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by **Dick Woodward**  
President  
Sierra Environmental Services, Inc.

## Site Assessment and Remediation Challenges Posed by Ether and Alcohol Fuel-Oxygenates in the Subsurface

The gasoline-oxygenate methyl tert-butyl ether (MTBE) and more recently tert-butyl alcohol (TBA) have been implicated in the degradation of groundwater in the vicinity of gasoline release. Several physical characteristics of MTBE and TBA differ from other gasoline hydrocarbons, most notably, solubility and adsorption. These differences have a major impact on fate and transport in the subsurface, selection of in situ remediation technologies and sequencing of technologies to achieve cleanup objectives. This presentation focuses on specific site assessment approaches for ethers and alcohols and the most effective remedial technologies.

While biodegradation of naturally occurring ethers is well documented, the study of bioremediation of low molecular weight ethers and alcohols such as MTBE and TBA is relatively recent. Several pure cultures of microorganisms have been isolated that mineralize them aerobically to carbon dioxide and water. There is also evidence of MTBE and TBA mineralization by mixed cultures in aerobic/anaerobic environments. In the field, increasing the dissolved oxygen concentration increases aerobic biodegradation rates in a strong dose-response relationship. Biodegradation has also been demonstrated with other electron acceptors including nitrate, iron, sulfate and carbon dioxide. Biodegradation is an important mechanism for natural attenuation of MTBE and TBA and the primary reason why MTBE and TBA plumes eventually stabilize.

Several landmark remediation case studies will be presented that illustrate the effect of physical and biodegradation characteristics on remediation technology selection. Every site is different, with its own set of characteristics and challenges. Regardless of the composition of gasoline, rapid source control is critical to minimize environmental impact. Optimal strategies take advantage of these site characteristics as well as the specific

physical characteristics of MTBE and TBA for cost-effective, timely and environmentally sound MTBE and TBA remediation. ■

### Biographical Sketch

DICK WOODWARD has over 29 years of experience in site assessment, fate and transport and bioremediation and is President of Sierra Environmental Services, Inc., an environmental remediation firm focusing on in situ bioremediation of organic compounds. He is Principal Microbiologist for Environmental Litigation Associates and member of the faculty of the Institute of Environmental Technology. For the past 3 years Woodward has been a major contributor to Lyondell Chemical's product stewardship and outreach program for MTBE. Woodward was formerly Vice President of ENSR International, where he developed and led the national bioremediation program.

