Groundwater Pump & Treat System Optimization Evaluation

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Background/Objectives. Langan assumed operation and maintenance of the treatment system in upstate New York in February 2018. As a part of whole system optimization, an on-site treatability was conducted to evaluate the groundwater pump and treat system . A series of 13 bag filters are used to remove solids from a 30 to 50 gpm extracted groundwater flow stream. However, system operations are constrained because of rapid filter clogging, requiring site inspections and maintenance three to four times per week. Such frequent filter changes increased the system labor requirements and constrained flow rates through the system, reducing effectiveness and increasing operational costs. The frequent maintenance effort also increased the carbon footprint of the system operation. Sodium hypochlorite was previously added to the extraction flow, but showed little effect in controlling the clogging issues. The objective of the system optimization is to identify a solution to the clogging issues and reduce the system carbon footprint.

Approach/Activities. In March 2018, Langan conducted the on-site bench-scale study, testing 18 different disinfectant, biocide, biodispersant, and anti-scaling agents. Langan suspected that the clogging issues were likely caused by a combination of microbial growth and mineral deposits. The testing program was designed to target both abiotic and biotic factors. The study was completed in three phases:

- Phase I: During this phase, bromine- and chlorine-based disinfection agents and organic biocides were tested to determine their site-specific effectiveness and dosages. The residual disinfection agent concentrations were measured along with visional observation of microbial activities under a microscope. The microbial populations were analyzed via Quantarray MIC (Microbial Insights, Inc.).
- Phase 2: During this phase, the disinfection and biocide agents were tested with and without biodispersants to determine their effectiveness for reducing microbial mobility and survival rates. Microscopic observation (video and photo records) and microbial analyses (plate count scan and RNA analysis) were performed.
- Phase 3: The effectiveness of anti-scaling and biodispersant compounds were tested through a bench-scale flow-through filtration system. The flow pressure and rate were recorded to evaluate agent effectiveness. The high flow and low filter back pressure suggested the optimal performance of the anti-scaling and biodispersant combination.

Between August and September 2018, a pilot test was performed to test the solution identified through the treatability test.

Results/Lessons Learned. The study identified the synergistic impacts from both biotic and abiotic factors. The extracted groundwater was extremely hard with elevated calcium and magnesium levels. Calcium precipitation formed small pin-like crystals, which served as a niche for attached microbial growth. Observations showed that the

microbial population increasing by more than an order of magnitude in an approximately one-hour residence time within the system. As the pin-like crystals further collect and grow in the filter bags, a biofilm from the microbes develops, coating the bag filters and protecting the microbes from common disinfection agents. Therefore, both biotic and abiotic factors needed to be controlled to solve the clogging issue. Sulfurovum capable of forming biofilm was identified as the most abundant microbes. The results of the treatability test showed that a combination of the following reagents should be successful to control the filter clogging issues:

- An organic bromine product showed the most optimal results in controlling microbial population.
- An organic phosphate based antiscaling agent showed the most optimal results of dissolving and preventing scale formation.
- A biodispersant showed the optimal results at penetrating biofilm to allow disinfection agent to attack microbes.

The on-going pilot already showed that the filter change frequency was reduced to once per week. Modification of reagent dosage is ongoing to further reduce the filter change frequency.