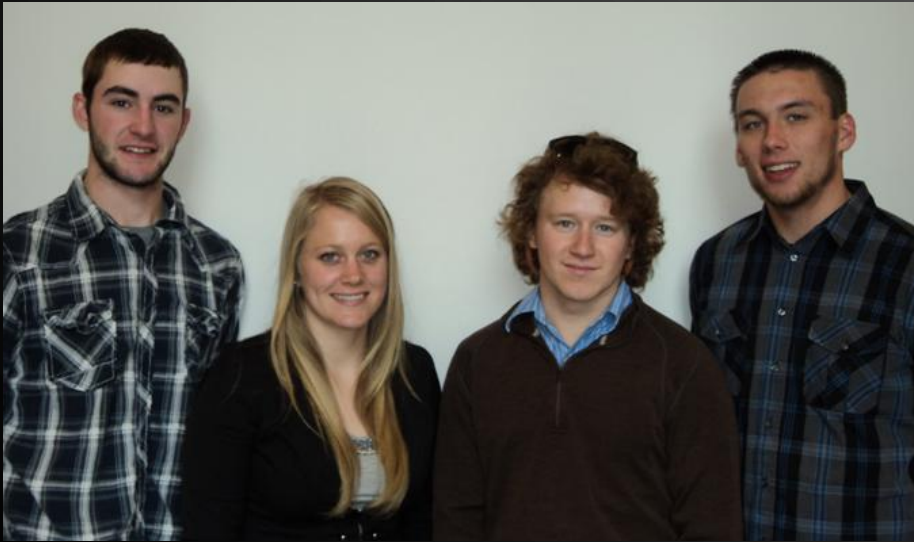


DYNAMIC COMMERCIAL FISHERY RACEWAY CLEANING SYSTEM



TEAM FINS FOR FILTRATION:

LEVI DAWES, KATE WICHER, MATT FRANCIS, JEREMIAH SCHROEDER

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY OF IDAHO

INSTRUCTOR: DR. TAO XING

THE PROBLEM

Clear Springs Inc. is a commercial fishery that maintains fish populations near raceway capacity. To ensure the health of their fish and their business they are looking for a more efficient way to clean their raceways.

Push-screen Method



Vacuum Pump Method



THE FACTS ABOUT CLEANING

- Cleaning is done manually using a screen and vacuum method
- Cleaning takes ≈ 112 hours/week
- Cleaning is an important aspect of fish health
- Particulate suspension decreases water quality
- Particulate increases potential for fish disease



Large Fisheries Need a Better Solution

$Q_{avg} = 7$ cfs $Depth_{avg} = 3$ ft

Raceway = 18 ft x 120 ft

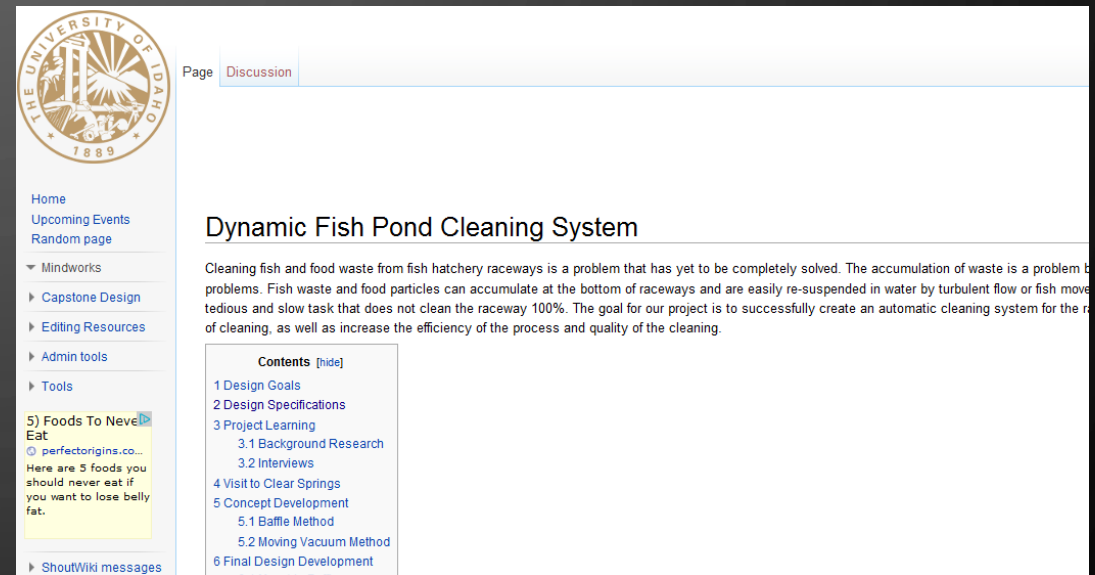
TEAM OBJECTIVE

Our objective is to design an automated cleaning system which requires little maintenance to reduce fine particulate from accumulating in raceways. Flow rates through the raceway should not be sacrificed in order to ensure fish health.



ACCOMPLISHED WORK

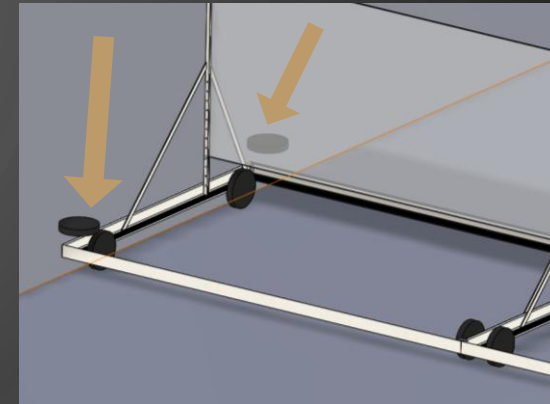
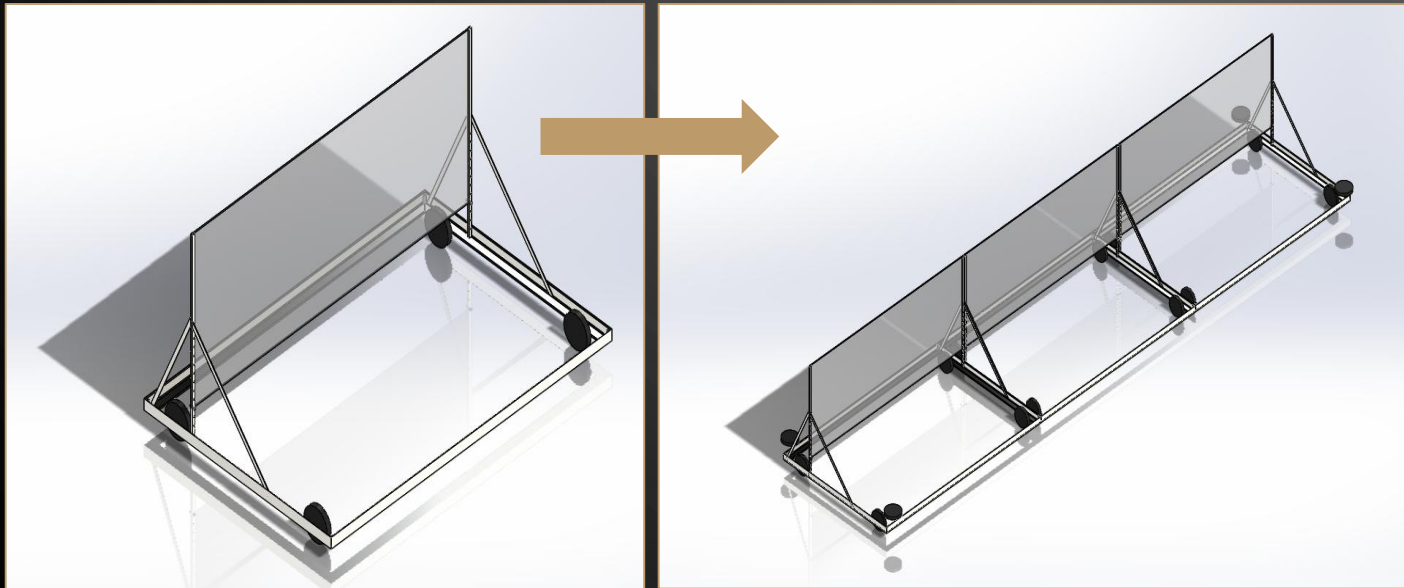
- Preliminary Model Scale Flume Testing
- Prototype SolidWorks Modeling
- Preliminary CFD Analysis
- Informational Wikipage



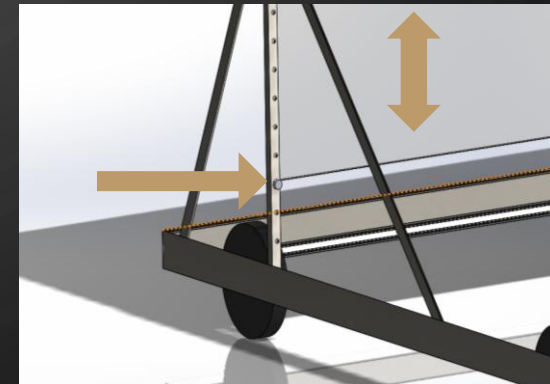
Find our Project on the *Mindworks Website*

SOLIDWORKS MODELING

Three Piece Full Scale Baffle Design



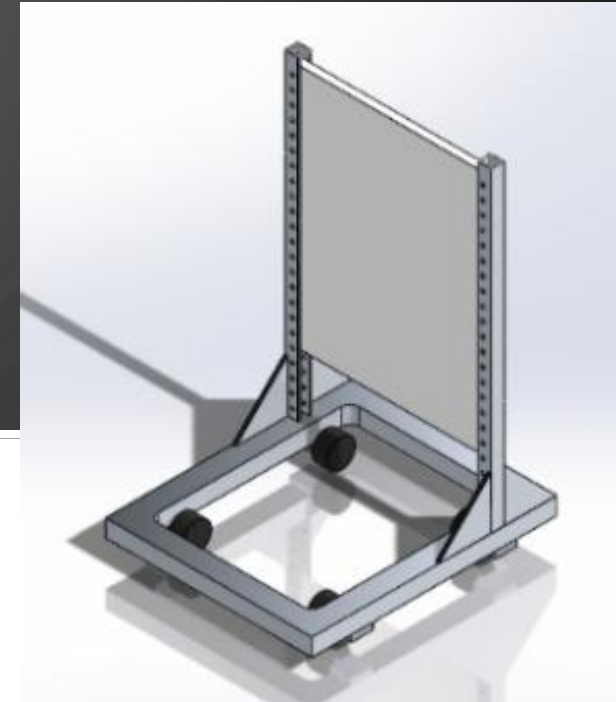
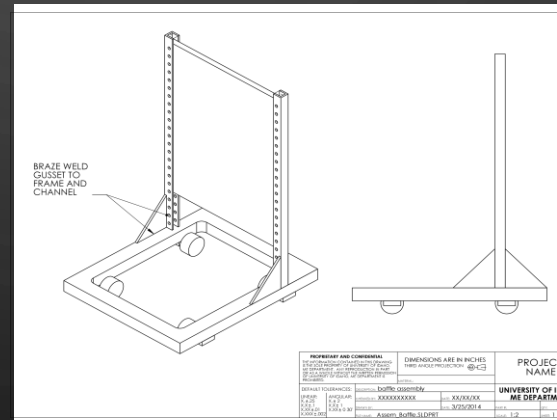
Horizontal Wheels



Pin-and-Hole Connections

MODEL SCALE TESTING

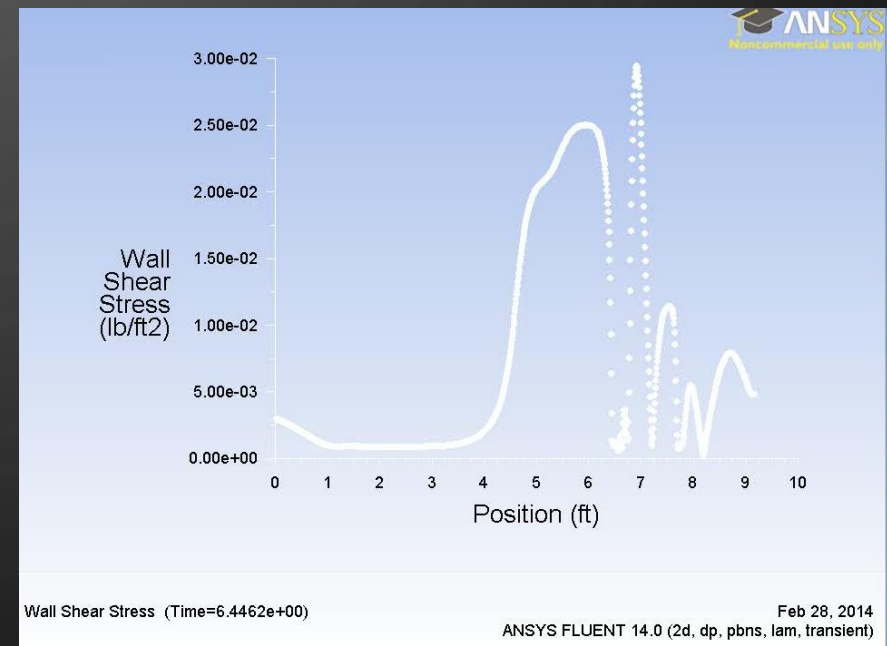
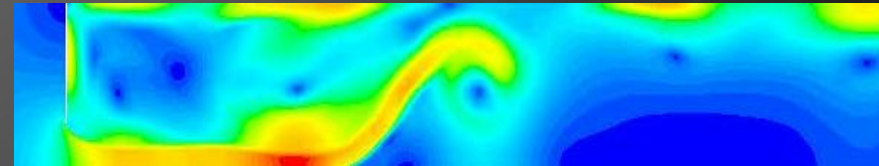
- Adjustable baffle wall height
- Only allows passage of water below the baffle wall
- Moved by the force of water (no external power needed)
- Detachable horizontal plate
- Lightweight/waterproof material



COMPUTATIONAL FLUID DYNAMICS

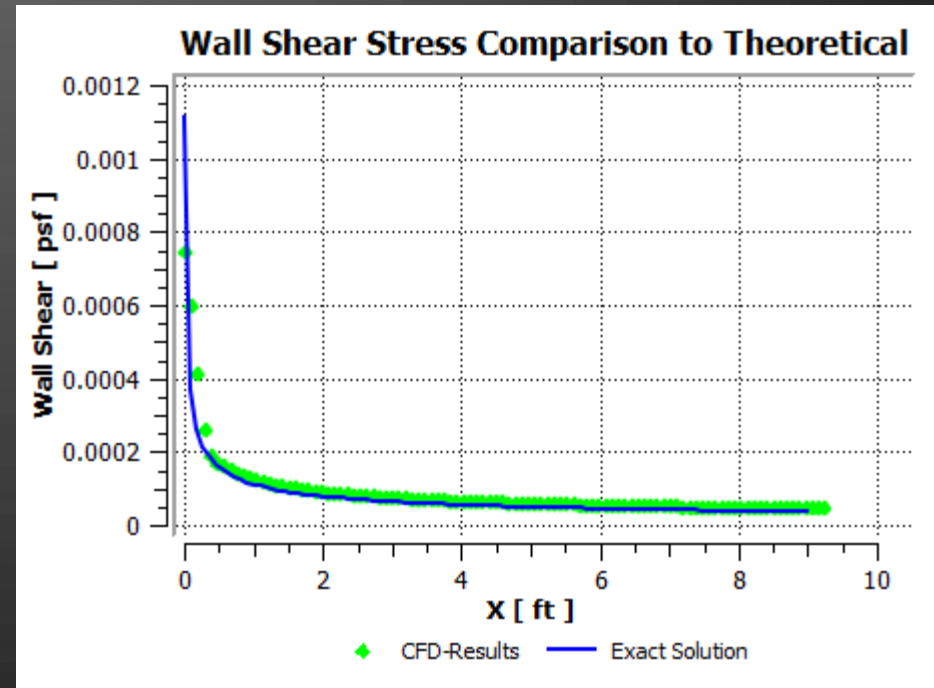
Goals

- Determine maximum baffle height that still re-suspends biosolids
- Analyze flow patterns to better understand why clouding occurs with a baffle
- Explore possible modifications to the geometry of the baffle for reduction of clouding



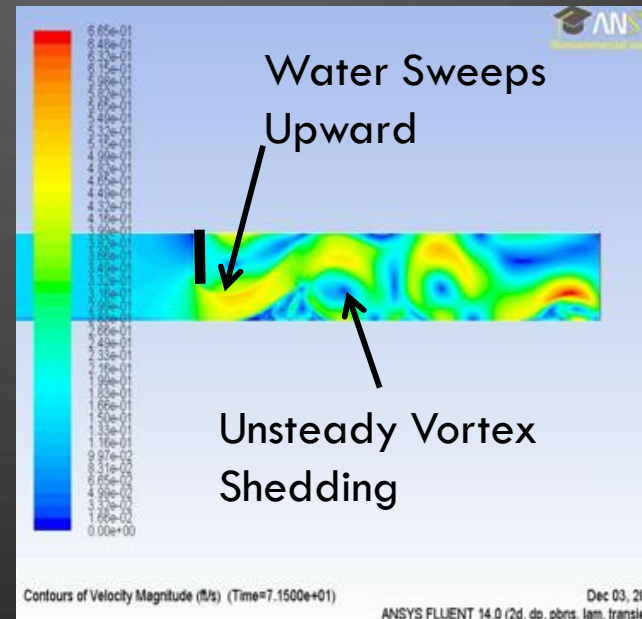
SIMULATION SETUP

- Application - ANSYS Fluent
- Geometry - Length and depth to match model scale flume
- Baffle placed in center of flume
- Grid – Uniform Spacing 100 X 1100
- Uniform velocity inlet and pressure outlet
- Transient simulations with video capture of velocity contours and plots of shear stress on raceway floor
- Conducted three separate studies

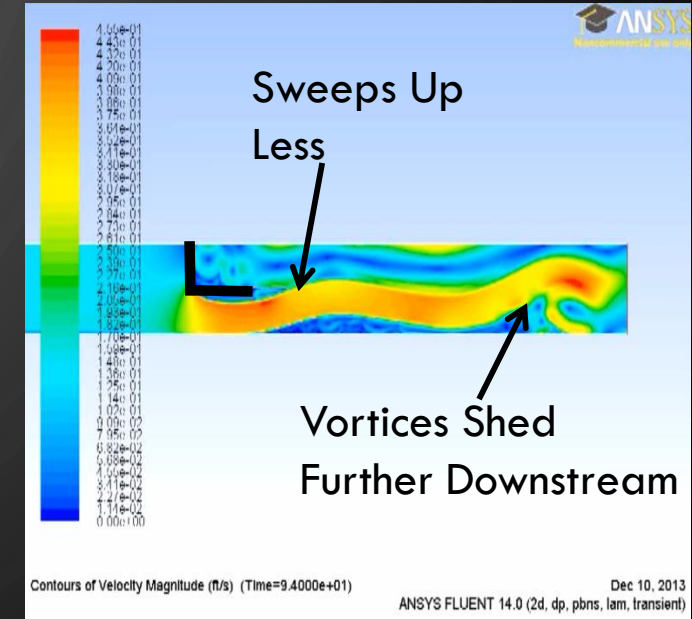


BAFFLE MODIFICATIONS

- Inlet velocity was the same as full-scale conditions
- Analyzed five different possible modifications to the baffle geometry
- Results – Horizontal plate modification appeared to be a significant improvement
- Raised questions regarding proper scaling of inlet condition



Vertical Baffle

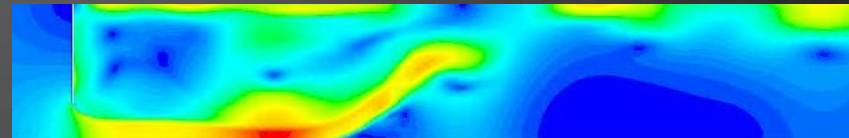


Vertical Baffle with
Horizontal Plate

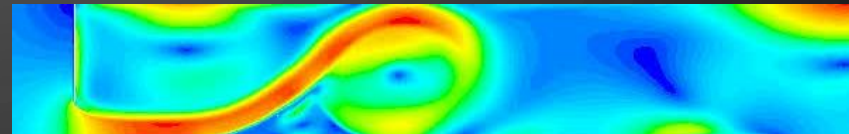
VELOCITY SCALING

- 1 simulation with full scale dimensions and conditions
- Model scale simulations with inlet velocity the same or scaled with Reynolds number and Froude number.
- Reynolds number simulation matched most closely
- Increased velocity
- Decreased time scale
- Increased shear stress

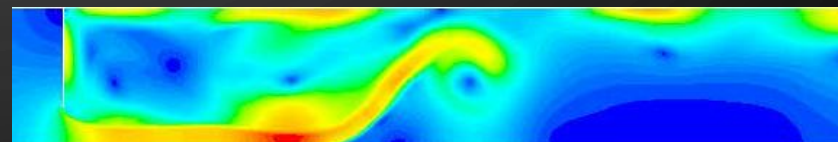
Full Scale



Model scale – Same velocity



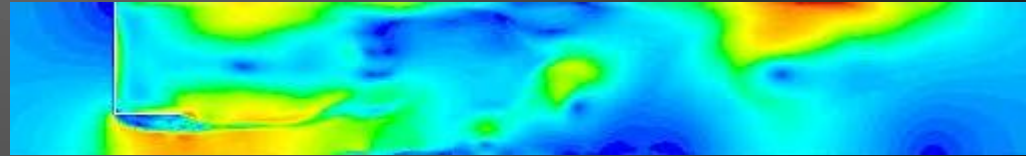
Model scale – Reynolds number



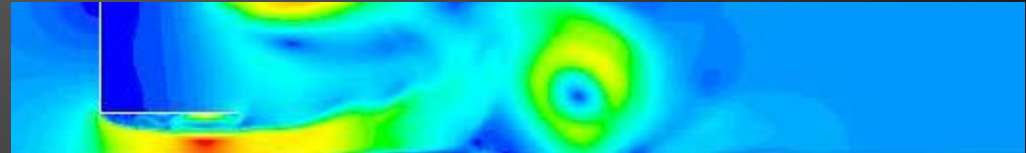
HORIZONTAL PLATE LENGTH

- Simulated four different lengths of horizontal plates
- Reynolds number similarity
- Longer plates seemed to work better
- Under these conditions, the horizontal plate may not be an improvement

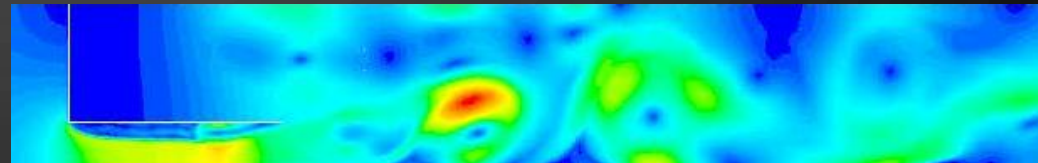
4 in



8 in



12 in



16 in



EXPERIMENTAL TESTING

SMALL SCALE BAFFLE IN A FLUME

- Analysis of proposed baffle geometry
- Tested a moving baffle
- Experimental testing of gap size
- 3D observations of particle movement and re-suspension

Flume

$$V_{avg} = 0.0676 \text{ ft/s}$$

$$Q_{avg} = 0.025 \text{ cfs}$$



TO CONSIDER...

SPECIFIC FORCE TO FIND GAP SIZE

Where y is the baffle gap size, b is the flume width, Q is the flow rate, and V is the velocity

With this calculated in a per unit area basis for the small scale flume, we get a recommended full size baffle gap of 5.4 inches.

Specific Force Equation:

$$SF = \rho g y^2 \frac{b}{2} + \rho Q V$$

MODEL SCALE TESTING : NO-NOTCH



MODEL-SCALE TESTING : NOTCH-ONE



MODEL SCALE: HORIZONTAL PLATE



RECOMMENDATIONS

Solution Type: Baffle

- A vertical baffle to concentrate biosolids in quiescent zones
- Stopping baffle before it reaches the end of the raceway
- Vacuum pump cleaning in quiescent zones

Benefits

- Reduces hours employees spend cleaning
- Automates cleaning without entering raceway
- Can be moved from one raceway to another
- Low maintenance
- Lasting low-cost solution