Remediation of Contaminated Sediments in Passaic River, NJ, with Ultrasound and Ozone Nano-bubbles

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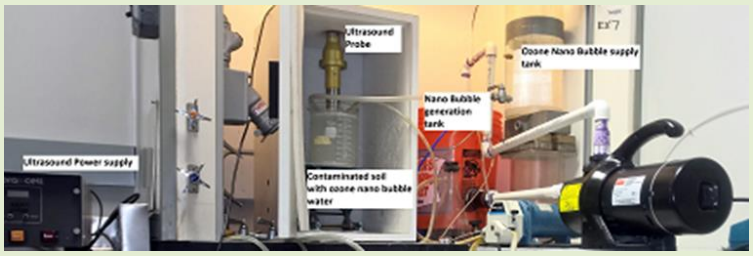
The Passaic River, NJ is the second most polluted river in the USA and a declared Superfund site with over one hundred industrial facilities discharging a number of contaminants. On March 3, 2016, the USEPA announced the record of decision (ROD) to dredge 3.5 million cubic yards of the contaminated sediments off the river from bank-to-bank at a cost $1.36 billion over six years. The remediation plan not only has a high price tag, but also has the potential to cause significant disruptions to the economic and social growth of the region over the proposed six years of dredging by transferring the dredged sediments via barges to a large dewatering facility close to Newark, NJ, and then transporting dewatered sediments via rail out of New Jersey.

The proposed research is an innovative approach to clean contaminated sediments in the river. It uses three innovative technologies, namely, ultrasound, ozone and nano bubbles, to provide a cost effective and environmentally sustainable on site treatment technology with lower total cost over shorter time span. It also has minimal adverse impact on the environment and the socio-economic growth of the region. The ultrasound energy provides agitation and soil decontamination. The ozone reacts with desorbed contaminants to help removal of them from the river. The nano bubbles help dissolution of ozone gas in water. Considering the Passaic River system, once the treatment is completed, any remaining dissolved ozone will break into oxygen and will help to revitalize microbes and the eco-system. In addition to the societal benefits, the project will accord the opportunity for the continuous training of several underrepresented graduate and undergraduate students to acquire deep appreciation for multidisciplinary research and to broaden participation and enhance diversity of NSF funded research.

The proposed research will evaluate the feasibility of the in-situ sediment decontamination procedure with ultrasound energy in the presence of ozone nano-bubbles. Three emerging technologies, namely ultrasound, ozone treatment and nano bubbles are combined in this research to address a major problem, in-situ decontamination of sediments. The purpose of the ultrasound energy is to provide agitation that will maintain the sediments in a suspended state, detach contaminants form the surface of sediments and release them to the bulk solution. The ultrasound energy will also generate bulk motion to enhance uniform application of the ozone to all contaminated particles and to facilitate desorption of contaminants from sediments. The role of ozone is to degrade desorbed organic contaminants in the sediment into intermediate products that are soluble in the aqueous phase and also to oxidize the desorbed heavy metals from sediments into soluble ions for enhanced removal by filtration. The ozone gas is to be delivered as nano bubbles to increase the ozone gas dissolution in water and to enhance the ozone gas stability in the liquid phase.



In order to validate and to optimize the proposed technology bench scale tests will be performed followed by statistical analysis. The key factors that contribute to the removal efficiency will be identified in bench scale tests and full factorial design will be performed to generate removal efficiency data for statistical analysis. In addition, stability of nano bubbles will be investigated to prolong the residence time in water as possible new technology to treat contaminated soils and ground water. Also the cleaning mechanism of ultrasound will be investigated using the theory of shock wave. Overall this research will provide a cheaper and efficient way to clean river.