Natural Source Zone Depletion of DNAPL: Is it a Thing?

Matt Rousseau, GHD

Introduction Recent years have brought a new understanding of the magnitude and importance of petroleum NAPL natural source zone depletion (NSZD) and its potential for more sustainable remediation and management of petroleum-contaminated sites. Accordingly, the assessment of NSZD is becoming a more standard consideration in petroleum NAPL conceptual site model development and site management decision-making. However, while numerous (and growing) instances of NSZD case studies at LNAPL sites exist in the literature (e.g., CRC CARE Technical Reports 44, 46 and 47), there are few published demonstrations of NSZD at DNAPL sites. This presentation will examine an Australian site with coal tar DNAPL occurring at a depth of 5-6 m bgs. The site is mostly paved (parking lot) with isolated areas of permeable surface cover (e.g., vegetated medians, small landscaped areas, etc.). NSZD monitoring was performed by GHD through the concurrent use of three different measurement techniques. The results of the different measurement approaches are compared/discussed, and contrasted against what are considered 'typical' NSZD rates at LNAPL sites (as reported in the literature and based on GHD experience).

Methods The confirmation of NSZD and estimation of rates was intended to be used as a stability line of evidence and to establish whether long-term risk management of residual DNAPL in place might be an appropriate and sustainable risk-based approach (i.e., assess whether the implementation of other options might provide a net benefit over NSZD alone given the increased costs/risk/carbon footprint involved). NSZD monitoring was performed using the surficial CO_2 efflux (dynamic closed chamber), soil gas gradient (small purge method), and biogenic heat (temperature profiling) techniques.

Results and Discussion The mean NSZD rate estimates for the soil gas gradient and temperature gradient methods were of comparable magnitudes of approximately 1,000 and 3,000 litres of DNAPL degraded per hectare per year (L/ha/yr), respectively. These rates are significant, albeit lower than what might be considered typical at Australian LNAPL sites. The mean NSZD rate estimate for the surficial CO_2 efflux method was 12,000 L/ha/yr, or an order of magnitude higher than the subsurface methods. The CO_2 efflux-based estimates likely contain significant positive bias due to a combination of potential error in background correction (variably vegetated surface cover) and the chimney effect produced by measuring CO_2 in small areas of permeable surface cover surrounded by paved surfaces.

Conclusions These results demonstrate that:

- bias in surficial CO2 efflux methods at paved sites may be an order of magnitude or more
- approaches to NSZD monitoring developed at LNAPL sites will also be applicable at certain types of DNAPL sites
- NSZD is a viable DNAPL remedial/management consideration

Matt Rousseau

Matt Rousseau is a Senior Environmental Engineer and NAPL Technical Lead with GHD based in Canada. Matt has been consulting for over 20 years, with a focus on NAPL sites specifically for most of that time. His work includes the development of NAPL site investigation and management strategies, with a focus on sustainable risk-based solutions. Matt regularly provides training related to NAPL site management and has helped develop related technical guidance documents in the U.S., Canada, and Australia. Matt is currently active in ITRC teams related to NAPL site management as a contributor and trainer, and with ASTM as a contributor to a new draft standard pertaining to the detection and quantification of NAPL biodegradation (NSZD). Matt has B.A.Sc. (1997) and M.A.Sc. (2000) degrees in Environmental Engineering from the University of Windsor in Windsor, Ontario, Canada.