

REVOLUTION NO. 4

Can We, Should We, Escape From the Grid?

By G. Tracy Mehan III

David Sedlak, a Berkeley engineering professor, has written a challenging, well-informed history of water and wastewater treatment. He employs a historical method in service of his argument for moving beyond massive, centralized treatment systems toward a more pluralistic, distributed system that takes advantage of modern innovations in membrane, information, and other technologies, including the emulation of more natural flow regimes in treatment processes.

Sedlak is definitely of the school that rejects the very idea of wastewater, in reality water that is wasted. It should be reused or recycled. And, rather than simply transporting stormwater off site and into the sea, it should be viewed as a precious commodity to be treasured or retained and treated on site through infiltration, evapotranspiration, or reuse. Conservation and stewardship should be elevated in the hierarchy of utility managers' values over a single-minded focus on volumetric sales. This, in turn, will necessitate the reinvention of how water services are priced.

He sees climate change, with its erratic precipitation patterns (too much or too little), as a primary driver of this imperative to get beyond the traditional water grid. Other drivers include a growing economy and population; ageing infrastructure; escalating costs of water capture, transport, storage, and treatment; and tenacious resistance to rate or price increases by local leaders and citizens whether it be for upgrading infrastructure or conservation.

In *Water 4.0: The Past, Present, and Future of the World's Most Vital Resource*,

Sedlak describes the "repeated cycle of growth, failure, and reinvention that has occurred over the past 2,500 years of urban water systems" which he views as "a series of revolutions."

Water 1.0 is epitomized by the incredible engineering feats of the Romans, adopted by European cities during their industrialization. Water 2.0 emerged from the challenges of water treatment to stem the scourge of diseases such as cholera and typhoid. Water 3.0 saw the adoption of sewage treatment as "a standard feature of urban water systems."

However, "the components of the fourth revolution are still a work in progress, with multiple paths leading to

the need to address previously under appreciated forms of pollution."

Sedlak opines: "I anticipate that change will arrive first in cities where extreme weather patterns create situations that cannot be easily remedied with water rationing or the construction of a few more storm sewers. By necessity, these places will serve as the laboratories where the rest of the owner's manual for Water 4.0 will be written."

In its first phase Water 4.0 will look like upgraded or super-charged versions of centralized systems (as in Singapore, Australia, and Israel) in which "imported water will be supplemented or replaced by desalination and potable water recycling" along with a vast array of incentives for conservation. Sewage treatment plants "will evolve from a means of protecting surface waters from pollution to systems that recover water, energy, and nutrients from sewage."

Sedlak writes that "in the future, there will no longer be separate divisions within cities or utilities dedicated exclusively to water supply, sewage treatment, or urban drainage. Instead, we will manage water holistically and will integrate the natural environment into water conveyance and treatment systems."

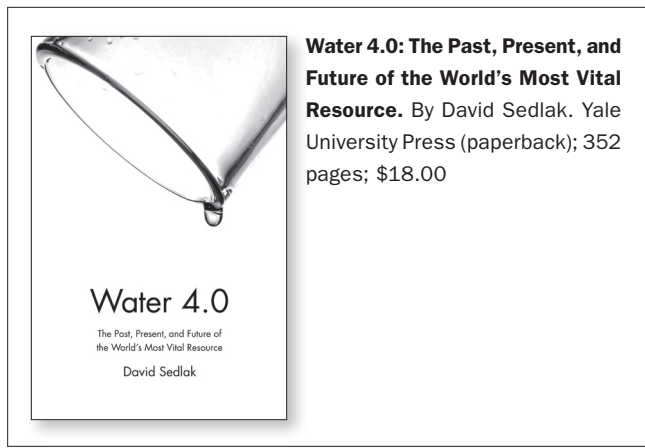
This trend is already evident in the water sector and has been described by various organizations as "one water," "total water solutions," "water resource recovery facilities," and the "utility of the future."

For good measure, you can throw in elements of "integrated water management" and watershed or source water protection.

Ferris Bueller famously said, "You can never go too far." Sedlak concurs and envisions a "distributed version of Water 4.0" taking "a more radical approach to urban water by pushing the responsibility for acquisition, treatment, and management of water back to the individual household or neighborhood" and, conceivably, re-

better water systems, provided that we are willing to invest the resources, energy, and political will needed to make them a reality."

Professor Sedlak ventures to "predict that over the next two decades cities will be pushed to start building the next generation of urban water solutions — Water 4.0 — as their water supplies and urban drainage systems fail to keep up with the effects of climate change and population growth, and as public opinion and new scientific data clarify



Water 4.0: The Past, Present, and Future of the World's Most Vital Resource. By David Sedlak. Yale University Press (paperback); 352 pages; \$18.00

ducing water use “by around 75 percent through the installation of ultra-efficient appliances and elimination of wasteful forms of outdoor water use.” In this new world of water, “landscape irrigation with drinking water will be unthinkable, and rooftop rainwater collection tanks, rain gardens, and household wells will be common features of housing developments,” which will not rely on “expensive and difficult-to-maintain centralized infrastructure.” There will still be centralized and legacy systems for most densely populated areas. Otherwise, look for “the disappearance of the water grid from many less-populated urban and suburban areas.”

Sedlak’s breathtaking opening and closing arguments, so to speak, are quite visionary. But the wizened skeptic should not mistake him for a utopian detached from the real world and its nitty-gritty details of history, engineering, science, technology, and economics. He is deeply informed on the intricacies of technological development in the multifaceted world of water, wastewater, stormwater, reuse, recycling, desalination, and conservation and efficiency. His narrative is accessible (even if you did not manage to stay awake in high school chemistry class), compelling, and well-sourced in the academic and technical literature.

The first 90 pages of *Water 4.0* offer a lively history of human beings coping with the challenge of obtaining potable water (“beverage of beggars”) and disposing of their wastes from Roman times through the Medieval and Renaissance epochs and well into the Industrial Revolution. “The combination of water filtration and chlorination was the first major innovation in drinking water since the Roman aqueducts and sewers,” observes Sedlak. “In fact, the U.S. National Academy of Engineering

identified water treatment and distribution as the fourth most important engineering feat of the twentieth century, after electrification, automobiles, and airplanes but ahead of electronics and the Internet.” In sum, they “revolutionized” water treatment. Sedlak does a fine job telling the exciting and interesting stories of the men and women and institutions who developed these solutions, the triumph of Water 2.0.

The same is true for Sedlak’s treatment of Water 3.0 as well the role of the Clean Water Act in the transition from primary to secondary treatment. He is also intellectually honest in noting that, despite the generous grant program that came with the CWA, wastewater utilities did not maintain and upgrade their systems. This has contributed to our present infrastructure investment gap four and a half decades later.

Sedlak offers separate chapters on contemporary challenges of chlorine and its cancer-causing disinfection by-products; “urban wet weather” issues (combined sewer overflows, stormwater, etc.), green infrastructure and low-impact development; emerging contaminants such as hormones, pharmaceuticals and toxic chemicals as well as non-potable and potable water reuse (“toilet-to-tap”) and desalination. These, too, are most informative, accessible and grounded in state-of-the art research and science.

Regarding infrastructure financing and water rates, Sedlak is resigned to the fact that political opposition will continue to hamper adequate investments in water infrastructure, old and new. This may not be a bad thing since he believes “that the impending costs of maintaining the status quo will be the push needed to start the fourth urban water revolution. Although the operating manual for Water 4.0 is incomplete, the promise of a less expensive and more sustainable alternative should serve as an incentive for working out the details.” He observes that,

The costs of maintaining the status quo will be the push needed to start the fourth revolution

for drinking water alone, replacing the first-generation systems will cost about \$13,500 per household.

“We can be sure, then, that our water bills will continue to increase for the next few decades,” writes Sedlak citing the Organization for Economic Cooperation and Development to the effect that “consumers in most developed countries already pay about twice as much as the average American for drinking water and sewer service.” Thus, “it seems likely that in about 15 years our bills will reach the current levels paid in our OECD peer countries — and there is no reason to think that they will stop there.” Sedlak makes a strong case that we may be able to move to that first, less radical stage of Water 4.0. As to the second, more radical phase, well, the reader can make his or her own judgment.

It would have been interesting to hear Sedlak’s perspective on non-technological solutions. What is the promise or peril of water markets, i.e., trades between cities, industries, and farmers? With agriculture holding rights to over 70 percent of the water in prior appropriation (“first in time, first in right”) states, but generating only 3-4 percent of GDP, might there be mutually beneficial trades? The same may be asked of trades between point-source dischargers and farmers to achieve least-cost reductions in nutrient pollution.

Sedlak has written a stimulating, provocative book that both informs and challenges the reader to think seriously, and creatively, about water management for the next generation.

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