

## **Sustainable and Climate Change Resilient Remediation is Integral to the Future of Contaminated Site Management**

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**Background/Objectives.** Over the past 20 years, there has been an increasing trend towards the implementation of sustainable remediation practices at contaminated sites. However, over that same timeframe, increases in climate-related extreme events (e.g., increase in frequency of occurrence and intensity; high intensity short duration events etc.) have resulted in significant impacts to various remediation strategies including physical remediation infrastructure and containment systems. As a result, contaminated site managers need to reevaluate the way they look at their remediation obligations and associated risks to sustainable remediation based on growing concerns related to the impacts of climate variability. We present a process by which climate change impacts can be assessed at the local level, discussed with all stakeholders and incorporated into sustainable remediation practices with consideration to all stakeholders while still meeting remedial goals. New ITRC and ASTM guidance also highlights the importance of building resilience into sustainable remediation strategies and are excellent sources of reference material for remediation practitioners interested in learning more about how climate change potentially impacts remediation strategies.

**Approach/Activities.** To address site-level risks from climate change, downscaled (regional-level) climate risk assessments focusing on extreme events can be effective. These efforts include an assessment of exposure to natural hazards; assessment of current and climate change extrapolated hazard vulnerabilities and developing GIS overlays to visually represent the potential differences; development of a risk matrix to identify short-term and long-term adaptation needs through a multi-criteria based cost benefit analysis; and design adaptation measures that can be integrated into the remedy selection process. Two case studies will be discussed describing the assessment process and resiliency design adaptations made.

**Results/Lessons Learned.** Not all effects of projected climate variability are equally likely to result in disruptive and costly damage for contaminated site management; some risks, such as gradual warming, do not present the same potential for increased operational expense, as more intense effects like extreme weather events and/or wildfires. Some regions may be completely unaffected, and may not be projected to experience significantly altered climate at all. Therefore, site-specific risk assessments and focus on the nature of contamination and planned remediation will minimize unforeseen environmental impacts while improving the sustainable remediation potential. A thorough assessment of the climate change vulnerabilities at a contaminated site, focusing on adaptive management measures that can be implemented to increase a remedy's resilience, continuous stakeholder engagement, leads to a more sustainable approach to Site remediation with consideration to all stakeholders and still achieving remedial goals. Reviewing the case studies will show that the earlier resilience to climate change and adaptive measures are incorporated into site remediation strategies the more impactful and cost effective.