POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
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From: M.Cubed
To: Marcia Tobin
Cc: Richard McCann, Leslie Dumas

Re: Addendum to Shortage Cost TM

Introduction

EBMUD has requested that analysis of water shortage costs in WSMP 2040 include information on potential impacts to business output, income, and employment. It has also expressed concern that the proposed methodology for estimating direct shortage costs presented in M.Cubed's October 18, 2007 TM and illustrated in the document entitled "Order-of-Magnitude Estimate of EBMUD System-Wide Shortage Cost" will understate customer shortage costs. This memorandum addresses both issues.

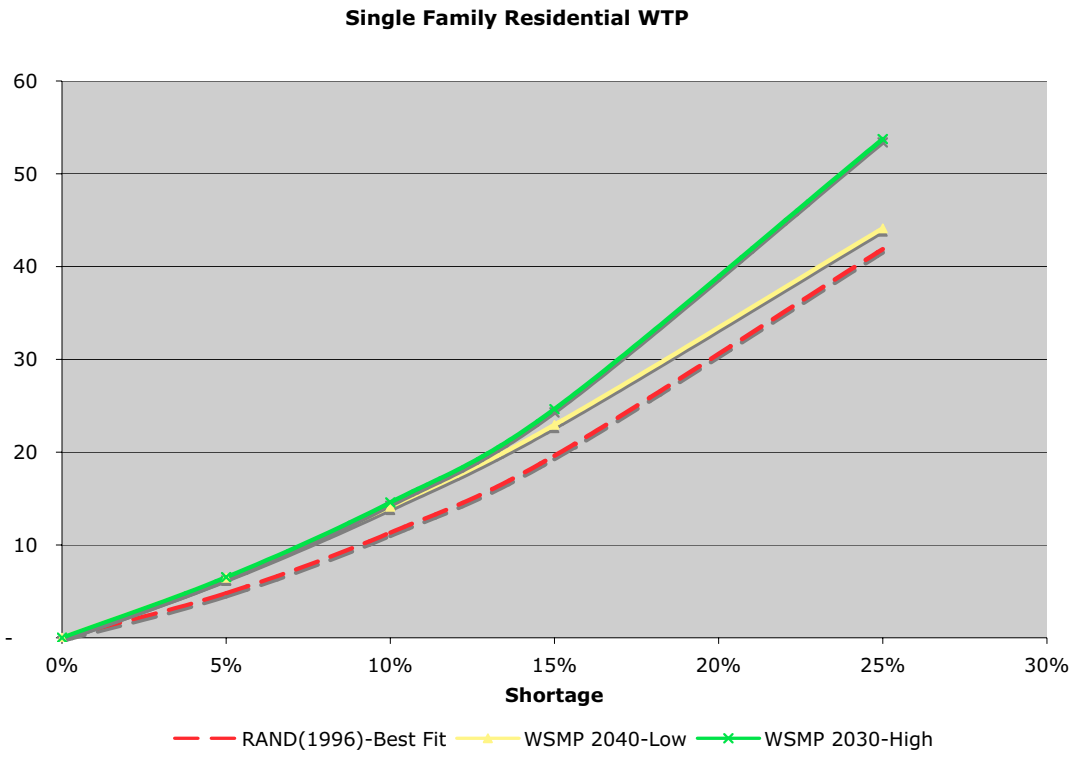
Magnitude of Direct Economic Impacts

RAND (1996) estimated demand functions for single family residential accounts served by the Alameda County Water District and used them to estimate the direct economic impacts of water shortages to this customer class for the period July 1991 to June 1992. This study provides the most comprehensive and rigorous statistical study of the economic impacts of the 1987-1992 drought of which we are aware. The statistical models were estimated using 10 years of bi-monthly consumption data for a randomized sample of 599 single-family accounts. Consumption and price data were combined with data on house size,

lot size, precipitation, temperature and other variables that drive household water use.

The direct economic impact derived from the demand function estimated for single-family accounts was compared to our preliminary estimates to determine if they were of similar order of magnitude. The results are shown in Figure 1. The estimates are similar in magnitude, though our preliminary estimates are approximately 5% to 35% higher for shortages in the range of 15% to 25%. The results suggest that the proposed methodology to estimate direct shortage costs to customers are consistent with empirical findings from California's last major drought cycle.

Figure 1



Estimating Impacts to Business Output, Income, and Employment

We have reviewed six studies that have estimated or examined the impact of water shortages on business activity. These studies were as follows:

- Spectrum Economics (1991). "Cost of Industrial Water Shortages: Preliminary Observations." Hereafter referred to as Spectrum(1991).
- Center for Regional Economy (2006). "East Bay Water Sources and a Pilot Study of User Response to a Potential Supply Disruption." Hereafter referred to as St. Mary's(2006).
- San Francisco Public Utilities Commission (2007). "Measures to Reduce the Economic Impacts of a Drought-Induced Water Shortage in the SF Bay Area." Hereafter referred to as SFPUC(2007).
- MHB Consultants, Inc. (1994). "The Economic Impact of Water Delivery Reductions on the San Francisco Water Department's Commercial and Industrial Customers." Hereafter referred to as MHB(1994). SFPUC(2007) utilized some of the results from MHB(1994) in its analysis.
- Brozovic, Nicholas, et al. (2006). "Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events." Hereafter referred to as Brozovic(2006).
- RAND (1996). "Drought Management Policies and Economic Effects in Urban Areas of California, 1987-1992."

The underlying data used for Spectrum(1991) is at least 20 years out of date (1987 base data and older industrial water use data from 1979). It also looks at only a 30% reduction scenario for a year, and respondents were told to ignore any measures they had instituted for the then-current drought (in 1990). This survey was primarily looking at impacts from permanent changes in Delta pumping requirements, not drought planning. The results are not directly applicable for the WSMP 2040.

St. Mary's(2006) attempted to update the Spectrum(1991) study. It added four scenarios, of which two or three are applicable to the WSMP, with 15% and 35% reductions for 6 months and 3 years. Unfortunately the report provides only a qualitative discussion of potential impacts. The study's author reported they received only a handful of survey responses and were unable to conduct any analysis. As a result this report is not usable for estimating shortage costs.

SFPUC(2007) and MHB(1994) estimated changes in output and payroll using output and payroll elasticities derived from survey responses from SFPUC industrial and commercial customers. Elasticities for aggregated commercial water use and aggregated industrial water use were estimated. Elasticities for specific industries or business were not estimated. The elasticities estimate the percentage change in output (or payroll) for a one percent reduction in water supply to the industry and can be used to estimate impacts of water shortage on output and payroll.

Brozovic(2006) estimated business output responses to reductions in water supply using estimates of business sector resiliency. The methodology closely follows that of Chang, et al. (2002), but employs a more refined business output response function. The resiliency factors used by Brozovic(2006), however, were taken directly from Chang et al. (2002). The business resiliency factors in Chang et al. (2002) were estimated with data from the 1994 Northridge and 1995 Kobe earthquakes. Resiliency factors were estimated at the 2-digit NAICS level of industrial classification, thus enabling more disaggregated impact estimates than SFPUC(2007). The output resiliency functions can be used to estimate impacts of water shortage on output.

The methods used by SFPUC(2007) and Brozovic(2006) are easily transferable to WSMP 2040 using data on business output (sales) and payroll from the 2002 Economic Census. This data is available for all cities and towns served by EBMUD, except Alamo, Castro Valley, Crockett, El Sobrante, Kensington, Rodeo, and Selby. These are small communities relative to other cities served by EBMUD, and excluding them is not expected to significantly bias results.

Using the 2002 Economic Census data will allow for impacts to be geographically disaggregated by city or by broader regions, such as West of Hills and East of Hills.

However, the change in output is not a good measure of regional impact because it does not account for imports of factors of production and intermediate goods into the region. Value-added, defined as the sum of regional labor, proprietor, and other income plus indirect business taxes, provides a better measure of regional impact. Value-added is the basis for the familiar gross domestic product (GDP) and gross state product (GSP) often reported in the press as a measure of national and state economic growth. We will be reporting a change in the business sector for the gross "regional" product (GRP) with this method. Changes in output can be converted into changes in value-added or GRP using Input-Output multipliers from a regional I-O model package such as IMPLAN. Likewise, changes in payroll can be combined with employment data from the 2002 Economic Census to roughly estimate changes in employment.

Figure 2 shows the percent reduction in baseline output for increasing levels of water shortage using the SFPUC(2007) and Brozovic(2006) methods. Commercial and industrial impact estimates under Brozovic(2006) are very similar, so only one curve is presented. Figure 3 shows the percent reduction in baseline payroll for increasing levels of water shortage using the SFPUC(2007) method. Table 1 shows payroll losses (millions of 2002 dollars)[1] for East of Hills and West of Hills for increasing levels of water shortage using the SFPUC(2007) method. Note that the shortage levels in the figures and table refer to the sector rather than the system-wide shortage. This is important to keep in mind since system-wide shortages may not be allocated proportionally across water customer classes.

[1] For the WSMP analysis, this will be converted to 2007 dollars using a GDP deflator.

Figure 2

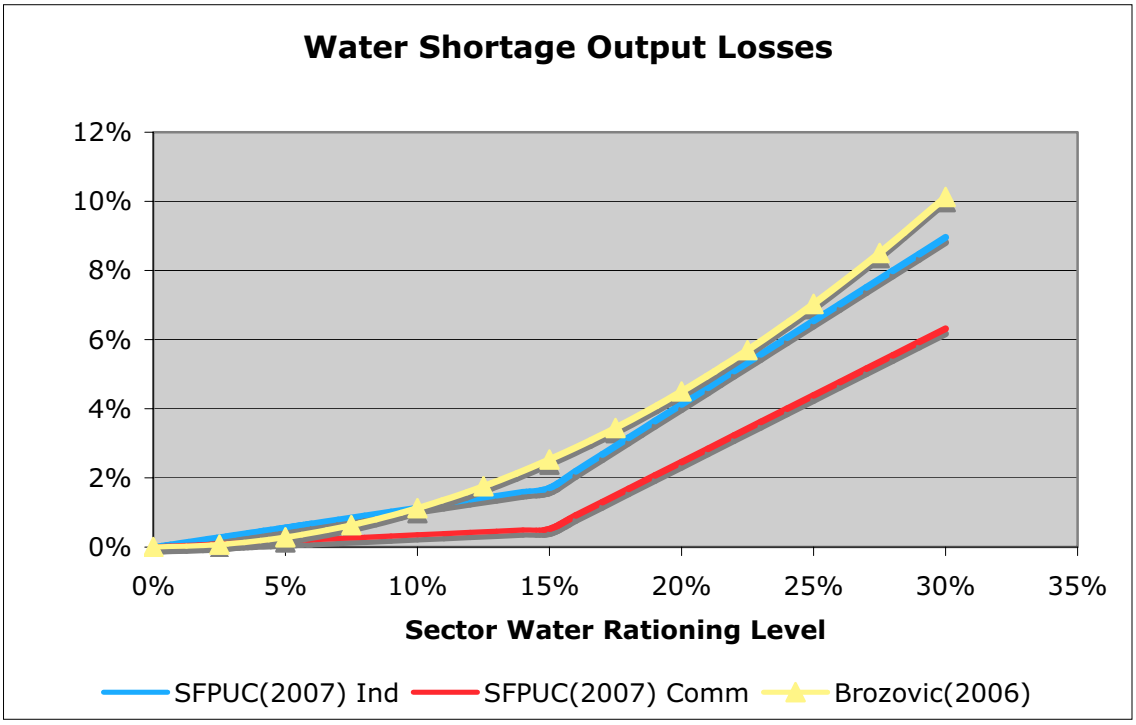


Figure 3

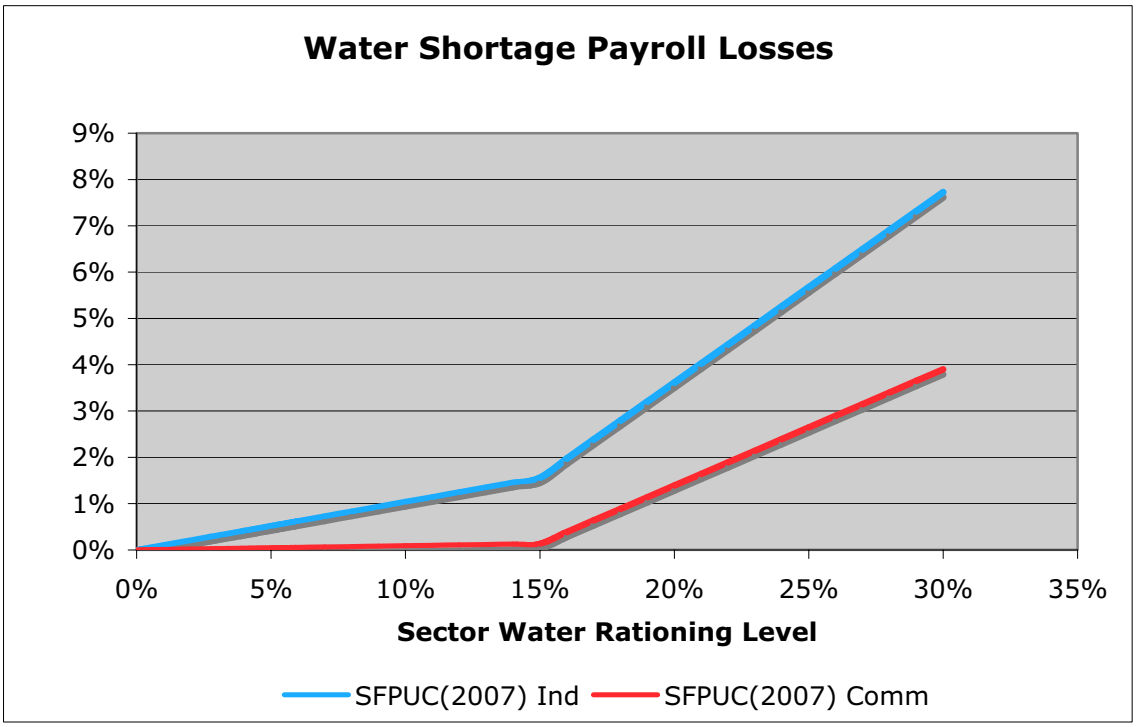


Table 1. Estimated Annual Payroll Impacts (Millions of 2002 $), SFPUC(2007) Method

	West of Hills			East of Hills		
Sector Shortage Level	Industrial	Commercial	Total	Industrial	Commercial	Total
5%	$10.6	$4.6	$15.2	$0.7	$1.8	$2.5
10%	$21.2	$9.2	$30.4	$1.4	$3.5	$4.9
15%	$31.9	$13.8	$45.6	$2.1	$5.3	$7.4
20%	$73.8	$141.7	$215.5	$4.8	$54.6	$59.4
25%	$115.8	$269.6	$385.4	$7.5	$103.9	$111.4

Industrial and Commercial Payroll: 1987-1991

RAND (1996) examined industrial and commercial water use over the period 1987-1991. As hypothesized by the SFPUC(2007) and Brozovic(2006) models, the study found a positive correlation between industrial water use and industrial payroll during the drought, shown in Figure 4, though changes in payroll were much less than proportional to changes in water use. Additionally, the latter part of the drought coincided with a broad economic recession, which also negatively impacted industrial payroll. While industrial water use in 1991 decreased by about 15% from the previous year, industrial payroll decreased by only 4%; however, most of this decrease probably was due to the economic recession as U.S. manufacturing employment decreased 3.5% in 1991.[2] The SFPUC(2007) model estimates that industrial payroll would decrease by 1.6% given a 15% reduction in industrial water use. Given that most of the decrease in industrial payroll between 1990 and 1991 probably was attributable to the recession, this estimate appears plausible.

The SFPUC(2007) predicts negligible impacts to commercial payroll for shortages of up to 15% and this appears consistent with changes in commercial payroll observed between 1987 and 1990 (Figure 5). During this period, while commercial water use decreased by about 4% from its 1986 level, commercial

[2] U.S. Census Bureau, *Statistical Abstract of the United States, 1993*, Table No. 647.

payroll continued to grow. Between 1990 and 1991 commercial water use fell by about 11% while commercial payroll decreased by about 2.6%. As with industrial payroll, given that the economic recession may account for much or most of this decrease the SFPUC(2007) payroll impact estimates appear plausible.

Figure 4

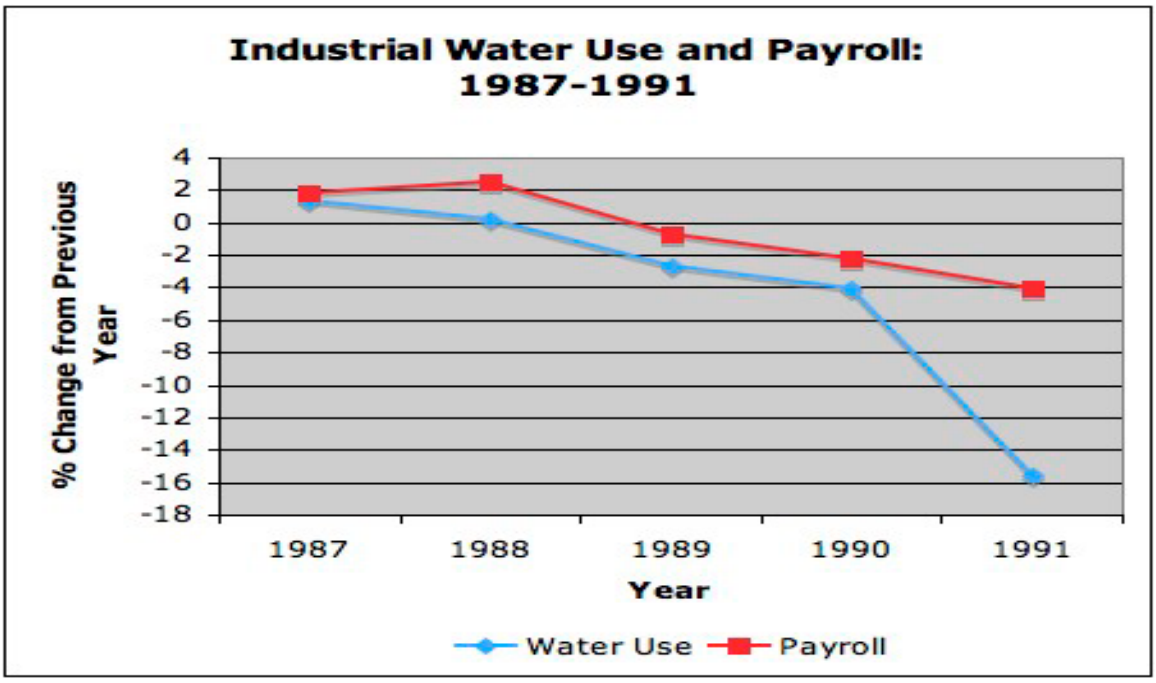
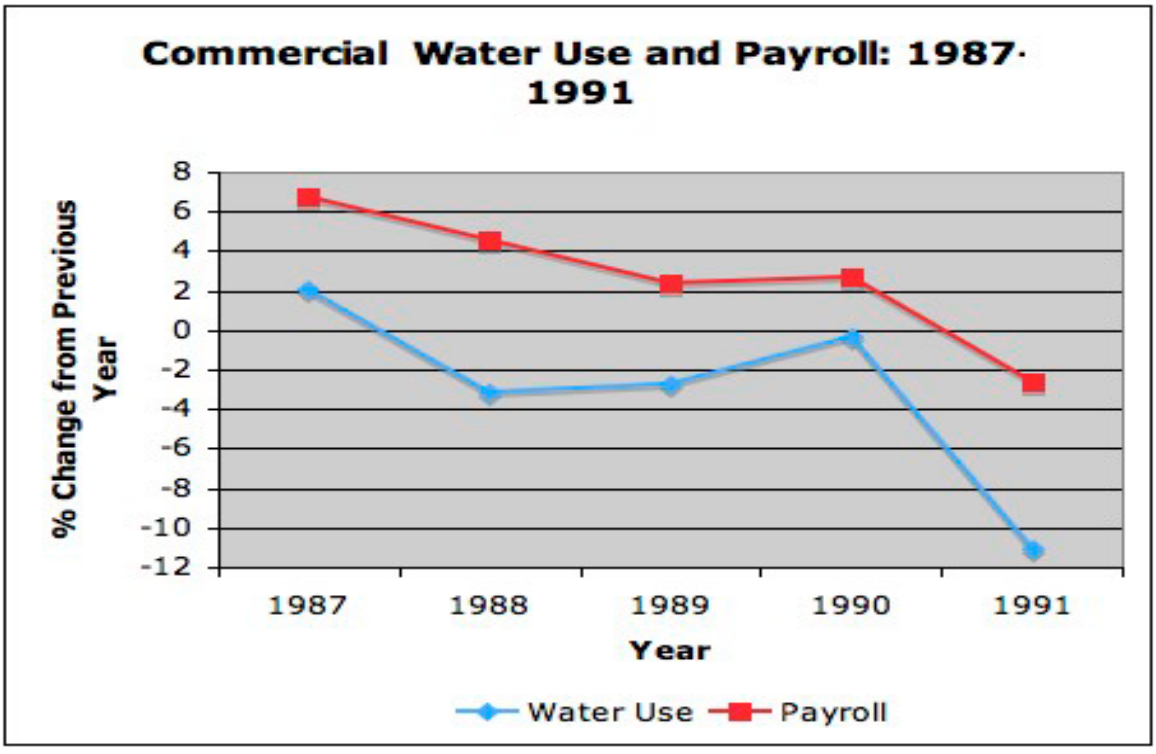


Figure 5



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