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SOUTHWEST
ENVIRONMENTAL
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US Territories Wastewater Operator Training Series

Session 10: Sedimentation (plus Flocculation & Floatation)

10/28/25



www.efcnetwork.org

This program is made possible under a cooperative agreement with US EPA.

Your trainers for today:



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Research Engineer



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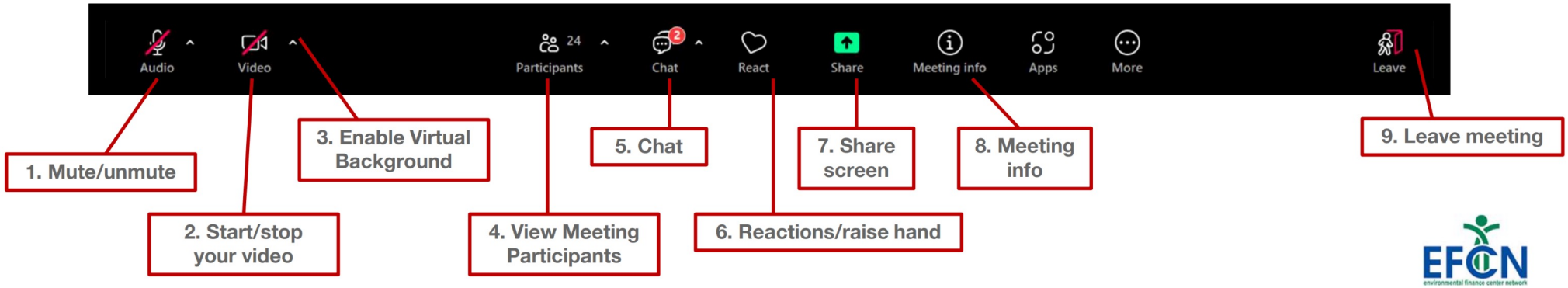
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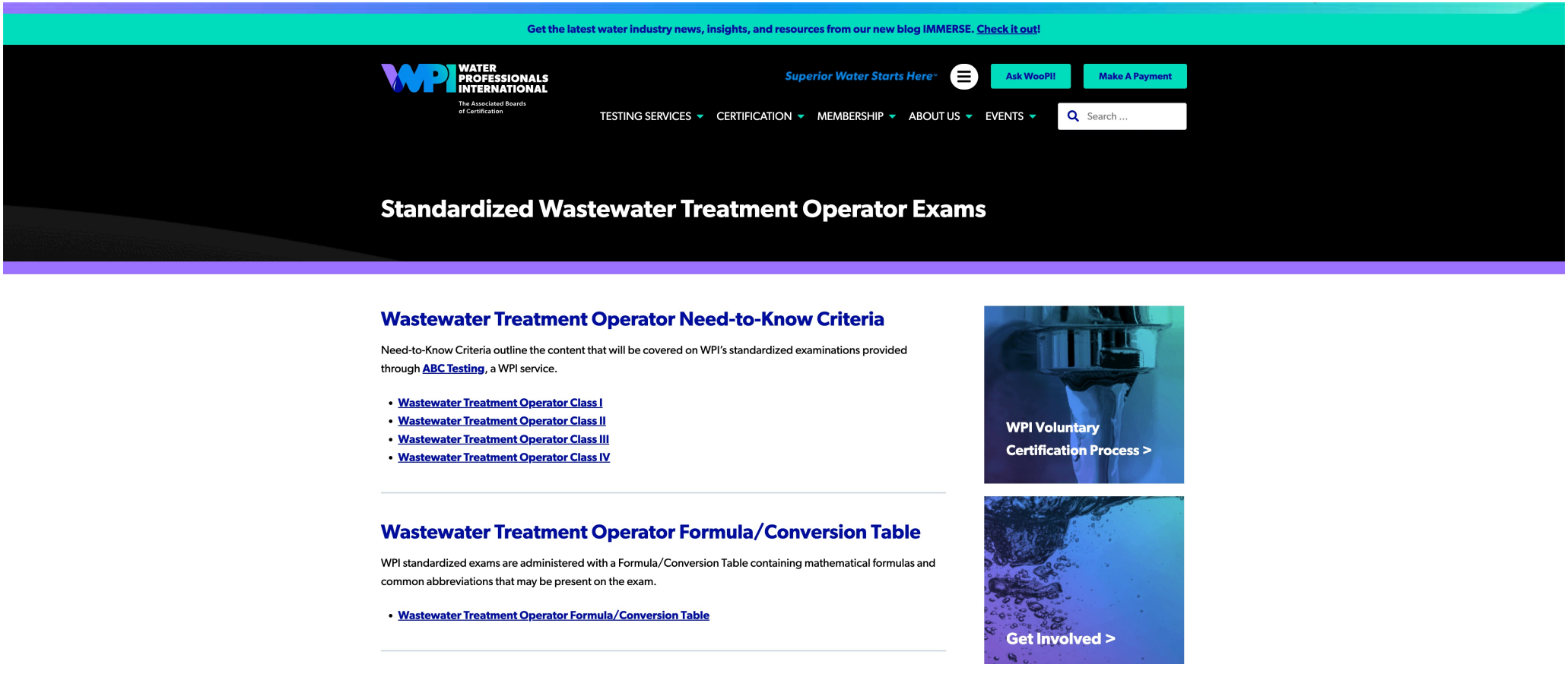
This training series is funded by the EPA

Attendee Meeting Controls

- Locate your control bar
- All attendees will see a black horizontal bar on their screen
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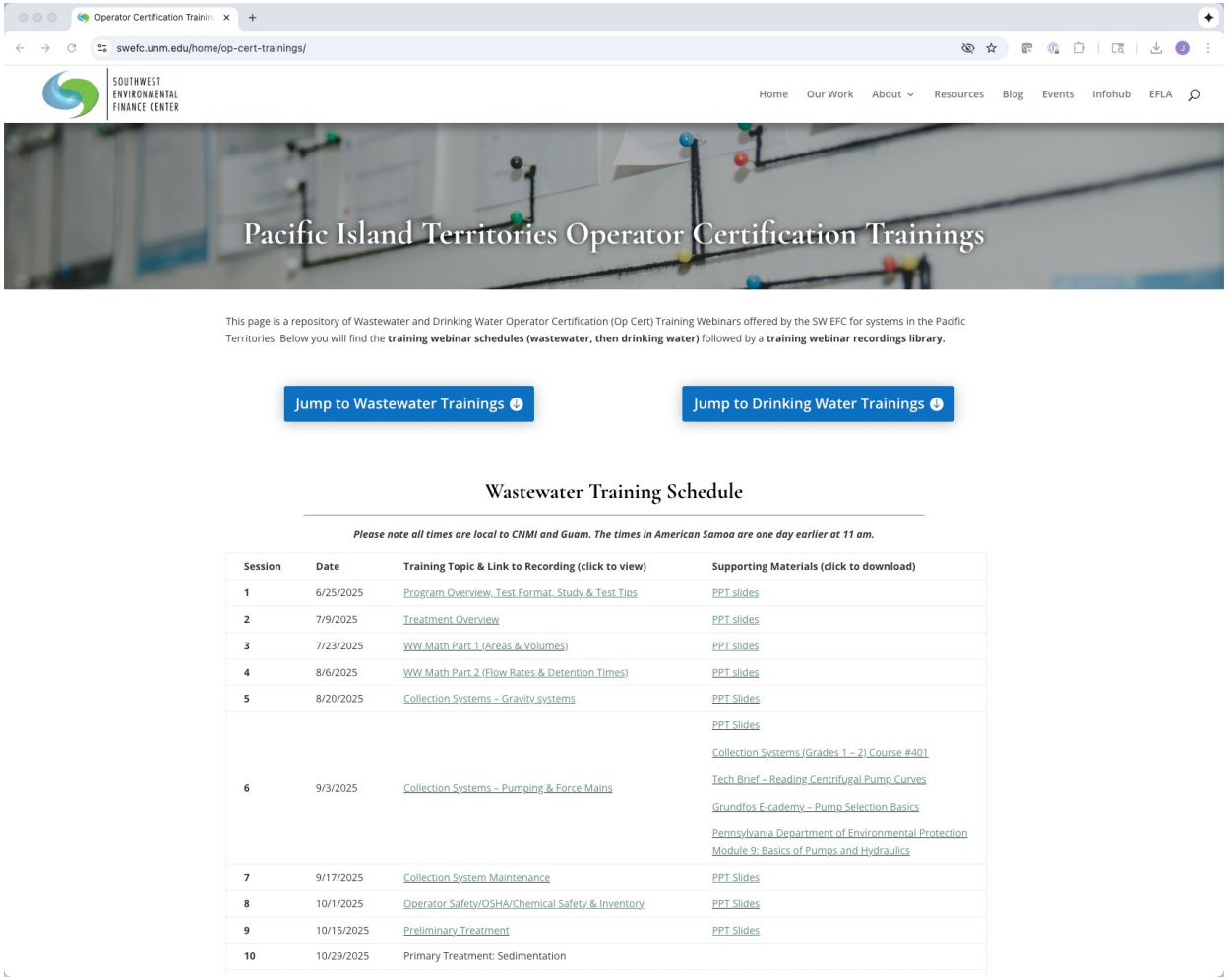
WPI/ABC Operator Certification



Schedule for 2025:

Date	Topic
6/24/25	Program Overview, Test Format, Study & Test Tips
7/8/25	Treatment Overview - Reg history, overview
7/22/25	WW Math Part 1 (Areas & Volumes)
8/5/25	WW Math Part 2 (Flow Rates & Detention Times)
8/19/25	Collection Systems - Gravity systems
9/2/25	Collection Systems - Pumping & force mains
9/16/25	Collection System Maintenance
9/30/25	Operator Safety/OSHA/Chemical Safety & Inventory
10/14/25	Preliminary Treatment
10/28/25	Primary Treatment: Sedimentation
11/11/25	Fixed-Film Media
12/2/25	Activated Sludge Part 1
12/16/25	Activated Sludge Part 2

https://swefc.unm.edu/home/op-cert-trainings/



Sign in for **every session to** ensure you **get credit** for attending

SOUTHWEST ENVIRONMENTAL FINANCE CENTER

US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet

Session Title: _____

Session Date: _____

Training Location: _____

Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____

Signature: _____

Title: _____

Date: _____

Please scan this sheet after each training session and email it to swefc@unm.edu with the subject line: "US Territories Op Cert Attendance Sheet"

“Sedimentation”

The settling of heavier particles in the wastewater

“Flocculation”

Gathering fine particles together after coagulation to form larger particles by a process of mixing

“Floatation”

Floating lighter materials like grease to the top for removal

The Sedimentation Principle is used throughout the treatment train.


In Preliminary Treatment


In Primary Treatment

In Secondary Treatment



Gravity Separation Theory

Type	Description	Application
Discrete Particle Settling	Low solids concentration, particles settle by gravity, particles settle individually w/out significant interaction with other particles	Grit & sand removal from wastewater
Flocculant Settling	Dilute suspensions of particles that coalesce (flocculate) during the settling process, increase in mass and settle at a faster rate	TSS removal in primary settling facilities & upper portions of secondary settling facilities; also removes chemical floc in settling tanks
Ballasted Flocculant Settling	Addition of inert ballasting agent and polymer to partially flocculated suspension to promote rapid settling and improved solids reduction (some ballasting agent recycled typically)	TSS removal in primary settling facilities; combined system influent; industrial wastewater (also reduces BOD and phosphorus)
Hindered Settling (aka "Zone Settling")	Intermediate concentration suspensions where interparticle forces hinder settling, and the mass settles as a unit with a solids-liquid interface at the top	In secondary settling facilities used in conjunction with biological treatment facilities
Compression Settling	Where particles are so concentrated that further settling results from compression due to weight of solids being added by sedimentation	Occurs in lower levels of a deep solids or biosolids mass, such as deep secondary facilities or biosolids thickening facility
Accelerated Gravity Settling	Removal of particles in suspension by gravity settling in acceleration field	Removal of grit and particles
Floatation	Removal of particles in suspension that are lighter than water by air or gas floatation	Removal of greases and oils, light material that floats, thickening of solids suspensions


Analogous to snowfall

Look at a snowglobe




You can experiment at home
with coffee grounds …


Poll Question


Poll Question

Grit removal works via sedimentation

What's grit? **Heavy particulate matter** like sand, eggshells, coffee grounds, bone fragments, seeds, etc.

How is it removed? **Water velocity is reduced** so that the **heavier** grit **particles** can **settle** to the bottom of the basin for mechanical removal, while lighter organic particles move to the next treatment unit

What's the ideal water velocity for grit removal? **1 ft/sec** is the ideal velocity though a range of 0.7 to 1.4 ft/sec is typically acceptable.

A little review: Grit Channels

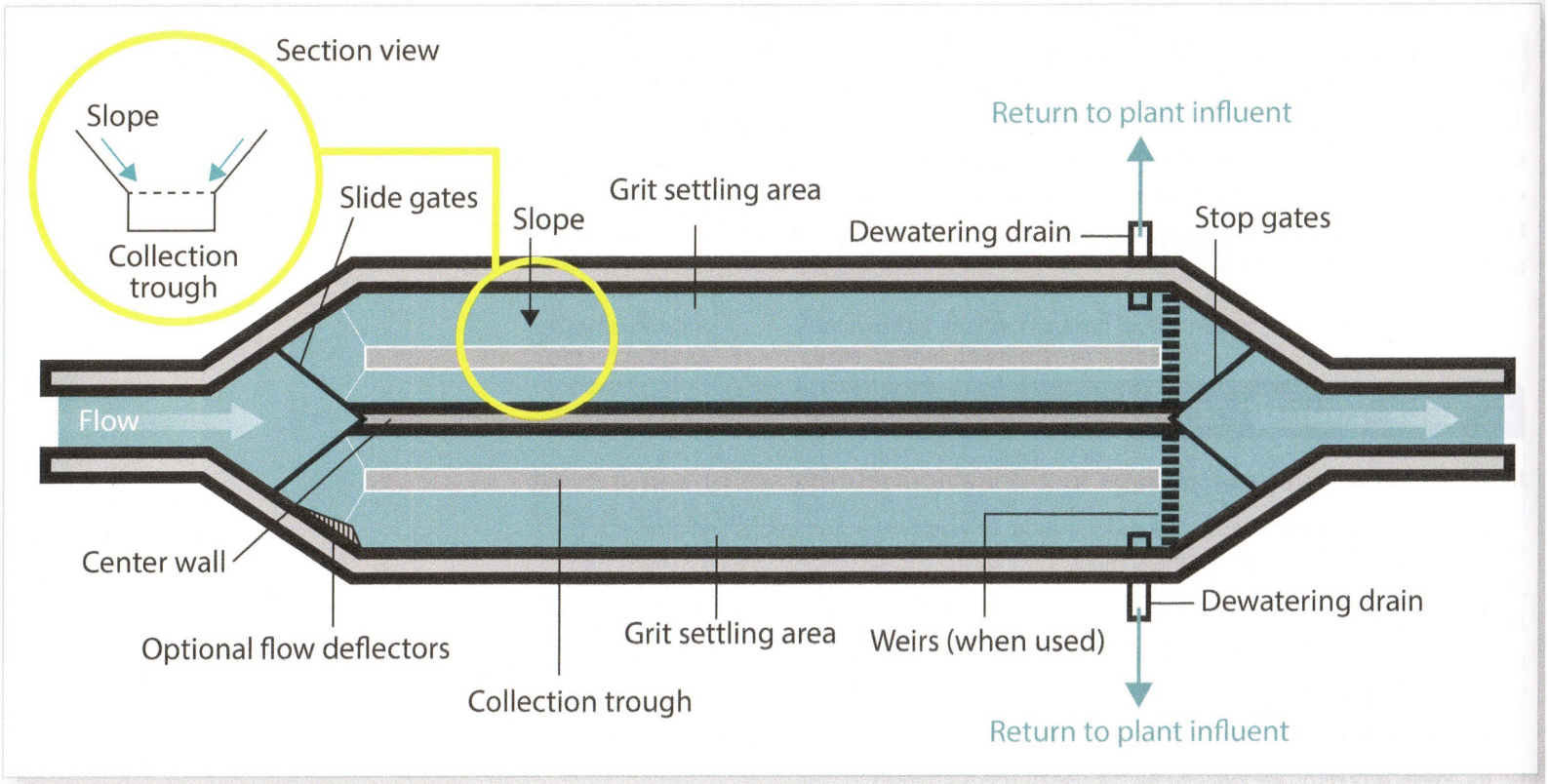


Figure 3.16 Grit channel

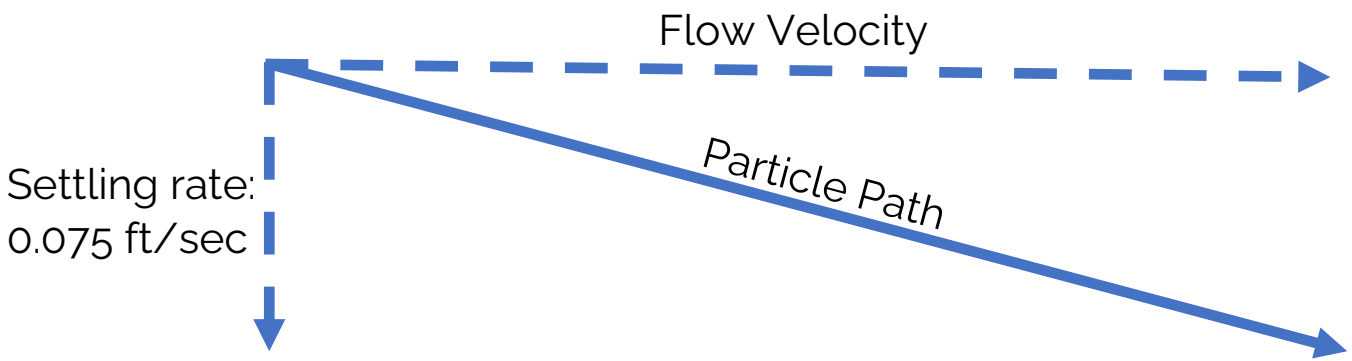
Source: Operation of Wastewater Treatment Plants, Vol 1, 8th Edition, Sacramento State, 2019

Grit removal via sedimentation

Designed to remove 0.2mm sized sand and heavier particles

They typically settle downward at about 0.075ft/sec

Imagine a 5 ft deep basin with 4 ft of water in it



$$settling\ time = \frac{depth}{settling\ rate}$$

$$settling\ time = \frac{4\ ft}{0.075\ ft/sec}$$

$$settling\ time = 53.3\ seconds$$

$$velocity = \frac{length}{time}$$

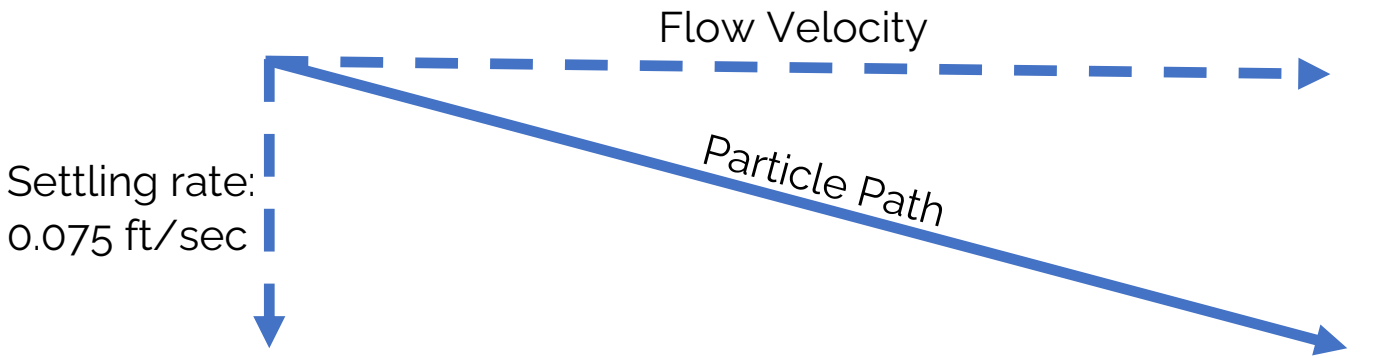
$$velocity \times time = length$$

$$1\frac{ft}{sec} \times 53.3 sec = 53.3\ ft$$

Grit removal via sedimentation

The flow has to be slow enough to let those particles settle to the bottom of the channel before it ends.

Of course, you're stuck with the channel length you have.
Let's say it's 50 feet long. What's the maximum velocity for removal?



$$settling\ time = 53.3\ seconds$$

$$velocity = \frac{length}{time}$$

$$velocity = \frac{50\ ft}{53.3\ seconds}$$

$$velocity = 0.94\ ft/sec$$

The maximum velocity of your flow in the channel is 0.94 ft/sec

Grit removal via sedimentation

The next question is: Will that velocity of 0.94 ft/sec be effective?

Item	Range Metric	Typical Metric
Detention Time	45 - 90 seconds	60 seconds
Horizontal Velocity	0.7 – 1.4 ft/s	1 ft/s
Settling Velocity (50 mesh)	9.2 – 10.2 ft/min	9.6 ft/min
Settling Velocity (100 mesh)	2 - 3 ft/min	2.5 ft/min
Headloss (% of channel depth)	30 – 40%	36%

It's in the right range

Source: Operation of Wastewater Treatment Plants, Vol 1, 8th Edition, Sacramento State, 2019

Grit removal via sedimentation

What other options are there for us to get to the ideal 1 ft/sec if that were determined to be necessary?

- **Adjust the inflow?**
- **Lower the water depth in the channel by opening the other one?**
- **Alter flow equalization practices**
- **Other options?**

- **What could work?**
- **What would be practical?**

Quick and dirty flow velocity estimation

Use a stick: **M**easure the time it takes to travel from one end of the basin to the other. **v = d/t**



Aerated Grit Chamber

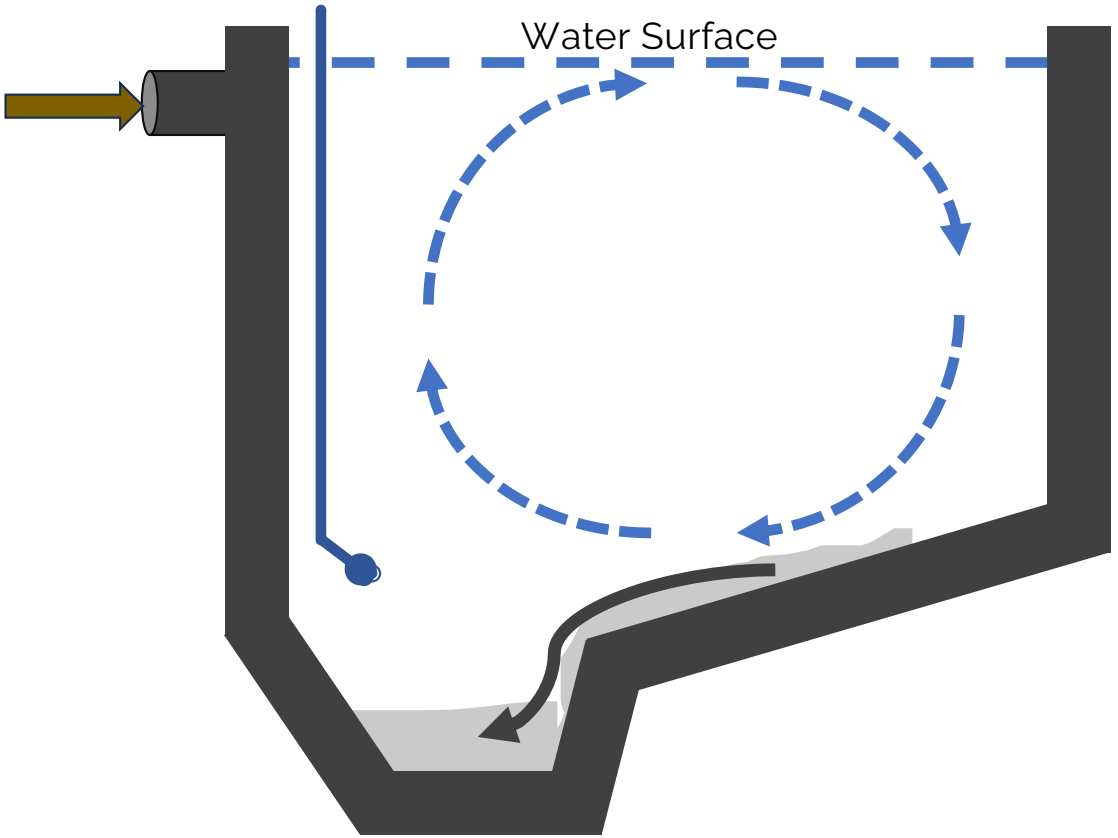
Influent enters perpendicular to axis of basin

Aerating disburses air into the wastewater to lower velocity

The air water mixture has a lower specific gravity than water alone – this causes the grit to settle out better

The rolling action of water in the tank also moves grit toward to bottom

Aerated grit chambers have low detention times – in the 3 to 5 minute range




In Primary Treatment

Primary sedimentation

Targeting particles with Specific Gravity between 1.01 and 1.05

Assume settling rate of 0.167 ft/min or 0.0028 ft/sec

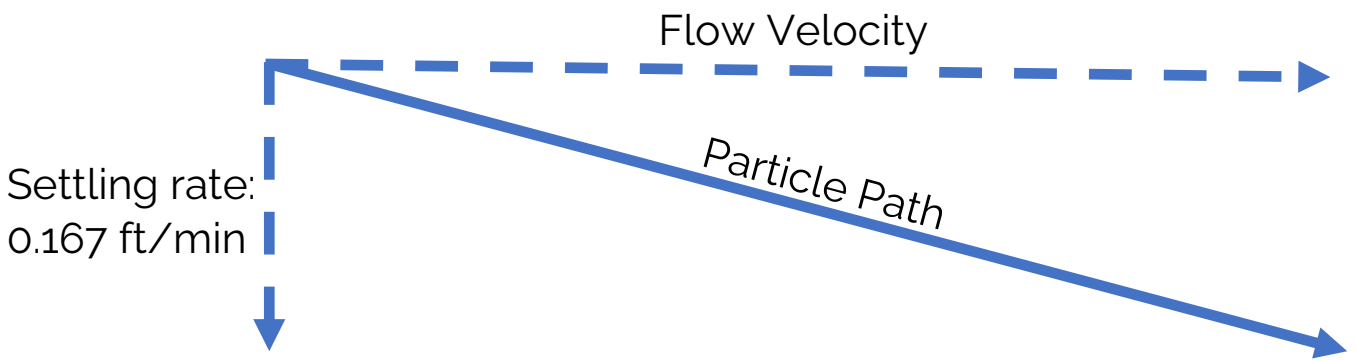
Assume horizontal flow velocity of 2 ft/min or 0.033 ft/sec

Basin is 200 ft long with 10 ft of water in it

$$settling\ time = \frac{depth}{settling\ rate}$$

$$settling\ time = \frac{10\ ft}{0.167\ ft/min}$$

$$settling\ time = 60\ min$$



Primary sedimentation

Targeting particles with Specific Gravity between 1.01 and 1.05

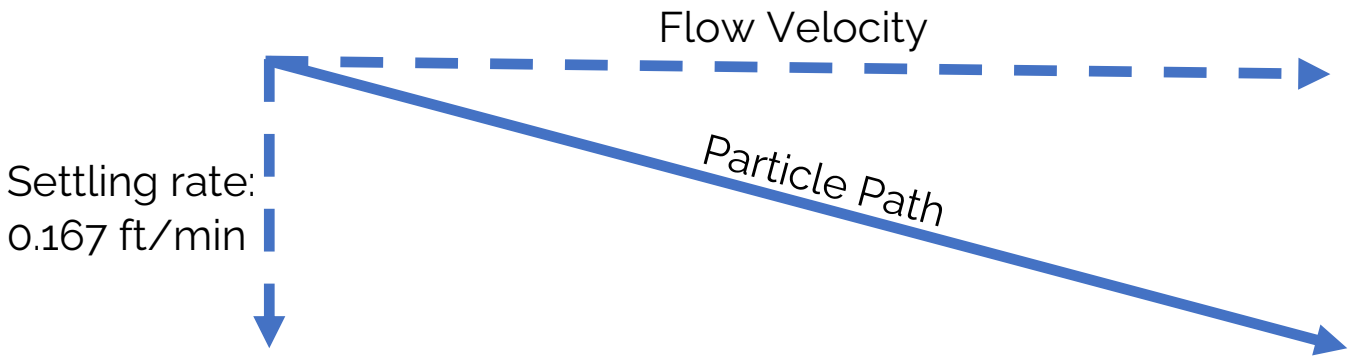
Assume settling rate of 0.167 ft/min or 0.0028 ft/sec

Assume horizontal flow velocity of 2 ft/min or 0.033 ft/sec

Basin is 200 ft long with 10 ft of water in it

$$settling\ time = 60\ min$$

What's the horizontal distance traveled?



$$horizontal\ velocity = 2\ ft/min$$

$$velocity = \frac{length}{time}$$

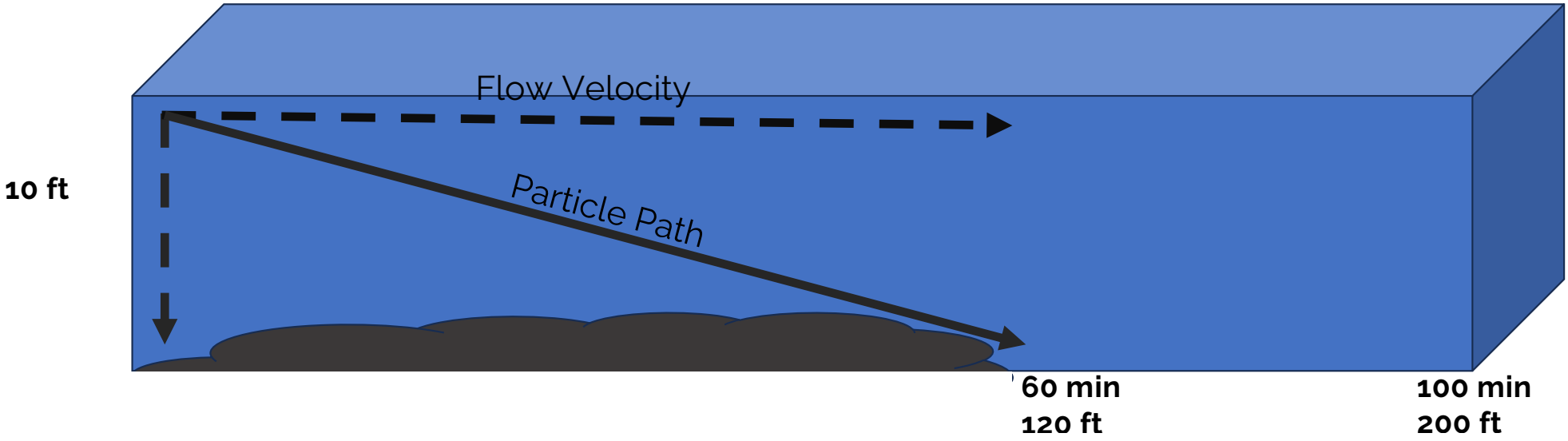
$$velocity \times time = length$$

$$2\frac{ft}{min} \times 60\ min = 120\ ft$$

Primary sedimentation

So, what does that mean?

Particles settling at this rate will settle within first 120 ft of 200 foot tank (first 60% from inlet) and water exiting will be clearer



Sedimentation Tanks Expected Removal Efficiency – 2 hr DT

BOD and TSS removal:

- **50 to 70% of TSS**
- **25-40% of BOD**

$$R = \frac{t}{a + bt}$$

R = expected removal efficiency
t = nominal detention time (hrs)
a, b = empirical constants

Item	a	b
BOD	0.018	0.020
TSS	0.0075	0.014

$$R_{BOD} = \frac{2}{0.018 + 0.020(2)} = 35.5\% \qquad R_{TSS} = \frac{2}{0.0075 + 0.014(2)} = 56.3\%$$


Poll Question

Detention Time

Settling tanks are typically designed for 2 to 3-hour detention times (though designs may vary)

Operator experience comes into play when actually running the plant because flows can increase or decrease suddenly, and organic loads can vary as well

Can calculate theoretical detention time using tank volume and flow rate

Can verify using dyes, tracers or floats

Actual detention times are often shorter than the calculated theoretical time

Detention Time

If you have a detention time of less than 2 hours and lab tests are showing poor solids removal, you may need to add tanks, or restrict flow to solve the detention time/solids removal problem

Detention times are going to vary considerably between day and night

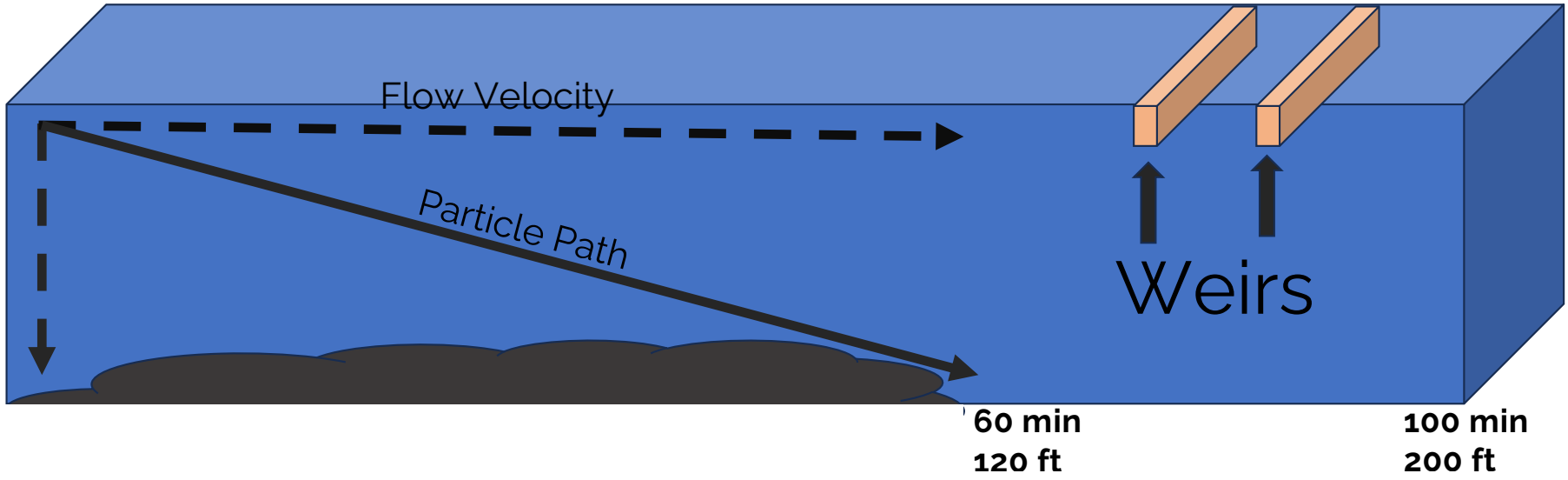
This is one reason some systems use flow equalization techniques in preliminary treatment

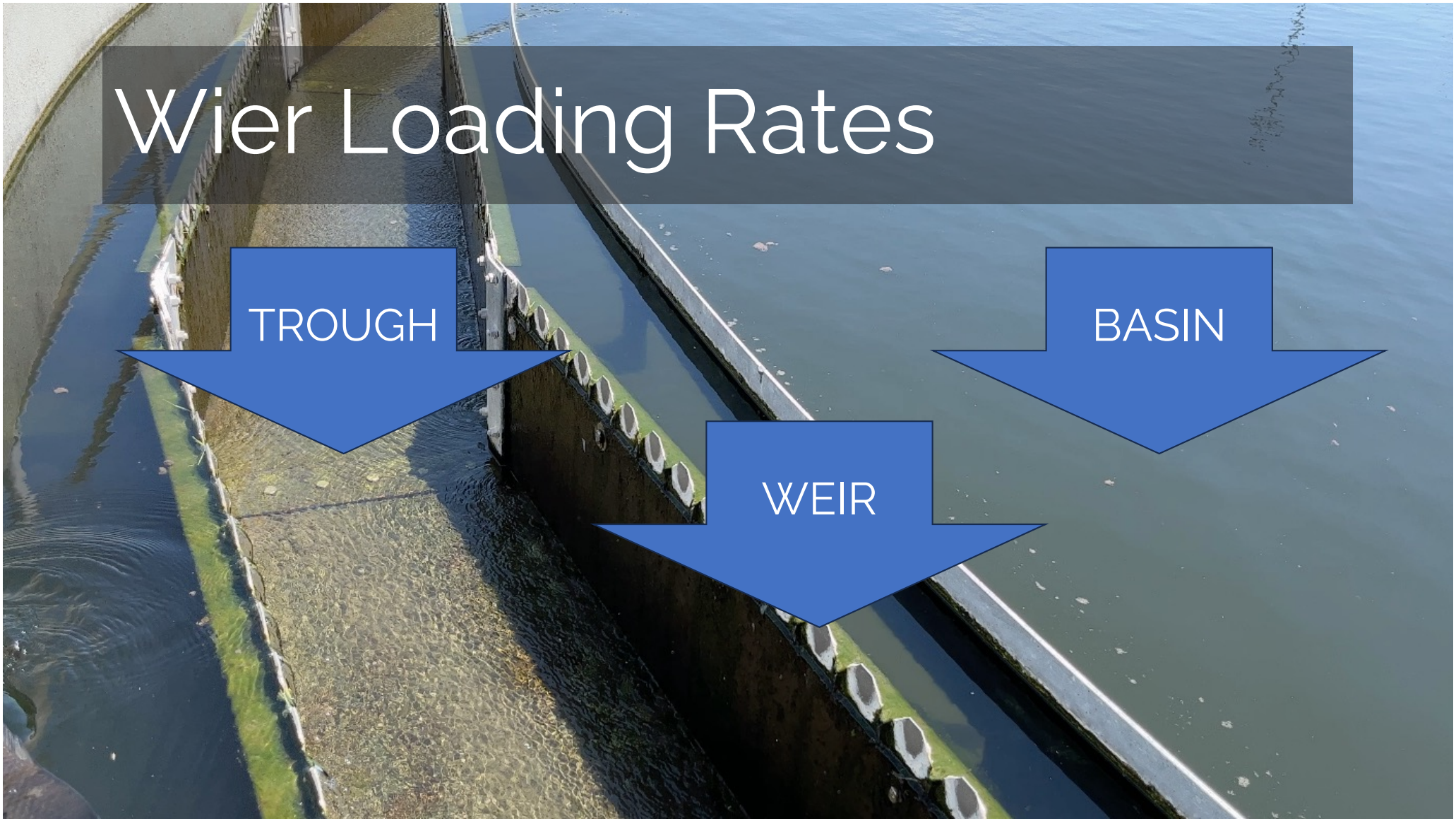
Horizontal Flow Design Criteria for Sedimentation

Item	Typical Horizontal Grit Channel	Typical Primary Settling Tank
Detention Time	1 to 3 min	2 to 3 hours
Horizontal Flow Velocity	0.7 to 1.4 ft/s	1 to 2 ft/min
Specific Gravity of Particles	~ 2.5 to 2.6	<1 to 1.25

Primary sedimentation

Particles settling at this rate will settle within first 120 ft of 200 foot tank (first 60% from inlet) and water exiting will be clearer




Wier Loading Rates
TROUGH
BASIN
WEIR

Wier Loading Rates

Number of lineal feet of weir on the clarifier in relation to flow

Weir Loading Rate is what volume flows over **1 linear foot** of weir **per day**

Typical design parameters are **10,000 to 20,000 GPD** per foot of weir

Might be higher for fast settling solids or intermediate treatment

Secondary clarifiers and higher quality water will require lower WLRs that what's acceptable for primary clarifier

Wier Loading Rates

So how do we calculate it?

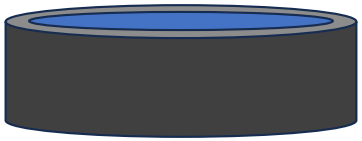
$$LR_{Weir} = \frac{Q}{L}$$

$$Q = Flow\ rate\ per\ day$$

$$L = Length\ of\ weir$$

Note that for a circular basin: $L_{circular\ weir} = \pi \times D$

Wier Loading Rates Example



$$D_{weir} = 75\ ft \quad Q = 5{,}000{,}000\ gpd$$

$$L_{circular\ weir} = \pi \times D$$

$$L_{circular\ weir} = 3.149 \times 75ft$$

$$L_{circular\ weir} = 236.18ft$$

$$LR_{Weir} = \frac{5{,}000{,}000\ gpd}{236.18\ ft}$$

$$LR_{Weir} = 21{,}170\ gpd/ft$$

Typical design parameters are 10,000 to 20,000 gpd/ft
This **might** be a problem.



Wier Loading Rates Example

$D_{weir1\ =\ 75}\,ft$ $D_{weir2\ =\ 70}\,ft$ $Q = 5{,}000{,}000\ gpd$

$$L_{circular\ weir} = \pi \times (D_1 + D_2)$$

$$L_{circular\ weir} = 3.149 \times 145ft$$

$$L_{circular\ weir} = 456.61ft$$

$$LR_{Weir} = \frac{5{,}000{,}000\ gpd}{456.61\ ft}$$

$$LR_{Weir} = 10{,}950\ gpd/ft$$

Typical design parameters are 10,000 to 20,000 gpd/ft
We're **are** within typical design parameters.

Surface Loading Rates aka "Overflow Rates"

GPD per ft^2 of clarifier surface area

Typical range is 300 to 1200 GPD/ft^2 depending on solids and treatment requirements

In cold regions low surface loading rates are common for small plants but in warm regions low SLRs can cause excessive detention time result in septicity

$$LR_{Surface} = \frac{Q_{GPD}}{A_{Surface}}$$

$$A\ (circular\ clarifier) = \pi \times Radius^2$$

Or

$$A\ (circular\ clarifier) = \frac{\pi}{4} \times Diameter^2$$

$$A\ (rectanguar\ \ clarifier) = L \times W$$


Poll Question

Things that impact sedimentation

A few examples

Temperature

You might see seasonal changes in settling rates that are primarily temperature driven



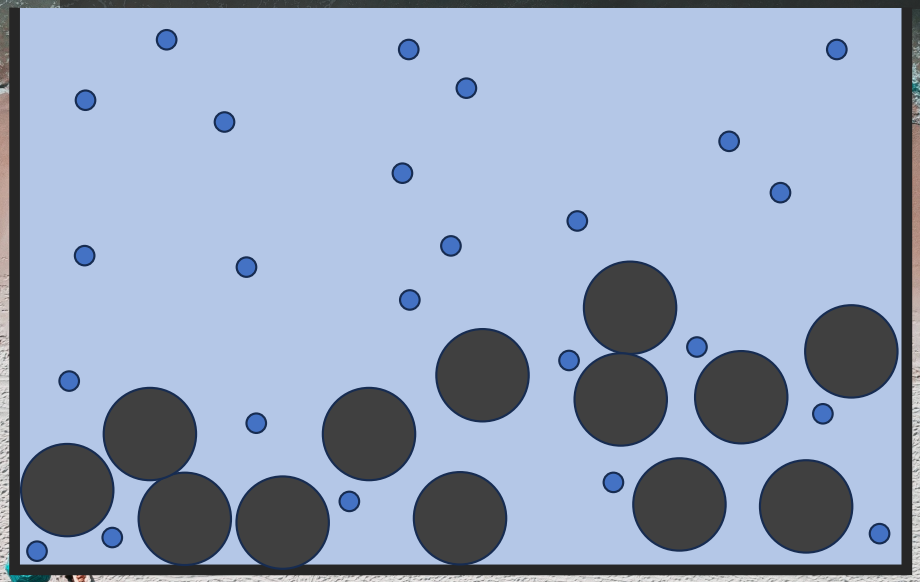


Temperature

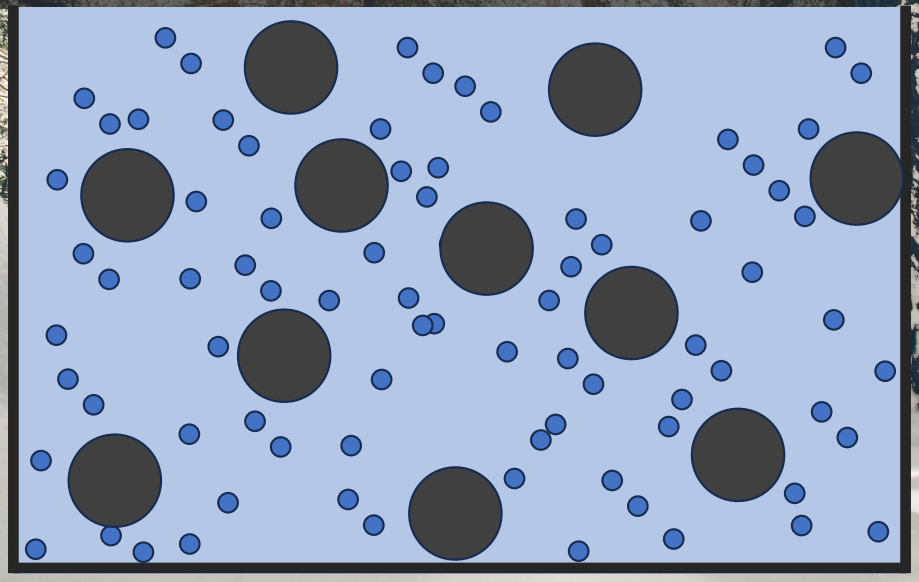
Particles tend to settle easier in warmer water – because it becomes less viscous

= Water Molecule

= Particles



Warm water 100 Degrees F

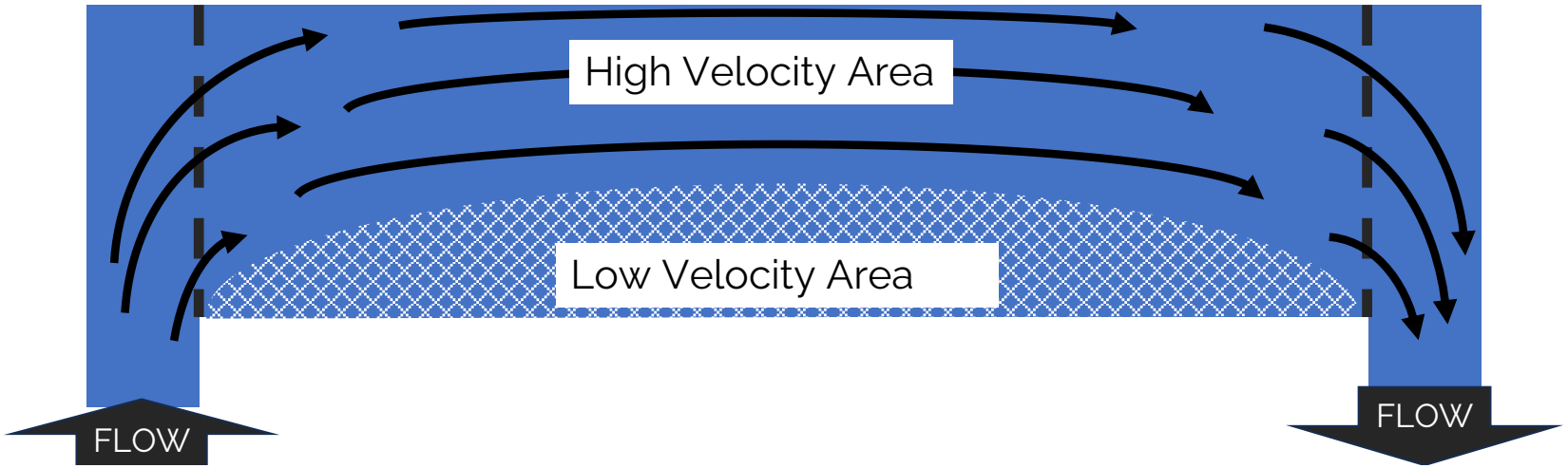


Cold water 40 Degrees F

Short Circuiting

When water isn't evenly disbursed across the tank area and velocity is much faster in some parts than others

In the high velocity area detention time is reduced and particles escape before settling; in the low velocity area septic conditions and odor can arise.

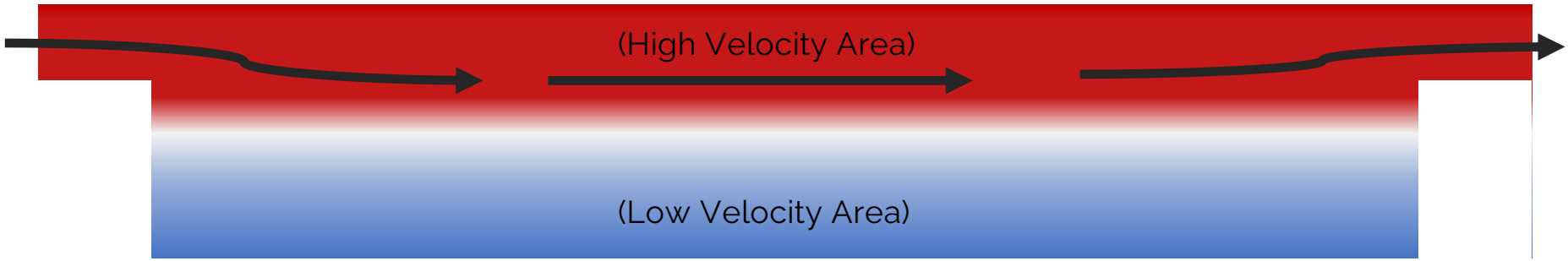


Short Circuiting: Temperature

Temperature stratification can cause short circuiting too.

Cold water is denser, warmer water tends to float on top.

If the basin is cold and the influent is very warm, it may flow along the top and cause septic conditions at the bottom

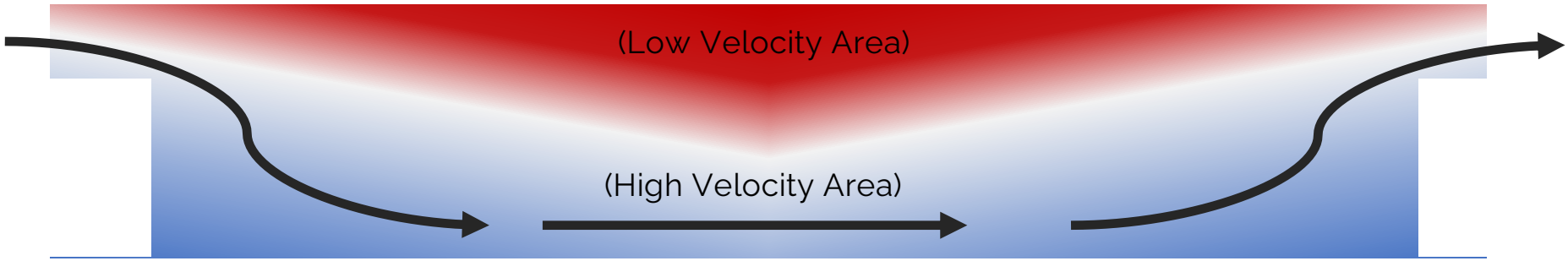


Short Circuiting: Temperature

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Cold water is denser, warmer water tends to float on top.

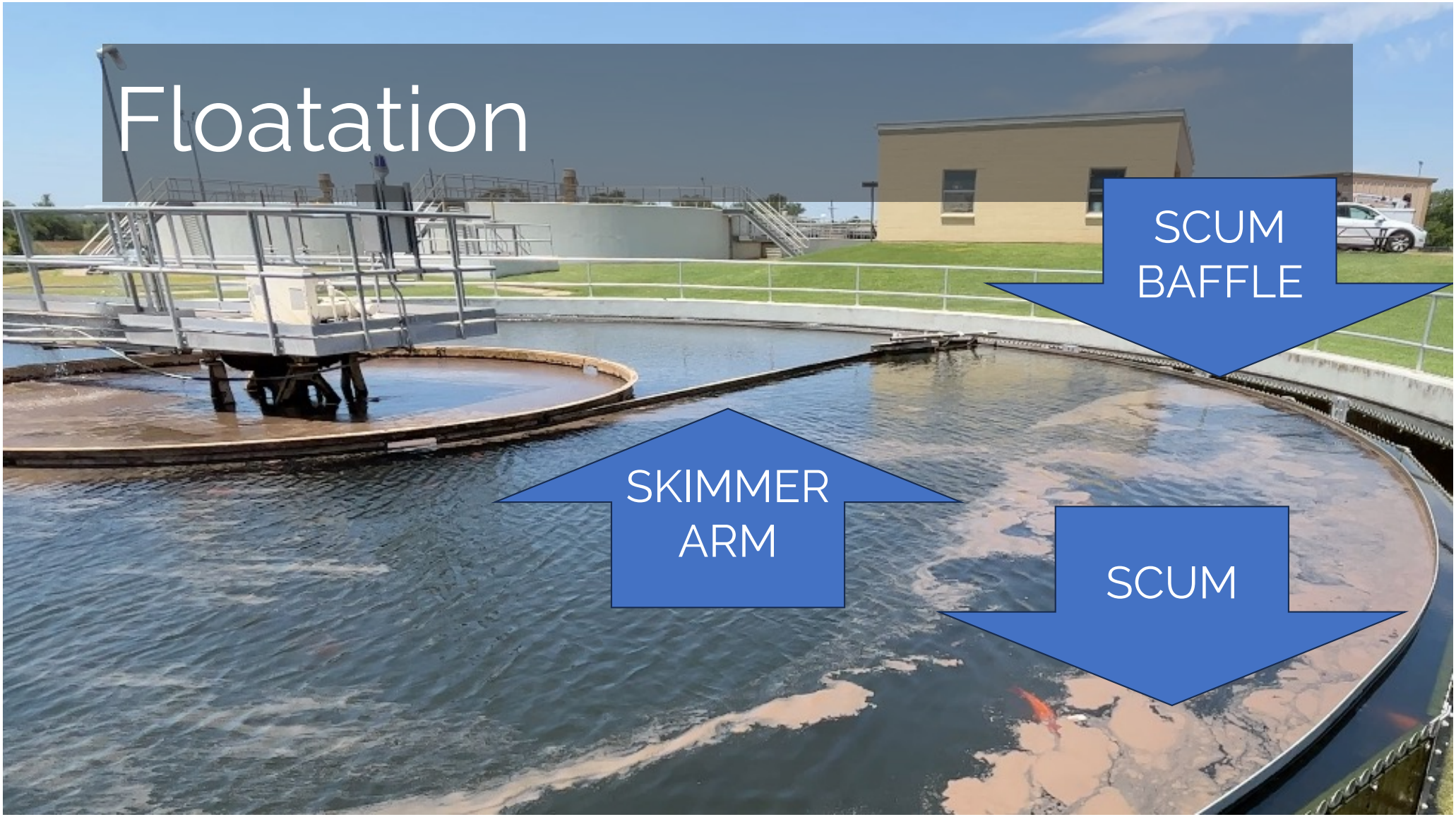
If the basin is warm and the influent is very cold, it may flow along the bottom, and cause septic conditions at the top




In Secondary Treatment


Secondary Clarification


Flocculation Well
CENTER WELL
WEIR


Floatation
SCUM BAFFLE
SKIMMER ARM
SCUM

Checking Facility Performance

You can use SLR, WLR, Removal Efficiency and detention time formulas to compare facilities to common design values

Used in combination with lab tests, process control tests they can help to verify operational goals are being achieved

If lab tests showing poor performance these math tests can help identify operational problems


Questions?

CONTACT INFORMATION



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