Waste Less, Pollute Less: Using Urban Water Conservation to Advance Clean Water Act Compliance

Cities and suburbs—and the wastewater and stormwater utilities that serve them—are among the largest sources of water pollution in many parts of the United States. They face hundreds of billions of dollars in investment needs to repair, maintain, and improve their infrastructure to comply with Clean Water Act standards that protect public health and the environment—and, in many cases, to maintain that compliance while accommodating population growth. These regulatory obligations include basic "secondary treatment" and advanced nutrient removal for sewage; control of combined sewer overflows (CSO) and sanitary sewer overflows (SSO); municipal separate storm sewer system (MS4) stormwater controls; and restoring or maintaining an overall state of good repair despite decades of under-investment in aging systems.[1]

At the same time, metropolitan areas in many parts of the country are facing serious water supply challenges in an era of chronic water scarcity, increased uncertainty in future water availability, and growing competition for water resources.[2] As global temperatures continue to rise, precipitation patterns change, and water demands increase, an increasing number of communities will be challenged to maintain adequate water supplies.[3]

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Source: Philadelphia Water Department.

A 55–gallon household rain barrel in Philadelphia.

Fortunately, there are many cost-effective urban water conservation strategies that can help address both water quality and water quantity needs, simultaneously relieving stress on urban water supply systems and keeping pollution out of our rivers, lakes, and beaches.

Measures that curtail indoor water use, such as water-efficient fixtures and appliances, also reduce strain on sewage collection and treatment systems, improving pollution control performance and reducing compliance costs. Measures that supplement local water supply by capturing rainwater for reuse or groundwater recharge, or that reduce outdoor water demand through reliance on native landscaping, also cost-effectively reduce stormwater pollution, CSOs, and SSOs.

Municipal wastewater and stormwater systems can improve their Clean Water Act compliance by implementing policies and programs that promote the use of water-saving measures—and many are already starting to do so. EPA and the states can apply Clean Water Act regulatory requirements and infrastructure financing programs to spur wastewater utilities and MS4s to do even more.

WATER CONSERVATION HELPS WASTEWATER UTILITIES MEET CLEAN WATER GOALS

Municipalities, water utilities, and wastewater utilities can use a range of approaches to reduce urban water demand or sustainably supplement local water supplies.[4] These include:

- Promoting or mandating the use of water efficient fixtures, appliances, and landscapes, as well as graywater and blackwater reuse systems,[5] through consumer incentives or rebates, direct replacement (e.g., in public buildings), and changes in local ordinances, building codes, or plumbing codes;
- Improved metering, volumetric billing, and conservation pricing, for drinking water, wastewater, and stormwater;
- Water loss audits and leak repair by drinking water utilities;
- Promoting rainwater harvesting, through stormwater management regulations that limit offsite discharge of stormwater runoff, consumer incentives or rebates, and changes in local ordinances, building codes, or plumbing codes; and
- Enhancing groundwater recharge, through stormwater management regulations that limit offsite discharge of runoff or through creation of regional stormwater recharge areas.

All of these water-saving measures also have water pollution control benefits. Reducing indoor water usage and/or reusing graywater for outdoor applications result in a lower volume of wastewater flows, while repairing leaks from drinking water distribution systems can reduce infiltration into underlying sewer pipes.[6] The resulting lower flows in sanitary sewers have many likely benefits for wastewater utilities' compliance with water pollution control requirements: reduced volume of wet weather overflows due to lower dry weather base flows; reduced, deferred, or avoided capital costs for new or expanded collection and treatment capacity that would otherwise be necessary to achieve or maintain Clean Water Act compliance and/or accommodate population growth;[7] and reduced energy demand (and associated operating costs) for pumping and treatment.[8] Lower-volume, more highly-concentrated wastewater flows (associated with improved indoor water use efficiency), also have the potential to improve efficiency of certain wastewater treatment processes at existing facilities, which would yield in lower operating costs and extended equipment replacement periods.[9,10]

Indeed, when explaining why federal wastewater infrastructure funds may be used for water conservation efforts, the U.S. Environmental Protection Agency (EPA) has explained that: "Water conservation and reuse programs can be developed to help systems avoid, downsize, or postpone wastewater projects. There are also benefits from increased treatment plant efficiency and reduced energy costs."[11] Similarly, EPA's WaterSense program, which promotes water-efficient appliances and fixtures, explains that: "Water efficiency can lessen the stress on [wastewater] systems and extend their useful life."[12]

Additionally, while targeted local water conservation programs can rapidly accelerate water use reductions, there is already a significant downward trend in per capita/household water use, due in large part to national plumbing fixture efficiency standards.[13] New national and state standards that are being phased-in over the next several years will accelerate this downward trend. Regionally-focused conservation efforts already underway will do so as well: a recent survey of 328 drinking water utilities nationwide found that nearly one-quarter of them have water conservation programs that anticipate achieving at least a 15% reduction in demand, including 6.5% of utilities that anticipate achieving more than a 30% reduction.[14] Wastewater utilities planning new or expanded treatment or collection infrastructure need to be aware of these downward trends in water use to ensure such investments are "right-sized," instead of relying on outdated assumptions that overestimate domestic wastewater flows.

Urban Green Infrastructure as a Statewide Water Supply Strategy

A 2009 study by NRDC and the University of California, Santa Barbara found that green infrastructure practices that emphasize groundwater recharge or capture and reuse at new and redeveloped properties had the potential to increase local water supplies by up to 405,000 acre-feet per year by 2030 in Southern California and the San Francisco Bay area. This represents enough water for more than 800,000 families each year. The analysis led to the inclusion of green infrastructure and stormwater capture in California's State Water Plan.

In 2014, NRDC updated this analysis and found that using these same practices to retrofit existing developed areas in Southern California and the San Francisco Bay area could supply up to 630,000 acre-feet of runoff annually, roughly the volume of water used by the entire City of Los Angeles each year.

Sources: Garrison, *et al., A Clear Blue Future: How Greening California Cities Can Address Water Resources and Climate Challenges in the 21st Century* (2009), available at http://www.nrdc.org/water/lid/.

NRDC and Pacific Institute, *Stormwater Capture Potential in Urban and Suburban California* (2014), available at http://www.nrdc.org/water/ca-water-supply-solutions.asp.

Capturing Rainwater from Rooftops

A huge amount of rain falls on rooftops—and almost all of it is treated as a waste, rather than as a valuable resource. A 2011 NRDC study of eight different cities shows that, under a range of rainwater harvesting scenarios, each city could capture rooftop runoff in amounts equal to the total annual water use of tens of thousands to hundreds of thousands of residents. For example, capturing the first inch of rooftop rainfall from each storm event in Atlanta, GA, from half of the city's roofs, could supply enough water for approximately 74,000 people, or nearly 15 percent of the city's total population.

Source: Garrison, *et al., Capturing Rainwater from Rooftops: An Efficient Water Resource Management Strategy that Increases Supply and Reduces Pollution* (2011), available at http://www.nrdc.org/water/rooftoprainwatercapture.asp.

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This cistern at a Whole Foods Market in Raleigh, NC, collects rainwater for interior restroom use.

GREEN INFRASTRUCTURE PRACTICES IMPROVE WATER USE EFFICIENCY, AUGMENT URBAN WATER SUPPLIES, AND REDUCE STORMWATER POLLUTION

Rainwater harvesting, green infrastructure that allows for groundwater recharge, and water-efficient landscapes can all be deployed to control stormwater pollution and sewer overflows, even as they enhance urban water supplies and improve water use efficiency.

By putting rainwater to productive use, rather than allowing it to carry away pollutants from paved surfaces into nearby surface waters, rainwater harvesting offers a cost-effective approach for supplying water and protecting urban waterways. Cisterns and rain barrels that capture rain from rooftops provide an inexpensive, on-site supply of water that can be used for outdoor non-potable uses with little, if any, treatment[15] or for a variety of additional uses, including potable supply, with appropriately higher levels of treatment. This reduces strain on existing water supply sources while reducing stormwater flows, a leading cause of surface water pollution and urban flooding.[16]

Groundwater recharge is another way to use rainwater to augment local water supplies. The same development patterns that generate polluted stormwater runoff—impervious spaces like pavements and rooftops—prevent rainwater from soaking into soils and recharging aquifers. Yet, nearly 50 percent of the total population of the United States depends on groundwater for some part of their water supply. That means green infrastructure practices—which use soils and vegetation to naturally filter and infiltrate rainwater into the ground—can be used to recharge local and regional groundwater aquifers across large portions of the country, while keeping polluted runoff out of rivers, lakes, and beaches.[17]

Across the United States, 270 billion gallons of water are used each week—a significant portion of it potable—to water 23 million acres of lawn.[18,19] Not only does maintaining these lawns use a tremendous amount of water, but lawns actually do a poor job of allowing rainwater to infiltrate into soils and recharge groundwater below. The rainwater and excess irrigation water that flows off of lawns washes large amounts of fertilizers and pesticides into local waterways.

In contrast, "water-smart" landscaping thrives primarily on normal rainfall instead of wasting potable water on irrigation; uses drought-tolerant species in arid climates; and uses plants that are more pest-resistant and need less artificial fertilizer than are typically used on lawns.[20] Native plant landscapes can infiltrate as much as 25 times more rainwater than turf grass,[21] reducing stormwater pollution while promoting groundwater recharge.

MUNICIPALITIES AND UTILITIES CAN ACT NOW TO SAVE WATER, SAVE MONEY, AND REDUCE POLLUTION

Both wastewater and stormwater utilities have the ability to implement virtually all of the water conservation strategies described above—often independently, using their own resources and authorities, and sometimes in partnership with local drinking water utilities or municipal governments. This includes consumer rebates for water-efficient fixtures, appliances, and landscaping; volumetric pricing for sanitary sewer service that incentivizes conservation; ordinances (or, for wastewater utilities, terms of service for new sewer connections) that mandate water-efficient fixtures, appliances, and buildings; and, especially for utilities that provide both water and wastewater service, water loss audits and leak repair in distribution systems.

WaterSense labeled toilets could save the average family 13,000 gallons of water per year.

This Water-Smart garden in Olympia, WA, includes edible and drought-tolerant plants. The plants are watered by a drip irrigation system that helps with reducing evaporation and runoff. A rain garden is also included to gather water from roofs, driveways and sidewalks. This reduces runoff.

Leaders in the wastewater utility industry recently envisioned that the wastewater "utility of the future" will engage pro-actively in water conservation efforts "to reduce sanitary wastewater and expansion of wastewater infrastructure."[22] For some, that future is already here. For example:

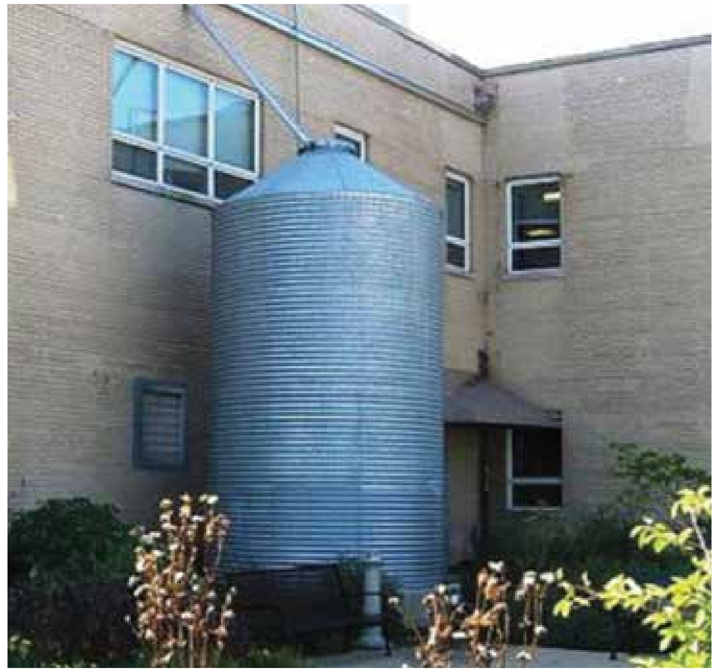
- The San Antonio Water System, an integrated water and wastewater utility, has kept water demand steady for 25 years, despite a 67% increase in the number or water customers, through an aggressive conservation program.[23] This has allowed the city to avoid up to $2.7 billion in additional water supply costs and over $1 billion in expanded wastewater treatment capacity costs.[24] In fact, despite its rapid population growth, the city has actually been able to close one of its four sewage treatment plants.[25]
- In California, the City of Los Angeles began a major water conservation initiative in 1988—including mandatory fixture retrofits in existing buildings and use of "ultra-low flush" toilets in all new buildings—that was expressly motivated by a desire to avoid overloading a municipal sewage treatment plant and protect water quality in Santa Monica Bay.[26] Through this and other water conservation efforts, the city's water usage remained relatively level even as population increased by nearly 1 million people.[27] The City of Santa Monica used a multi-faceted water conservation program—including a water fixture retrofit-upon-sale ordinance and a high-efficiency toilet rebate program—that reduced wastewater flows by 21 percent (and water demand by 14 percent) between 1990-2000.[28] The Sonoma County Water Authority offers rebates for high-efficiency toilets and clothes washers, and a variety of water efficiency rebates for commercial buildings, with the express purpose of limiting flows to wastewater treatment plants.[29] Various smaller California municipalities and utilities have also adopted water conservation requirements in response to capacity limitations at sewage treatment plants.[30]
- New York City, in the mid-1990s, was able to defer billion-dollar expansions of four sewage treatment plants through water conservation efforts—including meter installation and a high-efficiency toilet rebate program—that reduced average dry weather flows by 17% over five years.[31] More recently, the city has recognized water conservation as a cost-effective element of its plans to reduce CSOs, projecting that continued declines in water demand through 2030 will reduce annual CSO discharge volumes by 1.7 billion gallons, or 8%.[32] The city's integrated water and wastewater utility recently adopted a new water conservation plan, which includes a revival of the popular toilet rebate program, now using WaterSense-certified toilets that use 20% less water than federal performance standards; the city has also required that all new toilets installed citywide must meet the same water-efficiency standard. In addition to direct water quality benefits from reducing sewer overflows, the city projects over $6 million in annual operational savings (from reduced energy and chemical needs) from a targeted 5% decline in wastewater flows.[33]
- In the Boston metropolitan area, the Massachusetts Water Resources Authority (MWRA)—another integrated water and wastewater utility—has a "demand management program," which includes distribution of free low-flow showerheads and faucet aerators (with nearly 12,000 distributed in fiscal year 2013) and a major leak detection and repair effort.[34] The program is aimed at both "maintain[ing] regional water demand comfortably below the water supply system's safe yield" and "help[ing] maintain regional wastewater flow below the required

[Clean Water Act] permit limit" and has achieved both goals.[35] In addition to maintaining adequate wastewater capacity, a $40 million investment in water conservation between 1987 and 2004 allowed the utility to avoid $500 million in costs for new water supplies.[36]

- In Washington State, a regional wastewater utility serving Olympia and three other cities works closely with local drinking water utilities to promote water conservation, as a means of ensuring adequate wastewater treatment capacity. As of 2012, the program—which includes rebates for high-efficiency residential and commercial washing machines and toilets; free showerheads and faucet aerators; and rebates to industrial, commercial, and institutional customers for a range of water efficiency retrofits—had met its initial five-year goal of reducing wastewater flows by 1 million gallons per day.[37]
- By partnering with drinking water utilities that meter their customers' usage, wastewater utilities can utilize volumetric billing for sewer charges to incentivize conservation. In California, for example, although 90 percent of households pay metered rates for water drinking water, 70 percent pay a flat rate for sewer service.[38] Converting all of those households to volumetric wastewater rates could eventually save nearly 100 billion gallons of water per year.[39] The City of San Luis Obispo, for example, converted from flat rate sewer pricing to volumetric sewer pricing in 2007. Within 3 years, the city achieved a 25% reduction in per-household winter water use.[40]

In communities with obligations to address stormwater runoff and CSOs, utilities and municipal governments are also using incentives, regulations, and direct public investments to promote rainwater harvesting, groundwater recharge, and replacement of lawns with water-efficient landscaping:

- Cities around the country have adopted stormwater management regulations that limit offsite discharge of stormwater runoff and require compliance using practices that infiltrate, evapotranspire, or harvest rainwater.[41]
- The City of Los Angeles, which faces major stormwater pollution problems, has invested in large-scale stormwater capture and infiltration projects, for purposes of landscape irrigation, groundwater recharge, and pollution control.[42]



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A cistern in Chicago.

- The Northeast Illinois Regional Water Supply/Demand Plan, developed pursuant to gubernatorial executive order, calls for rainwater harvesting and groundwater recharge as strategies to both enhance regional water supply and reduce stormwater pollution.[43] The City of Aurora has embraced this approach by using green infrastructure to address its CSOs and stormwater pollution, while helping to form an alliance of 79 communities and five counties to collaboratively address regional water supply and groundwater recharge issues.[44]
- The City of Seattle's RainWise program will pay most of the cost of installing a cistern (or a rain garden) on a residential or commercial property, in order to reduce the city's CSO discharges.[45]
- So-called "cash-for-grass" programs, also known as turf removal rebates, are increasingly popular in drought-prone Southwestern cities, such as Las Vegas, NV; Austin, TX; and Long Beach, CA.[46] Typically, these programs require that turf be replaced with low-water demand plants and other permeable surfaces.[47] In Long Beach—which has a Clean Water Act permit with numeric targets to reduce stormwater runoff volumes—the Lawn-to-Garden Turf Replacement Program goes even further to encourage landscapes specifically designed to maximize stormwater capture.[48]

© Courtesy of the Metropolitan Sewer District of Greater Cincinnati

Bioinfiltration basin, Cincinnati Ohio.

EPA AND THE STATES CAN ENLIST URBAN WATER CONSERVATION EFFORTS TO HELP ACHIEVE CLEAN WATER ACT OBJECTIVES

Based on the many links between urban water conservation and water pollution reduction, water efficiency measures can be incorporated into both the regulatory and infrastructure financing provisions of the Clean Water Act—which are administered jointly by the federal government and the states—to help meet Clean Water Act objectives and moderate the cost of new or expanded clean water infrastructure.

Water conservation provisions are most suitable for inclusion in municipal Clean Water Act permits and enforcement orders in the following situations:

- **Combined Sewer Overflows:** Permits and enforcement orders should expressly require CSO communities to incorporate water conservation into both of their main CSO control obligations: implementation of the Nine Minimum Controls (NMCs) and development and implementation of a Long Term Control Plan, pursuant to EPA's CSO Control Policy.[49] One of the NMCs is to "maximize the use of the collection system for storage"[50] and EPA's NMC guidance explains that "[w]ater conservation will reduce dry weather sanitary flow and increase the volume of combined sewage that can be retained in the CSS [combined sewer system] and treated at the [sewage] treatment plant."[51] After implementing the NMCs, permittees must develop a LTCP, by evaluating a "reasonable range of alternatives" and selecting a broader set of controls that will be sufficient to achieve compliance with water quality standards.[52] EPA guidance states that "source controls," including green infrastructure, must be considered because they reduce overflows by reducing the volume of water going into a combined sewer system.[53] Since water conservation works in the same way, permits and enforcement orders should also clearly state that communities developing LTCPs must include water conservation among the strategies evaluated.
- **Sanitary Sewer Overflows (SSOs):** EPA guidance explains that the same rationale for green infrastructure that applies to CSOs can also apply to permits and enforcement orders regulating SSOs, particularly where such overflows are caused by "inflow" of stormwater into sewer pipes.[54] Likewise, the same rationale for water conservation applies in the SSO context.
- **Publicly Owned Treatment Works:** To ensure sewage treatment plants maintain adequate capacity to treat dry-weather flows, and to facilitate compliance with obligations to add new treatment units to enhance pollutant removal (e.g., advanced nutrient removal), permits for POTWs can include provisions for development and implementation of water conservation programs and rate structures designed to encourage more efficient water use. For example, in Boston, MWRA's permit includes a provision titled "Assurance of Compliance with 436 MGD [million gallon per day] Flow Limit," which requires submission of annual reports "describing the demand management programs, including water conservation programs, that [MWRA] is maintaining or encouraging, in cooperation with member communities." The reports must compare potable water and wastewater use over the preceding five years, describe and evaluate the effectiveness of implementation activities, and identify future demand management initiatives.[55] New York State uses a standard permit provision that if the annual average flow to a POTW for a calendar year has reached 95% of its design flow, the permittee must submit to the Regional Water Engineer a "flow management plan" to "identify and implement reductions in hydraulic loading to the POTW treatment plant. . . ., [including] water conservation measures to reduce customer usage by measures including but not limited to customer metering, meter calibration, retrofitting existing plumbing fixtures with water conservation fixtures and revision of water rate structures."[56] Permitting authorities could be even more pro-active by requiring water conservation programs well before flows have reached such critical levels.
- **Municipal Separate Storm Sewer Systems:** For all MS4 permits, states and EPA Regions should follow EPA recommendations to include an on-site stormwater retention standard for new development and redevelopment, and ensure that such standards allow infiltration and rainwater harvesting practices to be used for compliance.[57] Many permits issued by EPA and the states already include such provisions.[58] MS4 permits can also authorize the use of regional, off-site groundwater recharge projects as a compliance tool, as in the recently-

issued Los Angeles County MS4 permit, so long as localized pollution control targets will be met.[59] California's 2014 Water Action Plan, developed in response to severe drought, commits to "propose modifications [to existing programs] to incentivize and co-fund multi-benefit projects that promote integrated water management, such as stormwater permits that emphasize stormwater capture and infiltration, which provide both flood protection and groundwater recharge benefits."[60]

- Integrated Planning: EPA is encouraging communities to develop "integrated plans" for wastewater treatment, sewer overflows, and stormwater management, which would maximize efficiencies in compliance with overlapping regulatory requirements and be incorporated into Clean Water Act permits and enforcement orders.[61] EPA's integrated planning guidance highlights green infrastructure as "sustainable solution" that contributes to compliance with all of these Clean Water Act obligations.[62] Likewise, water conservation is a sustainable solution that can help address all of these issues and should also be included in integrated planning efforts.

State and federal infrastructure financing programs can also be tailored to promote water conservation as a Clean Water Act compliance strategy. Two key mechanisms available to states and EPA are placing water efficiency-related conditions of eligibility for financial assistance and directly supporting water conservation projects through grants as well as low-cost loans.[63] The Water Resources Reform and Development Act of 2014 adopts both of these approaches for the Clean Water State Revolving Fund (CWSRF) program. Under the new law, municipalities and utilities seeking CWSRF funding will be required to maximize water efficiency and reuse as part of all wastewater and stormwater infrastructure projects. Additionally, projects for managing and reusing stormwater, recycling wastewater, and that reduce the need for wastewater treatment through water conservation and reuse measures are now specifically called out by Congress as eligible for funding assistance, codifying a practice that is already allowed under EPA guidance. Further, water efficiency and stormwater management projects are now eligible for loan forgiveness and negative interest loans (essentially, grants) under the CWSRF, not just low-interest loans.[64]

States and EPA must be diligent in implementing these new CWSRF funding eligibility requirements, and should aggressively promote funding availability for water conservation projects. To date, states' use of financial assistance for water conservation programs has varied widely. Some aggressively use SRF and other funds to support water efficiency projects, and some states go further to condition utilities' eligibility for water infrastructure funds on their adoption of water efficiency practices. Conversely, in some states, SRF rules still need to be revised even to allow funding for water conservation projects. A summary of state policies to encourage water conservation and efficiency can be found in the Alliance for Water Efficiency's "Water Efficiency State Scorecard Report."[65]

Power Plant Water Use: More Huge Opportunities to Promote Water Efficiency in Service of Clean Water Act Goals

The electricity sector is another area where water efficiency and the Clean Water Act directly intersect. Power plants use tremendous amounts of water for industrial processes—including cooling systems and solid waste handling—that wreak major environmental havoc on rivers, lakes, and coastal waters. By modernizing these systems with more water-efficient designs and operation, the electricity sector can drastically reduce the nation's largest source of water demand and toxic water pollution as well as the destruction of billions of fish.

Full implementation of the Clean Water Act's provisions on power plants' cooling water intakes and toxic water pollution discharges would bring about precisely these improvements. Two EPA policymaking efforts—one recently completed but open to legal challenge, and one still pending—provide once-in-a-generation opportunities to improve nationwide standards. Further, whatever the outcomes of those federal rulemakings, states (and the EPA, where it issues Clean Water Act permits directly) should impose conditions in permits for individual power plants that drive the use of water-efficient practices, including closed-cycle or dry cooling, dry handling or closed-loop systems for managing coal ash, and wastewater recycling for managing solid waste from air pollution control devices.

For more information on these topics, see the following recent NRDC publications:

Power Plant Cooling and Associated Impacts: The Need to Modernize U.S. Power Plants and Protect Our Water Resources and Aquatic Ecosystems (April 2014), available at http://www.nrdc.org/water/power-plant-cooling.asp.

Protecting Our Waters from Toxic Power Plant Discharges and Reducing Water Use in the Process (April 2014), available at http://www.nrdc.org/water/files/power-plant-cooling-FS.pdf.

Endnotes

1 Minimum national sewage treatment standards include both "primary" treatment (mainly to remove solids) and "secondary" treatment (which typically involves using microbes to break down organic material and kill pathogens). "Combined sewer overflows" are releases of untreated sewage mixed with polluted runoff directly to water bodies, which occur by design when "combined sewer systems" that accept both sewage and stormwater are overwhelmed by rain. "Sanitary sewer overflows" are spills of raw sewage from "sanitary sewer systems" that are designed to accept only sewage, but which nonetheless become overwhelmed when rainwater or groundwater enters poorly maintained systems or when old or clogged sewer pipes burst. "Municipal separate storm sewer systems" are urban drainage systems designed to handle stormwater exclusively.

2 United States Global Research Program, *Climate Change Impacts in the United States*, 2014, http://nca2014.globalchange.gov/; Dorfman, *et al.*, *Thirsty for Answers: Preparing for the Water-related Impacts of Climate Change in American Cities*, 2011, http://www.nrdc.org/water/thirstyforanswers.asp.

3 Environmental Protection Agency, *Climate Impacts on Water Resources*, www.epa.gov/climatechange/impacts-adaptation/water.html.

4 NRDC and American Rivers, "Top 10 No-Regret Strategies," *Getting Climate Smart: A Water Preparedness Guide for State Action,* 2013, 48–55, *available at* www.nrdc.org/water/climate-smart.

5 The link between reduced indoor water use and reduced sanitary flow into wastewater collection systems is both obvious and documented in various studies cited below. The link between wastewater systems and leakage from drinking water distribution systems is less obvious, but no less real. In areas that suffer from both leaky underground water distribution systems and infiltration of groundwater into aging wastewater conveyance systems, drinking water leaks can ultimately enter wastewater sewers (which are situated deeper than drinking water pipes to ensure that sewage leaks do not contaminate drinking water lines). For example, New York City's Water Demand Management Plan states that the city's leak detection and repair efforts "reduce[] the volume of influent flow entering wastewater treatment plants by…preventing drinking water from unnecessarily leaching into the ground and getting into the sewer system."NYC Department of Environmental Protection, *Water Demand Management Plan,* 2013, www.nyc.gov/html/dep/pdf/conservation/water-demand-management-plan-single-page.pdf.

6 Graywater is defined slightly differently around the world but generally refers to the wastewater generated from household uses like bathing and washing clothes. It is distinct from blackwater, which refers to wastewater that has come into contact with fecal matter and urine.

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8 *See, e.g,*, Koyasko, supra note [7].

9 *See, e.g.*, AGRA Earth & Environmental Limited, *Study of Water Conservation as a Means to Improve Wastewater Treatment and Reduce Treatment Costs* (prepared for Environmental Canada, 1995), www.research.rem.sfu.ca/frap/9622.pdf; Maier, *et al.*, 1981. "Benefits from water conservation depend on comprehensive planning," *Water Resources Bulletin*. 17:4: 672–677.

10 It should be noted that these changes in flows can also lead to changes in physical and chemical processes that occur in pipes and within specific unit operations in the plant, which may require adaptations in the operations and maintenance of existing collection and treatment systems to avoid potential adverse impacts. Such effects have only been explored briefly in the literature *See, e.g.*, Marleni, *et al.*, "Impact of Water Source Management Practices in Residential Areas on Sewer Networks—A Review," *Water Science & Technology*, 65:4:624–642 (2012).

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12 Environmental Protection Agency, "Water Sense: Comprehensive List of All Frequent Questions," last updated June 10, 2014, www.epa.gov/WaterSense/full_list.html. (Accessed June 12, 2014.)

13 *Rockaway*, et al. 2011. "Residential Water Use Trends in North America," *Journal American Water Works Association*. Vol. 103, Issue 2.

14 Black & Veatch. *2013 Strategic Directions in the U.S. Water Industry* (2013). www.bv.com/docs/reports-studies/2013-water-report-web.pdf.

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