Arsenic

- Is it possible that flocculation could be a part of this research? From what I understand, the current experiment focuses on sedimentation (centrifuge), but I'm wondering how we could experiment with fractional coverage and collision potential without having a high-flow system like the laminar tube-floc set-up. Past research has explored coagulant dose, but perhaps AguaClara flocculation technology might improve results.
- We will need to move to continuous flow experiments at some point. Sedimentation is not a good process to be using for these low turbidity samples. Direct filtration is a much higher rate process than sedimentation.

Goals

Arsenic contamination of groundwater is a common problem and one of the methods of removing arsenic is based on flocculation and then removal of the flocs.

Review the report from the previous semester for literature review and background on the many hypothesized mechanisms. Our hypothesis is that arsenic removal requires good contact between arsenic and coagulant precipitate (hence a focus on rapid mix) followed by a highly efficient removal of the flocs that are loaded with arsenic. Given the low turbidity of most groundwater and the very low concentrations of arsenic relative to normal coagulant dosages, it is expected that a low coagulant dose should be adequate if there is ample opportunity for mass transport of arsenic to the coagulant precipitate. If a low coagulant dose is sufficient, then a SRSF should be able to capture the precipitate and produce a very low arsenic concentration. Given that arsenic removal efficiency will likely be correlated with coagulant precipitate removal efficiency, it may be beneficial to use 2 SRSF in series to enhance particle removal and provide additional protection against arsenic laden coagulant precipitate making it into the finished water.

It is possible that rapid mix flocculation, floc blanket, plate settler sedimentation, and SRSF would provide a better system for arsenic removal. This disadvantage of using this treatment train is that flocculation and

sedimentation require much larger (and more expensive) reactors than an SRSF. Thus it would be better if an efficient arsenic removal system could be created that doesn't require a sedimentation tank. Some flocculation time might be necessary to provide opportunity for more contact between arsenic and the coagulant precipitate.

The removal of arsenic by precipitation is expected to be limited by the transport of arsenic to the solid surface of the coagulating agent (either iron or aluminum salts). The flocculation process for groundwater containing arsenic is expected to be inefficient due to the low floc volume fraction. To compensate for the low floc volume fraction it may be necessary to use a longer residence time. Loss of coagulant to the walls of the reactor will also likely be a major problem for small scale reactors given the low solid surface area in suspension. It may be advantageous to use a contact chamber for rapid mix and initial precipitation to reduce losses to the reactor walls.

Devise methods to conduct research safely and to ensure safe disposal of arsenic contaminated waste. Determine the best way to prepare and to measure very low concentrations of arsenic. Design and fabricate a reactor system and data collection system that will make it possible for us to begin to optimize treatment processes for efficient and reliable arsenic removal. Determine how to create a raw water for testing. Should the raw water be created from distilled water or from tap water? What should be added to the raw water to set the ionic composition? How should pH be controlled?

Big Questions to begin answering

- Is arsenic removed by coprecipitation with the coagulant or by adsorption to previously precipitated coagulant? This can be be tested by adding arsenic to a suspension of previously formed flocs or adding coagulant to a solution of arsenic.
- Which coagulant, Fe(Cl)3, alum, or PACl is better at removing arsenic?
- Is arsenic removal limited by the mass transfer of arsenic to a precipitated coagulant surface, or by capture of the precipitated coagulant by plate settlers and filters?
- Would a floc blanket formed from coagulant precipitate enhance arsenic removal?

- Does addition of a small amount of clay enhance flocculation and arsenic removal?

Hypotheses to test:

- Extended rapid mix time improves arsenic removal efficiency
- Extended flocculation time improves arsenic removal efficiency
- Arsenic removal efficiency is correlated with aluminum removal efficiency
- Arsenic removal efficiency cannot exceed aluminum removal efficiency

One of the team members needs to become an expert on using the graphite furnace atomic absorption spectrophotometer (GFAA). Work with William Pennock to learn how to use the GFAA. Read the arsenic measurement method in standard methods and in the GFAA manual (near the instrument in HLS 150).

Determine appropriate furnace conditions (temperatures and times) for the dry, char, and atomize cycles for varying sample sizes. Investigate alternative graphite tube types (some are coated, others not, and some have depressions for holding the sample) and make a recommendation. Evaluate whether background correction with a deuterium light source is desirable or whether split beam operation would be preferred. Recommend an analytical wavelength and slit. Learn the procedure for optimizing furnace and beam alignment. Prepare a calibration curve with a series of As standards. Write up all findings and procedures for future use.