

Why Choose Packed Bed Technology?

Recirculating Packed-Bed Filter

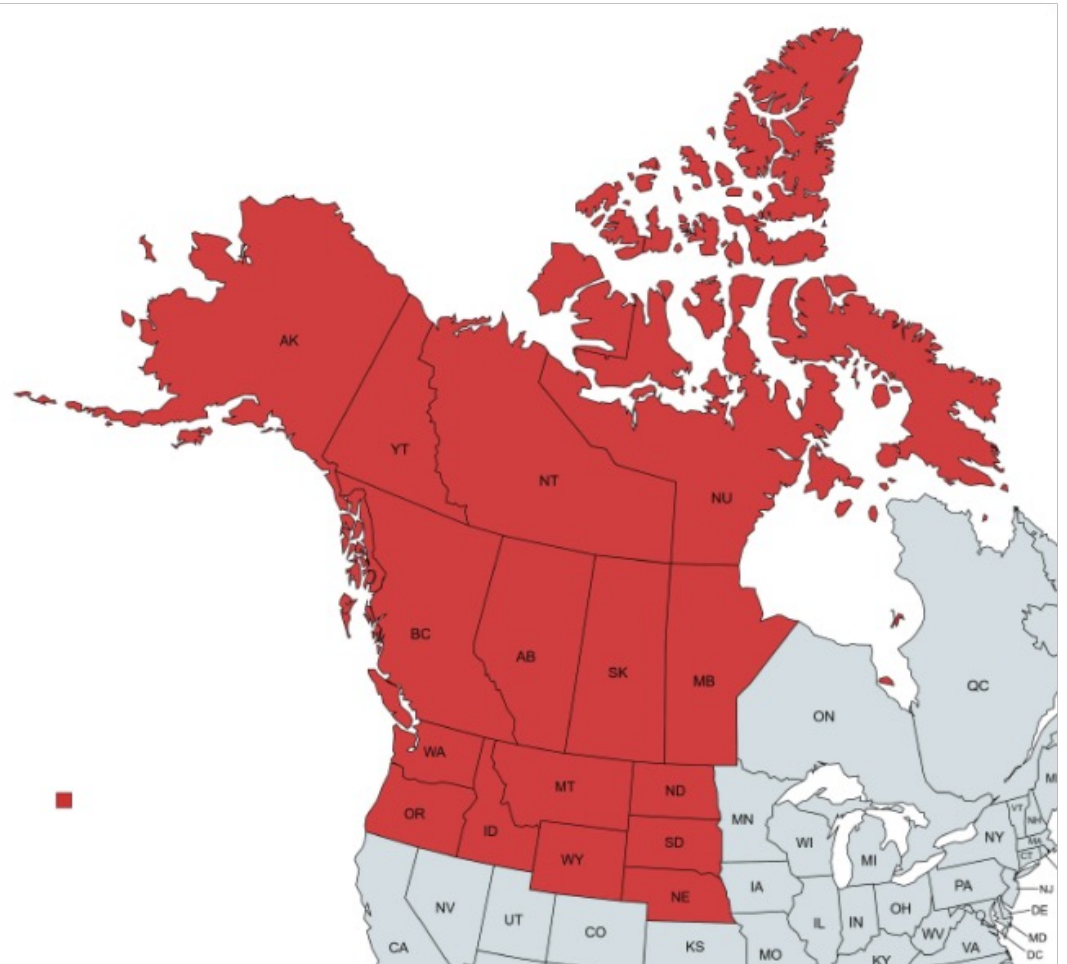
vs.

Activated Sludge

Johnathon Honeywell

Johnathon Honeywell, is a Regional Sales Engineer with Orenco Systems®, Inc., a wastewater equipment manufacturing firm based in Sutherlin, Oregon. In this role, he provides engineers and dealers in Orenco's Northwest Territory with technical assistance and design review. He also helps end users of Orenco's wastewater treatment systems troubleshoot any issues that arise after the system has been installed.

Johnathon holds a Bachelor of Engineering degree in mechanical engineering from the University of North Florida. In his spare time he enjoys being outdoors in his home state of Oregon.



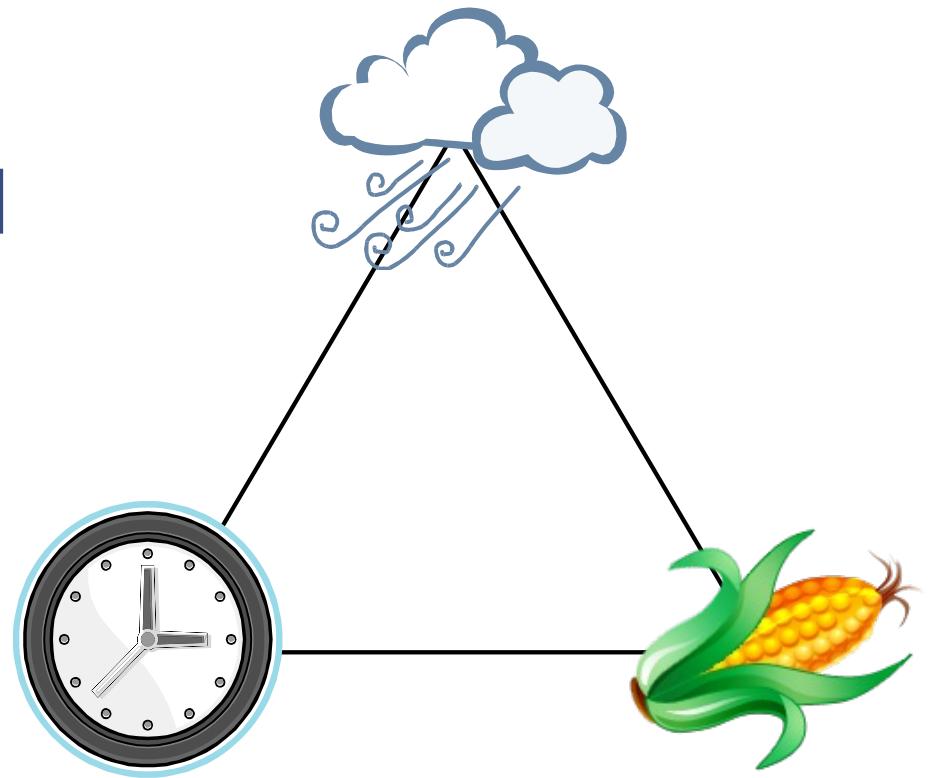
Overview

- Generalities of wastewater treatment
- Activated sludge treatment process
- Packed-bed filter process
- Operational comparison
- Application comparison

Wastewater Treatment

- Food
- Air
- Time

Balance these 3 in the correct proportions and in the correct forms



Wastewater Treatment

• Aerobic

- Carbon compounds + microbes + oxygen =>
carbon dioxide + water + more microbes
- With free oxygen
- Nitrification
 - Occurs when carbonaceous load is diminished

• Anaerobic

- Without free oxygen
 - Oxidant may be nitrate, sulfate, etc.
 - Digesters

Getting Oxygen to the Microbes

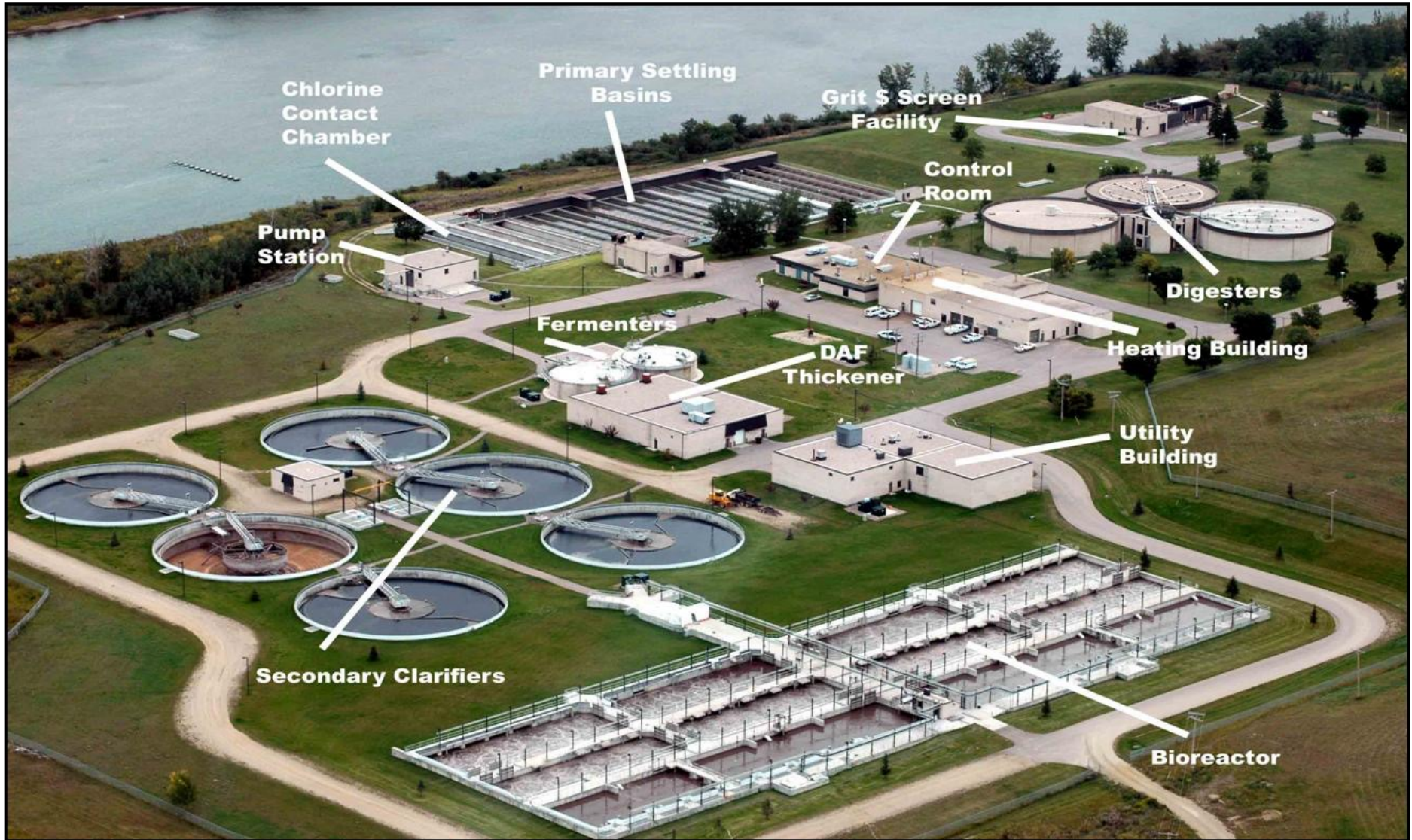


Activated Sludge

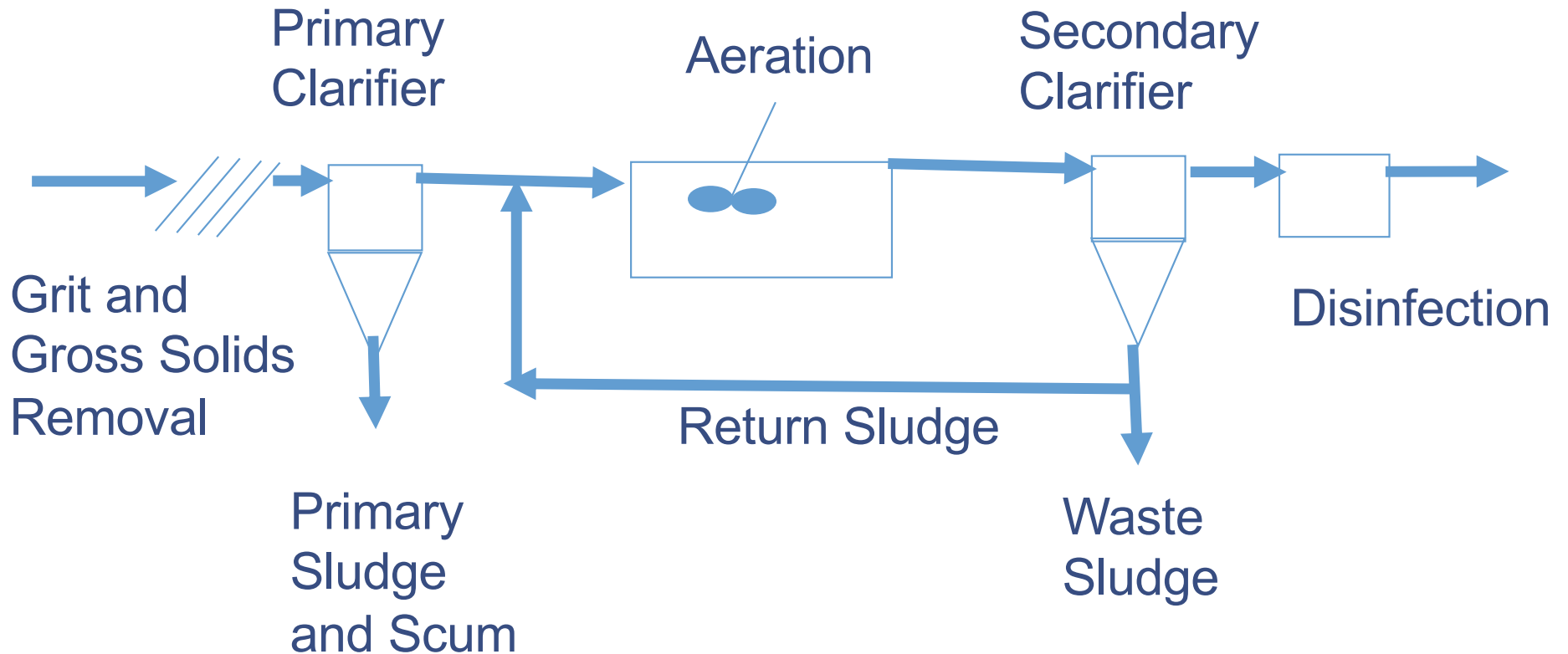


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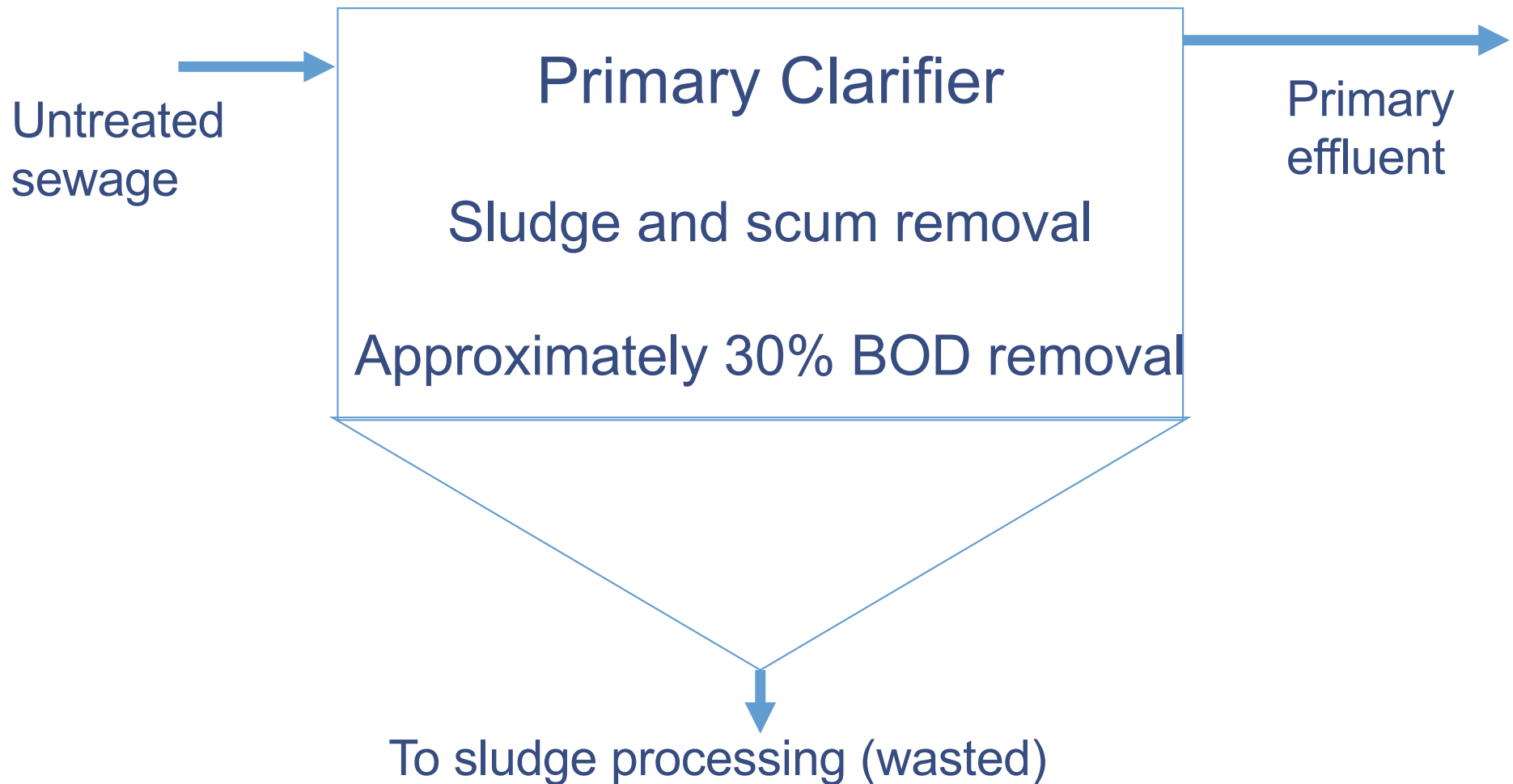
Unit Processes of Wastewater Treatment



Unit Processes for Activated Sludge



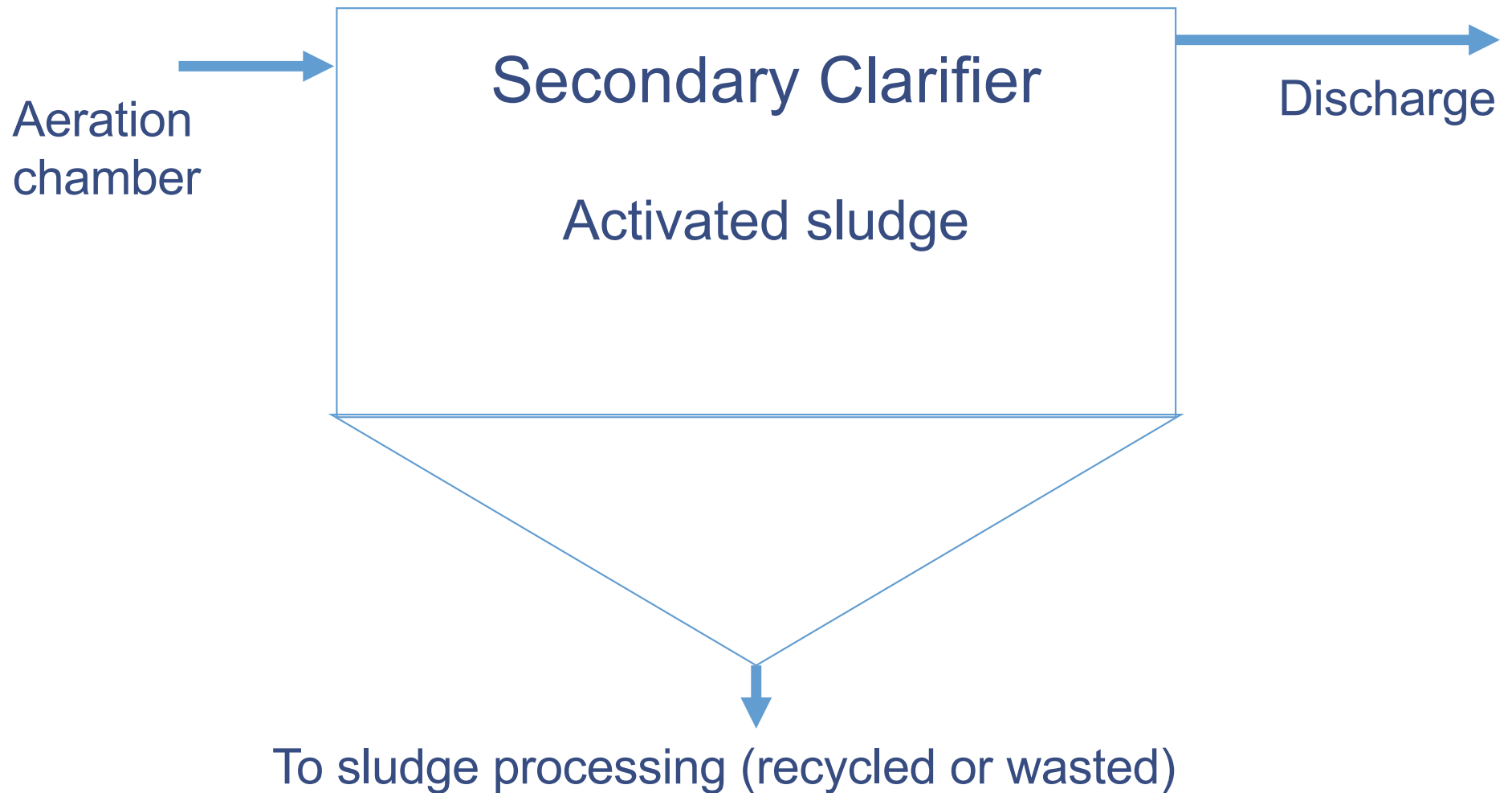
Grit Removal/Primary Clarifier



Aeration Chamber

- Oxygen is introduced to aerate the reactor
- Mixed liquor
 - Aerated microbial mass maintained in suspension
 - Recycled sludge added
- Extended air
 - Sludge held longer
 - Increased sludge age
 - Nitrification

Secondary Clarifier



Tertiary Treatment

- Processes that follow the secondary clarifier
 - Disinfection
 - Phosphorus reduction
 - TN reduction
 - PH adjustment
- Discharge

Activated-Sludge Process Operation

- Aeration chamber
 - Mixed-liquor monitoring
 - Correct balance of microorganisms to treat influent
 - Sludge-age monitoring
- Return activated sludge (RAS)
 - Concentration of sludge returned to aeration chamber
- Waste activated sludge (WAS)
 - Wasted sludge to discharge
 - Drying, dewatering, disposal

Recirculating Packed Bed Filters (RPBF)



Recirculating Packed-Bed Filter Process

Description

- Single and multiple pass
 - Dates to late 1800s
- Developed for small scale flows as supplementary septic system components
- Similar to trickling filters, but with lower loading rates and higher surface areas
- Media types
 - Sand/gravel
 - Peat
 - Foam
 - Textile (AdvanTex[®])

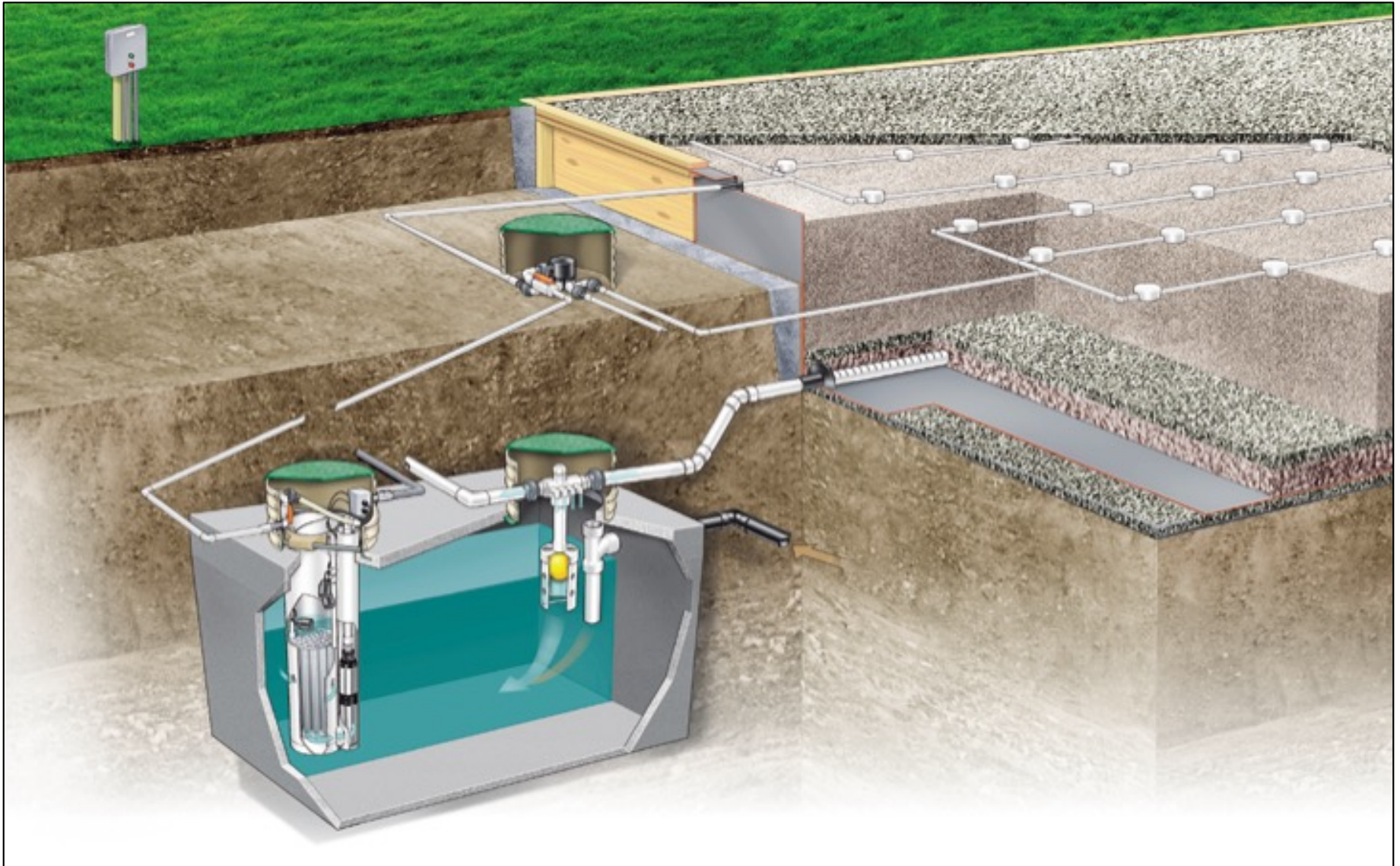
Recirculating Packed Bed Filter Process Description, cont.

- Media filters (RPBFs) ...
 - Secondary treatment units
 - Designed to follow primary treatment
 - Categorized as non-submerged, “fixed-film” treatment technology
 - Access to atmospheric oxygen

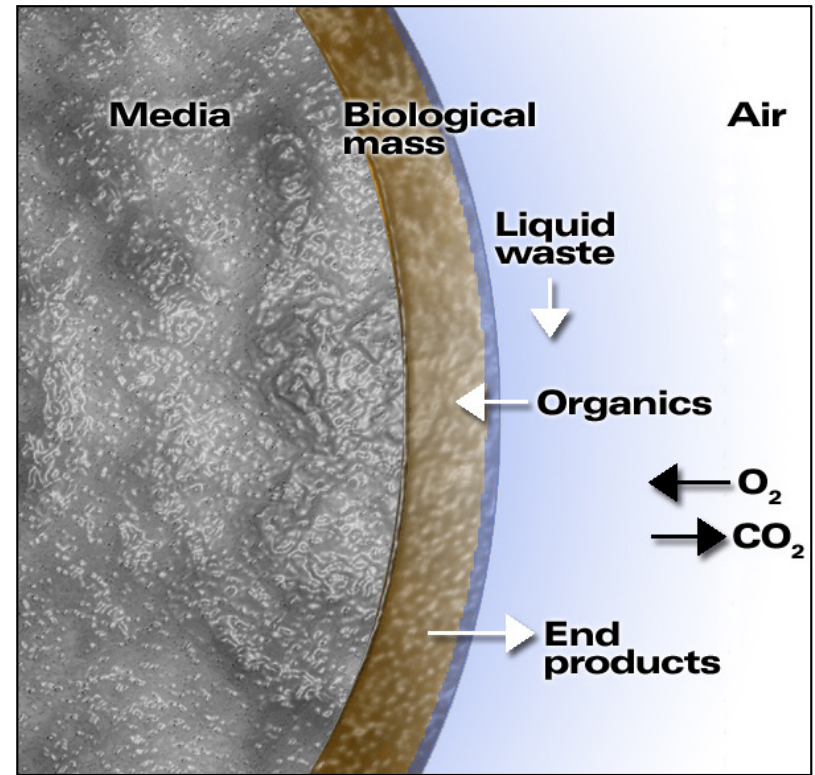
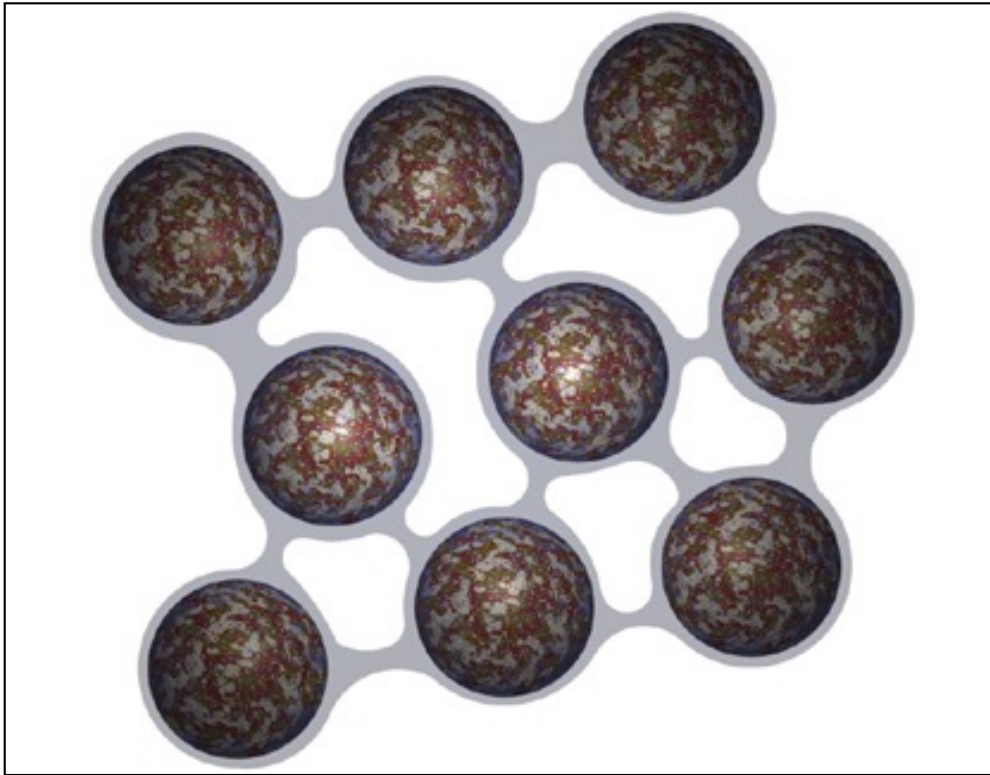
Primary Treatment

- Septic tanks/primary clarifiers/lagoons
- Sized to hold wastewater for extended periods of time
- >50% BOD₅
- Up to 70% TSS
- Fats/oils/grease (FOG) sequestering
- Mandatory

Typical PBF Recirculation Configuration

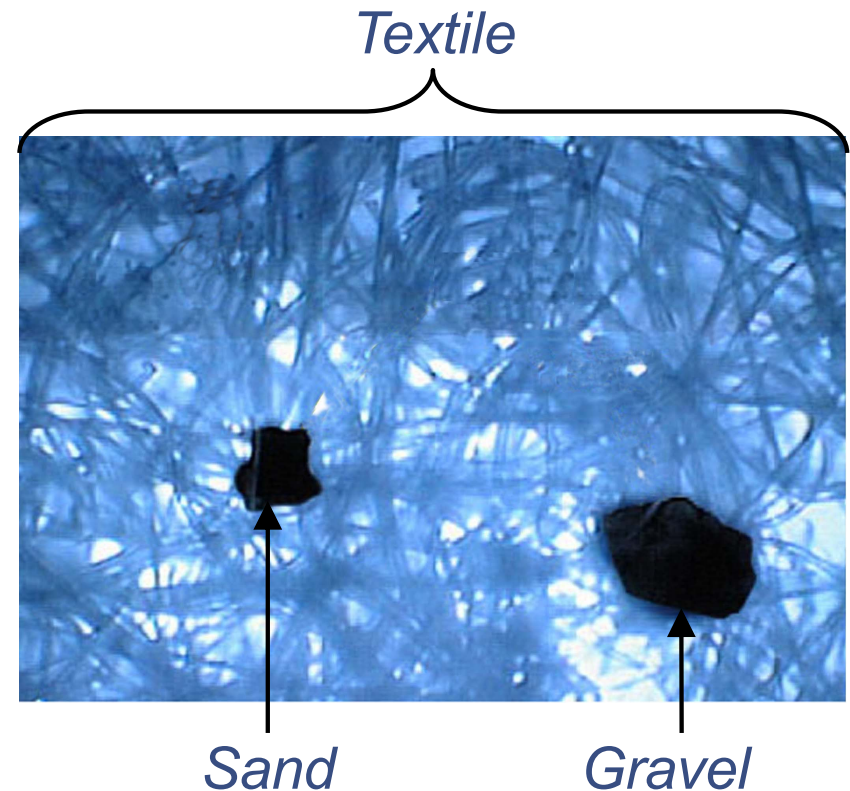


Fixed-Film Treatment



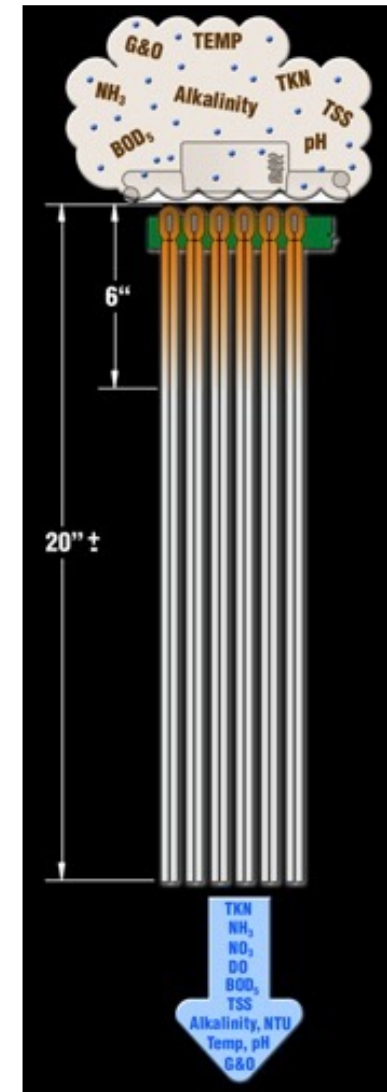
Textile Offers Greater Surface Area

- Textile is specifically engineered for WWT
- The more surface area, the more area for bacterial colonization
- The surface area is large enough that the microbial colonies do not grow in excess and slough



Packed-Bed Filter Biofilms

- Oxygen is diffused from the air that fills the unsaturated voids into the effluent and biofilms. (*Oxygen concentration in air ≈ 275 mg/L.*)
- After the carbonaceous demand is met in the upper levels of the media, inorganic constituents such as ammonia (NH_3) are reduced to nitrate (NO_3^-) by autotrophic bacteria in the lower region of the media.



Comparisons

- Variable flow, influent conditions
- Sludge/solids handling
- Operation and maintenance
- Power costs
- Advantages

Variable Conditions

- Flow
- Waste concentrations
- Phased growth
- Seasonal conditions

Operation and Maintenance

- Activated-sludge plants need almost constant operation.
 - Control food to microorganism ratio (sludge age)
 - Monitor settleability
 - Monitor flows
- RPBFs require very little operation.
 - Solids held in large septic tanks
 - Self-regulating bio-mat
 - High levels of dilution

Sludge Handling

- WAS
 - Testing determines when sludge should be wasted
 - Wasted sludge must be managed
 - Aerobic, anaerobic digestion
 - Drying beds, belt presses
 - Disposal
- RPBF systems only require septic tank, recirculation chamber pumping, 5-10 years



Power Consumption

- Activated sludge
 - Blowers
 - Compressors
 - Pumps
 - Rotary arms, etc.
- RPBFs
 - Pumps
 - Vent fan

Maryland Study

In 2009, President Obama issued an executive order to clean up the Chesapeake Bay.

Each state contributing (7 total) to the eutrophication of Chesapeake Bay, with the help of the EPA, put together Watershed Implementation Plans (WIPs).

Maryland, which collects a tax to publicly fund decentralized treatment systems, put together a testing program for various wastewater systems.

Maryland Study

Maryland's third-party "Best Available Technology" field-testing requirement for nitrogen:

<http://www.mde.state.md.us/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Documents/HB347%20ranking%20data%2001072015%20updating.pdf>

Matrix shows cost/pound of TN removed, electrical consumption, etc...

PBFs were consistently ranked as the most cost-effective technology.

Comparing Treatment Performance

Vendor In Ascending Order	Mean % Reduction TN (Using 60 mg/L Influent)	<i>Mean Effluent Concentration (Mg/L)</i>
AdvanTex AX20-RT	76%	14
AdvanTex AX20	71%	17
SeptiTech M40D	67%	20
Hoot BNR	64%	21
RetroFast	57%	25
Singular TNT	55%	27
Singular Green	55%	27

Comparing Treatment Performance

Vendor In Ascending Order	1 Year Electrical Consumption (represented as KWh/ year)	<i>Increased Electrical Costs Per Year Assuming \$0.11 Per kWh</i>
AdvanTex AX20	335.8	\$36.94
AdvanTex AX20-RT	335.8	\$36.94
Hoot BNR	765.77	\$84.23
Singular TNT	979.66	\$107.76
Singular Green	979.66	\$107.76
SeptiTech M40D	1934.50	\$212.80
RetroFast	2584	\$284.24

Advantages of Each Technology

- RPBF Pros

- Consistent high-quality treatment
- Limited operator involvement
- Low power costs
- Able to handle seasonal or increasing flows
- Excels in lower flow application
- Comparatively easy expansion
- BOD₅ and ammonia reduction
- Works exceptionally well with effluent sewers

- Activated Sludge Pros

- Quality treatment with good operator
- Relatively compact footprint
- High flow capacity
- Operational options

Technology Comparison Conclusion

- Recirculating Packed Bed Filters
 - Prime option for decentralized treatment
 - For applications where operational and power costs need to be low
 - Provides consistent treatment even when flow rates and influent waste strengths are not
 - Consistent operation not necessary
- Activated Sludge
 - For large scale system or municipalities
 - With competent operation, can achieve high-level treatment for multiple conditions

Summary

- Understand the requirements of the system for the waste stream
- Understand the requirements of the end user for the system chosen
- Consider life cycle costs

Solutions for Decentralized Wastewater Treatment

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