A HIERARCHICAL APPROACH TO THE USE OF REMEDY PERFORMANCE METRICS AND MONITORING FOR MULTI-PHASED SEDIMENT REMEDIES

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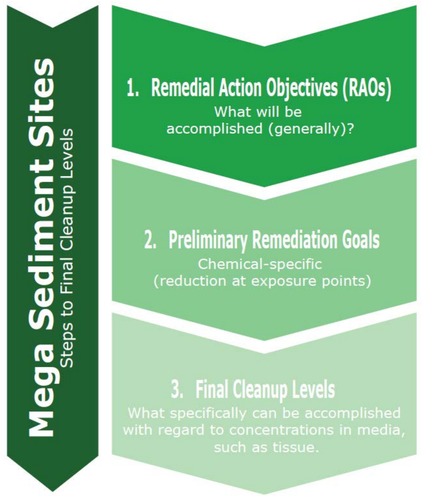
1. ABSTRACT

Background/Objectives: Remedial Action Objectives (RAOs), performance metrics and performance monitoring are typically established at the start of a remedy. Subsequent interpretation of performance monitoring data in relation to site-specific performance metrics is often difficult because expectations have not been established as to when the timing is right for any particular metric or combination of metrics to be decision-relevant. The objective of this presentation is to offer a hierarchical approach and framework to performance monitoring and metrics that explicitly takes into account the relative time sensitivity of various metrics and the life cycle of the remedial process at large sediment sites. The relative importance of different performance metrics changes over time in line with the short, intermediate and long term measures of success. This approach is particularly applicable to multi-phased and adaptive remedies.

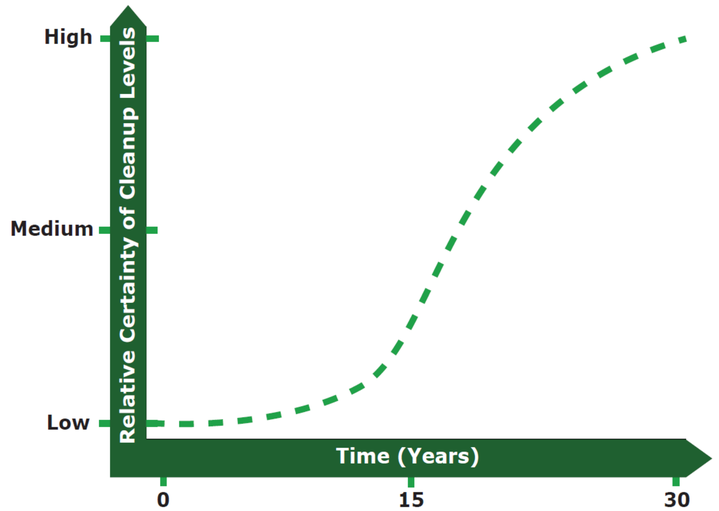
Approach/Activities: Multiple performance metrics are typically used to monitor remedial actions. A combination of physical, chemical and biological metrics is often employed. The authors will use a hierarchical listing of 12 types of metrics to illustrate an approach to how the performance metrics can vary over time. The relative weighting of metrics over time in decision-making should change to match site-specific conditions and the stage of remedy.

Results/Lessons Learned: The authors identify two sliding scales that are related to the 12 types of performance metric: action determinant scale and time determinant scale. The physical metrics (e.g. stability) are weighted more heavily on the action determinant scale while the biological metrics (e.g. fish tissue concentrations) are weighted more heavily on the time dependent scale. In the middle of each scale are the sediment and surface water chemical metrics. The application of this approach can provide a more realistic measure of the status of the remedy in relation to RAOs and performance goals as the remedial actions advance. When considered in a realistic time context, the more relevant performance measures can be taken into account in a more appropriate context by decision makers at each phase of the remedy.

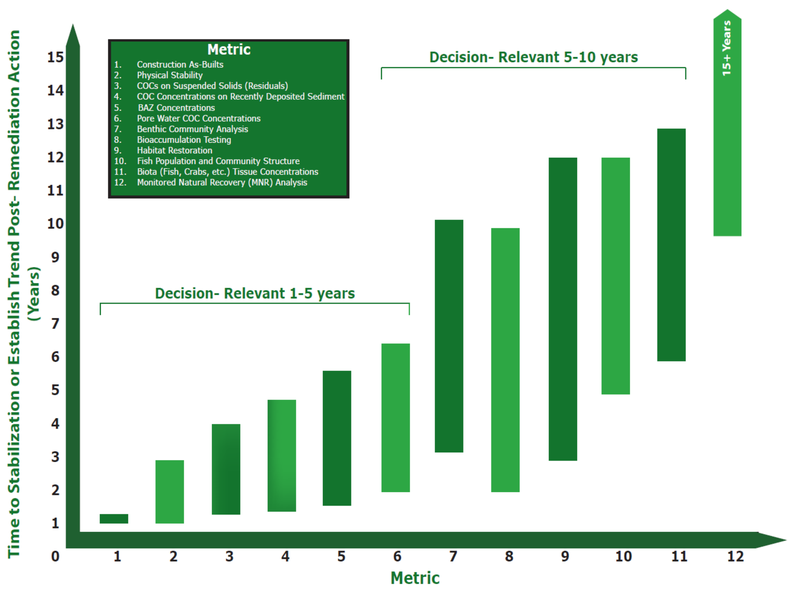
2. ESTABLISHING FINAL CLEAN UP LEVELS



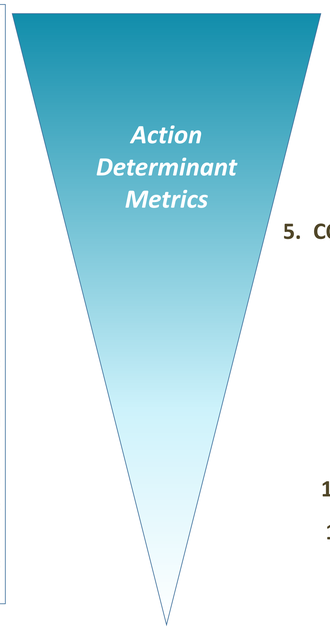
- Certainty of environmental response to cleanup is low until system stabilizes post-remediation.
- Stabilization leads to lower variability in field measures of cleanup response.
- Extended period after stabilization is needed to verify full effect of remedial actions and assess what has been achieved in relation of cleanup levels.
- More complicated to track if iterative optimization actions are taken to enhance the remedy.
- Performance measures should be matched with cleanup level certainty curve.



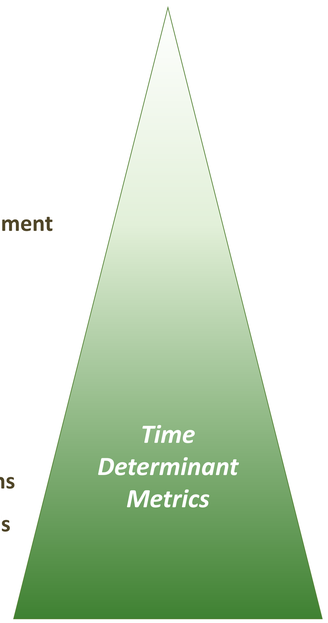
3. TYPICAL REMEDY PERFORMANCE METRICS IN RELATION TO THE ACTION TAKEN AND THE TIME SENSITIVITY OF THE RESPONSE



- Performance Metrics have different periods where their decision-making relevance is optimal.
- Physical measures are generally the most reliable indicators of the environmental response to cleanup in the short term (1 to 5 years following remediation).
- Biologically Active Zone (BAZ)/Exposure Point sediment concentrations are key short term measure
- Geochemical measures require more time to stabilize and reflect long term response (e.g., pore water)
- Biological measures such as community structure and sediment bioaccumulation testing are moderately quick to respond and track field conditions
- Animal communities and habitat structure take longer to be established
- Chemicals of Concern in Fish Tissues take extended period (5 to 10+ years) to stabilize
- Natural attenuation builds on multiple short term and long term metrics and generally requires the most time to establish
- Select combination of short- and long- term measures to initiate monitoring when related stability is established.



1. Construction As-Builts
2. Physical Stability
3. Pore Water COC Concentrations
4. COCs on Suspended Solids
5. COC Concentrations on Recently Deposited Sediment
6. Bioaccumulation Testing
7. BAZ Concentrations
8. Benthic Community Analysis
9. Habitat Restoration
10. Fish Population and Community Structure
11. Biota (Fish, Crabs, etc.) Tissue Concentrations
12. Monitored Natural Recovery (MNR) Analysis



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