Long Term Monitoring Optimization (LTMO) at Wood Treating Sites

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INTRODUCTION

What is Long Term Monitoring Optimization (LTMO)?

- LTMO is the critical assessment of long term data collection activities to ensure that they:
  - Provide an efficient and effective means of evaluating remedy effectiveness, and
  - Do not lead to the accumulation of extraneous data.
- LTMO is an industry-wide trend due to technical limitations in DNAPL remediation, and the proliferation of risk-based remedies.
- LTMO is typically applied on sites where exposure potential is negligible, but where groundwater contamination will persist over the long term.

Why did Beazer develop an LTMO Protocol?

- Beazer is a company with environmental legacy interests at wood treating sites across the US, and substantial long term groundwater monitoring requirements, including the following:
  - >10,000 samples per year
  - Average of 16 wells sampled per site (max = 42)
  - Average of 20 data sets available per site (max = 40), and
  - Average of >100 parameters analyzed per sample (max >300).
- The great majority of these monitoring results:
  - Are consistently non-detectable (for organic constituents)
  - Are detectable but not problematic (for inorganics), and
  - Are extraneous, relative to monitoring objectives.
- Beazer sees significant variation in regulatory monitoring requirements between sites, often due to:
  - Individual interpretations regarding EPA's desire to return groundwater to "most beneficial reuse"
  - Poorly defined performance objectives and points of compliance
  - Inadequate development and/or understanding of the Site Conceptual Model;
  - Presumptive regulatory resistance to monitoring program reductions
  - Varying regulatory emphasis on mass removal, and
  - Varying regulatory interpretation of "reasonable timeframe" for MNA remedies.
- The Beazer LTMO Protocol is intended to provide a consistent basis for assessing monitoring programs.

What is the technical basis for the Beazer LTMO Protocol?

- The LTMO Protocol is based on the defining characteristics of wood treating sites, including:
  - Site age
  - Common environmental release locations
  - Common wood preservatives
  - Dominant contaminants in groundwater, and
  - Typical DNAPL and dissolved phase distributions.
- The Protocol considers numerous USEPA documents that address LTM and LTMO, including:
  - *Guidance for monitoring at hazardous waste sites: framework for monitoring plan development and implementation (*USEPA , 2004), and
  - *Road Map for Long Term Monitoring Optimization* (USEPA/US Army Corp of Eng., 2005).
- The Protocol is designed to support Beazer's presumptive remedies for wood treating sites, namely:
  - Source control (long term containment and DNAPL recovery), and
  - Monitored Natural Attenuation (MNA).

What steps are used to apply the Beazer LTMO Protocol?

1. Identify and/or clarify site objectives for monitoring, corrective action, and remedy performance.
2. Review existing site data and Site Conceptual Model; clarify and enhance as required.
3. Evaluate the applicability of the Presumptive monitoring specifications:
   - **Analytical Parameters**
   - **Monitoring Locations**
   - **Monitoring Frequency.**
4. *Perform site-specific modifications, as required, using the Professional Judgment of Beazer, Site Consultants and Regulators.*

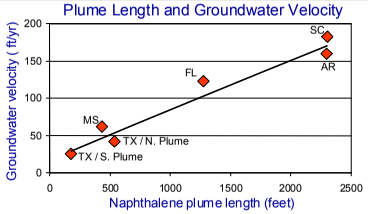
TYPICAL CONDITIONS AT WOOD TREATING SITES

Trends at Beazer Sites are similar to those across the industry:

- Average site age is 79 years.
- Any significant releases occurred primarily during earlier operations, when environmental controls were less stringent.
- The earliest preservative was creosote; still in common use.
- Creosote is the most common contaminant, followed by pentachlorophenol and then by metals (e.g., CCA)
- The most common dissolved phase constituents, in order of dominance, are: naphthalene and other low molecular weight PAHs > BTEX > pentachlorophenol > Metals.

Behavior of dominant constituents (PAHs and BTEX):

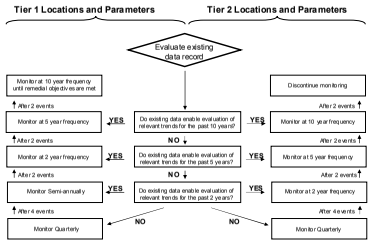
- Numerous studies indicate that these types of compound are biodegradable in the environment (e.g, see references in paper)
- The source material (primarily creosote) and the plumes have typically been in place for several decades.
- With these "mature" and biodegradable plumes, a relationship between plume length and groundwater velocity is apparent (see opposite figure)
- Consequently, most plumes are expected to be either stable or shrinking



Explanation:

- This graph shows Naphthalene data from 6 Beazer sites in 5 States
- On these sites, the Naphthalene plumes were the most extensive
- There were no hydraulic limits on plume growth at these site (e.g., no discharge to surface water, no pumping wells, etc.)
- The plume footprint appears to be well-predicted by groundwater velocity

PRESUMPTIVE MONITORING FREQUENCY



NOTE: Any decrease in monitoring Frequency is contingent upon ongoing compliance with remedy performance goals

Considerations in setting monitoring frequency for MNA Remedies:

- Changes in dissolved phase plume distributions on wood treating sites are expected to occur slowly because:
  - The predominant plumes are "mature" and biodegradable
  - source zones deplete slowly due to low solubility.
- After an appropriate period of confirmation, monitoring frequency should reflect this expected slow rate of change.

Approach for Frequency Optimization (see facing diagram):

- As a starting point, the existing data record is evaluated for trends relevant to the remediation and monitoring objectives.
- Initial monitoring Frequency is based on the length of the reliable and existing data record (see facing diagram).
- Shorter existing data record = greater initial Frequency.
- All monitoring Parameters and Locations are assigned to a Frequency "Tier":
  - Tier 1 – primary monitoring targets – more frequent, and
  - Tier 2 – secondary monitoring targets – less frequent.
- Quantitative statistical and geostatistical methods were evaluated for setting Frequencies, but were determined to be impractical for broad presumptive application. In practice, site-specific Frequencies would be further evaluated, and assigned based on professional judgment.

PRESUMPTIVE ANALYTICAL PARAMETERS

Considerations in selecting Analytical Parameters:

- Low molecular weight PAHs are high priority, based on predominant occurrence on wood treating sites and relative migration potential.
- Any PAHs not detected in excess of regulatory criteria would be excluded.
- Microbial parameters are excluded from the presumptive list because:
  - Their distribution tends to be highly variable and insensitive to the small plume changes, and
  - Microbial activity varies greatly across a given plume, depending on a range of factors (e.g., electron acceptor distribution, proximity to source zone, grain size, etc.).
- Microbial parameters would be considered for inclusion at sites where the remedy includes a component of engineered bioremediation.

Presumptive Parameters

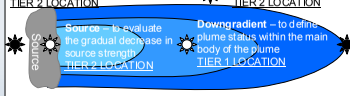
Parameter Group	Priority Parameter	Technical Basis
PAHs	Naphthalene Acenaphthylene Acenaphthene Fluorene Phenanthrene	Typically, PAHs are the most mobile and extensive contaminants at wood treating sites; these five are the most mobile of the 16 USEPA Priority Pollutant PAHs . TIER 1 PARAMETERS
Electron Acceptors and Metabolic By-Products	Nitrate Iron Manganese Sulfate	Provide ongoing data for performance monitoring of NA and/or plume dissipation; indirect evidence of plume status. TIER 2 PARAMETERS
Field Parameters	Dissolved Oxygen ORP, pH Conductivity, Temp Turbidity	Required to support sampling protocols; may contribute indirectly to monitoring of the status of site constituents. TIER 1 PARAMETERS

* Based on site data: Penta, BTEX and CCA metals may be added as Tier 1 Parameters

PRESUMPTIVE MONITORING LOCATIONS

Upgradient – to define groundwater chemistry before the source is contacted TIER 2 LOCATION

Cross-gradient – for ongoing definition of lateral plume extent TIER 2 LOCATION



Plume Front – to evaluate plume status at the Point of Compliance TIER 1 LOCATION

- One well to be monitored for each Location Type
- Site-specific modifications to be considered for conditions such as:
  - irregular plume distribution,
  - multiple source zones,
  - Significant migration in more than one hydrostratigraphic unit.

DATA EVALUATION AND MANAGEMENT DECISIONS

Monitoring data are evaluated on an ongoing basis, to support management decisions regarding remedy effectiveness. A range of tools are used including, but not limited to, the following:

- Graphical presentation of time series data for each well
- Statistical analysis of time series data, using Mann-Kendall or other methods
- Potentiometric surface maps
- Maps showing changes in DNAPL presence and thickness
- Maps showing changes in geochemical indicators
- Maps and cross-sections showing changes in contaminant concentrations, and
- Assessment of concentrations approaching asymptotic conditions