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Water Resources Planning and Management

Date: June 4, 2012
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Cc: Lorna Stickel, Dave Hasson, Tom Chesnutt
Re: FINAL Task A Technical Memorandum: Preliminary Review of Current and Prior Rate Structures

INTRODUCTION

Since the 2006-07 fiscal year, the City of Portland has had a uniform volumetric retail water rate for all customer classes, which has increased in nominal and real terms each year. Prior to that, between 1995 and April 2006, Portland had a 3-tier increasing block rate structure. This memorandum presents a primarily qualitative discussion of how the two rate structures compare in terms of:¹

- The degree to which they encourage water conservation by customers;
- Their compliance with OAR Division 86 requirements; and
- Their relative administrative costs.

Table 1 compares the current and 2005-06 inside-city retail rates.²

Table 1. Comparison of Current Uniform Rates to 2005-06 Increasing Block Rates

Year		Quarterly Base Charge ³	Commodity Charges (\$/ccf)			Average Rate (\$/ccf) *	
			Average Charge	Block 1	Block 2		Block 3
2005-06	Nominal Dollars	\$8.96	\$1.75	\$1.73	\$1.98	\$2.34	\$2.18
	2011-12 Dollars ⁴	\$10.05	\$1.964	\$1.941	\$2.222	\$2.626	\$2.45
2011-12		\$27.99	\$3.086				\$4.75

* Based on assumed monthly per-account usage of 6.6 ccf in 2005-06 and 5.6 ccf in 2011-12.⁵

The 2005-06 rates for all customers were the same, but the block sizes varied across different classes and customers. The single-family residential (SFR) customer block sizes were as follows:

¹ There may be other benefits and costs of each rate structure that are beyond the purview of this memorandum.

² Qualifying low-income customers receive a fixed bill discount.

³ Beginning in 2007-08, the base charge collected by PWB included both water and sewer.

⁴ The nominal-dollar rates are converted to 2011-12 dollars using the GDP Implicit Price Deflator.

⁵ While average monthly usage estimates are not available for 2005-06 and 2011-12, these figures are respectively the 2006-07 and 2010-11 averages estimated by Hossein Parandvash in *Analysis of Retail Water Consumption by Customer Class: Report Based on Analyses of the Billing and Production Data*. January 2012.

- Block 1: Up to 12 ccf per month
- Block 2: 12-20 ccf per month
- Block 3: Above 20 ccf per month

The blocks for customers in all other classes were based on a 12-month rolling average of each customer's prior consumption. Specifically, the first block for the non-SFR customers included all consumption up to 1.4 times the 12-month average, the second tier was between 1.4 and 2.0 times the average, and the third tier included all usage above 2.0 times the average. In both periods, most customers in all classes were billed quarterly.

While this initial task looks backward to the prior rate structure, the ultimate objective of this study is to look forward and, through more detailed and rigorous analysis, make recommendations regarding whether and how the current rate structure should be modified. That analysis will consider a much wider range of possible criteria (e.g. affordability, revenue impacts, etc.) against which to evaluate alternative rate structures. This memorandum should therefore be seen as setting the stage for that forward-looking analysis.

USING PRICE TO ENCOURAGE WATER CONSERVATION

Customer water consumption is influenced by a variety of factors, only one of which is price. Other factors include, but are not limited to:

- Codes governing water-using fixtures
- Weather
- Utility-sponsored conservation programs
- Local ordinances
- Supply restrictions due to drought or other events
- Economic conditions
- Changing ethics and values
- Land use regulations

There has been a large amount of empirical research into how water customers respond to changes in price. The literature has addressed several potential rate-related variables that might affect consumption:

Price level

If the price a customer pays for any commodity increases, demand will change (typically decrease) according to the customer's price elasticity for that commodity. The real price elasticity is defined as the percentage change in usage for each percent increase in real price. For example, an elasticity of -0.2 means that each 1% increase in real price results in a 0.2% decrease in usage. Demand is said to be elastic if the absolute value of the price elasticity exceeds 1; if the absolute value of the price elasticity is less than 1, the demand for that particular good is said to be inelastic.

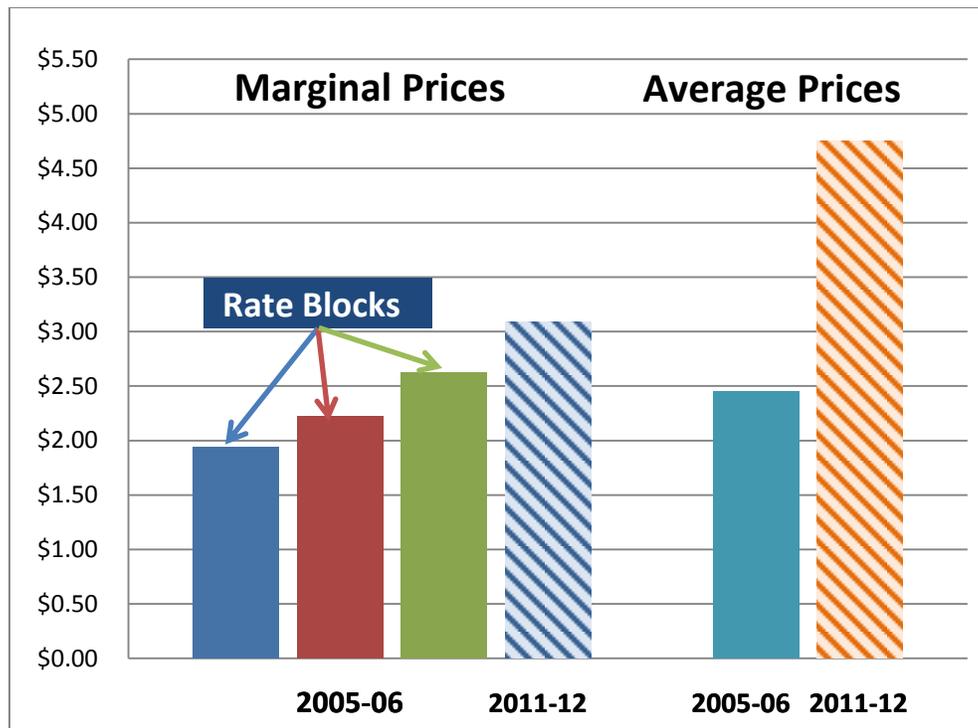
Generally speaking, most studies have concluded that water demands do, in fact, decrease in response to real price increases. These responses vary considerably among customers, are higher in the long-term than the short-term, and vary seasonally. Researchers have typically concluded that these impacts are

small (i.e. water demand is price inelastic). The issue of price elasticity will be addressed in more detail in subsequent tasks of this project.

What is less clear, particularly with regard to more complex rate structures, is whether water customers respond to average or marginal price. The average price paid by any customer in a billing period is simply the quotient of the customer’s total water bill and the number of units consumed. These are shown for typical SFR customers in the final column of Table 1. The marginal price is the variable cost paid for the last unit consumed.

Figure 1 compares these average and marginal prices in the two periods.

Figure 1. Comparison of 2005-06 and 2011-12 Marginal and Average SFR Prices (2011-12 \$/ccf)



Economic theory tells us that an informed customer will base his/her consumption decisions on the marginal price. For water customers facing complex rate structures (e.g. fixed as well as variable costs, multiple rate blocks, seasonal variation, etc.) it is not clear whether customer price response is primarily driven by marginal or by average price (or by some other price parameter(s)).

Rate structure

Apart from the “height” of the rates, i.e. the magnitude of the price facing a customer, does the rate structure “shape” independently influence consumption? For instance, if a hypothetical customer faced a price (marginal or average) under a uniform rate structure of, say, \$3.00/ccf, and the rate structure was subsequently modified, but this customer’s price remained at \$3.00/ccf, would the change in “shape” of the rate structure encourage that customer to reduce his/her consumption? Further, would that customer’s response to future price increases differ under the two rate structures?

This is a difficult question to answer and there have not been many empirical studies of this issue. A recent study by Olmstead et al. that did specifically address this issue was unable to detect an independent effect of “shape”.⁶ One of the co-authors of this paper has reached the following conclusion:

Many water utilities that have implemented [increasing block rates] consider them part of their approach to water conservation; and many state agencies and other entities recommend them as water conservation tools. But analysis indicates that increasing-block prices, *per se*, have no impact on the quantity of water demanded, controlling for price levels.⁷

Combined bills

Like many other jurisdictions, Portland issues combined bills for water and sewer/stormwater services. Arguably, the larger bill and higher effective prices that result from combining the water and sewer charges provide customers a large incentive to conserve. The combined bill has been an issue with Portland’s ratepayers and is believed by many to have contributed to the unprecedented decreases in overall and per customer water use in the past 20 years. However, the question that is relevant to this study is how and whether embedding the water charges in a larger overall bill affects the signals provided by the water rates. Once again, there is little research on this question. A recent study that does explicitly test for impacts of combined bills on responsiveness to variations in water price was unable to find a significant impact.⁸

Billing frequency

The vast majority of Portland water customers are billed quarterly. It is often assumed that less frequent bills result in a lesser customer price response. According to Worthington and Hoffman:

The theoretical argument is that households [that are billed more frequently] are more aware of the impact on income of large bills and these can potentially reduce water consumption in subsequent periods. Frequent billing also reminds consumers more frequently of the fact that water costs. On the other hand, less frequent billing does not afford the opportunity for households to quickly adjust consumption in light of these larger bills.⁹

But Gaudin points out that:

Two opposite forces could be at play: on the one hand, frequent bills are a reminder that water is not free and may create a better understanding on the part of consumers of the price structure and the relation between consumption and cost, increasing price elasticity; on the

⁶ Olmstead, Sheila M., Hanemann, W. Michael & Stavins, Robert N., 2005. "Do Consumers React to the Shape of Supply? Water Demand under Heterogeneous Price Structures," Discussion Paper 05-29, Resources For the Future.

⁷ Stavins, Robert N. "Misconceptions About Water Pricing," Harvard University, Belfer Center for Science and International Affairs. Posted March 14, 2009.

⁸ Gaudin, Sylvestre, "Effect of Price Information on Residential Water Demand," 2006, *Applied Economics*, 38, pp. 383-93.

⁹ Worthington, A.C., and Hoffman, M., 2006. "A State of the Art Review of Residential Water Demand Modeling," University of Wollongong, School of Accounting and Finance Working Paper Series No. 06/27.

other hand, more frequent billing causes smaller overall bills, which would dampen price elasticity.¹⁰

The few studies that have looked at the question have failed to find a significant relationship between billing frequency and customer demand.¹¹

Understanding of price

As reported by Klein et al.¹² a 1992 Georgia survey of some 400 water customers found that “slightly more than 60 percent were aware of what they paid on average; however, only twelve people indicated that they knew their water rate (and eight were wrong).” This study also reported on a 2005 survey in Florida in which “households were asked whether they knew the marginal and averages prices they faced. Only 6 percent of those surveyed reported that they knew the price.” Moreover, the results of this survey “suggest that (a) households facing increasing block rate structures are less likely to know the price of water, and (b) customers who indicated that they knew the price of water were two to five times more responsive to changes in price and also, on average, used more water.”¹³

The results seem to indicate that customers facing a more complex increasing-block rate structure have less understanding of what they are paying, and this lower level of understanding appears to lead to less responsiveness to price signals. While this is intuitively appealing, the fact that the customers who were most knowledgeable about their water prices also tended to be larger water consumers may indicate that their awareness of their rates, and their price responsiveness, were due at least in part to their higher water bills rather than to the rate structure.¹⁴ This multiplicity of causation illustrates the difficulty in reaching firm conclusions on the determinants of price responsiveness.

The degree to which customers understand their water rates can also be influenced by the content of the water bill. Gaudin¹⁵ found that price elasticity increases by 30% or more when particular kinds of price information are presented on the bill.

CONSERVATION INCENTIVES OF PORTLAND RATE STRUCTURES

We can apply the foregoing research findings to assess the relative conservation incentive provided by the current uniform and the past increasing-block rate structures in Portland.

¹⁰ Gaudin, op. cit.

¹¹ See, for example, Gaudin, op. cit. and Stevens, T.H., Miller, J. and Willis, C., 1992. “Effect of price structure on residential water demand”. Water Resources Bulletin 28: 681–685.

¹² Klein, Bobbie; Kenney, Doug; Lowrey, Jessica; and Goemans, Chris, 2007. “Factors Influencing Residential Water Demand: A Review of the Literature (Updated 1/12/07),” University of Colorado, Western Water Assessment. p. 9.

¹³ Ibid. pp. 10-11.

¹⁴ It could also be due to other customer characteristics such as, for instance, education levels.

¹⁵ Gaudin, 2006, op. cit.

Price level

Figure 1 above shows that, for all customers, the current uniform commodity charge is higher in real-dollar terms than the 2005-06 marginal rate, regardless of usage block. It also shows that the current average rate for an SFR customer with average monthly usage is higher than its 2005-06 counterpart. This is the case at all usage levels, i.e. the current average price exceeds the 2005-06 average price for all customers. This suggests that, regardless of the assumed magnitude of the price elasticity, and regardless of whether usage responds to the marginal or average rate, the current rate structure provides all customers with a greater conservation incentive than the 2005-06 block rates.¹⁶

In addition, for non-SFR customers, the basing of block size on prior usage attenuated the incentive to conserve since higher consumption resulted in larger first and second blocks.

Rate structure

Aside from the magnitude of the rates, the other major factor that differs between 2005-06 and 2011-12 is the rate structure. However, as discussed above, the extant research provides little basis for concluding that this structural difference will itself affect consumption decisions beyond the effects of the rate levels.

Combined bills

In both periods, water and sewer charges were combined in a single bill. The current sanitary sewer commodity charge for residential customers is a uniform \$7.63 per ccf of average winter usage.¹⁷ Bills also include a fixed monthly stormwater management charge.

For many, if not most, customers, the sewer and stormwater charges currently comprise a much larger portion of the combined bill than the water charges. Thus, the current average SFR monthly water bill is estimated to be about \$24, while the sewer/stormwater bill is \$57. The water charges thus comprise about 30% of the total bill.

The disparity between the two bill components was even larger in 2005-06.¹⁸ In that year, the average monthly SFR water bill was between \$14 and \$15. The average sewer/stormwater bill was \$43. The water charges therefore comprised about 25% of the bill.

The difference in the fraction of the total bill that is due to water charges might affect the conservation signals provided by water rates. Despite the fact that the literature suggests that combined billing does not significantly affect those signals, we might hypothesize that the fact that water charges in Portland are a larger portion of the total bill now than they were in 2005-06 might increase the attention paid by customers to the water portion of their bill and thus enhance price signals. There is no empirical evidence to support this hypothesis. To the extent that it has any validity, the effect is likely to be small.

¹⁶ This is true as well for all prior block rates at least back to 2000-01.

¹⁷ This figure includes \$.09/ccf for the Portland Harbor Superfund charge.

¹⁸ The average SFR water bill increased by 64% between 2005-06 and 2011-12. The comparable figure for SFR sewer/stormwater bills is 32%. The more rapid growth of the water bill is partly explained by the assignment in 2007-08 of the sewer customer service charge to water.

Billing frequency

The research does not support any systematic impact of billing frequency on price signals. In any event, in both periods, most water customers were billed quarterly.

Understanding of price

The survey results reported above may provide some indication that water customers facing increasing-block rates generally do not understand their rates as well and thus presumably are less responsive to price signals. To the degree that this is so, the efficacy of the current rates in encouraging conservation will be increased relative to the earlier increasing block rates.

Conclusion

The most reasonable conclusion is that, to the extent that the demands of Portland water customers are sensitive to price, the current rate structure provides a greater conservation incentive than the prior increasing block rates. While there are some rather speculative factors that may contribute in a small way to this conclusion, the overriding cause is the fact that, for all customers, real marginal and average water prices in 2011-12 are greater than those in 2005-06.

OAR DIVISION 86 REQUIREMENTS

Oregon Administrative Rules (OAR) Section 690-086-0150(4)(d) requires that all water providers implement:

A rate structure under which customers' bills are based, at least in part, on the quantity of water metered at the service connections.

Both the 2005-06 and the 2011-12 rate structures comply with that requirement.

In addition, OAR Section 690-086-0150(6)(d) requires either:

Adoption of rate structures, billing schedules, and other associated programs that support and encourage water conservation; OR

Documentation showing that implementation of [such a rate structure] is neither feasible nor appropriate for ensuring the efficient use of water and the prevention of waste

This requirement must be seen in more relative than absolute terms. Some rates provide a greater or lesser conservation incentive than others. As the foregoing discussion shows, it is often difficult to determine whether one set of rates or another provides a superior conservation incentive. But as concluded above, it appears likely that the current rates and billing schedule encourage customer conservation more than the earlier rates under the increasing-block structure, and therefore are in greater compliance with this requirement.

ADMINISTRATIVE COSTS

There is no data available regarding PWB's costs to administer the earlier increasing block rates or the current uniform rate, and there is little if any research on the relative administrative costs associated with different water rate structures. Nevertheless, it is safe to assume that a more complex rate

structure such as an increasing block rate is at least as expensive to administer as the Bureau's current uniform rate, and would likely be more expensive. This is even more true where, as was the case in Portland, the block sizes for some customers were based on their individual usage histories.

Functions for which administrative costs for an increasing block rate may be higher include:

- Rate setting. Designing increasing block rates that are consistent with accepted cost-of-service principles, address multiple financial objectives, are seen as equitable, and are sensitive to local concerns is likely to incur higher costs for both labor and non-labor analytical resources, in part to adequately track and analyze the necessary cost and usage data.
- Billing. The costs of developing systems that reliably produce accurate and informative bills in a timely fashion are likely to be higher for more complex, more-individualized rate structures. It is also possible that the ongoing production and transmission of the bills themselves will be more costly.
- Customer and stakeholder support. A more complex rate structure may require more staff time to effectively communicate its features in order to ensure that customers understand their bills and to answer other inquiries that are likely to arise.

SUMMARY

- The relative magnitudes of the marginal and average prices seen by customers in 2005-06 and 2011-12 likely result in the current uniform rates providing a greater conservation incentive than the previous increasing-block rates.
- There is little evidence that, assuming equivalent average or marginal rates, the difference in rate structure itself materially affects the conservation incentive.
- The fact that the water charges are currently a somewhat larger portion of the combined bill than in 2005-06 may slightly enhance the price signals transmitted to customers.
- To the extent that an increasing-block structure results in a lesser understanding by customers of their water rates, the conservation incentive of the current uniform rates may be enhanced relative to the earlier increasing block rates. This effect, if it exists at all, is also likely to be small.
- Both rate structures comply with OAR 690-086-0150(4)(d) regarding volumetric rates. The current rate structure appears to do a better job at complying with OAR 690-086-0150(6)(d) regarding rates that support and encourage water conservation.
- While comparative cost data is unavailable, it is at least plausible that the current uniform rate is less costly to administer than the prior increasing block rate.