Accepted Manuscript

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PII:	S0043-1354(18)30717-6
DOI:	10.1016/j.watres.2018.09.013
Reference:	WR 14063
To appear in:	*Water Research*
Received Date:	13 June 2018
Accepted Date:	04 September 2018

Please cite this article as: W. McCance, O.A.H. Jones, M. Edwards, A. Surapaneni, S. Chadalavada, M. Currell, Contaminants of Emerging Concern as Novel Groundwater Tracers for Delineating Wastewater Impacts in Urban and Peri-urban Areas, *Water Research* (2018), doi: 10.1016/j.watres.2018.09.013

Contaminants of Emerging Concern as Novel Groundwater Tracers for Delineating Wastewater Impacts in Urban and Peri-urban Areas

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Abstract

Management and treatment of environmental impacts from wastewater treatment plants (WWTPs) is a major, worldwide, sustainability challenge. One issue associated with WWTP operation is the potential for groundwater contamination via leaking or infiltration of wastewater, particularly with inorganic nutrients (ammonia and nitrate) as well as persistent organic compounds. Despite the potential for such contamination to create environmental and health risks, conventional methods, such as the assessment of major ions, nutrients, bacteriological indicators and conventional tracers (such as stable and radiogenic isotopes) are often unable to provide accurate delineation of multiple potential sources of contamination. This is particularly important for WWTPs which often occur in urban, peri-urban or intensively farmed agricultural areas where multiple potential sources (such as livestock, fertilisers, wastewater irrigation, and domestic septic systems) may contribute similar contaminants. This review explores the applicability of promising novel groundwater tracers, such as Contaminants of Emerging Concern (CECs) and isotopic tracers, which can be used in conjunction with conventional tracers (i.e. 'co-tracers') to provide a more definitive assessment of contaminant sources, plume delineation and even (potentially) indicating the age of contamination (e.g., recent vs. legacy). The suitability of the novel groundwater tracers is evaluated according to four key criteria: (i). sufficient presence in raw wastewater and/or treated effluents; (ii) diagnostic of WWTP impacts as opposed to other potential off-site contamination sources; (iii) persistence in the subsurface