DECLINING WATER SALES AND UTILITY REVENUES
A FRAMEWORK FOR UNDERSTANDING AND ADAPTING

A WHITE PAPER FOR THE
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The scenario is becoming all too familiar. Utility managers see falling water sales and falling revenues. Rates must be raised simply to maintain revenues, but rate increases are also needed to pay for the rising cost of infrastructure replacement and improvement. Higher rates might even induce a price response in the form of further declines in usage (shifts along the demand curve).[1] The effects of economic recession make matters worse, particularly for areas experiencing declines in service population and economic activity (shifts in the entire demand curve). As water price increases outstrip overall inflation, boards of directors and water customers alike are balking at successive and high rate increases. Promoting water conservation in this context seems illogical at best and self-destructive at worst. In a twist of distorted incentives, the water manager may even hope for drought. Infrastructure-intensive public utilities face a serious "conservation conundrum"[2] in that socially beneficial efficiency appears contrary to their financial self-interest, particularly in the short run. The combination of rising costs and falling sales is a potential recipe for revenue shortfalls and fiscal distress. *What is a water manager or rate regulator to do?*

A Summit on Declining Water Sales and Utility Revenues Summit in Racine, Wisconsin, convened by the Alliance for Water Efficiency, examined how this problem is manifested across the country. This white paper explores its root causes and offers potential utility and policy solutions.

Introduction

This white paper was drafted initially to frame the central issues in advance of an August 30, 2012 national summit of prominent water industry leaders, economists, and financial experts to examine the root causes of the current problems with water utility rates and revenues, and to outline potential utility solutions as well as policy and regulatory reforms. Finalized following the summit, the paper presents a framework for defining the problem and exploring both root causes and potential utility and policy solutions, as organized around five issue areas:

- Issue 1. How and why are water sales declining?
- Issue 2. Are water utility revenues falling short of requirements?
- Issue 3. Do water utilities and the conservation community have a messaging problem?
- Issue 4. What methods are available to repair revenues and improve fiscal stability?
- Issue 5. What role might industry standards, practices, and policy reforms play?

Water utilities today face a serious challenge related to what is loosely understood as "declining demand." Water "demand" connotes different meanings. Engineers think about demand in terms of water supply or production measures, also understood as "system load." Planners think about demand in terms of water consumption or sales measures, also understood as "realized demand." Economists think about demand in terms of a choice-based functional relationship between prices charged and *quantity*

[1] The association of rate increases with falling revenues is a phenomenon sometimes referred to as a "death spiral," even though relative price inelasticity will forestall the actual demise of a utility enterprise and rates can be adjusted for "demand-repression" effects in the context of rising revenue requirements. The responsiveness of water usage to prices varies but water demand has been empirically estimated to be less price-elastic than energy demand, making the "death-spiral" metaphor less applicable.
[2] Janice A. Beecher, "The Conservation Conundrum: How Declining Demand Affects Water Utilities." *Journal American Water Works Association* (February 2010).

demanded (a downward sloping curve reflecting both willingness and ability to pay).[3] For the purposes of this paper, we consider demand generally in terms of the aggregate quantity demanded from, and provided to, water customers.

For decades, efficiency and conservation have been advanced as part of an integrative approach to resource management that recognizes the joint consideration of supply and demand management in fulfilling community water needs. Like demand, "efficiency" also has different meanings. Technological efficiency is achieved when it is impossible to increase output without increasing inputs, whereas economic efficiency is achieved when the cost of producing a given output is as low as possible.[4] The latter depends in part on the former. Efficiency might also be defined in broader social terms (such as "service accessibility" or "highest and best use") or environmental goals (such as "resource preservation" or "maximizing production of ecological services"). This paper considers water efficiency as maximizing net benefits—the difference between the benefits of water consumption and the costs of the resources required to supply that consumption, including disposal of any "waste" water. Conservation generally involves a reduction in usage; conservation measures may be imposed to reshape water usage patterns or as part of drought or emergency management (including temporary rationing). Evaluating the desirability of a change in water consumption through efficiency or conservation measures requires comparing benefits and costs.

The rationale for improving the efficiency of usage through full-cost pricing, efficiency standards, and other means has always rested on the idea that efficiency gains on the demand side will translate into more efficient utility operations, including reduced operating costs in the short run (including the cost of energy and chemicals) and avoided capacity costs in the long run (including the cost of supply development, pipeline transmission, and treatment plants). Improved efficiency also reduces risk and uncertainty, including risk and uncertainty associated with volatile sales. Reduced environmental costs or added environmental benefits are also achieved over both the short and long terms.

Aggregate water withdrawal trends clearly illustrate the stability of water withdrawals relative to population growth, reflecting both lower per-capita usage and efficiency gains.[5] To illustrate the reality of declining water usage and its effects, we examine trends over the last decade for residential sales, revenues, and average sales price for a large sample of utilities in Wisconsin – host state to the National Water Rates Summit (Exhibit 1). Though the total number of residential customers has risen over the last decade (top line) total residential sales has been flat (light blue line) while the sales per customer trend shows a decline. Revenues per residential customer or per volume of sales (a proxy for average prices) have gone up.

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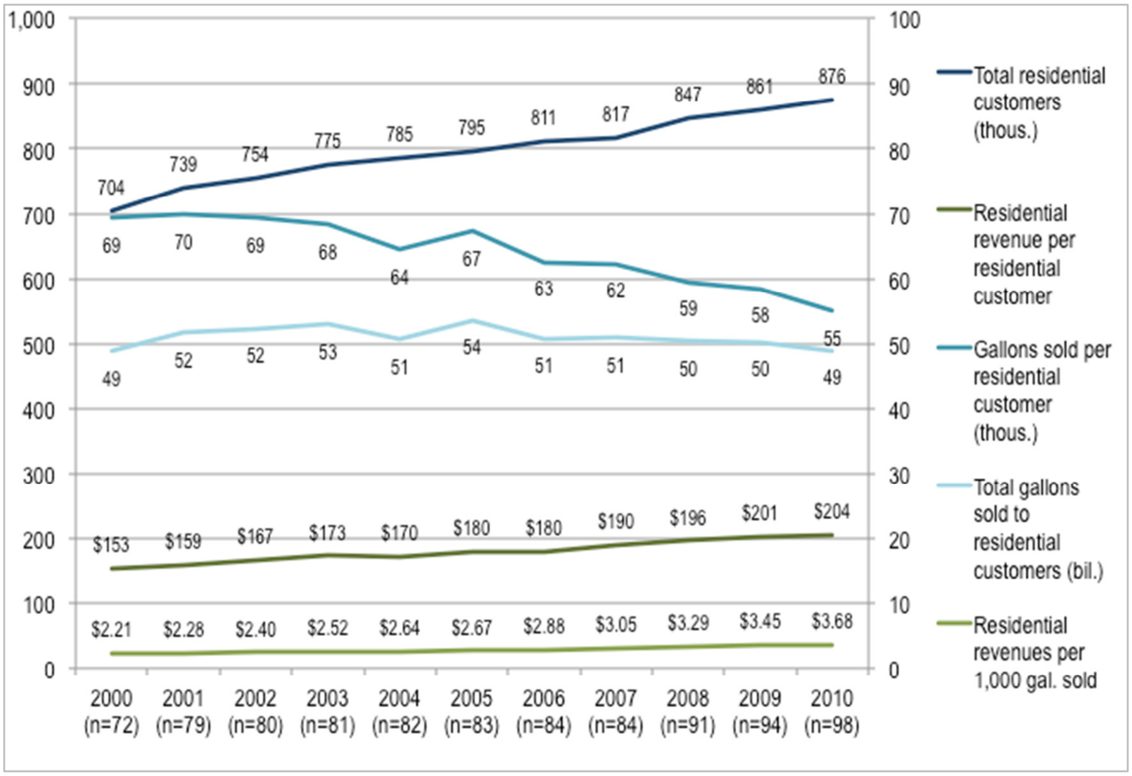
[3] For more on understanding water demand, see Stephen Merrett (2004), "The Demand for Water: Four Interpretations," *Water International* 29 (1): 27-29.

[4] These definitions are from About.com: Economics.

[5] Kenny, J.F. et al. (2009) *Estimated use of water in the United States in 2005.* U.S. Geological Survey Circular 1344.

Exhibit 1. Trends in Residential Water Sales and Revenues for Wisconsin Utilities (Class AB)

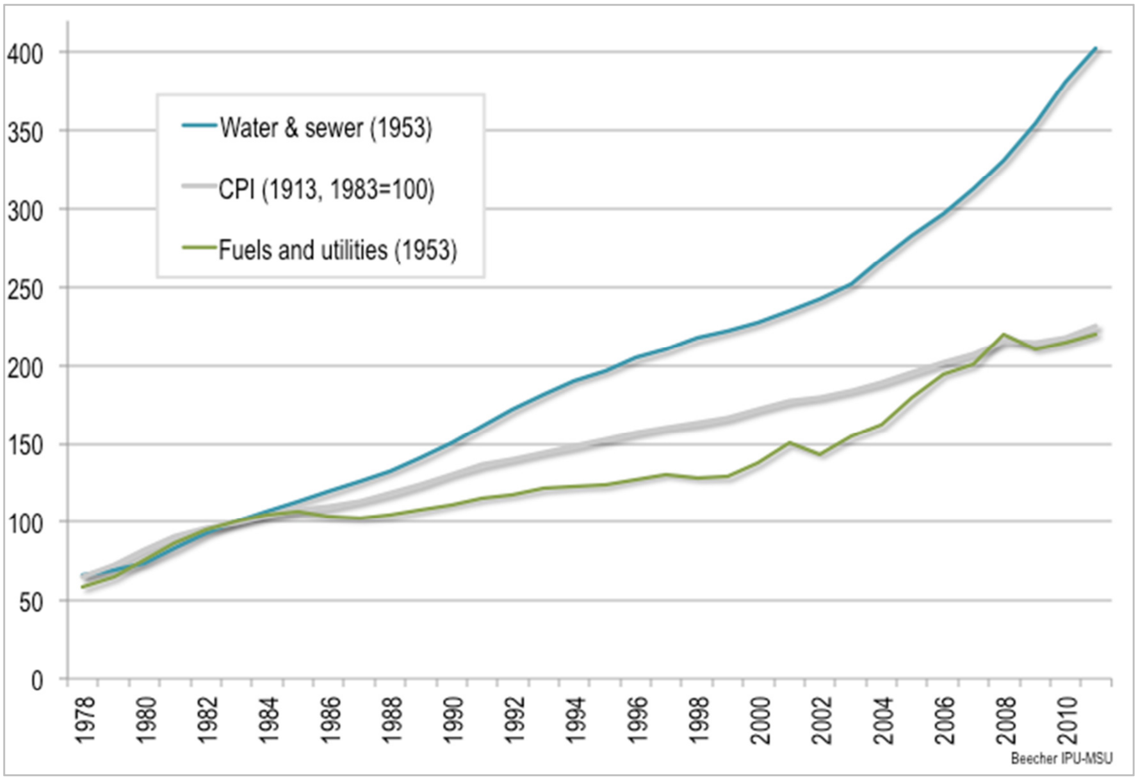


Source of data: Wisconsin Public Service Commission.

At least some of the trend in aggregate water usage appears to be durable, making for "new normals" in the water business. Flat or declining sales are affecting many water utilities, regardless of whether they have actively engaged in conservation programs. The loss of load caught many utility managers, industry analysts, and even efficiency advocates off guard. Improved standards and practices have helped to improve water efficiency and shift demand. In some cases, utility programs have accelerated market penetration and impact. Rising prices are also playing a role. Wisconsin is not the only state in the nation experiencing a rise in the real price of water. Exhibit 2 compares the national Consumer Price Index (CPI) to the indices for "water and sewer maintenance" and "fuels and utilities." Trends clearly indicate that water prices are under pressure, suggesting the potential for prices to influence the quantity demanded, even when demand is relatively "price inelastic."

Conservation may have value to the environment and society, but its economic value to utilities depends in part on whether costs can be avoided or revenues can be generated from an alternative end use for "conserved" water; if no economic value is perceived, the rationale for utility conservation programs is undermined. Otherwise, loss of water sales (or load) translates directly into loss of revenues, and loss of revenues translate into higher rates and charges simply to maintain revenue neutrality and cover the cost of operations, much of which is fixed in the short run. Given the prospects of new normals in water usage, utility revenues are in need of repair as much as water infrastructure. Yet more efficient water supply systems are de facto more sustainable systems because they are better positioned to operate within their economic and ecological means. The parameters of sustainability may vary by location, but true efficiency gains are universally good from an economic perspective.

Exhibit 2. Trends in Consumer Prices (CPI) for Water and Sewer Maintenance and Utilities



Source of data: Bureau of Labor Statistics.

In the long term, water supply and demand will find an efficient equilibrium. In the short term, however, reductions in water sales are a cause of fiscal stress for utilities and a potential disincentive to further investment in efficiency. This problem is exacerbated by the fact that water supply in general is a rising-cost industry. The combination of declining sales and rising costs, along with the movement toward full-cost pricing, is placing considerable pressure on utility water rates. For water utilities, a price that reflects true costs is a more efficient price. Regardless of the reason, higher rates can be expected to cause additional reductions in price-sensitive customer end uses, which in turn may require additional rate increases. Raising rates can become a political issue with elected boards and city councils as well as state regulatory agencies when jurisdiction applies. Customers are generally unhappy with high utility bills, particularly unhappy about paying anything more for water, and especially unhappy when they pay more while using less.

Water pricing is complex because it tends to involve multiple and sometimes competing policy goals (Exhibit 3). Pricing is central to long-term sustainability (Exhibit 4). Sustainable systems spend to an optimal service level and price in a manner that recovers capital and operating expenditures. The logic of economic efficiency applies both to spending and pricing. Underspending and overspending have deleterious effects, as do underpricing and overpricing. Cost studies can inform these determinations.

Revenue sufficiency and stability are core goals and a function of both rate levels and rate design. Ideally, rates are set to recover all revenue requirements, or the true cost of service. Water utilities are highly capital intensive but recover some fixed costs through variable charges, in part to amplify price signals and improve efficiency in usage over time. In some respects, the emphasis that conservation places on the *value of water* has detracted attention from the value – and the cost – of the substantial *infrastructure* required to provide safe, adequate, and reliable water service as well as fire protection and wastewater services.

Exhibit 3. Water Pricing Goals

Source: Janice A. Beecher, Institute of Public Utilities, Michigan State University.

Exhibit 4. Water Pricing and Sustainability

	Expenditures Relative to Optimal Service Level		
Prices relative to total expenditures	*<1 expenditures are below optimum ("cost avoidance")*	*= 1 expenditures are optimal*	*>1 expenditures are above optimum ("gold plating")*
<1 prices are below expenditures ("price avoidance")	Deficient system	Subsidized system	Budget-deficit system
= 1 prices are at expenditures	Underinvesting system	**SUSTAINABLE SYSTEM**	Overinvesting system
= >1 prices are above expenditures ("profit seeking")	Revenue-diverting system	Surplus system	Excessive system

Source: Janice A. Beecher, Institute of Public Utilities, Michigan State University.

For public utilities, it is not uncommon to see marginal costs (total costs/total units sold) below average costs, so pricing at marginal cost can result in insufficient revenues. In the short run, marginal costs may be low for systems with excess capacity resulting from load loss. When marginal costs exceed average costs (as in persistent scarcity conditions), then pricing at marginal cost can result in excess revenues. Depending on average and marginal costs (considered in the short and long runs), selling available water may well be efficient and consistent with the goals of stewardship and the boundaries of sustainability. Some communities are actively trying to attract water-intensive industries to their service territories (Evanston, Illinois, provides an example). Although total system (full accounting) costs are used to define revenue requirements, marginal costs can provide guidance for rate design. Indeed, marginal-cost pricing lends theoretical support for conservation-oriented rate structures.

Cost allocation and rate design assign cost responsibility to customers but should be "revenue neutral." Different rate structures, however, have different incentives and implications for utilities and their customers. High fixed charges (and decreasing-block rates) provide revenue stability and mitigate the utility's incentive to sell, but can weaken usage-based price signals and raise affordability concerns. High variable (or volumetric) charges (and increasing-block rates) provide more affordability but less stability, and make utilities more dependent on sales (including dry weather cycles). Concerns about revenues are turning more attention to a variety of conventional and unconventional cost recovery, revenue assurance, and rate-design options.

These dynamics have already been a source of frustration for utility managers and their customers. The relationship between revenue requirements, rates, and bills is complex (Exhibit 5). Particularly vexing is the potential association of efficiency and conservation with higher rates, which can undermine support for efficiency goals as well as the public's trust. Utility sponsored conservation programs can be especially hard to justify; in a context of excess capacity and revenue shortfall they appear rather self-defeating. Improving communications in this area is an urgent challenge for the water sector. The revenue issue is as much about messaging as about rates and rate structures.

Water utilities that are content with their financial situations have probably done many things correctly; there are a correspondingly large number of ways for water utilities might end up in a less satisfactory place. Thinking about solutions requires reexamining "the problem" and its root causes. Only by better understanding the nature of the problem and how it came to manifest can decision makers, water managers, and rate analysts begin to sculpt solutions.

Although much has been written about the revenue effects of conservation, there remains a need for a systematic framework for mapping potential relationships among revenues, rates, and bills. Such a framework can provide the basis for a new narrative about water conservation, in part to dispel the perceived connection between water conservation and all rate increases. The intended audience is water utility managers and their oversight boards, public utility regulators, consumer groups, conservation advocates, and other stakeholders. The following sections examine each of the five issue areas that framed the discussion at the National Water Rates Summit.

Exhibit 5. Revenues, Rates, and Bills: Mapping the Message

Condition	Revenue Requirements	Rate ($/unit)	Bill ($/customer)
Usage			
Usage decline (other things equal near term)	neutral	↑	neutral
Economic demand management	↓	↑	↓
Uneconomic demand management	↑	↑	↑
Costs			
Rising infrastructure costs	↑	↑	↑
Rising operating costs	↑	↑	↑
Supply-side efficiency	↓	↓	↓
Market			
Customer additions (gain scale)	↑	↓	↓
Customer losses (lose scale)	↓	↑	↑
Rate design			
Price-elastic usage	neutral	↑	↓
Price-inelastic usage	neutral	↑	↑
Cost reallocation	neutral	↓↑	↓↑
Full-cost pricing			
Subsidy	↓	↓	↓
Loss of subsidy	↑	↑	↑
Transfers	↑	↑	↑

Source: Janice A. Beecher, Institute of Public Utilities, Michigan State University.

Issue 1: How and why are water sales declining?

- Water usage and sales relate directly to water utility design, investment, and operation.
- Declining water sales of 1 to 3% annually is not an uncommon observation today.
- Water usage patterns differ between developed and developing political economies.
- Given water's essential nature, the trend in water sales will not reach zero.
- Water sales should eventually stabilize at a relatively efficient, predictable, and sustainable level.
- Declining sales are particularly problematic for "declining cities" experiencing population loss and weak economic activity.
- Declining sales have operational effects on water and wastewater systems.
  - Reduced water flows can affect water quality.
  - Reduced water and wastewater flows can affect infrastructure integrity (e.g., corrosion).
- Implications of declining water usage on operations.
  - Water and wastewater systems are likely suboptimal relative to utilization.
  - Long-life water infrastructure should be built to meet today's increasingly efficient use and tomorrow's prevailing usage patterns.
  - Changes in load create opportunities to avoid costs and redirect investment.
- Many systems have experienced declines in sales even under conditions of dry weather.
- A universally valid and reliable empirical model for estimating contemporary water sales has yet to be specified.
- Aggregate water usage is partly a function of socioeconomic conditions and characteristics.
  - Total water usage can grow with growing population and economic activity.
    - Growth masks per-connection and per-capita trends.
    - Loss of population will suppress sales.
  - Economic recessions will tend to suppress sales.
  - Recessionary influences on water sales vary in their duration and durability.
  - Water usage varies seasonally according to weather, namely, precipitation and evapotranspiration.
  - Climate change will influence weather and the quantity of water supplied and used in a given time period.
- Aggregate water usage can be understood as a function of per-connection and per-capita usage because different drivers are at work.
  - Evidence suggests that both are falling in many areas.
- Per-connection or household usage (weather adjusted) is a function of:
  - Household size (fewer people per household) and demographic composition.
  - Property (lot) size.
  - Composition of single- and multi-family housing.
  - Growth policies affecting housing.
  - Nature of commercial activities and industrial processes.
  - Efficiency in irrigation practices on customer premises.
  - Local codes and restrictions on irrigation.
  - Price-induced effects on discretionary use.
    - Metering elasticity of demand.
    - Price elasticity of demand (effect of marginal prices and the total bill for both water and wastewater).

- Per-capita water usage (weather-adjusted) is a function of:
  - National standards and codes for water-using fixtures and appliances.
  - Commercial and industrial process efficiencies and technologies.
  - Incentives that accelerate efficiency deployment (programs, rebates).
  - Changing culture, attitudes, and environmental ethic (for example, reduced urban irrigation) based in part on perceptions of scarcity in water supplies.
- Price appears to be playing an increasingly important role.
  - Full-cost pricing is necessary but not always sufficient for inducing efficient water use.
  - The current decline in water sales embeds a customer response to price that is often imperfectly recognized in utility planning and ratemaking.
  - Water is subject to the laws of supply and demand, just like other goods and services – water is essential but technically not "priceless" (that is, water services are excludable and "priceable").
  - Price is how we "self-ration"; that is, prices guide our consumption decisions.
  - Utility services are generally less price-elastic, but not perfectly inelastic (that is, usage is not completely unresponsive to changes in price).
  - The "real" (inflation-adjusted) price of water in the U.S. has been rising.
  - Usage may have entered a more price-elastic portion of the demand curve for water.
  - Different water uses within and across customer classes present different elasticities (essential use is less elastic).
  - Consistent with the law of demand, rising prices will affect the quantity of water demanded whether or not they are part of a conservation strategy.
- Falling sales and revenues are industry-wide problems directly related to the adoption of efficiency standards and practices.
  - Much of the efficiency gains are related to the effects of standards, prices, and economic conditions.
  - Some are due to the impact of utility efficiency programs.
  - The revenue impact may be the same but the policy implications differ.

Issue 2: Are water utility revenues falling short of revenue requirements?

- For the water industry, aging infrastructure needs and costs are blamed for a widening "gap" between expenditures and revenues for many, though not all, public utilities.
- The gap is essentially a "construct" for focusing policy attention.
- Strategies for closing the water utility funding gap from the top include:
  - Efficiency practices (least-cost).
  - Technological innovation (capital and operating).
  - Market-based approaches as appropriate (bidding).
  - Industry restructuring (consolidation and convergence).
  - Integrated resource management (supply and demand).
- Strategies for closing the water utility funding gap from the top include cost-based rates for water services.
- Economic regulation by state public utility commissions can help ensure both cost prudence and cost-based pricing.
  - State regulation can help "depoliticize" local ratemaking to some degree.
  - Given rising costs and falling revenues, operational efficiency and "cost control" are important but many utility costs cannot be avoided through supply-side and demand-side efficiency.

- Assuming that the utility's revenue requirements reflect the prudent cost of service, adjusted for any costs reduced or avoided through efficiency gains, the revenue shortfall problem can normally be explained by rates that are too low.
- Reasons for revenue shortfalls:
  - Lagging rate increases, so that revenues from rates will never be sufficient to cover actual revenue requirements or the budgeted cost of service.
    - Rate lag can reflect bureaucratic processes or "political will" (also known as "willingness to charge").
  - Under-collection of revenues or receivables owed to the utility.
  - Inadequate cost forecasting in the ratemaking process, including reliance only on historical cost data.
  - Inadequate sales forecasting in the ratemaking process, including "demand-repression" effects associated with rate increases.
    - Simplistic and non-robust linear forecasts and moving averages are inadequate.
    - End-use modeling is needed (market adoption rates).
    - General trends in water sales can be effectively forecast.
    - Scenarios can be used for modeling weather effects and the effects of weather on water usage can be estimated.
  - Inattention to rate design in terms of the allocation of costs to fixed and variable charges, and elasticity effects on revenue stability and sufficiency.
- For most water utilities, infrastructure replacement costs are outweighing the costs avoided through efficiency (particularly in the short term).
  - Water bills continue rise but not as much as they would without improved efficiency.

Issue 3: Do water utilities and the conservation community have a messaging problem?

- The water utility investment and cost profile may not be widely understood or appreciated.
- Piped community water service is capital intensive with high fixed costs.
- Fire protection needs present an engineering design and operational constraint.
- The conservation ethic has focused considerable attention on the "value of water" as compared to the "value of water service."
- In the long term, all costs are variable, but in the short term most costs are fixed.
- Water efficiency helps water systems avoid operating costs in the short run and capital costs in the long run.
- Declining sales may leave systems with excess capacity and stranded investment, which undermines the case for conservation in the short run.
  - Promoting water use and attracting water-using industries is controversial.
- The impact of efficiency and conservation on water rates and bills is controversial, but not necessarily well understood or well-articulated.
  - Revenue neutrality in ratemaking suggests that water rates increase due to falling sales, but water bills increase due to rising costs.
  - Lower sales volume, given a relatively fixed revenue requirement, implies the need for a higher average rate per unit of water (net of efficiency savings actually reflected in authorized requirements).
  - In the face of rising rates, customers who can conserve will pay less than customers who cannot conserve (a distributional effect).

- Conservation investments (like other investments) should be prudent.
  - Water use has both negative and positive impacts and externalities.
  - While efficiency is almost always desirable, not all forms of conservation are desirable, cost effective, or economically efficient.
  - Cost-effective conservation, by definition, reduces utility revenue requirements.
  - Prudent and planned conservation should not result in revenue shortfalls.
  - Although prices are rising, water bills over time will be lower than they otherwise would be (that is, lower highs).
- Water utilities and the conservation community have not been very successful in crafting a message to the public about:
  - The role of water utilities in resource stewardship and sustainability (the "blue industry" is a "green" industry).
  - The realized and anticipated benefits of efficiency in terms of water, energy, environmental protection, and infrastructure costs.

Issue 4: What methods are available to repair revenues and improve fiscal stability?

- A number of methods that utilities are considering for addressing revenue shortfalls are summarized here (Exhibit 6).
- When considering potential solutions, water utility managers are concerned about:
  - Rate lag between cost incurrence and cost recovery.
  - Reliance on volumetric charges and sales for utility revenues.
  - Revenue sufficiency and revenue stability over time.
- In many respects, traditional ratemaking principles and practices can effectively address material changes in costs, cost volatility, and changes in usage.
  - Under changing conditions of costs and sales, utilities need to be vigilant about rates.
  - All costs should be included in revenue requirements (full-cost pricing).
  - Revenue requirements should include costs for prudent conservation expenditures.
- Four key culprits in the revenue shortfall appear to be:
  - Lack of timely rate adjustments, including cost-adjustment rate mechanisms.
    - Ratemaking and regulatory politics may play a role.
    - Rate adjustments should be easier and more expedient for unregulated and/or publicly owned systems.
  - Inadequate cost and sales forecasting for the revenue requirements test year.
    - Lack of acceptance from state economic regulators.
  - Cost-allocation and rate-design practices.
    - Suboptimal allocation of costs to fixed and variable charges.
    - Possible over-reliance on variable charges.
  - Current loss of other revenue sources.
    - Subsidies from grants, loans, and intergovernmental transfers.
    - Recessionary effects on growth and system-development fees.
- The solution set varies based on utility organizational structure.
  - Larger systems have greater capacities and more options.

- Publicly owned systems may be subject to local political forces, but may have more flexibility to change practices.
- Regulated systems, including all private systems, must comport with regulatory standards and reviews.

- No recommendations are made here, as each method has potential advantages and disadvantages and involves tradeoffs.
  - Policy choices depend on perspective and goals (including equity and efficiency).
  - Some methods achieve similar goals by different means.
  - Consistency with generally accepted principles and practices and legal defensibility are concerns when departing from traditional forms of cost-based ratemaking.

Exhibit 6. Methods for Addressing Revenue Shortfalls

	Description	**Key Advantages**	**Key Disadvantages**
Rate adjustments	Rate reviews and adjustments that keep pace with changing conditions	▪ Reduces rate-adjustment lag	▪ Increases ratemaking expense ▪ May be politically unwelcome
Full-cost pricing	Water prices based on system budgeting cost of service studies	▪ Supports fiscal autonomy of system ▪ Enhances price efficiency	▪ May cause significant rate increases for subsidized systems
Depreciation expense	Include in rates an expense for the depreciating the value of utility assets	▪ Provides cash flow to system	▪ Requires utility basis of accounting and ratemaking ▪ May cause significant rate increases
Replacement value ratemaking	Base rates on anticipated cost of asset replacement	▪ Account for inflationary effects	▪ Requires utility basis of accounting ▪ May be arbitrary and inflate rates unnecessarily
Reserve-account funding	Use a special charge or equity return mechanism to build a reserve account	▪ Builds a reserve account for infrastructure replacement needs	▪ May be arbitrary and inflate rates unnecessarily ▪ May cause intergenerational equity concerns ▪ Funds may be diverted
Improved cost forecasting	Pro forma adjustments for known and measureable cost changes or use of future test year	▪ Reduces rate lag	▪ Requires analytical skill
Improved sales forecasting	Enhanced econometric modeling v. simple moving averages (e.g., statistically adjusted end-use modeling)	▪ Reduces rate lag ▪ Weather-adjusted water usage is relatively predictable	▪ Requires analytical skill
Weather normalization	Adjustment to forecast sales based on expectation of normal weather and precipitation	▪ Reduces weather impact on revenues	▪ Requires analytical skill

Exhibit 6. *Continued*

Cost-adjustment mechanisms	Pass through to customers of certain substantial and volatile costs (e.g., purchased water or power)	■ Simplifies and expedites rate adjustments ■ Keeps rates in line with actual costs	■ May provide a disincentive for cost control
Cost indexed rates	Rate adjustments based on a predetermined inflation index	■ Simplifies and expedites rate adjustments	■ May mis-estimate real costs
Demand-repression adjustment	Adjusts sales forecast to account for price elasticity on usage	■ Reduces rate lag by incorporating elasticity effects	■ Requires analytical skill
Revenue-stable rate design	Use of uniform rates, uniform by class, or large first blocks that stabilize revenues	■ Simplification and customer understanding	■ May not be perceived as sufficiently conservation-oriented
Fire-protection charges	Design of fixed charge based on the value and cost of fire protection	■ Stabilizes revenues by establishing a fixed charge	■ Weakens variable price signals ■ More affordable if based on property values
Three-part tariff	Design rates with three components: customer, capacity, and commodity charges	■ Stabilizes revenues by establishing a charge related to capacity costs	■ High fixed charges ■ Raises affordability concerns ■ May weaken variable price signals, particularly with regard to future capacity costs
Straight fixed-variable pricing	Alignment of fixed and variable charges with fixed and variable prices	■ Stabilizes revenues by effectively decoupling revenues from sales ■ Neutralizes the incentive to sell	■ High fixed charges ■ Raises affordability concerns ■ Weakens variable price signals, particularly with regard to future capacity costs
Water-budget rates	Rate design that considers property size, household size, and other variables in designing rate blocks based on a determination of "need"	■ Enhances revenue stability ■ Promotes conservation awareness ■ Politically acceptable to large-volume customers	■ Difficult to reconcile with cost-of-service and related equity and efficient principles ■ Administratively complex ■ May reinforces legacy choices ■ Regressive in customer impact
Rate stabilization fund	A designated fund for managing revenue deficits and surpluses	■ Provides fiscal protection for utility	■ May cause intergenerational inequity

Exhibit 6. *Continued*			
Public-benefit surcharge	A customer surcharge used to fund efficiency or other programs considered beneficial to the public	▪ Educates customers about programs and costs	▪ May invite political resistance
Lost-revenue adjustment	A rate mechanism or revenue recoupling method used to recover revenues lost due specifically to mandates designed to reduce usage	▪ Neutralizes the incentive to sell	▪ Difficult to segregate sales lost due to mandates ▪ Overstates incentive to sell
Revenue assurance or decoupling	A rate mechanism or revenue cap designed to decouple sales from revenues and profits	▪ Neutralizes the incentive to sell ▪ Case is easier for publicly owned utilities (risk and profit issues)	▪ Overstates incentives to sell ▪ Discourages economic sales ▪ Undermines price efficiency and variable pricing incentives ▪ Perpetuates legacy investment ▪ Shields utilities from elasticity effects
Earnings adjustment mechanism	A rate mechanism to compensate private utilities for profit erosion due to efficiency	▪ Neutralizes the incentive to sell ▪ Can be used with various performance metrics	▪ Undermines performance incentives ▪ Shifts risks to customers

Source: Janice A. Beecher, Institute of Public Utilities, Michigan State University.

Issue 5: What role do industry standards, practices, and policy reforms play?

- The impressive success of improved efficiency and the reality of declining water sales presents a challenge to water utilities is terms of:
  - The appropriateness of ratemaking methodologies.
  - The ongoing role of efficiency programs.
  - A discordant conservation message.
- Many policies and practices for water and other resources reflect an underlying assumption of economic and sales growth.
  - Water sales will not be a source of revenue growth for the water industry.
  - Expansion of the water industry will be limited.
  - Estimates of infrastructure needs may be distorted.
  - Infrastructure investment should emphasize re-optimization.
- Utility efficiency programs should be scrutinized to ensure they are prudent and cost effective.
  - Program subsidies must be cost-justified and ideally transitional with the purpose of hastening the adoption of self-sustaining efficiency technologies and practices).
  - Efficient prices, along with efficiency standards and consumer information, should be sufficient in the long run for most utilities and normal (nonemergency) circumstances.

- Analysts have considered the relative impact of prices and programs, with some asserting the predominant role of price (see Olmstead and Stavins, 2007).

- Sustainability is emerging as a better paradigm for water.
  - The industry must adjust to new normals in water usage in terms of infrastructure investment and efficient operations.
- Water utilities must have sufficient revenues to cover fixed costs and maintain safe and reliable service, including fire protection.
- Some solutions to the revenue shortfall issue raise institutional or public policy issues beyond the direct control of the individual utility.
- Policy responses that might be considered include:
  - Expanding economic regulation to ensure prudent investment and full-cost pricing, and depoliticize the ratemaking process (e.g., Wisconsin regulates all water systems).
  - Encouraging fiscal autonomy for water systems, supported by accounting and reporting standards as well as public and private lending requirements and other incentives.
  - Imposing regulatory, zoning, permitting or other restrictions on bypass of water utility service within an enfranchised service territory.
  - Promoting short-term and long-term supply and forecasting methodologies for both costs and sales, and requiring their use in capital planning and ratemaking.

Thinking About Solutions

- No single universally applicable solution can be offered: there is no magic bullet.
- Thinking about solutions requires reexamining “the problem” and its root causes.
- In thinking about potential solutions, some key questions should be addressed:
  - Does defining the problem define the solution?
  - Is the revenue sufficiency issue primarily a technical or political challenge?
  - Do structural characteristics of water systems matter to potential solutions?
  - What core ratemaking and other principles apply?
  - What tradeoffs are involved when choosing solutions?
- Does defining the problem define the solution?
  - Conducting a thorough assessment of existing rates is a necessary first step.
  - The assessment should consider whether the existing rate structure has proved adequate in the absence of severe recession, drought restrictions, or wet and cool weather.
  - More broadly, current water rates need to be assessed relative to expenditures, and expenditures need to be assessed relative to optimal service levels, preferable in a broader context of sustainability
- Is the revenue sufficiency issue primarily a technical or political challenge?
  - The water industry is not lacking in knowledge and tools for forecasting both sales and costs, as well as for asset and watershed planning and management.
  - Many nominal technical problems have underlying root problems: adherence to outdated financial practices, institutional inertia, regulatory guidance, and real or perceived political constraints.
  - Ratemaking to achieve goals requires leadership and political will, as much as technical knowledge (e.g., overcoming “NIMTO or not in my term of office”).
- Do structural characteristics of water systems matter to potential solutions?
  - The form and nature of solutions will be shaped and sometimes constraints by the institutional context.

    - Small water utilities will not have the same resources and options that are available to larger ones.
    - Municipal water utilities face a different set of political constraints and oversight than do investor-owned water utilities.
    - Different utilities can also face different regulation and different regulators.
- What core ratemaking and other principles apply?
    - Ratemaking is guided by a long tradition of well-established and well-tested principles, particularly in the regulatory context.
    - Generally accepted ratemaking principles relate primarily to efficiency and equity considerations, while recognizing the importance of compensating utilities for the cost of service.
    - Departures from cost-based rates and revenue neutrality in rate design are cause for concern and may invite legal challenges.
- What tradeoffs are involved when choosing solutions?
    - Water rates are designed to accomplish multiple objectives (Exhibit 3).
    - Revenue sufficiency is a necessary but not sufficient condition for water utilities to fulfill their mission.
    - Regulatory and political acceptance of rates is essential.

Concluding Thoughts

New normals in water usage are forming and the industry must find ways to navigate a path toward more efficient usage patterns. The water industry needs to own the issues of declining sales and revenues and update its message of conservation and efficiency to one of service and sustainability. Despite current trajectories, the declining usage problem is a transitory one; sales and revenues will eventually stabilize.

In many respects, the water sector has arrived at an inflection point where water managers must make tough decisions and where the industry as a whole needs to embrace a paradigm of sustainability, as opposed to one of perpetual growth. This is not to say that efficiency is no longer essential; in fact, efficiency is core to long-term sustainability. Efficiency efforts must be adjusted to new and hopefully improved conditions. Ironically, the industry and the conservation community must concede that efforts to improve efficiency are not failing but working. Efficiency gains should be celebrated for their impact on both water and energy, and also incorporated into capital planning and investment decisions. No longer just theoretical, the opportunity to avoid costs has arrived. The biggest risk for the industry may be building tomorrow's water supply infrastructure to meet yesterday's water demand.

Selected Readings

Aubuchon, Craig P. and J. Alan Roberson (2012) "Price perception and nonprice controls under conservation rate structures," *Journal American Water Works Association*.

> Abstract: This research evaluates the effect of price and nonprice conservation controls on monthly water system demand and explores differences in rate design, education and outreach programs, population growth, and regional climate variables among a national cross section of utilities. Using the Shin price perception parameter, this study found that under conservation rate structures, aggregate demand was related to something other than marginal or average price. The price–demand response increases with higher levels of consumption for both the marginal price and the total bill, which may provide preliminary evidence that the price signal of the total bill matters for demand. Nonprice controls were not found to be statistically significant in the study sample. Income elasticities were positive and slightly larger in magnitude than price elasticities, suggesting that over the long term, utility managers may need to increase rates faster than regional income growth for effective demand management.

Beecher, Janice A. (2010). "The conservation conundrum: How declining demand affects water utilities." *Journal American Water Works Association* 102 (2):78-80. [http://apps.awwa.org/WaterLibrary/showabstract.aspx?an=JAW_0071587]

> Abstract: This article discusses the significant financial challenge that utilities face in the rising infrastructure costs that must be recovered from a shrinking sales base. Fortunately, strategic coping methods are available such as forecasting, scenario-building, and planning. Utility plans should incorporate long-term goals and performance metrics as well as prudent investment strategies based on changing demand patterns. Cost recovery should recognize expenditures for cost-effective investments in efficiency, and regulators can provide additional incentives as appropriate. As long as costs and demand continue to shift, more frequent rate adjustments will help reduce lag and ensure that rates are properly aligned with costs. Forward- looking rates can be established by using a "future test year" for revenues. A demand-repression adjustment may be needed to recognize the effects of programs and prices on forecast use. Utilities will also need to examine rate-design options and assess whether they exacerbate or mitigate revenue volatility, uncertainty, and distributional consequences.

Beecher, Janice A. (2012). The ironic economics and equity of water budget rates. *Journal American Water Works Association* 104 (2). [http://www.awwa.org/publications/AWWAJournalArticle.cfm?itemnumber=58445]

> Abstract: Water budget rates are gaining attention in the water sector. Although clearly well-intended, the water budget approach to rates raises serious theoretical and practical issues familiar to applied regulatory economics. In essence, water budget rates exemplify "social rate-making," that is, a system of pricing that departs from traditional economic standards in the interest of serving social goals—in this case water conservation. The inherent problem with this particular rate structure, however, is not its good intentions but its disconcerting implications. The troubling irony of water budget rates appears to be lost in the deliberation.

Chesnutt, T.W., G. Fiske, J.A. Beecher, D.M. Pekelney (2007) *Water Efficiency Programs for Integrated Water Management,* Water Research Foundation.

> Executive Summary: Water utilities have increasingly come to appreciate the value of water use efficiency (WUE) for accomplishing their long-term mission of providing a safe and reliable potable water supply. The importance of water efficiency goes well beyond the short-term measures invoked to respond to drought emergencies, and is much broader in scope. Improved water-use efficiency is

seen as a viable complement to – and in some instances, a substitute for – investments in long-term water supplies and infrastructure. This understanding of water efficiency includes outdoor as well as indoor WUE, nonresidential water customers as well as residential customers, and utility delivery efficiency as well as end use efficiency. At the heart of the new understanding of water efficiency is an economic standard: a good WUE program produces a level of benefits that exceed the costs required to undertake the program.

Coomes, Paul, Tom Rockaway, Josh Rivard, and Barry Kornstein (2009). *North America Residential Water Usage Trends Since 1992,* Water Research Foundation.
[http://www.waterrf.org/ExecutiveSummaryLibrary/4031_ExecutiveSummary.pdf]

Conclusion: "This research documents a pervasive trend toward lower water usage per household. The magnitude of the decline is consistent across North American utilities and is confirmed by more detailed data provided by the study's 11 partner utilities, although there were annual variations due to regional factors. The results of the study's statistical models identify the magnitude of both positive and negative forces affecting water usage. The decline in number of residents per household is clearly an important factor in falling water consumption per residential customer. However, the negative consequences of smaller households appears to be more than offset by the positive consequences of higher household incomes. Higher incomes have led to larger homes, with more water-using appliances, and more landscape irrigation. Thus, the net decline in water usage per household appears to be due to the steady penetration of low-flow appliances over the past 20 years. The end-use study found that low-flow appliances and changing household demographics accounted for a 16 percent reduction in average household water use in 2007, as compared to 1990… The steady decline in usage per household has important financial-planning consequences for water utility companies, as infrastructure is spread over more housing units using less water than before. The data compiled in this research are intended to assist utilities in developing realistic management plans that take into account the primary causes of declining residential water usage. The data provide a tool for projecting residential water usage in light of utility-specific trends. Utilities serving communities with growth in single-occupant households are likely to see erosion in revenues per household. Additionally, new federal regulations governing water-conserving appliances and fixtures further indicate that residential water usage will continue to decline as newer homes make up a larger component of the housing stock. Utilities may find it useful to track persons per household in addition to number of households as they plan infrastructure and set rates… Although the rate of decline may slow, there is no indication that national household-size trends will reverse. Also, new and existing federal regulations will prompt further penetration of water-conserving appliances.

Dalhuisen, Jasper M., Raymond J.G.M. Florax, Henri L. F. de Groot, and Peter Nijkamp (2003). "Price and Income Elasticities of Residential Water Demand: A Meta-Analysis," *Land Economics* 79 (2):292-308. [http://le.uwpress.org/content/79/2/292.abstract]

Abstract: This article presents a meta-analysis of variations in price and income elasticities of residential water demand. Meta-analysis constitutes an adequate tool to synthesize research results by means of an analysis of the variation in empirical estimates reported in the literature. We link the variation in estimated elasticities to differences in theoretical microeconomic choice approaches, differences in spatial and temporal dynamics, as well as differences in research design of the underlying studies. The occurrence of increasing or decreasing block rate systems turns out to be important. With respect to price elasticities, the use of the discrete-continuous choice approach is relevant in explaining observed differences.

Danielson, Leon E. (1979). "An Analysis of Residential Demand for Water Using Micro Time-Series Data," *Water Resources Research* 15 (4):763-767.
[http://www.agu.org/pubs/crossref/1979/WR015i004p00763.shtml]

Abstract: Residential water demand is estimated as a function of temperature, rainfall, house value, water price, and household size using monthly cross-section and time-series meter readings from 261 residential households in Raleigh, North Carolina, between May 1969 and December 1974. Tests for validity of assumptions are made, and a methodological approach is used that provides unbiased estimates of parameters and standard errors with data that exhibit serially correlated residuals. Demand relations are estimated for total residential, winter, and sprinkling demands. Sprinkling use per period per customer for each year is estimated by subtracting winter (November–April) from summer (May–October) use. Household size explained the largest proportion of the variation in the data. Estimated sprinkling demand was found to be highly responsive to changes in water price and the level of the climatic variables, while total residential demand and winter demand were less responsive to price changes.

Fenrick, Steven Andrew, and Lullit Getachew (2012). "Estimation of the Effects of Price and Billing Frequency on Household Water Demand Using a Panel of Wisconsin Municipalities," *Applied Economics Letters* 19 (14): 1373-1380.
[http://www.tandfonline.com/doi/abs/10.1080/13504851.2011.629977]

Abstract: A demand function of residential water consumption is developed from a 1997 to 2006 panel of 200 Wisconsin water utilities. A double-log functional form is assumed and parameters are estimated using a random effects model. The results suggest that the price is inelastic yet negative and statistically significant and this elasticity response grows stronger as the marginal price level is increased. Additionally, the model reveals water savings due to monthly billing and also the annual water savings from technology adoption.

Grafton, R. Quentin, Michael B. Ward, Hang To, and Tom Kompas (2011). "Determinants Of Residential Water Consumption: Evidence and Analysis from a 10-Country Household Survey," *Water Resources Research* 47. [http://www.agu.org/pubs/crossref/2011/2010WR009685.shtml]

Abstract: Household survey data for 10 countries are used to quantify and test the importance of price and nonprice factors on residential water demand and investigate complementarities between household water-saving behaviors and the average volumetric price of water. Results show (1) the average volumetric price of water is an important predictor of differences in residential consumption in models that include household characteristics, water-saving devices, attitudinal characteristics and environmental concerns as explanatory variables; (2) of all water-saving devices, only a low volume/dual-flush toilet has a statistically significant and negative effect on water consumption; and (3) environmental concerns have a statistically significant effect on some self-reported water-saving behaviors. While price-based approaches are espoused to promote economic efficiency, our findings stress that volumetric water pricing is also one of the most effective policy levers available to regulate household water consumption.

House-Peters, Lily A., and Heejun Chang (2011). "Urban Water Demand Modeling: Review of Concepts, Methods, And Organizing Principles," *Water Resources Research* 47 (5).
[http://www.agu.org/pubs/crossref/2011/2010WR009624.shtml]

Abstract: "In this paper, we use a theoretical framework of coupled human and natural systems to review the methodological advances in urban water demand modeling over the past 3 decades. The goal of this review is to quantify the capacity of increasingly complex modeling techniques to account for complex human and natural processes, uncertainty, and resilience across spatial and temporal scales. This review begins with coupled human and natural systems theory and situates urban water demand within this framework. The second section reviews urban water demand literature and summarizes methodological advances in relation to four central themes: (1) interactions within and across multiple spatial and temporal scales, (2) acknowledgment and quantification of uncertainty, (3) identification of thresholds, nonlinear system response, and the consequences for resilience, and

(4) the transition from simple statistical modeling to fully integrated dynamic modeling. This review will show that increasingly effective models have resulted from technological advances in spatial science and innovations in statistical methods. These models provide unbiased, accurate estimates of the determinants of urban water demand at increasingly fine spatial and temporal resolution. Dynamic models capable of incorporating alternative future scenarios and local stochastic analysis are leading a trend away from deterministic prediction.

Hunter, Margaret, Kelly Donmoyer, Jim Chelius, and Gary Naumick (2011). "Declining Water Use Presents Challenges, Opportunities," *American Water Works Association Opflow*. [http://www.awwa.org/publications/OpFlowArticle.cfm?itemnumber=56556]

Abstract: For many North American utilities, residential water use has declined steadily for the last 20 years. In many locations, the trend has accelerated in the last decade. Several factors appear to contribute to declining household water use. The long-term trend could significantly affect the way utilities conduct their business and operations.

Krause, Kate, Janie M. Chermak, and David S. Brookshire (2003). "The Demand for Water: Consumer Response to Scarcity," *Journal of Regulatory Economics* 23 (2): 167-91. [http://ideas.repec.org/a/kap/regeco/v23y2003i2p167-91.html]

Abstract: Provision of water raises several issues for municipal utility companies and other suppliers, including reliability of supply in and regions or during droughts, equity issues that arise because water is literally a necessity, and heterogeneity in consumer response to regulatory policy. We combine experimental and survey responses to investigate demand for water. The experiments simulate water consumption from a potentially exhaustible source, revealing heterogeneous demand for water. We estimate econometrically water demand for different consumer groups. A regulator could use estimates of disaggregated demand to attain conservation goals by designing an incentive compatible pricing system. The example given achieves a conservation goal while minimizing enforcement costs and welfare loss.

Mayer, P., W. DeOreo, T. Chesnutt, D. Pekelney, and L. Summers (2008). "Water Budgets and Rate Structures: Innovative Management Tools," *Journal American Water Works Association* 100 (5).

Abstract: Water budgets, volumetric allotments of water to customers based on customer-specific characteristics and conservative resource standards, are an innovative means of improving water-use efficiency. Once thought to be impractical because of technological constraints, water budgets linked with an increasing-block rate structure have been implemented successfully by more than 20 utilities. Key issues identified in this examination of water budgets and their potential value to North American water utilities include: different practical approaches to water budget rate structures; the benefits and challenges of these approaches; the potential uses of water budgets during drought; and, important steps in the water budget implementation process.

Mehan, G. Tracy, III and Ian Kline (2012). "Pricing as a Demand-Side Management Tool: Implications for Water Policy and Governance," *Journal American Water Works Association* 104 (2). [http://www.awwa.org/publications/AWWAJournalArticle.cfm?itemnumber=58441]

Abstract: Full-value or -cost pricing and conservation pricing as demand-side management tools are examined along with the benefits of maintaining responsive and transparent government and the benefits realized as a result of such practices.

Merrett, Stephen (2004), "The Demand for Water: Four Interpretations," *Water International* 29 (1): 27-29.

Abstract: The management of water resources draws on a wide range of disciplines and one of the most frequent terms used among these disciplines is the "demand" for water. In fact, this single word can have at least four quite distinct meanings: the use of water, the consumption of water, the need for water, or the economic demand for water. Each of these four separate terms is carefully defined in the paper in the context of the hydrosocial balance of a region. The paper recommends precisely defining these four terms (use, consumption, need, economic demand) is necessary to avoid the ambiguities and confusion in water resources management that can arise from the catch-all term "demand." It is also indicated that to regard supply-side activities to reduce leakage and evaporation as a form of demand management is mistaken.

Mieno, Taro, and John B. Braden (2011). "Residential Demand for Water in the Chicago Metropolitan Area," *Journal of the American Water Resources Association* 47 (4):713-23. [http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2011.00536.x/abstract]

Abstract: "This paper provides the first contemporary analysis of residential water demand in humid Northeastern Illinois, in the vicinity of Chicago, and explores seasonal and income-based differentials in the responsiveness of water use to water prices. Using a panel of system-level data for eight water systems and controlling for seasons, weather, incomes, and community characteristics, the analysis yields low estimates of price elasticity of demand for water in line with other studies. Furthermore, price response is greater in summer and less in higher income communities. We suggest that use of seasonal pricing can help mitigate equity issues arising from differential income elasticities while taking advantage of the greater price responsiveness of summertime water use."

Olmstead, Sheila M., and Robert N. Stavins. 2007. "Managing Water Demand: Price vs. Non-Price Conservation Programs," Pioneer Institute. [http://www.hks.harvard.edu/fs/rstavins/Monographs_&_Reports/Pioneer_Olmstead_Stavins_Water.pdf]

Excerpt from conclusion: "Water management in the United States has typically been approached as an engineering problem, not an economic one. Water supply managers are often reluctant to use price increases as water conservation tools, instead relying on non-price demand management techniques. These include requirements for the adoption of specific technologies (such as lowflow fixtures) and restrictions on particular uses (such as lawn watering)… This paper has offered an analysis of the relative merits of price and non-price approaches to water conservation. On average, in the United States, a ten percent increase in the marginal price of water can be expected to diminish demand in the urban residential sector by about 3 to 4 percent. For the purpose of comparison, this average of hundreds of published water demand studies since 1960 is similar to averages reported for residential electricity and gasoline demand… Estimates of the water savings attributable to non-price demand management policies such as watering restrictions and low-flow fixture subsidies vary from zero to significant savings. These programs vary tremendously in nature and scope. More stringent mandatory policies (when well-enforced) tend to have stronger effects than voluntary policies and education programs."

Rockaway, Thomas D., Paul A. Coomes, Joshua. Rivard, and Barry. Kornstein (2011). "Residential Water Use Trends in North America," *Journal American Water Works Association* 103 (2): 76-89. [http://www.awwa.org/files/Resources/Waterwiser/JAW0211rockaway.pdf]

Conclusion: "This research investigated trends in household water use in North America. When controlling for weather and other variables, the evident decline in residential use was pervasive among the national and regional components of the study. A household in the 2008 billing year used 11,678 gallons less water annually than an identical household did in 1978… To investigate the causes of this decline, a local study of statistically representative households of the LWC was conducted in

Louisville. Adjusting for weather, water use per LWC customer fell from 208 to 187 gpd between 1990 and 2007, a decline of 21 gallons. Data-logging devices were installed at participating homes, and the data were incorporated into statistical models to examine possible causes and the relationships among socioeconomic factors, demographic factors, water-using appliances, behavior patterns, significant water features and types of irrigation, and residential water consumption. Demographic factors can account for a decline of 5 gallons, whereas income-related factors suggest an increase of about 5.4 gallons. This study attributes the remaining estimated net decline, about 19 gpd, to the increased installation of low-flow appliances in the Louisville market."

Standard & Poor's (2012) *From Droughts to Conservation: Water Can Have Big Effects on U.S. Municipal Utility Credit Quality.*

Overview: Intense competition for potable water means that while water in most of the U.S. is not yet priced like a commodity, it could be, and sooner than many might think. Although conservation efforts affect utility financial risk profiles, they can be beneficial. Making the most of increasingly scarce federal funds for infrastructure renewal and prudent risk management, including raising rates as needed, will be vital for utilities to maintain credit quality.