

# ***Interactive comment on “Sources and fate of nitrate in groundwater at agricultural operations overlying glacial sediments” by Sarah A. Bourke et al.***

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Dear authors,

Thank you for this interesting manuscript, in a challenging environment no doubts. I have a few suggestions to make for you to consider. First, I think providing a summary of N transport and transformations (including dissolved organic nitrogen and  $\text{NH}_4^+$ ) would have been useful. I note that data on  $\text{NH}_4^+$  and DON (DON = TKN -  $\text{NH}_4^+$ ) is presented in Supplementary Material, but a summary in the main text is warranted. To receiving environments, whether the N is DON,  $\text{NH}_4^+$  or  $\text{NO}_3^-$  matters little.

There is also limited information presented on the redox conditions in the three 'biogeochemical environments' present (waste piles/vadose zone/groundwater). Do these differ? This matters because the best conditions for N attenuation will be when we have alternating aerobic and anaerobic environments during transport. Is this the case here? Is there an effect of a shallower vadose zone at one of the sites (less nitrification)?

I would also suggest to de-emphasise 'denitrification' as a removal mechanism for nitrate unless you have additional measurements to back this up. In what seems like an heterogeneous environment, a range of processes could remove  $\text{NH}_4^+$  and  $\text{NO}_3^-$  (anammox,  $\text{NH}_3$  volatilisation, dissimilatory  $\text{NO}_3^-$  reduction to  $\text{NH}_4^+$ ...). It would be more prudent perhaps to talk about 'nitrate removal' instead of denitrification? The large variations in the stable isotope of nitrate data argues for a more complicated story than just nitrification-denitrification.

I hope this is helpful.

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Discussion paper

