


ADVANCES IN MONITORING PETROLEUM CONTAMINATED SITES

Federal Remediation Technologies Roundtable
November 2, 2016 Reston, Virginia

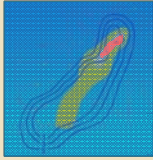



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Key Electron Acceptors For MNA (Yellow/Red Is BTEX Plume) (Concentration: mg/L)


Dissolved Oxygen "Hole"




Nitrate "Hole"




Ferrous Iron "Blob"



Sulfate "Hole"

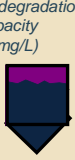


Dissolved Methane "Plume"




MNA Mass Balance in Plumes: Electron-Acceptor-Limited Biodegradation

Biodegradation Capacity
17 mg/L



Source Zone Concentration
(25 mg/L)



Observed Source Zone Concentration (8 mg/L)

ZAP!



Groundwater Flow

Monitored Natural Attenuation (MNA) versus Natural Source Zone Depletion (NSZD)

Monitored Natural Attenuation (MNA)

- Mostly focused on plume ("how far")
- For hydrocarbon plumes, key focus on:

<p>Electron Acceptors</p> <ul style="list-style-type: none"> • Dissolved Oxygen • Nitrate • Ferric iron (solid) • Sulfate • Methanogenesis 	<p>Electron Donors</p> <ul style="list-style-type: none"> • Benzene • Toluene • Ethylbenzene • Xylenes
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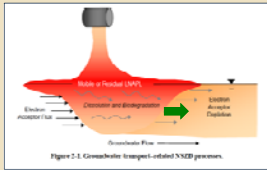



WAIT – THERE'S MORE!





Groundwater Mass Flux vs. Vapor Phase Mass Flux



Original NSZD Conceptual Model

Figure 2.1. Groundwater (orange)-related NSZD processes.

Lundgaard and Johnson, 2006; ITRC, 2009