**CHAPTER 1**

*NO SOLUTIONS REQUIRED*

**CHAPTER 2**

**WATER RESOURCES PLANNING AND MANAGEMENT**

* 1. The Internet is an excellent source of information on this topic. The level of integrated water resources management varies by state.
	2. Virtually all of the laws listed in Table 2.1 provide some protection for preventing and controlling water pollution. Information on each law may be found on the Internet. It is also important to note that the EPA only regulates at the Federal level and much of the cleanup and protection is now delegated to states and local governments.
	3. Point source pollution = Pollution that originates at one location with discrete discharge points. Typical examples include industrial and wastewater treatment facilities. Nonpoint source pollution = Pollution that is usually input into the environment in a dispersed manner. Typical examples include stormwater runoff that contains fertilizers, pesticides, herbicides, oils, grease, bacteria, viruses, and salts.
	4. Adverse health effects of toxic pollutants are numerous and can include a variety of conditions. Some pollutant-related conditions include asthma, nausea, and various cancers—among many others.
	5. Agencies that are responsible for water quantity and quality significantly vary by state.
	6. This is a subjective question and one that has been and will continue to be debated in the water resources community.
	7. Integrated water resources management is difficult to achieve because it involves both a financial and resources investment over time. It is also important to obtain concensus on this approach from all of the involved stakeholders. This difficulty is perhaps why there are so few examples of true integrated water resources management.
	8. This question is subjective but the student should research specific examples to support their argument.

**CHAPTER 3**

**THE HYDROLOGIC CYCLE AND NATURAL WATER SOURCES**

* 1. The answer to this question will vary by location.

3.2 reservoir area = 3900/640 = 6.1 sq. mi.

 annual runoff = (14/12)(190 – 6.1)(640) = 137,704 ac-ft

 annual evaporation = (49/12)(3900) = 15,925 ac-ft

 draft = (100 X 365 X 106)/(7.48 X 43,560) = 112,022 ac-ft

 precipitation on lake = (40/12)(3900) = 13,000 ac-ft

 gain in storage = 137,704 + 13,000 = 150,704

 loss in storage = 112,022 + 15,925 = 127,947

 net gain in storage = 22,757 ac-ft

* 1. reservoir area = 1700 hec = 17 X 106 sq. meters

annual runoff = 0.3(500 X 106 – 17 X 106) = 144 X 106 sq. meters

annual evaporation = 1.2 X 17 X 106 = 20.4 X 106 sq. meters

draft = 4.8 X 24 X 60 X 60 X 365 = 151.37 X 106 m3

precipitation on lake = 0.97 X 17 X 106 = 16.49 X106 m3

gain in storage = 144 X 106 +16.49 X 106 = 160.49 106

loss in storage = 151.37 X 106 + 20.4 X 106 = 171.77 X 106

net loss in storage = 11.28 X 106 m3

* 1. To complete a water budget, it is first important to understand how the water budget will be used and what time step will be necessary to successfully model the system. Once the budget is conceptually designed, a variety of online sources can usually be used to collect the data. These sources include—but are not limited to:
* state regulatory agencies
* special water districts
* weather agencies,
* local governments
* geological surveys
* agricultural agencies

Historical data and previous reports can also yield important information on the system. Verification and calibration data should also be considered as part of the data collection effort.

* 1. The solution for this problem will vary based on location.

3.6

|  |  |  |  |
| --- | --- | --- | --- |
| Event (n) | Precip (inches) | Tr = n/m | Freq. (% years) |
| 1 | 33 | 10 | 10 |
| 2 | 29 | 5 | 20 |
| 3 | 28 | 3.33 | 30 |
| 4 | 28 | 2.5 | 40 |
| 5 | 27 | 2 | 50 |
| 6 | 26 | 1.67 | 60 |
| 7 | 22 | 1.4 | 70 |
| 8 | 21 | 1.25 | 80 |
| 9 | 19 | 1.1 | 90 |
| 10 | 18 | 1 | 100 |

n = 10, m = rank, Tr = n/m, Freq = (1/Tr) X 100 Then plot precipitation versus frequency.

3.7

|  |  |  |  |
| --- | --- | --- | --- |
| Event (n) | Precip (inches) | Tr = n/m | Freq. (% years) |
| 1 | 89 | 10 | 10 |
| 2 | 75 | 5 | 20 |
| 3 | 72 | 3.33 | 30 |
| 4 | 70 | 2.5 | 40 |
| 5 | 69 | 2 | 50 |
| 6 | 66 | 1.67 | 60 |
| 7 | 56 | 1.4 | 70 |
| 8 | 54 | 1.25 | 80 |
| 9 | 48 | 1.1 | 90 |
| 10 | 46 | 1 | 100 |

n = 10, m = rank, Tr = n/m, Freq = (1/Tr) X 100 Then plot precipitation versus frequency.

* 1. Once the data is organized in a table (see below), the solution can be found. Note that the cumulative max deficiency is 131.5 mg/mi2, which occurs in September. The number of months of draft is 131.5/(448/12) = 3.53. Therefore, enough storage is needed to supply the region for about 3.5 months.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Month | Inflow *I* | Draft *O* | Cumulative Inflow Σ *I* | Deficiency*O* - *I* | Cumulative DeficiencyΣ (*O* – *I*)\* |
| Feb | 31 | 37.3 | 31 | 6.3 | 6.3 |
| March | 54 | 37.3 | 85 | -16.7 | 0 |
| April | 90 | 37.3 | 175 | -52.7 | 0 |
| May | 10 | 37.3 | 185 | 27.3 | 27.3 |
| June | 7 | 37.3 | 192 | 30.3 | 57.6 |
| July | 8 | 37.3 | 200 | 29.3 | 86.9 |
| Aug | 2 | 37.3 | 202 | 35.3 | 122.2 |
| Sep | 28 | 37.3 | 230 | 9.3 | 131.5 |
| Oct | 42 | 37.3 | 272 | -4.7 | 126.8 |
| Nov | 108 | 37.3 | 380 | -70.7 | 56.1 |
| Dec | 98 | 37.3 | 478 | -60.7 | 0 |
| Jan | 22 | 37.3 | 500 | 15.3 | 15.3 |
| Feb | 50 | 37.3 | 550 | -12.7 | 2.6 |

\* Only positive values of cumulative deficiency are tabulated.

* 1. S = 128,000/10\*100\*640 = 0.20

3.10 S = 0.0002 = volume of water pumped divided by the average decline in piezometric head times surface area

 0.0002 = V/(400 X 100)

 Noting that there are 640 acres per square mile

 V = 0.0002 X 400 X 100 X 640 = 5120 acre-feet

3.11 Draft = (0.726 mgd) X (30 days/mo) = 21.8 mg/month

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month | Inflow *I* | Draft *O* | Deficiency*O* - *I* | Cumulative DeficiencyΣ (*O* – *I*)\* |
| April | 97 | 21.8 | -75.2 | 0 |
| May | 136 | 21.8 | -114.2 | 0 |
| June | 59 | 21.8 | 37.2 | 0 |
| July | 14 | 21.8 | 7.8 | 7.8 |
| Aug | 6 | 21.8 | 15.8 | 23.6 |
| Sep | 5 | 21.8 | 16.8 | 40.43 |
| Oct | 3 | 21.8 | 18.8 | 59.2 |
| Nov | 7 | 21.8 | 14.8 | 74 |
| Dec | 19 | 21.8 | 2.8 | 76.8 |
| Jan | 13 | 21.8 | 8.8 | 85.6 |
| Feb | 74 | 21.8 | -52.2 | 33.4\* |
| March | 96 | 21.8 | -74.2 | 0 |
| April | 37 | 21.8 | -15.2 | 0 |
| May | 63 | 21.8 | -41.2 | 0 |
| June | 49 | 21.8 | -27.2 | 0 |

\*Maximum storage deficiency is January 85.6 mg/mo/sq. mi.

Storage capacity = 85.6 mg/mo/sq.mi.

* 1. Pn = (1 – 1/Tr)n

log Pn = n Log (1 – 1/Tr)

n = log Pn/log (1 – 1/Tr)

A straight line can be defined by this equation and the following probability curves will appear.