Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

From Horizontal to Vertical: Uncovering the Key Process Driving Hydrocarbon Source Zone MNA

Charles J. Newell (cjnewell@gsi-net.com) (GSI Environmental Inc., Houston, Texas, USA)

Background/Objectives. The theory and practice underlying Monitored Natural Attenuation of hydrocarbon sites was changed little from the mid-1990s to the late 2000s. Since then there has been an explosion of research, technology development, and applications of the *Monitored Natural Attenuation* (MNA) of hydrocarbon source zones, an approach now called *Natural Source Zone Depletion* (NSZD).

Approach/Activities. This presentation will provide a historical perspective from the perspective of an MNA researcher and practitioner who has been active during the development of both MNA and NSZD. In particular, the role of methanogenesis in both dissolved plume MNA (as expressed in the BIOSCREEN MNA model) and in current NSZD conceptual models will be reviewed.

Results/Lessons Learned. Garg et al. (2017) presents a general history of the evolution of MNA to NSZD, and compares and contrasts the two different technology variants. This talk will review the history, key developments, and implications of the split between MNA and NSZD technologies and practices as shown in the table below.

	Hydrocarbon Attenuation in the 1990s - 2000s	**Hydrocarbon Attenuation Now**
Nomenclature	Monitored Natural Attenuation (MNA) of dissolved plume	Natural Source Zone Depletion (NSZD) of LNAPL body
Management Focus	How far plume will migrate	How long will sources last
Key Constituents	Dissolved BTEX	All LNAPL Constituents
Key Biodegradation Process	Electron-acceptor mediated biodegradation	Methanogenesis
Key Unsaturated Zone Biodegradation Process	Volatilization of LNAPL Followed by Aerobic Biodegradation of Hydrocarbon Vapors	Anaerobic Biodegradation (Methanogenesis) of LNAPL followed by aerobic methane oxidation
Key Saturated Zone Biodegradation Process	Anaerobic biodegradation of dissolved BTEX	Anaerobic biodegradation of LNAPL by methanogenesis with off-gassing and ebullition
Key Metric	“Biodegradation Capacity” (BIOSCREEN mass balance)	“NSZD Rate”
Key Measurement	Upgradient vs. Downgradient electron acceptors and by-products	Carbon dioxide efflux; gradient of oxygen consumption in unsaturated zone; thermal flux
Representative Attenuation Rates	BTEX half-life of 2-4 years	NSZD rate of 100s to 1000s gallons / acre / year