HRS: Plate Settlers

High Rate Sedimentation

Determining a method to increase longevity and stability of the floc blanket with implementation of plate settlers

Previous Work on HRS

Figure 1: Matt Hurst's, and by extension, Casey Garland's testing design

- Matt Hurst
  - Gives the team controlled variables
- Clup
  - Angle α range
- Garland
  - Operation and use of the Sedimentation Tank
- Summer 2018 Team
  - Recycle Line
- HRS: Flow Recycle (Fall 2018)
  - Following the path of research

High Rate Sedimentation

- Overall goals:
  - Increase flow rate
  - Decrease tank size
  - Lower effective cost

- Worse performance at higher upflow velocities

Figure 2: Picture from a plant in Las Vegas, Honduras

Sedimentation Tank Model

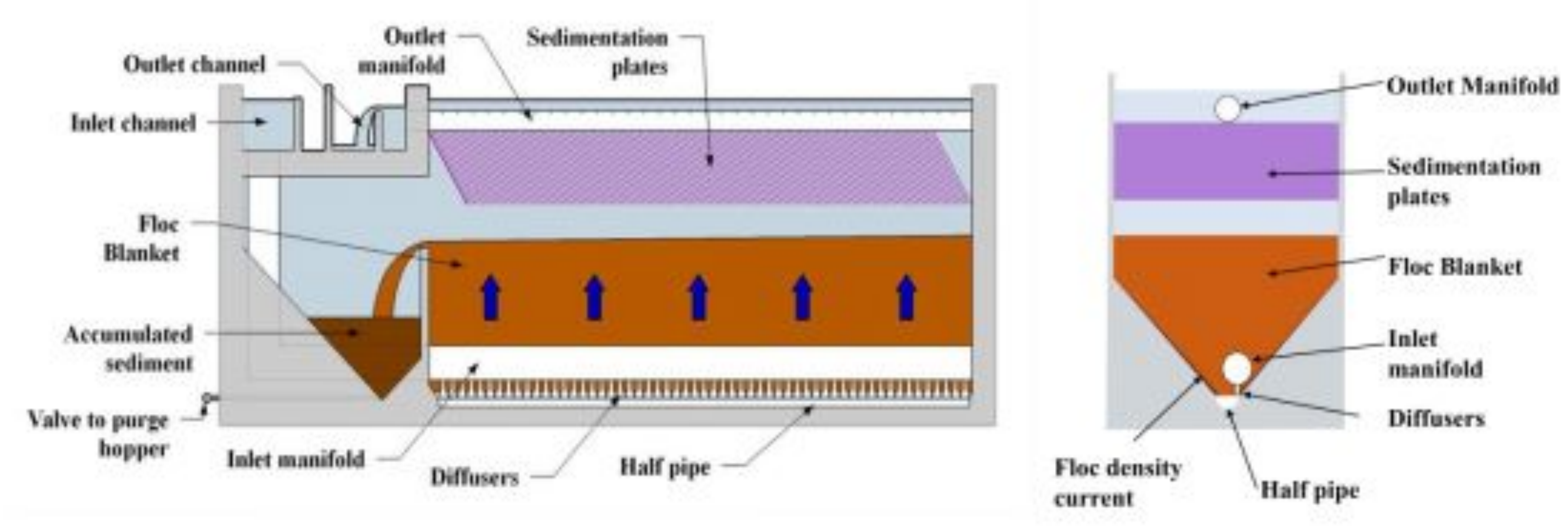

Figure 3: Side-by-side of plant sedimentation tank and lab model

Sedimentation tank

The Basics

Figure 4: Flocculator

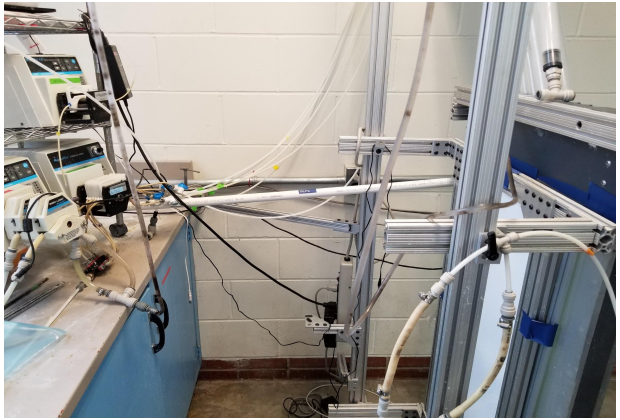

Figure 5: Connection from the sedimentation tank to the pumps

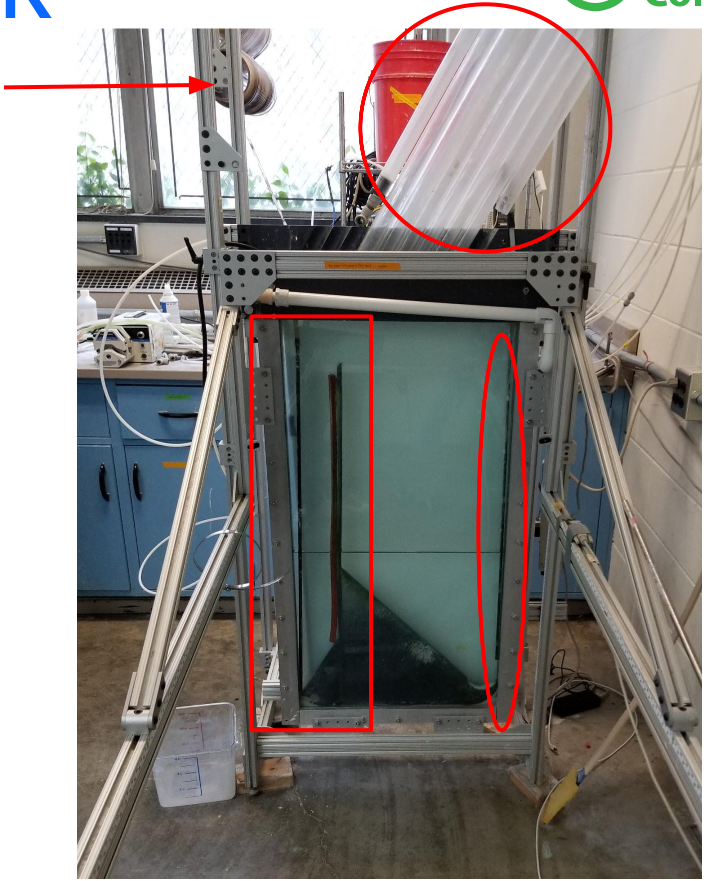

Figure 6: Sedimentation tank model

New Operations

Figure 7: The new setup

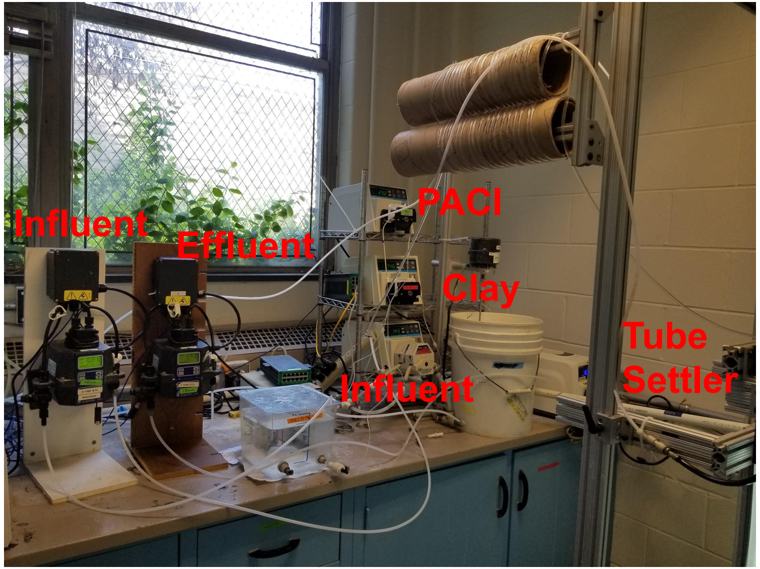

Figure 8: Lab setup

Figure 9: The tube settler connection

Choosing Configurations

```
#inputs
C_sys = 4.2*(u.mg/u.L)
C_labstock = 70.28*(u.g/u.L)
Q_sys = 1*(u.mL/u.s)
K_dilution = 5*(u.mL/u.L)
V_reservoir = 5*(u.L)
Frac_reservoir = .76
Q_per_rpm = .00195 *(u.mL/u.s)
```

Figure 10: Python calculations for dosing and flow

Figure 11: Clay entering the tank

Goals & Plate Settler Theory

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In lab goals:

- Cleaning and baseline tests
- Modeling a plate settler insert

How Plate Settlers work:

- Capture velocity - model applied to a tube
- Getting the longest possible path of a floc

$$\frac{d}{V_c\cos(\alpha)} = \frac{L + d\tan(\alpha)}{V_\alpha} = \frac{L\sin(\alpha) + \frac{b}{\cos(\alpha)}}{V_{up}}$$

$$V_c = \frac{dV_{up}}{L_{tube}\sin(\alpha)\cos(\alpha) + d}$$

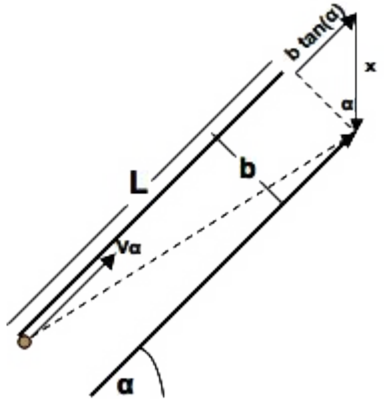

Figure 11: Longest possible path of a floc through a sedimentation tube

Introducing new plate settlers

- Increasing the area where the flocs can settle

- **<u>Best possible outcome:</u>** A stabilized floc blanket; equal density of flocs throughout the whole blanket.

Figure 12: Plate placement device

Designing and Testing

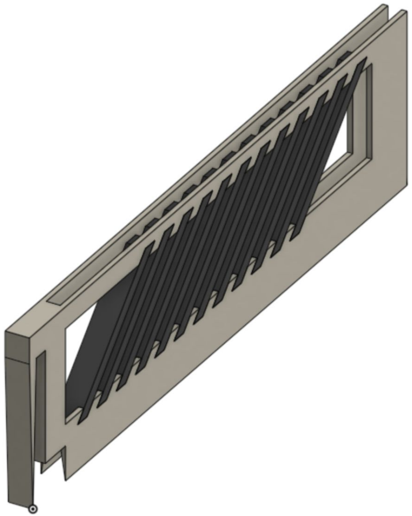

Figure 13: Top isometric view of model

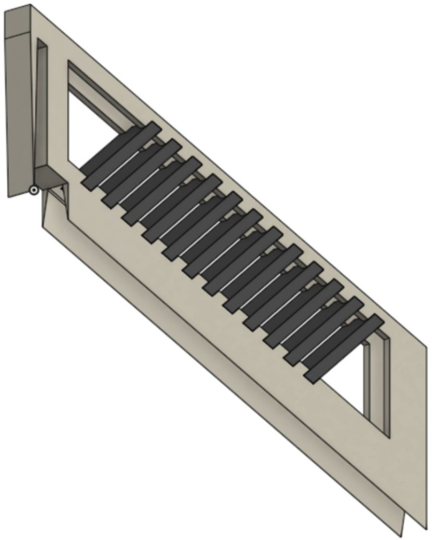

Figure 14: Bottom isometric view of model

- Testing without opening the tank
- Module-oriented design
- Minimizing the unwanted effects on flow
- Proof of concept

Figure 15: Bottom view of model

A New Approach

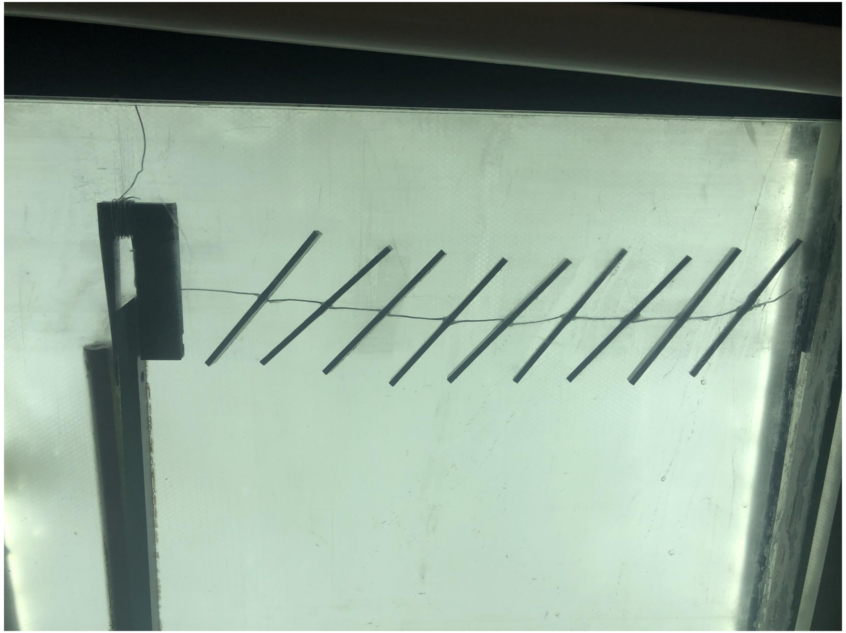

Figure 16: New plate settler design

- Printing problems leading to new ideas
- Drop lines
- Slide on, slide off
- Minimize sedimentation interference

What Is Next

Possible adjustments in the plate settler apparatus:

- Two stiffer wires
- Anti-deformation latching device
- Putting silicone in the sides of the plates
- Adding a second effluent pump
- Fixing the leakage across the inner-tank.
- Trying different materials, thickness, distance between plates, wires, etc.

Figure 17: Sedimentation tank with the new plate settlers

Questions and Recommendations

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Appendix Slides

Troubleshooting the Tank

Figure 18: Sedimentation in the tank

<u>If the sedimentation tank is not working, try...</u>

- Calibrating the turbidity meters
- Ensuring the influent valve is turned off when not in operation
  - Prevents pressure build-up
- Verify the clay-mixer is properly turned on
- Cleaning the tank using the sponge
  - Removes large particle clogging
- Reconnecting the sensors and pumps to ProCoDA

Floc Blanket Formation (x60 Speed)

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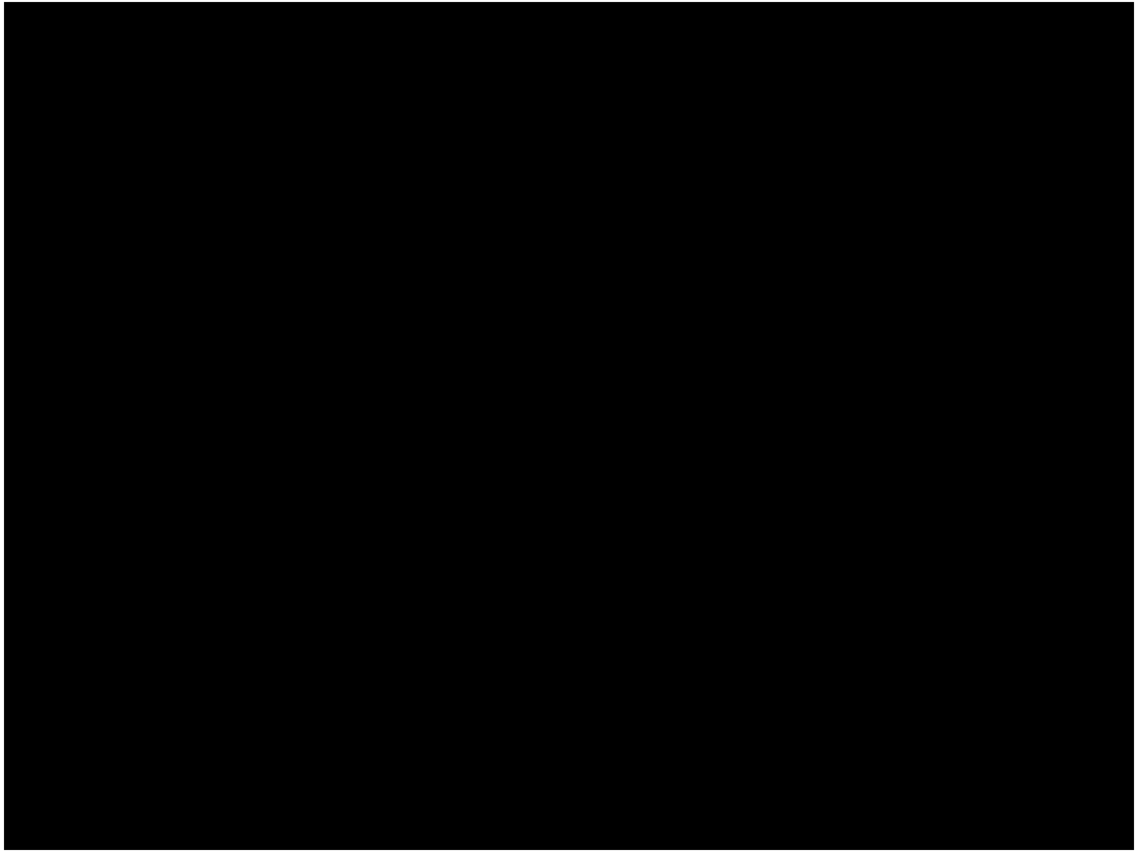

Expression for Collision Potential

$$CP_{fb} \propto C_{fb}\,\theta_{fb}\,v_{hindered}$$

$$CP_{fb} \propto \frac{C_{plant} + C_{recycle}\Pi_{recycle}}{\left(1 + \Pi_{recycle} - \frac{v_{hindered}}{v_{up}}\right)\left(1 + \Pi_{recycle}\right)}\,\frac{H_{fb}\,v_{hindered}}{v_{up}}$$