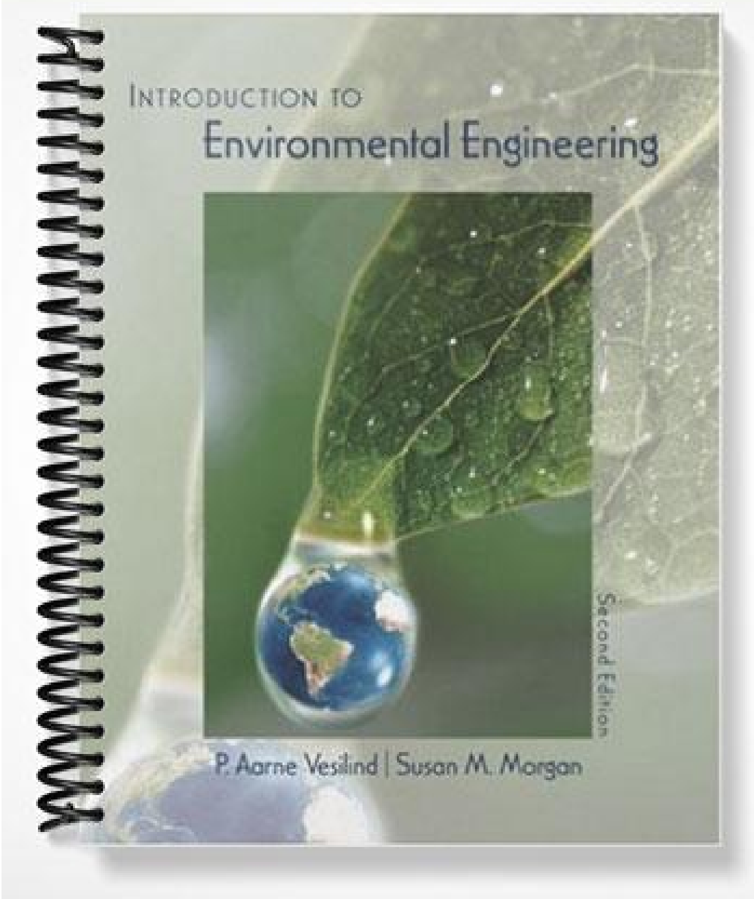
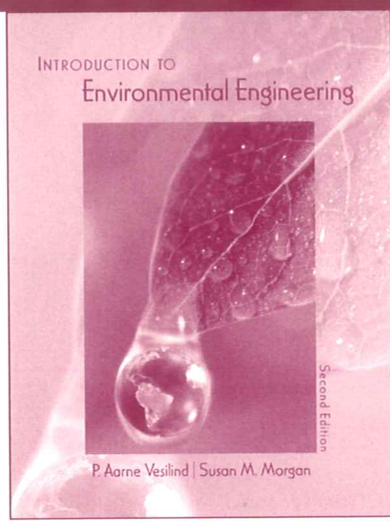
SOLUTIONS MANUAL



Solutions Manual



for Vesilind and Morgan's

Introduction to Environmental Engineering

Second Edition

Susan M. Morgan
P. Aarne Vesilind

Solutions Manual

for

Vesilind/Morgan's

Introduction to Environmental Engineering

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Chapter 1

Section 1.1

1. Most people assume it is safe, as they assume most products they buy are safe. Is it the government's responsibility? The product manufacturer's? The seller's?
2. There are several types of hepatitis and many routes to exposure. Hepatitis A is the most prevalent. Hepatitis A and hepatitis E are mainly transmitted through the fecal-oral route, while hepatitis B, C, and D are spread through blood or other body fluids (e.g., saliva, semen, and urine). Hepatitis can be transmitted sexually as well as through shared utensils (e.g., razors and toothbrushes) and un-sterile instruments and needles (including intravenous drug use).
3. Is the university at fault? The family of the children? The city? The water company?

Section 1.2

1. Lowest risk that is practical—i.e., technically, socially, and economically feasible.. Issues – wearing seat belts, distractions while driving (e.g., cell phones, radio, talking), strong cars vs. fuel efficiency, etc.
2. Why is this the most important issue? How does this affect me?
3. Exposure to "germs," especially at a young age, is important in developing the immune system.

Section 1.3

1. Economic hardship – let companies continue polluting to provide jobs
2. Everyone eventually dies. Everyone has a reason for living.
3. Communication gap? Some people have limited exposure to pets? Hierarchy with people at the top? Suffering isn't as great? (Similar concept applies to prosecution of animal abuse cases – with some atrocious acts being committed with minor punishment compared to if the act was committed on a human)

Section 1.4

1. Toxicity. Minor nutrient.
2. Where is the contamination and in what levels? What levels are dangerous? Is the contamination contained where it is or does it need to be removed or treated? How can it be removed or treated so that risks are minimized?
3. Yes, it's possible for something to be beneficial to human health at low doses but detrimental at high doses—e.g., salt, fat, minor nutrients, alcohol. Depending on levels, water is necessary for life so low doses are bad but extremely high doses can dilute the blood chemistry.

Section 1.5

1. An infectious agent killed the Martians. None of the technological solutions worked.
2. Romanticized. Novels, movies, plays, etc. are entertainment – idealized conditions. We don't want to be hit with the nitty gritty realities.
3. Many old city sewers are very large diameter. Building with brick, building a larger sewer would be easier than a small sewer.

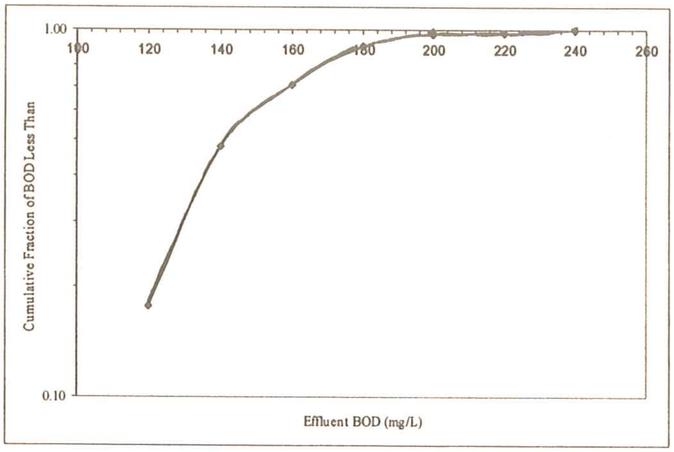
Section 1.6

1. Typically, most waste is landfilled. Some might be incinerated commercially; some might be burned by citizens. Recycling is also popular in many areas. Some might also wind up as litter or be illegally dumped.
2. MSW is not considered by law to be a hazardous waste or material. However, it contains many items that can be hazardous, such as batteries and cleaning fluids; these items are known as household hazardous waste. Some areas have permanent collection sites for these materials; some areas have specific collection days. Some states ban certain materials from landfills, such as batteries. These materials are collected by suppliers, i.e., an auto repair shop.
3. Government has the responsibility to look at the big picture. However, states and individuals have certain rights as well.

Chapter 2

2-1.
Use grouped data analysis. Determine the average BOD for each range. Normalize the number of samples in each group by dividing by the total number of samples (102) to obtain the fractional probability. Using probability paper, plot fractional probability versus BOD (mg/L).

BOD Range mg/L	Mean mg/L	Samples r	Sum r	P (Sum r)/n
110 - 129	120	18	18	0.176
130 - 149	140	31	49	0.480
150 - 169	160	23	72	0.706
170 - 189	180	20	92	0.902
190 - 209	200	7	99	0.971
210 - 229	220	1	100	0.980
230 - 249	240	2	102	1.000



(a) $P_{10} = 112$ mg/L
(b) $P_{50} = 142$ mg/L
(c) $P_{95} = 195$ mg/L

2-2.
(a) Use standard deviations for a normally distributed curve, i.e., ±0.335 with a mean at 0.5 probability.
C_v = (mean)/(standard deviation)

Fractional Probability	Cheyenne	Pueblo	Kansas City
0.5 – 0.335 = 0.165	14.61 – 3.61 = 11.00	11.51 – 5.29 = 6.22	36.10 – 6.64 = 29.46
0.5	14.61	11.51	36.10
0.5 + 0.335 = 0.835	14.61 + 3.61 = 18.22	11.51 = 5.29 = 16.80	36.10 + 6.64 = 42.74
Coefficient of variation	4.05	2.18	5.44

Kansas City has the most variable rainfall.

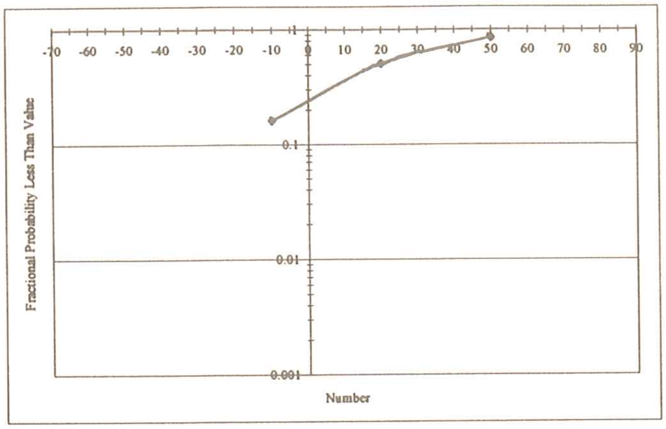
(b) Use probability paper to plot probability values versus rainfall. From the graph, determine the fractional probability (x) that rainfall will be less than 20 in/y for each city. Then the probability that rainfall will exceed 20 in/y is 1 – x. Multiply this fraction by 50 y to determine how many of the next 50 y will have rainfall exceeding 20 in.
Cheyenne: ~3 – 4 y (3.5 y)
Pueblo: ~2 – 3 y (2.5 y)
Kansas City: ~50 y (i.e., every year)

(c) Cheyenne: (0.2)(50 y) = 10 y
Pueblo: (0.52)(50 y) = 26 y
Kansas City: (~0)(50 y) = ~0 y

(d) 1 – 0.5 = 0.5

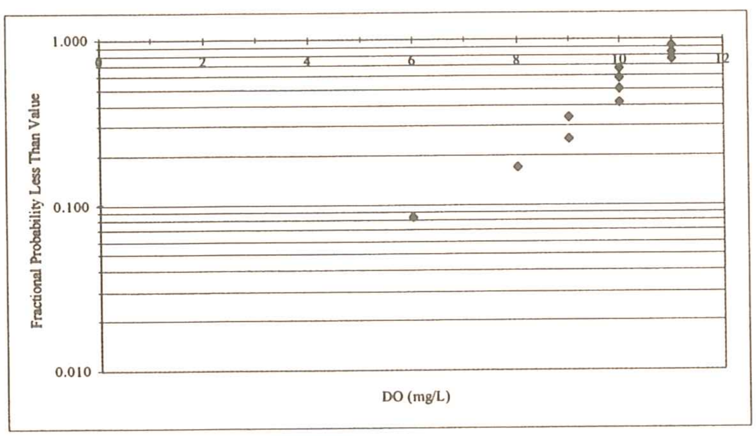
2-4.

Using probability paper, plot fractional probability versus number.



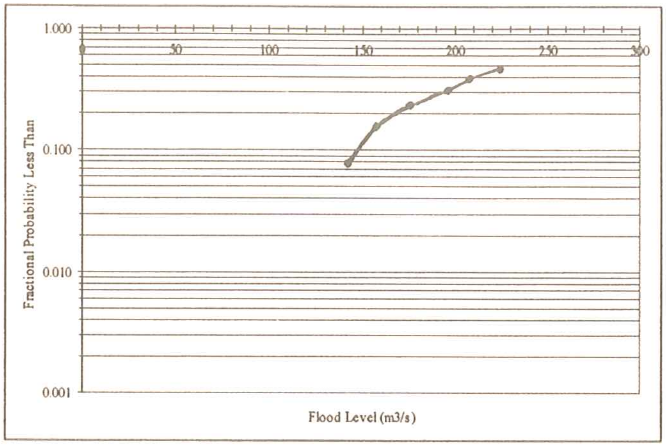
(a) $1 - 0.975 = 0.025$
(b) ~0.975
(c) <0.001
(d) $p = 1 - 0.84 = 0.16$ that $x \geq 50$ and $p = 0.025$ that $x \geq 80$ so $p = 0.16 - 0.025 = 0.135$

2-5.



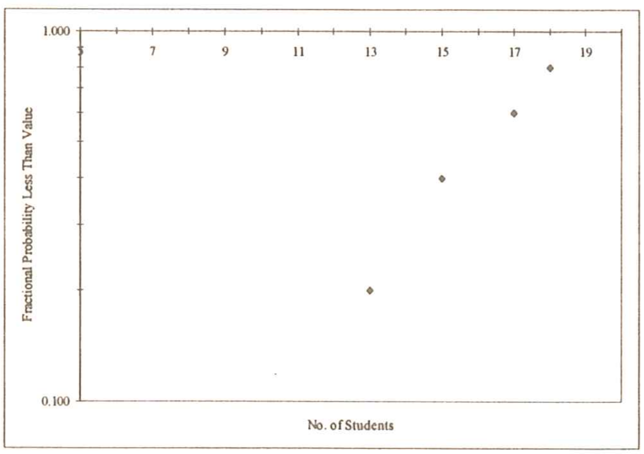
(a) $p \approx 1 - 0.6 = 0.4$
(b) $p \approx 0.2$
(c) Average = $117/12 = 9.75$ mg/L ≈ 10 mg/L
(d) Std dev = $(28.25/11)^{0.5} = 1.6$ mg/L

2-6.
Plot fractional probability versus flood level.
Return period = 1/fractional probability
Fractional probability = 1/500 = 0.002
Probability = 1- 0.002 = 0.998



Flood level ≈ 260 m^3/s

2-7.



P ≈ 0.14 so (barring any size constraints that will affect the probability) the number of years out of 20 that will have a class with fewer than 10 students is (0.14)(20 y) = 2.8 y, so ~3 y

2-8.
Assume a consumption rate (volume per person per day)

2-9.
Sulfur emissions = 0.2 x (electricity production)/(energy content)
= 0.2 x (0.28 x 10^{12} W)(1 J/s / W)(3.15 x 10^7 s/y) / (30 x 10^6 J/kg) = 5.9 x 10^{10} kg/y

2-12.
C = (1 g)/[(8 oz)(0.249 L/ 8oz)] = 4.0 g/L
Assuming that tap water does not contain salt and that the salt takes up no volume