EDAW Inc
150 Chestnut Street, San Francisco, California 94111
T 415.955.2800 F 415.788.4875 www.edaw.com

Memorandum

Date:	March 14, 2008
To:	Mike Tognolini & Alex Coate EBMUD
From:	EDAW Team, led by M.Cubed
Subject:	Cost of Water Shortage

Distribution: Tom Francis (EBMUD), David Blau (EDAW), Dave Richardson (RMC), Leslie Dumas (RMC), Richard McCann (M.Cubed)

For your review and comment, we present the results of the requested evaluation of the projected costs of system-wide rationing levels of 10%, 15%, & 25% for 6 customer classes (single-family residential, multifamily residential, commercial, industrial, institutional, and irrigation). Based on your comments, we intend to present this information at the Board workshop on 3/25/08.

Approach

For residential, institutional & dedicated irrigation customer classes, shortage costs are measured in terms of lost consumer surplus. This is the original demand integration method we proposed for estimating shortage costs. This method was used by RAND to estimate the shortage costs for Alameda County Water District resulting from the 1987-92 drought. The RAND results are similar in magnitude to the findings here. More information on the RAND study and results is presented at the end of this memo along with information on the studies that we reviewed and applicability of those studies to this evaluation.

For the commercial and industrial customer classes, shortage costs are based on lost regional value added (which equals lost labor income, proprietor income, property income, profits, and indirect business taxes).

This hybrid approach is the same one used by Brozovic, et al. for SFPUC.

Shortage costs are based on Conservation Level A. Higher levels of conservation would reduce shortage costs by a small amount and therefore, we have presented the highest cost of the options. Shortage cost estimates for the institutional customer class may change once we have received the updated conservation allocation from EBMUD (this is another reason that we based the shortage costs on Conservation Level A).

Water Shortage Costs by Rationing Level, 2040 Level of Development

Table 1: Customer Class Water Shortages and Water Shortage Costs, 2040 Level of Development

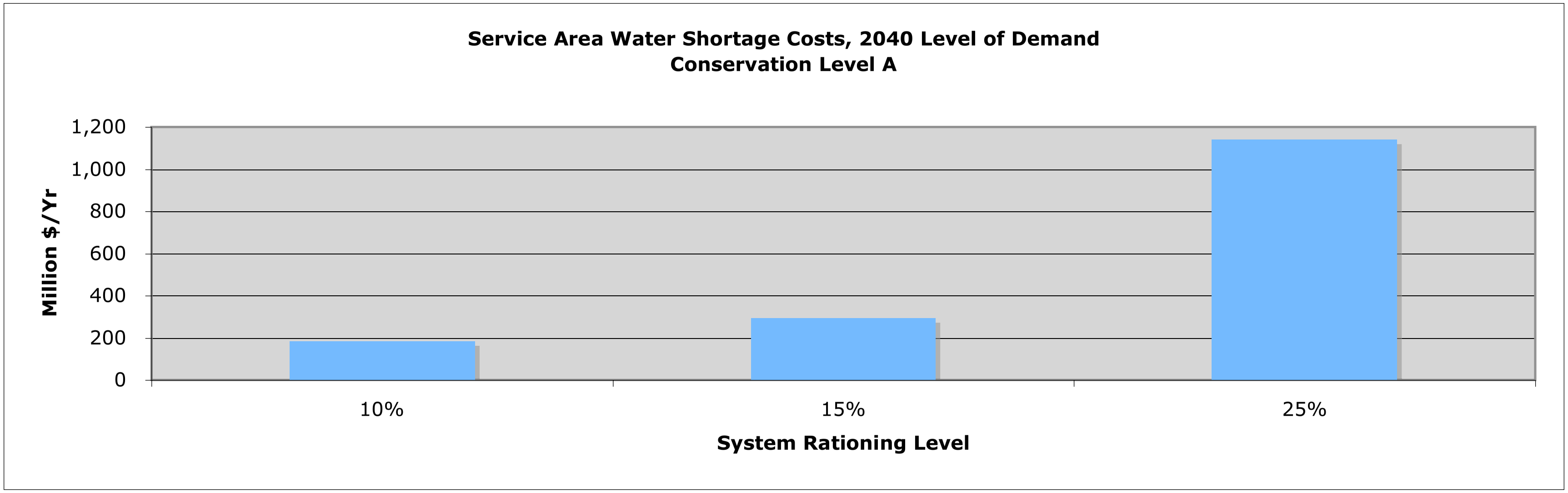
	Water Shortage Cost **		
	Mil. $ Per Yr. of Shortage		
Rationing Level	**10%**	**15%**	**25%**
Single Family	24.2	47.5	150.7
Multi Family	6.4	12.1	34.2
Commercial	94.5	142.3	786.2
Industrial	57.7	86.8	145.1
Institutional	0.5	0.8	1.7
Irrigation	2.6	5.6	24.6
Total	186.0	295.1	1,142.5

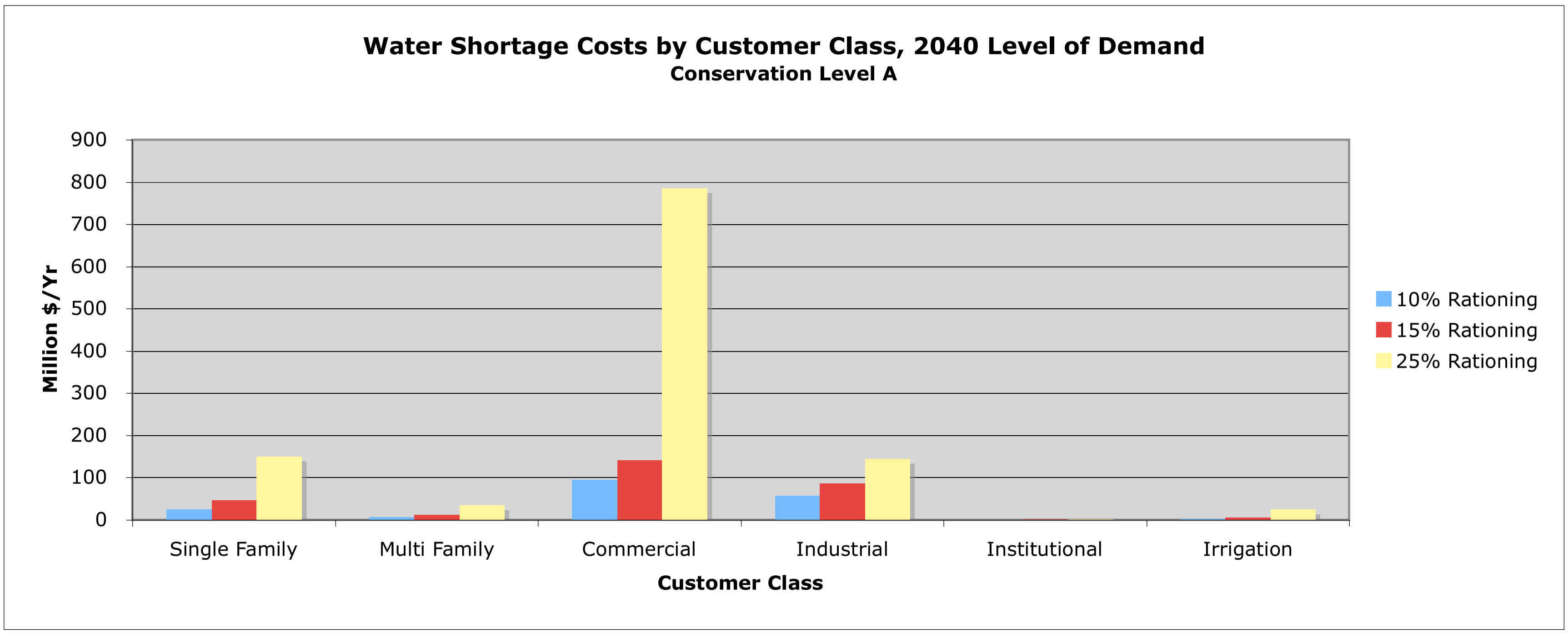
** Shortage costs calculated assuming Conservation Level A.
Water shortage cost = consumer surplus losses for residential, institutional, and irrigation customer classes plus regional value added losses for commercial and industrial customer classes. Regional value added losses equal the sum of losses to labor income, proprietor income, profits and property income, and indirect business taxes.

Table 2: Regional Economic Impacts Per Year of Water Shortage, 2040 Level of Development

	Rationing Level: 10%			Rationing Level: 15%			Rationing Level: 25%		
Economic Indicator	Comm.	Ind.	Total	Com.	Ind.	Total	Com.	Ind.	Total
Employment, Jobs	318	472	790	479	710	1,188	5,745	1,186	6,931
Payroll, Mil. $	16.2	33.0	49.2	24.4	49.7	74.1	292.8	83.0	375.8
Value Added, Mil. $	94.5	57.7	152.2	142.3	86.8	229.1	786.2	145.1	931.3
Output, Mil. $	131.2	147.4	278.6	197.5	221.8	419.3	1,091.0	370.7	1,461.7

EBMUD WSMP 2040





EDAW Inc
150 Chestnut Street, San Francisco, California 94111
T 415.955.2800 F 415.788.4875 www.edaw.com

RAND Study

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.

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).

EDAW Inc
150 Chestnut Street, San Francisco, California 94111
T 415.955.2800 F 415.788.4875 www.edaw.com

- 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

EDAW Inc
150 Chestnut Street, San Francisco, California 94111
T 415.955.2800 F 415.788.4875 www.edaw.com

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.