Smaller Scale, Bigger Concept

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When I was asked to write an article on the decentralized concept of "waste" water management, the request was to offer a "… comparison of centralized and decentralized wastewater systems with the pros and cons of each." It strikes me that the most important, most practically dominant contrast is that the biggest "pro" of the conventional centralized concept is that it is accepted—despite its many flaws—as THE way to plan and implement "organized" wastewater systems by all the institutions that deal with wastewater management, while the biggest "con" of the decentralized concept is that it is not accepted, in fact not even understood. Sure there is a group of dedicated people within EPA that actively promotes consideration of decentralized wastewater systems, but it seems that their major focus hews to what I call a "dichotomy" view of this function. The bulk of their effort deals with individual on-site systems as THE alternative to "sewer" systems, as if it is always one or the other. The decentralized concept is much bigger than that, however, encompassing a continuum of options for planning and implementing wastewater systems.

That said, it is obviously necessary to provide a working definition of the decentralized concept, then to review how it compares with the conventional approach. Cut to its most basic, the idea is to treat—and reuse where practical and beneficial—the "waste" water as close to where it is generated as practical. Sure the "on-site" system is the most ubiquitous example of this strategy, but an individual system for each generator is not the only—and often not the best—way to organize the overall wastewater system. A treatment center might also serve a group of homes, a commercial center, a whole subdivision, or the central core of a community. Note that the latter might, in fact be considered a "centralized system". Clearly, we must differentiate between "centralized system" as a collection of hardware components and as an organizing paradigm. The former can be a part of a decentralized concept system, the latter excludes consideration of the decentralized concept. It is the exclusionary conventional paradigm which is compared with the decentralized concept in the following.

Many considerations would determine how close to the source of generation it is practical to place the treatment center. One very important factor is the potential for beneficial reuse of reclaimed water, challenging the very concept of "waste" water. Other considerations include topography, soil conditions, development density (existing or desired), type of land use, and environmental impacts of the wastewater management function in any given locale.

It is also important to understand that the decentralized concept embodies organized management of the overall system. It seems that "decentralized management" instead of "decentralized concept of management" has become the standard shorthand for this strategy. This is obviously a misnomer, since it is the system hardware that is decentralized, while the management function can be as highly centralized as it is for any conventional "regional" system. It must be kept in mind that sewer mains, lift stations and treatment plants in a centralized system would not continue to function properly for very long if their operations and maintenance were left to the whims of individual users. A decentralized concept system is obviously no different in this regard. ALL facilities must be managed by an entity with powers and duties appropriate to the demands of the methods used.

An immediately obvious difference in the two strategies is that the decentralized concept eliminates a very large portion of the very expensive conveyance system required to execute the conventional centralized strategy, a system which does nothing but move pollution from point to point. Actually, we are finding out that the conventional collection system does more than just move pollution—it seems that it also distributes it. In his keynote address at the ASAE Ninth National Symposium on Individual and Small Community Sewage Systems, Dr. George Tchobanoglous stated that, due to leaking sewers, the whole water table of the Los Angeles basin is contaminated at a low level. This highlights that the collection system, besides consuming a large majority of the investment in a conventional, centralized system, is itself a potential environmental and public health hazard. This is rich irony, since the original reason for being of "the sewer" was to eliminate public health problems by piping the wastewater "away".

Another major difference in the two concepts is that, in a conventional centralized system large flows are routed through one main or one lift station or one treatment plant. Therefore, the consequences of any mishap are often "large". I have often said, not entirely tongue-in-cheek, that the rationale for a "regional" system is to get all this stuff together in one place where it can REALLY do some damage. By contrast, flows at any point in a decentralized concept system generally remain very low, so that the consequences of any mishap would be "small".

In any case, the likelihood of mishaps—leaks, bypasses, overflows, etc.—would be lower in a decentralized concept system. A major feature of the concept, at least as I envision and practice it, is the almost exclusive use of effluent sewers for any conveyance that is required, and the use of more "fail-safe" treatment methods. The conveyance system that remains is built "tight" with cleanouts in place of manholes, and is smaller, of more limited extent and carries only liquid effluent. Thus, it presents a much lower potential for leaks and overflows, and it also minimizes infiltration/inflow and the problems caused by wet weather surge flows in conventional systems. Because treatment centers are dispersed, lift stations are eliminated or greatly reduced in number in a decentralized concept system, further lowering the potential for bypasses.

"Fail-safe" treatment methods are those that, by their very nature, are resistant to bypassing poorly treated effluent. An excellent example of this is the contrast between a biofiltration system (e.g., a "sand" filter)—the type of technology highly favored for use in the decentralized concept—and the activated sludge plant most often used at the end of conventional centralized collection systems. The activated sludge plant depends for its treatment effect on very few trophic levels of organisms, living in concentrations far higher than found anywhere in nature, so the process is inherently unstable. It depends upon constant inputs of energy and close attention to process function in an attempt to prevent "upsets" which can happen quite quickly if optimal conditions are not maintained. Typically there is no physical barrier to passage of poorly treated effluent in that treatment system, so any upset results in release of poorly treated effluent in short order. Once off track, it often takes some time for the process to "settle down" and all the while an out of compliance discharge is occurring. By contrast, the biofiltration system depends upon many trophic levels of organisms for treatment and is fairly low rate, so it is inherently stable. The filter bed also presents a physical barrier to passage of poorly treated effluent. The major failure mode is clogging of the filter bed, a condition that generally builds up very slowly, affording the operator the opportunity to conduct required maintenance essentially at his leisure. When properly designed and loaded, maintenance requirements would be minimal and filter runs of several years should be expected. Insightful design of the filter bed system allows the bed to be restored to normal function quite expeditiously at the end of a filter run, taking the bed out of service for only a few hours.

By such judicious choice of technologies, the presence of many small dispersed treatment centers which the decentralized concept may entail would not create the untenable operations and maintenance liability that the concept's detractors claim. Of course there would be an organizational challenge in

setting up the management system to address dispersed treatment centers, and that is probably the biggest reason why this alternative concept is resisted by operating entities, engineers which serve them, and regulators which permit and oversee them. They feel they can maintain better control over a single centralized facility than they could over many dispersed facilities. That view is colored, I believe, by experience with conventional treatment methods and lack of familiarity with "alternative" methods. And, as just reviewed, that "control" of conventional technologies is often illusory.

Through the elimination of much of the conveyance system, the use of lower cost effluent sewerage systems, and the use of low maintenance treatment methods that are cost effective to deploy at small scale, a decentralized concept system will quite often be far less expensive to install and to operate and maintain than a conventional centralized system. Many examples of this have been generated all over the country. Perhaps the greatest testimony to the institutional resistance to the decentralized concept is that these cost advantages are not compelling; rather, uncertainties about how to manage the system and/or a view that anything but "the sewer" is a secondary good tend to dominate the considerations. I clearly recall the time a woman stood up during a meeting and asked, "Why don't we just pay more and get a real sewer system?"

Besides the environmental and fiscal aspects, a number of "societal" factors differentiate the two concepts. One, referred to previously, is that beneficial reuse of effluent can become more cost efficient when integrated into the decentralized concept. The reclaimed water would be made available throughout the service area, nearer to points of potential reuse, decreasing the cost of the redistribution system. Non-potable demands such as landscape irrigation, toilet flush supply, and cooling tower makeup supply could be served with appropriately treated reclaimed water. In many areas, this could be a significant contribution to the regional water economy, a factor that will likely become more important as fresh water supplies become increasingly strained worldwide.

Regarding water conservation, a little noted feature of using decentralized concept systems is that they would accommodate any level of water conservation found to be economically attractive or ecologically necessary. Only liquid effluent is transported, so reduced wastewater flows due to water conservation measures would not cause clogging problems in the collection system, as has occurred in conventional centralized systems.

A decentralized concept system can also be easier to plan and finance. Each project would be small in comparison to the typical "regional" system expansion. The management needs of each area or new development would be considered directly and could be generated independently. Also, much of the cost of the decentralized concept system could be privatized to those who directly benefit from those investments, or assigned directly to the activity generating new demands on a much fairer basis. Quite often, the full cost of conventional centralized system expansion and upgrading is "buried" in bonds and service charges which are born by all customers regardless of whether the expansion project benefits them in any way except to keep the overall system in compliance.

Another aspect of public financing is the time value of money. In a decentralized concept system, capacity expansion—and therefore capital requirements—would track actual demand much more closely than it typically does in a "regional" system. In centralized systems, considerable investment is often required to build facilities that would not be fully utilized for many years to come.

The decentralized concept also provides greater flexibility to address a variety of situations within a service area in the most cost efficient, environmentally sound and societally responsible manner. With the system facilities decentralized, there would be no compelling reason to impose a "one size fits all" management approach. Different strategies could be employed in various parts of the service area—e.g., individual on-site systems in low density areas, cluster systems for pockets of development, and more

centralized systems in more impacted areas. As this implies, centralized systems can indeed have a place within the decentralized concept, as noted earlier. This would allow a regional management entity to cost efficiently assure that ALL the wastewater management activities in its area were addressed in the most responsible manner, whereas typically these authorities only address areas to which they extend conventional sewers and leave the rest of the area pretty much completely unmanaged.

Another aspect of this flexibility is that the system can be designed and installed in a manner that is "growth-neutral", whereas installing or extending centralized systems often spurs growth—even requiring it to be fiscally viable in many cases—regardless of whether or not this fits with community planning desires. A frequent consequence of conventional sewer authorities refusing to accept management responsibility for anything except centralized sewerage service is that some areas are forced into accepting the "big sewer" and the growth consequences that it entails, at the expense of the existing populations. Indeed, such "annexations" are often driven by land development interests.

Clearly the conventional centralized system has its place, but also quite clear is that there is ample reason to question if that place is everywhere that an "organized" wastewater system is desired. As reviewed, several comparisons indicate that the decentralized concept can produce systems that are more fiscally reasonable, more environmentally benign, and more societally responsible in many situations. However, lack of understanding and fear of the unfamiliar retards even the consideration of anything except the conventional paradigm by operating entities, engineers and regulators.

Indeed the biggest "pro" of the conventional, centralized system is its familiarity, and the biggest "con" of the decentralized concept is that very few understand it. This is unfortunate, because the two concepts should complement each other, not be mutually exclusive. The decentralized concept is, in fact, an overarching concept that can include centralized systems, making it the truly regional strategy for planning and implementation of wastewater management systems.