Chapter 1

Section 1.2.1

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 1.2.2

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), heavier, safer cars vs. lighter, fuel efficient cars, 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 1.2.3

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 1.2.4

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. (See http://info.med.yale.edu/caim/umd/chemsafe/references/dose.html. Per Paracelsus (1493 - 1541), "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison.")

Section 1.2.5

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. When building with brick, building a larger sewer would be easier than a small sewer. Many old city sewers are very large diameter and built out of brick. The engineers won out.

Section 1.2.6

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. While technically not a waste if reused, some "waste" is donated to charities, families, and friends and some is sold in second-hand stores, flea markets, and yard sales.

2. MSW is considered by law to not 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.

Section 1.3

1. Its ability to replace other materials, e.g., fertilizers. Technology, end use, economics.

2. Energy use, footprint. Consider methods to reduce energy use; make use of kinetic energy of flowing water; consider alternative disinfectants; consider source control and conservation efforts to reduce the amount of drinking water required and the amount of wastewater generated; integrate recycling water and waste materials into designs; increase use of rainwater harvesting and stormwater reuse.

Chapter 2

2-1. Total pipe cost = (\$/ft) (15 mi) (5280 ft/mi)
Total capital cost = (total pipe cost) + (pumping station capital cost)
Annual capital cost (principal + interest) = (total capital cost) (C_R)
C_R = capital recovery factor = 0.10185 for 20 y at 8%
Total annual cost = (annual capital cost) + (annual power cost)

Pipe Diameter (in)	Total Pipe Cost (\$)	Pumping Station Capital Cost (\$)	Total Capital Cost (\$)	Annual Capital Cost (\$/y)	Annual Power Cost (\$/y)	Total Annual Cost (\$/y)
8	396,000	150,000	546,000	55,610	10,000	65,610
10	633,600	145,000	778,600	79,300	8,000	87,300
12	950,400	140,000	1,090,400	111,057	7,000	118,057
16	1,108,800	120,000	1,228,800	125,153	6,000	131,153

(a) On the basis of total annual cost, the cheapest alternative is the 8-in pipe at \$65,610/y. One would have to assume that the 8-in pipe would have adequate capacity for the projected needs over the expected life of the system.

(b) Hedonistic ethics require maximizing personal pleasure. The engineer would recommend the 16-in pipe as the total capital cost, \$1,228,800, is the highest.

2-2. (a) Current waste disposal cost = \$1,200,000/y

Proposed waste disposal cost = (annual capital cost) + (annual operation cost) + (rent)

Annual capital cost = (capital cost) (C_R) = (\$800,000) (0.10185) = \$81,480/y
Proposed waste disposal cost = (\$81,480/y) + (\$150,000/y) + (\$200,000/y) = \$431,480/y

For the power company, the proposed waste disposal method is a good deal; it saves them \$768,520/y.

2-3. B/C ratios can be done with either annual costs or present worth costs. The only criterion is that all the costs have to be in the same units (i.e., either \$ or \$/y).

Benefits:
Annual benefits = (\$5.00/wk) (52 wk/y) = \$260/y
Present worth of benefits = (annual benefit) (C_P) = (\$260/y) (1.8333) = \$476.66

Costs:
Annual costs = (operating cost) + (capital cost) (C_R)
= (\$1.50/wk) (52 wk/y) + (\$4.00 + \$0.50) (0.54544) = \$80.45/y

Present worth of costs = (capital costs) + (operating cost) (C_P)
= (\$4.00 + \$0.50) + (\$1.50/wk) (52 wk/y) (1.8333) = \$147.50

$$B/C = \frac{\$260/yr}{\$80.45/yr} = \frac{\$476.66}{\$147.50} = 3.2$$

Because the B/C ratio is greater than 1, you should build the birdhouse.

2-4. Some items to consider…(1) Defense: collect data to determine potential effects in current and future uses for the stream and (2) Definition of pollution: What is unreasonable? What is a beneficial use? Who decides?

2-5. Some items to consider…Personal ethics, professional ethics, societal morals, public relations, B/C or other economic analysis

2-6. Some items to consider…Personal ethics, societal morals, effects on ecosystem and on vehicle, potential accidents caused

2-8. Original estimates:

Estimated construction cost = \$1.5 mil
Estimated benefit = \$2 mil
B/C = 1.3
Decision = build

Actual costs:

Actual construction cost = \$3 mil
Estimated benefit = \$2 mil
B/C = 0.7
Decision = do not build

Sunk cost method:

Assume sunk costs = \$1 mil
Additional construction cost = \$3 mil – \$1 mil = \$2 mill
Estimated benefit = \$2 mil
B/C = 1
Decision = break-even, build

2-12. For the environmental effects of deicers, see, for example, Michigan DOT's research on deicer effects and mitigating measures.

2-13. Capital costs – including permits and potential delays, operating costs – including pollution control and waste management, safety/insurance issues, public relations, potential future regulations, potential supply issues

2-14. (a) The calculation can be done on present worth or annual costs.