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Hydrology and Earth System Sciences Discussions

Interactive comment on "Domestic wells have high probability of pumping septic tank leachate" *by* J. E. Horn and T. Harter

Anonymous Referee #2

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My comments strongly echo those of the first reviewer:

1. The authors are tackling an important and useful topic, and by addressing the issue in a probabilistic framework are likely to generate novel results when compared to existing regulatory frameworks.

2. The methodology used is so poorly communicated that it is almost impossible to comment on its validity.

In particular the authors must clarify:

a) the distinction between the detailed 3D model used to simulate the groundwater flow and mentioned in Section 2, and the simple geometric analysis presented in Section

4 was utterly unclear to me. Is the 3D model being used to determine the size and orientation of a capture zone relative to the properties of the aquifer, and then the spatial analysis attempts to "arrange" different combinations of capture zones and drain fields, given potential designs of land parcel allocation?

b) I concur with the confusion of Reviewer 1 re the shape of the capture zone – how is the rectangular shape arrived at? While I appreciate that in the presence of a regional flow field the capture zone may be anisotropic, surely it never contains a sharp vertex! I recommend that more details of the 3D model are provided, and that at least an example of the model results is presented, along with the derivation of the capture zone from those results. I also suggest that the range of model runs undertaken with the 3D model be comprehensively summarized (I suggest in tabular form).

c) The capture zone itself is presumably a probabilistic value based on the region from which some % of the well flow is derived? How was this defined? Given that part of the motivation for the study is to consider viruses and other particles where very low contamination can be problematic, what is the appropriate threshold value to define this zone? This concerns me when the 3D model ignores dispersion, and needs more justification.

d) Initially, I was utterly confused by the purpose and the implementation of the spatial analysis. There are a few things about this approach that I found confusing. Firstly the authors state that each grid cell represents a property lot – this becomes confusing because the probabilistic analysis is done on a "within-lot" level. Secondly, the description of increasing the capture zones while decreasing the drainfields and altering the property boundaries is... just really hard to understand. Its taken me about 5 read-throughs to see what you were getting at. If I understand correctly, the idea is that if any part of a drainfield intersects the capture zone, the authors treat that as a "hit". Therefore, a new" footprint" can be drawn that equates to the capture zone plus the lengthscale of the drain field, and any drainfield location within that footprint will have some of its area within the capture zone of the wells? I strongly suggest that the authors consider

explaining this by defining some new geometric concept (like a buffer or footprint or similar) so that they can avoid talking about "increasing the capture zone", which just rings alarm bells when you read it. Even after this, I must admit I'm still confused about the effect of "decreasing the lot size" ... and I don't think this is really what the authors mean, is it – isn't it meant to indicate that the potential area within the lot that could have a drainfield in it is lower than the total area, because the property boundary must be avoided? Does it really mean that a buffer is applied along the edges of all cells? Given the fact that the area around the boundary cannot have a drain field in it, I am concerned about the use of the polybool tool. Is polybool applied to the grid, or to the grid cells minus a buffer at the boundary? Clearly it should be the latter – but this is not clear.

Figure 1 and 2 are not working as well to explain these ideas as they could. For instance, it would be easier to understand Figure 2 if the capture zones shown were the same relative scale as they are in Figure 1. It would also be very helpful to show Figure 2 at an expanded scale, which would allow the authors to show the full overlap of the capture zone across multiple lots. I've attached a different version of Figure 1 and 2 that I think captures the authors' intentions:

The original capture zone is shown as the dashed line. The capture zone "footprint" is shown as the solid shape The cell array is shown, with buffers at the property boundaries grayed out The red cells are those intersected by the capture zone footprint The areas within the cells that are overlapped and are outside the buffer are shown in green The areas in the footprint that cannot contain the center of a drain field are shown in blue. The probabilities per cell would be computed as the green area for each cell divided by the grey area for each cell.

Finally, I also suggest that the authors present the "end result" first. For instance, as I understand it, the probability that is being computed is something like:

p(intersection) = Sum over all directions [p(direction) * p(capture zone overlaps a cell |

direction) * p(capture zone overlaps drain field | capture zone overlaps cell)] ??

Leading with this probability computation and then showing how each term was estimated would be very helpful.

3. Is there potential to use the results from this analysis to discuss improvement of regulatory approaches, beyond density related guidelines?

4. Lit review sections of the document could be made much more readable by removing the in-text citations and simply including the references at the end of the sentences. This was egregious in page 5704 lines 13 - 17 (why not say: "Many authors determined significant correlations... etc (citation, citation, citation)?) and page 5705 lines 9 - 17. In the latter, please avoid literature reviews that are just chronologies – why not simply state that existing models have used coupled chemical - groundwater flow models to address this problem and to compute the range of lot densities (citation, citation, citation)? More importantly, what was missing from these studies that motivated the authors to undertake the current study?

5. There were numerous typos in the document and some areas of where the text could be tightened. The typos are just those I noticed in passing, but they do suggest that a further edit for language and minor errors would be useful. E.g. Abstract line 5 – sentence beginning "Particularly" is unclear; line 14 define "high septic system density" since otherwise arbitrary Page 5704, line 23, fix up "Wright" reference Page 5706 line 26, leach fieldS Page 5708, line 4, "a capture ZONE" (not zones) Page 5713 – suggest that the different lot sizes be simply presented in tabular form

6. Figures 3 and 4 – Firstly a question – why are there multiple values for the probabilities of a given lot size and septic system density? I believe this represents the variation with different hydraulic properties in the aquifer? If so, perhaps it is more appropriate to show e.g. a box plot for each lot size / septic system combination? Secondly, looking at these figures, it seems like there might be near-linear relationships between the risk and the densities for a given set of assumptions. Have you plotted the trend in

probability with lot size with all other values fixed? This might generate useful rules of thumb, while nonlinearities in this relationship would highlight the importance of moving beyond simple mass balance approaches (which would predict a linear relationship between probability and septic system density).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5701, 2011.

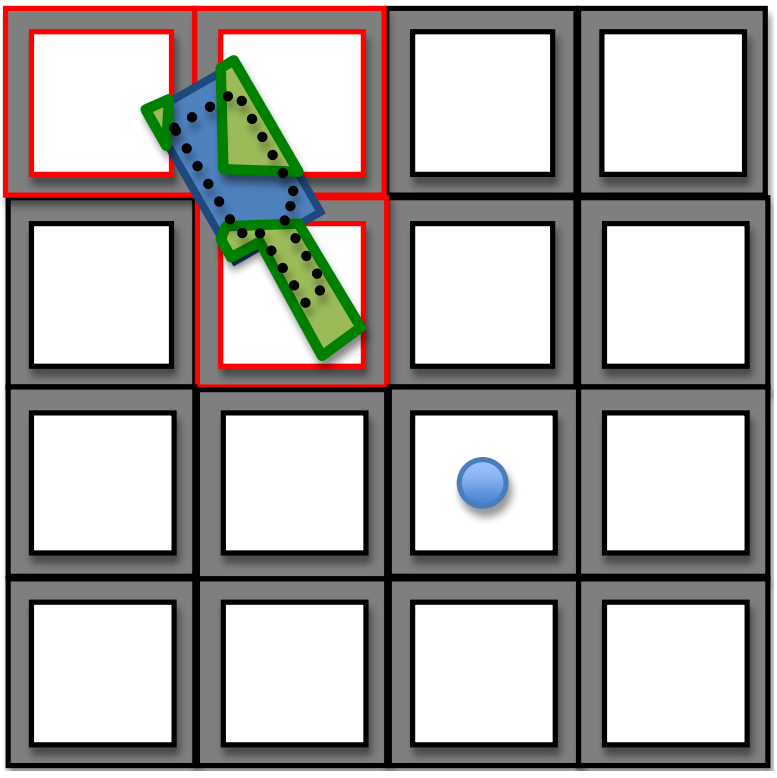

Fig. 1.