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INTRODUCTION

Until approximately 40 years ago, pollution problems were a minor aspect of the production of goods and materials in the United States. The legal system treated pollution law as a minor part of the general prohibition of the law of torts against acutely injuring a person or his property. However, because of the diversity of pollution sources, the long lag time between exposure and harm, and the subtlety of adverse effects of exposure, it was difficult to establish the causal links between a source and a specific injury necessary to maintain common law tort actions. The existence of pollution was also considered a minor and easily corrected dysfunction of the economic system. Advances in waste disposal technology and the switch from coal to natural gas solved some 19th and early 20th century problems without burdening either production processes or the government. As a result of the lack of effective constraints on waste disposal, disposers were free to use air and water sheds as sinks.

The experience of southern California in understanding the nature of automobile-caused air pollution (smog), along with inversion-caused acute air pollution episodes in Donora, Pennsylvania and London, England first alerted the United States to the systemic nature of much pollution, the costs to humans and property, and the need for more stringent, public and centralized regulatory responses to the problem. In the 1970s, an extensive series of pollution control statutes and ordinances were rapidly enacted by federal, state and local governments. The national commitment to pollution control appears to be firm, but we are still trying to understand the strengths and weaknesses of the scientific, economic and moral assumptions that underlie our pollution policies. We are still trying to define the balance between viewing the appropri-

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ate response to the pollution problem as one of protecting the integrity of natural ecosystems and one of preventing specific harm to humans.

Air and water pollution are primarily the product of four related forces: industrial activities, energy extraction and production, transportation (primarily the automobile) and urban concentrations. Water pollution is also caused by modern agricultural technologies, especially the application of large amounts of fertilizers, pesticides and water for irrigation, and by land development.

Pollution is common to all countries with these activities regardless of the political structure and organization of the economy. However, decisions about what emissions and effluent discharges constitute pollution which should be reduced or eliminated involve cultural, economic, political and scientific judgments. The basic object of pollution control strategy is to reduce the levels of emissions and effluent discharges to protect the integrity of the air and water sheds of a country to the level which is consistent with the overall development policies of the nation. In the formulation of air and water pollution policy, a country must make the following five basic choices:

- the selection of one or more emission and effluent reduction goals;
- the identification of the sources of pollution that will be targeted for reduction and the air and water sheds that will be protected;
- the formulation of reduction standards for different sources of emissions or effluents;
- the selection of the methods of achieving compliance with the goals and standards; and
- the determination of enforcement techniques to insure that pollution sources actually reduce their effluent and emissions according to policy.

Pollution control policy is primarily a governmental responsibility in the United States. Air and water sheds could originally be used as sinks with little restriction because they were commons; everyone had equal rights to use them, so many became stressed. The idea of a common law or constitutional right to be free from pollution has not progressed far in our jurisprudence, and does not underlie pollution policies. Instead, federal regulatory programs effectively create regulatory property rights in air and water sheds on behalf of the public that limit the use of the air or waters as sinks.

Pollution regulation in the United States is a highly legalistic system. The discretion of pollution control agencies is circumscribed by the duty to follow strict procedures in the adoption of rules and to justify - to some degree - the scientific

and economic rationality of the rules. Federal and state constitutions guarantee due process and protect private property from confiscation, and all regulations must be constitutionally valid.

In the United States, the implementation of each of these steps is done through legislation and administrative rules. Thus our legislatures and administrative agencies must make difficult choices. Further, because the United States is a federal system, it has been necessary to allocate responsibility between the national and state governments as any large country must strike a balance between centralized and decentralized control.

The elimination of large amounts of pollution limits individual choice and conflicts with continued economic development. It is expensive to clean up existing sources of pollution, especially as progressively more stringent reduction levels are achieved. There can be high opportunity costs if clean air and water sheds are closed to new industrial development or such development is limited to prevent pollution. Thus, in each of these steps, the United States has to some degree considered the costs and benefits of achieving emission and effluent reductions to try and integrate our pollution policies with private actions and public policies that promote continued economic development.

GOAL SELECTION

Five basic pollution control goals can be identified:

- *Heritage Resource Preservation.* Air and water sheds that are pristine or almost so can be preserved regardless of their value for alternative uses.
- *Most Sensitive Use Protection.* The human uses of an air or water shed or flora and fauna proxies most sensitive to pollution can be identified. Reduction levels can be set to protect these sensitive users or proxies.
- *Property and Health Damage Prevention.* The historic reason to limit pollution was to prevent damage to property and to protect human health and this goal remains central to most regulation. Crude estimates of these damage levels can be made and reduction levels can be set to eliminate damage and injury. Once these standards are met, selected air and water sheds can be used as sinks for waste disposal.
- *Risk Minimization.* Since the mid-1970's, United States pollution control policy has been increasingly focused on hazardous substances that present long term risks of illness and genetic mutation rather than immediate threats to property or life. We have often tried to minimize

these risks by reducing them to close to zero. The United States Environmental Protection Agency often uses a risk factor of one death per one million exposed people over their lifetime.

- *Damage-Risk Balances.* In contrast to conservative risk minimization strategies, it is possible to trade risk protection against the value of an air or water shed for waste disposal. Permissible or safe degradation levels can be established or the most appropriate uses of a resource can be identified and reduction levels based on these use categories established.

United States air and water pollution policy is a mix of all of these goals. For example, Heritage Resource Protection has been adopted for air pollution and implemented by the non-degradation policies of the federal Clean Air Act. Under these provisions, all large national parks and other undeveloped rural areas have been placed in a classification which forbids virtually any measurable increase of several defined pollutants. Visibility is also protected within these areas by vague prohibitions against "plume blight" and other sources of visibility impairment. Other areas which substantially exceed the national air quality standards allow only a small increase in specified pollutants. Large potential sources of pollution are subject to a special pre-construction review to determine whether the source will emit too much of the defined pollutants. Thus, in non-degradation areas, economic growth through local development is blocked or sharply curtailed to protect the relatively pristine air quality.

Water pollution regulation was originally based on identifying different uses of water and allowing pollution compatible with the designated use of the water. This water zoning strategy, however, was impossible to implement. In 1972, the federal government passed the Clean Water Act which adopted a Most Sensitive User Protection standard as an interim standard for all surface waters. The Act established the goal of making all streams fishable and swimmable by 1983. Further, the Act adopted a standard close to Heritage Resource Preservation by setting as the ultimate goal the prevention of the discharge of any pollutant into the waters of the United States.

The Clean Air Act has adopted a multi-goal approach to its basic regulatory structure by establishing primary and secondary standards to be met at different times in the future. The primary standards are Property and Health Damage Prevention standards designed to eliminate any human health effects of air pollution. The secondary standards are Most Sensitive Use Protection standards, designed to prevent any injury to

ecosystems, fauna or flora, materials, or other more sensitive aspects of the natural or human world.

The original air and water pollution goals were premised on the assumption that the worst sources of pollution were sewage, similar industrial discharges, and dust. By the mid-1970s the unseen chemicals in discharges were identified as a more serious long term problem. Water pollution policy has now shifted its focus to the minimization of the risks of exposure to hazardous pollutants. Many laws have been enacted to allow administrative agencies considerable discretion to set reduction standards that provide "a margin of safety" from identified and suspected risks.

Many industrial and municipal sources of air and water pollution argue, however, that Damage-Risk Balances should be established. For example, many sources located on the coasts and on large bodies of water claim that the quality of the receiving waters should be taken into account to allow them to reduce the pollution treatment they must provide. The federal Clean Water Act generally disallows credit for receiving water quality except in the case of thermal pollution. Sources of air pollution argue that high stacks should be allowed so that they can disperse air pollutants rather than treat them. Other pollution sources claim that intermittent controls are appropriate, rather than continuous, capital intensive technologies.

SOURCES OF POLLUTION

Pollution sources have been targeted for regulation in the United States for three reasons:

- the severity of the problem;
- the ease of implementing regulation; and
- the benefits of national versus state regulation.

In both air and water pollution the obvious sources - industrial and municipal discharge outfalls and smokestacks - were regulated first. To prevent states from competing for industry among themselves, "stationary sources" of air pollution and "point sources" of water pollution were subject to uniform, national standards set on an industry by industry, process by process basis.

Air pollution is also a product of the internal combustion engine. National standards have been imposed upon different categories of vehicles to establish a long-term limit on the effluent from each vehicle over its lifetime. The manufacturer of each vehicle is required to provide the basic air pollution control equipment, and some maintenance and compliance action is required of the owner of each vehicle.

The most difficult to control sources of water pollution are those that result from land uses such as irrigated and pesticide-treated agriculture, land drainage, timber harvesting, mining and urbanization. These sources are less amenable to national standards and require many individuals to adopt new technologies and to change land use practices. It is estimated in the United States that more than half of the remaining water pollution is caused by such indirect sources, and that the cost of removing the major urban and agricultural indirect sources will cost more than all water pollution control efforts so far.

Land use sources of water pollution are classified as non-point sources and are not subject to uniform national reduction standards. The United States has a complex but incomplete approach to non-point source pollution. For example, the federal government limits the use of pesticides that pose a risk of cancer, but does not limit the amount of use of chemicals not presently known to cause cancer. Fertilizer use is unregulated once the product is screened as safe under the Toxic Substances Control Act. The key to attempted controls is the local regulation of land use activities. All potential sources of pollution are subject to a general federal standard - best management practices - but states and local governments must implement this standard. States have had some success at inducing voluntary modifications in cropping patterns, and units of local governments are beginning to limit activities that cause erosion and hence run-off.

Indirect sources of air pollution have been addressed only episodically, and mainly through transportation controls and land use siting regulation. Indirect sources of air pollution are typically large attractors of mobile sources such as highways congested in the high traffic periods and shopping centers and stadiums that attract large crowds. Because of the American love affair with the internal combustion engine's freedom of movement, the transportation controls and land use siting regulations have often proven unpopular. Indeed, the United States Environmental Protection Agency was obliged to abandon a generation of such controls in the 1970s as a result of the political pressures generated by control proposals for major urban areas such as New York, Chicago and Los Angeles.

All air sheds are protected, but not all sources of water pollution are equally regulated. Most of our focus has been on surface water. Ground water is less protected because regulation is shared among all three levels of our government - federal, state and local - and regulatory gaps exist.

The regulation of ground water contamination has proved much more difficult compared to the control of surface water pollution for four reasons. First, the major sources of ground

water contamination are both discrete - a hazardous waste site - and diffuse - agricultural leachates and urban runoff. Second, the case for national uniform standard of quality is less compelling. The federal Environmental Protection Agency has proposed a ground water policy that permits aquifer classification based on the existing or likely use of the groundwater, a policy abandoned for surface waters. Third, because pollution sources are more diffuse compared to surface water and contamination is related to the rate of ground water extraction, decentralized rather than centralized solutions are preferable. Finally, ground water pollution sources are difficult to detect as compared to surface point sources, and the polluted ground water does not attract the notice of a surface water with dead fish floating or a clearly visible discoloration or oil slick.

At the present time, the federal ground water regulation is limited to the protection of public drinking water supplies, the clean-up of abandoned hazardous waste sites and the regulation of existing and new hazardous waste facilities. The Safe Drinking Water Act, amended in 1986, gives the federal Environmental Protection Agency broad authority to establish both primary (health-based) and secondary (welfare-based) ground water quality standards for drinking water supplies, following the dichotomy of regulation adopted in the Clean Air Act. These standards apply at the tap and set appropriate maximum contamination levels for specified chemicals. Specifically, the law requires EPA to adopt regulations for:

- a system of national standards (maximum contaminant levels or MCLs) and treatment technologies for public drinking water;
- an underground injection control program;
- a program to protect sole source aquifers (i.e., aquifers that are the main source of drinking water for a community); and
- a system to approve state well-head area protection programs.

Units of local governments are beginning to limit activities that threaten to contaminate ground water supplies.

In addition to effluent and emission regulation designed to protect local and regional areas, air and water pollution regulation must confront problems that are national and international in scope. At present, it has proved more difficult to deal with such large scale problems. No overall strategy for reducing emissions which may cause damage to the ozone layer of the atmosphere, or to effectively control acid deposition problems affecting several countries exists. With air streams able to travel thousands of miles and able to rise into the

higher reaches of the atmosphere, a national or international approach to certain issues is needed. In water pollution as well, ocean dumping and effluents into rivers which flow thousands of miles are not now adequately regulated.

REDUCTION STANDARDS

Reduction standards can be set by defining the desired quality of the receiving media and working backward to emission limitations or by setting emission limitations on the assumption that they will produce the desired media quality. The United States uses both approaches, but with greater emphasis on direct emission and effluent limitations.

Ideally, the damage that emissions and effluent discharges cause would be determined scientifically and pollution limitations would be set based on that information. We have established media standards based on this theory under the Clean Air Act. An elaborate process has been mandated under which a "criteria document" is drafted reflecting the best scientific knowledge available at the time concerning effects. A "control techniques document" is then drafted which sets out the state-of-the-art pollution controls available. The limitations are then set based upon the health effects (primary standards) and welfare effects (secondary standards), taking into account the most effective controls available. However, it has proved impossible to base reduction limitations on anything but crude estimates of aggregate damages.

The difficulties of correlating media quality with emission and effluent limitations have led us to ask how much pollution is it technically possible to eliminate? Both air and water pollution legislation have adopted a "technology-forcing" approach. The basic idea is to force existing sources of pollution to retro-fit and to force new sources of pollution to adopt state-of-the-art technologies. In both cases, a substantial amount of resources have been devoted to the development and testing of pollution control devices and techniques to meet the increasing demands of the standards and the threat of sanctions or a shut-down if the standards are not met.

To accomodate the time needed for development of pollution controls, water pollution regulation in particular initially adopted a two stage model of technology adaptation. Industries were required to adopt "Best Practicable Technologies" and then to upgrade their controls to "Best Available Technologies". When the latter proved too ambitious, the standard was scaled back to "Best Conventional Technologies" for non-hazardous pollutants.

IMPLEMENTATION OF REDUCTION STRATEGIES

Ultimately pollution control policy is established by the implementation strategy. Selected pollution control strategies are a function of four factors: (1) the ease of administrative enforcement, (2) the economic efficiency of the strategy, (3) the expectations of the regulated "community" and the public, and (4) the need for relief from the strict enforcement of a standard in any given case. In the United States we have generally chosen to implement pollution control goals and standards through command and control regulations. Subject to increasing legislative control, administrative agencies are directed to promulgate rules that specify maximum discharge or concentration levels.

Entities subject to regulation must monitor themselves and are subject to public monitoring. The entities are liable for civil and criminal enforcement, including fines, if they violate the standards. Ultimately, we rely on voluntary compliance by plant managers backed up by episodic government enforcement activities. Enforcement is shared between units of government and private citizens. The imposition of regulations is the exclusive function of the government, although private citizens have extensive rights to provide information and opinions. However, the prosecution of violations of standards may be brought by either the government or private citizens pursuant to statutory guidelines. Most enforcement actions are brought by government, but in some very significant areas, the major enforcement activities have been privately initiated and prosecuted.

Exclusive reliance on command and control regulation has been vigorously criticized. Our technology-forcing regulations are defended as cheaper to administer, more equitable and capable of producing a more efficient allocation of resources. However, critics influenced by welfare economics theory urge that a pollution fee system should be adopted or property rights in pollution created. For example, discharge rights would be sold so that the discharger can make the choice between paying the price of the fee or reducing discharges. The most cost-effective sources presumably would reduce their emissions and other sources would pay the fee. If the fee is set at the proper amount, the appropriate level of reduction would be achieved with the least use of resources, and a source of funds to compensate those injured, to clean-up the environmental effects, and to search for new pollution controls would be established.

So far, a pollution fee system has not be resorted to because of a fear that such a system would undermine realization of the strict pollution reduction goals. This fear is especially

applicable to emissions of toxic substances, where there is concern that a fee system would allow too many people to be exposed to substances toxic in very low concentrations. Any choice system in which a decisionmaker is left with the option of paying a fee and not eliminating a toxic emission is considered unacceptable by many commentators and decisionmakers.

The stricter regulation becomes, the greater the push for flexibility or variation becomes. Flexibility is built into all our command and control regulatory schemes. Both the Clean Air Act and Clean Water Act authorize a variety of exceptions and variances from the regulations established for pollution sources. Some of the variances are clearly economic in nature. They are designed to take into account the age or different processes of the source or the economic feasibility of effluent reduction by the particular entity. Others take into account the quality of the receiving medium and the possibility of dispersing or diluting the effluent. An additional category of exceptions are political and represent the success of particular industries in removing themselves from regulatory schemes which would otherwise demand substantial pollution reductions.

In addition to variances and exceptions, the federal Environmental Protection Agency has developed devices to provide incentives for pollution reduction. One such device is the "bubble". Under the "bubble", all emission points of a particular entity are aggregated and treated as if they were one large point. Within the source, changes may be made in the mix of emissions without additional regulation, so long as the overall emissions of the source are not increased. Through the "bubble", a source can determine the mix of pollution controls which comply with the standards at the most economic and efficient rate for the entity. The "bubble" is a controversial flexibility device. Critics fear that the changes made by the entity will in fact increase the emissions from the plant without forcing the regulatory scrutiny required by the command and control scheme. In addition, the unregulated effluents which were previously controlled by the required pollution control devices might well not be covered by the changes, causing a net increase in pollution caused by the source.

Two particular strategies for implementing pollution reductions should be highlighted. First, as mentioned earlier, some areas of the country have been determined to be pristine or unusually clean. In those areas, special "prevention of significant deterioration" rules have been established to maintain the very high levels of air quality. Development is forbid-

den or discouraged for the purpose of preserving untainted areas.

Second, other areas have been determined to be so dirty that special regulatory programs are required to attempt to raise the environmental quality towards the national ambient standards. These "non-attainment areas" are subject to special limits on development, including pre-construction reviews of major sources wishing to locate or expand in these areas. Part of the non-attainment program is the offset. The Clean Air Act mandates that new sources can only begin operations in non-attainment areas by causing other sources in the area to reduce emissions by more than the new source will generate. This limit on new development can have major economic consequences for an area and prevent the achievement of local development goals. However, without such an offset policy, a total moratorium on development might be imposed for health or welfare reasons.

ENFORCEMENT OF STANDARDS

Regardless of the pollution control scheme established, and regardless of the social or political system involved, an enforcement program is necessary to verify compliance and force to comply those who don't wish to devote time, effort, and resources to environmental protection. There are several elements to the enforcement scheme in the United States.

First, state governments are heavily involved in enforcement activities in our federal scheme of pollution regulation. Under the Clean Air Act, states develop state implementation plans which set out the enforcement mechanisms which will be followed. These may include on-site visits by enforcement personnel, continuous or periodic monitoring of emissions, self-reporting by enterprises, performance standards for production processes, and other techniques.

Second, federal enforcement exists through approvals of state plans and enforcement activities and through the direct regulation of sources. Both the state and federal governments may use administrative processes to issue permits, assess penalties, establish timetables for compliance or use the court system to assess administrative or civil fines or criminal penalties.

Third, private citizens may play a major role in the enforcement process through complaints to the government regulatory bodies or through private litigation against the government entities for failure to enforce or against the source for failure to comply with the regulations.

The best form of enforcement is preventative. To prevent the violation of standards, the United States relies on dis-

charge licenses. This is the scheme followed for point sources under the Clean Water Act. Each point source must have a license to release effluent, defining the quantity of releases and the substances and concentrations in the effluent. In addition, a timetable is established in the license to guide the installation of additional or more advanced pollution control equipment and to define the required reductions in effluent quantity, substances and concentrations. In theory, the license ultimately will lead the point source to a level of no effluent. Point sources must monitor and report their results periodically. In addition, enforcement personnel from the state or federal government will periodically verify the accuracy of the reports. Pollutants detected downstream through sampling of the water, visible pollution or fish kills will lead to greater monitoring activities and the use of civil and criminal penalties.

Despite preventive enforcement, post-licensing violations may occur. To deter such violations, penalties may be imposed. Civil or criminal liability for the entity may be appropriate, and may be exacted through fines or other payments, or even through closing or reducing operations of the entity. In addition, damages payments may be required from the entity to compensate those who may be injured by the failure to comply with the regulations. Payments to government entities might be required to repair natural resources damage caused by the entity and to bear the costs of enforcement.

Individual criminal or civil responsibility can be imposed. Officers and decisionmakers may be held criminally liable for their decisions leading to environmental degradation or human injury, and be subjected to fines or prison sentences. Civil liability may be imposed, forcing managers to pay compensation to injured individuals and governments. Managers might be dismissed from their jobs or demoted as a result of their activities and decisions. Such penalties are comparatively rarely invoked in the United States.

CONCLUSION

The United States has created a comprehensive and complex system for regulating air and water pollution. The system has faced many important scientific, philosophical, economic and political issues. Not all have been satisfactorily solved but useful models for comparison exist. Any system, however different its political and economic organization may be, is faced with similar issues. The solutions may well take similar paths if air and water pollution is to be regulated to a reasonable level to protect human and environmental values.

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