

# Engineered Landfills: Field-Scale Geotechnical Testing, Numerical Modeling, and Sustainable Leachate Management

**Milind V. Khire, PhD, PE, BCEE, D.GE**

Professor of Civil & Environmental Engineering  
University of North Carolina, Charlotte

Municipal solid waste (MSW) landfills are increasingly operated as bioreactors to accelerate waste decomposition, enhance landfill gas generation, and reduce long-term environmental impacts. A key challenge is achieving effective distribution of recirculated leachate within highly heterogeneous waste masses. This presentation reviews research on the development, field implementation, and performance of patented permeable drainage blankets as an alternative to conventional trench-based leachate recirculation systems. Through field-scale demonstrations, laboratory experiments, and numerical modeling, the hydraulic effectiveness of permeable blankets constructed from recycled materials is evaluated. Results show that these systems can improve moisture distribution, reduce localized saturation, and enhance the efficiency of leachate recirculation.



The presentation also highlights the use of instrumented monitoring systems for real-time estimation of waste hydraulic properties and recirculation performance. Field and laboratory studies, coupled with HYDRUS-2D simulations, are used to investigate liquid flow, pressure distribution, and moisture movement within landfill waste. The findings demonstrate how integrating field experimentation, numerical modeling, and real-time sensing can improve the design and operation of engineered landfills, leading to more sustainable and cost-effective waste management practices.

## **Bio of Dr. Milind V. Khire, PhD, PE, BCEE, D.GE**

Dr. Milind V. Khire is a Professor of Civil and Environmental Engineering at the University of North Carolina at Charlotte. He earned his Ph.D. in Geoenvironmental Engineering from the University of Wisconsin–Madison and has more than 30 years of experience spanning academia, consulting, and applied research. Prior to joining UNC Charlotte, he served on the faculty at Michigan State University and worked as a geoenvironmental engineer with Geosyntec Consultants in USA and Tonkin & Taylor in New Zealand.

His research focuses on sustainable waste management, landfill engineering, PFAS contamination, groundwater remediation, unsaturated flow, and geoenvironmental sensing technologies. Over the past 25 years, he has led or co-led more than \$7.7 million in externally funded research sponsored by organizations including the National Science Foundation, Environmental Research & Education Foundation, Waste Management, Duke Energy, GE Hitachi, and TVA. His work has advanced bioreactor landfill technology, landfill cover systems, PFAS management, and real-time monitoring of geoenvironmental systems.

Dr. Khire is a licensed Professional Engineer, a Board-Certified Environmental Engineer (BCEE), and a Diplomate in Geotechnical Engineering (D.GE). He has authored more than 100 technical publications, holds multiple patents related to landfills, and has received several prestigious honors, including the ASCE Croes Medal, the Engineering Society of Detroit Alpha Award for Innovation, and the ASCE Exemplary Service Award. He remains actively involved in professional societies, technical committees, and international collaborations in geoenvironmental engineering committees, and research review panels.