SUMMARY: MANAGEMENT OF SUBSURFACE REDUCTIVE DISSOLUTION UNDERNEATH LANDFILLS

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High concentrations of iron have recently been observed in groundwater and soils around municipal solid waste landfills in Florida. The levels have been attributed to reductive dissolution from native iron in the soil perhaps caused by a shadowing effect of the landfill liner, which inhibits the reaeration of the shallow aquifer beneath the landfill. In this study, the research team will evaluate the validity of this hypothesis, develop a list of engineering management alternatives for controlling the release of iron in-situ, and conduct laboratory experiments on management methods for dealing with this issue.

Recently elevated concentrations of iron have been observed in groundwater monitoring wells down gradient of lined landfills in Florida. The source of this iron contamination has not been verified yet, but is potentially associated with the presence of the landfill by either one or both of the following mechanisms: 1) the source of the iron is direct release of iron from the municipal solid waste leachate, or 2) the source is from naturally-occurring iron mobilized from the soil due to changes in soil chemistry or local hydrology. After the source is determined, the immediate question is if iron is being mobilized, is this a sign that other, potentially more toxic metals, like arsenic, are also being transported downstream too? If this is the case, then how do we control these releases?

Once the source of the elevated iron is determined, the next step will be to determine if co-liberation of toxic metals is also occurring, and if so, to come up with an effective strategy to remediate the problem. The research team will focus on identifying viable engineering alternatives that will minimize the potential disturbance to the system, limit treatment costs, and produce the most effective results. The goal of this research is: 1) to investigate the key parameters governing reductive dissolution of iron; 2) to develop a list of engineering management alternatives for controlling the release of iron in-situ; and 3) to conduct laboratory experiments on methods for iron and co-contaminant removal from groundwater at landfill impacted sites.

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PROGRESS REPORT
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Project Title: Management of subsurface reductive dissolution underneath landfills
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Progress to Date:

- **Task 1**. **Develop a list of engineering alternatives for managing elevated iron levels**. The graduate research team of Richard Reichenbach, Ahmed Al Basri, and André McBarnette has started the literature review of in-situ management methods for iron mitigation. Preliminary results were compiled in late March 2011, and further refinement is ongoing.

- **Task 2. Conduct laboratory experiments on selected treatment technologies for managing iron dissolution**. We have conducted preliminary experiments to develop the aquarium testing unit set-up (Figure 1 and Figures 7 and 8). We have also received the custom reactor coil (Figure 2) for plug flow configuration of the pilot unit for testing. The existing PIMA and photocatalytic processes (Figures 3 and 4) are being modified for soil treatment. We are also very excited to report that we have received additional funding support from the FAU College of Engineering and Computer Science to purchase an advanced oxidation pilot plant unit for testing photocatalytic oxidation and ultraviolet radiation processes (Figures 5 and 6). This unit arrived in November 2010 and has been flow tested already.

Figure 1. Aquarium testing set-up

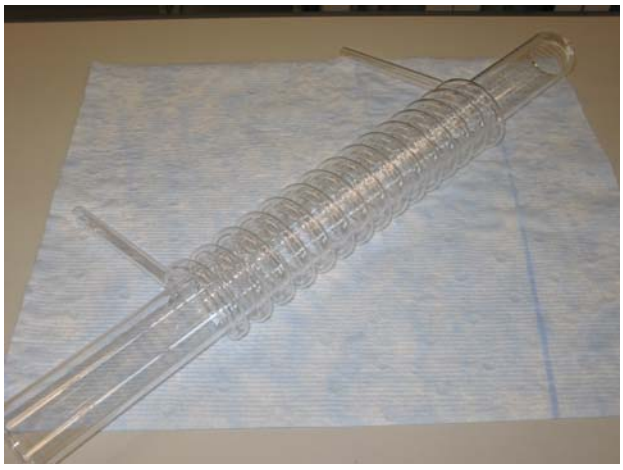

Figure 2. Custom quartz rector coil

Figure 3. UV reactor set-up

Figure 4. UV reactor safety cabinet

Figure 5. Falling film reactor

Figure 6. Pump and treat pilot plant

Figure 7. Aquarium testing unit

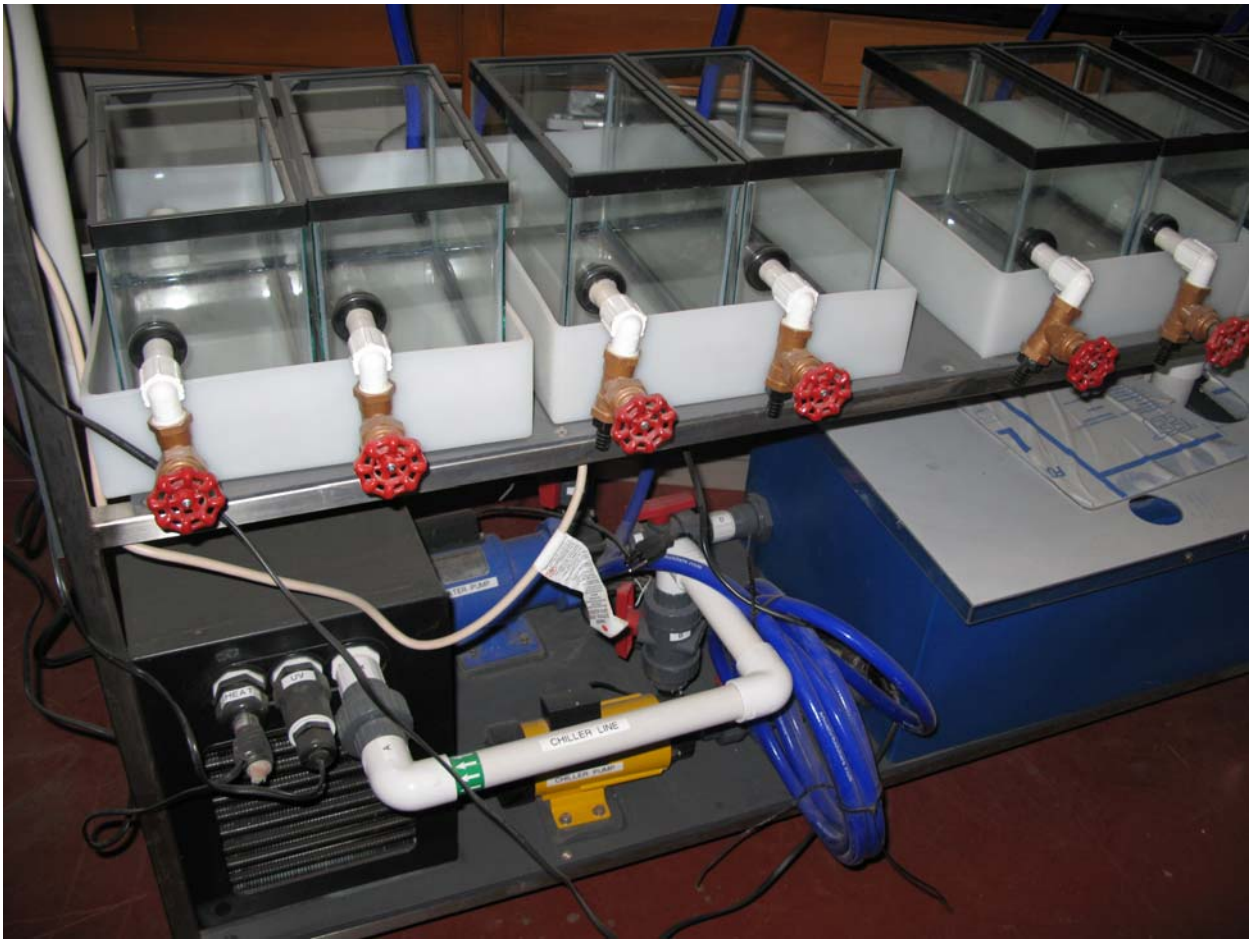

Figure 8. Close up of aquarium testing unit.

After the TAG meeting on February 25, 2011, Allan Choate (TAG Member) informed us that Polk County would like to participate in the study. On May 11, 2011, the principal investigator met with Polk County officials to obtain samples of soil, leachate, and groundwater for preliminary testing.

Figure 9. Leachate sample collection from Polk County facility.

Figure 10. Allan Choate assisting with the leachate sample collection.

Figure 11. Soil sampling from the downstream SE corner (left) and from the upstream NE corner (right). The NE corner samples were taken just south of the monitoring wells that reported elevated iron readings.

Mr. Choate gave the team a brief summary of the Polk County facility. Phase 3 (60 acres) is currently active, receiving Class 1 waste since November 2006. The original facility was 100 acres of unlined landfill (pre-1985). Phase 1 is a single bottom liner (43 acres) and Phase 2 is double lined and consists of another 43 acres in final closure. Phase 3 has a 2 acre test liner with an array of 20 monitoring wells. This is where the iron/arsenic problem was first detected. The general direction of groundwater flow is from NE to SW. The facility is located in an area that was used for phosphate mines originally. The leachate is stored in an onsite storage tank and is pumped to the local POTW (Central Region WWTP) by gravity (5 miles). There are no pretreatment requirements according to a negotiated 5 year contract to dispose of the WWTP sludge residuals in exchange. This contract is renewable for up to 30 years. The amount of leachate generated is on the order of 20,000 gpd from the 150 lined acres on the site. This is down from 50,000 gpd after final closure of Phase 2. The Central Regional WWTP at the end of Eagle Lake Road in Winter Haven, FL. This facility is a 1.1 MGD permitted capacity contact stabilization system with rapid infiltration basins and irrigation disposal.

Also Tim Vinson informed our team that Drs. Townsend and Ma have information that might assist our study. Mr. Al Basri will be collecting this information shortly. Ahmed Al Basri has also measured the aquaria and determined the appropriate amount of sample required for our first preliminary tests with the in-situ recirculating well technology. He is in the process of determining the iron concentrations in the soil, leachate, and groundwater samples. He has been working on a spectrophotometric method for determining iron in soil samples and has refined the soil digestion procedure based on Florida Department of Environmental Protection Standard Operating Procedures.

Research planned for the upcoming months:

- Continue the preliminary literature review
- Begin aquarium-scale preliminary testing.
- Design and conduct experiments to test the process for iron treatment.