

compare its discoverable advantages and disadvantages with the predicted advantages and disadvantages of the proposed reform, discounting as best we can for our lack of science. On the basis of such a comparison, we can make a rational decision which will involve the unworkable assumption that only perfect systems are tolerable.

**Recognition of Necessity**

Perhaps the simplest summary of this analysis of man's population problems is this: commons, if justifiable at all, is justifiable only under conditions of low-population density. As the human population has increased, the commons has had to be abandoned one aspect after another.

First we abandoned the commons in food gathering, enclosing farm land and fencing pastures and hunting and fishing areas. These restrictions are still not complete throughout the world.

Somewhat later we saw that the commons as a place for waste disposal would also have to be abandoned. Restrictions on the disposal of domestic sewage are widely practiced in the Western world; we are still struggling to close the commons to pollution by automobiles, factories, insecticide sprayers, fertilizing operations, and atomic energy installations.

In a still more embryonic state is our recognition of the evils of the commons in matters of pleasure. There is almost no restriction on the propagation of sound waves in public medium. The shopping public is assaulted with mindless music, without its consent. Our government is paying out billions of dollars to create supersonic transport which will disturb 50,000 people for every one person who is whisked from coast to coast 3 times faster. Advertisers muddy the airwaves of radio and television and pollute the view of travelers. We are a long way from outlawing the commons in matters of pleasure. Is this use of our Puritan inheritance makes us view pleasure as something of a sin, and pain (as, the pollution of advertising) as the sign of virtue?

Every new enclosure of the commons involves the infringement of somebody's personal liberty. Infringements made in the distant past are accepted because no one temporarily complains of a loss. It is the newly proposed infringements that we vigorously oppose; cries of "rights" and "freedom" fill the air. But what does "freedom" mean? When men mutually agreed to pass laws against robbing, mankind became more civilized, not less so. Individuals locked into the logic of the commons are free only to bring on personal ruin; once they see the necessity of mutual coercion, they become free to pursue their own goals. I believe it was Hegel who said, "Freedom is the recognition of necessity."

The most important aspect of necessity that we must now recognize, is the necessity of abandoning the commons in breeding. No technical solution can rescue us from the tragedy of overpopulation. Freedom to breed will bring ruin to all. At the moment, to avoid making decisions many of us are tempted to propagandize for conscience and responsible citizenship. The temptation must be resisted, because an appeal to independently acting consciences selects for the disappearance of all conscience in the long run, and an increase in anxiety in the short.

The only way we can preserve and nurture other and more precious freedoms is by relinquishing the freedom to breed, and that very soon. "Freedom is the recognition of necessity"—and it is the role of education to reveal to all the necessity of abandoning the freedom to breed. Only so, can we put an end to this aspect of the tragedy of the commons.

# Environmental Engineering

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Environmental regulations have existed for centuries. Because of poor air quality near his palace in about A.D. 1300, King Edward II of England reportedly ordered any person burning coal to be hanged. However, no major environmental legislation in any country existed until the second half of the twentieth century. The first significant laws in this area were federal statutes passed in the United States in the 1970s dealing with air and surface water quality and hazardous waste.

Those laws are still in effect in much of their original form. However, they are still in a period of transition. What is legal or accepted practice today may be illegal in a few years. When today's average college student was born, the first significant environmental laws had been passed, but their requirements were just beginning to become effective. You have been witness to the most sweeping environmental regulations in history.

This chapter introduces the process that brings about changes in environmental law, and briefly describes major federal environmental laws. More detailed discussions of each area of legislation will appear where appropriate in later chapters.

## CONTENT OF ENVIRONMENTAL REGULATIONS

The U.S. Congress writes environmental laws. For such legislation to be enacted, lawmakers must perceive that environmental regulation benefits society. Only after legislators see the public interest in and the public's desire for such laws will they be passed. In the United States a law can be passed by a simple majority of the House of Representatives and the Senate if the bill is signed by the president. However, if the president vetoes the bill, a two-thirds majority of both houses is required to override. Several important pieces of environmental legislation have been passed over presidential vetoes during the past twenty-five years.\*

When Congress passes environmental legislation, it directs the appropriate federal agency to develop and publish regulations to implement it. Before 1970 the U.S. Public Health Service was the agency most concerned about environmental matters. In 1970 Congress created the U.S. Environmental Protection Agency. Since then the EPA has been responsible for enforcing applicable federal laws. In many cases the laws allow the states to adopt and enforce the federal laws.

There are laws, for example, to protect people from the toxic effects of copper and lead in drinking water. These require the EPA to determine

acceptable levels of the contaminants and what must be done to bring excessively high levels into compliance. In this case the EPA set maximum contaminant levels for metals, and public utilities are now required to test their drinking water for actual amounts. If a public water supply has levels in excess of the limits, responsible officials must initiate a treatment plan to reduce the contamination. Individual states may adopt the federal regulations and obtain EPA permission to enforce them.

## Why Are Environmental Laws Passed?

Hindsight tells us that the United States should have passed hazardous waste laws in about 1940. Regulations would then have been in place as the petrochemical industry developed. However, in the 1940s the world did not envision a petrochemical industry—or the hazardous wastes it was later to generate.

Hazardous wastes became more and more of an issue during the 1970s. Although many toxic compounds existed before the 1940s, during that decade synthetic organic chemistry was born, and with it came catalytic synthesis of gasolines from heavier crude oils. That infant enterprise bloomed into the massive petrochemical industry of today. Many synthetic organic chemicals are carcinogenic, but carcinogens often have latency periods of 10 to 20 years. Thus, it took decades for scientists, engineers, and physicians to recognize the link, which is tenuous even today, between particular chemicals in the environment and adverse health effects. One initial missing element was the ability to detect chemicals at extremely low levels. One cannot regulate something that cannot be detected. Where typical laboratory detection limits were in the mg/L range in the 1950s, they are in the  $\mu\text{g/L}$  or ng/L range today. In other words, detection limits are three to six orders of magnitude lower.

The point is, people in industry did not even imagine the hazards they were creating in the 1940s and 1950s. These dangers were not realized until the 1960s and 1970s. Even today we do not understand what effects extended exposure to low levels of many chemicals may cause. However, technical people have gradually become aware of environmental problems related to a wide array of synthetic chemicals, many of them herbicides and insecticides. After these problems were understood and made public, citizens and Congress had to be convinced of the seriousness of the risks, so laws could be passed to protect human health and the environment. Unfortunately, this is often a slow process.

## The U.S. Environmental Protection Agency

Congress created the U.S. Environmental Protection Agency in December of 1970, giving it several missions: to establish standards to protect the environment consistent with U.S. goals; to conduct research on the adverse effects of pollution and methods and equipment for controlling it; to gather

\*The Clean Water Act of 1972 (PL 92-500) was passed over President Nixon's veto. The Resource Conservation and Recovery Act and the reauthorization of the Clean Water Act in 1987 were passed over President Reagan's vetoes.

information on pollution and its effects; to use this information to strengthen environmental protection; to help others protect the environment through grants and technical assistance; and to assist the Council on Environmental quality in developing and recommending to the president new policies on protecting the environment.

The EPA is the primary agency responsible for protecting the environment, although several other agencies are also involved in particular areas. One exception is the control of nuclear wastes, where primary responsibility lies with the U.S. Department of Energy. The EPA's duties include enforcement of air quality standards, drinking water quality standards, stream discharge standards, solid and hazardous waste disposal standards, and the cleanup of abandoned hazardous waste sites. In many cases the agency encourages or allows individual states to take over the primary enforcement of these standards, but federal officials maintain overall responsibility. The EPA has divided the nation into ten regions, with an office and administrator for each. The regions are shown in Figure 2.1, the office addresses in Table 2.1.

State agencies enforce state environmental laws and regulations—and in many cases the federal regulations as well. In general, for a state to enforce the federal regulations, it must first adopt regulations equivalent to

TABLE 2.1 U.S. EPA Regional Office Addresses

|   |  |
|---|--|
| U.S. EPA Region 1<br>JFK Building<br>Boston, MA 02203               | U.S. EPA Region 2<br>26 Federal Plaza<br>New York, NY 10278  |
| U.S. EPA Region 3<br>841 Chestnut Street<br>Philadelphia, PA 19107  | U.S. EPA Region 4<br>345 Courtland Street, NE<br>Atlanta, GA 30365                                   |
| U.S. EPA Region 5<br>77 West Jackson Blvd.<br>Chicago, IL 60604     | U.S. EPA Region 6<br>First Interstate Bank Tower<br>1445 Ross Avenue, Suite 1200<br>Dallas, TX 75202 |
| U.S. EPA Region 7<br>726 Minnesota Avenue<br>Kansas City, KS 66101  | U.S. EPA Region 8<br>999 18th Street, Suite 1500<br>Denver, CO 80202                                 |
| U.S. EPA Region 9<br>75 Hawthorne Street<br>San Francisco, CA 94105 | U.S. EPA Region 10<br>1200 Sixth Avenue<br>Seattle, WA 98101   |

or stricter than federal requirements. The names of state agencies vary. There is, for example, the New Jersey Department of Environmental Protection, the Arkansas State Department of Pollution Control and Ecology, and the Illinois Environmental Protection Agency.

### Methods of Regulation

Speed laws in this country are regulated by posting the legal speed limit on each highway, and spot checking motorists to ensure compliance. There is no way to prevent motorists from speeding if they desire to do so. However, they run a risk of being apprehended by police officers using radar or other speed detection instruments. The penalty for speeding is usually a fine. Environmental laws often work in a similar manner. The city or industry (discharger) must obtain a permit that states the types of pollutants that may be discharged and the allowable amounts. The permit is equivalent to highway speed limit signs. The discharger must monitor the levels of the various pollutants, an action analogous to a driver watching a speedometer, and keep these below the permitted levels. One difference, however, is that the discharger, as a part of the permit, must not only check levels of various pollutants, but also submit reports on these levels every 3 months. This would be equivalent to the government requiring you, to turn in quarterly summaries of the maximum speeds at which you drive each day.

When dischargers violate their permit conditions, they must notify the

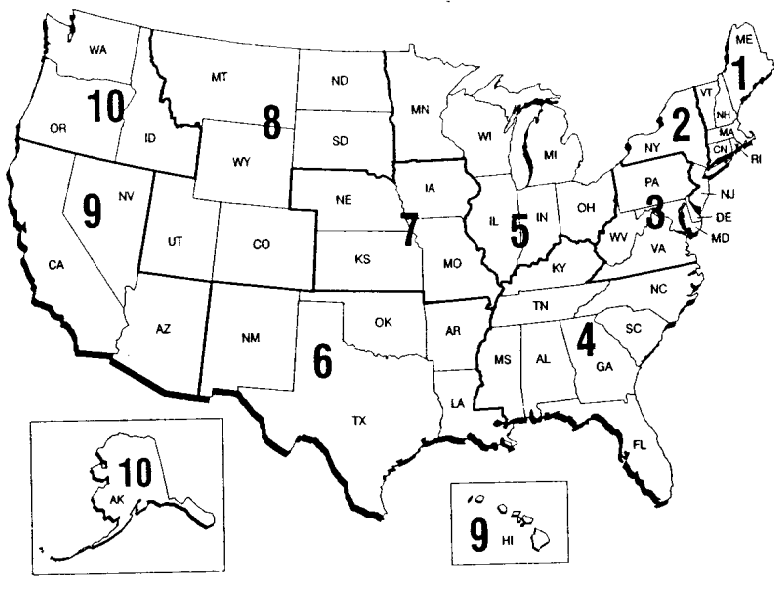


FIGURE 2.1 U.S. EPA Regions.

revolving state loan program over a period of 4 years. [1]. In addition, it required permits for storm water discharge from city streets, parking lots, and industrial areas.

**Air Quality Regulations.** Since air pollution has two major sources—industry, including power plants, and highway vehicles—the approach to regulating and improving air quality is somewhat different from that applied to other types of pollution. The federal government has approached this by requiring limits on emissions from industries and power plants and by requiring auto manufacturers to produce vehicles with improved emissions. The first federal legislation in this area was the Air Pollution Control Act of 1955, PL 84-159. It did not really control air pollution, but it did provide for research on its effects and training of pollution control personnel. The law was a small first step. Other legislation followed in 1962 and 1963, and in 1965 the Motor Vehicle Air Pollution Control Act, PL 89-272, was passed. This began the auto emissions controls that remain in effect. Other laws were passed in 1967, 1970, and 1977, and controls on industries and power plants have gradually increased. The most recent major legislation is the Clean Air Act Amendments of 1990, which requires reductions in air pollutants in major cities not in compliance with air quality standards. The 1990 measure tightens emission requirements for automobiles and trucks and places additional controls on almost 200 toxic air pollutants [5].

## DRY METHODS

Water quality standards can be based on either the quality of the effluent being introduced into the environment or on the quality of the surrounding environment, or both. Each method has advantages. Standards maintaining a set environmental quality are probably best for the environment. But they are difficult to regulate. Where multiple dischargers exist, it is often difficult to prove which is responsible, and in some cases, several dischargers may be responsible for a single adverse condition. An extreme example is metropolitan smog. Do you blame the industries present? If so, which ones? Do you blame the automobiles emitting pollutants? The trucks and busses? In reality, all are partially responsible. So how do you reduce smog? Possible options are shown in Table 2.2.

### Environmental Quality-Based Standards

Environmental quality-based standards\* focus on the quality of the receiving water or local air. A discharger may release pollutants in any

\*Environmental quality-based standards are often called **stream-based standards** when applied to water, although the concept applies to lake or ocean water as well. When applied to air quality, these requirements are often termed **ambient air quality standards**.

TABLE 2.2 Methods of Controlling Air Pollution in Cities

| SOURCE      | POLLUTANTS                                | METHODS OF CONTROL   |
|-------------|---|--|
| Industries  | Volatile organics                         | Require reduced emissions  |
|             | Volatile chlorofluorocarbons              | Require reduced emissions  |
|             | Particulate inorganics                    | Require reduced emissions  |
| Automobiles | Hydrocarbons                              | Improve discharge nozzles at filling stations and ventilation in gasoline tanks  |
|             | Products of incomplete combustion         | Require better combustion efficiency of auto makers and emission testing and regular engine maintenance of drivers<br>Limit gasoline suppliers to oxygenated fuels |
|             | Chlorofluorocarbons from air conditioners | Require the redesign of automobile air conditioners so vehicles made in the future can use other refrigerants.   |

quantity that does not cause the receiving water or local air quality to drop below established minimums. **Receiving water quality standards** have advantages. They maintain the water or air quality above a preset minimum, and dischargers can get rid of larger quantities of water pollutants during high-flow/low-temperature periods or more air pollutants during windy/low-temperature periods. However, there are significant disadvantages as well. One is the difficulty of enforcement, particularly where there are multiple dischargers within a given stream reach or local area. Also, water conditions are hard to monitor. A discharger's required effluent quality varies with the stream flow, wind currents, and temperature, so monitoring must be continuous. In many cases dischargers need to take measurements elsewhere because upstream contaminant levels affect the amounts of pollutants that can be discharged, on site. And to benefit from such standards, industries must have highly trained personnel and real-time monitoring equipment. Thus, it is difficult for most dischargers to maintain compliance.

### Effluent-Based Standards

**Effluent-based standards** concentrate on the quality of the discharger—either water or air. With this type of requirement, a discharger has definite parameters to meet, and workers do not have to concern themselves with variations in stream flow, weather conditions, temperature or other receiv-

ing water or air conditions. Complying with effluent-based standards is also easier from the standpoint of consistency. There is a specific allowable level for each pollutant based on discharge concentration, discharge mass, or both. The discharger must keep contaminants below that limit.

For the same reasons it is also easier for regulatory agencies to monitor effluent-based standards. One apparent disadvantage of them, however, is that they do not allow flexibility in protecting the ambient environmental quality. But since streams can better assimilate wastes during cooler weather and high water flows, different effluent standards can be set for different seasons. Such an approach combines advantages of the two regulatory methods, and similar flexibility can be built into air pollution control as well.

## 7 ENVIRONMENTAL ETHICS

A corporation is in business to make a profit for its shareholders. Its primary purpose is not to protect the environment. However, businesses are required to comply with environmental regulations—a process that normally requires a significant investment in both capital expenditure and operating costs. When environmental regulations are applied fairly overall, other factors usually play a dominant role in determining the relative profitability of competing companies. However, where one facility operates in a location where environmental regulations are more stringent than those experienced by competitors, it may be required to operate at lower profit, or at a loss. Or it may have to raise its prices. Few companies are successful at selling equivalent products at prices higher than those of the competition. And companies cannot operate at a loss for extended periods. They must either close or move to areas where environmental regulations are less restrictive. Applied uniformly, federal standards are the fairest method of providing environmental protection while allowing businesses to compete.

There are exceptions to the free-market rule that companies cannot sell products for long at uncompetitive prices. Particularly in recent years, some consumers have been willing to spend more for “environmentally friendly” products. A number of such products—including everything from recycled paper made into bathroom tissue to automobiles to fast food to many small consumer goods packaged in recyclable paper—are doing well. So progress is being made.

## 7 Questions

1. Distinguish between effluent-based standards and water quality-based standards.

2. Distinguish between ambient air quality standards and air emission standards.
3. Using the government documents or science/engineering section of your library, write one- to two-page summaries of
  - a. PL 92-500
  - b. Superfund
  - c. CERCLA
  - d. Current wastewater treatment regulations
4. What session of Congress enacted PL 92-500? How many other acts were passed in that session before this legislation?
5. Determine what EPA region you are in. Where is the regional headquarters?

## References

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