AZO DYES: A CASE FOR THE USE OF INDICATOR COMPOUND CLOSURE CRITERIA

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Azo dyes represent the largest class of synthetic dyes used in industry. Many azo dyes and their breakdown products are toxic and/or mutagenic to life. Manufacturing activities have resulted in the release of these compounds into the environment, which is typically observed visually by a color change in soil and/or groundwater. Dye evaluation, especially in an environmental context, is complicated due to the following factors:

- most of the dyes themselves are mixtures of many compounds,
- a facility may have produced several dyes during its operational history,
- dyes typically have relatively low water solubility's and do not partition into groundwater to any appreciable extent,
- dyes may degrade within the environment into more toxic and more soluble compounds, and
- analytical techniques are not useful in quantification of dye compounds due to lack of analytical standards, chemical structures of dyes, and possible interferences in the sample matrix.

The lack of applicable laboratory analytical methodology and toxicological information about individual dyes presents a technical challenge for describing a closure process for the site affected by this contaminant. This paper presents the remedial strategy implemented at a former dye manufacturing facility (the facility) to use degradation byproducts as indicator compounds for the presence and remediation of azo dyes. Components of this remedial strategy can not only be applied to azo dye compounds, but to other chemical mixtures and conglomerates with similar technical challenges.

For this facility, the conceptual site model indicates that the azo dyes primarily entered the subsurface as a dissolved phase in xylene that was used as a solvent. Based on site ground-water data, the anaerobic reductive transformation of azo dyes is resulting in the formation of aromatic amines. The field and laboratory studies conducted at this site indicate that the aromatic amines degrade under aerobic conditions. The aromatic amines are more mobile and more toxic than parent azo dye compounds. Standards and toxicological data for some aromatic amines are available, and these compounds can be identified and quantified using known analytical methods. The remedial strategy for this site consists of the following components:

- Addition of aromatic amines to the list of constituents of concern,
- Removal of xylene by air sparging to immobilize dyes on the subsurface soil particles and to promote aerobic degradation of the aromatic amines previously formed, and
- Rebound monitoring of aromatic amines at down-gradient points to constitute a suitable metric to evaluate remedial progress related to the presence of azo dyes.