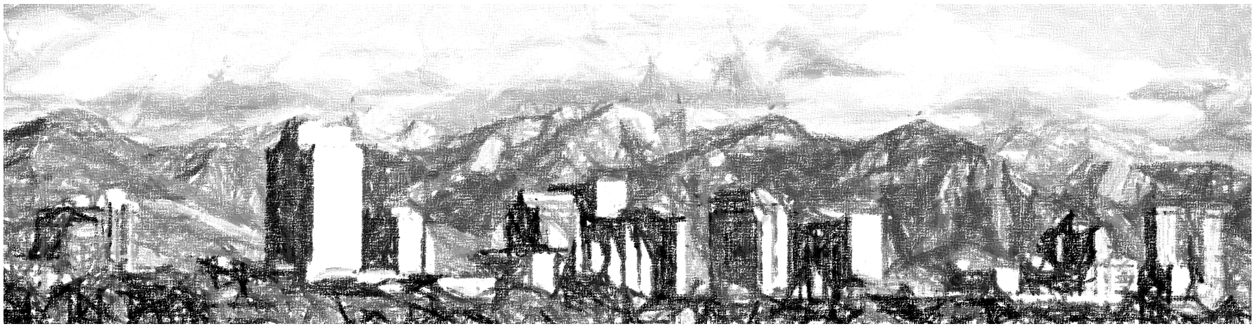

A Guide to Municipal Water Conservation Pricing in Utah

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The Need for Conservation

Utahns recognize water is a precious natural resource, its availability critical to maintaining our health, food supply, and environment. Less well understood is that, as a critical *economic* resource, water also has monetary value. While the average Utahn could tell you the approximate price they pay for a gallon of gasoline or a dozen eggs, they are unlikely to know the price of water (the Utah average is about $2.48 per 1,000 gallons).[2] Informing consumers of the value of the water they use is essential for promoting wise resource stewardship. Currently, Utah is struggling in this regard, with its per capita urban water consumption rate one of the highest in the nation.[3] Recognizing water's monetary value is necessary to promote investment in conservation. While higher rates may be unpopular for some consumers in the short run, a lack of price incentives results in inefficient and wasteful water use and ultimately higher costs for water users and the environment.

Utah faces a daunting challenge over the next 30 years in managing its water resources in the face of intense population growth. Salt Lake and Utah Counties are projected to increase their combined populations from 1.55 million to 3.21 million by 2060 and water utilities throughout the state must secure reliable water supplies well ahead of actual demand increases. Options for new supply are limited, and water managers will increasingly be asked to do more with less. Urban water conservation will be part of any balanced solution to address future water demand. Water utilities can decrease water demand by creating rate structures and conveying rate information to encourage conservation. This factsheet provides information on the use of price to encourage water conservation in Utah.

Water Rates and Price

Consumers of all goods and services, including water, respond to price. Higher gas prices encourage consumers to combine trips to town, buy more fuel-efficient vehicles, or even take public transportation. However, not all goods are equal, and the extent to which a consumer can easily use less determines how responsive they will be to a price increase. It's easy to buy less steak if it gets expensive, but if food prices increase across the board, consumers still need to eat. Water has characteristics both of a necessity, like food, and a luxury, like steak. Water for drinking and sanitation is a necessity, and price is likely to have little impact on demand. However, most of the water used by residential consumers in Utah is for lawn watering, giving them more flexibility in responding to rate increases. For instance, high water prices might encourage users to make sure their sprinklers aren't leaking and discourage them from hosing down their driveway.

While water prices can encourage responsible resource use, many consumers are unlikely to know what the price of water is. When a consumer receives a water bill, the total charge is referred to by economists as *total price*. If the consumer divides the total price by the quantity of water used, this is the *average price*. If a consumer thinks this price is too high, they might change their behavior. However, economists argue that consumers respond most reliably to increases in the *marginal price*, the price of consuming the next additional unit. Consider a wasteful water user whose sprinklers are watering more street than lawn. At the average price he pays for water, he is happy with having plenty of water for showering, dishwashing, and green grass. However, if he considers his marginal price, the price of the last bit of water consumed, he will likely realize that taking the time to realign his sprinklers would save him money without reducing what he gets from the water.

This is where things get tricky. How water price is interpreted, and how a consumer determines how much water to conserve, depends on the information provided on the water bill. Water bills may show total price, average price, marginal price, or a combination of the three. Utilities across Utah are adopting rate structures that use marginal price to encourage water conservation. The remainder of this factsheet explores how these structures work and key considerations for utilities in designing and implementing conservation pricing.

Municipal Water Pricing

Water utilities typically use one of three types of pricing: flat-rate, uniform-rate, and block-rate. Flat rates charge the consumer the same amount regardless of the amount of water used. Think about flat rates as an all-you-can-eat buffet; they encourage waste because there is no charge for going back for more, or leaving food on your plate. Uniform rates charge the same amount per unit for all levels of consumption. They are moderately effective at encouraging conservation because each additional unit incurs and additional charge. Block rates charge a rate that changes with differing levels of use. With a decreasing block rate, customers will pay less per unit as use increases (bulk discounts). More interesting for conservation pricing are increasing block rates (conservation pricing), which increase the price of a unit of water as use increases. Increasing block rates can create a strong incentive for high-use consumers to reduce water consumption.

A 2013 survey of municipal water suppliers in Utah reported that 7% use a flat rate; 26% a uniform rate; 45% an increasing block rate; 2% a decreasing block rate; and the remaining 21% do not report their rate structures. The number of utilities reporting increasing block rates in 2013 was up significantly from 2006, and since the 2013 survey, a change to Utah law now compels culinary water providers to use an increasing block rate structure (Utah Code 73-10-32.5).

To understand how consumers respond to increasing block rates, consider the rate schedule for a municipal water supplier in Utah shown in Figure 1. The blocks are the marginal price charged to a consumer, and we have calculated average price per unit. Increasing block rates mean increasing average price. Consumers pay more for individual units of water as they increase use, and the average overall price of a unit of water increases. For instance, a user consuming 90,000 gallons per month pays $0 for the first 10,000 gallons, $0.50 for each 1,000 gallons up to 50,000 gallons, and $1.00 per 1,000 gallons for the next 30,000 gallons up to 90,000. The total price of the water is $50, meaning the average price is around $0.55 per 1,000 gallons. Similarly, a user consuming 160,000 gallons per month sees an average price of around $1.00, but pays a marginal price of $2.00 for an additional 1,000 gallons of water.

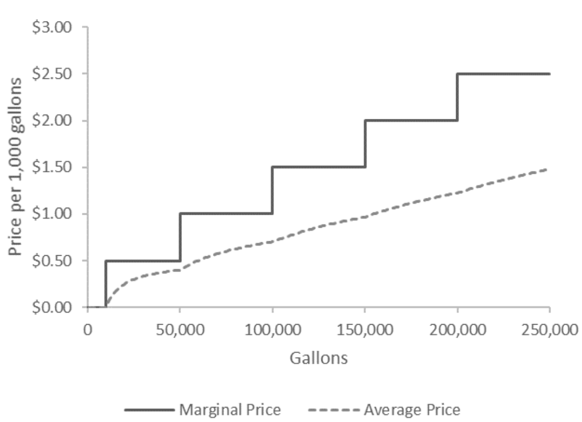

Figure 1: Marginal and average prices seen by consumers under increasing block rates for a municipal water utility in Utah.

Service Address: NORTH EAST			Service Dates: 06/01/18 - 06/30/18	
Meter Readings			Service	Total Charges
Previous	Current	Usage		
300	346	46	Previous Balance	$211.56
			Last Payment	-$211.56
			Water	$44.00
			Sewer	$50.00
			Garbage	$17.00
			Green Waste	$4.00
			Dispatch	$3.00
			Storm Water	$3.00
			Adjustments	
			Total Due	$121.00

Figure 2: Example of a water bill from a Utah municipal water utility.

In addition to the price of water, and not shown in Figure 1, all utilities in Utah charge a base-rate on their monthly water bills, a charge consumers must pay regardless of quantity used. Water utilities often use base rates as a consistent source of revenue for funding operations, with the median utility receiving around 71% of total water revenue via base rate charges. Because the base rate is not linked to the amount of water used, it does not rise and fall with water use and is not an effective conservation pricing measure.

Consumer Response to Water Rates

In economic theory, *the law of demand* suggests consumers will respond to an increase in water price by using less water. The extent to which an increase in price leads to a decrease in quantity demanded is known as *price elasticity.* Although consumers of all goods are expected to respond to price in this manner, the magnitude of the change varies. For water, consumers are typically shown to be relatively inelastic, meaning a given percentage increase in price results in a smaller percentage decrease in demand. For instance, a meta-analysis of elasticity estimates from 64 journal articles found an average elasticity of -0.41 for residential water users, meaning a 10% increase in price reduces demand by 4.1%.[4] Simply choosing a plausible elasticity range, for instance 0.2-0.6, and multiplying by the rate increase faced by each user would give a rough estimate of the percentage each user would reduce consumption.

In reality, when consumers receive a water bill, it may be combined with other utilities like sewer and trash. The bill might clearly show water use and the increasing block rate structure or may provide limited or no information on how reducing water use will affect total charge. Consumers may try and respond to increasing block rates by looking at the marginal price they pay for water, or they may just look at whether their total bill has increased or decreased. Below is the relevant portion of an actual water bill received by one of the authors. Monthly usage of 46 indicates 46,000 gallons and the increasing block rate structure leading to the $44.00 water charge is not documented anywhere on the bill. Further research revealed that the city charges the price schedule shown in Figure 1, plus a $26 base charge. By using 46,000 gallons of water (shown under usage), primarily for outdoor turf irrigation on a ½ acre lot, the author incurred a base fee of $26.00, then received the first 10,000 gallons free, followed by the remaining 36,000 gallons at a price of $0.50 per 1,000, for a total price of $44.00:

$$(\$26.00) + (\$0.00) \times 10 + (\$0.50) \times 36 = \$44.00$$

While this utility has adopted conservation pricing, a more effective bill would provide clear information on the pricing structure to help the consumer understand the value of conservation.

Water Rate Changes

This section provides information on how to predict a change in water use after a rate change. An example from a 2013 rate change implemented by a municipal water utility in Utah, shown in Figure 3, is illustrative. The left panel shows the rate change. While the tier changes and price increases are not large, they do change the marginal and average price faced by consumers. The right panel shows these changes, for instance the initial price of the first block was $1.12 and decreased to $1.04, reducing marginal cost by about 7%. The rate change was accompanied by an increase in the base charge, so the average price this tier's overall bill increased by about 12%. For some users, the change in marginal price is

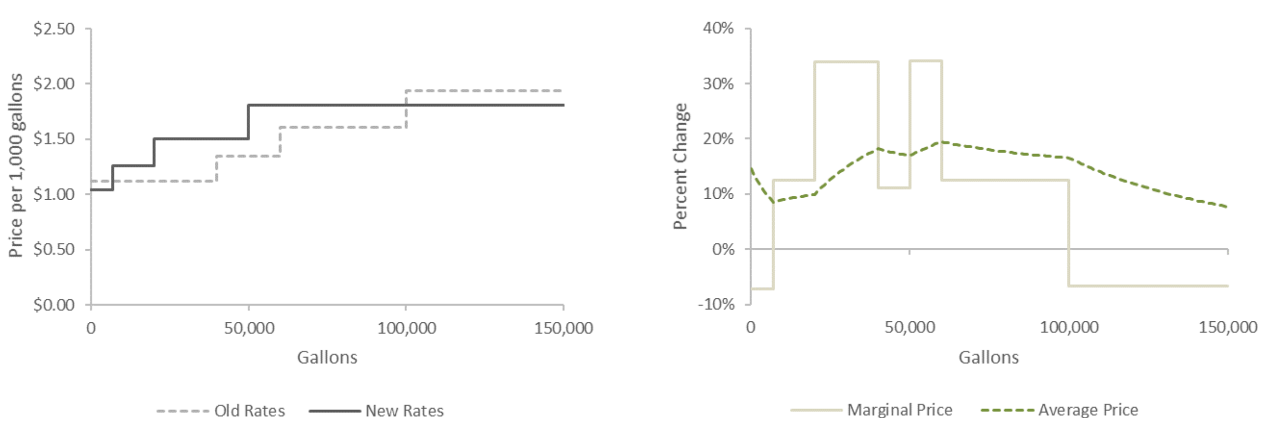

Figure 3: Change in water rate structure for a Utah municipal water provider: old and new rates (left panel) and price change observed by consumers (right panel).

dramatic, with the price paid for the last unit of water increasing over 30%. Further, some high-use consumers actually see a reduction in their marginal price. On the other hand, average price rises consistently around 8-15% across all user types.

To estimate how the rate change will affect consumption, we use the following procedure:

1. Make an assumption about whether consumers respond to marginal price (blocks) or average price.

2. Make an assumption about consumer elasticity of demand. The meta-analysis elasticity of 0.41 is a good starting point, but include higher and lower elasticity estimates as a sensitivity check.

3. Calculate the percent change in per-unit price (average or marginal) at the customer's current use level:
$$Pctg\ Change = \frac{(new\ rate - current\ rate)}{(current\ rate)} \times 100$$

4. Multiply the result from step 3 by the choice of elasticity in step 2 to arrive at the percentage change in water consumption

We follow the above procedure to calculate the expected change in water use of customers of the utility whose rates are shown in Figure 3. To do so, we break users into usage bins, for instance we lump users who consume 10,000-20,000 gallons per month, and then predict the change in water use both for the average price change and marginal price change shown on the right hand side of Figure 3. We assume a -0.41 price elasticity of demand (we used -0.21 and -0.61 as low and high elasticity estimates but do not display the results here). Because all users see an increase in average price, the average price prediction shows decreases in use across all users. Alternatively, some user bins actually see marginal price decreases as a result of the new rates, so the marginal price prediction shows users in those bins increase water use. The rate change in Figure 3 occurred in 2013, and so we are able to observe the accuracy of our simple predictive model. Figure 4 shows usage predictions for both the marginal and average price approaches, as well as the actual change observed in each bin, after controlling for precipitation and temperature. [5] The figure suggests that the rate increases have decreased usage, and predictions based on both marginal and average price changes reflect the pattern of observed actual changes. Using either approach (or both together) provides a low-effort and potentially useful prediction of rate change effects. As a final point, note that the highest-use bin (>160,000 gallons) increased their use after the rate change. These users saw a decrease in the marginal cost of water, and responded by increasing use, as predicted by the marginal cost calculation.

Additional Considerations

There are a number of considerations facing utilities in setting up water rates. We describe three areas of emerging research in the implementation of conservation pricing: political resistance, bill design, and messaging.[6]

Opposition to rate increases is standard for utilities operating in a variety of sectors. Because water utilities are the only game in town, consumers may feel trapped and try to resist rate changes they see as "imposed" on them. Public involvement and education may limit the

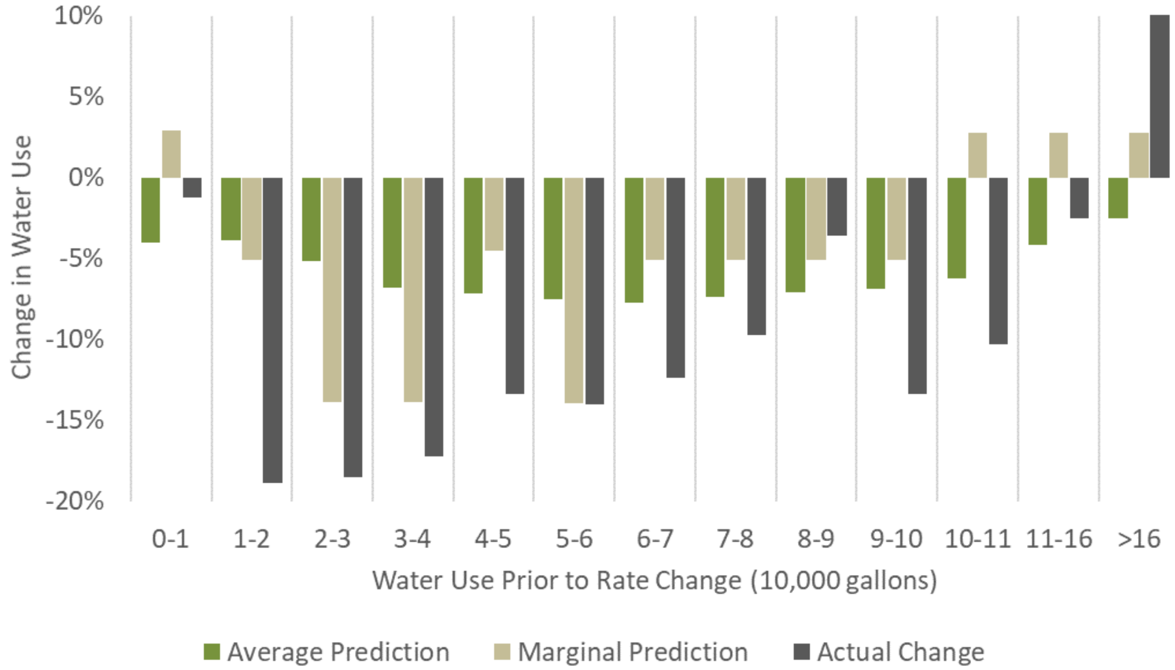

Figure 4: Predicted water usage response to average and marginal price changes plotted alongside actual changes.

amount of political opposition. The Environmental Protection Agency suggests small rate increases over a number of years may be favorable to large, infrequent rate increases in encouraging public support.[7]

We detailed earlier a water bill that failed to convey the underlying conservation pricing information. Because consumers cannot respond to incentives they do not see, conservation pricing will be more effective if the rate structure for water is displayed on every bill. Designing bills to convey marginal price information, often framed to consumers as the value of conserving water, is beneficial in helping them understand how reduced use saves money. Utilities use different billing formats and vendors, so it is important to explore what options are available. Formal or informal surveys of consumers can provide information on how well they interpret the conservation pricing incentives on their water bills.

Finally, consumer water bills offer an opportunity for utilities to convey the value of water beyond price. There is growing evidence that *conservation messaging*, such as inserts or on-bill messages that explain the importance of water stewardship are effective at reducing water consumption. Further, comparisons of a consumer's water use with other households can offer a key, non-price incentive to conserve. Research suggests consumers are strongly motivated to conserve if they know their neighbors use less than they do.

[1] Work on this project was supported by the Utah Extension Water Initiative while Drs. Edwards and Sutherland were in the Department of Applied Economics at Utah State University. Both are now in the Department of Agricultural and Resource Economics at North Carolina State University. Please contact Dr. Edwards (eric.edwards@ncsu.edu) with any questions about this factsheet.

[2] Throughout this factsheet we use data from the 2013 Survey of Drinking Water Systems conducted by the Division of Drinking Water. The survey is sent to all 472 community water systems registered in Utah and received 310 responses. We use 2013 data because this was the last year the survey collected water rate information. Reference: Utah Division of Drinking Water, 2015. 2013 Survey of Drinking Water Systems. Utah Department of Environmental Quality, Division of Drinking Water Report. Available at http://drinkingwater.utah.gov

[3] Utah Division of Water Resources, 2010. Municipal and Industrial Water Use in Utah: "Why do we use so much water when we live in a desert?" Available at http://digitallibrary.utah.gov/awweb/awarchive?type=file&item=39171

[4] Dalhuisen, J.M., Florax, R.J., De Groot, H.L. and Nijkamp, P., 2003. Price and income elasticities of residential water demand: a meta-analysis. Land economics, 79(2), pp.292-308.

[5] We use 12 years of data, 7 years pre-change and 5 years post-change to estimate the change in August consumption using an OLS regression with bin fixed-effects and bin-temperature and bin-precipitation controls. Rates change only slightly in other years and blocks remain constant. Bin is determined by usage the year prior to the change.

[6] Detailed discussion can be found here:

- American Water Works Association, 2017. M1 Principles of Water Rates, Fees and Charges. AWWA, Denver, CO, 417p
- Texas Water Development Board, 2004. Water Conservation Best Management Practices Guide. Texas Water Development Board Report 362. Available at http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R362_BMPGuide.pdf

[7] Environmental Protection Agency, 2006. Setting Small Drinking Water System Rates for a Sustainable Future. EPA 816-R-05-006. Available at https://www.epa.gov/sites/production/files/2015-04/documents/epa816r05006.pdf

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