Progress report --
Potential Cost Savings due to Financial Consolidation of Water Infrastructure
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Residents of the Hudson-Mohawk River Watershed and the state of New York face serious challenges during coming years to maintain water infrastructure, including both water supply and sewage treatment. For example, maintaining wastewater infrastructure is expected to cost more than $36 billion by 2028 (NY-DEC 2008). Given this extremely high cost, one of the few potential opportunities for substantial cost savings is consolidation of water infrastructure entities. For this reason, I have undertaken a critical review of the literature on this topic to estimate the potential for cost savings and the strengths and weaknesses of consolidation for reducing overall costs. I am focusing on organizational consolidation without physical consolidation because it will be applicable to all entities, while physical consolidation is applicable to just the very few entities that could feasibly be physically connected. This report summarizes progress to date along with discussion of plans for the remainder of this aspect of our research project.

Literature on the potential cost savings was identified by searching online bibliographic databases including the "Web of Science", as well as asking researchers with expertise in this topic for relevant citations. Most of the literature focuses on water supply rather than sewage treatment, probably because there are many small water supply systems, and thus more potential for consolidation. In this report I review the 3 most relevant studies on water supply including one national study, one from the Lehigh Valley in neighboring Pennsylvania, and one from New York State.

At the national scale, a key study of water supply costs suggested that doubling the size of a small water system would save 10.5%, while combining small systems to a medium system would save 26.3%, with the majority of savings due to capital, labor, and materials (Shih et al. 2006). However, a great deal of variation was found in cost within a size class, thus increasing size does not guarantee savings. Indeed, the large variation in costs within a size class indicates either (1) there could be large cost savings due to other factors or (2) that there are factors that strongly affect cost that vary among locations. Improved understanding of this variation is needed to better understand the potential for cost savings with consolidation. Furthermore, while this study discussed consolidation, in particular organizational (as opposed to physical) consolidation, it did not quantify the degree to which such consolidation would reduce costs. Instead, it analyzed the difference in cost for different sized entities, and assumed that consolidation of smaller entities would reduce costs to the same level as an existing entity of the larger scale. However, larger entities are likely to differ from smaller entities in important ways besides just size. In particular, the average density of customers of water services is likely to be greater for larger entities than smaller ones. This difference in density is likely to affect the costs of water supply because less energy will be required to transport water per customer in a dense system compared to a sparse system due to length and diameter of pipes. Indeed, there are likely to be dis-economies of scale for larger entities if the costs of transporting water rise faster than the number of customers served. The authors acknowledge this issue, but do not quantify it. For this reason, in my judgment, they do not provide convincing evidence that consolidation will provide any cost savings at all.

A study in the Lehigh Valley of Northeastern Pennsylvania (Cromwell et al. 2008) developed a tool for estimating the cost savings of different degrees of organization consolidation. They used actual cost data from many entities, and then projected future costs based on a number of assumptions. Then they developed scenarios of consolidating to the sub-regional or regional scale. They assumed that costs would decrease by 20% for consolidation to the sub-regional scale and by 28% at the regional scale. However, they do not provide any analysis to support this assumption. They do claim that savings of up to 30% are reasonable based on the results of Shih et al. (2006). However, the authors (Shih et al.) discuss that the value of 30% is not reasonable because it is based on a change in costs for individual facilities from 1995 to 2000 that was likely due to gains from higher capacity utilization rather than true scale economies. Instead the value of 10% is representative of their results from their models based on a larger panel of data from a single year. However, as discussed above, even this lower value cannot be interpreted as savings due to consolidation, but rather, the difference between existing larger entities and existing smaller entities. Thus while Cromwell et al. (2008) provide detailed cost models for different scenarios of consolidation, their fundamental assumption of cost savings is not supported either by their own analysis nor by the cited analysis of Shih et al. (2006).

In New York State, economies of scale for small rural water systems serving 10,000 or fewer persons were analyzed based on data on 37 systems for which loans were provided (Boisvert & Schmit (1997). While this study is older than the others discussed above, it is still quite relevant as the types of systems employed have not changed radically since the 1990s, although of course total costs have likely increased. They found that total costs per person increase substantially with decreasing population density, from $200-300 at a density of 5 persons per hundred linear feed of transmission and distribution pipe to $600-$700 at 0.5 persons. These results support the concern discussed above that comparing the cost of different sized water supply entities without accounting for differences in density could be extremely misleading, as the difference in cost across the observed range of densities was larger than the difference in average costs among smaller and larger entities in previous studies. This New York study also found that when including both water treatment and distribution, economies of size are exhausted quickly as system size increases. For systems of the average density of 2 persons per 100 linear feet of pipe, the optimal (lowest-cost) system size ranged from 8,000 to 11,500 people. The authors did not specifically address cost savings due to consolidation and focused only on systems smaller than 10,000 customers, but their results do not provide any data to suggest any substantial savings due to consolidation. However, they did note that for water treatment (not distribution), on average, capital accounts for about 45% of costs, while operating costs account for the remaining 55%. They suggest that if lower-cost capital can be obtained, substantial savings could be obtained. If capital costs are indeed lower for larger entities, this could result in savings with organizational consolidation. There are other factors that could plausibly result in lower costs with consolidation, including the cost of materials (by purchasing larger volumes), and sharing of employees or equipment. Indeed, the national analysis by Shih et al. found that capital costs, outside services, and materials all contributed to the economies of scale. However, there remain the issues that other factors such as density may be confounded with scale, so it cannot be concluded that these economies of scale would apply, at least to the same degree, with consolidation of smaller organizations as occurs with existing larger organizations.

I had planned to calculate the potential cost savings due to organizational consolidation of smaller water infrastructure entities up to the county scale, for each county in the Hudson/Mohawk watershed, including if appropriate a range of estimates based on results from the literature. However, to date I have not found any convincing evidence of meaningful cost savings due to consolidation. Additionally, there would likely be additional costs to consolidation, at least in the short term, due to the time required for personnel to plan and carry out organizational consolidation, as well as the need for outside expertise such as lawyers. Thus any potential cost savings would need to be balanced against these temporary cost increases to estimate overall savings.

There can certainly be non-financial benefits to consolidation, including (1) additional technical expertise to improve operations and reduce violations of standards (Lee and Braden 2008), (2) improving risk management for rare events such as unplanned major replacements or effects of natural disasters such as floods (Cromwell et al. 2008), and (3) improving technical capacity for financial and technical planning including asset management (Cromwell et al. 2008). While these benefits do not provide a means of reducing costs, they could improve the quality and thus the value of the water supply or sewage treatment service.

I have identified additional literature that is relevant to consolidation of water infrastructure, including both peer-reviewed scientific articles and case studies. This literature includes analysis of sewage treatment in addition to water supply (e.g. Hopkins et al. 2004 and Carruthers and Ulfarsson 2008). During the remainder of the project I will review this additional information and also ask other Cornell colleagues within the larger coordinated Hudson/Mohawk to provide feedback on these preliminary conclusions before finalizing them. If credible estimates can be made of potential savings due to consolidation, I will analyze one or more scenarios of potential savings for the Hudson/Mohawk watershed.

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Literature Cited

Boisvert, R. and T. Schmit. 1997. Tradeoff between Economies of Size in Treatment and Diseconomies of Distribution for Rural Water Systems. Agricultural and Resource Economics Review:237-246.

Carruthers, J. I. and G. F. Ulfarsson. 2008. Does 'smart growth' matter to public finance? Urban Studies **45**:1791-1823.

Cromwell, S. and S. Rubin. 2008. Estimating benefits of regional solutions for water and wastewater service. American Water Works Association Research Foundation.

Hopkins, L. D., X. H. Xu, and G. J. Knaap. 2004. Economics of scale in wastewater treatment and planning for urban growth. Environment and Planning B-Planning & Design **31**:879-893.

Lee, M. Y. and J. B. Braden. 2008. Examining mergers in small CWSs: The role of regulatory compliance. Journal of the American Water Works Association **100**.

NY-DEC. 2008. Wastewater Infrastructure Needs of New York State. New York State Department of Environmental Conservation.

Shih, J.-S., W. Harrington, W. A. Pizer, and K. Gillingham. 2006. Economies of Scale In Community Water Systems. Journal AWWA **98**:100-108.