3 Water Use History

SECTION 3

Water Use History

This chapter describes the water use history for Lebanon's system. This history includes average and maximum demands, per capita demands, metered consumption, and unaccounted-for water.

Definition of Terms

Demand refers to total water use; that is, the sum of metered consumption (residential, commercial/industrial, and governmental), unmetered uses (for example, fire fighting or hydrant flushing), and water lost to leakage, reservoir overflow, and evaporation.

When discussing daily or annual water use, the terms *demand* and *production* are used synonymously in this report. Both refer to all water used in the system; that is, the sum of metered and unmetered use. Demand equals production because both terms refer to all water that is delivered from the water treatment plant (WTP) to the distribution system.

The terms *demand* and *production* are not synonymous with respect to hourly demands. Water is produced at the WTP at a relatively steady rate throughout the day. Hourly water demands fluctuate in response to water use patterns by residential, commercial, and industrial customers. For example, hourly demands typically exceed the production rate during morning and afternoon/early evening peaks. Hourly demands will be less than the production rate during nighttime hours. Hourly demands will be estimated for use in the distribution system modeling.

Metered use or *consumption* refers to the portion of water use that is recorded by customer meters.

Connection refers to a metered connection to a customer of Lebanon.

Unaccounted-for water refers to the difference between production and consumption. Unaccounted-for water includes unmetered hydrant use, other unmetered uses, and water lost to evaporation, reservoir overflow, and leakage. Meter inaccuracies (both production and customer) also contribute to unaccounted-for water.

Specific *demand* terms include:

- *Average day demand (ADD):* total annual production divided by 365 days
- *Maximum day demand (MDD):* the highest system demand that occurs in any single day of a calendar year
- *Maximum monthly demand (MMD):* the highest monthly production during a calendar year
- *Peak hour demand (PHD):* highest hourly demand that is experienced

MDD is an important value for water system planning. The supply flows (canal flow, water rights) and supply facilities (intake, raw water pumps, treatment plant, and finished water pumps) must be capable of meeting the MDD. If the MDD exceeds the combined supply capacity on any given day, storage levels will be reduced. Consecutive days at or near the MDD will result in a water shortage.

The most common units for expressing demands are million gallons per day (mgd). One mgd is equivalent to 695 gallons per minute (gpm) or 1.55 cubic feet per second (cfs). Units of million gallons (MG) are also used.

Historical Average and Maximum Demands

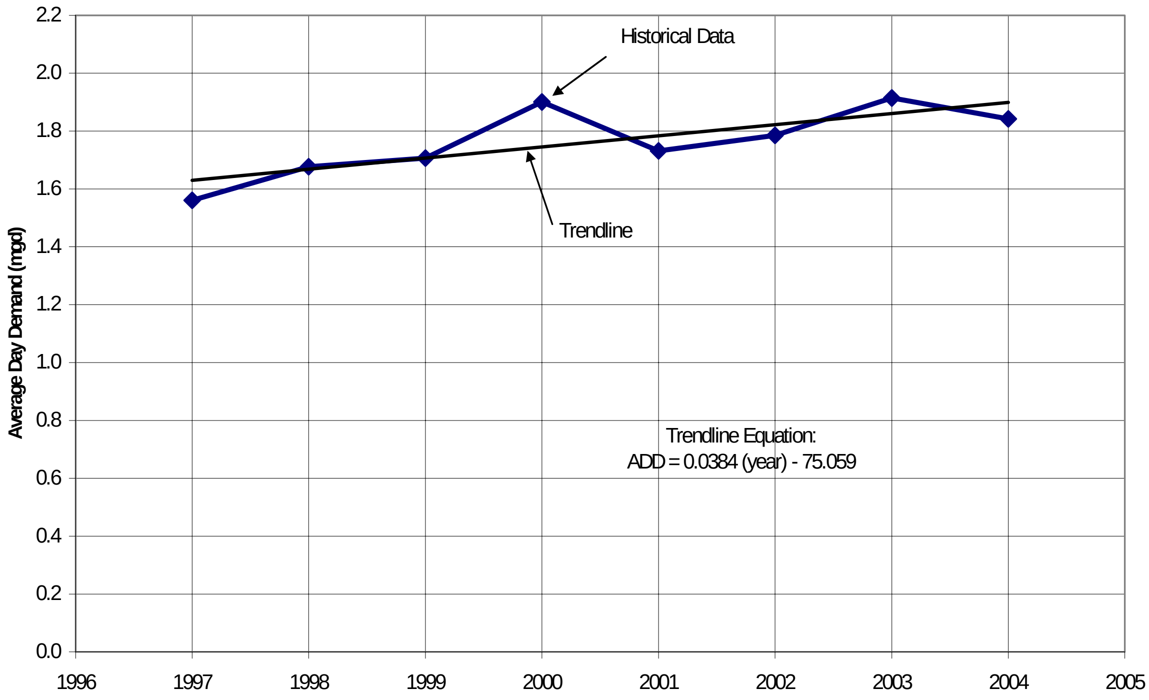
Exhibits 3-1 and 3-2 summarize ADD records for Lebanon for 1997 through 2004. The ADD has ranged from 1.6 mgd to 1.9 mgd. The trendline included on Exhibit 3-2 indicates that the ADD has increased slightly from 1997 through 2004 at a rate of 0.04-mgd per year. The recent ADDs have increased by a small amount from the values presented in the city's 1989 *Water Facility Study* (master plan). This plan indicated that the ADDs for 1986 through 1988 ranged from 1.62 to 1.80 mgd.

EXHIBIT 3-1
Average Day Demand Records

Year	Average Day Demand (mgd)	Annual Production (MG)
1997	1.56	---
1998	1.68	612
1999	1.71	623
2000	1.90	640
2001	1.73	632
2002	1.78	651
2003	1.91	699
2004	1.84	672
Minimum	**1.6**	**612**
Maximum	**1.9**	**699**

Notes:
1997 ADD based on 11 months of data. February data was not available for that year.

EXHIBIT 3-2
Average Day Demand



Exhibits 3-3 and 3-4 summarize MDD records for 1993 through 2004. The table and chart both include the single-day MDD and the 3-day MDD. The 3-day MDD represents the demand on the day before, the day of, and the day following the MDD occurrence. It provides an indication of the duration of peak demands.

EXHIBIT 3-3
Maximum Day Demand Records (production records)

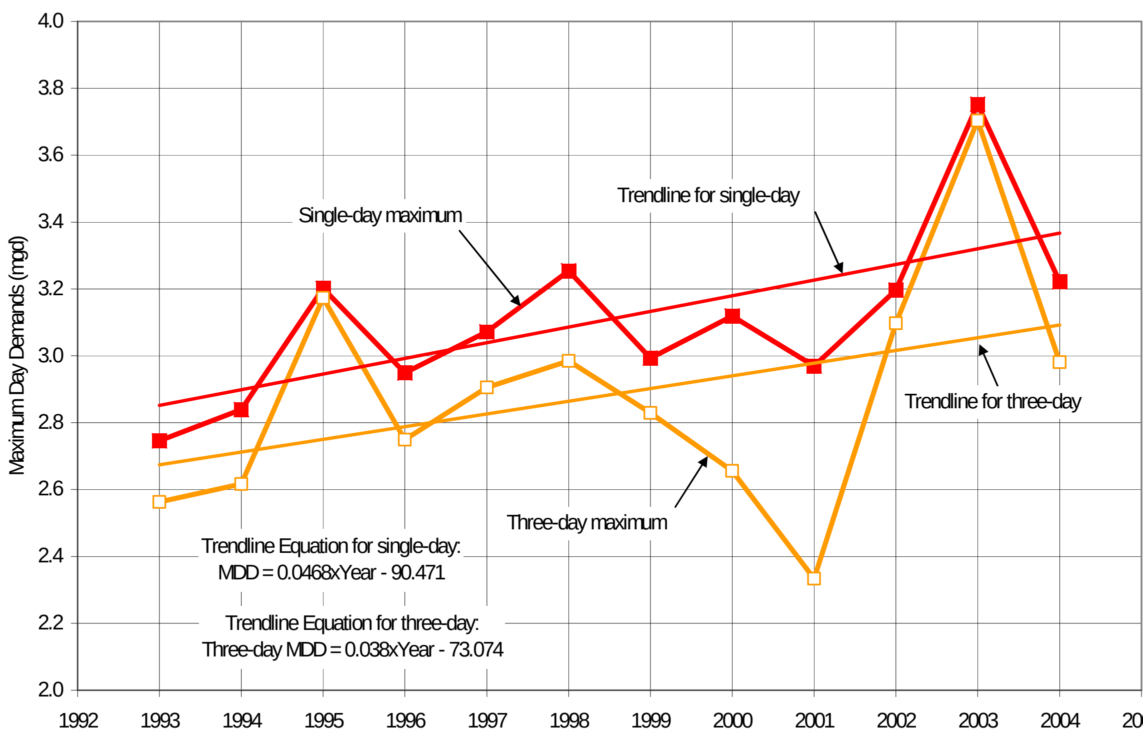
Date	Year	Maximum Day Demand (mgd)	3-day Maximum Day Demand (mgd)	3-day / 1-day MDD, as %
Aug 04	1993	2.75	2.56	93%
Jul 21	1994	2.84	2.62	92%
Sep 03	1995	3.20	3.17	99%
Jul 16	1996	2.95	2.75	93%
Aug 14	1997	3.07	2.91	95%
Jul 28	1998	3.25	2.99	92%
Jul 28	1999	2.99	2.83	95%
Aug 17	2000	3.12	2.66	85%
Sep 22	2001	2.97	2.33	79%

EXHIBIT 3-3
Maximum Day Demand Records (production records)

Date	Year	Maximum Day Demand (mgd)	3-day Maximum Day Demand (mgd)	3-day / 1-day MDD, as %
Aug 14	2002	3.20	3.10	97%
Jul 29	2003	3.75	3.70	99%
Jul 22	2004	3.22	2.98	93%
	Minimum	2.7	2.3	79%
	Maximum	3.8	3.7	99%
	Average	3.1	2.9	93%

Note: 3-day maximum includes day before, day of, and day after maximum day, divided by 3

EXHIBIT 3-4
Maximum Day Demands



The MDD has ranged from a low of 2.7 mgd to a high of 3.8 mgd. The highest value of 3.8 mgd occurred in 2003. The 3-day MDD ranged from 2.3 to 3.7 mgd. The 3-day MDD has typically equaled 93 percent of the single-day MDD. However, in 2001 the 3-day MDD was only 79 percent of the single-day MDD.

The city's 1989 plan indicated that the MDD for 1986 to 1988 ranged from 2.8 to 3.6 mgd.

The trendline included on Exhibit 3-4 indicates that the MDD has trended upward at the rate of 0.05-mgd per year for the last 12 years. According to this trendline, the expected 1-day MDD for year 2004 was 3.32 mgd. The actual recorded MDD for 2004 was 3.22 mgd.

MDDs fluctuate from year to year because they are strongly influenced by weather patterns:

- Maximum temperatures
- The number of consecutive days at high temperatures
- When the high temperatures occur during the summer (early while residents are more consistent in their outdoor irrigation, or later when they are less consistent)
- Overall rainfall levels during the summer
- Consecutive days without rainfall

Because of these factors and their influence on the MDD, using values estimated by the trendline to project MDDs is advisable. The records for Lebanon suggest that the MDD for any particular year may vary from the trendline, either higher or lower, by as much as 0.4-mgd. Including this allowance in planning for source development is recommended. In addition, some cities have chosen to maintain a reserve capacity above this allowance to account for sudden increases in customer base. This enables a city to accommodate a new customer with a high water demand, or a surge in residential development.

Average Summer and Winter Demands

Outdoor irrigation contributes to higher demands in the summer months. The monthly demand records are displayed in **Exhibit 3-5.** Of the 8 years of data analyzed, the peak monthly demand has occurred during July for 5 years and during August for 3 years. The MMDs have ranged from 72 to 96 MG. The average for the period was 80 MG.

Peaking Factors

Peaking factors, the ratios of MDD:ADD and MMD:ADD, are useful for hydraulic modeling of the system and for demand forecasting. **Exhibit 3-6** summarizes the peaking factors for 1997-2004. The MDD:ADD has averaged 1.8, the three-day MDD:ADD has averaged 1.7, and the MMD:ADD has averaged 1.5.

The MDD:ADD peaking factors for 1997-2004 are displayed in **Exhibit 3-7**. The peaking factor has remained relatively constant during this period.

The city's average peak hour to maximum day (PHD:MDD) peaking factor for the years 2000 to 2004 was 1.4, as was the 2004 value. This is a typical value for Willamette Valley cities of similar size to Lebanon. The peak hour demand in 2004 was 4.94 mgd.

EXHIBIT 3-5
Monthly Demand Records, February 1997 - December 2004

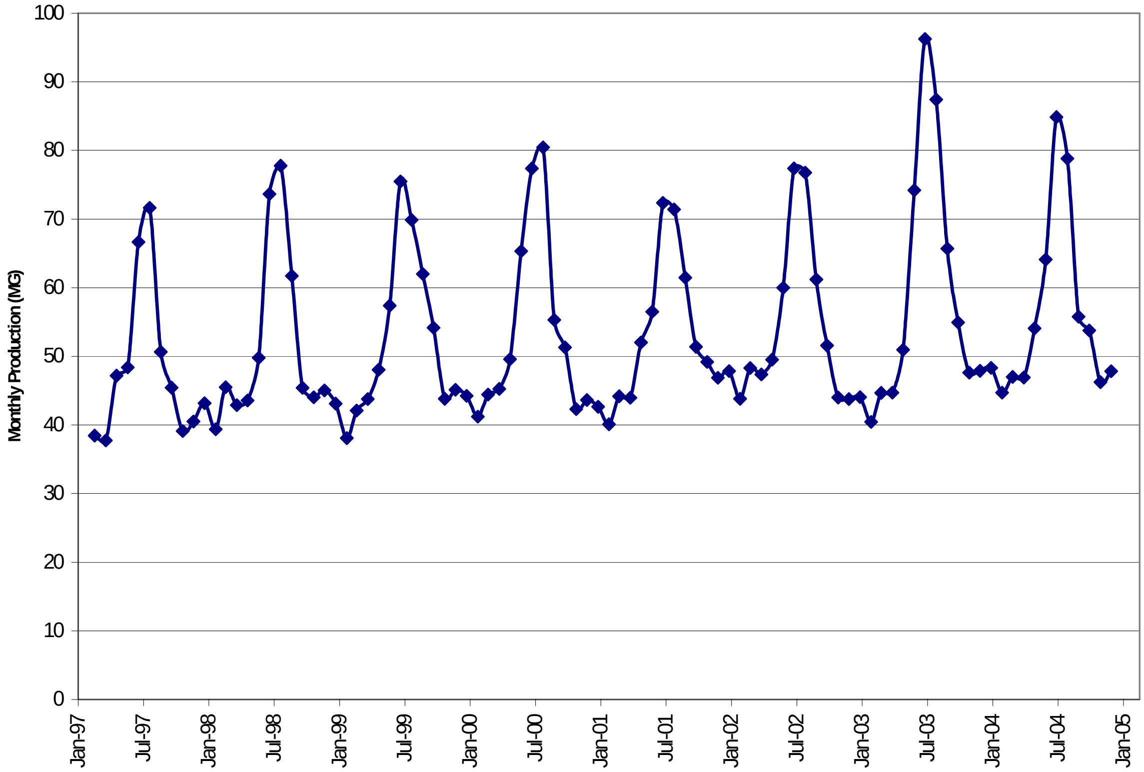
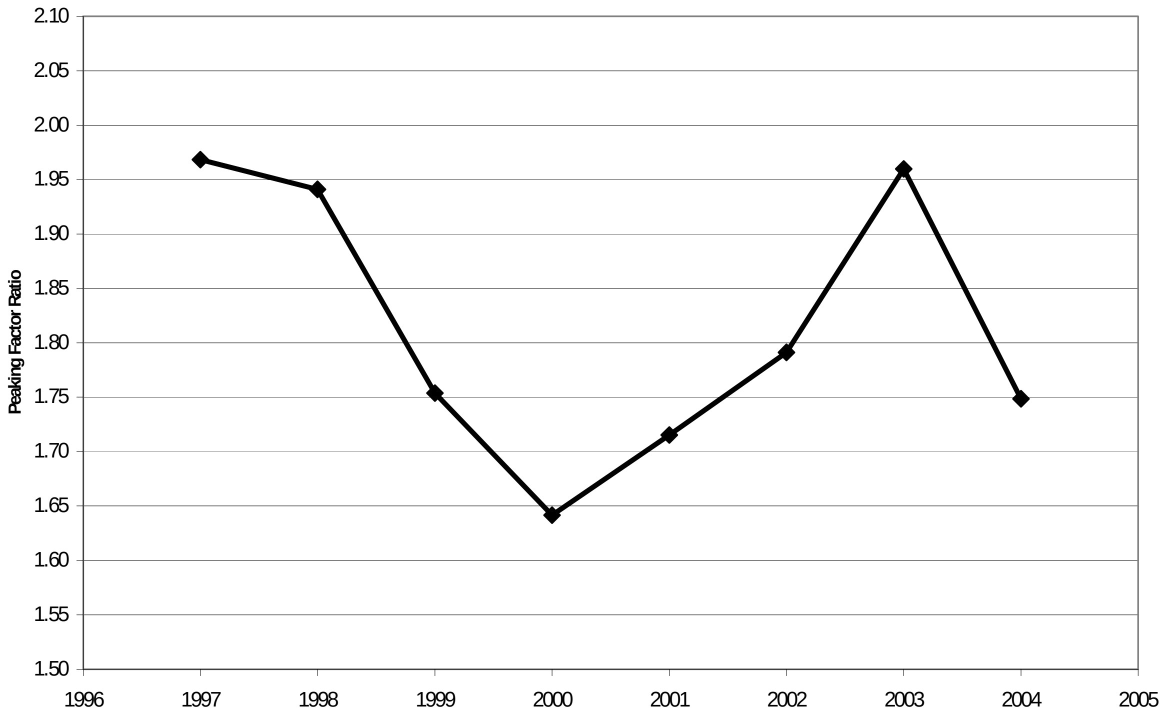


EXHIBIT 3-6
Peaking Factors
(For Maximum Day, 3-day Maximum Day, and Maximum Monthly Demands)

		1-day MDD		3-day MDD		Maximum Monthly Demand		
Year	**ADD (mgd)**	**1-d MDD (mgd)**	**Ratio 1-d MDD: ADD**	**3-d MDD (mgd)**	**Ratio: 3-d MDD: ADD**	**MMD (mgd)**	**Ratio: MMD:ADD**	**Ratio: MMD:MDD**
1997	1.6	3.1	2.0	2.9	1.9	2.3	1.5	0.8
1998	1.7	3.3	1.9	3.0	1.8	2.5	1.5	0.8
1999	1.7	3.0	1.8	2.8	1.7	2.4	1.4	0.8
2000	1.9	3.1	1.6	2.7	1.4	2.6	1.4	0.8
2001	1.7	3.0	1.7	2.3	1.3	2.3	1.3	0.8
2002	1.8	3.2	1.8	3.1	1.7	2.5	1.4	0.8
2003	1.9	3.8	2.0	3.7	1.9	3.1	1.6	0.8
2004	1.8	3.2	1.7	3.0	1.6	2.7	1.5	0.8
		Minimum	**1.6**		**1.3**		**1.3**	**0.8**
		Maximum	**2.0**		**1.9**		**1.6**	**0.8**
		Average	**1.8**		**1.7**		**1.5**	**0.8**

EXHIBIT 3-7
Maximum Day Demand to Average Day Demand Peaking Factors



Historical Per Capita Demands

Lebanon's water system serves a small number of residential customers that live outside of the city limits. There are also customers that live within the city limits who use individual wells for their water supply and, therefore, are not customers of the city's system. Because of these factors, the city's water system service area population is not equal to the city population.

The service area population was determined based on the *Linn County/Lebanon City Coordinated Population Forecast for the City of Lebanon*, as explained on page 4-3 in the Population Forecast section of Chapter 4, Water Use Projections. The city population was adjusted upward to account for water customers located outside the city limits and downward to account for those living within the city limits but not served by the city's system. The resulting service population for 2004 was 13,260.

To determine per capita water use values, the ADD and MDD (both single-day and three-day) values predicted by their respective trendlines were used, rather than the historical values for 2004. The trendline predictions account for the variations from year to year and thus represent more typical values. The predicted ADD for 2004 equals 1.89 mgd, the predicted single-day MDD equals 3.32 mgd, and the predicted three-day MDD equals 3.08 mgd.

ADD: 143 gallons per capita per day (gpcd)
Single-day MDD: 250 gpcd
Three-day MDD: 232 gpcd

These per capita values represent the total system demand divided by the service population. Therefore, they include commercial, industrial, and governmental demands as well as residential demands. An ADD per capita value of 143 gpcd is comparable to values for other Western Oregon communities.

Historical Consumption

Exhibits 3-8 and 3-9 display monthly consumption (metered use) patterns for the city in terms of total volume consumed and monthly percentages of annual consumption. During the past 5 years (2000 to 2004), consumption has averaged approximately 34 MG a month for November through February, and approximately 61 MG per month during June through August. Approximately 46 percent of the annual consumption occurs during the four-month period from June through September.

EXHIBIT 3-8
Average Monthly Consumption for 2000 to 2004
(Total of all customer categories

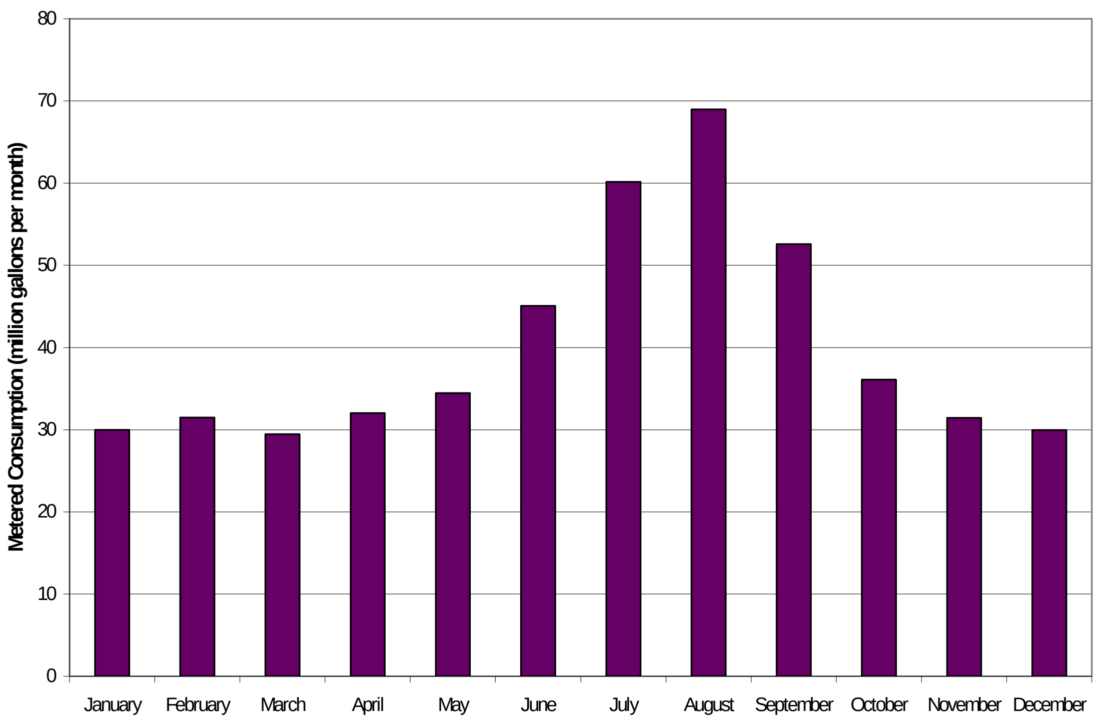


Exhibit 3-10 displays consumption by the major customer categories: residential, commercial/industrial, and governmental. The governmental category includes facilities owned by the city including the wastewater treatment plant, city-owned buildings, and irrigation of city properties. The proportion of metered water use per category from 2000 to 2004 was as follows:

- Residential: 56 percent
- Commercial/Industrial: 41 percent
- Governmental: 3 percent

EXHIBIT 3-9
Average Monthly Percentage of Annual Consumption for 2000 to 2004
(Total of all customer categories)

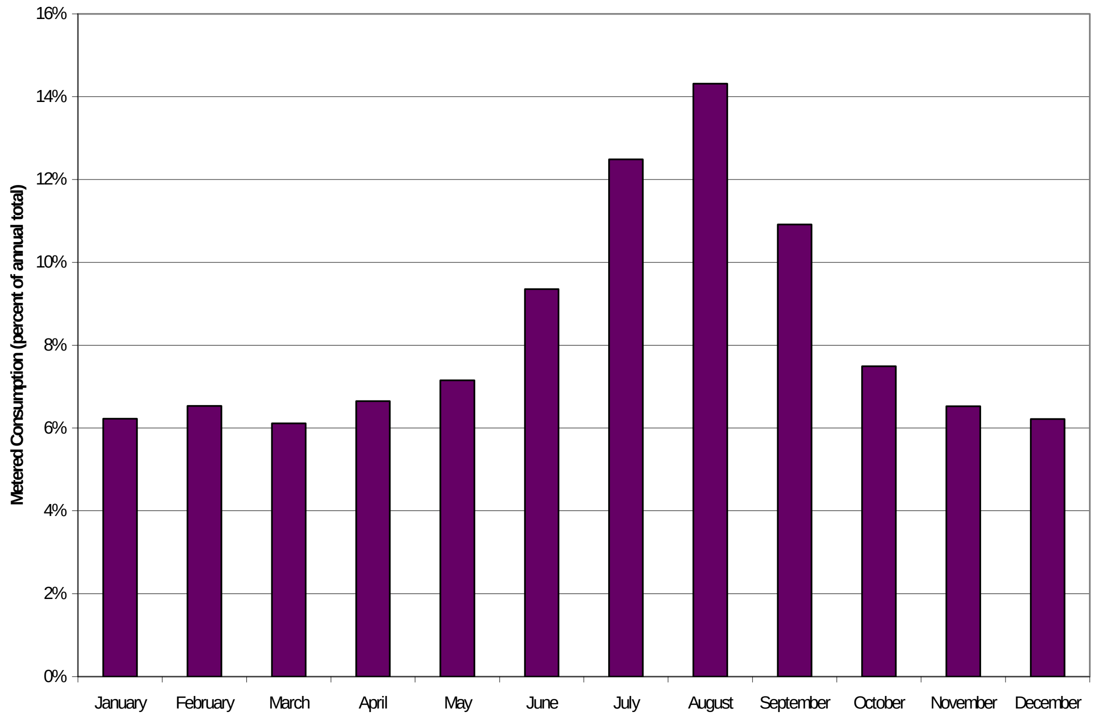
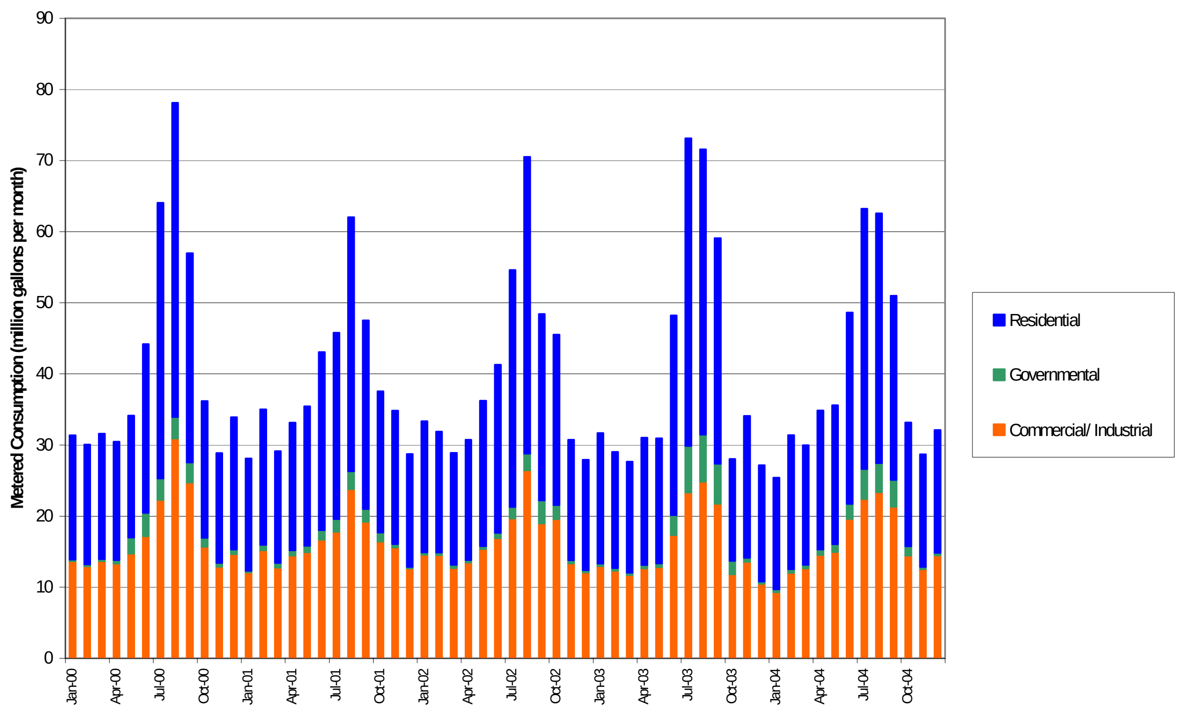


EXHIBIT 3-10
Monthly Consumption for 2000-2004



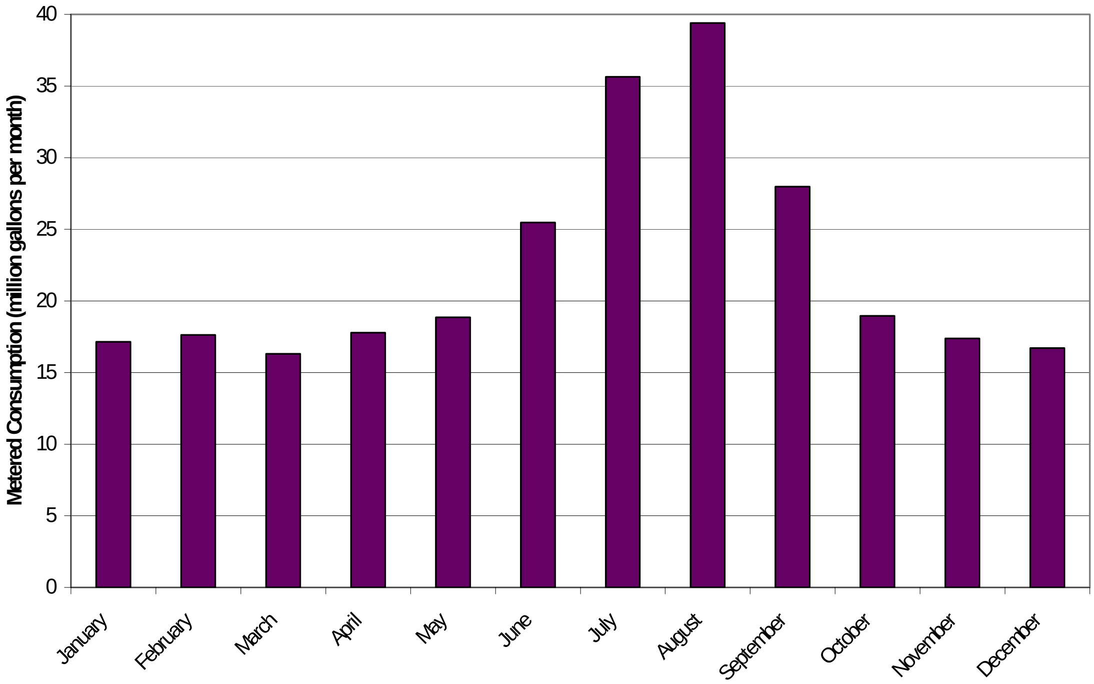
In determining buildout water use projections, the residential/governmental component of the per capita demands becomes important. A residential/governmental per capita value can be estimated by multiplying the overall per capita value by the percentage of water use by the residential and governmental customer categories as follows:

Residential/Governmental ADD = 59% x 143 gpcd = 84 gpcd
Residential/Governmental MDD = 59% x 250 gpcd = 148 gpcd

Residential Consumption

Exhibit 3-11 displays the average residential use by month over the 5-year period from January 2000 through December 2004. Residential consumption has reached a high of approximately 39 MG per month during August, and has dropped to 18 MG or less during the months of November through February.

EXHIBIT 3-11
Average Residential Monthly Consumption for 2000 to 2004



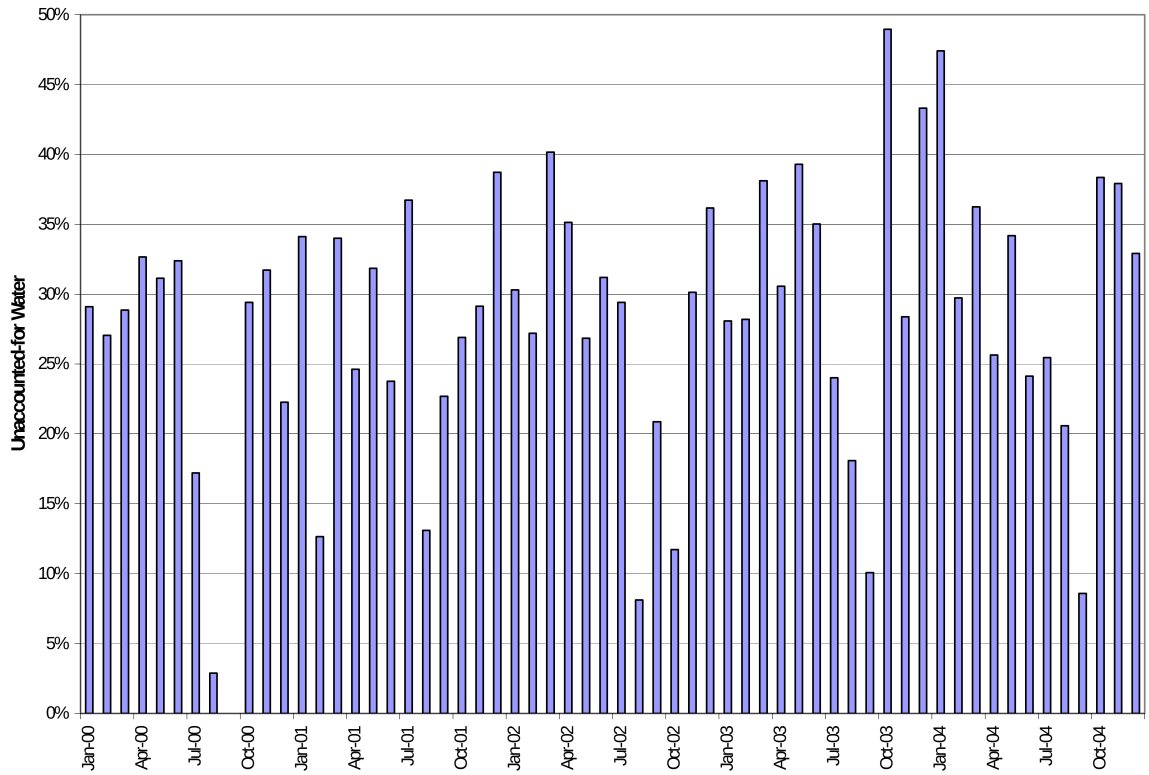
Historical Unaccounted-for Water

A comparison of the demand data with the consumption data provides a value for the unaccounted-for water, which is the difference between production and metered use. The percentage of unaccounted-for water equals the production minus the metered use, divided by the production. The causes of unaccounted-for water include unmetered hydrant flushing, meter inaccuracies, evaporation from reservoirs, reservoir overflows, unmetered hydrant use for fire fighting or other purposes, and leakage.

Exhibit 3-12 illustrates the unaccounted-for water percentage for January 2000 through December 2004. The value has ranged from –3 percent to 49 percent, with an average of

28 percent. The -3 percent value occurred during a single month, September 2000, and its cause is unknown. It appears to be an erroneous data point caused by inaccurate records for production or consumption, or both. (Exhibit 3-12 does not show this single negative value; the y-axis was set to zero because this data point appears to be in error.)

EXHIBIT 3-12
Unaccounted-for Water



When the city acquired the water system from Pacific Power and Light in 1984, the unaccounted-for water rate was greater than 40 percent. System improvements by the city have reduced this rate to an average of 28 percent. However, 28 percent exceeds the Oregon Water Resources Department's (OWRD's) municipal goal of 10 percent or less for unaccounted-for water. A value of 28 percent means that on average for 2004, the city did not account for 530,000 gallons per day. This amount was pumped into the system from the WTP but was not measured at customer meters.