Ecosystem Restoration by Thermal In Situ Sustainable Remediation (TISR^{SM})

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Background/Objectives. As of 2017, U.S. EPA and its partners reported overseeing up to approximately 1,319,100 facilities with varying degrees of contaminant cleanup and monitoring. Traditional environmental restoration is inherently energy intensive. Driven by a sustainable energy source (solar collection or waste heat capture), TISR^{SM} (US Pat. Nos. 10,384,246, 10,688,545) is an innovative technology that utilizes renewable energy, and low-maintenance borehole heat exchangers (BHEs) for low temperature heating of the subsurface to treat environmental contaminants in soil and groundwater. The closed-loop heating system relies on thermal conduction and advection to increase the target treatment zone approximately 10 to 20°C above ambient temperature. This elevated temperature results in the enhancement of biological, chemical, and physical processes that attenuate, degrade, and remove contaminants. TISR is an alternative to the physical contaminant mass recovery such as excavation, or unsustainable energy-consuming treatment systems prevalent among practitioners. TISR can be complementary to many other remedial technologies – air sparge, biosparge, chemical oxidation, or reductive dichlorination, for example. Operational ease to incorporate TISR into existing infrastructure reduces environmental restoration time, project life-cycle cost, and overall carbon footprint. Ecosystem restoration using sustainable technologies, such as TISR, offer an innovative tool for environmental practitioners, facility owners, and our society.

Approach/Activities. Following the introduction of TISR in 2015, several studies and applications have been completed and have validated TISR as a successful remedial technology proving that a sustainable approach does not limit the effectiveness of the remediation technology. Utilizing solar collectors, TISR has now been implemented at 16 sites worldwide including in the United States, Mexico, Brazil, and the Netherlands. The scale and magnitude of these systems has expanded, while best practices and guidance continue to be refined for greater efficiencies and optimization of heat transfer and energy use. Additionally, waste heat capture from traditional remedial technologies has been utilized to reduce operating timeframes and the overall environmental impact. Installation of a TISR system utilizing an active manufacturing facility waste steam is currently underway as a means to integrate production and remediation in a symbiotic manner.

Results/Lessons Learned. Solar collection, or waste heat capture to operate TISR systems, has been successful beyond initial testing and optimization. It continues to evolve by integrating alternative sustainable heat sources as well as synergistic enhancements with existing infrastructure to enhance ecosystem restoration and reduce operational carbon footprint. An overview of TISR projects from 2015 to present, operational data, lessons learned, design criteria, and a focused alternatives comparison through the carbon footprint lens will be presented.