APPENDIX F. WATER AND WASTEWATER PRICES

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APPENDIX F. WATER AND WASTEWATER PRICES

F.1 SOURCE OF INFORMATION

This appendix documents the methodology for estimating escalation rates of water and wastewater prices.

The escalation of water and wastewater disposal costs, i.e., the rate at which water and wastewater prices are changing, was determined through an examination of trends in historical prices. The earliest historical data with both water and wastewater prices are from a survey commissioned by Ernst and Young in 1986.[1] A similar survey was conducted in 1998 by Raftelis[2] These surveys for urban households include the fixed or minimum charge, water charge, and wastewater charge for 10 ccf[a] of water consumption. See Figure F.1 for the locations of the cities used.

[a] ccf = hundreds of cubic feet (cu. ft. x 7.48 = U.S. gallons)

Figure F.1 Location of 38 Cities Used for Determining Price Escalation

LBNL had four criteria in composing the data set:

1. The same utilities were used for each year that data was available.
2. Information on fixed charges was important to calculate a marginal price for water and wastewater. The fixed charges were subtracted from the bill for 10 ccf to get an approximate marginal price.
3. Both water and wastewater pricing for 10 ccf was needed for consistency between data sets.
4. The population served by the utility determined the weighting used.

Figures F.2 and F.3 below show the distribution of price escalation rates for water and wastewater and water-only cases.

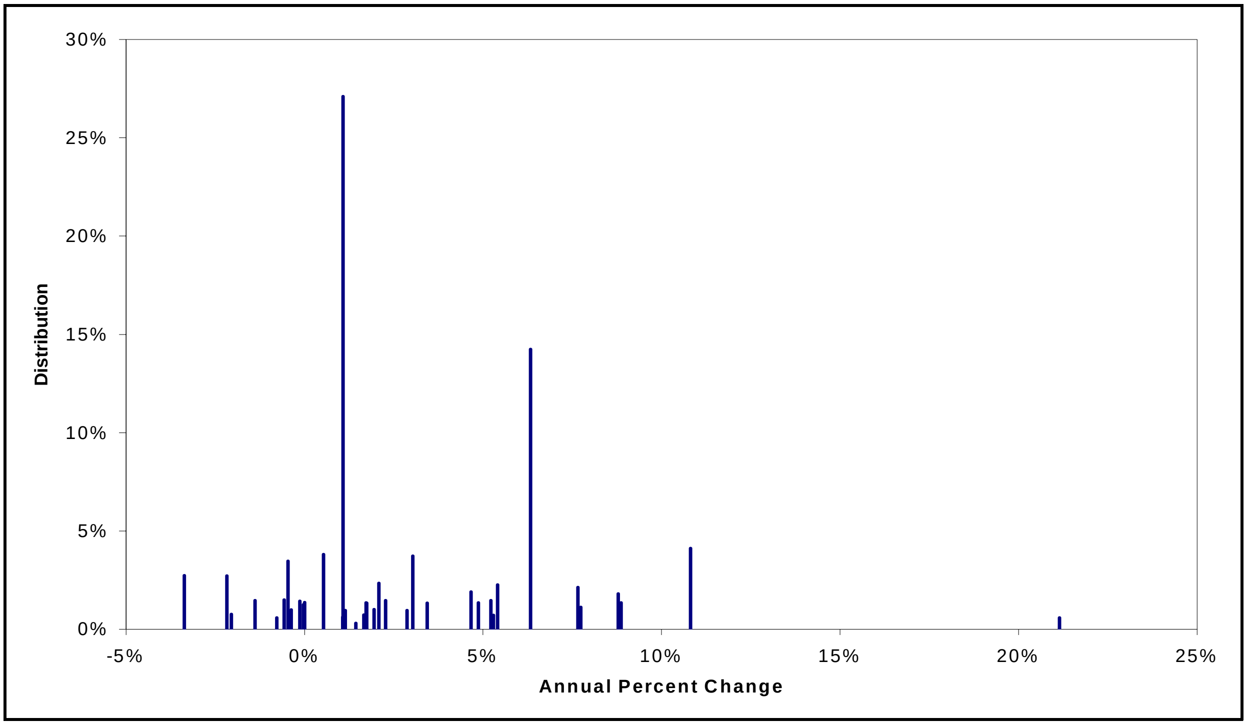

Figure F.2 Annual Percent Change in Water & Wastewater Prices for 38 Cities (from 1986-1998, in 1997$)

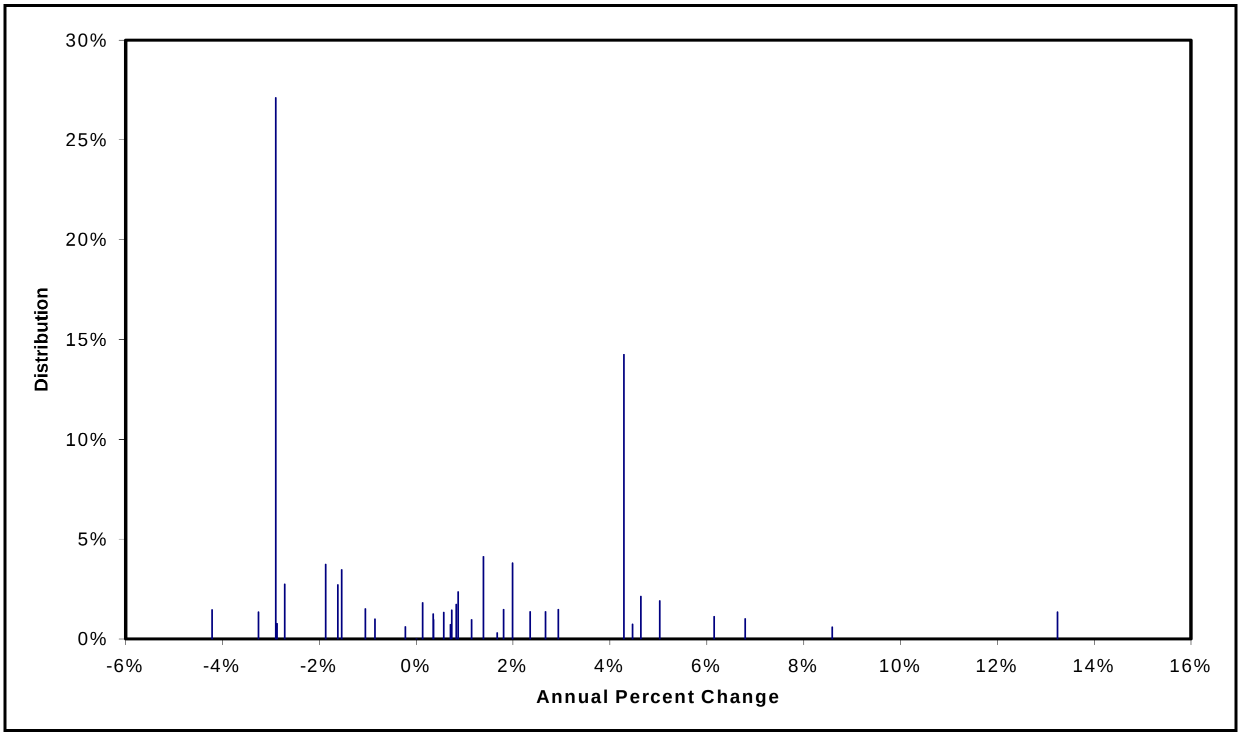

Figure F.3 Annual Percent Change in Water-Only Prices for 38 Cities (from 1986-1998, in 1997$)

F.2 METHOD TO DETERMINE HISTORICAL WATER AND WASTEWATER PRICE TREND

To determine an escalation rate, the data was manipulated in four ways: (1) a marginal price was figured for each city; (2) the weighted average marginal rate for the all 38 cities was calculated for the years 1986 and 1998; (3) the average marginal rate was converted into 1997$; and (4) a compounded percentage change between the years 1986 and 1998 was computed. The average escalation of marginal prices is determined by assuming a compound (exponential) percentage escalation between the points for 1986 and 1998. Equation 2 was used for the calculation.

$$\textit{Marginal Rate Growth Percentage} = \left(\left(\frac{marginalprice_{1998}}{marginalprice_{1986}} \right)^{\frac{1}{(1998-1986)}} \right) - 1 \qquad \textbf{(1)}$$

F.3 IMPLEMENTATION INTO LCC SPREADSHEET

Price Distributions. In the LCC analysis, two different distributions and one calculation was used. Distributions are based on 1998 prices and are converted to 1997 dollars.

1. water-only
2. water and wastewater
3. calculation of well water pumping savings (used electricity price)

Unlike the situation for fuel prices, the RECS household data set sampled in the LCC analysis does not provide information on water use. Water prices are therefore selected from a distribution of prices that are applicable to each individual RECS sample. The price distribution used for a particular household depends on if it is connected to utility water, wastewater, or has an individual well pump and septic tank. Table F.1 shows that for purposes of calculating water and wastewater savings, households can be separated into four categories: 1) having well pumps and septic systems (urban or rural); 2) having water and wastewater utilities (urban); 3) having water and wastewater utilities (rural); and 4) having a water utility only (rural). Additional detail on the RECS database and the market segments are discussed below.

Table F.1 Summary of Market Segments – Weighted RECS Households having a Washer and a Dryer

Market Segment	Percent of Total Market	Data Used
Households having a well pump (10.7% rural & 6.0% urban)	16.7%	Household-specific marginal electricity price
Urban without a well pump (i.e., having utility water & wastewater)	74.3%	Urban water & wastewater prices
Rural – having utility water and wastewater	4.8%	Urban water & wastewater prices
Rural – having utility water and septic tank	4.2%	Urban water-only prices

RECS. A database of households having both a washer and a dryer was obtained from EIA's RECS93 survey. From this database households were classified according to whether or not a household has a well pump and whether a household is located in an urban or rural area. The information on which RECS house had a well pump allowed us to use the electricity marginal rate for that specific house to calculate the energy saved due to lowered demand for pumped water. If a household does not have a well pump, RECS is used to determine if the household is classified as urban or rural. Urban houses not having a well pump (74.3% of total households) are assumed to have utility water and wastewater connections. Rural households not having a well pump (9% of total households) are classified as having either both utility water and wastewater or having utility water and a septic tank. The ratio of these two options was determined from the American Housing Survey data (division of the Census Bureau). The remaining possibility, households having a wastewater utility and a well pump account for only 2% of all households, according to the Census Bureau's American Housing Survey(AHS). The data used was normalized without this last scenario to simplify the analysis.

Urban: water & wastewater. The distribution and escalation for urban water and waste water is used. The marginal cost of water and wastewater disposal was determined by removing fixed rates and using a typical consumption level. Urban water and wastewater marginal rates were added to get a combined urban water and wastewater per gallon price.

Rural: water & wastewater. For rural households with both water and wastewater services, we assumed that their price was the same as the urban segment and had the same escalation rate. In general, rural water prices tend to be higher than city water prices.

Rural: water & septic tank. For the case of rural households having utility-supplied water, but not having wastewater services (e.g., having a septic tank), it was assumed that the water supplied had the same price as "water only" (without wastewater removal costs) for the urban areas. Because we had disaggregated prices for urban water and wastewater, we could just use the value for water. Although there is some evidence to the contrary, we assumed that there would be no savings in septic tank maintenance costs due to reducing the amount of water saved with an efficient clothes washer.

Individual well & septic tank. Since there is not much documentation on how much cost or energy is attributed to using individual well pumps, the value had to be calculated. We assumed the installation and maintenance of a well pump was a fixed cost that did not vary with the amount of water use. The same assumption was made for septic tanks. We only considered the actual cost of electricity to pump the gallons of water used. Therefore, the savings were for the electricity saved by having reduced operating hours for the well pump due to the total amount of water pumped being less. The marginal electricity price for the individual RECS household with a pump was used.

Factors that determine the electricity needed to pump a stated amount of water include the efficiency of the pump and pump motor and the depth from which the water has to be pumped. Other factors are the friction in the pipes that the pump has to overcome and the pressure setting of the bladder tank (assumed to be 40 psi or 92 feet of head) and the type of pump used (which affects efficiency). The depth of wells vary across the U.S. and is often dependent on the area of the country. A well of 100 to 300 feet is typical and therefore a depth of 200 feet was chosen as a typical value. The total discharge head is the sum of the depth to pumping level, the elevation, the service pressure, and the friction loss. The pumping energy required is directly proportional to the head of the pump. A typical well water pump was selected out of an equipment catalog (Grainger's 1997), thereby including the actual performance and efficiencies in an actual pump. Specifications included a 3/4 horsepower pump with a pumping capacity of 5.1 gpm at 292 feet of head. The electric motor efficiency was assumed to be 70%. Pumping energy was determined to be 2.61 kWh per 1000 gallons. This value was multiplied by the dollars per kWh and the reduction in the number of gallons (in 1000s) pumped over a year to determine the dollars per year saved to pump well water from an individual well pump.

The flowchart in Figure F.4 shows the decision process used by the LCC spreadsheet.

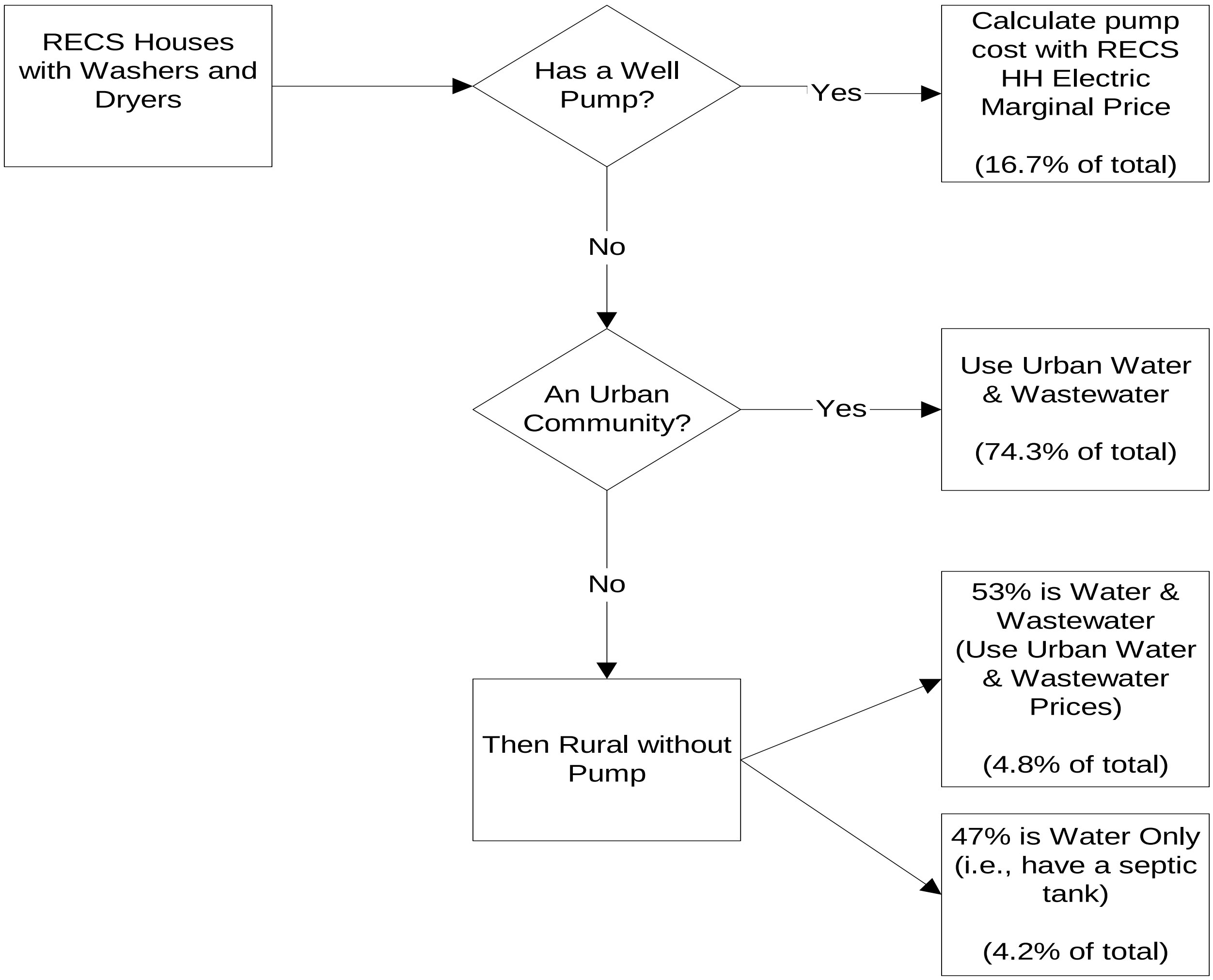

Figure F.4 Flow Chart for Water Choice in LCC Spreadsheet

Average, High and Low Escalation Rates. The LCC spreadsheet also allows for high and low water price escalation sensitivities. The scenarios for high and low escalation were chosen in the following manner:

1. In the LCC analysis a distribution of water/wastewater price was used, but the escalation rate was modeled as an average value. Because the escalation rate can vary, high and low escalation rates were also part of a sensitivity analysis. The LCC spreadsheet allows the user to select high and low escalation rates.
2. The years 1986 and 1998 were used to determine the escalation rate.
3. The escalation rates were ranked from highest to lowest by city and a cumulative weighting by population was determined.
4. The high and low boundaries were determined by the escalation rates that fell within the population weighting of 25% and 75%, corresponding to just above the 25% lowest rates

and just below the 75% of the lowest rates.

5. The escalation rate for well pumps is same as for escalation of electricity prices for individual RECS households (i.e., if electricity rates decrease, this should lower utility pumping costs.)

Figure F.5 plots the future trends for the high, low, and average prices.

Water price and water escalation rates used in spreadsheet. Table F.2 summarizes the water price input parameters for the LCC spreadsheet**.**

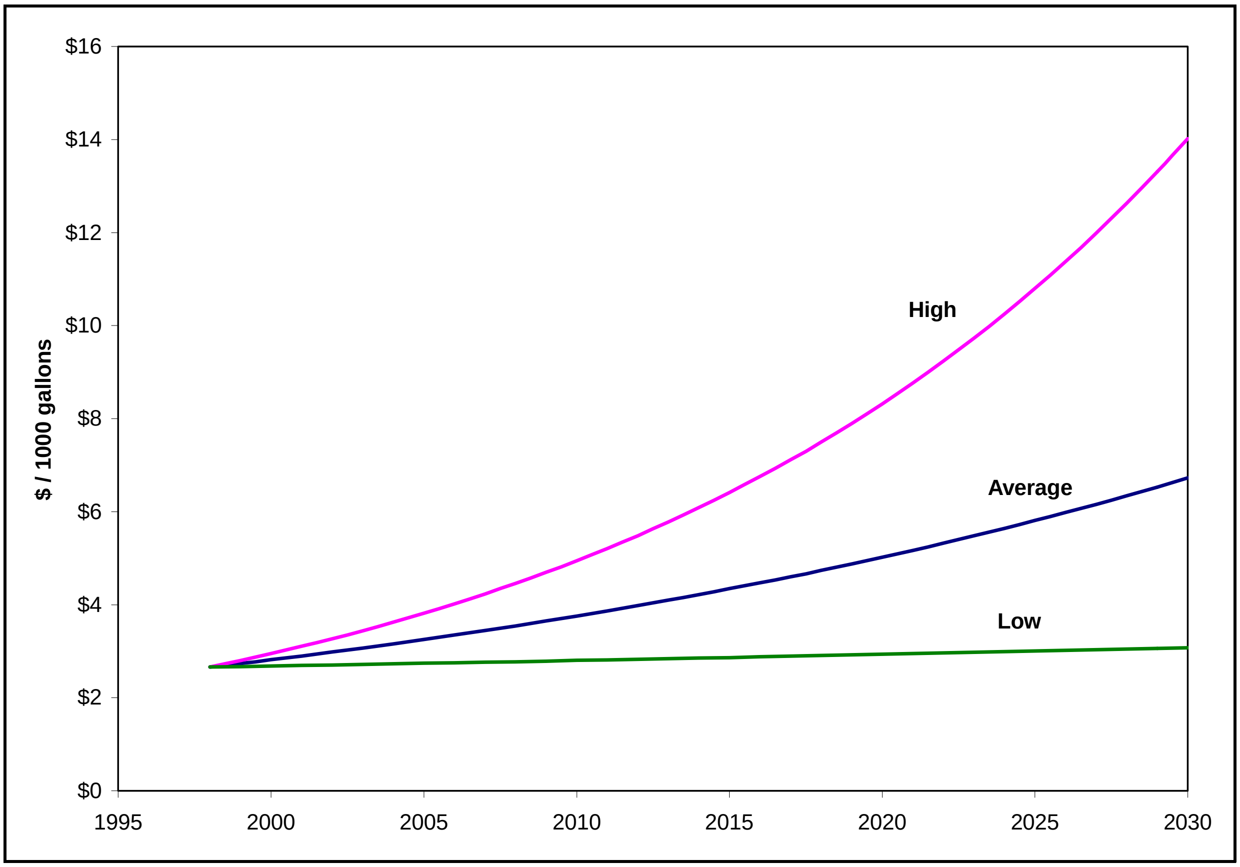

Figure F.5 Water and Wastewater Price Trends

Table F.2 Marginal Prices and Escalation Rates

Market Segment	Weighted Average Price (1997$)	Percent Annual Escalation Rate			Percent of Total Households
	per 1000 gallons	Average	High	Low	
Households having a well pump (10.7% rural & 6.0% urban)	$0.21	AEO ref.	AEO high	AEO low	16.7%
Urban without a well pump (i.e., having utility water & wastewater)	$3.02	3.01	5.41	0.53	74.3%
Rural having utility water and wastewater	$3.02	3.01	5.41	0.53	4.8%
Rural having utility water and septic tank	$1.32	0.64	2.93	-2.89	4.2%

For the "**sample calc**" single value calculation used for the rebuttable payback, the weighted average water price of $2.48 is used.

For purposes of determining national dollar savings, a single combined water price was used in the NES/Shipment spreadsheet. A year by year projected future price can be found in spreadsheet: NES2KO515-2T.xls in sheet "Projections" in columns V through Y. These values average in the cost of individual well pumps and households without wastewater disposal.

REFERENCES

1. Ernst & Young, *1986 National Water and Wastewater Rate Survey*, 1986. Washington, DC.

2. Raftelis Environmental Consulting Group, *1998 Water and Wastewater Rate Survey*, 1998. Charlotte, NC.