IOWA STATE UNIVERSITY
Environmental Engineering and Department of Agricultural and Biosystems Engineering

Resuspension of *E. coli* from stream bottom sediments

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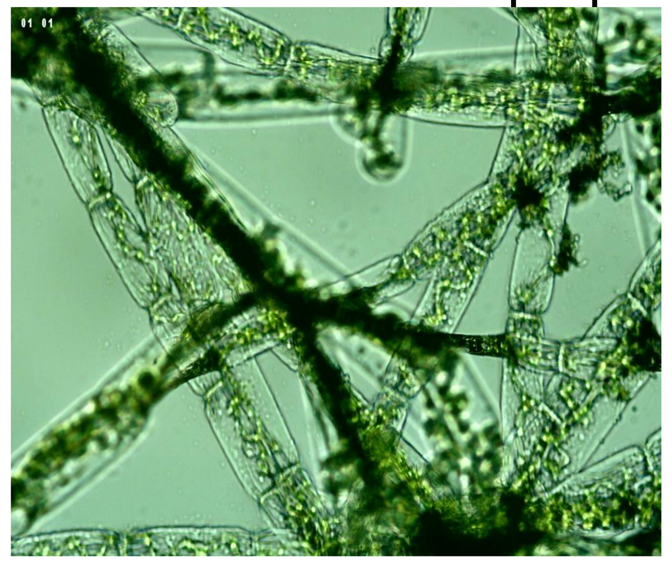
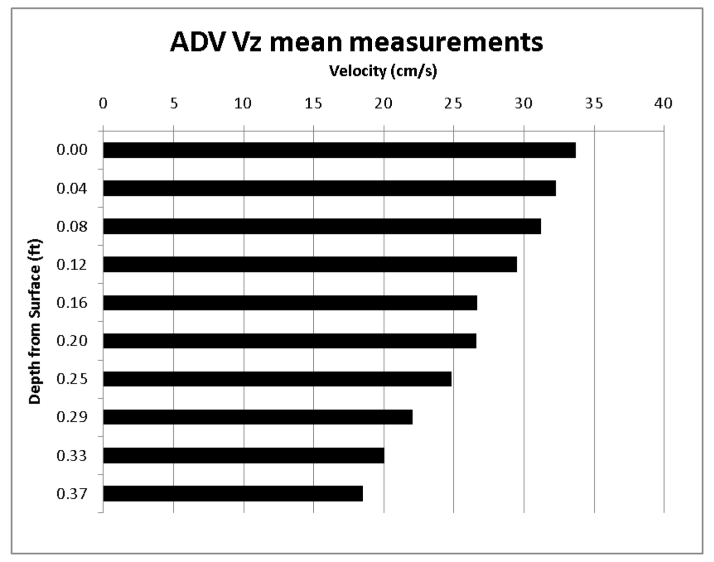
Introduction:

Photo 1: Spring Biofilm Collection

E. coli are found in the intestines of warm blooded animals and are used to indicate the presence of pathogenic organisms, which when present in waters, pose a risk to public health. Watershed scale water quality models do not account for the *E. coli* that survives in the bottom sediments of streams and is resuspended during high flows or storms. The microorganisms in streams are suspended along with sediment particles or in the freely suspended state. The goal of my research is to improve water quality models and better predict the risk to human health through the following objectives:

- Test resuspension of *E. coli* in a laboratory flume
- Develop models of *E. coli* resuspension dependent on flow and sediment properties





Right- Figure 1. Biofilm growth from flume, Left-Figure 2: Velocimeter Mean measurements in flume

Methods:

Each test was completed in a recirculating flume and samples were collected at eighteen collection points (fig. 3). Resuspension of *E. coli* was repeated over a range of flows with three substrates: sand, sand-silt and sand-silt-biofilm (fig 1, table 1).Velocity was measured with an ADV (fig. 2) and particle sizes were measured with a LISST (Laser in-situ scattering and transmissometry) device (fig. 6). *E. coli* was analyzed using membrane filtration techniques.

Substrate	Flow rates (m^3/s)	Critical Shear Stress (N/m^2)	Depth (m)	% Attached
Sand	4.45E-3 to 1.04E-2	2.48E-01	2.8 to 1.7	3% to 17%
Sand/Silt	1.56E-3 to 5.44E-3	1.33E-01	1.6 to 2.8	12% to 57%
Sand/Silt/Biofilm	1.42E-2 to 1.61E-2	1.91E+00	1.7 to 2.8	9% to 82%

Table 1: Parameter outline for experiments completed. Shear stress was calculated to run test below and above critical velocity.

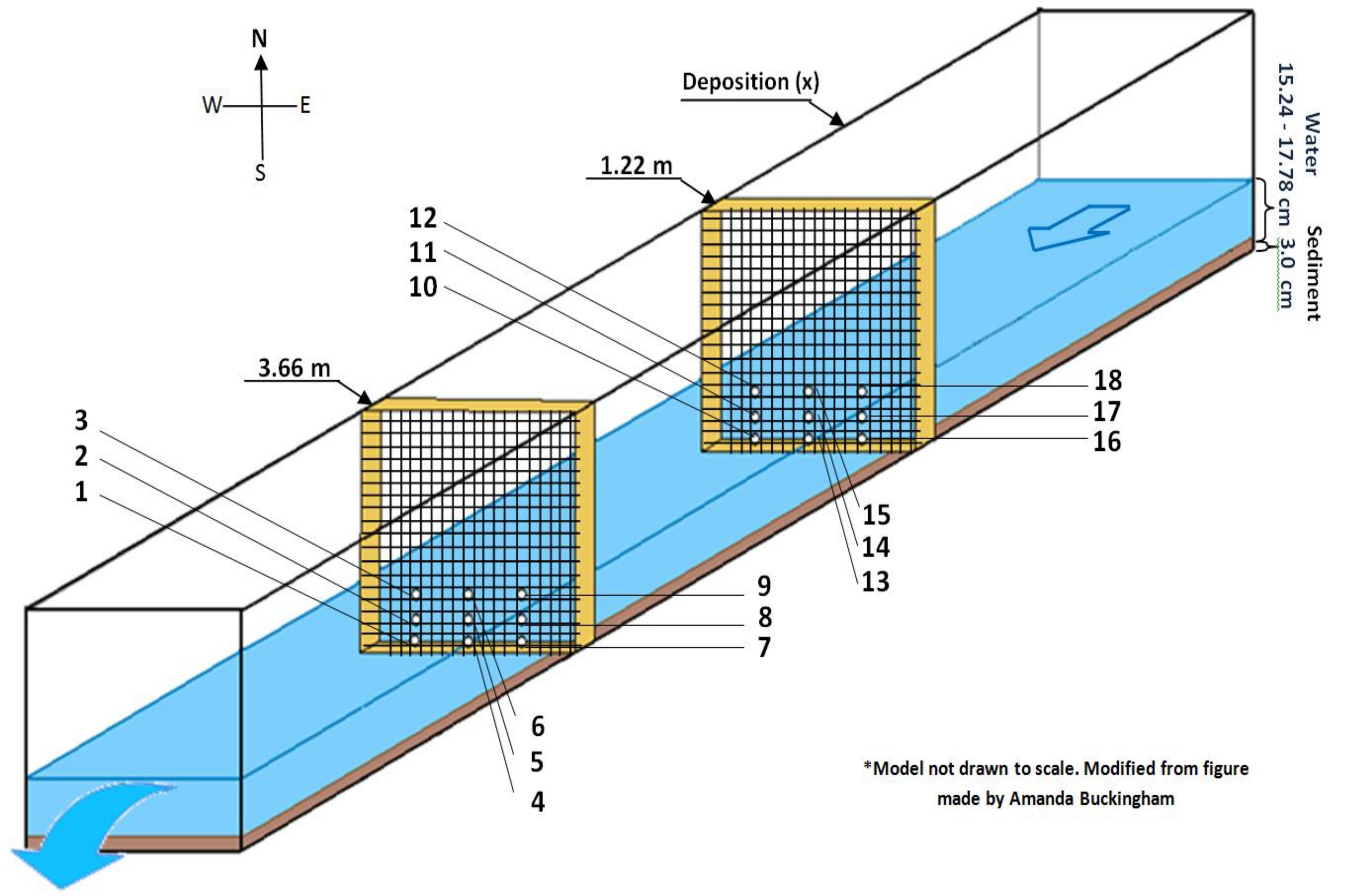
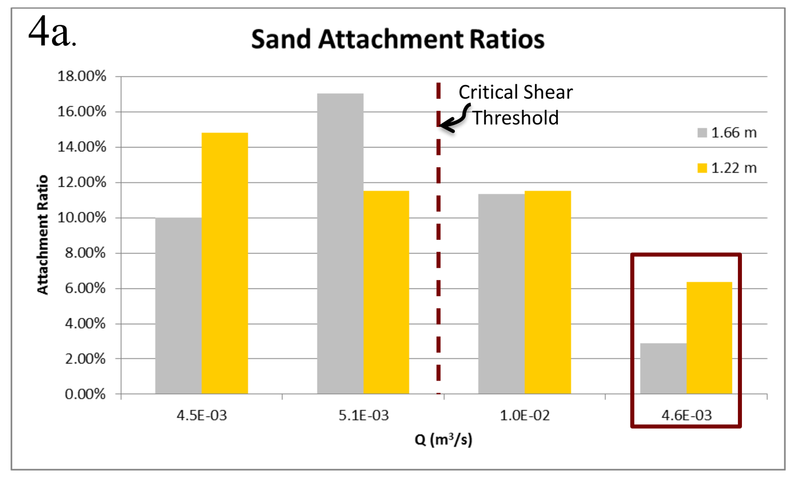
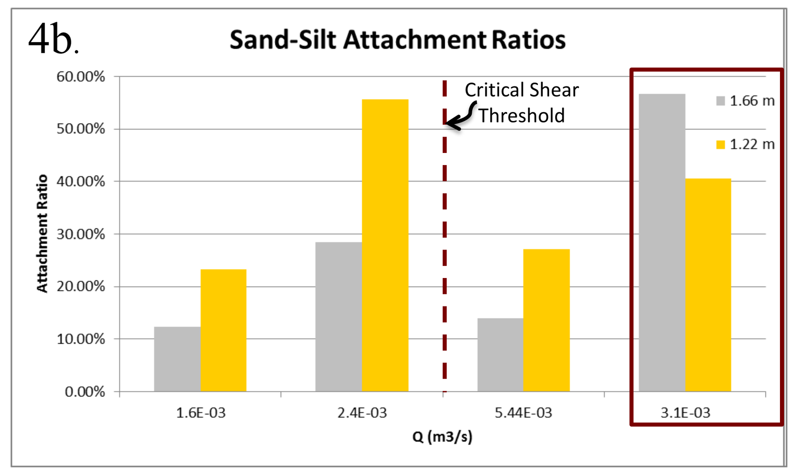


Figure 3: Flume sampling 18 points and sediment water ratios, inoculation would happen in the sediment of the flume from 0 to 3.66 m.





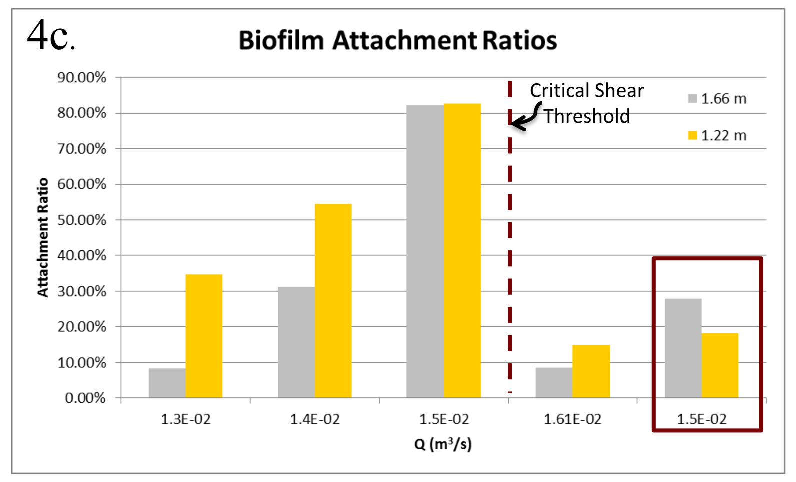
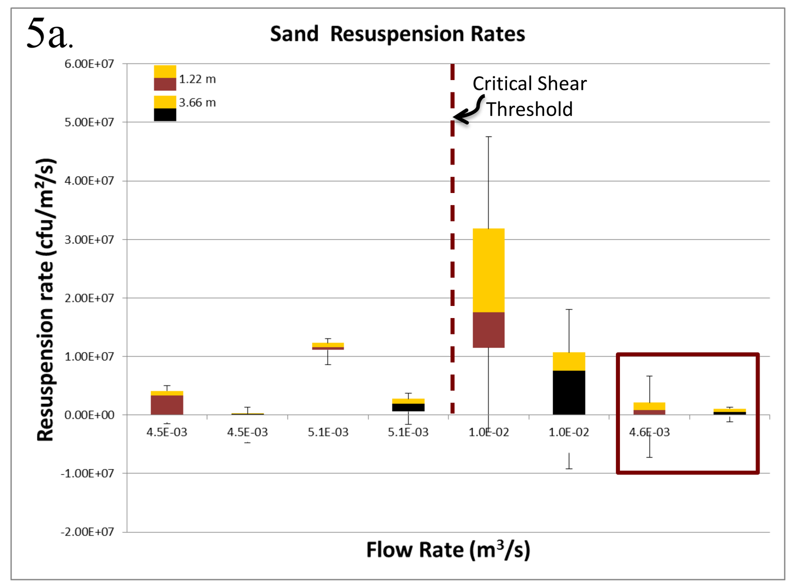
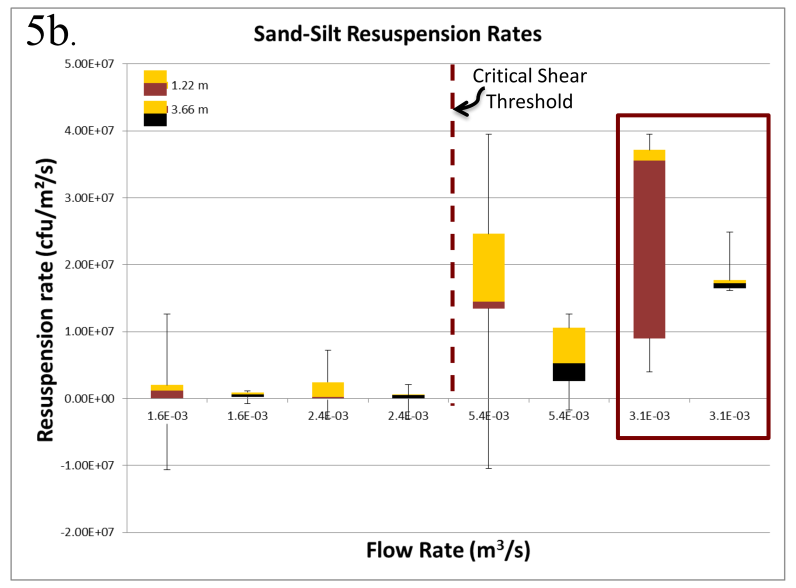


Figure 4 a-c: Attachment ratios at 1.22 m and 3.66 m, two locations where samples were collected in the flume. Measurements were collected at water depth of 0.17 meters except for final sample at 0.23 meters (outlined in red).





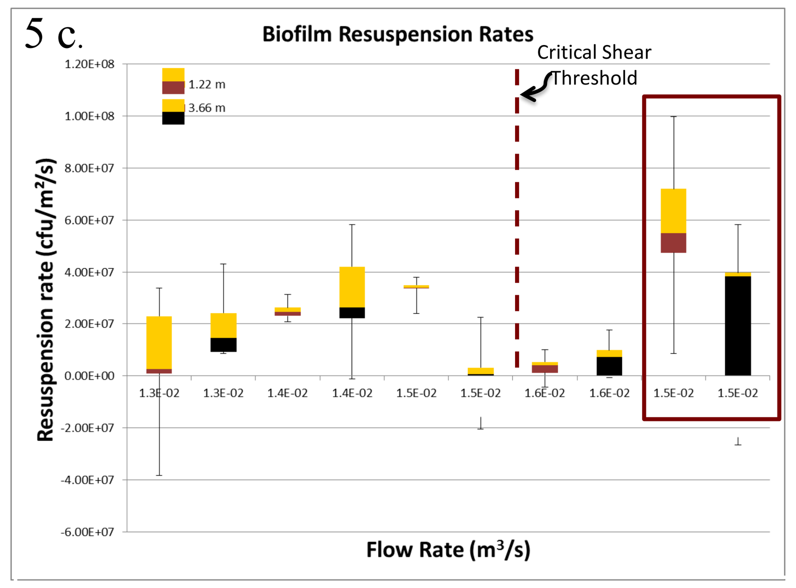


Figure 5 a-c: Resuspension rates at 1.22 m and 3.66 m. Resuspension for sediment area upstream of the testing site. Measurements were at depth 0.17 meters except for final sample at 0.23 meters (outlined in red).

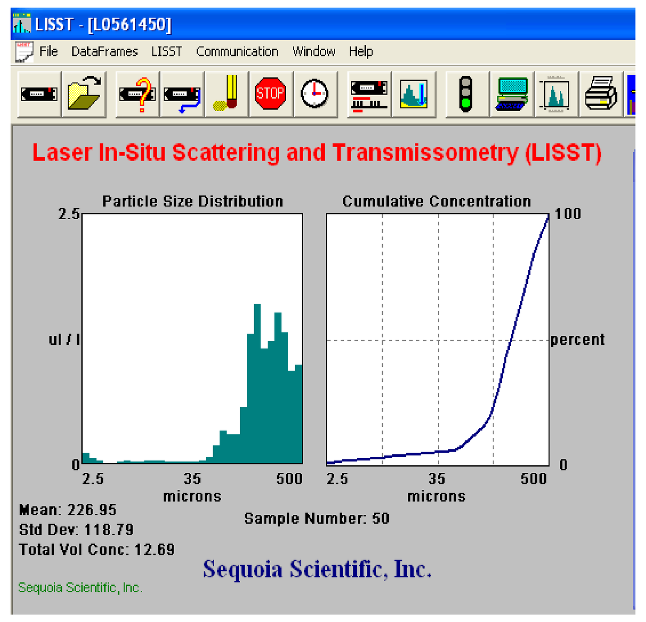


Figure 6: LISST Particle size distribution and Cumulative Concentration Diagrams

Results:

Results from the thirteen completed experiments are complied in Table 1. This shows the flows, water depths, and critical shear stresses tested for the three substrates. The percent attached ranged from 3 to 82%. As seen in Figure 4, the percent attached increased with flow but then decreased at flows above the critical shear threshold. The resuspension rates generally increased as the velocity increased, except in the case of the biofilm. Sand and biofilm experiments with a higher water depth resulted in lower attachment ratios. The higher water depth for sand-silt experiments resulted in higher attachment and resuspension rates.

Future work and Implications:

Results will be evaluated using sediment resuspension equations to predict resuspension of microorganisms. Developed equations will be tested on data collected from field resuspension experiments. Results will be useful for water quality modeling and TMDL development by the Iowa Department of Natural Resources (IDNR). The results of my project could also potentially assist wastewater treatment plants as they determine appropriate *E. coli* discharge levels and prevent future infractions of regulations.

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Photo 2: Amy Cervantes preparing for a run

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