

2026 ONSITE WASTEWATER MEGA CONFERENCE
Westminster, Colorado

Septic Tanks – Bigger is Better

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The materials being presented do NOT reflect the opinions of NOWRA

Treatment overview

Physical
Biological
Chemical



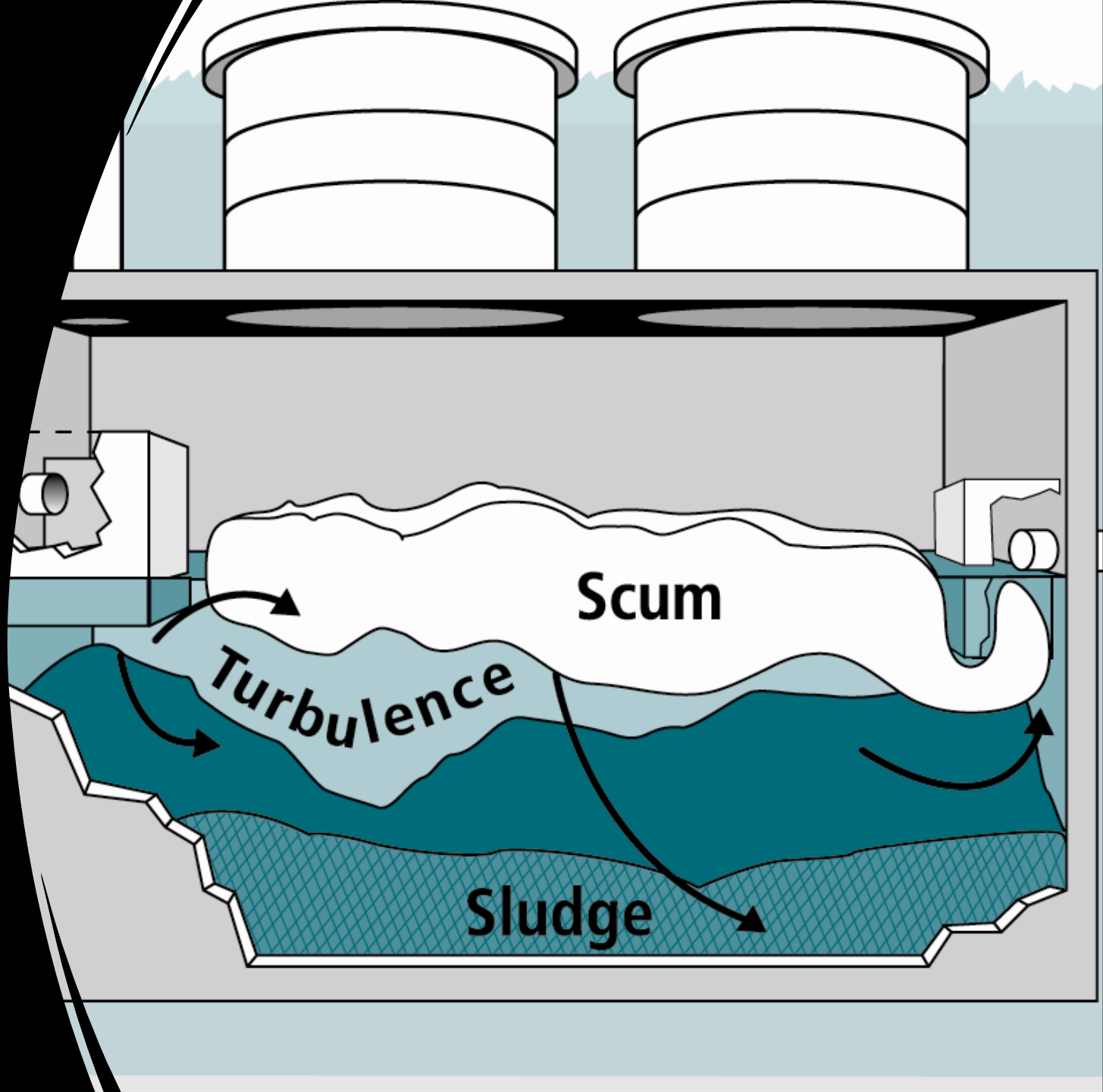
The physical processes

- Flow attenuator
- Temperature cooling
- Settler



Flow attenuation

- If higher velocities come into the septic tank they are somewhat dampened by the septic tank
- There is still the risk that high velocities can disrupt settling
- To truly spread out peaks flow equalization is needed



Temperature cooling

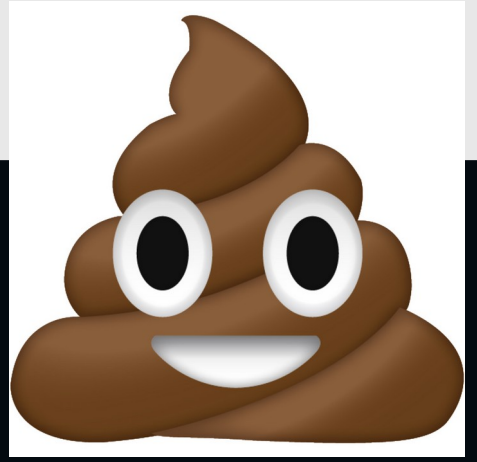
- Positive for grease traps designed to allow the fat, oil and grease (FOG) that would be in a solid at room temperature to solidify in the scum layer
- Negative as soil temperatures (particularly in cold climates) are below optimum for bacteria



Solids removal

- Primary sources are the toilet and kitchen sink
- Large variety of garbage
  - Should not be disposed of, but it has to be accounted for

Fecal matter



Residual foodstuff



Fat, oil and grease

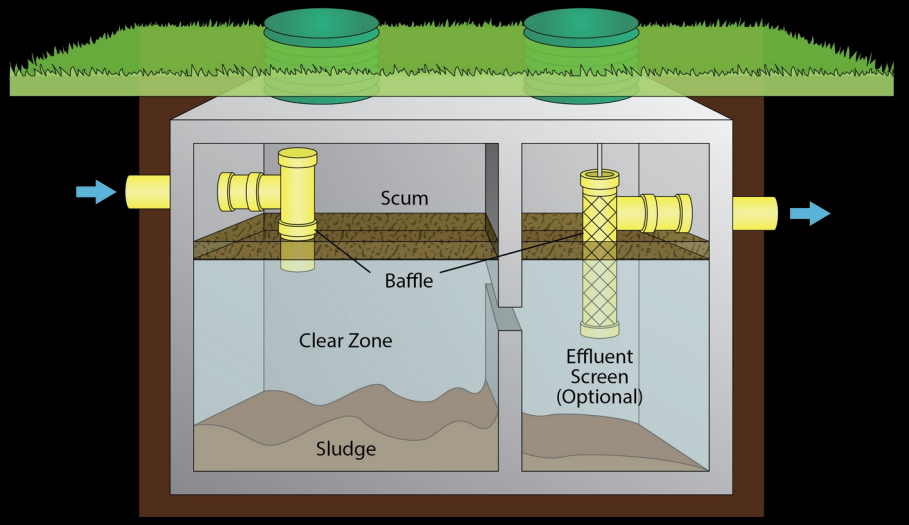


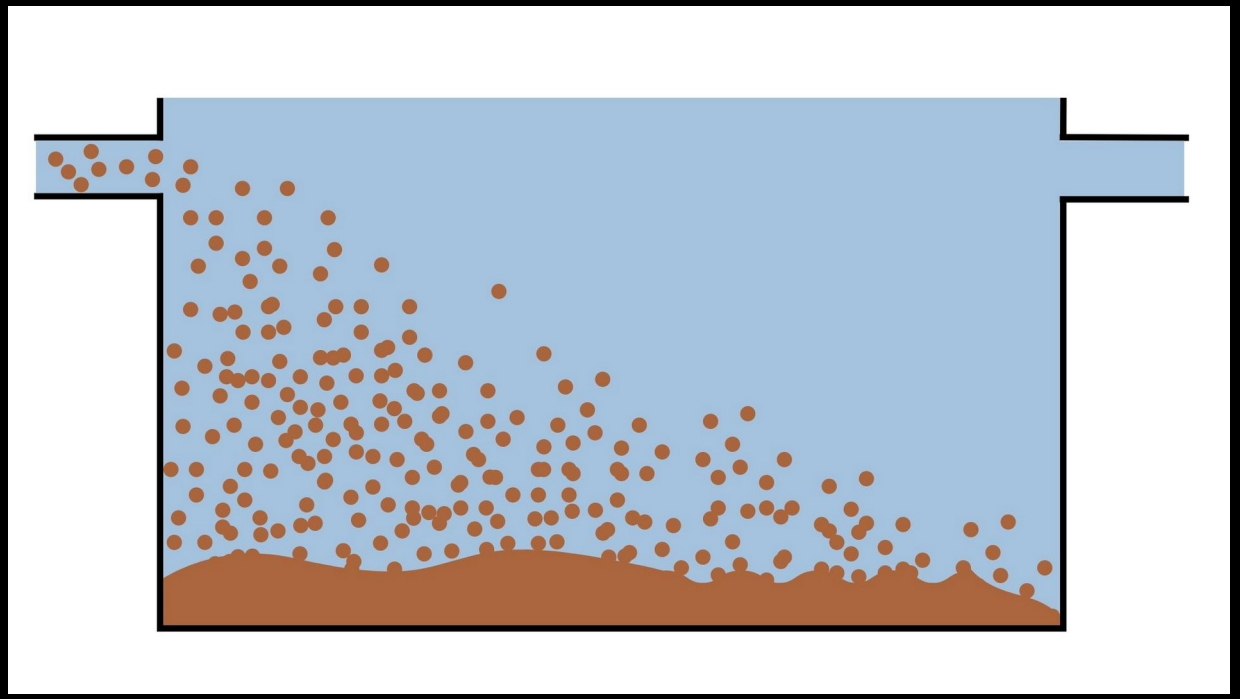
Garbage



Settling - Stoke's law

- Particle velocity up or down depends on Stoke's Law
- Dependent upon density of particle, density of wastewater and the size of the particle





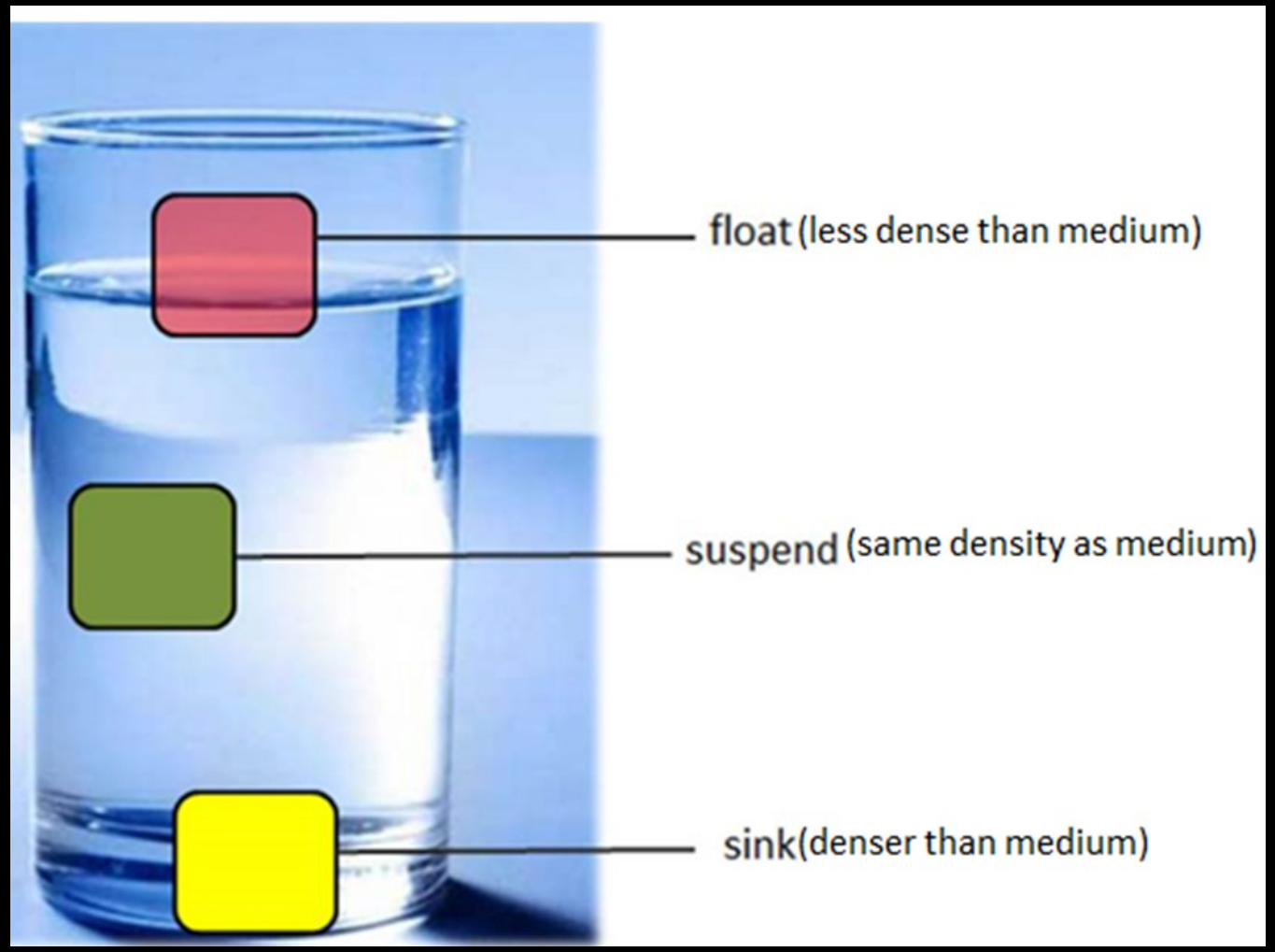
Particle/globule size

- Particle size influences settling
- Smaller particles less likely to settle/float
- Emulsified? mechanically or chemically
- FOG - temperature

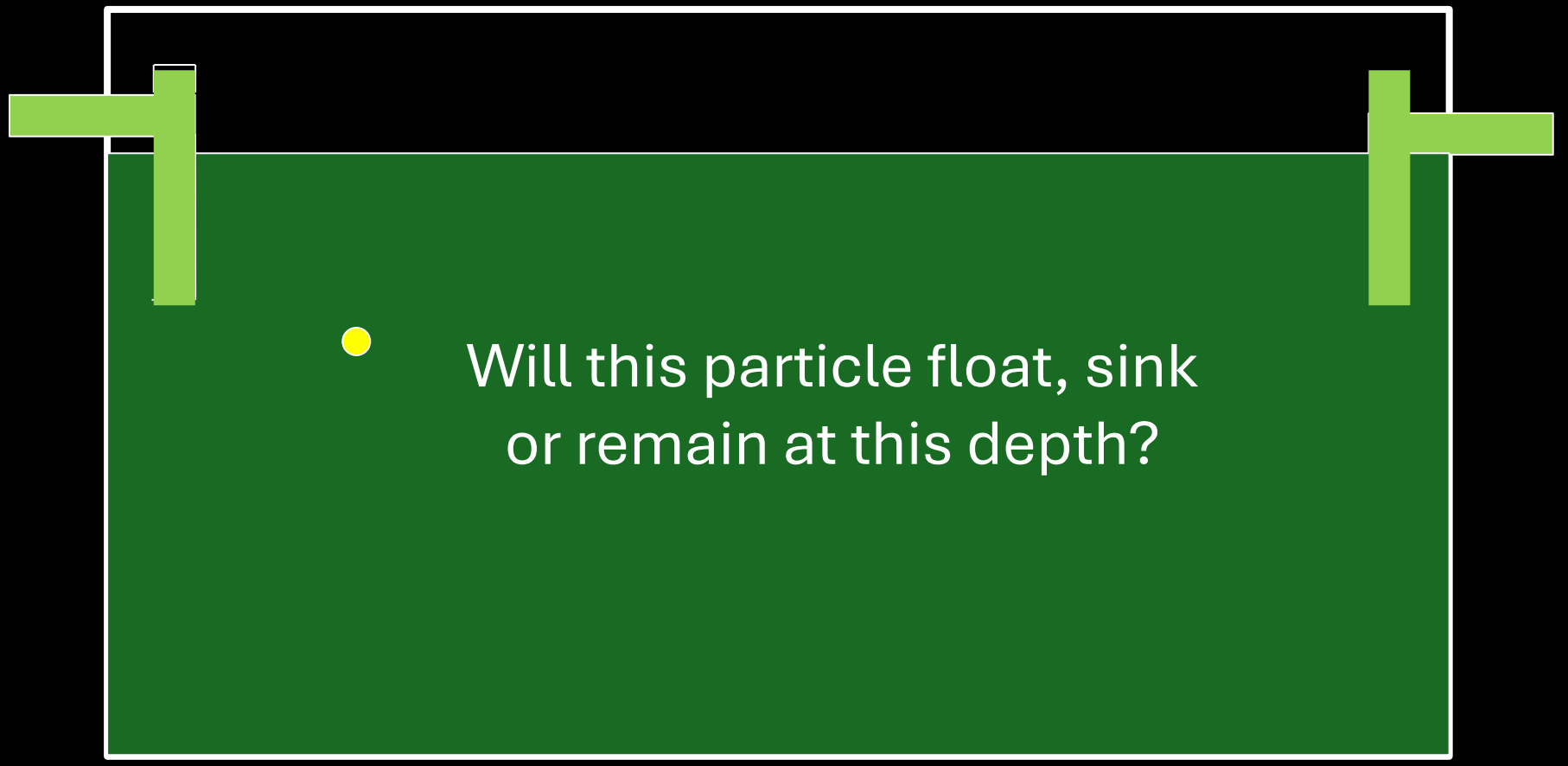


Solids separation

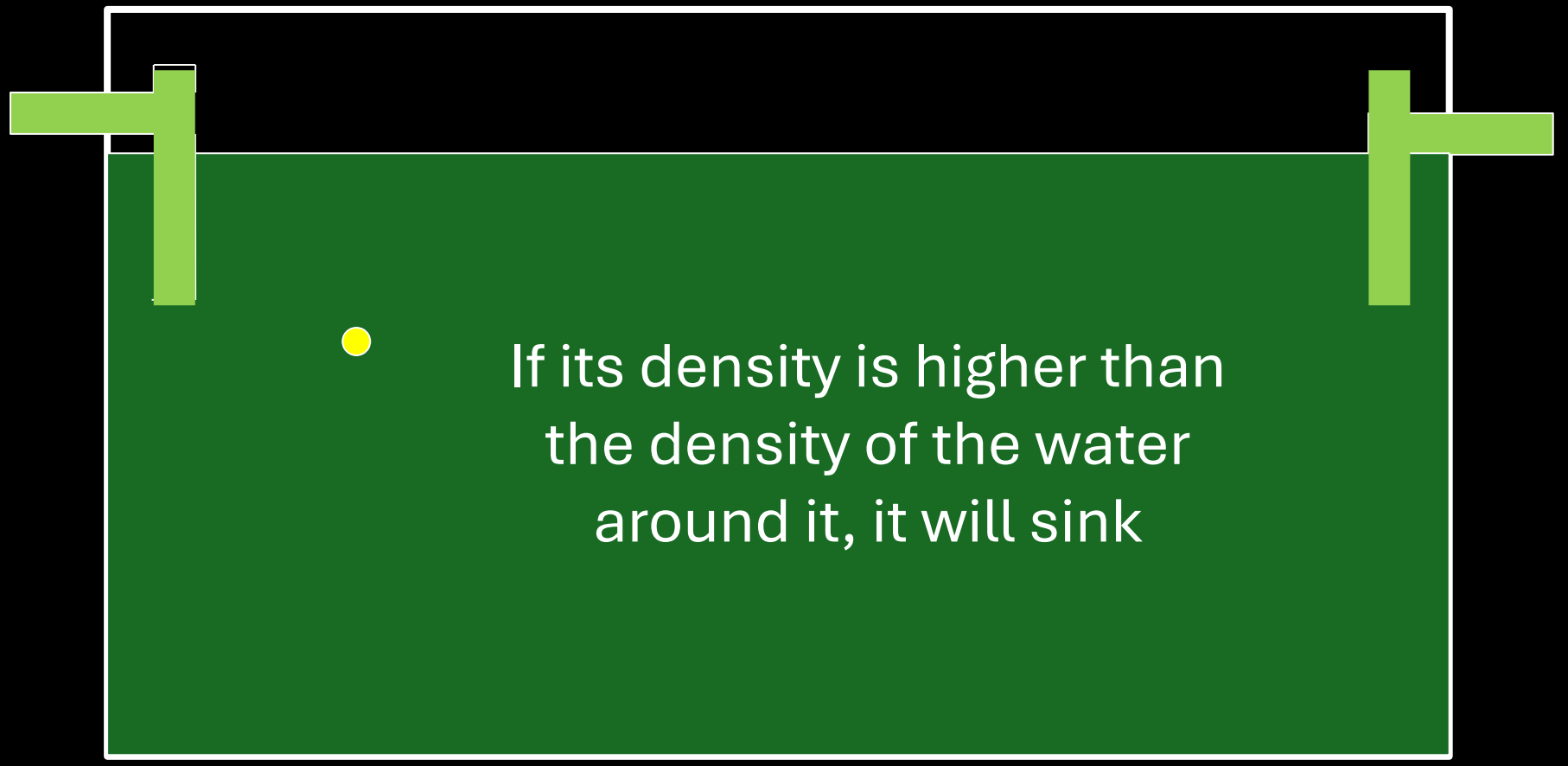
- In the septic tank separation is based on density relative to water
  - Density greater than water
    - Sinks and becomes sludge
  - Density less than water
    - Floats and becomes scum
  - Density the same as water
    - Remains suspended solids



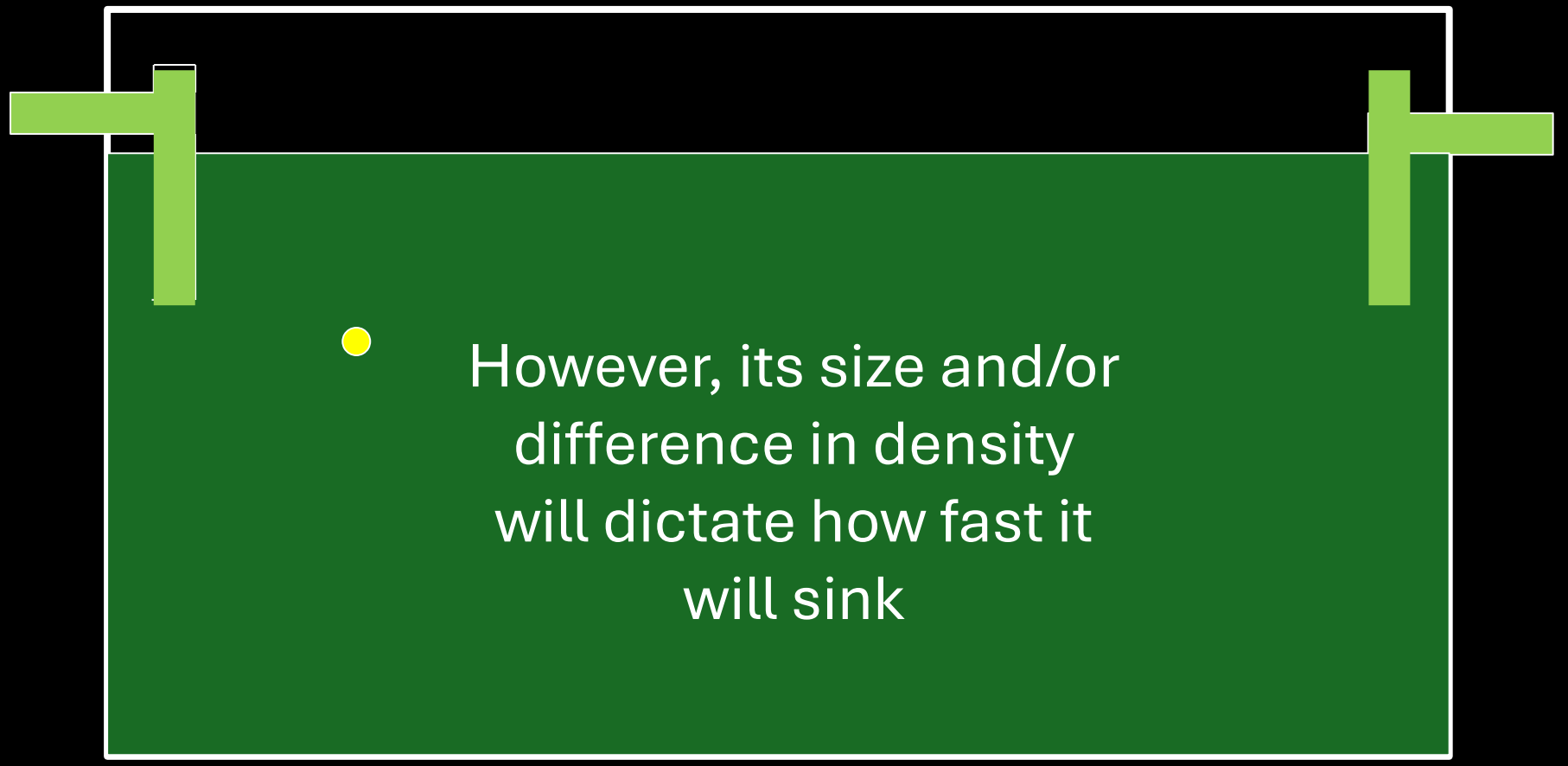
Stoke’s law



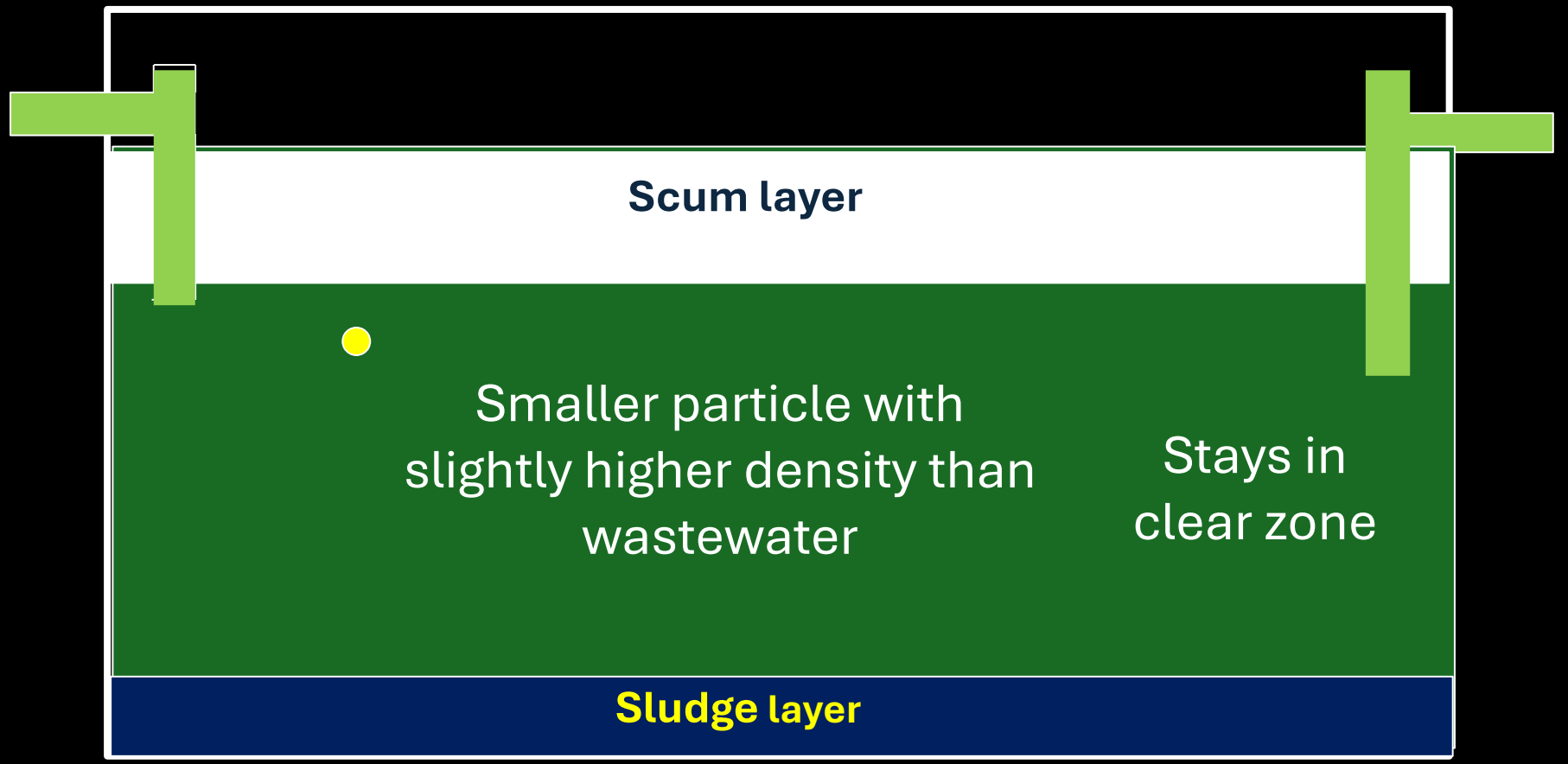
Stoke’s law


If its density is higher than
the density of the water
around it, it will sink

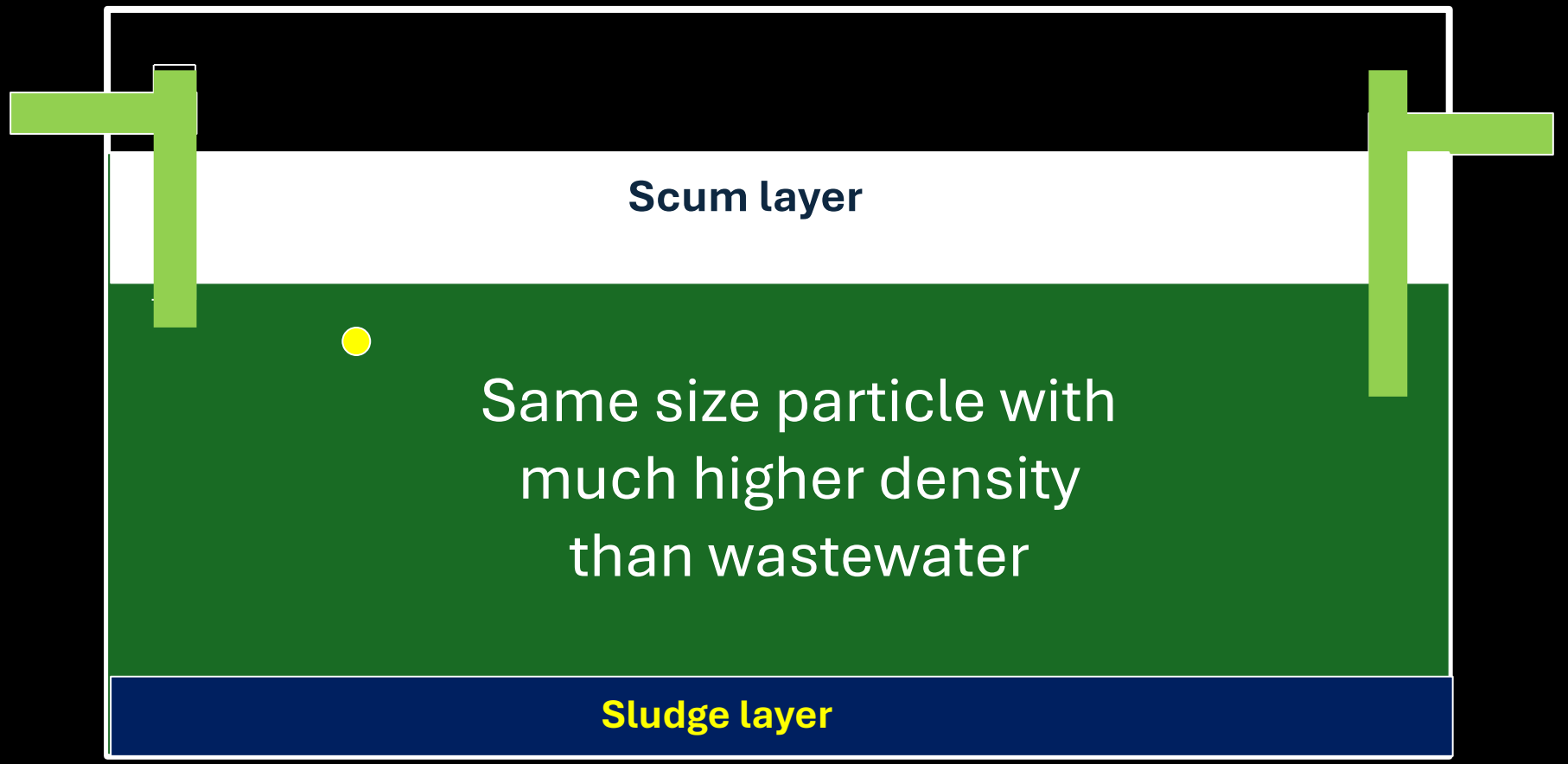
Stoke’s law


However, its size and/or
difference in density
will dictate how fast it
will sink

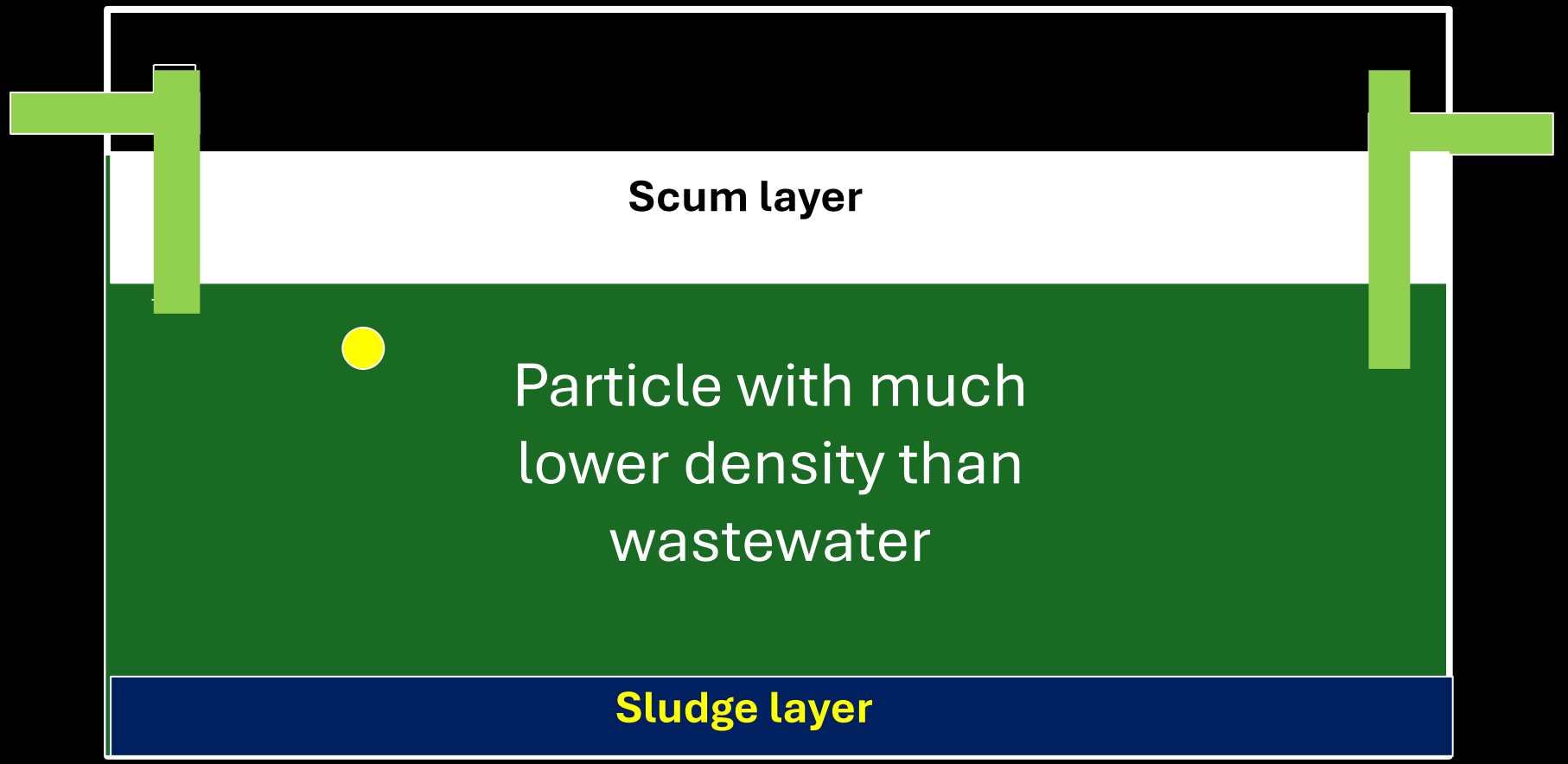
Stoke’s law


Scum layer
Smaller particle with slightly higher density than wastewater
Stays in clear zone
Sludge layer

Stoke’s law

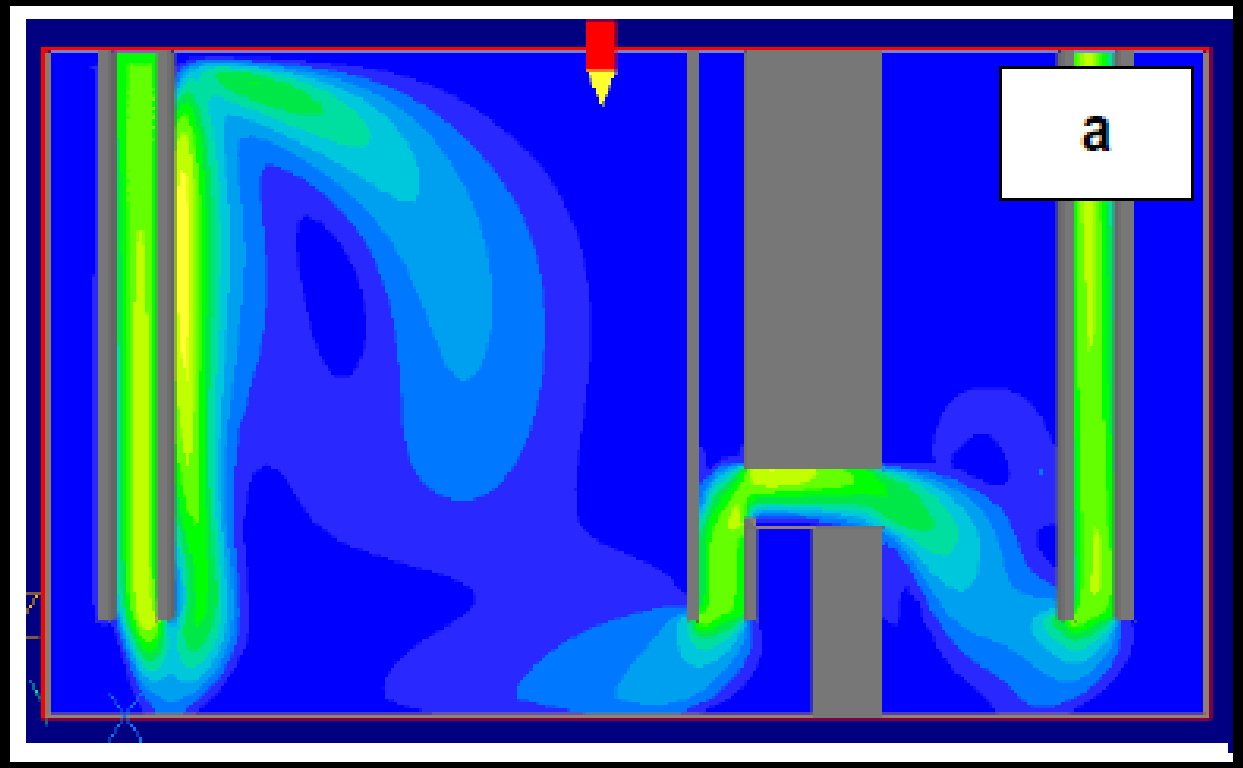

Scum layer
Same size particle with
much higher density
than wastewater
Sludge layer

Stoke’s law

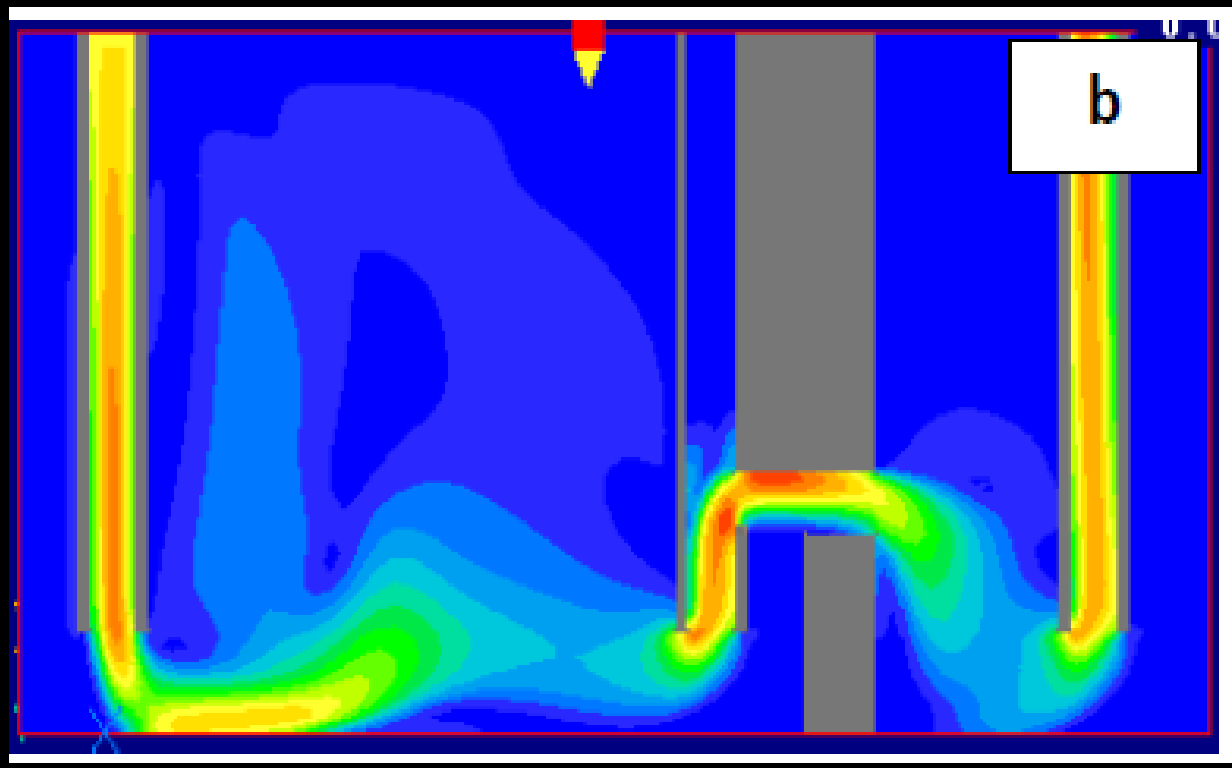

Scum layer
Particle with much lower density than wastewater
Sludge layer

Will it rise or not?

Grease globules - size has an effect



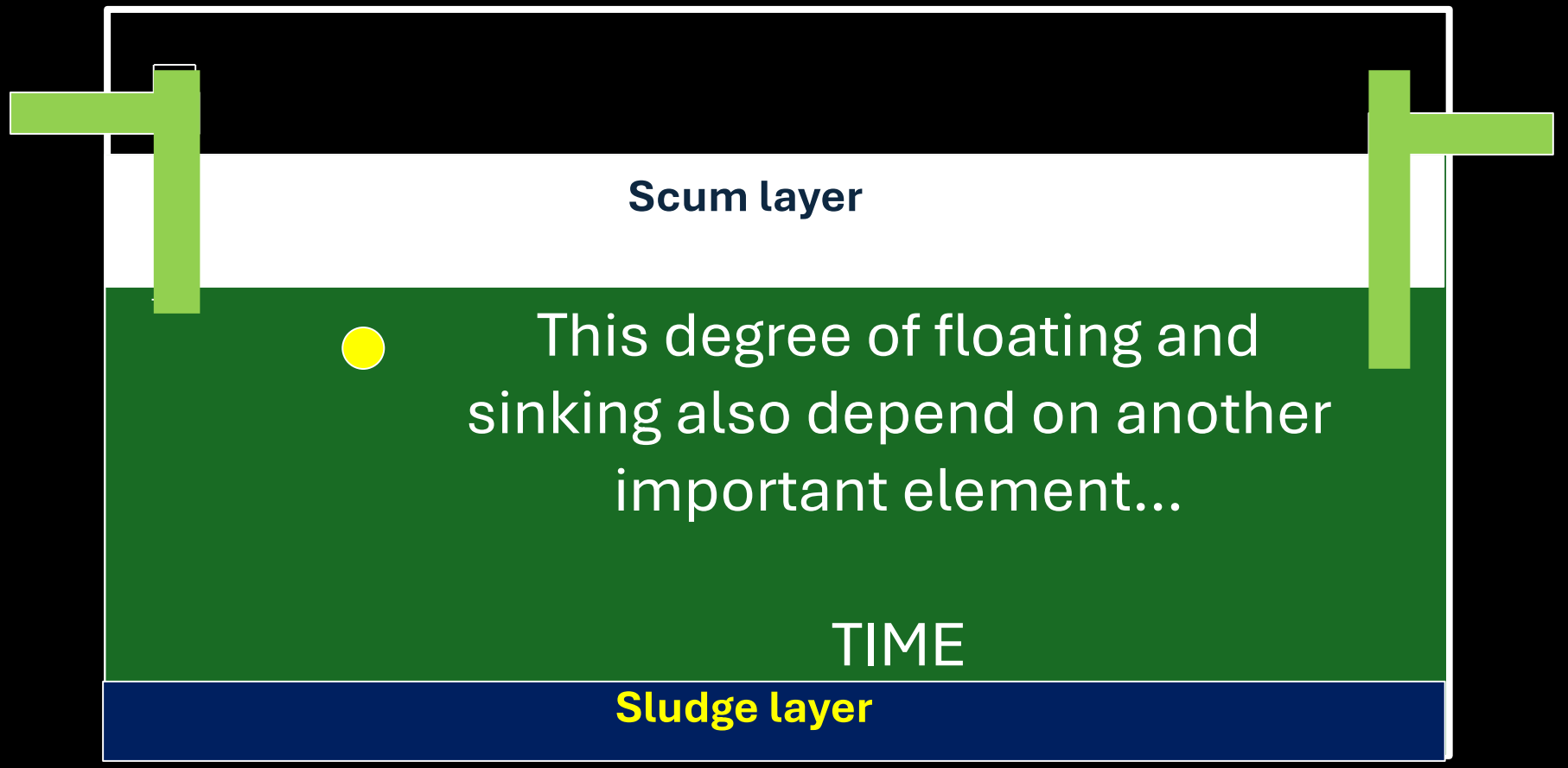
150 microns



80 microns

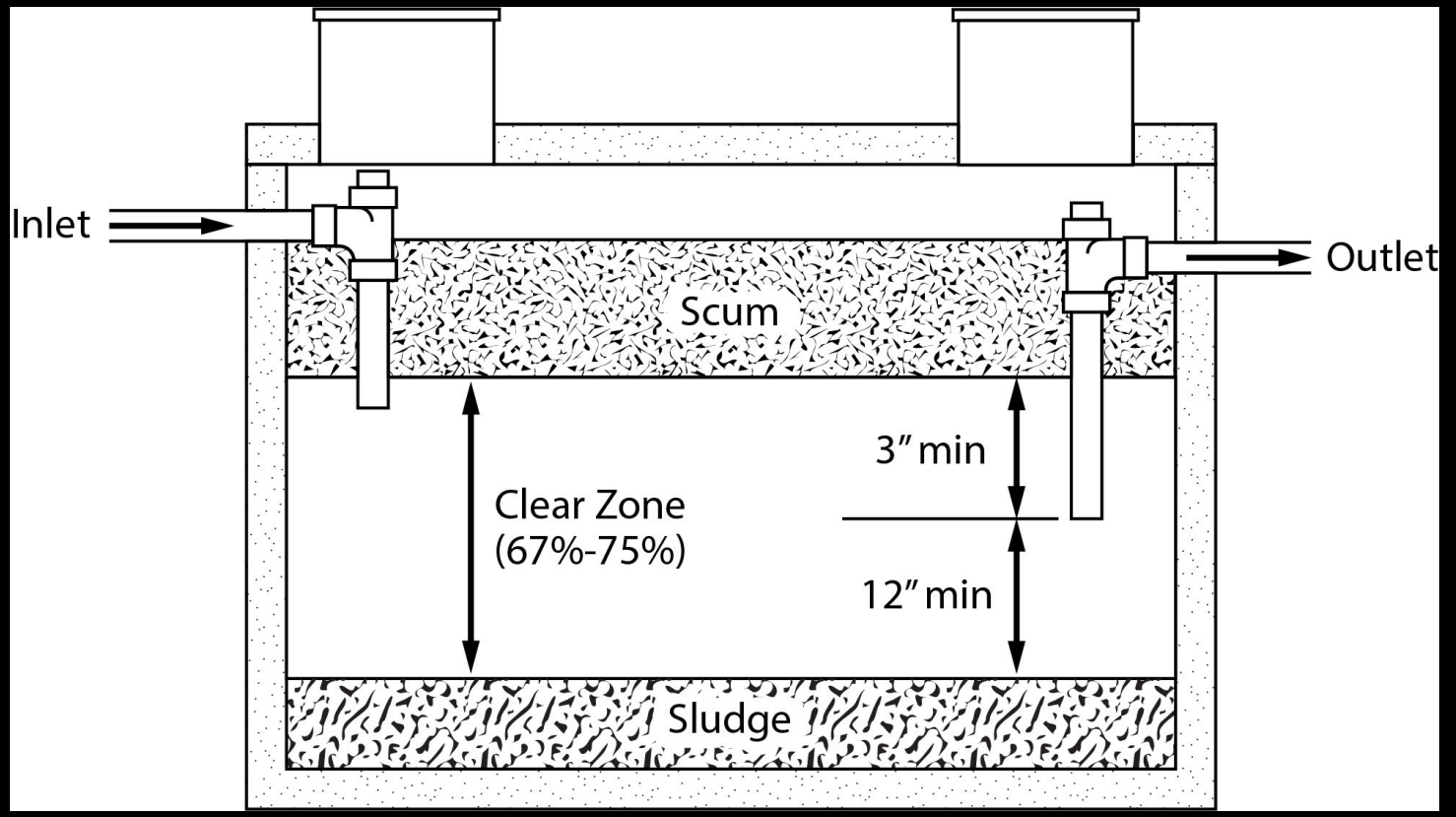
WERF FOG Interceptor Design and Operation Guidance Manual

Stoke’s law


Scum layer
This degree of floating and sinking also depend on another important element…
TIME
Sludge layer

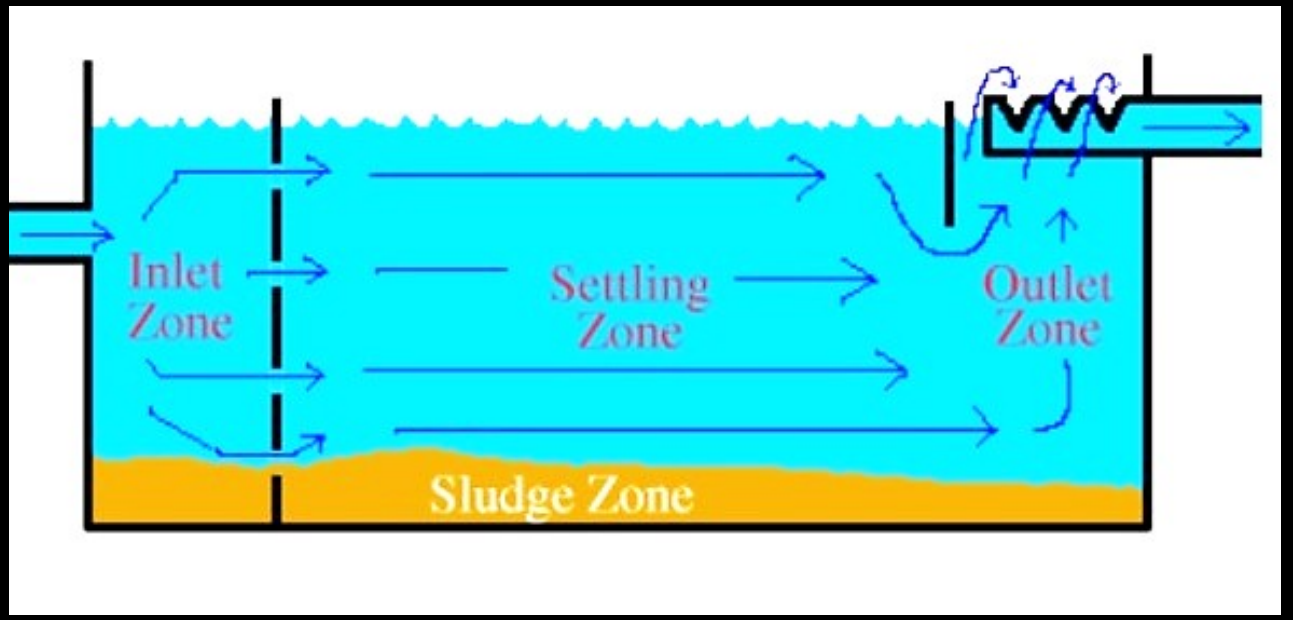
Retention time

- Time it takes for wastewater to get from inlet to outlet
- Shorter retention times mean less time for separation and organic consumption
- Retention time depend primarily on
  - Flow rate
  - Size of tank
  - Design of tank
  - Sludge/scum in tank

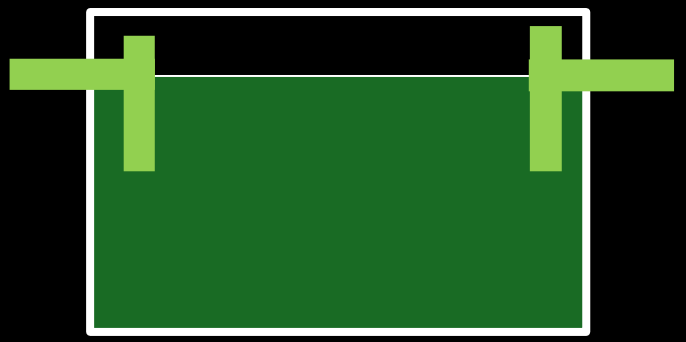


Maximizing retention time

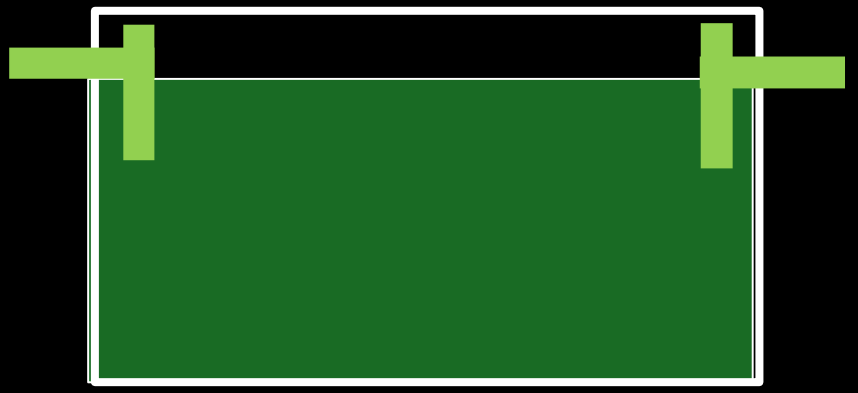
- Slow velocity
- Avoid turbulence, eddies, spikes in velocity
- Use as much of the tank as possible



Retention time – Peak flows

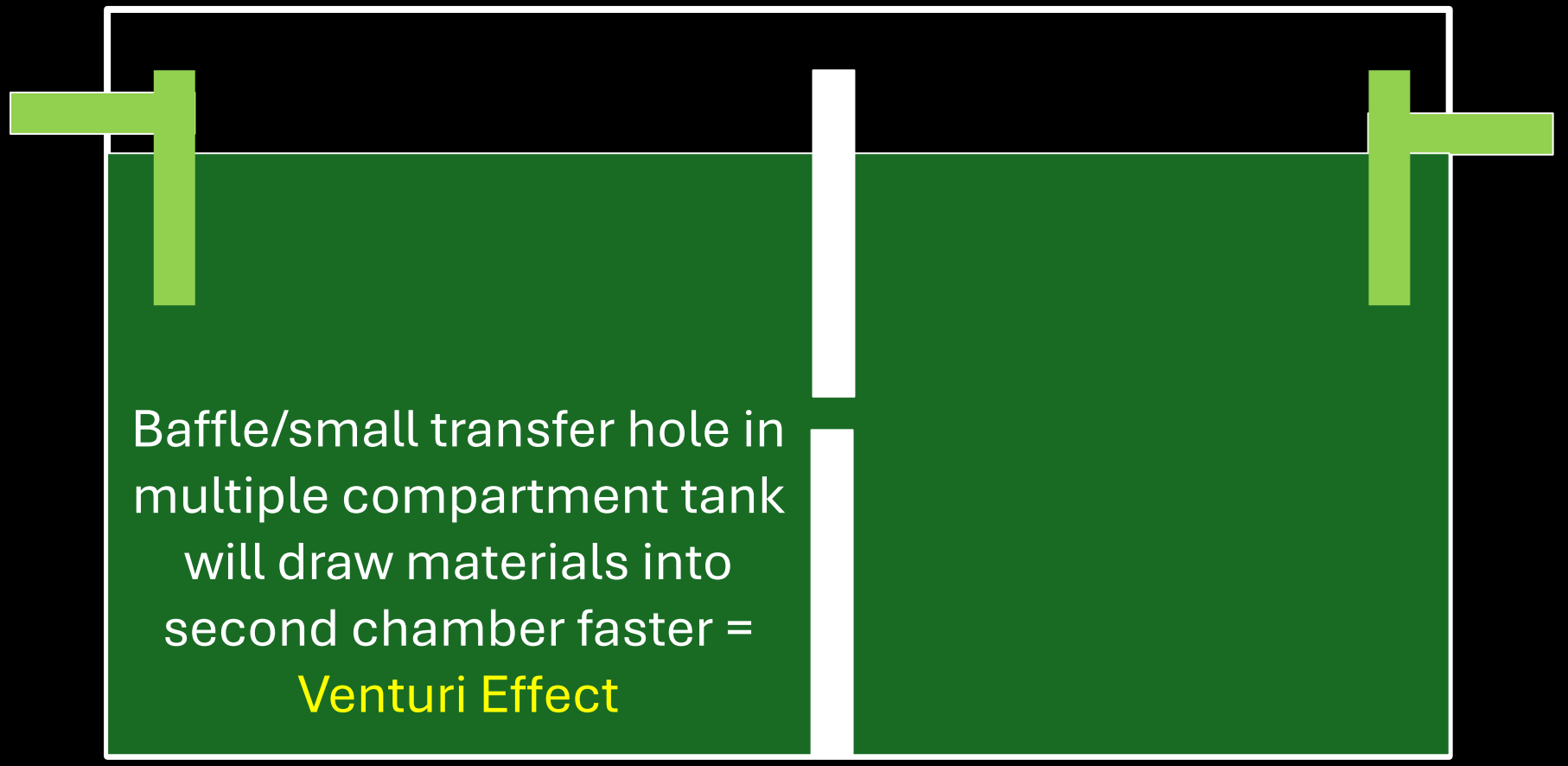


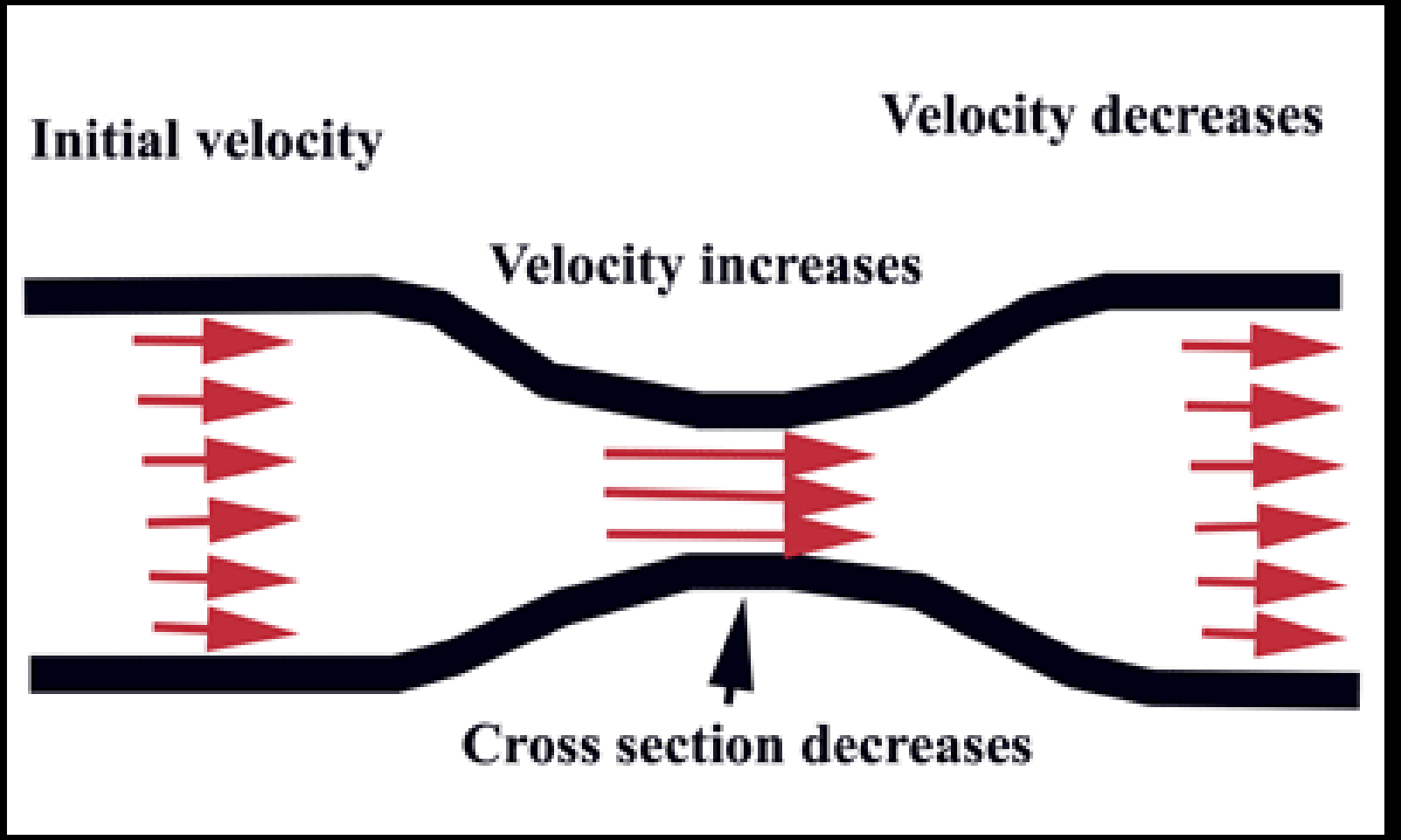
Peak Flow: 5 gal/min
Tank Size: 500 gallons
Retention Time: 100 min



Peak Flow: 5 gal/min
Tank Size: 1000 gallons
Retention Time: 200 min

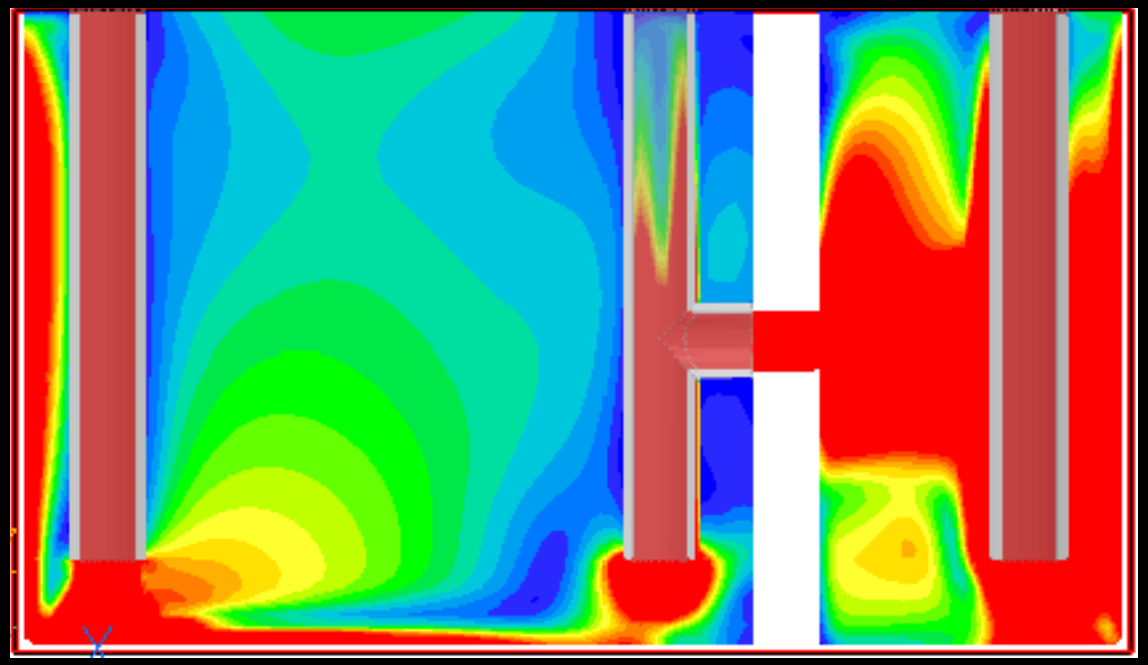
Velocity impacts - Compartments



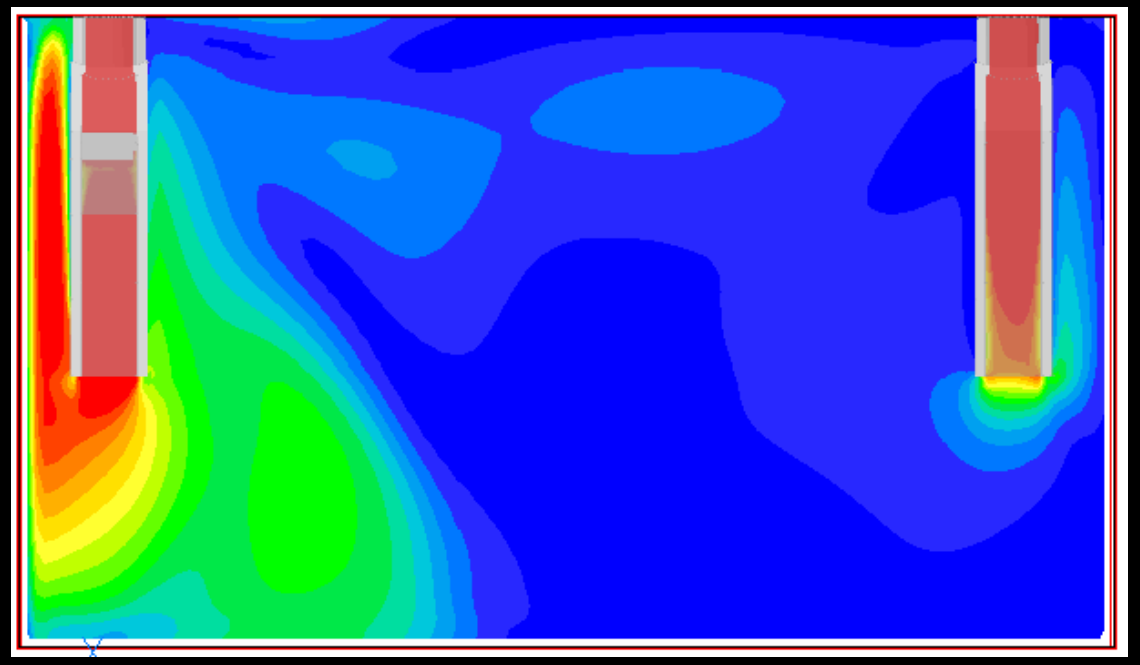


Venturi effect

Baffle or no baffle?



2 compartment - baffle transfer port



1 compartment - same size

Compartmentation research

Comparison of Effluent from Single and Compartmented Septic Tanks

National Sanitation Foundation Study (Seabloom et al., 1982)

Characteristic		Single Chamber Influent	Single Chamber Effluent	Single Chamber Percent Removal	Double Chamber Influent	Double Chamber Effluent	Double Chamber Percent Removal
BOD	mg/L	184	85	54%	184	99	46%
Suspended Solids	mg/L	234	44	81%	234	123	48%
Settleable Solids	mL/L	16.9	0.2	98.8%	16.9	0.6	96.6%

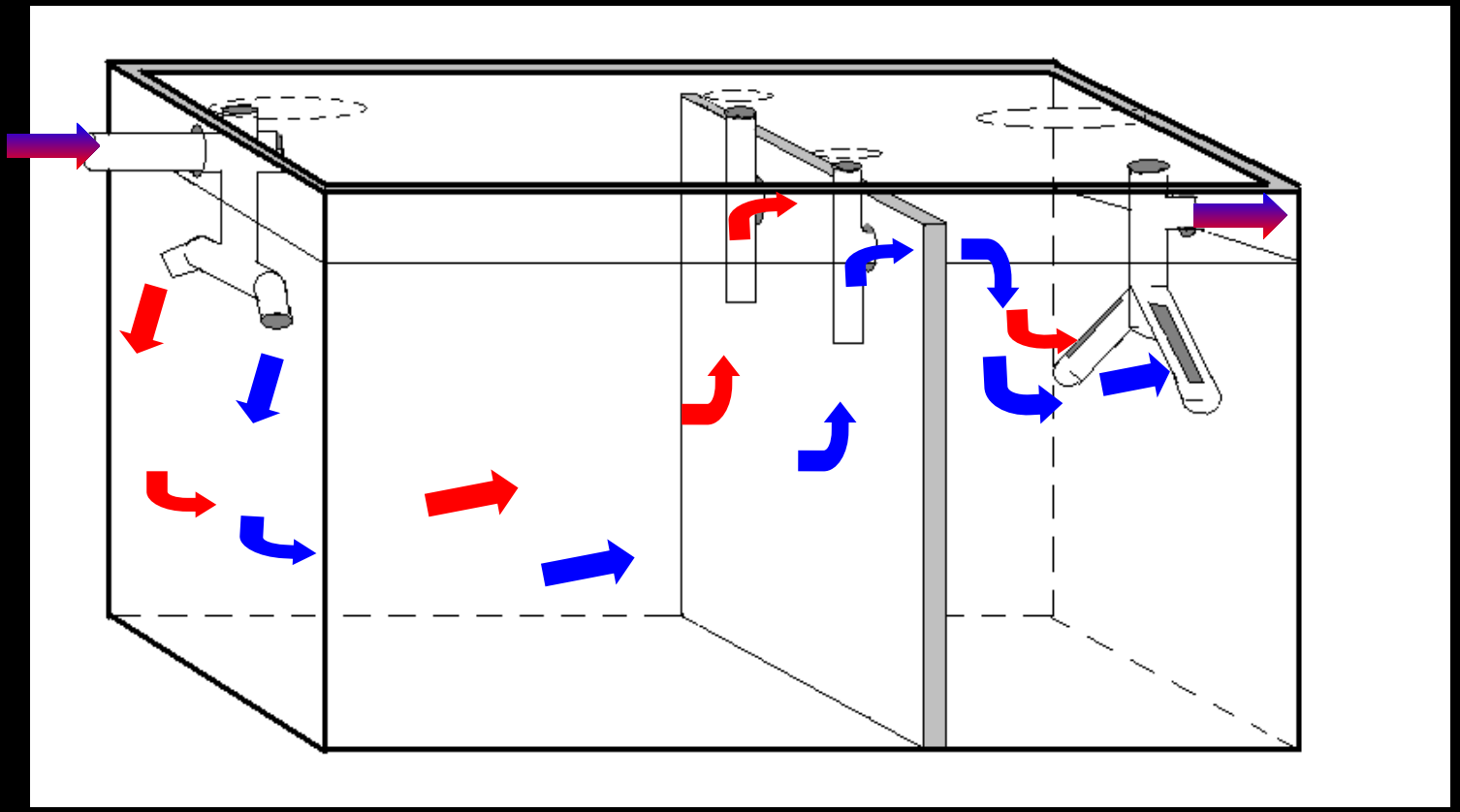
University of Maine Study (Boyer and Rock, 1992)

BOD	mg/L	288	195	32.3%	267	184	31.1%
Suspended Solids	mg/L	310	64	79.5%	306	57	81.5%
Settleable Solids	mL/L*	--	--	--	--	--	--

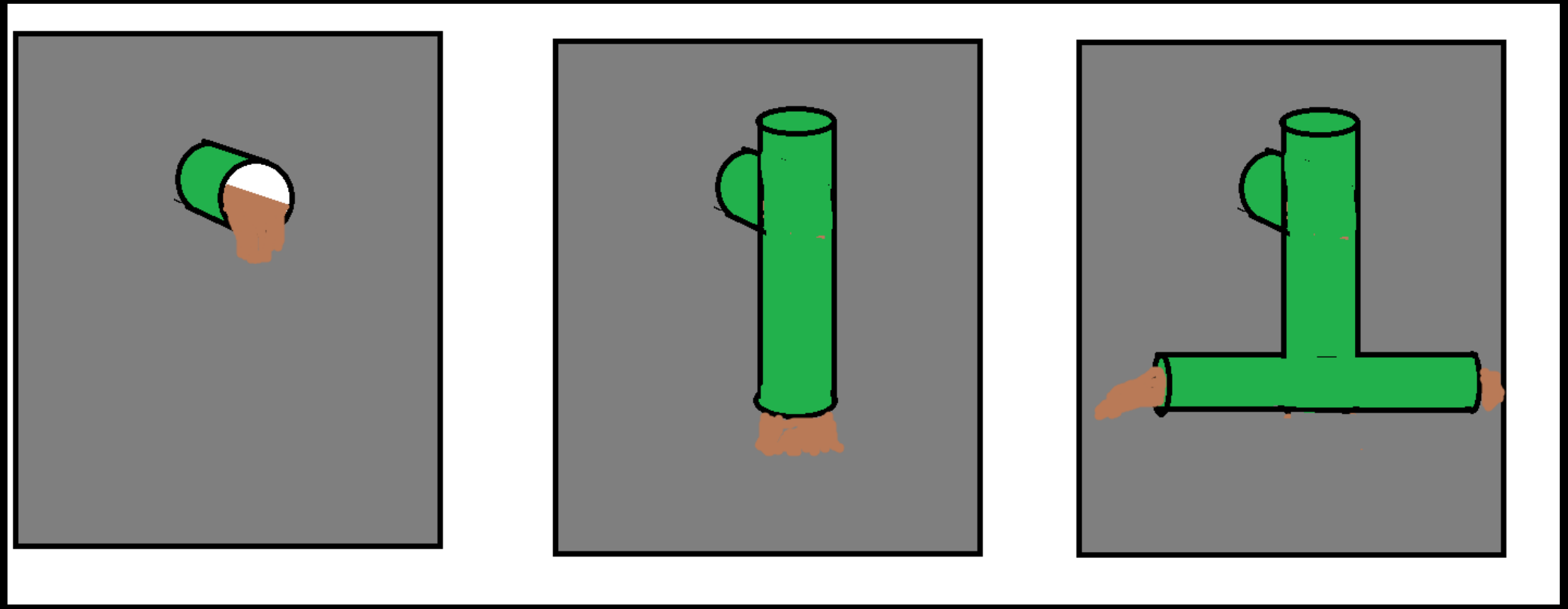
*Not available. Effluent values represent values from tanks without screens or effluent filters.

Compartments

- Comparts to increase treatment only works when the transfer holes are larger, so they don’t short circuit the system
- Using multiple holes or slots can help
- Distributive inlet to use the entire tank area instead of just the middle could help too

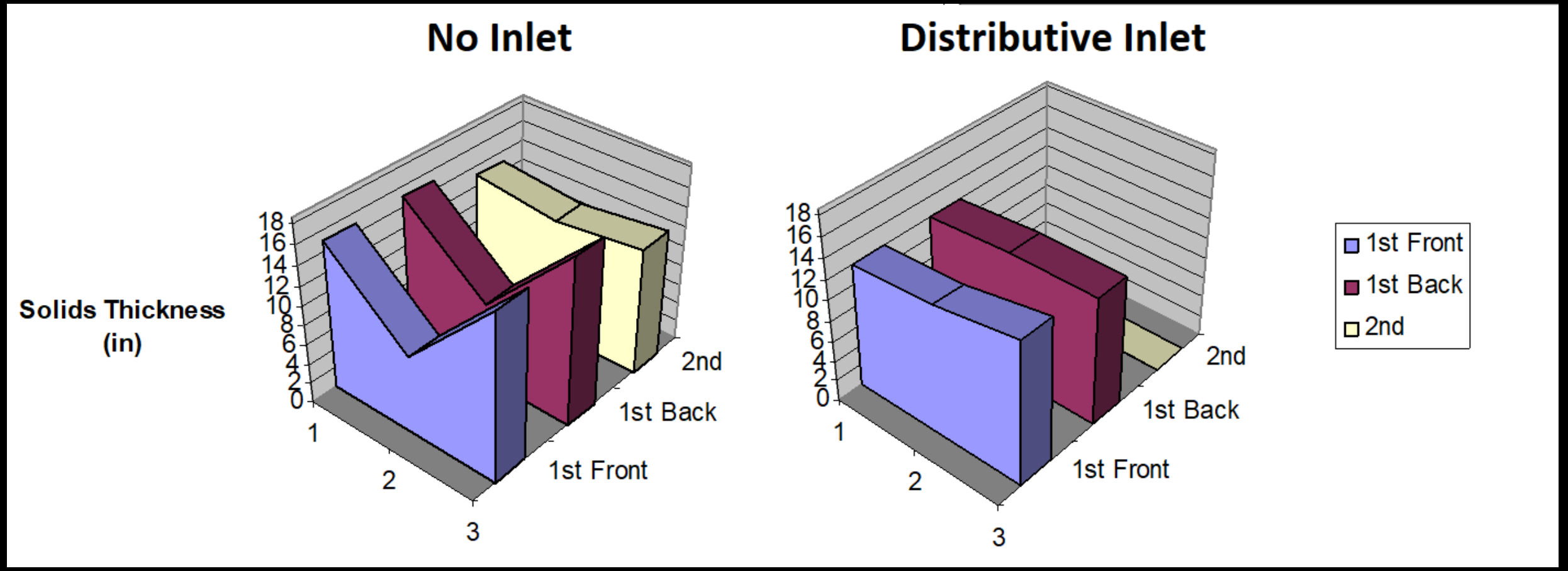


Distributing the flow



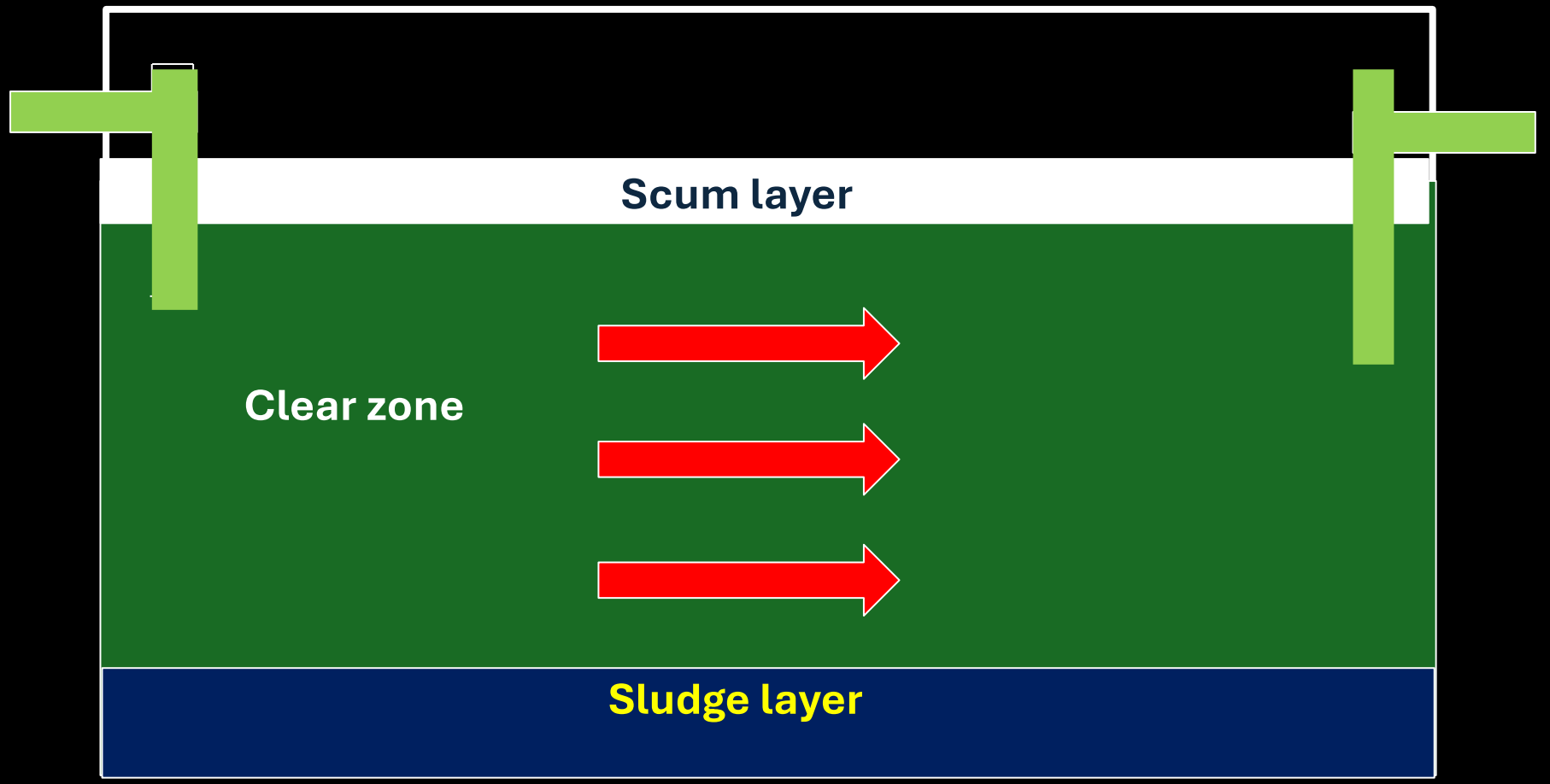
No Inlet **Standard Inlet** **Distributive Inlet**

Distributing the flow



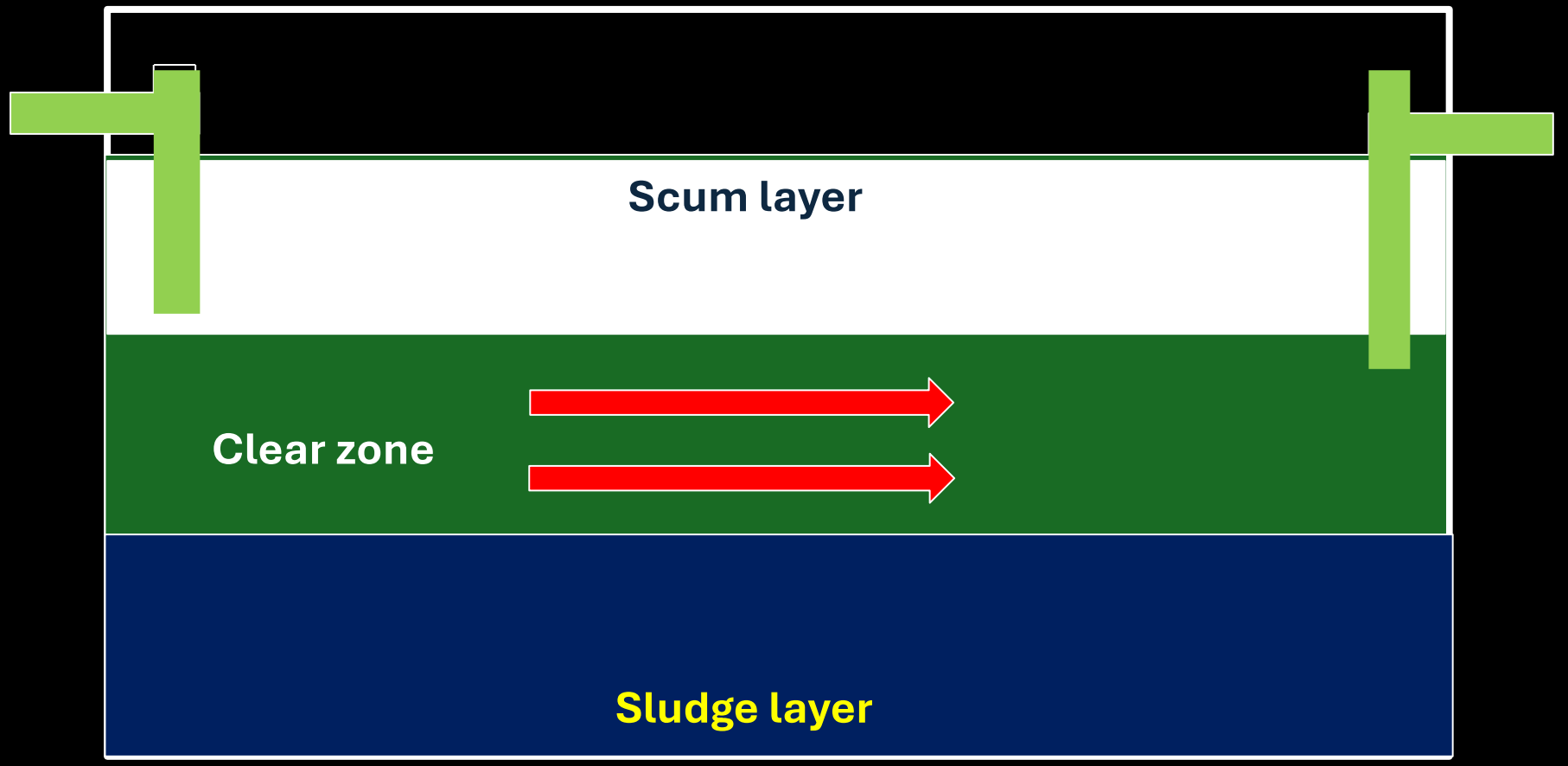
WERF FOG Interceptor Design and Operation Guidance Manual

Retention time – clear zone impacts



Large clear zone, less velocity, more retention time, distance for settling

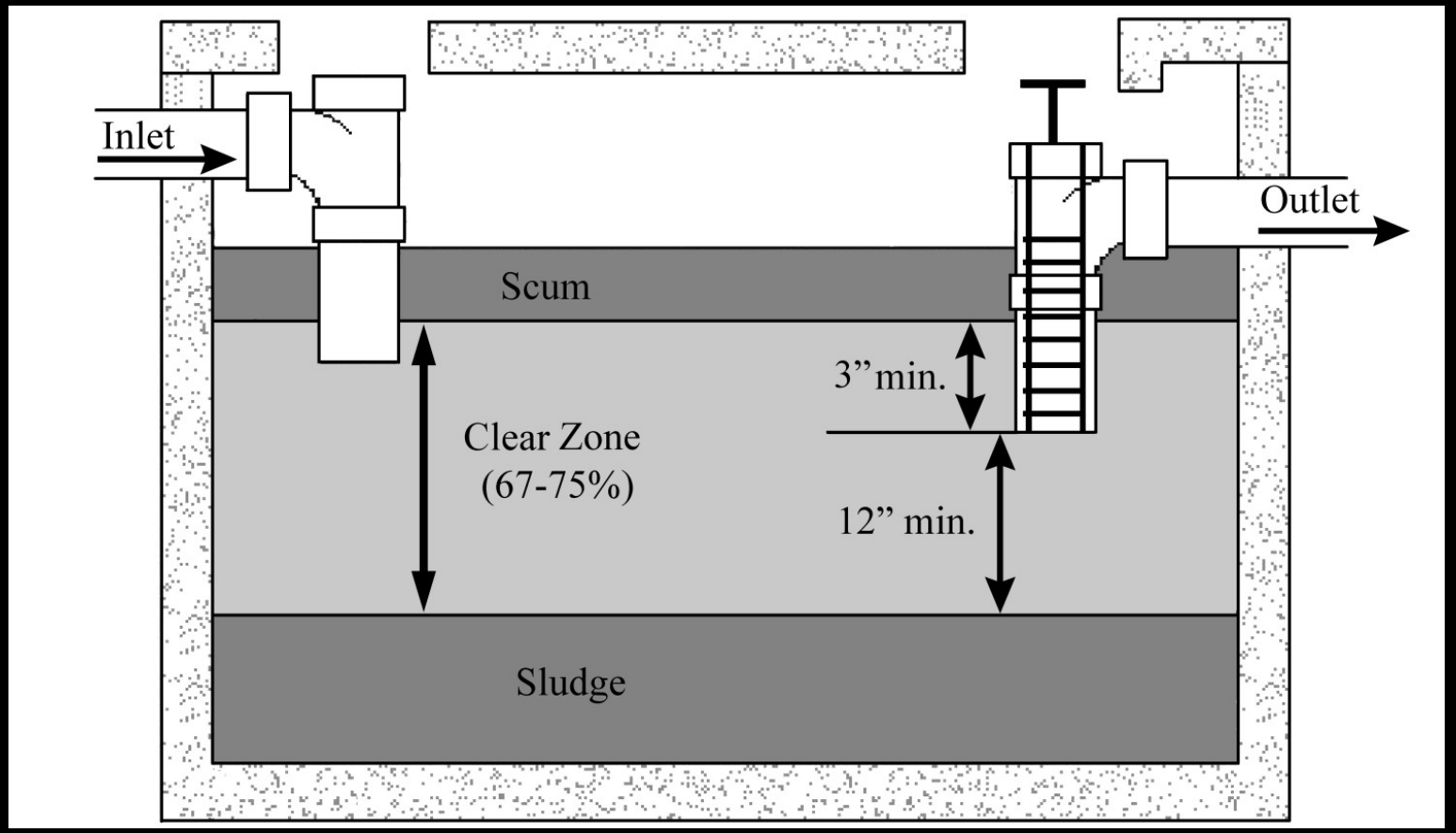
Retention time – clear zone impacts



Reduced clear zone, higher velocity, less retention time, less distance for settling

Inlet and Outlet Baffles

- Baffles help to keep the layers separated
  - Allows the clarified wastewater to move to the soil treatment area
  - Prevents scum from exiting
- Wastewater entering the tank ***displaces*** an equal volume out of the tank



Maintenance:

When to pump?

Sludge + Scum makes up 25-33% of the working volume



Effluent screens/filters

- Effluent screens are designed to capture solids that may still be suspended in the effluent as it exits the tank
- Assist with solids retention during peak flow events
- Little data exists comparing septic tanks with and without screens – more research is needed

The biological process

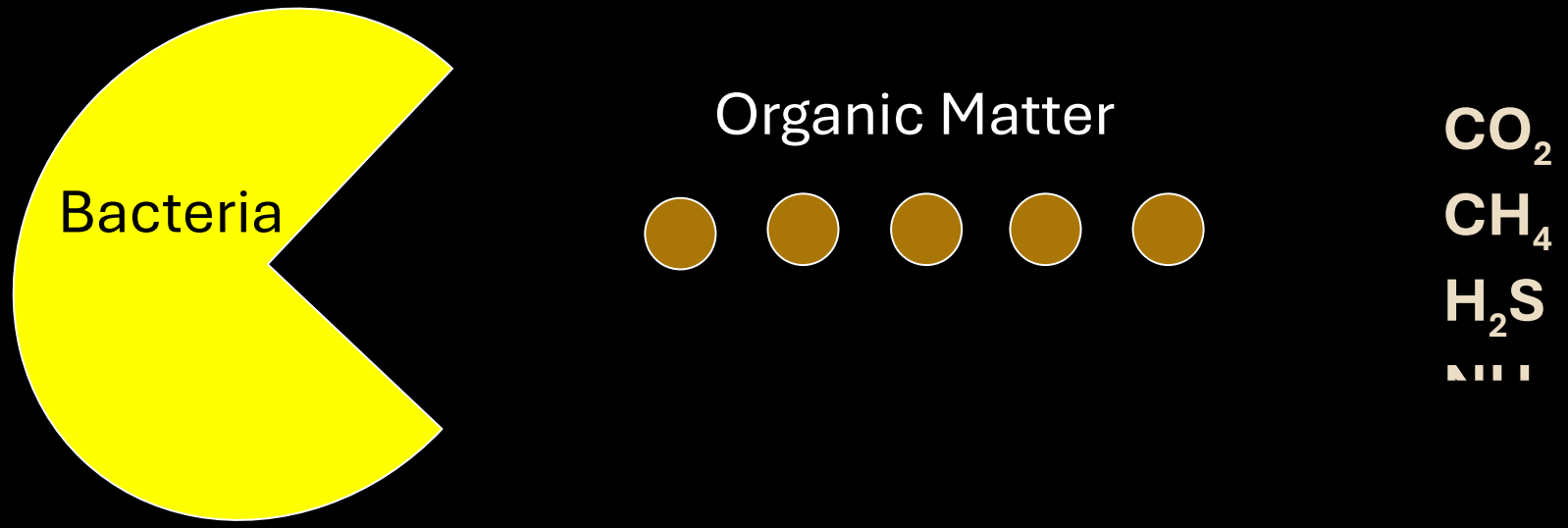
This is where bacteria comes in...

Important in breaking down biodegradable material



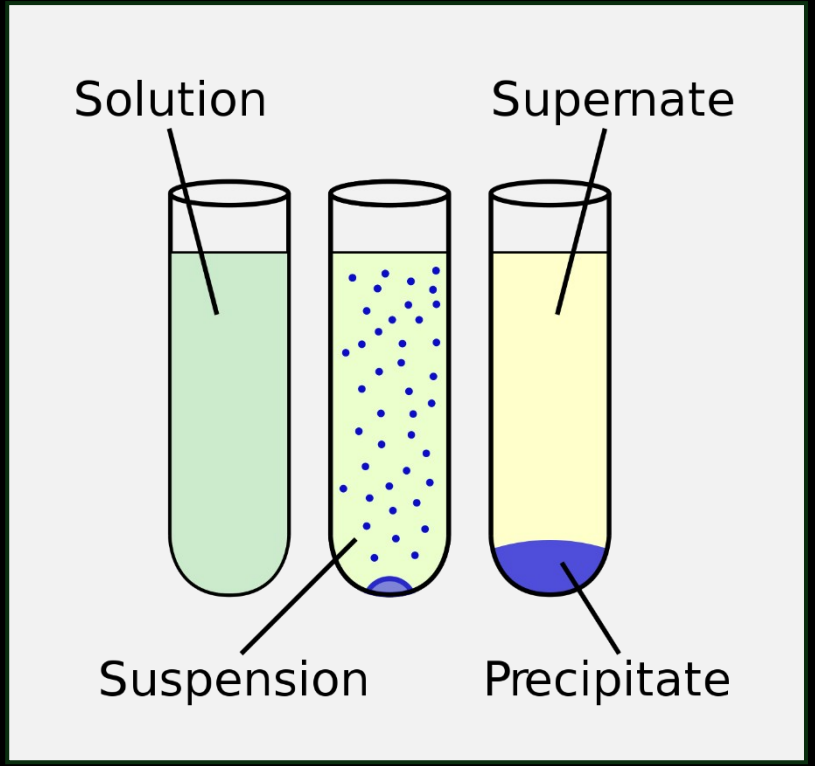
The biological process

Naturally occurring bacteria break down biodegradable material in anaerobic environment and release of gases and nitrogen



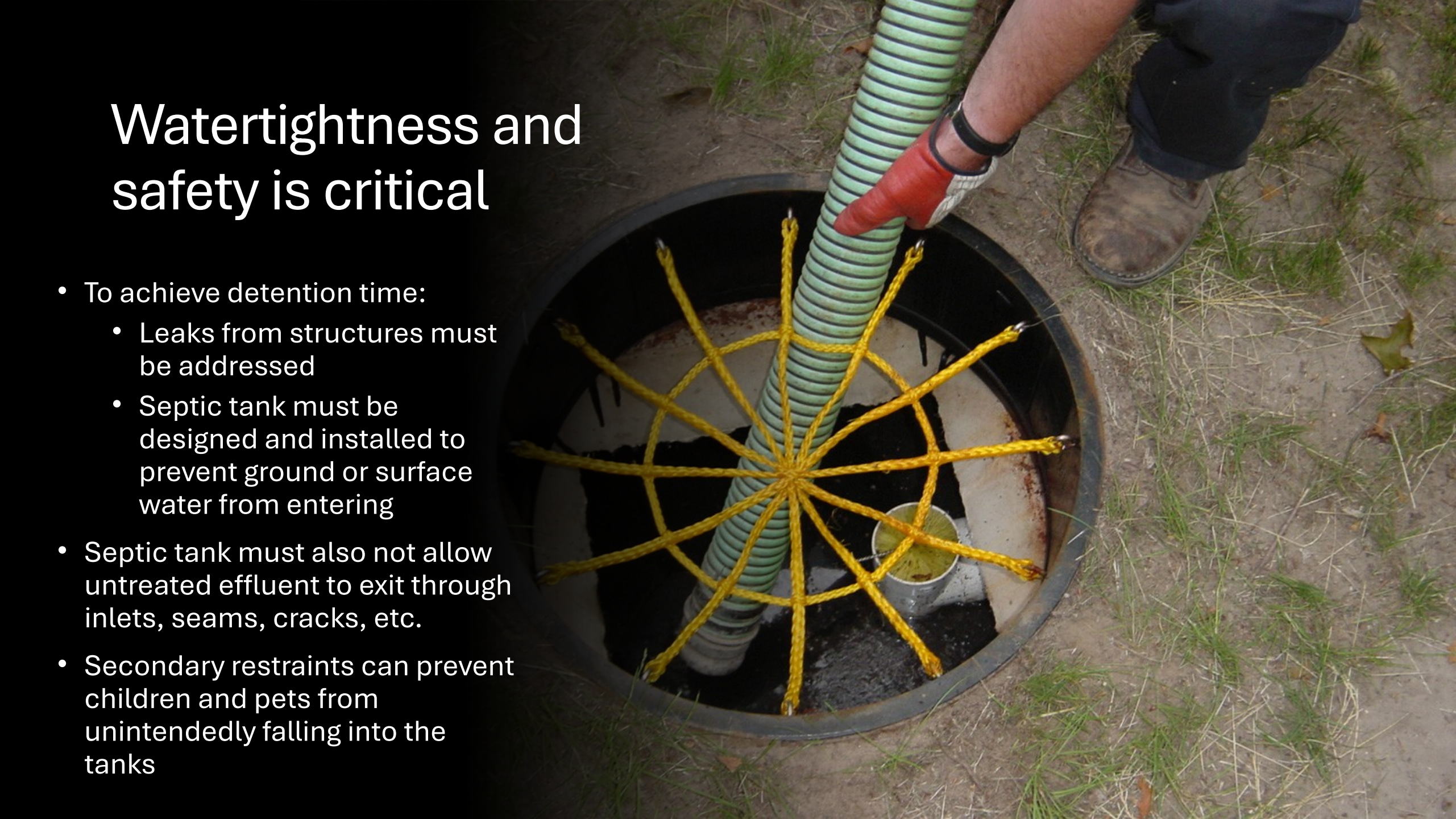
The chemical process

- Precipitation – when a solution becomes a solids
- Adsorption – binding of compounds together
- Ion exchange such as conversion of NH3 (ammonia) to NH4 (ammonium)



Watertightness and safety is critical

- To achieve detention time:
  - Leaks from structures must be addressed
  - Septic tank must be designed and installed to prevent ground or surface water from entering
- Septic tank must also not allow untreated effluent to exit through inlets, seams, cracks, etc.
- Secondary restraints can prevent children and pets from unintendedly falling into the tanks





Sewage Tank Design

Design and treatment in a septic tank

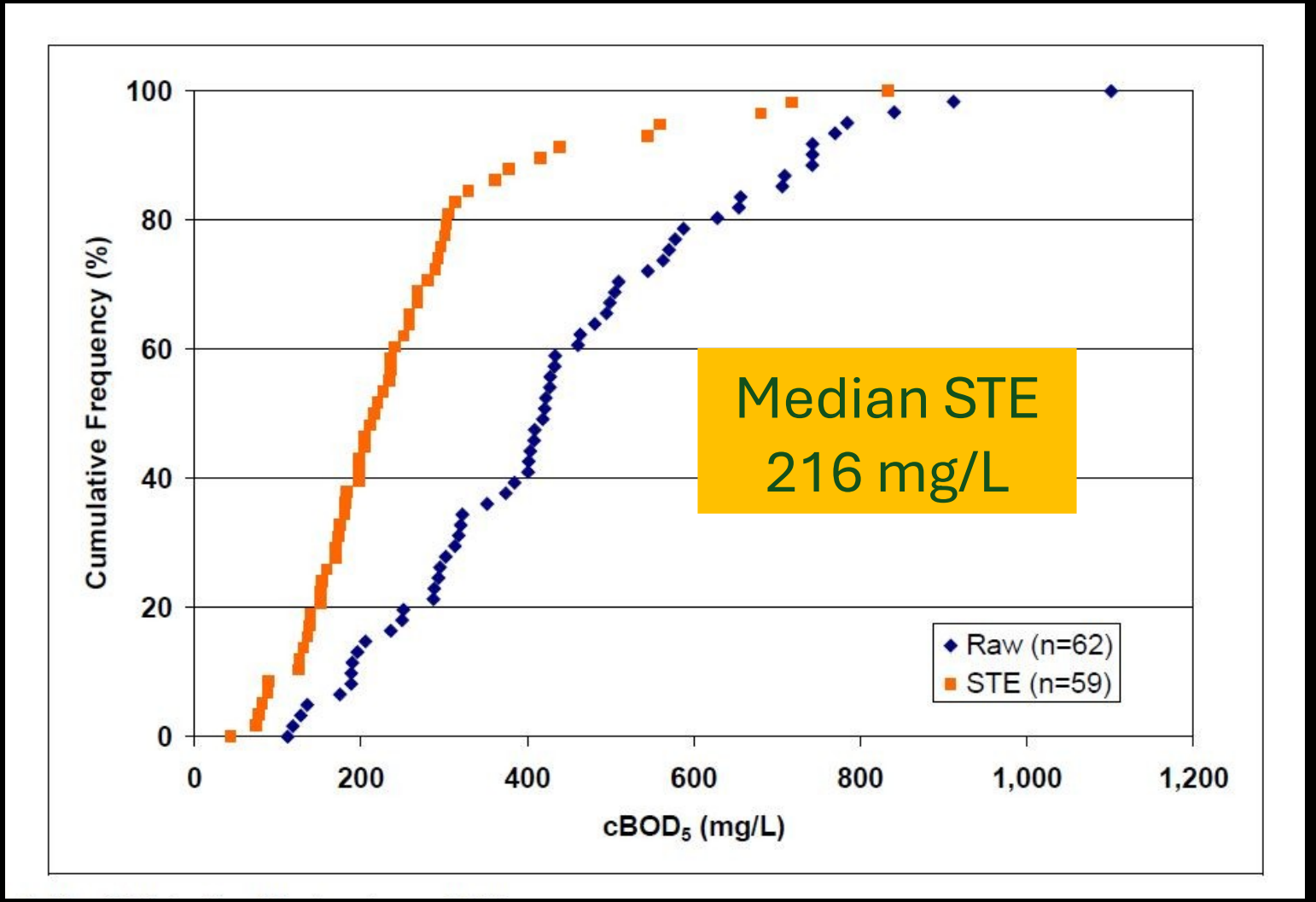
The tank must be large enough to retain the wastewater in a relatively quiet state to allow settling and flotation to occur

Referred to as detention time and is an important design consideration

Typically process reduces the solids content by 60 to 80%

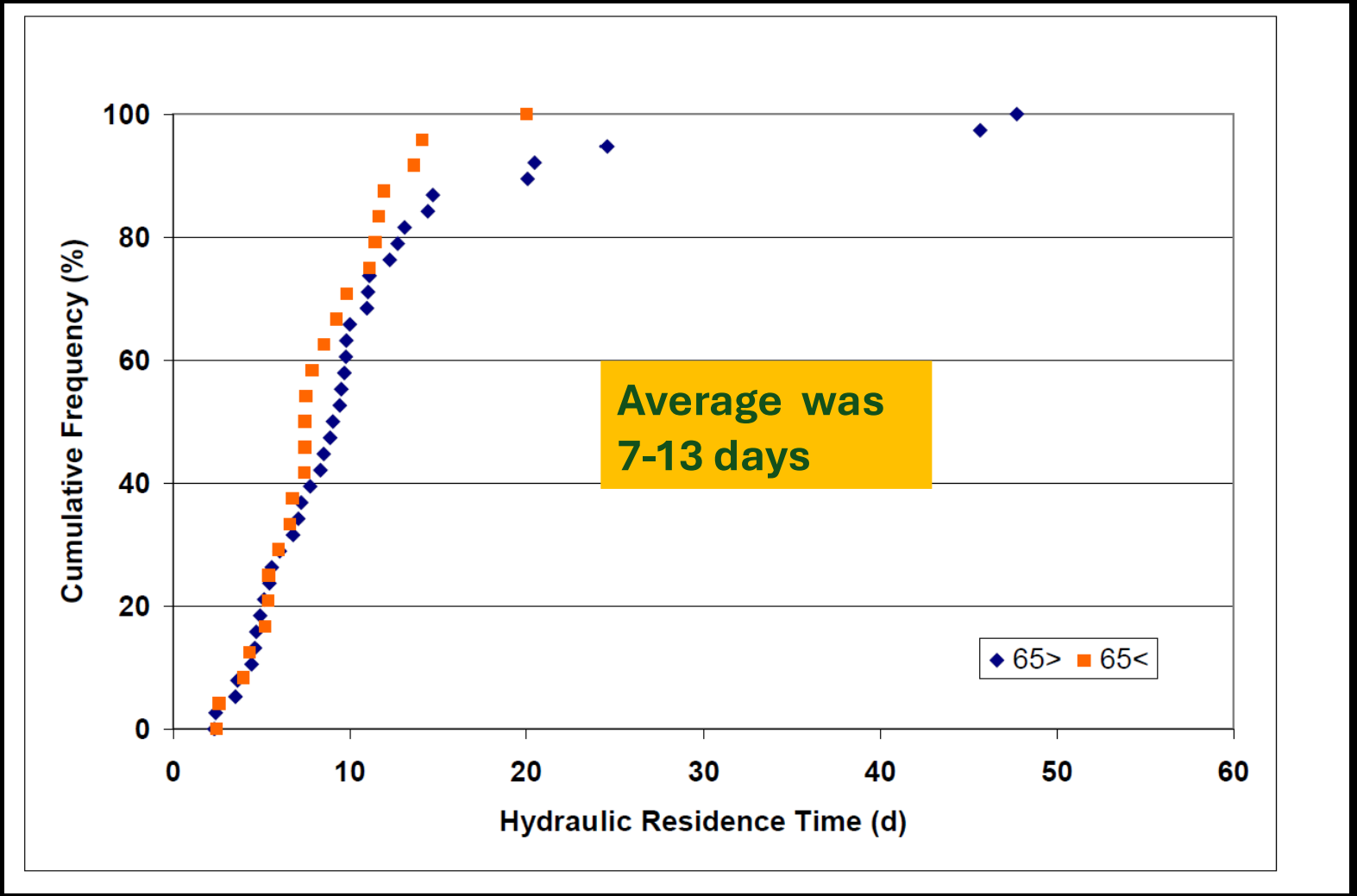
Because majority of material captured in the tank is organic, ~50% of the organic load is removed by during liquid-solid separation

Residential BOD in Raw and Septic Tank Effluent (STE)



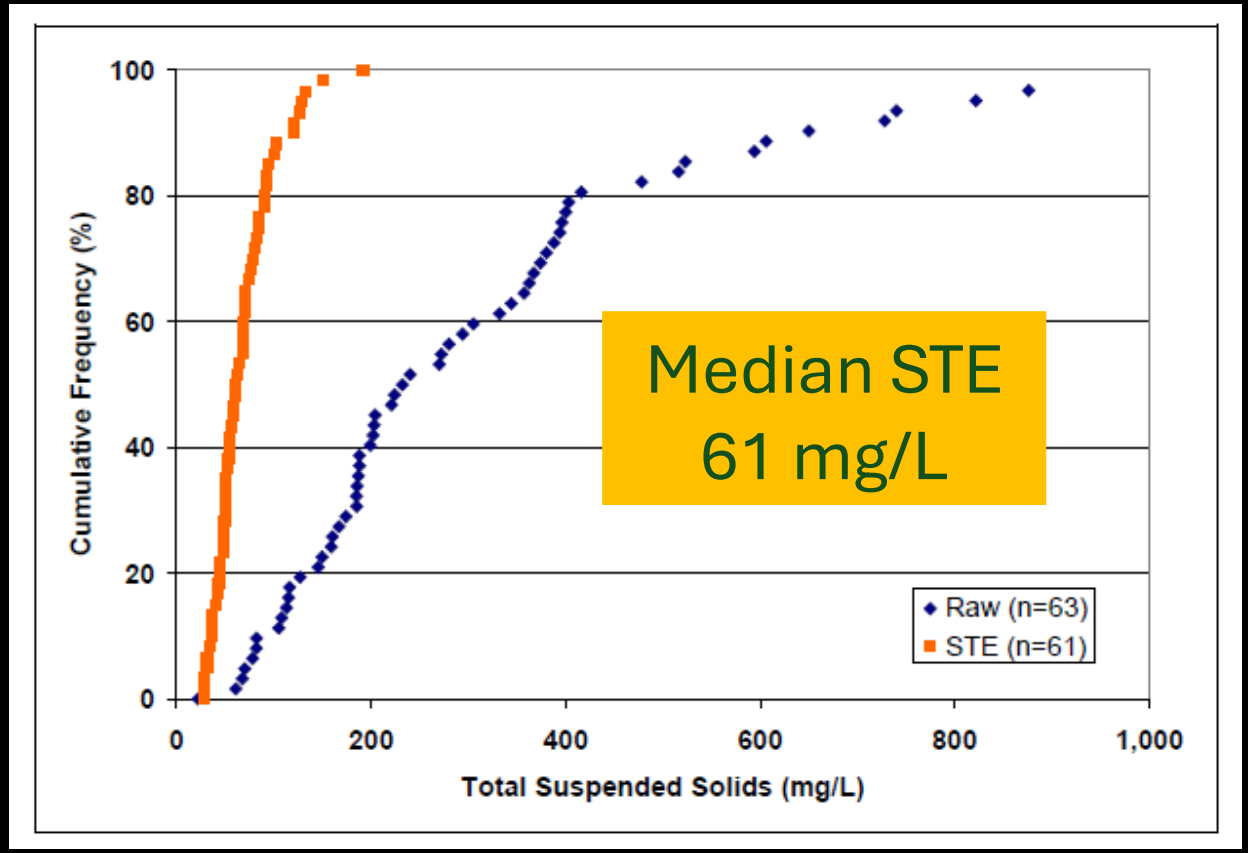
2009 Influent Constituent Characteristics of the Modern Waste Stream from Single

Hydraulic retention time in septic tank by age



Organic and inorganic solids

- Fibers from synthetic clothing (lint from washing machine), minerals, metals and salts from soil material, plumbing, make-up
- Typically estimated with total suspended solids test (TSS)



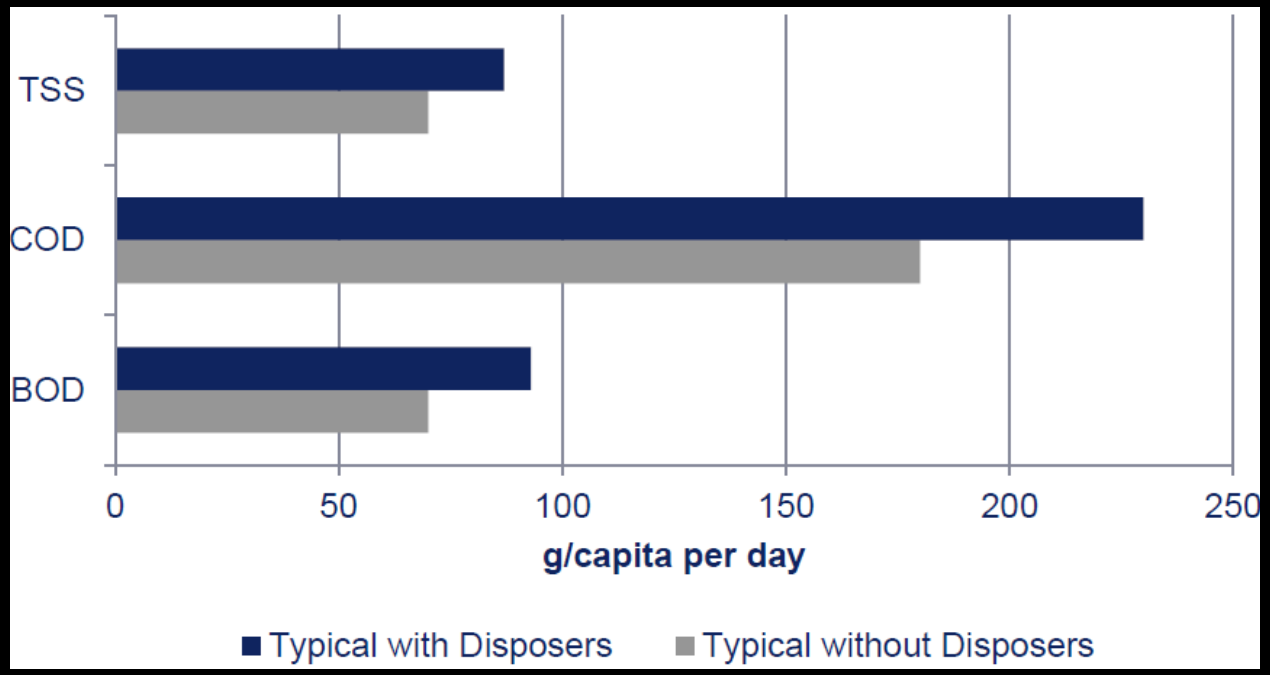
✓Septic tanks appears to perform well their duty of removing solids

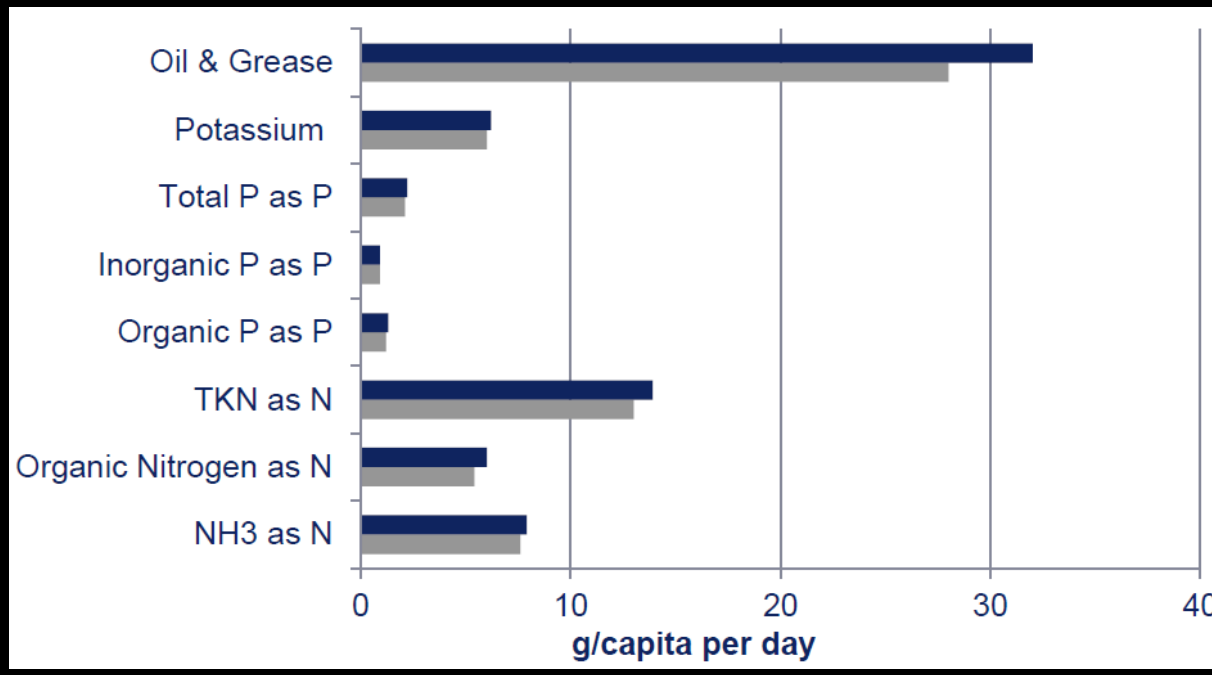
✓Effluent filter is an added safety factor

Residential Septic Tank Capacity

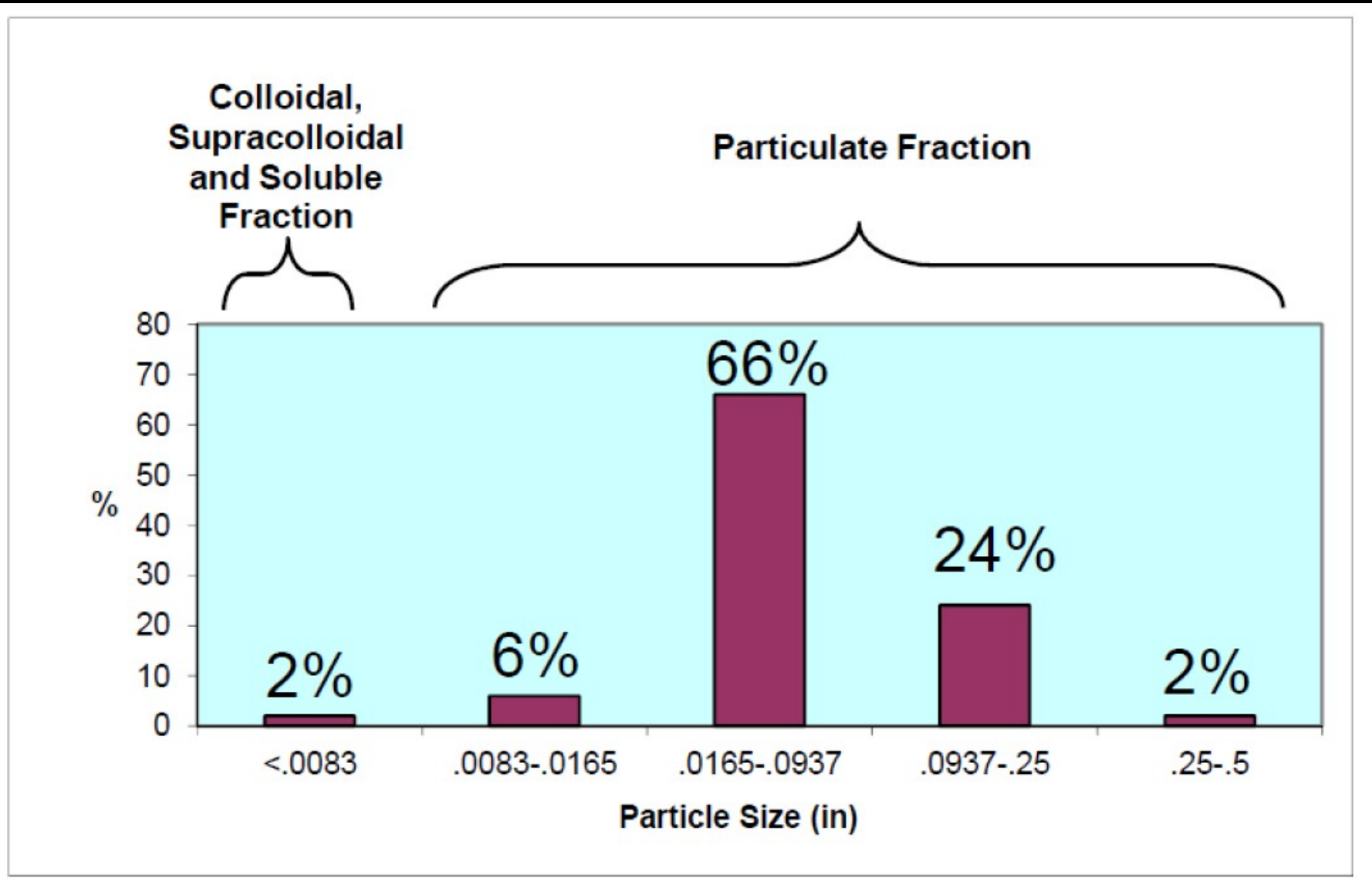
- Some states consider bedrooms alone when sizing
  - For single family homes with no in home business
- Some regulations add extra capacity if a garbage disposal or sewage ejector/grinder pump is part of the system
- Some states or counties require an effluent screen
- Criteria: Hydraulic detention time plus solids storage
  - ~2 days detention of design flow
  - Add solids storage volume equal to 1/3 – 1/2 of the above hydraulic detention

Garbage disposal - effluent quality





TSS 33% and BOD 24% an increase



Particle Size Distribution of Ground Food Waste Based on Fineness Testing.

Minnesota septic tank capacity: dwellings

# of Bedrooms	Peak Flow (GPD)	Septic Tank Capacity (Gal)	With Garbage Disposal (Gal)*	Pumping from Basement (Gal)*
3 or less	450	1000	1500	1500
4-5	600	1500	2250	2250
6-7	750	2000	3000	3000
8 or 9	900	2500	3750	3750

* Must have multiple tanks or compartments



Commercial Tank Sizing Recommendations

- Septic tank size gravity = Design flow X 3.0
  - 3 days detention time

- Septic tank size under pressure (grinder pump) = Design flow X 4.0
  - 4 days detention time

Summary

- Septic tank treatment depends upon many variables
- Key factors
  - Tank design/sizing
  - Particle size
  - Velocity
  - Sludge/scum accumulation
- At the time of design, tank sizing is the one variable you have control over

Questions & more information

Got an idea for an article send and email to:
sfheger@gmail.com

Pumper

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