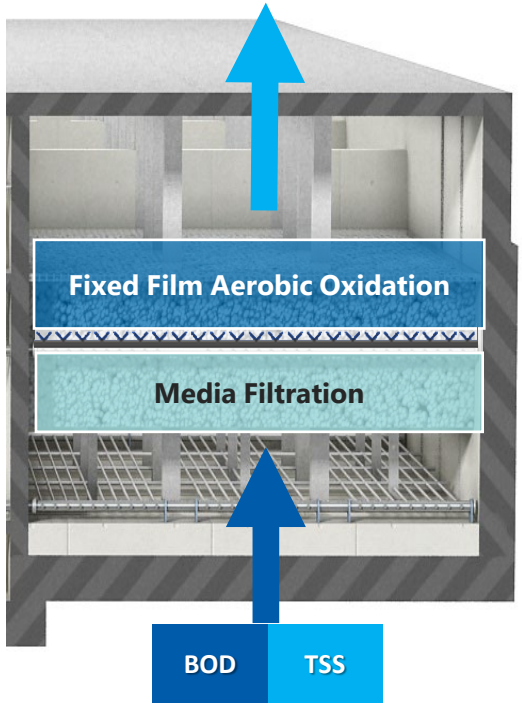
PROTEUS+ Biological Filter

- Process air grid inside media bed
- Minimum HRT ~ 15min
- Option as "Super-Primaries" (HPO, Capacity Limited)
- Increased Peaking Capacity (2-5x)

Process Models:

GPS-X

BioWin



Wet-Weather Influent

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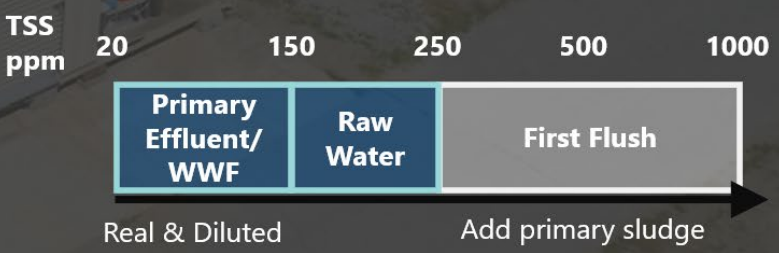
PRIMARY & WWF
13-MONTH PILOT

GENESEE COUNTY MICHIGAN

PHASE 1: Quantify performance at wide range of influents, simulating variable wet weather flows

PHASE 2: Stable performance with dilute Primary Effluent

PLUS: Catch a real wet weather event



3rd Party Reviewer: Dr. Glen Daigger
Paper at WEFTEC 2020

PROTEUS MICHIGAN PILOT
RESULTS SUMMARY FOR PLANT W/SEPARATED SEWER

Removal	Proteus Primary Filter		Proteus+ (Biological Filter)	
	Raw Water	Primary Effluent	Raw Water	Primary Effluent
TSS	78%	71%	84%	84%
Total BOD	61%	51%	81%	60%
Filtered BOD			74%	43%
COD	67%	57%	79%	58%
Fecal Coliform	51%		79%	
Chlorine Demand	70%		88%	

CONCLUSIONS

- Auxiliary high-rate filters are gaining popularity for wet weather/CSOs

  → Proteus proven at scales of 195 MGD and 95 MGD in Korea

- **Dual-Use configurations give these systems dry-weather value**
- High-rate filters achieve carbon diversion benefits in APT

  → But, denitrifying plants may not want max TSS/BOD removal

- Proteus filters can adjust media size to customize TSS/BOD removal
- Adding chems improved TSS/BOD removal, regardless of media size
- New aerated options offer true biological treatment of WWF

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THANK YOU

TOMORROW WATER

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