CHAPTER 1
SOLUTIONS

1-1 Total daily withdrawal

Given: Population in 2000 = 281,421,906

Solution:

a. Using the total daily withdrawal of 5,400 Lpcd:

(281,421,906 people)(5,400 Lpcd) = 1.52×10^{12} L/d

b. Converting to m^3

$$\frac{1.52 \times 10^{12} \text{ L/d}}{1000 \text{ L/m}^3} = 1.52 \times 10^9 \text{ m}^3/\text{d}$$

1-2 Estimate per capita withdrawal for public supply

Given: Population data from 1950 to 2000 and corresponding public supply withdrawal

Solution:

a. Use a spreadsheet to estimate the withdrawal

Problem 1-2
Intro. To ENE 5th Edition

Population	Withdrawal, m^3/d	Year	Withdrawal, Lpcd
151325798	5.30E+07	1950	350.24
179323175	7.95E+07	1960	443.33
203302031	1.02E+08	1970	501.72
226542203	1.29E+08	1980	569.43
248709873	1.46E+08	1990	587.03
281421906	1.64E+08	2000	582.75

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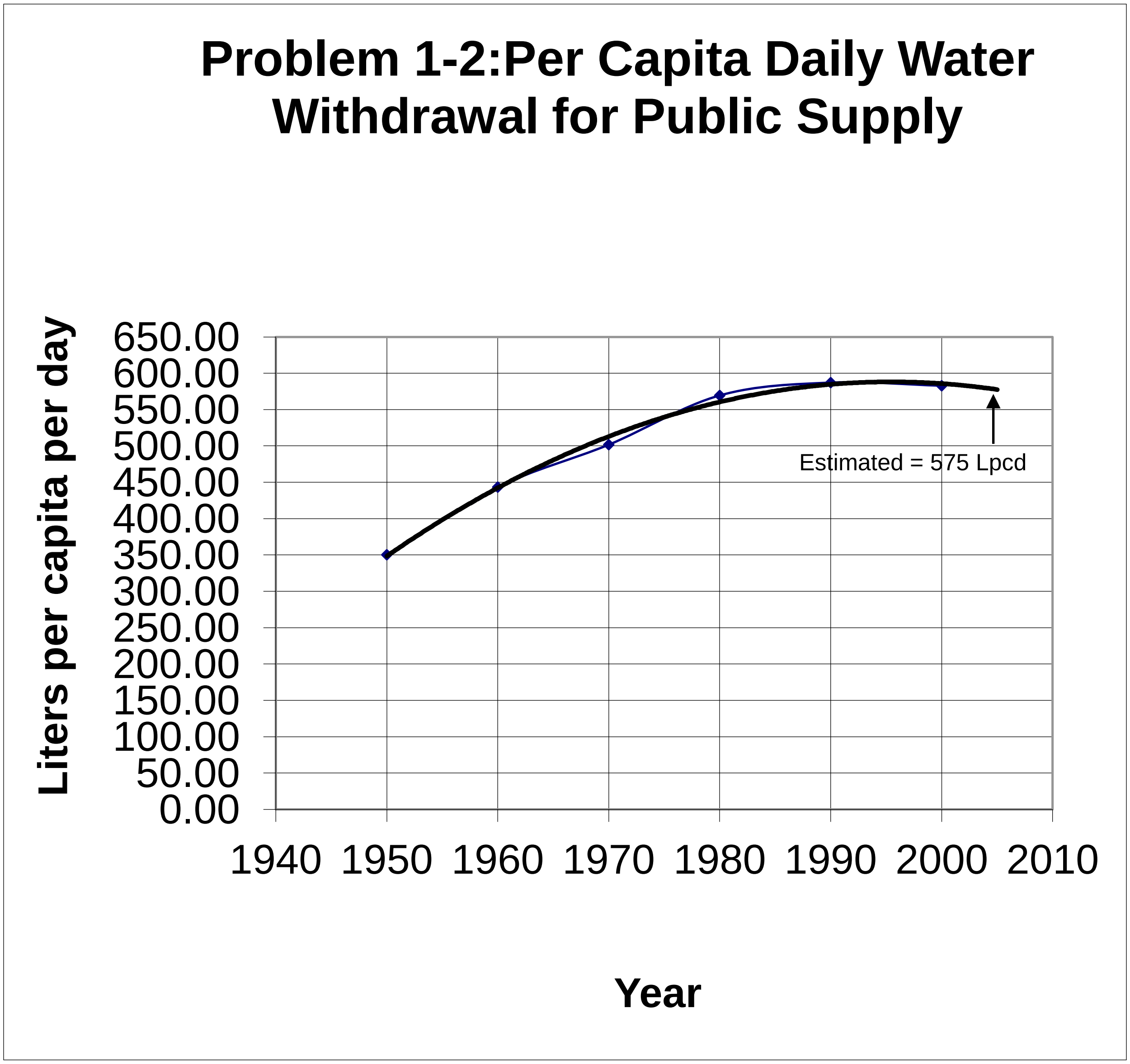

Figure S-1-2: Per capita daily water withdrawal

1-3 Additional average daily water production required

Given: 280 houses and, from text: 1,320 L/d - house

Solution:

$$(280 \text{ houses})(1{,}320 \text{ L/d - house}) = 3.7 \times 10^5 \text{ L/d}$$

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1-4 Additional average water production required with low-flush toilets

Given: 320 houses that have low flush valves that reduce water consumption by 14% and, from text, 1,320 L/d - house

Solution:

Additional demand = (320 houses)(1,320 L/d - house)(1 – 0.14) = 3.18×10^5 L/d

1-5 Repeat Prob. 1-3 for peak demand

Given: 280 metered houses, AWWA average

Solution:

a. From text: peak hour = 5.3(avg. day)

(5.3)(280 houses)(1,320 L/d - house) = 1.96×10^6 or 2×10^6 L/d at the peak hour

1-6 Water lost (in liters) in one year

Given: One drop per second, 0.150 mL per drop

Solution:

(0.150 mL/s)(86,400 s/d)(365 d/y)(1×10^{-3} L/mL) = 4,730 L/y

1-7 Monthly cost of not repairing valve

Given: Valves deliver 130.0 L/min, Water cost = $0.45 per cubic meter

Solution:

a. Assuming 30 d/mo

(130.0 L/min)(1440 min/d)(30 d/mo)(1×10^{-3} m^3/L) = 5,616 m^3/mo

(5,616 m^3/mo)($0.45/$m^3$) = $2,527.20 or $2,530/mo

1-8 Value of water lost

Given: Year 2000 data from Prob. 1-2, 15% water loss, cost of water = $0.45/$m^3$

Solution:

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a. Amount of water lost

$(1.6 \times 10^8\ m^3/d)(0.15) = 2.4 \times 10^7\ m^3/d$

b. Value

$(2.4 \times 10^7\ m^3/d)(\$0.45/m^3) = \$1.08 \times 10^7$ or $\$1.1 \times 10^7/d$

1-9 Cost of bottled water

Given: 0.5 L bottle of water costs $1.00

Solution:

a. Convert L to m^3

$$\frac{0.5L}{1000\,L/m^3} = 0.0005 \text{ or } 5.0 \times 10^{-4}\ m^3$$

b. Cost

$$\frac{\$1.00}{5.0 \times 10^{-4}\,m^3} = \$2 \times 10^3 \text{ or } \$2000/m^3$$

1-10 Daily per capita withdrawal for South Carolina

Given: USGS circular 1268 at /usgs.gov

Solution:

a. From the web site

Domestic withdrawal for SC = 63.5×10^6 gal/d

Population = $4,010 \times 10^3$

b. Per capita

$$\frac{63.5 \times 10^6\ gal/d}{(4010 \times 10^3\ people)(0.2642\ gal/L)} = 59.94 \text{ or Lpcd}$$

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1-11 Lowest domestic withdrawal in the world

Given: Pacific Institute web site (www.worldwater.org/table2.html)

Solution:

a. From the web site column labeled "Domestic Use" in m^3/p/y

Gambia and Haiti tied at 1 m^3/person – y

b. Convert to Lpcd

$$\frac{(1\,\text{m}^3/\text{person}\cdot\text{y})(1000\,\text{L}/\text{m}^3)}{365\,\text{d}/\text{y}} = 2.74 \text{ or } 3 \text{ Lpcd}$$

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DISCUSSION QUESTIONS

1-1 Effect of price on demand

Given: Doubling of price of water

Solution:

In the U.S. the price of water does not severely affect the demand because water is so cheap. Doubling of the price would reduce the demand but it would not drop in half.

1-2 Type of water treatment

Given: water is from wells and proposed treatment is filtration. NOTE: it is assumed that the well water is either hard or has a high iron content.

Solution:

The answer is False.

The revised statement is: A softening plant or iron removal plant would be appropriate to improve the quality of the water.

1-3 Water pressure problems

Given: Gettysburg, PA has difficulty in supplying water over 4th of July weekend but not other times of year.

Solution:

Because of its historical significance, thousands of tourists descend on Gettysburg on the 4th of July weekend. The visitors use a large quantity of water before and after their sightseeing tours. The large demand exceeds the systems capacity to maintain the pressure in the system. This may be because of the lack of adequate storage, the small capacity of the water treatment plant, or the large pressure drops due to friction in the distribution system, or some combination of the three.

1-4 Recommended plan for a new water treatment plant

Given: Average daily demand = 11,400 m^3/d. Proposal A is for 475 m^3/h and 2,500 m^3 of storage. Proposal B is for 1,080 m^3/h and no storage.

Solution:

Proposal A is preferred for several reasons. First, the 475 m^3/h will meet the average

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daily demand of 11,400 m^3/d (475 m^3/h x 24 h/d = 11,400 m^3/d). Second, the 2,500 m^3 of storage will provide a reserve capacity equal to the maximum hour (5.3 times the average day). Third, the smaller plant will be more economical to build.
Proposal B will not be able to meet the maximum hour demand (5.3 x 475 m^3/h = 2,520 m^3/h) and will, on the average, be over designed for capacity and, thus, not be economical to build.

1-5 Infiltration & Inflow

Given: Homeowners have connected downspouts and sump pumps to sanitary sewer.
Solution:

The water entering the sewer is called inflow. (Choice = (b).)

These connections, in effect, make the sanitary sewer a combined sewer. (Choice = (d).)

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1-6 Shiny Plating Co. ethics problem

Given: Long ethics problem dealing with the Shiny Plating Co.
Solution:

In the interest of waste minimization, the company should install the pollution control equipment. The two year payback is reasonable. "Lack of capital and high interest rates," are common excuses for not installing control equipment. The short payback time is indicative of long term profitability of the control device.

1-7 Leather tannery ethics problem

Given: Long ethics problem dealing with leather tannery.
Solution:

Select answer A. The discharge was illegal and not reporting is likewise illegal. Both professional ethics and environmental ethics

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