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Thermal In Situ Sustainable Remediation (TISR): Linking Renewable Energy to Sustainable Site Restoration

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Background/Objectives. Degradation of organic contaminants occurs three times faster by increasing the temperature from 10°C to 20°C. Conventional-energy based thermal remediation techniques with lower target subsurface temperature (20°C - 80°C) are being applied to enhance bioremediation. Additionally, heat sources such as aquifer geothermal energy storage for heating and cooling buildings which involves pumping and reinjection of groundwater and typically operate at low temperatures (< 25 °C) and are also being applied for contaminant attenuation in urban groundwater plumes. TISR is aimed at enhancing degradation rates by increasing the ambient soil and groundwater temperature to 20-30 °C using renewable energy. TISR promises sustainable treatment technology with faster clean-up times, lower operational maintenance and significant life-cycle cost reduction compared to traditional remedial alternatives.

Approach/Activities. Thermal modelling and pilot testing is ongoing to support full-scale TISR (US Patent Pending) implementation in the state of New York where the subject plume spreads across 10 acres. TISR application at this site does not entail any groundwater pumping and is focused on capturing solar energy to facilitate subsurface groundwater heating in order to enhance the remediation of benzene, toluene, ethylbenzene, and xylene (BTEX). Total BTEX baseline concentration of 14 mg/l is reported at the pilot test location. The TISR system consists of a closed-loop system containing a working fluid, solar collectors and a network of borehole heat exchangers (BHEs). Each BHE consists of thermally conductive, high surface area BHE placed at the targeted treatment interval to ensure effective heat transfer to the reactive zone. Subsequently, the heat extends to the design radius of influence via soil-particle conduction and heated-groundwater advection.

Results/Lessons Learned. This paper will present site screening, thermal modelling results, design details, and recent pilot test findings including: achieved subsurface temperatures, observed contaminant reduction, biological community analysis, and geochemistry trends. Field results thus far indicate that within five feet around the BHE, subsurface temperatures ranging from 20 to 30 °C and 50-90% reduction in BTEX could be achieved after one year of operation. Results may vary based on the solar energy input, solar collector size, depth of BHE and the time period of system operation. Correlations between the modelling and field scale implementation will be presented in conjunction with observed treatment performance. Comparison of 2015 pilot data with the 2016 data collected after system enhancements such as short term heat storage will also be presented.