Water and Wastewater Infrastructure in the United States: The Clean Water-Energy-Climate Nexus

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When Congress adopted comprehensive amendments to the Federal Water Pollution Control Act in 1972, commonly known as the Clean Water Act ("CWA"), the nation faced an immense challenge in addressing the human health and environmental consequences of water pollution. Key pollution sources included industrial discharges; "nonpoint source" runoff from farms, city streets, and other intensive land uses; and inadequate facilities for the proper collection, treatment, and disposal of municipal sewage and sewage treatment residuals ("municipal sewage systems").

With respect to municipal sewage (the principal focus of this article), the biggest challenge was to pay for the collection and treatment systems needed to serve a rapidly growing and urbanizing U.S. population while meeting the new technology-based treatment requirements and ambient water quality goals established in the CWA. To meet those needs, Congress expanded pre-existing programs to provide federal financial aid to municipalities to build or upgrade municipal sewage systems. In Title II of the CWA, Congress established (1) a "construction grants" program with federal subsidies to finance municipal sewage systems and (2) related planning provisions to ensure that federal funding was used as effectively as possible. From 1970 to 1995, the federal government invested over sixty-one billion dollars in the construction grants program. In 1987, Congress

3. In addition to liquid effluent from municipal sewage, municipalities face the equally challenging problem of managing large volumes of sewage sludge, or "biosolids," generated during the sewage treatment process. See Dade W. Moeller, Environmental Health 203–08 & figs. 8.5–8.6 (3d ed. 2005) (describing typical sewage treatment processes and depicting generation of sludge at end of process).
6. In addition to minimum technology-based treatment requirements, all point source discharges also must meet supplemental "water quality-based" effluent limitations as necessary to meet water quality standards adopted to protect beneficial uses in specific water bodies. CWA §§ 301(b)(1)(C), 302, 303(c)–(d), 33 U.S.C. §§ 1311(b)(1)(C), 1312, 1313(c)–(d) (2006). For municipal sewage discharges, compliance with water quality-based limits typically requires additional measures to reduce nutrients (nitrogen and phosphorus) and other "tertiary" or other "advanced" wastewater treatment methods to meet water quality standards. For a general description of tertiary treatment methods, see Moeller, supra note 3, at 207–08.
9. Id. at §§ 201(g), 202, 205, 33 U.S.C. §§ 1281(g), 1282, 1285 (2006).
11. U.S. ENVTL. PROT. AGENCY, EPA-832-R-00-008, PROGRESS IN WATER QUALITY: AN EVALUATION OF THE NATIONAL INVESTMENT IN MUNICIPAL WASTE...
replaced the construction grants program with a revolving loan fund.12 Although Congress provided an additional sixteen billion dollars to states to capitalize those funds,13 this effectively transferred most of the fiscal burden of constructing and upgrading municipal sewage systems back to states and cities.

By some measures, Title II of the CWA was among the Act’s most successful initiatives. Between 1972 and 2008, the number of people in the United States served by advanced wastewater treatment increased from under 8 million to 113 million, and the population served by less than secondary treatment14 dropped from 50 million to fewer than 4 million.15 According to EPA, these investments resulted in significant reductions in pollutant discharges, despite equally significant increases in the amount of sewage accepted by the nation’s treatment systems.16 Those reduced discharges, in turn, generated measurable improvements in some measures of water quality downstream of major municipal treatment facilities.17

Despite the hundreds of billions of dollars that federal, state, and local governments invested to improve water and wastewater infrastructure in the past forty years,18 and the even higher amounts to operate and maintain those facilities (“O&M costs”),19 prospective municipal sewage system funding needs in the United States in 2012 are similar to those faced in 1972.20 The nation needs similar levels of investment in infrastructure to store, transport, treat, and distribute water supplies to growing cities.21 The United States faces at least a trillion dollars in water and wastewater capital expenses over the next twenty years.22 Yet, those needs come when the federal budget deficit has escalated, prompting increasingly vocal calls for fiscal austerity.23

Moreover, continuing U.S. population growth,24 urbanization, and an increasing percentage of the nation’s population served by municipal treatment systems25 threaten to offset many of the gains achieved over the past four decades.26 Astonishingly, EPA estimates that, by 2016, ultimate biochemical oxygen demand discharge levels will be similar to those existing in the mid-1970s and, by 2025, will resemble those existing before the 1972 Act.27

Notably, these estimates assume that we will continue to use technologies in which the majority of treated sewage is discharged to surface waters.28 That is ironic because, as discussed in more detail later,29 Congress intended in 1972 to shift our municipal wastewater system away from surface water discharges and toward wastewater recycling and reuse.28 Those measures should have reduced demands on both the supply end and the treatment end of the municipal water cycle.31 Clearly, those provisions did not work as intended.32 Indeed, there is reason to believe that the CWA itself was responsible for some of the inefficiency in waste-

15. Secondary treatment refers to the minimum level of treatment Congress deemed acceptable for municipal sewage, and is defined more specifically by regulation. CWA § 301(b)(1)(B), 33 U.S.C. § 1311(b)(1)(B) (2006); see Moeller, supra note 3, at 173; 40 C.F.R. § 133 (2012) (defining the level of control attainable through use of secondary treatment).
17. Progress in Water Quality, supra note 11, at ES-5 (reporting forty-five percent decline in biological oxygen demand (“BOD,”) loadings in the face of thirty-five percent increase in BOD influent, reflecting an increase in BOD, removal efficiency from sixty-three percent to nearly eighty-five percent). The study also reports similar figures for ultimate biochemical oxygen demand (“BOD,”), which includes both carbonaceous (organic) and nitrogenous materials that reduce oxygen levels in receiving waters during decomposition processes. See id. (reporting twenty-three percent decline in BOD, loadings in the face of thirty-five percent increase in BOD, influent, reflecting an increase in BOD, removal efficiency from thirty-nine percent to sixty-five percent).
18. See Progress in Water Quality, supra note 11, at ES-10 (reporting improvements in dissolved oxygen (“DO”) levels, particularly in urbanized areas).
20. See id. (operation and maintenance (“O&M”) costs per year approximately equaled capital costs in 1987, but increased yearly to approximately twenty-five billion dollars in 2006 because of aging infrastructure and higher material and energy costs).
21. Compare Progress in Water Quality, supra note 11, at ES-2 (discussing that approximately $77 billion was spent by the federal government between 1970 and 1999 to fund municipal wastewater treatment), with Clean Watershed Needs Survey, supra note 15, at 2–2 (explaining that $298.1 billion will be required to fund the nation’s current wastewater needs).
23. See discussion infra Part I.A.
25. See Progress in Water Quality, supra note 11, at ES-6 (estimating U.S. population at 295 million in 2025, compared to 140 million in 1968).
26. See id. (estimating percentage of population served by municipal treatment systems increasing from seventy-one percent in 1968 to eighty-eight percent in 2025).
27. See id. (projecting that BOD, load levels, which had improved, will be similar to 1968 levels due to increased demand on infrastructure). “BOD” refers to “biological oxygen demanding” pollutants, which deplete oxygen in water bodies during the waste degradation process.
28. See id. (estimating national BOD, loadings of 21.065 metric tons per day (“mtpd”) in 2025 compared to 21,280 mtpd in 1968, despite an increase in BOD, removal efficiency from thirty-nine to seventy-one percent).
29. Id.
30. See discussion infra Part II.
31. See, e.g., CWA §§ 104(o), 105(d), 201(b), (d), (g), 33 U.S.C. §§ 1254(o), 1255(d), 1281(b), (d), (g) (2006).
32. See S. Rep. No. 95-370, at 4 (1977) (stating that “the purpose of these funds is not to finance the future growth needs of the United States. Rather, the purpose is to eliminate backlog with limited provisions for growth set forth specifically in the statute to recognize the cost effectiveness factors and to achieve a balance between the pressures for economic development and the need for environmental improvement”).
33. See Nat’l Research Council, Water Reuse: Potential for Expanding the Nation’s Water Supply Through Reuse of Municipal Wastewater 15 (2012) (stating that approximately 33 billion gallons are discharged daily from
Large amounts of water are used to generate energy in the United States, especially for electricity and transportation, but significant energy resources are also used to pump, transport, treat, and distribute water to end users. Hydrologic changes caused by climate change are likely to exacerbate existing regional imbalances between water supply and demand, but the energy needed to redistribute water from areas of surplus to areas of need can generate additional greenhouse gas ("GHG") emissions. At the back end of the municipal water cycle, energy is required to collect, pump, treat, and dispose of municipal sewage and the resulting effluent and biosolids.

This confluence of circumstances suggests that we need to consider future water and wastewater infrastructure in the United States in the context of a clean water-energy-climate nexus. Under a "business as usual" approach, we will continue to move massive amounts of water over long distances, treat all of it to drinking water quality regardless of actual end use, and collect and treat all of the resulting wastewater to meet receiving water standards. We will discharge most of that wastewater to surface waters, whether or not the effluent resource can be reused. The business as usual approach will perpetuate extremely high fiscal costs. It will also offset and eventually overwhelm the surface water quality improvements achieved over the past forty years, and increase energy costs and GHG emissions, thus further exacerbating climate change.

Part I outlines the significant financial and other investments needed to provide safe water to a growing and urbanizing population and to treat and safely dispose of the wastewater generated by that water use. It also explains that climate change is likely to increase the financial and environmental costs of moving water and that, conversely, the energy used to operate water and wastewater systems will contribute to climate change. Part II analyzes the impacts of the CWA on past water and wastewater infrastructure.

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34. See Train, The EPA Programs and Land Use Planning, supra note 33.


36. See id. § 304(d), 33 U.S.C. § 1314(d) (2006) (containing no similar provision regarding energy). In the 1977 Amendments, Congress only added a tepid provision prohibiting EPA from awarding grants unless the applicant had "taken[ ] into account and allow[ed] to the extent practicable the more efficient use of energy and resources." Federal Water Pollution Control Act Amendments of 1977, Pub. L. No. 95-217, § 12, 91 Stat. 1569 (1977) (codified as amended at 33 U.S.C. § 1281(g)(5)) (adopting CWA § 201(g)(5)).


41. Although the focus of this article is on wastewater infrastructure pursuant to the CWA, and public water supply needs under the Safe Drinking Water Act, 40 U.S.C. §§ 300f–300q-26, is beyond the scope of this analysis. As explained herein, it is artificial to disaggregate the "front end" from the "back end" of the urban water cycle.


43. See generally Electricity Consumption for Water Supply & Treatment, supra note 39 (evaluating potential for energy efficiency through reuse but documenting prevailing surface water discharge approach).

44. See Energy Efficiency for Water and Wastewater Utilities, supra note 42.
strategies, and identifies potential future lessons. Part III suggests technological and legal strategies to meet future water and wastewater needs that might be more sustainable from both an environmental and fiscal perspective. Part IV concludes that a more sustainable path does lie ahead, but that we will have to design, build, and operate a new generation of water and wastewater infrastructure systems in the twenty-first century if we are going to meet increasingly important public health, environmental, and economic needs in a way that is fiscally affordable and that does not exacerbate climate change.

I. Water and Sewage Infrastructure: Needs, Imperatives, and Challenges for the Twenty-First Century

A. Documented Water and Wastewater Needs

According to EPA's most recent Clean Watershed Needs Survey (“CWNS”), the documented nationwide costs for publicly owned treatment works (“POTW”), combined sewer overflow (“CSO”) corrections, and stormwater management facilities and programs over the next twenty years are $298.1 billion.45 EPA reports that the majority of those costs derive from the need to replace existing, but aging and deteriorating, infrastructure, to meet stricter water quality requirements, and to address population growth.46 Although large, the CWNS estimates are probably low because states also estimate at least an additional $36.8 billion in costs that were not included in the CWNS because they did not meet EPA's reporting requirements.47 EPA also believes that stormwater collection and treatment needs are underreported, perhaps by a significant amount.48

EPA's parallel report on drinking water infrastructure needs estimates an additional $334.8 billion in capital improvements over the 20-year period from 2007 to 2026.49 The highest capital needs are for distribution and transmission pipes and treatment and storage facilities,50 the magnitude of which stems from the age of our distribution system. Much of our infrastructure is reaching the end of its design life.51

Combined, EPA's two most recent “needs surveys” for drinking water and wastewater suggest a conservative estimate of $632.9 billion in capital needs over the next two decades, or an average of almost $32 billion per year (in constant dollars).52 For several reasons, however, each of these estimates understates the financial investments needed to maintain and improve the quality and capacity of our complete water supply and wastewater treatment and disposal systems—what might be referred to as the full urban water cycle. First, as discussed more extensively below,53 current estimates do not account for increased water supply, wastewater, and stormwater collection and treatment needs due to climate change.54

Second, EPA's drinking water supply and treatment cost estimates include only those portions of the public water supply system eligible for Drinking Water State Revolving Fund (“DWSRF”) financing under the Safe Drinking Water Act.55 Additional costs not included in the DWSRF include capital and O&M costs associated with dams and raw water reservoirs,56 and long-distance conveyance systems needed to transport water from areas of supply to areas of need in some parts of the country, particularly the arid west.57 According to one estimate, for example, it will cost an estimated sixty-six billion dollars over the next decade to address existing dam safety problems.58 Not all of those costs are attributable to public water supply because dams serve other purposes—such as irrigation water supply, flood control, and power production. The estimate also does not include construction costs for new dams or reservoirs.59 Similarly, the combined price tag for major new water pipeline projects that are proposed in the planning or construction process is at least thirty-five billion dollars.60 Those facilities also serve irrigation and other needs, however, not all of their costs can be attributed to public water supply.

Third, although some other surveys and analyses suggest that EPA's estimates are in the correct range,61 others suggest that they may be low. The American Water Works Association (“AWWA”), for example, in what it characterizes as “the most thorough and comprehensive analysis ever undertaken of the nation's drinking water infrastructure renewal needs,”62 calculated national costs for replacing, restoring,
and expanding only buried water delivery mains.\textsuperscript{65} That estimate does not include water supply and storage infrastructure, treatment facilities, and local delivery pipes, which AWWA calculates at over \$1 trillion over the next 25 years and exceeding \$1.75 trillion by 2050.\textsuperscript{64} More than half of these expected costs—fifty-six percent—stem from the fact that so much of our “buried” water supply system is very old, dating in some cases to the late 1800s,\textsuperscript{65} which generates a significant risk of breakage, deteriorating service, or higher repair costs to avoid leaks or more severe problems with the system.\textsuperscript{66} The remaining investments are needed to address population growth and migration.\textsuperscript{67}

One potentially disturbing implication of the AWWA analysis is that the calculated investment needed to replace water mains alone are substantially higher than reported in EPA’s drinking water needs survey.\textsuperscript{68} It is possible, of course, that AWWA’s methodology, which assumes needs based on the predicted life of existing infrastructure based on the material used in various systems over time,\textsuperscript{69} overstates needs because some materials may have longer useful lives than predicted. It is also possible, however, that drinking water systems have seriously underestimated their repair and replacement needs in EPA’s Needs Surveys because of the inherent difficulty of evaluating the condition of buried infrastructure, particularly for old systems in densely built cities. Those errors could haunt systems in the form of higher O&M expenses, service disruptions, or leaking pipes that increase water use and exacerbate existing supply problems.\textsuperscript{70}

Despite the large number of zeroes attached to these cost estimates, one legitimate reaction to these apparently high costs might be that these costs are really not all that large for such fundamental public infrastructure. Leaving aside the policy question of whether water infrastructure costs should be borne by localities, states, or the national government, the federal budget is a useful measuring stick to evaluate the magnitude of these costs. Assuming a trillion dollar price tag over twenty years, the resulting average annual expenditure of about forty billion dollars nationwide does not seem high compared to a proposed federal budget with annual outlays approaching four trillion dollars, much less a national gross domestic product of nearly sixteen trillion dollars.\textsuperscript{71} Annualized water infrastructure costs seem reasonable even compared to the proposed \textit{discretionary} federal budget outlays of more than \$1.3 trillion.\textsuperscript{72} When compared to the proposed \textit{non-national security} portion of discretionary outlays—\$462 billion in 2012—however,\textsuperscript{73} the estimated annual cost of water infrastructure becomes a much less trivial 9\% share.\textsuperscript{74} But, that raises the question of why basic water and wastewater is not as essential to our “security” as are military and related expenditures.\textsuperscript{75}

\section*{B. Collective Amnesia: Water and Wastewater Infrastructure Still Matters}

Assessing costs in isolation is rarely meaningful. Without suggesting that the value of safe drinking water or healthy aquatic ecosystems can be captured in a formal cost-benefit analysis,\textsuperscript{76} we should consider water and wastewater infrastructure costs in the context of their critical role in maintaining the health of U.S. residents and aquatic ecosystems, as well as their importance to the economy. Many Americans likely take for granted the fact that we can obtain as much relatively safe water as we need for typical residential uses simply by turning the tap and that it is similarly simple to dispose of residential wastewater by flushing our toilets.\textsuperscript{77} Those amenities reflect the significant investments that U.S. cities, states, and the federal government have made over the past century.\textsuperscript{78} To remind ourselves of the importance of those services, or to reduce our complacency, we need only look to some other parts of the world, or not too far back...

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  \item[63] This study was based not on a survey of existing public water supply systems, but a nationwide analysis of when water delivery systems were installed, what materials were used, the design lives of those materials, and, therefore, the likely replacement timing and costs. \textit{Buried No Longer}, supra note 62, at 5–9.
  \item[64] \textit{Id.} at 3, 9 fig. 6.
  \item[65] \textit{Id.} at 6 fig. 2.
  \item[66] \textit{Id.} at 10.
  \item[67] \textit{Id.}
  \item[68] EPA estimated total transmission and distribution needs over the next 20 years to be about \$200 billion. \textit{Drinking Water Infrastructure Needs Survey}, supra note 21, at 6. In contrast, the AWWA estimated needs to be a trillion dollars over 25 years for water mains alone, a difference of at least a factor of 4. \textit{Buried No Longer}, supra note 62, at 3. (Assuming that annual needs will be roughly consistent, EPA’s 20-year estimate would translate to \$250 billion over 25 years, but includes more distribution facilities than water mains alone.)
  \item[69] \textit{See} \textit{Buried No Longer, supra note 62, at 8.}
  \item[70] \textit{Id.} at 13.
  \item[71] Annual federal budget outlays for FY 2012 were \$3.729 trillion. \textit{Office of Mgmt. & Budget, Fiscal year 2012 Budget of the U.S. Government 171 tbl. S-1} (2012).
  \item[72] Much of the federal budget is dominated by “mandatory” expenditures for programs such as Social Security and federal health care (Medicare and Medicaid). \textit{See} id. at 174 tbl. S-3 (showing mandatory program outlays of more than \$2.1 trillion and discretionary outlays of \$1.344 trillion for FY 2012).
  \item[73] \textit{Id.} National security expenditures include the military as well as intelligence agencies.
  \item[74] The estimated \$40 billion annualized cost necessary to maintain water infrastructure amounts to 9\% of the \$462 billion requested in the President’s budget for non-discretionary outlays. \textit{See} \textit{id.}
  \item[75] \textit{The Defense Department’s requested budget share for FY 2012 was \$553 billion, compared to \$9 billion for all EPA programs. Id. at 199 tbl. S-11.}
  \item[76] \textit{See generally} Frank Ackerman & Lisa Heinezenling, \textit{Priceless: On Knowing the Price of Everything and the Value of Nothing} (2004) (critiquing cost-benefit analysis and providing examples of how it inadequately captures the full value of environmental and other resources).
  \item[77] \textit{E.g.,} Peter Lehner, \textit{Exec. Dir., Natural Res. Def. Council, Presentation at The J.B. & Maurice C. Shapiro Environmental Law Symposium: The Clean Water Act at 40} (Mar. 23, 2012). By relatively safe, I mean that most public drinking water in the United States is potable that it is extremely unlikely to contain serious pathogens or other acute human health risks. That does not mean that the U.S. drinking water supply is free from contaminants in potentially harmful amounts. \textit{See, e.g.,} U.S. Gov’t \textit{Accountability Office, GAO-11-381, Drinking Water, Unreliable State Data Limit EPA’s Ability to Target Enforcement Priorities and Communicate Water Systems’ Performance at Highlights} (2011) (reporting on violations and failure to accurately report violations).
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in our own history. According to recent assessments by the United Nations and the World Health Organization, nearly 900 million people lack access to an improved water supply and about 2.5 billion people are not using improved sanitation systems. Diarrheal diseases cause significant numbers of preventable deaths among both children and adults, and the United Nations estimates that improved drinking water and sanitation could reduce those diseases by nearly ninety percent and thereby prevent over two million childhood deaths per year. Five thousand children die each day from diarrheal ailments (one every seventeen seconds), and an estimated three million people die per year from all water-related diseases. Large populations lack access to sufficient water supplies and droughts can leave populations virtually devoid of access to any fresh water, whether improved or not. A cholera epidemic in the early 1990s in South and Central America resulted in 750,000 illnesses and at least 19,000 deaths.

Until the early to mid-twentieth century, when the United States began to invest in more sophisticated water and wastewater systems, the situation here was not significantly better than exists today in these developing nations. Indeed, a famous early U.S. Supreme Court case involving interstate environmental harm involved an effort by Chicago to divert raw sewage, which Illinois alleged resulted in increased mortality from typhoid fever, from its own drinking water sources far downstream to St. Louis.

In 1900, infectious disease mortality in the United States was about 800 per 100,000 individuals per year. By 1980, this rate declined to 36 deaths per 100,000 people per year. Waterborne illnesses followed this downward trend in parallel with the construction and operation of modern water and sewer systems. In the first and second decades of the twentieth century, for example, typhoid deaths in Philadelphia plummeted after the city began to filter, and later to chlorinate, public drinking water supplies. Surveillance and reporting capacity suggests that the incidence of those diseases is widely underreported, and the number of identified waterborne pathogens has increased over the past century. Nevertheless, deaths associated with reported drinking water diseases in the United States declined dramatically in the first half of the twentieth century.

Notably, however, the reported number of illnesses due to waterborne disease outbreaks and deaths from those outbreaks increased from the 1980s to the 1990s and into the new millennium. Several factors might explain, including (1) the high percentage of reported deaths in the single notorious outbreak of cryptosporidiosis in Milwaukee and its impact on HIV positive individuals; (2) improved surveillance and reporting; and (3) the increasing importance of deficiencies in the post-treatment water distribution system as opposed to the raw water supply or treatment efficacy. This increase in waterborne illnesses should serve as a particularly important warning given that so much of our water delivery infrastructure is aging and deteriorating, with potentially troublesome impacts on public health. But, there are a number of other reasons why we should not be complacent about water and wastewater infrastructure.

For one thing, even though the majority of U.S. residents are served by modern water supply and sewer systems, discrete, but significant, portions of the population are not. A 2008 article by Dr. Peter Hotez of The George Washington University documented five regional “communities” in which substandard plumbing, water, or sanitation caused disease burdens similar to those in developing nations. For example, in Appalachia, as of 2000, an estimated 169,000 households had no indoor plumbing and almost 3% of the


82. Id. at 13.


88. Id.

89. Id. at 64.

90. Möller, supra note 3, at 159.

91. See Michael E Craun et al., Waterborne Outbreaks Reported in the United States, 0.4 Suppl. 2 J. Water & Health 19, 21 (2006) (noting that reporting of disease outbreak is voluntary); Preventing Waterborne Disease, supra note 85, at 3 (recognizing a connection between mild symptoms and underreporting).

92. Craun et al., supra note 91, at 27.

93. See id. at 23, 25; Preventing Waterborne Disease, supra note 85, at 4.

94. See Craun et al., supra note 91, at 23 fig. 2, 25 fig. 5.

95. Id. at 27. Cryptosporidiosis is a disease caused by infection with the protozoan cryptosporidium. See Möller, supra note 3, at 168–70. The Milwaukee incident was a particularly dramatic but not entirely unique occurrence. Another outbreak of cryptosporidiosis in Georgia in 1987, for example, affected an estimated 13,000 people. Preventing Waterborne Disease, supra note 85, at 1.

96. See Craun et al., supra note 91, at 21–22 (discussing gaps and trends in disease surveillance data and reporting).

97. See id., at 24–25 (noting that distribution deficiencies were responsible for more than half of all water-borne disease outbreaks between 2001 and 2002).

98. See, e.g., Buried No Longer, supra note 62, at 4 (documenting the age of U.S. water infrastructure and explaining related problems).

99. See id. at 13 (discussing both tap water quality problems and the effect of service reliability on firefighting flows); Am. Soc. of Civil Eng’rs, Failure to Act, The Economic Impact of Current Investment Trends in Water and Wastewater Infrastructure 25 (2011) (hereinafter Failure to Act).

100. See generally Peter J. Hotez, Neglected Infections of Poverty in the United States of America, 2 PLoS Neglected Tropical Diseases, no. 6, e256, 1 (June 2008), http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0000256 (discussing five poor U.S. communities with disadvantaged populations and lacking adequate plumbing and sewer facilities being affected by similar water-borne diseases as those in developing countries).
region lacked complete plumbing.\(^\text{101}\) In some counties, up to a quarter of all households lacked plumbing.\(^\text{102}\) In the Mexican border region, an estimated 30,000 housing units had no indoor plumbing, not including mobile homes.\(^\text{103}\) In some areas of the Native American tribal regions, up to twenty percent of all homes lack complete indoor plumbing, which is five times the national average.\(^\text{104}\) Other areas with similar problems include the Mississippi Delta and some disadvantaged urban areas in the northeast and the upper Midwest.\(^\text{105}\) Lest we be complacent in other parts of the country, nationwide there are an estimated 300,000 cases of cryptosporidiosis and up to 2.5 million cases of giardiasis annually,\(^\text{106}\) and large numbers of additional illnesses continue to occur due to more strains of bacteria, viruses, and parasites in drinking water.\(^\text{107}\) Another study estimated that up to 11.7 million cases of acute gastroenteritis in the United States annually were attributable to contaminated drinking water from community supply systems.\(^\text{108}\)

Studies indicate that waterborne disease also imposes significant economic burdens in the United States. For example, a recent analysis by the Centers for Disease Control and Prevention indicated, based on the data from large insurance claims databases for 2004–2007, that the hospitalization costs from three waterborne diseases (Legionnaires’ disease,\(^\text{109}\) cryptosporidiosis, and giardiasis) were as high as $539 million per year.\(^\text{110}\) A more broadly focused analysis by the American Society of Civil Engineers projected that failure to bridge water and wastewater infrastructure funding gaps will result in significant costs to the U.S. economy by 2020, including $206 billion in increased costs to businesses and households, the loss of 700,000 jobs, $734 billion in lost business sales, and $416 billion in losses to Gross Domestic Product.\(^\text{111}\)

C. The Bidirectional Relationship Between Climate Change and Water and Wastewater Infrastructure Needs

Climate change will exacerbate our water and wastewater infrastructure needs by significantly changing regional patterns of water supply and demand.\(^\text{112}\) It is also likely to make that infrastructure even more important to protect human health and the health of our aquatic ecosystems.\(^\text{113}\) Conversely, especially if we adopt a “business as usual” approach, the infrastructure necessary to provide safe drinking water and to protect our waterways from sewage and stormwater pollution will use more energy and contribute further to climate change.

I. Increased Water Pollution Risks from Climate Change

The infrastructure necessary to ensure a safe public drinking water supply and to protect our water supply from municipal pollution will be even more important given predictions that risks from infectious disease will increase as temperatures rise in some parts of the country.\(^\text{114}\) Waterborne diseases, such as cryptosporidiosis and giardiasis, increase after heavy downpours,\(^\text{115}\) which are expected to occur more frequently and more intensely as climate change progresses.\(^\text{116}\) The United States is already experiencing an increase in dengue fever and Chagas disease\(^\text{117}\) in portions of the South and Southwest, and experts predict further epidemics, especially among the poor, as climate change progresses.\(^\text{118}\) The same may also be true for other pathogens, including those that have been limited mainly to the tropical developing world in recent decades.\(^\text{119}\)

Warming water temperatures will also degrade water quality in several respects. For example, higher temperatures will reduce levels of dissolved oxygen, increase concentrations of phosphorus and other pollutants, and increase algal blooms and the number of waters affected by high bacteria and fungi levels.\(^\text{120}\) Higher levels of ambient pollution will result in stricter water quality-based treatment requirements for sewage treatment plants and other dischargers.\(^\text{121}\) Thus, a higher percentage of sewage treatment

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114. See generally Brett Israel, Warming Climate Reveals Links to Infectious Disease, The Daily Climate (Apr. 5, 2012), http://www.www.dailyclimate.org/today-newsroom/2012/04/climate-infections (summarizing research predicting that climate change will expand the geographic range and increase adverse effects of some infectious diseases).
117. Dengue fever is a debilitating viral disease transmitted by mosquitoes, and Chagas disease is another tropical infectious disease transmitted by triatomines (“kissing bugs”). See Moeller, supra note 3, at 254–55.
118. See Horner, supra note 100, at 4, 6.
121. See National Water Program Strategy, supra note 116, at 9; CWA § 301(b)(1)(C), 33 U.S.C. §§ 1311(b)(1)(C) (2006) (requiring stricter effluent limitations where necessary to meet ambient water quality standards); see also id. § 303(d), 33 U.S.C. § 1313(d) (requiring establishment and plans to limit aggregate dis-
plants may need to install more expensive advanced waste treatment systems.\textsuperscript{122} Likewise, higher pollutant levels in drinking water sources will require additional treatment, resulting in higher system costs.\textsuperscript{123} In coastal areas, saltwater intrusion will further impair available water sources or generate significantly higher treatment costs to make the water usable.\textsuperscript{124}

Climate change also has the potential to increase the volume of water needed to meet municipal and other needs, which would, in turn, increase the amount of wastewater likely to be generated. Higher temperatures will increase demand for water to grow plants (both crops and landscaping) by causing higher rates of evapo-transpiration (the loss of soil moisture through evaporation and plant uptake) and by reducing soil moisture.\textsuperscript{125} Even without increased demand, outdoor residential water use represents half of residential water use in some regions.\textsuperscript{126} Higher temperatures will also generate higher cooling water needs for power plants, which account for a significant percent of water withdrawals in many parts of the country.\textsuperscript{127} All of those factors suggest the need to transport, store, treat, and dispose of more water than anticipated absent climate change.

Precipitation patterns are also predicted to shift dramatically due to climate change.\textsuperscript{128} Some areas will receive more precipitation in the form of more frequent and intense storm events—meaning that some areas will face more intense and more frequent flooding—while other regions will have to deal with more severe and longer droughts, if not more permanent increases in aridity.\textsuperscript{129} Areas receiving more precipitation, particularly in the form of more frequent and more intense storms, will further tax urban stormwater collection and treatment facilities and will also cause more frequent and larger overflows from combined sewers and sanitary sewer systems.\textsuperscript{130} Areas receiving less precipitation will need to either increase supplies or reduce demand, or potentially restrict growth.\textsuperscript{131} Ultimately, the question is whether the appropriate response is to move yet more water to where people live or want to live, or to move people to where the water is.\textsuperscript{132} The former would require us to transport more raw water from water-rich to water-poor regions, treat the conveyed water to appropriate standards for the intended end use, collect and treat that effluent to the levels required by the CWA, and then discharge the resulting effluent into an entirely different watershed.\textsuperscript{133} The latter could generate significant social and economic dislocation costs.\textsuperscript{134}

2. The Impact of Water and Wastewater Infrastructure on Climate Change

Water and wastewater infrastructure contributes to climate change due to the significant energy costs of moving such massive quantities of water (often by pumping long distances or over significant grades) and then treating that water at both the front and back ends of the urban water cycle.\textsuperscript{135} This is particularly true in regions with historical mismatches between water sources and areas of growth. For example, one study estimated that a remarkable nineteen percent of California’s electricity is used to move, treat, and supply water for both irrigation and municipal and industrial use.\textsuperscript{136} Although a significant portion of water in California is used for agricultural irrigation, even residential water supply is energy-intensive. The energy needed to supply water to the average Southern California household comprises about a third of the region’s average household electrical use.\textsuperscript{137} In Arizona, the Central Arizona Project (“CAP”) pumps over 500 billion gallons of water per day 3,000 feet up from the Colorado River and more than 300 miles south to metropolitan Phoenix and Tucson, making the CAP the single largest electricity user in Arizona.\textsuperscript{138}

Nationally, the Electric Power Research Institute (“EPRI”) estimated that approximately four percent of electricity in the United States is used to move and treat water and wastewater.\textsuperscript{139} As a result, approximately eighty percent of the cost of processing and distributing water is reflected in electricity, and EPRI projects that usage will increase in direct proportion to an estimated fifty percent growth in the U.S. population by 2050.\textsuperscript{140} That, of course, would cause a significant increase in both system costs and GHG emissions, assuming a “business as usual” approach to water and wastewater supply over the next half century.

Climate change might increase usage above EPRI’s projections in regions where reduced surface water supplies require either the additional long-range water transport discussed above or additional groundwater pumping, which consumes...
about thirty percent more electricity than surface water supplies.\textsuperscript{141} Likewise, adverse impacts of climate change on water quality could increase energy use for wastewater treatment—again assuming that cities continue to discharge wastes to surface waters—because advanced treatment requires three times more electricity than conventional treatment systems.\textsuperscript{142} Moreover, it is not clear whether EPRI’s projections account for raw water supply storage and conveyance. The projections are based on EPA’s inventory of public water supply systems,\textsuperscript{143} but EPA’s database includes only those components of the water supply system eligible for state DWSRF funding, and excludes raw water supply storage and conveyance.\textsuperscript{144} Thus, states with long water conveyance systems could use significantly more energy than those included in EPRI’s analysis.\textsuperscript{145}

Adaptation measures to deal with the increased water and wastewater needs caused by climate change could, depending on the strategies used, exacerbate the underlying problem.\textsuperscript{146} Some solutions, however, such as improved efficiency or reusing wastewater, could reduce energy use and avoid further contributing to climate change. EPA has also provided significant guidance to water and wastewater utilities on technologies available to reduce energy use and to promote “green infrastructure,”\textsuperscript{147} although that technical advice has no regulatory force and does not address the underlying issue of the volume of water conveyed and treated under current practices.\textsuperscript{148} Moreover, an increasing imbalance between supply and demand could also generate proposals for more, or longer, inter-basin water transfers. Those transfers would exacerbate climate impacts if they rely on power generated by fossil fuel combustion. More intensive treatment of both raw water and wastewater to meet public health and environmental quality goals will also require higher energy use.\textsuperscript{149}

II. Impacts of the CWA on Existing and Future Water and Wastewater Infrastructure

Title II of the CWA helped cities to achieve significant progress in reducing municipal pollution over the past forty years. The job, however, was never completely finished, and completion of the task is increasingly difficult in the face of aging infrastructure, continued population growth, eroding levels of public investment, and now climate change. Ironically, although Congress anticipated some of the problems that resulted from the Title II program and adopted several provisions designed to prevent them,\textsuperscript{150} for various reasons, the provisions did not have their intended effects. Nor has the shift from a federal grants program to a revolving loan program in 1987 appear to have corrected those problems or provided adequately for future needs. A review of the design and implementation of Title II and its impacts on growth patterns and water and wastewater infrastructure strategies in U.S. cities and suburbs may suggest ways to deal with the daunting task of meeting those needs over the next several decades. Although Congress clearly did not consider climate change impacts when it wrote the 1972 Act, because climate change had not yet attracted that level of public attention,\textsuperscript{151} this review also suggests that more fiscally and environmentally sustainable strategies could simultaneously be used to reduce the climate change impacts of meeting water and wastewater treatment needs.

A. The 1972 Vision for Sustainable Infrastructure

When Congress passed the 1972 Act and later amendments,\textsuperscript{152} it recognized the danger that federally subsidized treatment systems would perpetuate ecologically unsustainable\textsuperscript{153} methods of municipal sewage treatment and disposal, and equally unsustainable land use practices that might exacerbate the municipal sewage problem. Congress attempted to address those problems first through provisions designed to promote a transition away from surface water discharges and toward the reuse and recycling of wastewater,\textsuperscript{154} and second through planning provisions designed to tailor new infrastructure to existing, and reasonably anticipated, community needs instead of serving as fuel for new growth.\textsuperscript{155}

\textsuperscript{141} Id.
\textsuperscript{142} Id. at 1–2.
\textsuperscript{143} Id. at 2–3.
\textsuperscript{145} This is suggested strongly by the disparity between EPRI’s nationwide estimate that four percent of electricity is used to provide and treat water, Electricity Consumption for Water Supply & Treatment, supra note 39, while a comprehensive analysis by the California Energy Commission indicates that water-related uses consume nineteen percent of the state’s electricity and thirty percent of its natural gas. Gary Klein, Cal. Energy Comm., CEC-700-2005-011-SE, California’s Water-Energy Relationship 1 (2005).
\textsuperscript{146} Electricity Consumption for Water Supply & Treatment, supra note 39, at 1–2.
\textsuperscript{148} Id.
\textsuperscript{149} Electricity Consumption for Water Supply & Treatment, supra note 39, at 3–5 tbl. 3–1 (showing ascending electricity consumption needs for more advanced sewage treatment methods).
\textsuperscript{150} See, e.g., Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 826 (codified at 33 U.S.C. § 1255(d)) (adopting CWA § 105(d)).
\textsuperscript{151} Although scientists had begun to study anthropogenic climate change in the 1950s and 1960s, it did not receive significant political attention at least through the 1970s. See Naomi Oreskes & Erik M. Conway, Merchants of Doubt 170–71 (2010).
\textsuperscript{153} Although the term “sustainability” was not in vogue at the time, the principles Congress articulated are consistent with that usage.
I. Wastewater Reuse and the Zero-Discharge Goal

Consistent with the statute’s zero-discharge goal,\textsuperscript{156} Congress was concerned that municipalities were perpetuating the practice of disposing of treated municipal sewage into the nation’s waters and sought instead to encourage municipalities to reclaim and recycle both wastewater and the nutrients they contain to fertilize soil and to replenish groundwater supplies.\textsuperscript{157} Congress was also concerned with maximizing the value of federal fiscal investments in municipal treatment systems:

The tremendously increased level of funding for construction proposed . . . requires that Congress give some policy direction to the Administrator in carrying out this program and to maximize the return on the public tax dollar. The Committee has, therefore, included a requirement that Federal assistance for the construction of waste treatment facilities must require, where appropriate, practices which will recycle and reclaim water and provide for the contained or confined disposal of pollutants. This bill would establish a policy in concert with the fundamental ecological principle that, to the extent possible, all materials should be returned to the cycles from which they were generated. Properly managed, this means pollutants do not escape or migrate to cause degradation of the water, air or land environment.\textsuperscript{158}

To fulfill this goal, the Senate Committee emphasized the need to include water recycling as part of the preferred technology for municipal sewage disposal, for EPA to reject grants unless the applicant proved that innovative and alternative (“I&A”) waste treatment management methods were not available, and for EPA to promote land disposal and waste recycling through planning, research and development, and other programs.\textsuperscript{159}

In the 1972 law, Congress backed up this rhetoric through statutory provisions designed to promote, but not require, I&A treatment systems. In Title I of the Act, which was created by the 1972 Amendments, for example, Congress authorized and directed EPA research and grants on methods for “reducing the total flow of sewage, including, but not limited to, unnecessary water consumption,”\textsuperscript{160} and for “claiming and recycling water.”\textsuperscript{161} As a fundamental planning component of the construction grants program, the waste treatment management plans, guided by section 201 of the Act, required planners to “provide for the application of the best practicable waste treatment technology (“BPWWT”)” before any discharge to receiving waters, including reclaiming and recycling of water . . . .\textsuperscript{162} The mandatory grant conditions included in section 201(g) by the 1972 Amendments prohibited EPA from issuing construction grants after June 30, 1974, absent a showing that the applicant had “studied and evaluated” I&A waste management practices and that the proposed facilities will “provide for the application of [BPWWT] over the life of the works” and “take into account and allow to the extent practicable the application of technology at a later date which will provide for the reclaiming or recycling of water or otherwise eliminate the discharge of pollutants.”\textsuperscript{163}

In the 1977 legislative history, Congress expressed frustration with the lack of progress in adopting the I&A waste treatment methods called for in the 1972 legislation and called for “a major reorientation of the construction grant program.”\textsuperscript{164} As a result, Congress prohibited EPA from awarding grants after Fiscal Year 1978 unless applicants demonstrated that they had studied and evaluated I&A treatment processes and more efficient uses of energy and resources.\textsuperscript{165} It also increased the federal project share from seventy-five percent to eighty-five percent for I&A projects\textsuperscript{166} and added a series of additional incentives for I&A systems,\textsuperscript{167} including higher priority for construction grants\textsuperscript{168} and set-asides reserving a small percentage of federal funding for increasing the federal share for I&A projects.\textsuperscript{169} None of those provisions, however, required the use of nontraditional sewage treatment and discharge methods.\textsuperscript{170}

From a compliance perspective, in the 1972 Amendments, Congress adopted a two-phase schedule for increasingly stringent effluent limitations applicable to POTW’s. First, the Amendments created section 301(b), which required POTW’s to achieve, by July 1, 1977, effluent limitations based on sec-

\begin{itemize}
\item 158. Id.
\item 159. See id. at 23–26, reprinted in 1972 U.S.C.C.A.N. 3680–93.
\item 160. Federal Water Pollution Control Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 823–34 (codified at 33 U.S.C. § 1254(o)) (adopting CWA § 104(i)).
\item 161. Id., 86 Stat. 826 (codified at 33 U.S.C. § 1255(d)) (adopting CWA § 105(d)).
\item 162. Id., 86 Stat. 833–34 (codified at 33 U.S.C. § 1281(b), (d)) (adopting CWA § 201(b), (d) and directing EPA Administrator to “encourage” adoption of recycling, confined and contained pollutant disposal, and wastewater reclamation).
\item 163. Id., 86 Stat. 834 (codified at 33 U.S.C. § 1281(g)(2)) (adopting CWA § 201(g) (2)). The meaning of “provide for” is not particularly clear. However, Congress later repealed the statutory mandate to adopt BPWWT. See discussion infra p. 16.
\item 164. H. REP. No. 95-830, at 56–57 (1977), reprinted in 1977 U.S.C.C.A.N. 4424, 4431. “The 1972 amendments redirected the water pollution program to municipal waste treatment and recycling which would lead to reclaiming and recycling of water and the confined and contained disposal of wastes so that pollutants would not migrate to cause environmental pollution. Little was done to achieve this result.” Id. (emphasis added); see also S. REP. No. 95-370, at 2–3 (1977), reprinted in 1977 U.S.C.C.A.N. 4326, 4328–29 (reiterating dual statutory goals of adequate treatment of sewage and requiring programs which emphasized reclaiming and recycling sewage, conserving water, reusing valuable nutrients, and reducing flows,” and noting that the Senate Committee had identified “only one operating major land irrigation system in the United States”).
\item 166. Id. § 17, 91 Stat. 1571 (codified at 33 U.S.C. § 1282(a)(2)–(4)) (adopting CWA § 202(a)(2)–(4)).
\item 169. Id. § 2891 Stat. 1576 (codified at 33 U.S.C. § 1285(j)) (adopting CWA § 205(j)).
\item 170. See supra notes 164–68.
\end{itemize}
ondary treatment as defined by EPA by regulation.\textsuperscript{171} Second, they created section 201(g)(2), which required POTWs to achieve the more stringent requirements of BPWWT by July 1, 1983.\textsuperscript{172} Congress defined BPWWT in section 201(b) as “including reclaiming and recycling of water, and confined disposal of pollutants . . . .”\textsuperscript{173} Although the 1972 Amendments required EPA to publish “information, in terms of amounts of constituents and chemical, physical, and biological characteristics of pollutants, on the degree of effluent reduction attainable through the application of secondary treatment,” it only required EPA to issue “information” on alternative waste management for purposes of compliance with section 201.\textsuperscript{174} EPA promulgated “information” on secondary treatment in the form of enforceable regulations similar to effluent limitations guidelines for industrial sources,\textsuperscript{175} but it did not adopt similar requirements defining BPWWT. As discussed further infra,\textsuperscript{176} Congress amended section 304(d) in 1977 to require EPA to promulgate guidelines for identifying and evaluating I&A wastewater treatment processes and techniques.\textsuperscript{177}

Thus, although Congress later repealed the second phase of municipal controls, its intent in 1972 and 1977 was eventually to require POTWs to adopt BPWTT controls that would include wastewater reclamation and recycling.\textsuperscript{178} Those practices would have, in the long run, reduced pollutant discharges to surface waters and, by reclaiming and recycling wastewater, reduced water supply needs and accompanying energy use at the front end of the urban water cycle.\textsuperscript{179} That smaller energy use, in turn, would have reduced the ongoing climate change impacts of water and wastewater infrastructure.\textsuperscript{180} Those technologies also might have tempered the magnitude of system expansion and rehabilitation that communities face today, thus reducing the prospective climate change impacts of future infrastructure construction.

\textsuperscript{171} Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 844–45 (codified at 33 U.S.C. § 1214) (adopting CWA § 301(b)).
\textsuperscript{172} Id., 86 Stat. 833–34 (codified at 33 U.S.C. § 1311) (adopting CWA § 301).
\textsuperscript{173} Id. (codified at 33 U.S.C. § 1311(b)). This two-phased ratcheting of technology-based controls for municipal sources was similar to that required for industrial point sources. See CWA § 301(b), 33 U.S.C. § 1311(b) (2006) (requiring sources other than POTWs to achieve effluent limitations based on the “best practicable control technology currently available” by July 1, 1977 and based on the “best available technology economically achievable” by July 1, 1983).
\textsuperscript{174} Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 852 (codified at 33 U.S.C. § 1314(d)). Technically, section 1281(g)(5) only prohibited EPA from issuing construction grants to applicants who had not satisfactorily demonstrated that they had studied and evaluated innovative and alternative treatment processes and techniques, but presumably Congress intended this definition to apply as well to the requirements of then-existing section 301(b)(2)(B), which required POTWs to comply with the analogous innovative and alternative treatment requirements described in section 1281(g)(2)(A).
\textsuperscript{175} 40 C.F.R. § 133 (1974).
\textsuperscript{176} See infra Part II.B.
\textsuperscript{180} See supra Part I.C.2.

2. Growth, Land Use Planning, and the Urban Water Cycle

\textit{a. Grant Conditions to Prevent Growth Subsidies}

In designing the 1972 construction grants program, Congress also expressed concern about the potential for federally subsidized sewage systems to induce sprawl growth, which could exacerbate pollution of urban and suburban waterways in the long run.\textsuperscript{181} Again, although Congress was not considering climate change in 1972, excess growth could also contribute to climate change by increasing the energy use and resulting GHG emissions needed to supply water and treat sewage from those expanding communities. To address growth concerns, Congress first imposed growth-related limitations and conditions on federal construction grants.\textsuperscript{182} Second, Congress adopted provisions regarding state and local land use and waste management planning to guide the construction grants program specifically and adopted more comprehensive water pollution control efforts generally.\textsuperscript{183}

The 1972 Amendments limited grants for sewage collection systems to (1) the replacement or rehabilitation of existing collection systems where needed to ensure system integrity and performance and (2) to new collection systems in existing communities with sufficient existing or planned capacity to treat the sewage collected.\textsuperscript{184} The 1972 Conference Committee explained that this provision was designed to guard against the use of federal funds to subsidize new development:

It is the committee’s intent that sewage collection systems for new communities, new subdivisions or newly developed urban areas, be addressed in the planning of such areas and be included as a part of the development costs of the new construction in these areas. They are not to be covered under the construction grant program.\textsuperscript{185}

Congress was more ambivalent about subsidizing growth through expanded sewage treatment plant capacity. Because the goal of the program was to finance facilities needed to eliminate discharges of raw or inadequately treated sewage, it would make little sense to construct a facility in a growing community based on existing sewage flows, with inevitable system failures or overflows as soon as the expected growth overwhelmed plant capacity. On the other hand, Congress determined that building plants with capacity beyond expected needs would likely induce growth, and thereby exacerbate pollution.\textsuperscript{186} To balance the goal of financing adequate sewage collection and treatment capacity against the risk

\textsuperscript{183} See discussion infra II.A.2.b.
of induced growth, Congress adopted a series of provisions that evolved to become more stringent over time, reflecting Congress’s increasing frustration with the program’s growth inducing effects.187

In the initial 1972 Act, Congress had authorized “sufficient reserve capacity” and funded POTW’s based on a comparison of the costs of initial construction relative to the costs of later expansion.188 The Act also required that collection systems not be subject to excessive infiltration.189 In 1977, however, Congress amended the reserve capacity limitation to require EPA to consider “efforts to reduce total flow of sewage and unnecessary water consumption,” and to base its reserve capacity on actual population projections prepared as part of formal planning processes either under the CWA or as part of an independent municipal master plan.190 Congress adopted a somewhat different approach in the Municipal Wastewater Treatment Construction Grant Amendments of 1981, in which it restricted reserve capacity to no more than forty years for grants issued prior to enactment of those amendments, no more than twenty years for grants issued between then and October 1, 1984, and to ending needs for any grants awarded thereafter, capped at existing needs as of October 1, 1990.191 Moreover, Congress required growth projections to be based on reliable population information.192

Three other related sets of provisions augmented Congress’s efforts to balance the water quality justifications for federal construction grants against its stated policy of not subsidizing growth. First, Congress authorized federal courts to impose sewer hookup bans on systems with influent levels that exceeded treatment plant capacity in ways that would violate the POTW’s discharge permit.193 This provision mirrored existing sewer hookup moratoria used by state, regional, and local governments to manage growth.194 Second, in the 1981 Amendments, Congress prioritized grants for projects designed to meet water quality needs as opposed to system expansion to accommodate new growth or other goals not related to water quality.195 Third, by mandating that users pay sufficient fees to cover their proportionate share of system O&M requirements,196 Congress sought to minimize the impact of federal subsidies on growth. The user fee provisions survived multiple judicial challenges,197 but it is not clear how effective they were at limiting the growth impacts of federal subsidies.


In a second strategy to limit the growth-inducing effects of federal sewage treatment subsidies, Congress linked grant awards to a series of statutory planning provisions, although the extent to which plan preparation was mandatory, and if so by which entity, was not entirely clear.198 One of the national policies Congress articulated in the CWA was to promote and implement “areawide waste treatment management planning processes.”199 In addition to “facilities plans” required as a prerequisite to a construction grant,200 Congress adopted two broader planning processes relevant to the construction grant program.

Section 201 purported to “require and to assist the development and implementation of waste treatment management plans and practices which will achieve the goals of this Act.”201 As discussed above, those plans were supposed to “provide for” application of BPWT,202 but Congress also directed that, “[t]o the extent practicable, waste treatment management shall be on an areawide basis and provide control or treatment of all point and nonpoint sources of pollution….”203 Nothing specifically mandated a linkage between construction grant awards and section 201 per se,204 but Congress established that linkage indirectly through section 208 of the Act, which authorized states or groups of local governments to prepare “areawide waste management plans” for areas they identified as having “substantial water quality control problems.”205 Section 208 plans, in turn, were supposed to be prepared through a “planning process consistent with” section 201, thus incorporating any requirements of section 201 into section 208.206

The extent to which Congress intended section 208 plans to be mandatory was controversial, and the statutory text was somewhat inconsistent in this regard. Section 201(a)

189. Id., 86 Stat. 834 (codified as at 33 U.S.C. § 1284(a)(3)) (adopting CWA § 204(a)(3)).
198. See infra, n. 200.
202. Id. (codified as amended at 33 U.S.C. § 1281(b)).
203. Id. (codified as amended at 33 U.S.C. § 1281(c)).
204. As discussed above, the Act did prohibit EPA from issuing grants absent an evaluation of the alternatives and treatment methods identified as one component of section 201 planning. See id., 86 Stat. 834 (codified at amended 33 U.S.C. § 1281(g)(2)).
expressed a statutory purpose “to require and to assist the development and implementation of waste treatment management plans . . . .”220 Section 208, however, required EPA to issue guidelines “[f]or the purpose of encouraging and facilitating the development and implementation of” such plans.220 Moreover, section 208 authorized state governors or localities to identify planning areas and to designate responsible planning areas and entities.220 Although section 208 indicates that the state “shall act” as the planning agency for areas not identified as having special water quality problems,222 the only apparent penalty for failure to do so was that the state would forego federal grants to conduct that very planning.221 As such, in the initial years of the program, states had designated only about five percent of the nation’s waters for local planning, and EPA had not required states to adopt plans for undesignated areas.221

Judicial reaction to this inconsistent language was mixed. One district court held that section 208 planning was discretionary.223 The Court of Appeals for the D.C. Circuit, however, upheld a district court decision ordering EPA to promulgate regulations requiring states to submit plans for all state waters for which local planning entities had not been designated.224 Nevertheless, the Court acknowledged that withholding of state planning funds was the only means of enforcing this “requirement.”225

Once state or regional agencies adopted section 208 plans, specific statutory provisions linked the award of construction grants to consistency with, and implementation of, the plans.226 The plans themselves addressed a broad array of point and nonpoint source water pollution control programs.227 As relevant here, the statute required plans to identify treatment works and associated collection and other systems for the region for a twenty-year period, updated annually, along with construction priorities and schedules, facility locations, and the entities responsible for building, operating, and maintaining them.228

Consistent with the policy of Congress to “recognize, preserve, and protect the primary responsibilities and rights of States . . . to plan the development and use . . . of land and water resources . . . .”219 EPA’s statutory authority over the substantive growth management contents of these plans is limited. Section 208 requires states to submit lists of designated planning areas and planning entities to the EPA Administrator for “approval”220 and includes detailed requirements regarding what the plans “shall include.”222 The Act then directs governors or designees to certify plans annually and to submit them to the EPA Administrator for approval.222 Again, however, EPA’s only enforcement mechanism in the event of inadequate planning is weak. The Administrator could withdraw approval of a state’s entire section 208 planning program, but only for a “substantial failure” to meet the statutory requirements.223 The Administrator may also withhold grant funds to implement the planning process.224 Unlike other provisions of the CWA, in which EPA has authority to implement substantive programs if a state fails to do so adequately,225 EPA has no authority to adopt or implement an areawide waste treatment management plan under section 208 if a state fails to do so or fails to do so to the Administrator’s satisfaction.226 Thus, although the statute links construction grants to section 208 plans, and although those plans must identify new or upgraded sewage treatment collection and treatment needs to meet water quality goals and anticipated growth, the Act leaves land use and growth management decisions to states and localities.

Congress also linked construction grant awards directly to state adoption of water quality management plans pursuant to the “continuing planning process” under section 303(e) of the CWA.227 In particular, the Act requires EPA to determine, before approving a construction grant, that the state was implementing “any required plan” under section 303(e) and that the proposed project is “in conformity with such plan,” or that the state was in the process of developing such a plan and that the proposed project would conform to that plan.228 That linkage ensured that any grant-funded project would comply with applicable effluent limitations and state water quality standards for purposes of achieving the substantive waste treatment requirements of the Act.229

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210. Id. (codified as amended at 33 U.S.C. § 1288(a)(6)).


213. Evans v. Train, 460 F. Supp. 237, 244–45 (D. Ohio 1978) (holding that grant awards must apply only with “any applicable” plans, and that regional planning is therefore encouraged but not mandatory). See also Note, The National Land Use—Environmental Problem: Legal and Pragmatic Aspects of Population Density Control, 43 U. Cin. L. Rev. 377, 383 (1974) [hereinafter The National Land Use—Environmental Problem] (expressing view that section 208 planning requirements were options).


215. Id. at 580 (holding that this method of obtaining compliance would not violate the Tenth Amendment). The Supreme Court later confirmed, in reviewing a different statute, that Congress could not compel states to take regulatory action, but that it could induce state action through funding incentives or partial preemption provisions. New York v. United States, 505 U.S. 144, 145 (1992).


224. Id. § 208(f), 33 U.S.C. § 1288(f).

225. See, e.g., id. §§ 303(c)(3)–(4), 303(d)(2), 402(a), 33 U.S.C. §§ 1313(c)(3)–(4); 1513(d)(2); 1542(a) (2006) (authorizing federal implementation of water quality standards, total maximum daily loads, and point source permitting programs).


227. CWA § 305(e), 33 U.S.C. § 1313(e).

228. Id. § 204(a)(2), 33 U.S.C. § 1284(a)(2) (2006). Presumably, the second option of a plan in process was designed to keep the construction grants program in operation pending state compliance with the new planning provision of section 303(e), although states were required to submit their initial plans under that provision within a half year of enactment of the 1972 Act. See id. § 303(e)(2), 33 U.S.C. § 1313(e)(2).

section 208, section 303(e) expressly requires EPA approval of the content of state plans,230 and the statute requires the “incorporation” of any applicable plans developed under section 208.231 Incorporation of section 208 planning elements into section 303(e) plans, however, does not appear to have given EPA independent authority, beyond what was apparent on the face of section 208, to approve any substantive land use aspects of those plans.

Clearly, Congress intended to link federal sewage infrastructure subsidies to state and local land use and growth management planning, especially through area-wide waste treatment management plans.232 Through that process, it hoped to encourage the construction of wastewater collection and treatment infrastructure necessary to solve the nation’s serious water quality problems, while avoiding the potential for federal subsidies to induce growth, particularly sprawl growth that Congress feared would both exacerbate water pollution and increase water and wastewater infrastructure costs (and that, in hindsight, could also contribute further to climate change).233 As discussed below, however, the tools Congress chose to strike that balance were inadequate to the task. We did succeed, at least temporarily, in ameliorating many of the most severe public health and environmental problems caused by the disposal of raw or inadequately treated sewage.234 We did not, however, do so without causing unwanted consequences in terms of induced growth and even greater and more expensive infrastructure needs moving forward.235

B. Aspirations, Reality, and the “Business as Usual” Approach

I. Short-Term Pollution Control Versus Long-Term Infrastructure Reform: The Marginalization of Recycling and Reuse

Congressional aspirations for a new, more sustainable approach to municipal sewage treatment flew in the face of the ongoing water quality crisis and the huge backlog in federal funding for municipal treatment projects. Neither EPA nor the courts were anxious to slow progress in addressing severe, immediate pollution needs in order to promote a shift to new methods of municipal waste treatment and disposal based on reclamation, recycling, and land disposal of wastewater and its components.236 Continuing the existing approach to sewage collection and treatment would also have the unforeseen effect of increasing the energy needed to support sprawling communities and to provide water and waste-water treatment services for growing communities, thus contributing to climate change as well as water pollution.237

Two early lawsuits challenging construction grant decisions highlighted the tension between the short-term goal of mitigating pollution quickly and the longer-term goal of more sustainable waste treatment and disposal practices. In City of North Miami, Florida v. Train,238 opponents of new regional treatment plants and upgrades to existing treatment plants in southeast Florida argued that local planners and EPA, in both CWA planning and the environmental impact statement (“EIS”) for the project under the National Environmental Policy Act (“NEPA”),239 failed to give sufficient credence to land application of treated sewage as an alternative to continuing ocean disposal.240 The proposed upgrades were designed to remedy gross pollution of canals and other waters in Dade County due to inadequate or failing septic tanks and small “package” treatment plants.241 As one indication of the tension between the goal of rectifying acute ongoing pollution quickly and longer-term reforms, a coalition of local businesses and environmental groups joined together as interveners to help defend the proposed project.242

EPA approved the grant applicant’s decision to reject land disposal alternatives for the Dade County regional project because of potential unresolved health impacts and groundwater contamination, high land acquisition costs, higher construction and operation costs, and a range of other problems.243 Although recognizing the potential benefits of land disposal options, EPA ultimately concluded that it was not appropriate in the south Florida region based on the technology and information available at the time:

Land disposal of treated wastewater can provide additional water purification (after waste treatment), conserve freshwater, and utilize nutrients and other constituents for productive purposes when applied to crops. Studies on the health risks of land disposal indicate a continuing concern, while still drawing the general conclusion that it is safe and acceptable if soil, hydrologic, and climatic conditions are favorable. However, this method of waste water disposal has limited applications in Southeast Florida because of the high ground water table and the unsuitability of the soil of some available unurbanized land.244

237. See infra p. 17.
239. NEPA requires preparation of an environmental impact statement (“EIS”) for any major federal action, including federal project funding, that may cause a significant impact to the human environment. 42 U.S.C. § 4332(2)(C). EPA’s practice was typically to prepare an Environmental Assessment where it found no significant impacts, but it did prepare an EIS for a relatively small percentage of construction grants projects with either significant impacts or significant public controversy. See Sewers, Clean Water, and Planned Growth, supra note 33, at 757–59.
241. See id. at 1266–67. EPA has identified Dade County as the largest single polluter in the eight state EPA region, with ocean discharges of ninety-four million gallons per day (“mgd”) of sewage, including twenty-two mgd of entirely untreated sewage and an additional twenty-five mgd of sewage that had been “treated” only by skimming of floatable solids. Id. at 1268.
242. Id. at 1265–66.
243. See id. at 1271–72.
244. Id. at 1272 (quoting U.S. ENVT, PROT. AGENCY, FINAL ENVIRONMENTAL IMPACT STATEMENT, NORTH DADE COUNTY, FLORIDA 213–17 (1973)).
The Court upheld EPA's decision, noting that the selected plan would enable the county to meet the looming 1977 CWA deadline for secondary treatment.245

Similarly, in Environmental Defense Fund, Inc. v. Costle, environmental groups challenged, again under both NEPA and the CWA, decisions by EPA and New York State to fund sewage treatment facilities on Long Island.246 The region had experienced massive population growth in the preceding decades and faced equally daunting future growth.247 The Long Island region faced a tradeoff between significant existing and threatened groundwater pollution from cesspools and septic tanks and the fact that seepage from those individual home treatment systems also recharged the region's sole source of drinking water aquifers.248 The environmental group plaintiffs argued that the appropriate means of dealing with this tradeoff was to treat the region's sewage to sufficient levels such that, through land application, it could be used to recharge the area's declining groundwater without posing health or environmental risks, thereby avoiding the risk of polluting nearby coastal receiving waters and losing a valuable public resource.249 EPA, however, approved the treatment and ocean disposal alternative, arguing (as it did in Florida) that land treatment and disposal had not yet reached a point of technological development where it could be employed safely in the region.250 The court upheld EPA's (and the state's) decision as being based on a reasoned and well-informed analysis of the comparative risks of the two main alternatives.251

These cases suggest that EPA's main approach to implementing the construction grants program was to facilitate compliance with the 1977 secondary treatment deadline through the “business as usual” approach of building large secondary treatment systems with effluent disposal to adjacent surface waters and not to promote wastewater reclamation and land disposal or reuse. For example, EPA's "National Municipal Policy," the policy document designed to bring cities into compliance with the CWA's requirements, focuses on regulatory, grant funding, and enforcement strategies designed to achieve secondary treatment, with no significant attention to promoting alternative disposal methods.252 Congress expressed displeasure with this philosophy when it revisited the Act in 1977, and in particular with the paucity of I&A systems funded or built despite the statute's significant push in that direction.253 As a result, one of the stated purposes of the 1977 Amendments in the legislative history was to "reorient the direction of the program toward use of alternative technologies as required in the 1972 Act."254

The 1977 Senate Report also criticized EPA for defining secondary treatment "without recognition of reclaiming and recycling alternatives."255 Technically, this criticism was slightly misplaced because the 1972 Act included separate mandates for EPA to define secondary treatment and I&A systems.256 In principle, however, the Committee was correct because EPA had promulgated no regulations addressing BPWTT or I&A systems parallel to those governing secondary treatment, which was consistent with its apparent practice of promoting traditional treatment and disposal over alternative disposal practices that would beneficially reuse sewage effluent and its components.257 Congress followed up on this criticism by amending section 304(d) to even more explicitly require EPA to "promulgate . . . guidelines for identifying and evaluating innovative and alternative wastewater treatment processes and techniques referred to in section 201(g) (5) of this Act."258

EPA complied with this new requirement the following year,259 in an appendix to its construction grants regulations.260 That appendix, however, did not purport to define BPWTT for regulatory purposes in a manner parallel to its secondary treatment regulations.261 The appendix is contained in, and only appears applicable to, the construction grants program itself,262 whereas the secondary treatment regulations apply to POTW's generally, whether federally funded or not.263 Finally, the appendix does little more than provide vague, descriptive definitions of what kinds of systems EPA would consider "innovative" and "alternative" for purposes of construction grants funding incentives.264

Moreover, roughly contemporaneous with the 1977 Amendments, a third court battle over a regional sewage treatment system highlighted EPA's ongoing reluctance to impose I&A treatment requirements, even where necessary to temporarily divert sewage flows that exceeded treatment system capacity to alternative land disposal. In Montgomery Environmental Coalition v. Costle, environmental groups challenged EPA's refusal to require the Washington, D.C.

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247. See id. at 985.
248. See id.
249. See id. at 985–86.
250. See id. at 986.
251. Id. at 1010. The Court remanded for a supplemental EIS to evaluate further the impact of the proposed discharges on the shellfish industry. Id. at 993.
253. See S. REP. No. 95-370, at 3 (1977), reprinted in 1977 U.S.C.C.A.N. 4326, 4329 (expressing displeasure at finding only one "operating major land irrigation system in the United States").
254. Id.
255. Id.; see 40 C.F.R. § 133 (1974) (secondary treatment regulation with no provisions addressing reclamation or recycling or other I&A alternatives).
257. Id. § 304(d), 33 U.S.C. § 1314(d).
261. That Congress intended EPA to promulgate regulations governing I&A systems is suggested because the term “guidelines” tracks the language used for industrial effluent limitations guidelines more closely than did the term “information” used for secondary treatment. Compare CWA § 304(d)(3), 33 U.S.C. § 1314(d)(3) (requiring “guidelines” for I&A waste treatment systems), with id. § 1314(b), 33 U.S.C. § 1314(b) (requiring “guidelines” for industrial effluent limitations).
area’s Blue Plains POTW to divert excess flows to land treatment to balance flows with plant capacity.\textsuperscript{265} EPA’s General Counsel issued an opinion that the agency “could not prescribe the choice of treatment techniques through the permit process until stricter standards [BPWTT] became applicable . . . in 1983.”\textsuperscript{266} The court rejected EPA’s conclusion and remanded to EPA to consider that possibility.\textsuperscript{267}

Just a year after the decision in \textit{Montgomery Environmental Coalition}, however, Congress itself dealt I&A wastewater treatment technologies the biggest legal blow. In the 1981 Amendments, with little fanfare or attention,\textsuperscript{268} Congress repealed the statutory requirement to achieve BPWWT—and its associated goal of reclaiming and recycling of water—as a second phase of technology-based treatment requirements for municipal sewage.\textsuperscript{269} Notably, this amendment did not eliminate the various provisions in the statute discussed above requiring EPA to promote I&A systems, requiring grant applicants to fully consider those alternatives, and requiring EPA to define the characteristics of those systems.\textsuperscript{270} Indeed, the same set of amendments increased funding incentives for I&A projects compared to other systems.\textsuperscript{271} But, with this one strike of the pen, Congress repealed the single provision in the statute actually requiring the use of I&A treatment.\textsuperscript{272}

Although the benefits of reclaimed wastewater had begun to be understood much earlier,\textsuperscript{273} several national studies have confirmed the viability and safety of using reclaimed wastewater for uses such as ground water recharge and landscape irrigation\textsuperscript{274} and for food crop production.\textsuperscript{275} More recently, EPA has published guidance documents on the issue,\textsuperscript{276} and in 2012, the National Research Council, in cooperation with EPA, published a comprehensive evaluation of the potential to reuse municipal wastewater to expand water supply.\textsuperscript{277} Despite these developments, however, EPA’s most recent needs survey confirms that recycled water projects continue to reflect only a very small percentage of total identified future funding.\textsuperscript{278} Moreover, documented water recycling needs actually decreased by fourteen percent since the previous survey (2004),\textsuperscript{279} and two thirds of those needs were in just two states (California and Florida).\textsuperscript{280}

This failure of the initial 1972 goal to address the nation’s sewage collection and treatment needs through wastewater reuse and recycling obviously was one reason for our accompanying failure to achieve the “zero discharge” goal of the 1972 Act.\textsuperscript{281} Rather than reusing and recycling wastewater for irrigation, urban landscaping, or other uses, we simply continued to discharge those wastes—admittedly with better treatment—into the nation’s waterways. At the same time, as explained more fully below,\textsuperscript{282} our inability to promote widespread wastewater recycling and reuse increased the amount of new water we needed to provide to growing communities, and then to treat and dispose of that water as well, all with higher accompanying fiscal, environmental, and energy and climate costs.

\section{Fueling Growth Versus Rapid Obsolescence}

The South Florida, Long Island, and Washington, D.C. metropolitan area cases discussed above also suggested tension between the need to accommodate projected regional growth and the potential that the funding of massive new sewage collection and treatment systems with excess capacity would both exacerbate and change the geographic nature of that growth.\textsuperscript{283} Numerous factors explain urban and suburban growth patterns.\textsuperscript{284} Nevertheless, all three cases suggested that the funding of large regional POTWs and expansive sewer systems might contribute to that growth. Again, while Congress was more concerned in 1972 with the fiscal and water pollution implications of using federal funding to stimulate suburban growth, that same relationship would also contribute to climate change\textsuperscript{285} by expanding auto-dependent communities that would also require more water supply and wastewater collection and treatment capacity.

In the Florida case, for example, in addition to badly needed upgrades to existing treatment plants, the federal sewage subsidies increased regional treatment capacity from 141 to 245 million gallons per day (“mgd”),\textsuperscript{286} both to improve treatment at existing, but inadequate, local facilities\textsuperscript{287} and to support new growth. In the Long Island litigation, the proposed project was designed to accommodate almost a doubling of Nassau County’s population by 2020, and a more

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\bibitem{265} Montgomery Envtl. Coalition v. Costle, 646 F.2d 568, 585 (D.C. Cir. 1980).
\bibitem{266} Id. at 586.
\bibitem{267} Id. at 588–89, 595.
\bibitem{270} See id.
\bibitem{271} Id. § 8(a), 95 Stat. 1625 (amending 33 U.S.C. § 1282(a)(2) to authorize twenty percent higher federal share for I&A projects, up to a maximum federal share of eighty-five percent).
\bibitem{272} Id.
\bibitem{275} See Nat’l Research Council, \textit{Use of Reclaimed Water and Sludge in Food Crop Production} 3 (1996).
\bibitem{278} \textit{Clean Watershed Needs Survey}, \textit{supra} note 15, at vi fig, ES-1 (identifying recycled water distribution as 1.5% of documented future needs).
\bibitem{279} Id. at viii.
\bibitem{280} Id.
\bibitem{282} See infra Part III.
\bibitem{283} See supra pp. 14–15.
\bibitem{285} See generally Molly O’Meara Sheehan, \textit{Worldwatch Inst., Worldwatch Paper} #156, \textit{City Limits: Putting the Brakes on Sprawl} (2001) (linking sprawl growth to climate change as well as other environmental problems).
\bibitem{287} See id. at 1266.
\end{thebibliography}
than quadrupling of the population of Suffolk County.\textsuperscript{288} The communities planned to expand sewer capacity and nearly triple treatment capacity at one plant from 45 mgd in the 1980s to 120 mgd by 2020.\textsuperscript{289} Again, it is not clear whether all of the growth served by the new capacity would have occurred anyway, or whether some was stimulated by the new capacity. In Montgomery County, Maryland, one federal court rejected EPA’s refusal to consider sewer hookup moratoria to confine inflows to existing treatment plant capacity,\textsuperscript{290} while another upheld EPA’s unusual step of refusing to award a construction grant for a proposed regional treatment plant that exceeded EPA’s own needs estimates absen firm commitments by other communities to hook in to the new plant.\textsuperscript{291}

Other litigation more specifically highlighted the tension between implementing the Act’s growth-limiting provisions in the face of the compulsion to address immediate water quality needs. In Evans \textit{v.} Train, plaintiffs alleged that construction grants were being used in violation of the express prohibition in CWA section 211\textsuperscript{292} to support future growth, including new housing subdivisions.\textsuperscript{293} The District Court acknowledged: “the legislative history of section [211] suggests that Congress intended the cost of sewage collection systems for new communities (including subdivisions) to be addressed in the planning of such areas and as development costs rather than under the construction grant program.”\textsuperscript{294} The defendants, however, responded that they were only using federal grants to fund interceptor sewers in existing areas rather than collection systems in new areas.\textsuperscript{295} The Court, with some apparent frustration, found the record insufficient “to determine where collecting sewers terminate and interceptor sewers begin, which collecting sewers are to serve existing rather than new communities, and the scope of federal funding for collecting sewers.”\textsuperscript{296}

Although courts typically deferred to EPA decisions and community preferences regarding grant awards and sewage treatment system investments, contemporaneous analysis suggested that the construction grants and related provisions of the CWA might stimulate unexpected growth and that existing sewage collection and treatment facilities had already done so.\textsuperscript{297} Studies conducted both before and after the enactment of the CWA concluded that interceptor sewers and sewage treatment plant expansion drove new development and generated suburban sprawl.\textsuperscript{298} One reason for this phenomenon was the desire of local communities to take maximum advantage of the newly increased level of federal funds to finance as much new capacity as possible.\textsuperscript{299} To do so, communities had an incentive to inflate population growth projections to justify higher capacity facilities.\textsuperscript{300} Once large new facilities were built, those growth projections became self-fulfilling prophecies.\textsuperscript{301} Developers preferred to build in communities with new sewer systems because they reduced their costs of installing separate onsite treatment (septic) systems and because it increased property values and therefore the prices they could charge for new homes.\textsuperscript{302} Communities had a strong incentive to authorize those proposed new developments so that they could repay their share of the capital costs, even if it was smaller than federal funding, as well as ongoing O&M costs.\textsuperscript{303}

The preference Congress established in the CWA for areawide waste treatment planning and management\textsuperscript{304} encouraged communities to design and build large regional treatment facilities rather than smaller, local plants.\textsuperscript{305} Those regional facilities and their associated collection systems arguably reinforced the nature and geography of sprawl development occurring in and around large metropolitan areas.\textsuperscript{306} To convey sewage from diverse localities to centralized plants, communities had to build large new interceptor sewers, many of which traversed previously undeveloped areas.\textsuperscript{307} Increased capacity allowed or even encouraged much of the new induced growth that occurred in those open spaces.\textsuperscript{308}

That growth increased the miles of new water supply distribution pipes needed to serve those communities, along with the significant energy (hence, climate change) and O&M costs associated with both the front end water supply and back end waste collection sides of the urban water cycle.\textsuperscript{309} Notably, while agreeing on the potential growth-inducing effects of federal construction grant subsidies, commentators differed in their views about the potential for the CWA’s

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\item[289.] Id. at 986. Another previously un-sewered part of the region would be served by a thirty mgd treatment plant by 1985. Id.
\item[294.] Id.
\item[295.] Id.
\item[296.] Id. See also Town of Orangev. v. Gorsuch, 718 F.2d 29, 37–38 (2d Cir. 1983) (rejecting argument that new sewage treatment capacity will automatically provide pressure for development rather than meeting present needs and already anticipated growth).
\item[297.] See Sales, supra note 33, at 614, 620; Sewers, Clean Water, and Planned Growth, supra note 33, at 734, 739.
\item[298.] See Phillips, supra note 33, at 71–74.
\item[299.] See id. at 73; Federman, supra note 10, at 144; Sales, supra note 33, at 619 (noting that the construction grants program was, at the time, the largest non-military component of the federal budget, second historically only to transportation, and therefore that “sewers are big business and local governments are anxious to get their piece of the action”); Sewers, Clean Water, and Planned Growth, supra note 33, at 733 (describing CWA Title II as providing “lavish financial assistance”); see also id. at 736 (temptation for municipalities to seek aid).
\item[300.] See Phillips, supra note 33, at 72; Federman, supra note 10, at 145; Sales, supra note 33, at 619–21.
\item[301.] See Phillips, supra note 33, at 72.
\item[302.] See id.
\item[303.] See id.; Federman, supra note 10, at 145; Sewers, Clean Water, and Planned Growth, supra note 33, at 741.
\item[304.] See CWA §§ 201(c), 201(e), 208(b), 33 U.S.C. §§ 1281(c), 1281(c), 1288(b) (2006).
\item[306.] See URBAN SPRAWL, supra note 284, at 5–11.
\item[307.] See Phillips, supra note 33, at 72–73; see Federman, supra note 10, at 146–47.
\item[308.] See Train, The EPA Programs and Land Use Planning, supra note 33, at 273; Sewers, Clean Water, and Planned Growth, supra note 33, at 743–44.
\item[309.] See Train, The EPA Programs and Land Use Planning, supra note 33, at 261.
\end{enumerate}
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planning provisions to anticipate and address those sprawl growth incentives. Former EPA Administrator Train seemed confident that “section 208 areawide waste management plans will influence overall residential patterns by deciding which areas are to be serviced by public facilities and by prescribing alternative methods of maintaining water quality in the regions.”310 Another author—overly optimistic in retrospect—proclaimed that “[p]erhaps the most significant and certainly the most widely acclaimed provision of the entire act is Section 208.”311 But, one early analysis suggested pre-sciently that it was “highly dubious” that the CWA’s planning provisions would succeed in controlling growth because “in practical effect, the Act is satisfied if sufficient treatment plants are built so that the effluvia generated by urban sprawl is not unpalatable to fish.”312 Another commentator noted that “EPA’s slothful administration of the planning programs, particularly the section 208 program, may indicate that future implementation of the various planning efforts by state, regional and local agencies will not be decisive.”313 An EPA Regional Administrator was only slightly more sanguine: “[S]ewage treatment plants with excess capacities will accelerate growth in suburban areas because developers tend to go where sewer capacity is already available. Unless such accelerated growth is well planned and controlled, it can produce air and water pollution problems that may be worse than the original problems the sewage facility was designed to solve.”314

Congress also expressed frustration with the degree to which EPA ignored its growth concerns in implementing the Act. The 1977 Senate Report complained: “Collector sewers, interceptor sewers, and treatment plants were approved even though their primary purpose was to meet growth needs.”315 The Committee reinforced that its intent in the 1972 Act was to address the existing backlog in sewage treatment capacity, not to finance community growth.316 Congress therefore adopted provisions more specifically limiting construction grants to projects designed to meet the enforceable requirements of the Act and prohibiting grants for new collector sys-

310. Id. at 274.
311. Sales, supra note 33, at 616. It is undoubtedly unfair to criticize early predictions in hindsight, but most observers would say that the section 208 program, after receiving significant attention during the first decade after the 1972 Act, has been largely quiescent in the ensuing thirty years. See David Zaring, Note, Agriculture, Nonpoint Source Pollution, and Regulatory Control: The Clean Water Act’s Bleak Present and Future, 20 HARV. ENVTL. L. REV. 515, 523–24 (1996); see also Robert D. Fentress, Comment, Nonpoint Source Pollution, Groundwater, and the 1987 Water Quality Act: Section 208 Revisited?, 19 ENVTL. L. 807, 818–19 (1988–89).
312. The National Land Use—Environmental Problem, supra note 213, at 383–84.
313. Phillips, supra note 33, at 94. Phillips noted the large number of facilities plans moving through the system before the more comprehensive, land use-oriented planning processes were even developed. Id. at 93. See also Sewers, Clean Water, and Planned Growth, supra note 33, at 745–46, 751–54 (describing inadequate use of CWA planning provisions to prevent induced growth and the delay in implementation of planning provisions). As noted above, environmental groups had to sue EPA to speed up and make more comprehensive the section 208 process. See supra text and accompanying notes Part II.B.1.
314. Snyder, supra note 33, at 735.
315. S. REP. NO. 95-370, at 3 (1977), reprinted in 1977 U.S.C.C.A.N. 4326, 4329. The report bemoaned that “over-sized interceptors and new collectors are constructed in suburban areas in anticipation of development, and treatment plants are sized to accommodate that growth.” Id.

tems unless adequate capacity is in place to treat the collected sewage to secondary treatment standards or above.317 As discussed above, Congress amended the Act in both 1977 and 1981 in an effort to reign in the growth-inducing tendencies of the construction grants program, apparently without significant success.318

In the 1987 CWA Amendments, Congress adopted Title VI to phase out the construction grants program and replace it with a State Revolving Loan Fund program (“SRF”).319 The legislative history of this quantum shift in federal sewage treatment financing strategy includes an objective section-by-section description provided by the Chairman of the House Committee on Public Works and Transportation.320 Clearly, however, Congress adopted this change to eliminate the federal subsidies that had created the incentives and accompanying problems discussed above,321 and instead to encourage states and communities to take responsibility for their wastewater treatment needs in a more efficient way.322

Based on the situation in which we now find ourselves, however, this strategy of trying to promote state and local infrastructure self-sufficiency has not worked. Moreover, with the phase-out of CWA Title II and its replacement with the far less prescriptive provisions of Title VI, Congress abandoned whatever control it may have had over state and municipal wastewater collection and treatment decisions.323 Federal sewage treatment subsidies cannot be blamed for the nation’s population growth over the past forty years. Arguably, however, they are at least significantly responsible for the nature and location of that growth, and for the tremendous resulting infrastructure pressures a generation later. The key question, addressed in the following Part, is whether lessons learned from this history can lead us to a more economically and environmentally sustainable strategy for water and wastewater infrastructure financing in the future, particularly given the anticipated effects of climate change.

III. Toward a More Sustainable Strategy for Cost-Effective and Climate-Sensitive Water and Wastewater Structure

The nation now faces as significant a funding gap for public water and wastewater infrastructure as it did in 1972, and several respected (even if legitimately self-interested) entities have proposed increased public investments to bridge that gap.324 If the wastewater components of those needs are not

317. See id.
318. See, e.g., supra note 152 and accompanying text.
321. See supra notes 271–306 and accompanying text.
met, the United States faces the prospect of water quality problems as severe as it experienced before the 1972 Act. Serious public water shortages and public health concerns could arise if we do not invest in water supply and treatment systems. But, although the problem in 1972 was that too few communities had yet built or modernized their water and sewage conveyance and treatment systems, current problems derive from the fact that those systems are already aging and have not been able to keep up with continuing growth, given recent levels of public investments in system maintenance, upgrades, and expansion. Finally, even more so than was true in the 1970s, these problems coincide with an energy crisis stimulated by climate change, and our choice of future solutions will either exacerbate or help to mitigate that crisis. Increased public investment in water and wastewater infrastructure is therefore critical if we are to maintain the public health and environmental quality gains made over the past century. Whether the federal, state, or local governments make those investments is another question, which will be addressed only briefly below. Meeting local and regional water and wastewater needs in a safe, environmentally acceptable way is a fundamental function of state and municipal governments, notwithstanding arguments about “unfunded federal mandates.” Moreover, using federal tax dollars to pay for local infrastructure is effectively a redistribution of tax dollars from some communities with lower needs (or needs that have already been paid for) to areas of higher need.

Following the initial infusion of federal funds into the drinking water and water quality revolving loan funds, federal policy for the past quarter century has been to require states and cities to pay for their own water and wastewater infrastructure costs. That policy clearly has not, however, resulted in sufficient public investment in water and wastewater infrastructure. Moreover, to make a largely unfunded approach work, the federal government might have to return to the aggressive enforcement policy it adopted vis-à-vis local governments in the 1970s. Although the courts ruled quite clearly during the construction grants program that municipal compliance with the CWA was required independent of federal funding, that posture inevitably will generate additional tension between the federal and state governments.

The alternative approach is a renewed federal financial commitment to help meet regional and local water and wastewater infrastructure needs. That approach has the advantage of potentially increasing federal control over the manner in which those funds are spent, but also suggests pitfalls similar to those experienced during the Title II construction grants program. A new federal funding program to meet these needs, therefore, should draw lessons from the construction grants program, and particularly given the new challenges suggested by climate change, do a better job of promoting sustainable infrastructure solutions.

A. Lessons from the Construction Grants Experience

Although current needs are not identical to those we faced in 1972, and political and fiscal conditions have changed significantly, it is still useful to reflect on some of the lessons learned from the CWA construction grants program in designing any new federal water and wastewater infrastructure funding program. First, if not managed carefully, federal infrastructure subsidies can have unintended consequences for local and regional growth patterns, which can affect both fiscal and energy costs as well as impacts on water quality and climate change. In addition to any alleged equity concerns about redistributing federal tax dollars from some regions to others, subsidies can generate inefficiencies because end users pay a smaller percentage of the actual costs of new water and sewage service.

Second, despite its best intentions, Congress largely failed in its efforts to use federal funding to promote I&A wastewater treatment systems focused on recycling and reuse of sewage effluent and the elimination of surface water discharges. It is not clear whether that failure resulted primarily from thehortatory and incentive-based, rather than mandatory, nature of provisions regarding I&A technologies; from the understandable compulsion to redress immediate and often severe water quality problems as quickly as possible based on existing, “off-the-shelf” technologies; from concerns about the health and environmental effects of wastewater recycling and reuse, or public acceptance of those practices; from the systemic, technological inertia of the engineering firms who were largely responsible for designing and building most major municipal systems; from the preference for short-term cost-effectiveness over long-term sustainability in system design and construction; or from some combination of those factors.

325. See Failure to Act, supra note 99, at 2.
326. See id.
327. See generally Robert W. Adler, Unfunded Mandates and Fiscal Federalism: A Critique, 50 Vand. L. Rev. 1137 (1997) (critiquing the assertion that the federal government must provide funding for all federal regulatory mandates).
328. See infra pp. 1–4; see, e.g., Progress in Water Quality, supra note 11 (stating that the federal government invested sixty-one billion dollars in the construction grants program).
330. See infra pp. 1–4; see, e.g., Progress in Water Quality, supra note 11, at ES-1, 2-63 to 2-68 (discussing public investment in water and wastewater infrastructure).
331. See National Municipal Policy, supra note 252 (articulating conditions under which EPA took enforcement action against municipalities that missed CWA deadlines).
333. See supra pp. 1–2; see also Federman, supra note 10, at 140 n.1 (discussing the high costs associated with construction grant programs administered through federal subsidies).
334. See supra Part II, pp. 16–17; see also, e.g., Urban Sprawl, supra note 284 (discussing the impact of POTWs on growth patterns in South Florida, Long Island, and Washington, D.C.).
336. See supra Part II; e.g. H.R. Rep. No. 95-830, at 5, reprinted in 1977 U.S.C.C.A.N. 4429 (prohibiting EPA from awarding federal grants unless applicants considered I&A treatment processes, but not requiring the use of these I&A processes); see also City of N. Miami, Fla. v. Train, 377 F. Supp.
None of the strategies Congress adopted and retained in the 1972 Act to address these twin concerns seem to have made a significant difference on a national basis. Those approaches included financial incentives through devices such as higher federal funding shares, promulgation of information and guidelines, grant conditions on factors such as system size, user fee requirements to reduce the effect of subsidies, or either site-specific or comprehensive planning requirements. At the same time, however, withdrawal of federal funding through the SRF approach has been equally ineffective in inducing more efficient technologies, as reflected by the very small percentage of projects in EPA’s current needs survey identified as using recycling and reuse. Although the elimination of federal subsidies may have reduced affirmative incentives to build oversized collection and treatment facilities using traditional technologies, clearly, that has not been sufficient to eliminate systemic inertia to continue existing infrastructure practices. Moreover, in 1981, Congress repealed the only truly mandatory requirement designed to promote more sustainable infrastructure, and even that requirement would have worked only if EPA had implemented and enforced that provision aggressively.

Drawing on these lessons, one of two approaches could be considered as we tackle the massive infrastructure gap facing the nation’s water supply and sewer systems. One strategy would be a return to a firmer set of mandates requiring more sustainable infrastructure alternatives, as envisioned by Congress in its initial, unfulfilled, and later repealed call for a second round of technology-based standards for municipal discharges. That approach, however, would require significant and predictably controversial federal rulemaking and likely result in legal challenges. It would also be politically contentious and undoubtedly require a renewed federal enforcement effort against municipalities.

The second approach would be for Congress to renew federal financial commitments to help communities meet their daunting infrastructure needs. Given the equitable issues surrounding federal tax redistribution to support such programs, however, as well as the efficiency concerns and distorting impacts of subsidies, it would be both reasonable and appropriate to condition such funding on fixed conditions rather than the largely hortatory statements included in Title II. Under this approach, municipalities would remain free to choose whatever infrastructure options they deem best. The federal government would only subsidize investments, however, designed to move away from the energy-intensive, water-wasteful, and water quality-risking policies of the past.

B. Ideas for a Sustainable Water Infrastructure Policy

Given the above history and the institutional and technological inertia accompanying water and wastewater infrastructure policy over the past forty years and longer, it will not be easy to move from a “business as usual” scheme to a more sustainable approach. Even under the most optimistic scenario, changes will not happen overnight, and must reflect long-term goals. On the other hand, the longer we wait to begin to change our approach, the more money we will spend in the long run, and the more adverse effects we will generate in terms of energy use and climate change. Without implying that any of the following ideas are “silver bullets” that will solve these problems individually or even collectively, the following substantive principles should be considered to guide future infrastructure policy, and each will face significant implementation challenges.

First, to reduce the use of energy-intensive, fiscally expensive, and inefficient water conveyance systems, communities should no longer import water from long distances, and particularly from another basin with higher accompanying pumping requirements, unless that water is demonstrably necessary for potable uses as opposed to outside watering and other non-potable uses. That would encourage cities to meet other water needs through wastewater recycling and reuse. Notably, reducing surface water withdrawals for conveyance to cities generates more than a one to one reduction in lost stream flows because of system conveyance losses. Therefore, this strategy would generate particularly high environmental benefits in addition to reduced energy and fiscal costs. Reduced energy use, in turn, will lower GHG emissions and impacts on climate change as well.

Second, we no longer have the luxury of incurring the high fiscal and energy costs necessary to treat all public water to drinking water standards whether or not it is intended for potable end use. Although modern treatment of public water supply was responsible for a huge proportion of the reduced incidence of waterborne diseases in the United States, those gains do not require the same treatment levels for water used to irrigate lawns or to flush toilets, which represent a very

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1264, 1271–74 (S.D. Fla. 1974) (holding that EPA was authorized to approve a grant that considered but did not use 162A treatment processes because of potential health concerns and the high cost of land acquisition needed to implement land application of treated sewage in comparison to continued ocean disposal, and because the approved plan would allow Dade County to meet the 1977 deadline for secondary treatment under the CWA).

337. See discussion supra Parts II.A.1–2. See, e.g., Clean Watershed Needs Survey, supra note 15, at vi fig. ES-1 (identifying recycled water distribution as 1.5% of documented future needs).

338. See discussion supra Part I.A; Drinking Water Infrastructure Needs Survey, supra note 21, at i–ii (identifying small fraction of projects proposed for recycling and reuse).


341. See, e.g., Koppers Co. v. EPA, 767 F.2d 57, 61 (3d Cir. 1985) (noting the repeal of the provision relating to best practicable wastewater treatment technology).

342. Many of these ideas were collected at an urban water policy conference in which the author participated that led to a collaborative book, although most of the suggested technologies are currently in use. Cities of the Future, Towards Integrated Sustainable Water and Landscape Management (Vladimir Novotny & Paul Brown, eds. 2007).


344. See Vladimir Novotny, Effluent Dominated Water Bodies, Their Reclamation and Reuse to Achieve Sustainability, in Cities of the Future: Towards Integrated Sustainable Water and Landscape Management 191, 200 (Vladimir Novotny et al. eds., 2006).
high percentage of residential water use,\textsuperscript{345} so long as sufficient treatment is applied for the specified end uses.

Several technologies are available to facilitate this change. For example, although it would be very costly to retrofit existing distribution and plumbing systems, it would be comparatively cheaper to do so for new developments and for new construction, or potentially for aging systems requiring significant reconstruction or replacement.\textsuperscript{346} In Japan, large urban buildings rely on rainwater capture for toilet flushing and cooling water, which can represent twenty to sixty percent of a building’s water demand.\textsuperscript{347} In areas that use dual plumbing systems with recycling, water demand overall is much lower,\textsuperscript{348} which reduces existing demand and expansion needs both at the front and at the back ends of the urban water system.

Third, no wastewater or wastewater residuals should discharge to surface waters if those resources can receive alternative end uses in the community, including groundwater recharge. Some experts argue that wastewater can undergo separation into components based on waste concentrations and types, including separation of urine and fecal matter, so that we do not need to devote expensive wastewater treatment capacity to diluting wastes.\textsuperscript{349} As is true for water supply, if less stringent treatment is needed for the intended end use, such as aquifer recharge or direct reuse, than for surface water discharges, both cost and energy savings can be realized.\textsuperscript{350} Between 1986 and 2004, for example, wastewater reuse in Florida increased by more than 300%, and the major catalyst was limitations on discharges to surface waters.\textsuperscript{351}

Fourth, communities can adopt the principle of cascading water use so each gallon is used as many times as possible, with water quality requirements and accompanying treatment costs descending according to the end use.\textsuperscript{352} For example, high quality public water supply can be used first for potable use, followed sequentially by industrial use, cooling water, etc.\textsuperscript{353} Again, those strategies will minimize both front and back-end water supply and treatment needs.

Fifth, even with federal subsidies or other public funding to capitalize new or rebuilt water and wastewater systems, the prices charged to system users as a whole should reflect the full costs of construction, financing, and O&M, as well as any reasonably ascertainable environmental costs. Full cost pricing promotes efficient water use, thereby reducing both front-end and back-end systems size needs and O&M costs and energy use.\textsuperscript{354} Concerns about affordability are important, but they can be addressed with pricing strategies such as differential fees, lifeline rates, or ascending block pricing\textsuperscript{355} rather than by making water and wastewater treatment artificially cheap to the entire community.

These are just some of many options for improving the fiscal, energy, and environmental sustainability of our water infrastructure. Other available tools include low flow plumbing fixtures and other efficiency investments, grey water reuse, xeriscaping, and fixing leaks in water storage, distribution, and wastewater collection systems.\textsuperscript{356} The more important issue is what legal, policy, and funding strategies are best designed to promote their widespread and effective use.

\section*{IV. Conclusion}

Just a few years after Congress passed the 1972 CWA Amendments, former EPA Administrator Russell Train wrote:

\begin{quote}
One of the major challenges to our society, and specifically to our states and localities, is to deal effectively with the issues of growth. These issues will involve an increasing shift in emphasis from abatement to the prevention of pollution. In terms of technology, EPA must seek not simply to encourage the development of more sophisticated kinds of “add-on” controls, but to push effectively for basic changes in the processes themselves. In terms of life-style changes and land use environmental policy decisions, the EPA must encourage the states and localities—and their citizens—to really come to grips with the complex and critical consequences posed by our patterns and pressures for physical growth.
\end{quote}

Unfortunately, although there has been a lot of innovation in the design of water and wastewater systems over the past forty years, most communities have elected not to adopt them, and, for the most part, Administrator Train’s admonitions have gone unheeded. If this practice continues in the twenty-first century, regardless of how much money we pour into our water and wastewater infrastructure, it is reasonable to predict that we will find ourselves back in the same position in another forty years. Moreover, the use of twentieth-century infrastructure will continue to exacerbate climate change through its large energy costs and will fail to address the more difficult water management challenges that are likely to occur in a warming world. Technologies are readily available to forge a more sustainable infrastructure path for the next forty years. It is largely a matter of finding the legal, policy, and financing tools needed to support and promote them.

\textsuperscript{345} See Heaney, supra note 343, at 245–46.
\textsuperscript{346} See id. at 236–41.
\textsuperscript{347} See H. Furumai, Reclaimed Stormwater and Wastewater and Factors Affecting Their Reuse, in Cities of the Future: Towards Integrated Sustainable Water and Landscape Management 223–25 (Vladimir Novotny et al. eds., 2006).
\textsuperscript{348} See Andrew Speers, Water and Cities—Overcoming Inertia and Achieving a Sustainable Future, in Cities of the Future: Towards Integrated Sustainable Water and Landscape Management 26 (Vladimir Novotny et al. eds., 2006) (comparing 220 L/day average household use with traditional systems to 60 L/day in systems with recycling configurations).
\textsuperscript{349} See id. at 26–27.
\textsuperscript{350} See id.; Novotny, supra note 344, at 201.
\textsuperscript{351} See Heaney, supra note 343, at 246.
\textsuperscript{352} See Speers, supra note 348, at 25.
\textsuperscript{353} See id.
\textsuperscript{354} See, e.g., G. Tracy Mehan III & Ian Kline, Pricing as a Demand-Side Management Tool: Implications for Water Policy and Governance, 104 J. Amer. Water Works Ass’n 61, 62–63 (2012) (arguing that charging full cost of water would promote more efficient use).
\textsuperscript{355} See id. at 63 (discussing the policy implications of demand-side pricing strategies).
\textsuperscript{356} See Novotny, supra note 344, at 200.
\textsuperscript{357} Train, The EPA Programs and Land Use Planning, supra note 33, at 288.