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Interactive comment on "Inclusion of Tank Configurations as a Variable in the Cost Optimization of Branched Piped Water Networks" *by* Nikhil Hooda and Om Damani

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Dear Anonymous Reviewer, thanks for taking the time to review our paper and providing us with constructive suggestions and comments.

The context of the problem that we are solving is primarily a rural one. Our choices have been guided by how to best serve villages in developing countries.

1a. The authors say, "the purpose of using tanks is to divide the network into a primary network and secondary network" (Page 1, Line 28). This is not true. The primary purpose of using tanks is to balance the hourly varying demands and to reserve water for emergency, such as during pipe or other system component failure as well as for

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fire fighting.

Response: What we have assumed as purpose of the secondary network is what you call the “purpose of the tanks”.

On line 2 of page 2, we stated that “This division of responsibility helps in providing a more equitable distribution of water in the entire network.” In the developing countries where most of the rural population gets insufficient water per capita (as little as 40 litre per person per day), in the absence of tanks, households at tail end of the network will not get even this meagre amount when those near the head of the network keep their taps open. That is, the purpose of secondary network includes balancing “the hourly varying demands” and goes beyond it in making sure that people get minimum assured quantity of water. In our work-area, “reserving water for emergency” is not an important goal since every day is an emergency. Based on your feedback above, we will further elaborate the purpose of the secondary network in the revised version of the paper.

1b. Therefore, it is not practical to decide tank configurations from the point of view of capital cost alone

Response: We indeed agree that the capital cost is not the only consideration when designing tanks. Therefore, in the JalTantra system, we have provided the option to fix tanks at locations where designers want or alternatively disallow tanks where not appropriate because of other considerations. Optimization problem is then restricted to subset of permitted locations. We briefly mention this user defined functionality in the JalTantra system section on page 7 but do not elaborate it further since in the paper we were focused on the mathematical details of the optimization problem.

2. ... Thus flow rate in a secondary network is higher than that in a primary network." The trade-off ("push and pull") between pipe and tank costs is largely based on this assumption, but this is not always true. The assumption that secondary networks are scheduled to run for a few hours every day is only true in a rotational water supply system, which cannot be avoided if there is water scarcity..

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Response: Your observation is correct that secondary networks need not always run for a smaller number of hours. But that is the reality in most of the developing world. In fact, none of the top 10 cities in India have the luxury of 24/7 water supply. Ministry of Drinking Water, state of Maharashtra, where we reside has only recently increased the design demand from 40 lpcd to 65 lpcd (litre per capita per day) for rural areas. “Water scarcity” is a fact of life.

And this is not just in India. Many participants at CCWI conference where we presented this work told us that they operate in similar conditions.

In any case the stated assumption was just to motivate how different configurations maybe costed differently. The actual model is not contingent on this assumption. It is not a consideration at all in the model. As such, no matter what the number of hours the secondary network operated for, the model should optimize.

In summary, the typical rural scheme in India is gravity fed while at the same time consisting of several intermediate tanks. It is the conversations with government engineers and their feedback that prompted us to include tanks as part of the optimization. We agree that considering pumps and therefore the operational cost will result in a better solution. We mention this in our future work section on page 8 and since the CCWI 2016 conference (where this paper was presented), we have indeed extended our JalTantra system to include pumps. Both capital and operational cost are now considered.

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