we learned to treat these contagious diseases, smoking probably had little effect on overall life expectancy. Now that these other causes of death are practically gone, we live long enough that smoking has a real effect on life expectancy. So also with air pollution.

It is useful to contrast the air pollution situation, for which we have taken action so recently, with water pollution, for which we have had active programs for over a century. The worst water problems were caused by contamination of drinking water with human sewage. This quickly spreads cholera, typhoid, and amoebic dysentery. These diseases are sudden and dramatic in onset and often swiftly fatal. Their connection with polluted water is easily demonstrated. Thus, we responded to he water pollution problem much sooner and more vigorously than we have to the iir pollution problem.

Evidence of the effects of air pollution on health (see Chapter 2) is much less lramatic than that for water pollution. One can seldom point to a pile of corpses and ay, "They died of air pollution," as one can after a cholera outbreak due to polluted vater. The effects are more like those of smoking; we seldom say, "He died of moking," but we know that smoking has been shown to decrease the life expectancy f the smoker and to increase the incidence of certain well-defined illnesses in nokers and in those who breathe secondhand smoke. The fact that so many people—icluding educated people—smoke demonstrates that this type of argument is not persuasive as the sight of the corpses after an epidemic spread by water pollution. any people do not take very seriously the loss of life and health due to air pollution, e that due to smoking, because they believe it is "only statistical."

The effects of air pollution and of smoking are also analogous in that many ople who have lived in badly air-polluted environments all of their lives have cellent lungs and hearts. Similarly, everyone knows someone who lived to be a gorous 95 and smoked cigarettes or cigars every day. Those examples exist; the unterexamples died younger, of diseases caused or aggravated by air pollution or oking.

Public awareness of air pollution developed at a period when the problem was s severe in many respects than it had been previously. Before the introduction natural gas as the principal fuel in most U.S. cities, winter air was much dirtier h coal soot than it is now. Likewise, early in this century, the emissions of sulfur xide from copper smelting in cities such as Tacoma, Salt Lake City, El Paso, and iconda were much greater than they are now. At those times, there must have n dissatisfaction about these sources of pollution, but presumably not at the level have had in the past few years.

This increase in awareness is partly explained by the increased wealth of the ıtry, as mentioned before. We once thought these pollutants were necessary comitants of a prosperous economy; we now know otherwise. Similarly, we believed that nothing could be done about such problems. Now that we have ied to read the genetic code and put people on the moon, it is harder to argue we cannot control air pollution. We can; this book explains the technical bases some of the details of how to do it.

FROM deNevers (2000)

1.3 DIRTY AIR REMOVAL OR EMISSION CONTROL?

Example 1.1. The area of the Los Angeles basin is 4083 square miles. The heavily polluted air layer is assumed to be 2000 ft thick on average. One solution to Los Angeles' problems would be to pump this contaminated air away. Suppose that we wish to pump out the Los Angeles basin every day and that the air must be pumped 50 miles to the desert near Palm Springs. (We assume the residents of Palm Springs won't complain.) Assume also that the average velocity in the pipe is 40 ft/s. Estimate the required pipe diameter.*

The flow rate required is

$$Q = \frac{AH}{\Delta t} = \frac{4083\ \text{mi}^2 \cdot 2000\ \text{ft}}{24\ \text{h}} \cdot \frac{(5280\ \text{ft/mi})^2}{3600\ \text{s/h}} = 2.63 \times 10^9\ \frac{\text{ft}^3}{\text{s}}$$

$$= 7.47 \times 10^7\ \frac{\text{m}^3}{\text{s}}$$

and the required pipe diameter is

$$D = \sqrt{\frac{4Q}{\pi V}} = \sqrt{\frac{4 \times 2.63 \times 10^9\ \text{ft}^3/\text{s}}{\pi \times 40\ \text{ft/s}}} = 9158\ \text{ft} = 2791\ \text{m} \quad ■$$

This is about six times the height of the tallest man-made structure, and far beyond our current structural engineering capabilities. Similar calculations (Problem 1.1) show that the power required to drive the flow exceeds the amount of electrical power generated in the Los Angeles basin. We are unlikely to solve our air pollution problems by pumping away the polluted air, although this solution is still frequently proposed. Instead, we must deal with those problems by reducing emissions, the principal subject of the rest of this book.

1.4 ONE PROBLEM OR A FAMILY OF PROBLEMS?

In Table 1.1 we see emissions estimates for the major man-made pollutants for the United States in 1997. From this table, we see the following:

1. There are six individual pollutants listed, which are the major regulated pollutants in the United States. There is a much longer list of other pollutants, emitted in much lesser quantities and regulated in a different way in the United States (see Chapters 3 and 15).
2. Some of the pollutants come mostly from transportation (motor vehicles) and others come mostly from industrial sources.
3. There is no entry for "General air pollution." The public thinks in terms of "general air pollution" and wonders if the problem is mostly industry (them) or autos (us).

*Note: The symbol ■ indicates the end of an example.