**Objective:** To construct and then use a simulation model to evaluate water use demands and determine (a) the sizing and cost of a new water treatment plant, (b) the commodity rate to be charged for the water and (c) identify any required policy or operating changes to the water system.

**Background:** A Virginia town wants to replace its current ground water system with surface water and build a water treatment plant to serve a growing community. The state requires that the plant be designed for peak day capacity. Once the WTP in online, the groundwater wells will be abandoned. The four (4) ground water wells will cost $50,000 each to abandon.

**Research:** Planning Factors

1. The current rate for water is **$1.83** / 1,000 gallons and the ratepayers are very sensitive to rate increases. As a government, the town is not allowed to make a profit on their water. The mayor and entire Town Council are up for re-election next year.
2. In **2011** the wells will pump an average of 4.1 MGD and the Customer Services Department billed an average of 3,350,000 gpd.
3. The peak day demand is **44%** greater than the average annual day demand for this town.
4. Design & construction of the new plant will take three years and will cost **$2.10**/gallon of new plant treatment capacity. The Town can purchase 4.5%, 40 year bonds to finance this construction.
5. The town wants the new plant to last at least 30-years before having to expand.

**References:**

1. The Commonwealth of Virginia Waterworks Regulations (Chapter 590, Section 690)

Viessman & Hammer, Water Supply and Pollution Control, Table 5.3

Residential Customers

1. The town will have **12,000** customer accounts (single family homes) at the beginning of 2012 and is growing at 1.81% / year.
2. The 2010 census showed that there was an average of 2.75 people / residence.

Industrial Customers

1. A local historical brewery has been in business in the town for since the town started and employs 500 people. Many of the voting population either work at the brewery or has family that supports the brewery. The brewery needs 62.5 gpm and will continue to buy water as long as the rate is no greater than $1.90 / 1,000 gal. If it goes higher they will move their plant to another town with less expensive water.
2. A summertime cannery uses 80,000 gph for its 2 eight-hour shifts, (starting at 5:00am) 5-days / week (Monday thru Friday) but will permanently close at the end of **its 2022** season.
3. The town is being considered as a site for a new semiconductor chip plant starting in **2016.** It will pay good salaries and substantial taxes to the town and will employ 40 people, but will require **1.3** MGD. Due to constant manufacturing improvements, the factory’s demand for water is anticipated to decline by **12%** each year. The type of chip made in this plant will become obsolete and the plant will close by the end of 2030.

Commercial

1. A 500-unit luxury apartment complex is under construction and anticipates starting to rent 100 units/year starting in the beginning of **2013**. (Hint: Use one of your references here.)
2. A 200-room motel just opened with an average occupancy rate of **73%.** They anticipate having to raise room rates by 3.8% each year that they are open. (Hint: Use one of your references here.)
3. Phase 1 of Mason City Mall will open **in 2016** with (800,000 ft2) of shopping. Phase 2 of the project will open in 2018 with an additional 625,000 ft2 of department stores. Finally, Phase 3 in **2025** will include 100,000 ft2 of department stores.

#### **Model Assembly and Approach:**

1. Prepare a spreadsheet model with columns labeled as follows:

|  |  |
| --- | --- |
| Column | Column Title |
| 1 | “Start of Year” and number the years from **2009 through 2030** |
| 2 | “Residential Demand (gpd)” |
| 3 | “Brewery (gpd)” |
| 4 | “Cannery (gpd)” |
| 5 | “Chip Plant (gpd)” |
| 6 | “Total Industrial Demand (gpd)” [col. 3 + col. 4 + col. 5] |
| 7 | “Apartments (gpd)” |
| 8 | “Motel (gpd)” |
| 9 | “Mason City Mall (gpd)” |
| 10 | “Commercial Demand (gpd)” [col. 7 + col. 8 + col. 9] |
| 11 | “Total Average Annual Daily Demand (gpd)” [col. 2 + col. 6 + col. 10] |
| 12 | “Add’l Peak Day Capacity (gpd)” |
| 13 | “Adjusted Demand (gpd)” [col. 11 + col. 12] |
| 14 | “Unbilled Water (gpd)” |
| 15 | “Plant Sizing Demand (gpd)” [col. 13 + col. 14] |
| 16 | “Monthly Water Sales (gal/mo)” |

1. Set-up fields for: (a) plant size (round up to the nearest 100,000 gallons/day (you don’t design plants in fractions), (b) Plant Cost, (c) Monthly Bond Payment, (d) Add’l Rate/1,000 gallons (this is the additional cost that the customers will have to pay each month to pay for the bond, (e) Final Rate/1,000 gal (this is the total rate that the customers will have to pay for their water).
2. You may want to set up “target” fields for the following quantities as you will want a way to easily change them:
   1. Peaking factor
   2. Percent unbilled water
   3. Construction cost/gallon

**Report:**

1. Report on your initial findings:
   1. Plant capacity (MGD)
   2. Plant capital cost
   3. Bond Payment Required ($/mo.)
   4. Increase in the monthly commodity charge ($/1,000 gal)
   5. New total commodity charge ($/1,000 gal)
2. Discuss the political ramifications of the new plant:
   1. How will the customers react to the new commodity rates?
   2. What impact will the new rates have on the Brewery and what community reaction do you anticipate?
3. Illustrate your plant sizing discussion with a stacked bar graph of demand vs. year showing the components of the total demand (residential, industrial, commercial, peaking factor and unbilled water demand).
4. What impact on the new plant’s size and costs would the following have if individually done:
   1. Reduce the peaking factor to 20%
   2. Reduce the unbilled water to 12%
   3. Loss of the brewery
   4. Deny phase 3 of the Mason City Mall
   5. Buy-out the cannery and stop their water demand
5. Make a recommendation to the Town Council on actions they should take to achieve the lowest cost with the greatest public acceptability.