Digital Twins for Contaminated Sites: Concepts, Opportunities and Challenges

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Digital twins are virtual replicas of physical objects, systems, or processes that are used to simulate, analyze, and optimize their real-world counterparts. This technology is widely used in various industries, including manufacturing, healthcare, urban planning, and more,to enhance decision-making, improve efficiency, and predict outcomes. With rapid growth in applications of geographic information systems (GIS) and environmental databases for contaminated site management, the foundational components are already in place to move the industry forward through the application of digital twin technologies.

However, digital transformation for site management does not inherently employ digital twin technology, which requires additional effort and deliberation. A common problem is the continuation of “paper-based” analytical methods using digital formats, which limits innovation in site management and decision making. On the other hand, there are misconceptions that many “press-button” solutions exist to turn the digital data into useful information for site management. It is, therefore, important to explore the opportunities for site management using digital twin technologies and examine the requirements and opportunities to convert digital data to digital twins.

This presentation provides a view of potential applications of digital twin technologies for contaminated site management. Case studies are provided to demonstrate notable areas where the applications of digital twin technologies are promising, including construction of conceptual site models (CSMs), risk ranking of contaminated sites, design of monitoring networks and schedules, site-specific risk assessment, and site risk management or remedial design. Emphasis is placed on the importance of spatial models and dynamic models in the conversion of digital data to digital twins. Finally, the discussion highlights the essential changes needed in industry perceptions of digital data and the updates required in regulatory guidance.

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Mr. Yong Li has more than 30 years of experience in hydrogeology and contaminant hydrogeology. He is currently a project hydrogeologist at Parsons. His environmental consulting experience includes contaminated site investigations at numerous sites throughout Canada. Mr. Li specializes in site characterization, site-specific risk assessment,guideline determination and modification, environmental modeling, environmental statistics, remediation option evaluations, and application of geographic information system in environmental projects. Mr. Li holds a Bachelor of Science in hydrogeology, a Master of Science in hydrogeology, and a Master of Science in Geographic Information System.

Sean Elliot

Mr. Sean Elliot is an associate geologist at Parsons. His work focuses primarily on conceptual site models and site characterization, assessing risk and data gaps at contaminated sites throughout the Canadian Prairies and Northern Canada. Mr. Elliot holds a Bachelor of Science in Geoscience and a Master of Science in Hydrogeology, with research surrounding low impact development functionality in Canada, specifically looking at vadose zone processes in frozen media.