## Chapter 2

2.1
$$\frac{21{,}400{,}000{,}000\,\text{m}^3}{(1{,}000{,}000\,\text{people})\left(\frac{100\,\text{gal/day}}{\text{person}}\right)\left(365\,\frac{\text{day}}{\text{yr}}\right)\left(0.003785\,\frac{\text{m}^3}{\text{gal}}\right)} = 155\ \text{years}$$

2.2
$$\text{land area} = \frac{2.14\times10^{10}\,\text{m}^3}{1.0\,\text{m}} = 2.14\times10^{10}\,\text{m}^2$$

$$\text{area} = 2.14\times10^{10}\,\text{m}^2\left(\frac{1\,\text{km}^2}{1{,}000{,}000\,\text{m}^2}\right) = 21{,}400\,\text{km}^2$$

$$\text{area} = 21{,}400\,\text{km}^2\left(100\,\frac{\text{ha}}{\text{km}^2}\right) = 2{,}140{,}000\ \text{hectares}$$

$$\text{area} = 21{,}400\,\text{km}^2\left(\frac{1\ \text{mile}^2}{2.59\,\text{km}^2}\right) = 8{,}263\,\text{mile}^2$$

$$\text{area} = 8{,}263\,\text{mi}^2\left(640\,\text{ac/mi}^2\right) = 5{,}288{,}000\ \text{acres}$$

2.3
$$\text{evaporation} = (65{,}800\,\text{ha})\left(\frac{1\,\text{km}^2}{100\,\text{ha}}\right)\left(1{,}000{,}000\,\frac{\text{m}^2}{\text{km}^2}\right)(0.25\text{m})(0.7) = 115{,}150{,}000\,\text{m}^3$$

$$\text{evaporation} = 4.066\times10^9\,\text{ft}^3 = 93{,}340\ \text{ac-ft}$$

2.4
$$\text{volume} = (280\,\text{km}^2)(1{,}000{,}000\,\text{m}^2/\text{km}^2)(0.725\,\text{m}) = 2.030\times10^8\,\text{m}^3$$

$$\text{volume} = 7.168\times10^9\,\text{ft}^3 = 5.362\times10^8\,\text{gal} = 164{,}560\ \text{acre-feet}$$

2.5
$$\text{volume} = \left(8{,}250\,\frac{\text{ft}^3}{\text{s}}\,\text{day}\right)(86{,}400\,\text{s/day}) = 7.128\times10^8\,\text{ft}^3$$

$$\text{volume} = 16{,}364\ \text{acre-feet}$$

$$\text{flow rate} = \frac{7.128\times10^8\,\text{ft}^3}{(30\,\text{days})(86{,}400\,\text{s/day})} = 275\,\text{ft}^3/\text{s}$$

$$\text{flow rate} = (275\,\text{ft}^3/\text{s})(0.02832\,\text{m}^3/\text{ft}^3) = 7.79\,\text{m}^3/\text{s}$$

2.6 annual water use = $950{,}000(175\,\text{gal/day})(365\,\text{days/yr}) = 60{,}680$ million gallons/year

$$\text{annual water use} = 8.11\times10^{9}\ \text{ft}^3/\text{yr}$$
$$= 186{,}200\,\text{ac-ft/yr}$$
$$= 93{,}880\ \text{sfd/yr}$$
$$= 2.297\times10^{8}\,\text{m}^3/\text{yr}$$
$$= 2.297\times10^{11}\ \text{liters/yr}$$

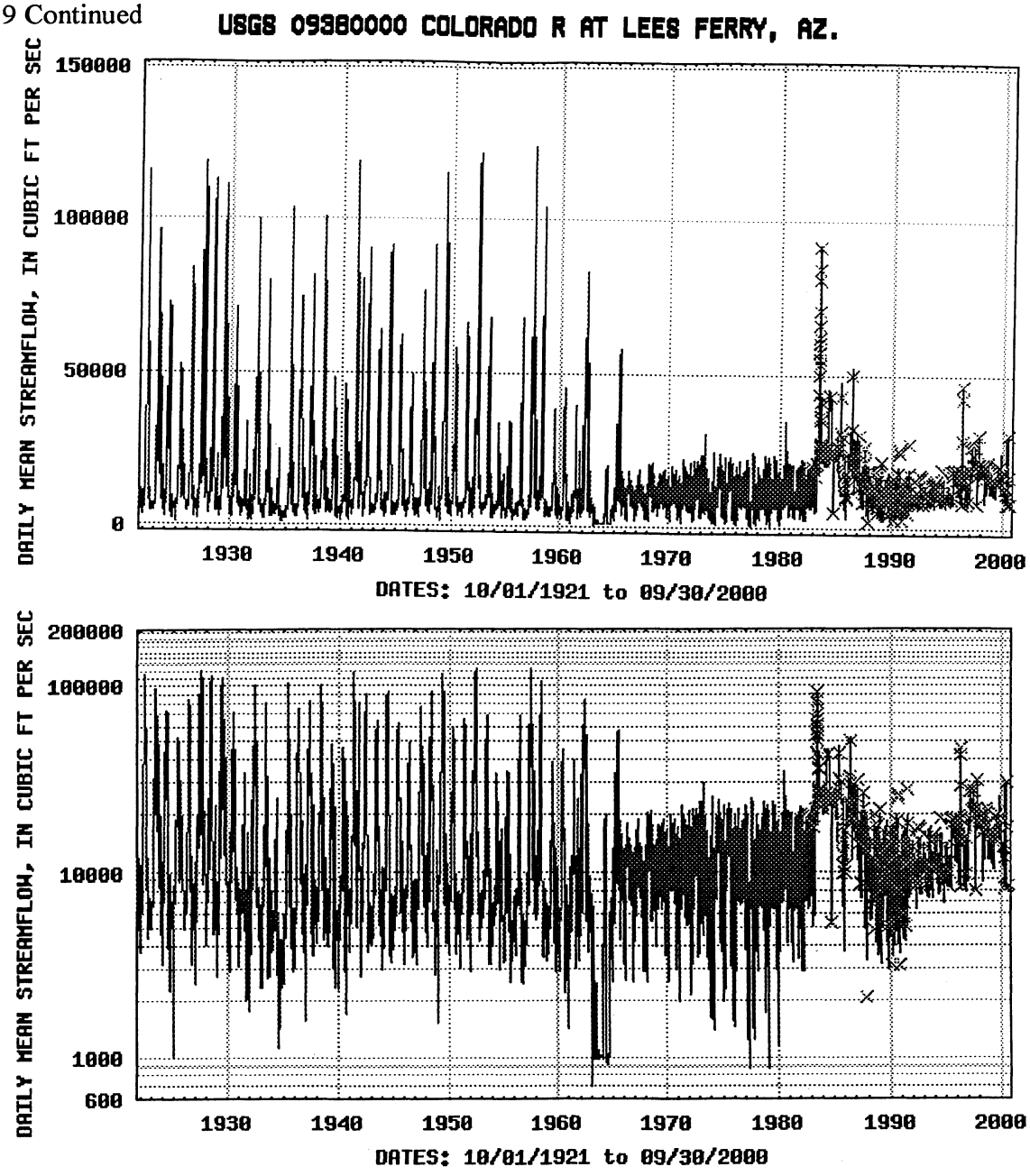
2.7
$$\text{irrigation requirement} = 1.2\,\text{ft} - \frac{3.2}{12}\,\text{ft} = 0.933\,\text{ft}$$
$$\text{volume} = (780\,\text{ac})(0.933\,\text{ft}) = 728\ \text{ac-ft}$$
$$= 3.17\times10^{7}\ \text{ft}^3$$
$$= 898{,}000\,\text{m}^3$$

2.8
$$\text{flow} = (132\,\text{mi}^2)(640\,\text{ac/mi}^2)(25\,\text{inches/yr})(\text{ft}/12\,\text{inches})(0.20)$$
$$= 35{,}200\,\text{ac-ft/yr}$$
$$\text{flow} = 17{,}450\ \text{sfd/yr}$$
$$\text{flow} = \frac{\left(17{,}750\,\frac{\text{ft}^3}{\text{s}}\cdot\text{day}\right)/\text{year}}{365\,\text{days/year}} = 48.6\ \text{ft}^3/\text{s}$$
$$\text{flow} = 1.38\ \text{m}^3/\text{s}$$

2.9 The National Water Information System (NWIS) can be accessed through the U.S. Geological Survey web site: http://water.usgs.gov

The drainage area above station 09380000 on the Colorado River is 111,800 mile$^2$. The daily flow hydrograph printed through the NWIS is reproduced on the next page alternatively with an arithmetic scale and a log scale.

2.9 Continued



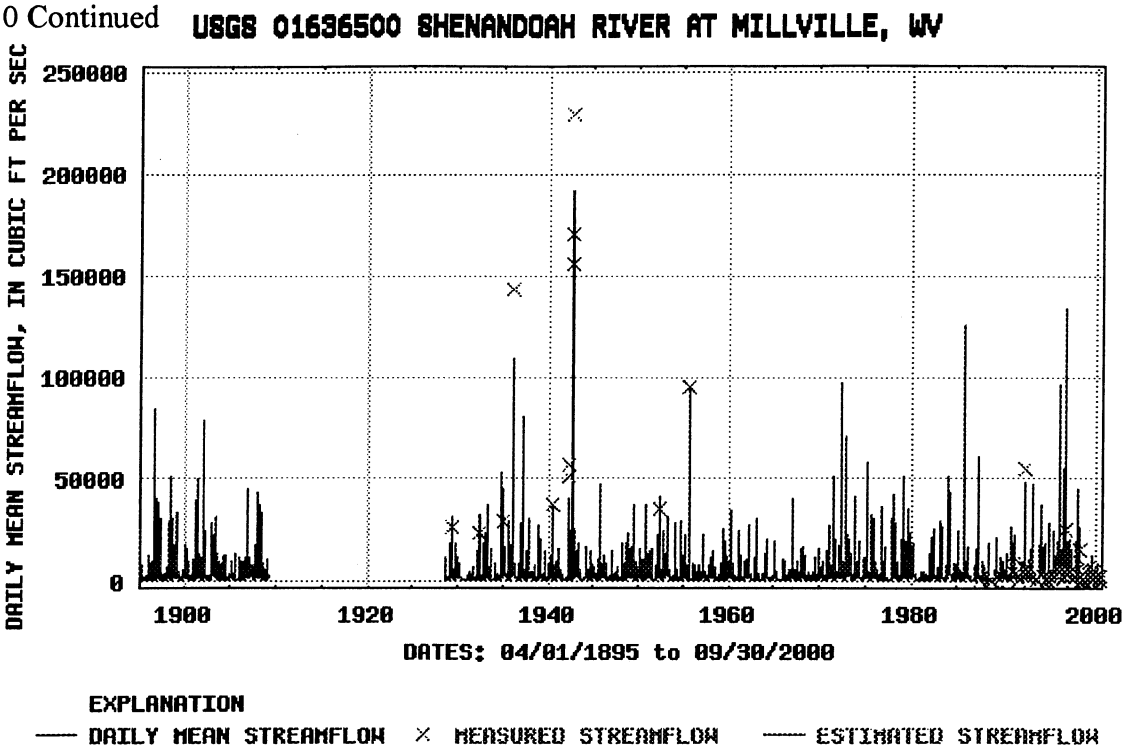

2.10 The National Water Information System (NWIS) can be accessed through the U.S. Geological Survey web site: http://water.usgs.gov

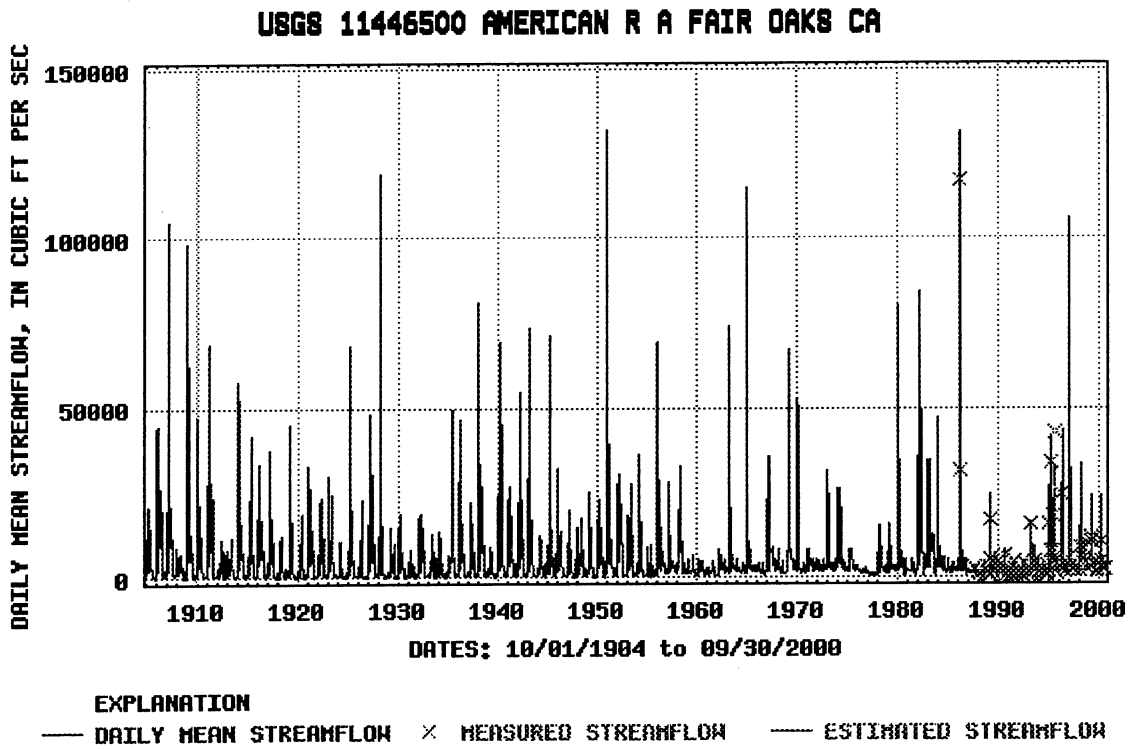
The drainage areas are:

station 01636500 on the Shenandoah River: drainage area = 3,022 mile$^2$
station 11446500 on the American River: drainage area = 1,888 mile$^2$

Hydrographs printed through the NWIS are reproduced on the next page.

2.10 Continued




2.11 Problem 2.11 consists of repeating Problems 2.9 and 2.10 for a gaging station of your choice.

2.12

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A, $ft^2$ | 3.6 | 11.1 | 19.5 | 25.8 | 22.8 | 19.2 | 14.4 | 6.9 |
| V, ft/s | 0.72 | 1.01 | 1.295 | 1.435 | 1.23 | 1.14 | 1.025 | 0.84 |
| Q, $ft^3/s$ | 2.6 | 11.2 | 25.3 | 37.0 | 28.0 | 21.9 | 14.8 | 5.8 |

flow rate = 147 $ft^3/s$

2.13

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A, $m^2$ | 1.90 | 3.96 | 5.28 | 6.28 | 7.10 | 5.36 | 3.06 | 0.98 |
| V, m/s | 0.345 | 0.425 | 0.47 | 0.505 | 0.59 | 0.535 | 0.42 | 0.30 |
| Q, $m^3/s$ | 0.656 | 1.683 | 2.482 | 3.171 | 4.189 | 2.868 | 1.285 | 0.294 |

flow rate = 16.63 $m^3/s$

2.14

| Subbasin Area $Km^2$ | Subbasin Area % | Annual Precipitation (mm) | Weighted Precipitation (mm) |
|---|---|---|---|
| 5,200 | 4.16 | 981 | 40.8 |
| 18,600 | 14.88 | 752 | 111.9 |
| 32,400 | 25.92 | 678 | 175.7 |
| 20,800 | 16.64 | 495 | 82.4 |
| 37,200 | 29.76 | 520 | 154.8 |
| 10,800 | 8.64 | 504 | 43.5 |
| 125,000 | 100.00 | | 609.1 |

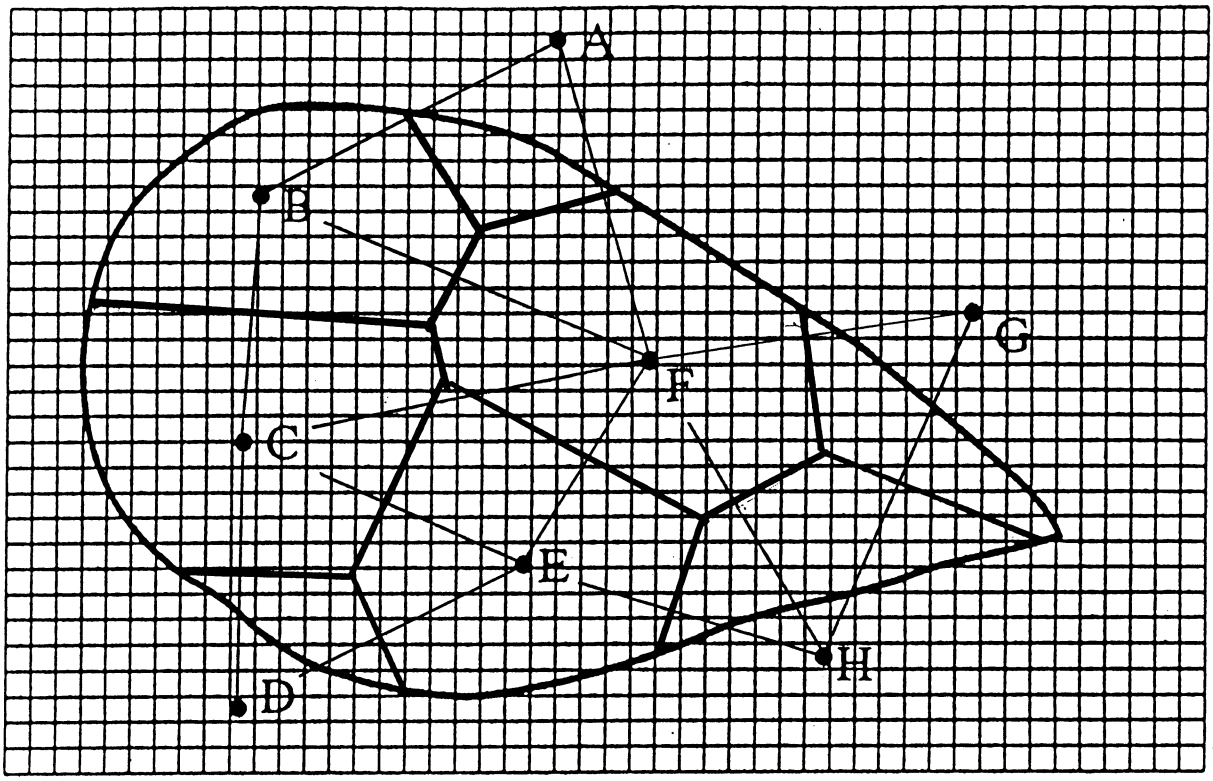
Basin mean annual precipitation = 609 mm

2.15

| Gage | Area (%) | Rainfall (mm) | Weighted Depth (mm) |
|---|---|---|---|
| A | 24 | 11 | 2.64 |
| B | 21 | 14 | 2.94 |
| C | 37 | 26 | 9.62 |
| D | 8 | 42 | 3.36 |
| E | 10 | 36 | 3.60 |
| | --- | | --- |
| Total | 100 | | 22.16 |

Average rainfall depth = 22 mm

2.16 and 2.17 The Thiessen polygon network for Problems 2.16 and 2.17 is provided below.




2.16

| Gage | Area (%) | Rainfall (inches) | Weighted Depth (inches) |
|---|---|---|---|
| A | 3 | 5.6 | 0.168 |
| B | 16 | 4.2 | 0.672 |
| C | 21 | 3.9 | 0.819 |
| D | 4 | 2.5 | 0.100 |
| E | 20 | 1.8 | 0.360 |
| F | 22 | 0.9 | 0.198 |
| G | 5 | 2.4 | 0.120 |
| H | 9 | 0.3 | 0.027 |
| Total | 100 | | 2.464 |

Average rainfall depth = 2.5 inches

2.17

| Gage | Area (%) | Rainfall (mm) | Weighted Depth (mm) |
|---|---|---|---|
| A | 3 | 25 | 0.8 |
| B | 16 | 18 | 2.9 |
| C | 21 | 92 | 19.3 |
| D | 4 | 95 | 3.8 |
| E | 20 | 192 | 38.4 |
| F | 22 | 175 | 38.5 |
| G | 5 | 152 | 7.6 |
| H | 9 | 168 | 15.1 |
| Total | 100 | | 126.4 |

Average rainfall depth = 126 mm