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Hydrology and Earth System Sciences Discussions

Interactive comment on "Detection of contaminant plumes released from landfills" *by* N. B. Yenigül et al.

Anonymous Referee #3

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General Comments:

In this paper, the authors evaluate the likelihood of detecting a contamanant plume emanating from a landfill in a hypothetical aquifer. A monitoring well network is set up downgradient of the landfill, and both instantaneous and continuous leaks from the landfill are evaluated. The authors compare analytical and numerical results for a homogeneous aquifer and for a heterogeneous aquifer. For the heterogeneous aquifer, the analytical solution uses an effective macrodispersivity to account for the heterogeneity. The authors compare simulated concentrations with analytical concentration, and they also compare 'detection probabilities' from analytical and simulation results. The main conclusions of this paper are (1) that numerical simulation results can match analytical results for homogeneous aquifers, (2) likelihood of detection decreases as

heterogeneity increases, and (3) the analytical solution for the heterogeneous case overestimates the likelihood of detection. Neither of the first two conclusions are significant. It is well-known that numerical approximations can be quite accurate, so (1) is not an important contribution of this paper. Also, it is well known that a plume moving through a heterogeneous aquifer follows a circuitous path that is dependent on the spatial pattern and degree of heterogeneity of hydraulic conductivity. If the spatial pattern is not known, the exact path cannot be known, and the likelihood of detection by a finite number of monitoring wells would decrease. The third conclusion is a more significant contribution. Although it is generally understood that an analytical model is not appropriate for modeling contaminant transport in a heterogeneous aquifer, it is done in practice quite often. This conclusion illustrates the degree to which this practice can produce misleading results. I am not convinced that this is a substantial contribution.

Specific Comments:

If the point is to demonstrate that using the analytical solutions to the mean concentration may not be appropriate for modeling likelihood of detection in a heterogeneous aquifers, then the point can easily be made with just the heterogeneous example. I don't see this as being a substantial contribution, however.

Technical Comments:

Why is the analytical solution averaged over the numerical grid block? The authors claim that this is leading to errors between the numerical and analytical solution near the source. The point on a numerical solution is to approximate the analytical solution, so it doesn't make sense to 'average' the analytical solution and then use the 'averaging' as a reason for the discrepancy between the two.

What location (yw) is used to calculate the analytical detection probabilities?

Explain why the analytical concentrations for an instantaneous source in a heterogeneous aquifer is below the simulation results, while for a continuous source, the analyt-

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ical concentration is always higher than the simulation results. I can't understand what would cause the relative difference to switch from negative to positive just by extending the duration of the leak. The continous leak is just a superposition of many instantaneous leaks; if the concentration for each instantaneous leak is always lower for the analytical solution than for the numerical, why would the superposition be higher for the analytical than the numerical?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 819, 2006.