Benefits and Process of Completing an Integrated MNA Feasibility Study Prior to Determining Corrective Action Strategy

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Abstract
Completing an integrated MNA feasibility study prior to determining a corrective action strategy can help produce a more cost-effective and successful long-term remedy to potential groundwater impacts. This presentation will provide an overview of Monitored Natural Attenuation (MNA) at Coal Combustion Residual Sites (CCR) sites and will provide examples of the benefits and process for completing an MNA feasibility study.

An integrated MNA feasibility study is beneficial because it can determine if MNA alone is a viable corrective measure, if MNA is a viable corrective measure only in combination with additional corrective measure(s), or if MNA is not a viable corrective measure. An early determination of MNA viability can help produce cost-effective solutions and reduce completing unnecessary corrective measures, while still achieving site remediation goals.

The MNA feasibility study should be completed on a site-specific basis to provide an initial determination of: 1) plume stability, 2) potential attenuation mechanisms, and 3) attenuation capacity/stability of the aquifer system. The study should be completed using a methodical process incorporating a review of existing data, likely impacts of “active” corrective measures, geochemical analysis, mineralogy, sorption capacity, attenuation kinetics, and overall likelihood of successful MNA.

Introduction
MNA is not a “do nothing” approach and is not a new process or technique, and often requires more, not less, evaluation to implement. MNA has been an USEPA approved method for corrective action since the 1990’s. A defensible MNA feasibility study needs to closely follow the USEPA Guidance’s on MNA as a remedial strategy ((USEPA 2007a and 2007b) and should use best practices from the Interstate Technology Regulatory Council (ITRC) document: “A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater” (ITRC 2010). To do this, the USEPA has developed a 4 phase or tiered approach. This document/presentation summarizes these phases, discusses some best
practices/strategies needed to complete each phase and the benefits to completing this process.

**Phase 1 – Demonstrate that the plume is stable**

The first step in completing an MNA feasibility study is to demonstrate that the contaminant plume is stable, not expanding, and that immobilization is occurring. This step requires a good understanding of the site conceptual model, the nature and extent of the contaminant plume, and a statistical understanding of the data. To complete this step, additional monitoring wells and sampling may be necessary. Determination of plume stability should be completed for each constituent that requires corrective action individually. If it is determined that the plume is not currently stable, additional measures such as enhanced or engineered MNA should be investigated to see what actions would be required to stabilize the plume. An early determination of plume stability can provide major cost saving in the selection of a corrective action.

**Phase 2 – Determine the Mechanisms and Rates of Attenuation**

Phase 2 aims to answer the question of whether attenuation will support a reasonable timeframe to use MNA. To determine this, an investigation into the aquifer components that are involved in the attenuation process is needed. An investigation into these mechanisms needs to be completed on a site-by-site basis, and is typically comprised of the following steps:

- Developing a detailed groundwater flow model (Modflow, Feeflow, etc)
- Conduct a detailed geochemical assessment and 1-D geochemical modeling (saturation, speciation, complexation)
- Evaluation of total metals and minerology of relevant materials (upgradient, downgradient, background)
- Evaluation of current sorption load and sorption potential
- Evaluate and consider the kinetic of relevant attenuation process

If it is determined that a reasonable timeframe for attenuation has a low potential for success, then a look into enhanced MNA approaches are needed (source treatment, etc. Figure 1). An early determination of this can provide cost/time savings before starting Phase 3.

**Phase 3 – Determine Capacity of Aquifer to Attenuate**

This phase consists of determining if the capacity of the aquifer (water/solid/air) is sufficient enough to attenuate the contaminant mass in groundwater to meet the required...
site limits and if once immobilized, will the constituents remain stable (not remobilize). This phase requires an understanding of the potential contaminant fluxes and of the mass/solid phase reactants. To fully understand the contaminant fluxes, source testing is likely required.

If it is determined that the aquifer system does not have the capacity to attenuate the contaminant mass in groundwater below site limits, then an enhanced or engineered MNA approach should be considered and then MNA be re-evaluated (Figure 2). If the aquifer system does have the capacity, then an investigation into whether the contaminants are stable when attenuated should be completed. Investigation would include:

- Long-term predictive geochemical models to evaluate for system changes (redox, pH, etc.)
- Batch modeling to test the limits of attenuation that would lead to a regulatory exceedance
- Evaluation of the effects of possible enhanced MNA scenarios

![Figure 2. CCR program recommended sequence of events for entering MNA](image)

**Phase 4 – Design a Performance Monitoring Program**

If Phases 1-3 all demonstrate that MNA is a viable option, either by itself or when paired with an enhanced MNA approach, then a performance monitoring program should be designed. This monitoring program needs to be based on the mechanisms of attenuation in steps 2 and 3 and will require frequent monitoring to ensure that modeling and other predictive analysis completed in phases 1-3 are valid. This performance monitoring program will also include contingency plans (tailored to site-specific conditions) should MNA not perform adequately as predicted.

Additionally, Phase 4 will have required continual communication with stakeholders, ensuring that the process is working and that if something is not working, that there is a
backup plan in place. With these contingency plans in place, MNA can pose the lowest risk to human health, relative to other remedial alternatives.

**Benefits of Early MNA Feasibility Study**

An early determination to whether MNA is a viable option can provide large cost savings if done correctly. Following the steps outlined by the USEPA provides a defendable and sensible approach to determining the feasibility of MNA, and if at any step along the process if it is determined the MNA has a low potential for success, then an investigation into enhanced or engineered MNA should be considered. Completing this feasibility study prior to selecting a corrective measure can help avoid implementing costly and unnecessary corrective measures that may not be required.