## Introduction:

Introduce the problem statement with regard to lattice Boltzmann and colloidal particles here.

1. Describe what colloids are
2. History of colloid research (brief relevant)?
3. Describe why we care about them environmentally (colloids sorb chemicals, viruses, bacteria and can increase transport rates)
4. Briefly describe the approach that was taken for performing research
5. Define the structure of the paper (in the approach?)

## Lattice Boltzmann

### 2.1 Lattice Boltzmann introduction

1. Describe what lattice Boltzmann is/why it is an import method
2. Brief history of relevant LB research
3. Describe the problem with regard to LB research (Lots of image analysis methods, many to choose from
4. Brief overview of the project approach

### 2.2 Lattice Boltzmann methods

1. Lattice Boltzmann methodology including equations and review
2. Image Analysis methodology and overview

### 2.3 Results

1. Lattice Boltzmann results (No reliable predictions!)
2. Kozeny-Carmen results too (Follow the LB-predictions)

### 2.4 Discussion and conclusions

1. Wrap up the section with analysis of the results and organic matter issues.

## Colloid model development

### 3.1 LB-Colloid introduction

1. Describe the importance of colloid transport
2. Brief history of relevant of colloid research
3. Describe the problem with regard to previous research (long model run time, closed source simulation software, overly complex, etc…)
4. Brief overview of the project approach

### 3.2 LB-Colloid methods

1. Describe the relevant mathematics used within the LB-Colloids simulation software
2. Brief background on the equations, and meaning of each term (what it is, where its from, what it calculates)

### 3.3 Initial results

1. Display sensitivity analysis results from initial runs of colloids models

### 3.4 Discussion

1. Interpretation of the initial results with regard to principal components of the colloid equation

### 3.5 Outcomes/Deliverables

1. Reference the LB-Colloids user manual (Appendix #{}) and describe the functionality and extensibility of the software

## LB-Colloids validation

### 4.1 Introduction to graphene simulation

1. Describe the importance of graphene transport
2. Describe background research on graphene transport
3. Describe the research problem
4. Brief overview of the project approach

### 4.2 Simulation initial conditions/methods

1. Describe the initial conditions for simulating colloid transport
2. Describe the laboratory setup for colloid breakthrough experiments

### 4.3 Results

1. Show initial results for LB-Colloid simulations
2. Identify limitations with the results

### 4.4 Calibration

1. Describe the model calibration process
2. Display the calibrated simulation results

### 4.5 Discussion

1. Talk about the limitations/advantages of this approach
2. Link CDE to a field based approach if possible (maybe show a Hydrus1d run of colloid transport)

### 4.6 Conclusions

1. Conclude research with ‘Life’s a happy song’