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Hydrology and Earth System Sciences Discussions

Interactive comment on "Stream depletion rate with horizontal or slanted wells in confined aquifers near a stream" *by* Pei Rong Tsou et al.

Anonymous Referee #3

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Review on "Stream depletion rate with horizontal or slanted wells in confined aquifers near a stream" In this contribution, an analytical solution for horizontal wells near a stream is presented and the sensitivity of several controlling factors on stream depletion rate are analyzed. The comments of the previous reviewers were mainly on the mathematical formulation and, in my opinion, the points raised have been sufficiently well addressed by the authors. I have some additional comments. The intention is to make this paper more useful to a wider audience and also point out some areas where additional discussion will strengthen the paper. I am happy to review a revision of the paper.

General comments:

- Implicit assumptions about the stream and the aquifer are made but not mentioned or

discussed in detail. See in the specific comments for more information.

- The authors present their work in the context of engineering solutions, and I therefore suggest to include a brief discussion on the implications of the assumptions and the limits of the method.

- The authors might consider to include a comparison with a numerical model. This might allow to verify their solutions and also to quantify the implications of the assumptions made. A comparison with a numerical model is not an absolute must, but I believe it would be an interesting addition to their work.

- Some relevant papers are not cited and should be included, especially concerning the nature of the streambed and the hydrological implications of pumping next to rivers. See below for details.

Specific comments: Abstract:

-first sentence: reword, it is too long and I did not understand it.

Intro: Comment: Pumping water next to a river may result in negative consequences, e.g. an increased infiltration rate can cause a river to become ephemeral. I would not only highlight the engineering aspects of pumping next to a river, but also add some points discussing that increased stream depletion can be a significant problem (see and cite e.g. Konikow, L.F., Kendy, E., 2005. Groundwater depletion: A global problem. Hydrogeology Journal, 13(1): 317-320.)

- 2349, line 2: remove "the" so that it reads . . ."(1979), groundwater. . .."

- 2349 line 9: Common assumptions of these solutions should be discussed because they are also made in this approach. All the cited papers here (including this one) are assuming that the interaction between the aquifer and the river remains fully saturated and therefore connected. However, pumping next to a river frequently results in a disconnection between surface water and groundwater. Under disconnected reaches, an additional drawdown does not result in a local increase of the infiltration rate. I

suggest that the authors add the following text block and include the references: “These analytical solutions assume that no unsaturated zone between the river and the water table develops. However, if the streambed has a lower hydraulic conductivity than the aquifer, pumping is likely to induce unsaturated flow and to disconnect the surface water from the groundwater. Once groundwater disconnection from the river, additional drawdown does not result in a local increase of the infiltration rate. The conditions under which a disconnection can occur have been discussed in detail by Brunner et al. 2009. Fox (2007) used a semi-analytical approach and showed how the length of the unsaturated zone under a river increased in time as a result of pumping. These studies illustrate that it is important keep in mind that if a streambed has a lower conductivity than the aquifer (e.g. through streambed clogging), a disconnection between surface water and groundwater is likely to occur as a result of pumping. In this case, these solutions should no longer be applied directly as one of the main assumptions is no longer fulfilled.”

Fox, G.A., Gordji, L., 2007. Consideration for unsaturated flow beneath a streambed during alluvial well depletion. J Hydrol Eng, 12(2): 139-145.

Brunner, P., Cook, P.G., Simmons, C.T., 2009. Hydrogeologic controls on disconnection between surface water and groundwater. Water Resour. Res., 45(1): W01422 doi:10.1029/2008WR006953

- 2349 line 12-13: change it to ....” Installing horizontal wells has ....”. The next sentence (“The problems with ...”) is not understandable, please be more specific and detailed.

2349 line 24: This sentence is unclear and should be reformulated.

- Methods: All the implicit assumptions should be listed and dicsussed: o It is assumed that the river stage is not influenced by pumping o It is assumed that the system remains confined during pumping. o It is further assumed that the streambed has the same conductivity as the aquifer o It is assumed that the stream and the aquifer re-

main hydraulically connected during pumping (as mentioned on page 2354). It is worth pointing out that this assumption is in fact a consequence of assuming the same hydraulic conductivity in the aquifer as well as in the streambed.

2350, first sentence: the behavior instead of behaviors.

2351, line 2: “is the specific storage”

2351, line 10 “...are formulated as ” instead of ...”are respectively considered as”.

2351 line 15: remove “The”

2353, line 8 “...Appendix A”

2354: ...”hydraulically connected with...”

2354: line 9: Equation 23 is developed....”

2354 line 11:”independent of...” ÂÍ

2354 line 15: I suggest to provide some justification on why the exponential terms are neglected.

2355 line 6: remove the respectively at the end of the sentence

Results and discussion: I think some key points should be added: - Under what conditions do the authors suggest to use their solutions? - What are the implications of the assumptions? A critical one that should be addressed is the assumption of a fully connection during pumping Also, the available literature on horizontal wells under rivers does not seem to be explored adequately, e.g. the paper “Numerical simulation of groundwater flowing to horizontal seepage wells under a river” by Wei Wang and Ge Zhang,Hydrogeology Journal, Volume 15, Number 6 / September, 2007 is relevant for this work. Also, I suggest that the authors of this paper also consult the reference within Wang and Zhangs papers, there might be interesting additions to mention.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 2347, 2010.