SPECIAL PROBLEMS OF WATER POLLUTION: THE PRIVATE SECTOR

Pollution problems in the private sector of our economy have increased with industrial and agricultural activity. Where formerly a firm could discharge its wastes into a nearby stream without causing much concern, today any significant pollution is almost sure to raise havoc. The public is becoming concerned about water pollution and what it is doing to the water recreation areas of our nation. Industries dislike having to purify water before they can use it. Because overused and degraded water is less efficient for irrigation than pure water, farmers are concerned over having to buy more water to do the same work. Finally, enlightened municipalities are realizing the potential health hazards of impure drinking water, especially where pesticides and other chemicals are the pollutants.

Unless something is done about water pollution, we will be faced with even graver problems in the future. The amount of water available for use by man is limited. On the supply side, the dependable fresh water available in the United States is about 315 billion gallons per day.[1] By 1980, it is estimated that the supply can be increased to 515 billion gallons per day through impoundment and other devices. "The maximum dependable supply which can be developed through improved engineering and extended public works is approximately 600–650 billion gallons per day."[2] These supply figures become meaningful when the present and future demand for this limited supply of water is considered. In 1900, the population of the United States was approximately 76 million. Today, our population exceeds 200 million and it is estimated that by the year 2000 this figure will double.[3] As population increases, industrial and agricultural activity will increase to keep pace with new demands for food, clothing, durable goods, and other products. The following are estimates of present and future water needs of our country:[4]

	1960	1980	2000
Domestic and Municipal	22[5]	29	42
Industrial	160	363	662
Agricultural	141	167	184

In light of these competing demands, water used for waste carrying purposes performs a minimal social and economic function. On this point, everyone will readily agree. The question is, how is our society going to solve the problems of water pollution created by the people who grow and manu-

[1] U.S. PUBLIC HEALTH SERVICE, INDUSTRIAL INCENTIVES FOR WATER POLLUTION ABATEMENT 6 (1965) [hereinafter cited as INDUSTRIAL INCENTIVES].

[2] *Id.*

[3] *Id.*

[4] *Id.* at 8; Bowen, *Water Shortage Is a Frame of Mind,* in THE WATER CRISIS 84 (G. Nikolaieff ed. 1967).

[5] Figures in billions of gallons per day.

facture commodities vital to our economy? In an attempt to answer this question, this chapter first discusses the nature of the pollution problems created by agriculture and various industries. This is followed by a discussion of the adequacy of technology to deal with these pollution problems. An important subject to consider in devising a water pollution abatement system for the private sector is the economic effect such a system of control will have on the individual polluting firm and on the economy in general. These effects are discussed in light of present and proposed water pollution control schemes. Finally, an evaluation is made of the various types of legal controls available for pollution control in the private sector.

I. Pollutants and Their Effect on Water

Before discussing the particular pollution problems of industries and agriculture, it is essential to understand a few basic concepts about water pollution and how it occurs.[6]

Until recently, all water pollutants were generally classified as degradable or non-degradable, according to their behavior when they are discharged into water. Degradable pollutants are broken down and purified by the water, while non-degradable pollutants undergo no great change once in a body of water.[7] Domestic sewage is probably the best known degradable pollutant, but in the aggregate industry produces greater amounts of organic degradable waste. For example, a single pulp mill can produce degradable wastes equivalent to the sewage flow of a large city.[8] When a substantial load of degradable waste is expelled into an otherwise clean stream, a process known as "aerobic degradation" begins immediately. Stream biota, primarily bacteria, feed on the waste and break it down into its inorganic components which are basic plant nutrients. During this process, some of the oxygen which is dissolved in any clean water is consumed. Some oxygen is replaced in the water through natural processes,[9] but if the amount of waste in the water becomes great enough, the process of degradation may exhaust the dissolved oxygen. In such cases, degradation still takes place, but it takes place anaerobically, that is, through the action of bacteria which do not use free oxygen but organically or inorganically bound oxygen. In other words, once all the free oxygen in water is used up in the degradation process, the oxygen used for further degradation comes from oxygen which is bound with other substances such as nitrates and sulfates. Gaseous by-products result from this oxygen-freeing process, and the water emits foul odors and appears black and bubbly. Low levels of dissolved oxygen can kill fish and

[6] Discussion taken from O. Herfindahl & A. Kneese, Quality of the Environment 10–18 (1965). For a more detailed discussion, see L. Klein, River Pollution II: Causes and Effects (1962).

[7] O. Herfindahl & A. Kneese, *supra* note 6, at 10, 15.

[8] One pulp mill on the Coosa River, which runs through Georgia and Alabama, discharges effluents which absorb as much oxygen as does untreated sewage from a city of 200,000 persons. Carr, *Death of the Sweet Waters,* 217 The Atlantic, May 1966, at 95.

[9] Oxygen is replaced in water through the process of photosynthesis and by contact between the water surface and air.

cause other ecological changes. Also, the plant nutrients produced by bacterial degradation of degradable wastes may cause algae blooms. Large amounts of algae can be toxic, produce odors, and reduce a river's aesthetic appeal, as well as increase treatment problems.

Effluents which contain degradable material are usually measured in Biochemical Oxygen Demand (BOD), a measure of the rate at which dissolved oxygen is drawn upon in a stream.

Non-degradable pollutants are those which are not attacked by stream biota and undergo no great change once in water.[10] Included in this group are inorganic substances such as ordinary salt, inorganic colloidal matter, and salts of numerous heavy metals. When large quantities of these substances are present in water they cause toxicity, unpleasant taste, hardness and corrosion. These substances necessitate the use of water softeners, distilled water, and extra soap. To take care of these pollutants, dischargers rely heavily on the dilution capacity of receiving waters. Once mixed with large quantities of clean water the presence of these pollutants becomes insignificant.

There is a third group of pollutants of relatively recent origin which do not fit into either the degradable or non-degradable categories. They are called "persistent pollutants."[11] These pollutants are best exemplified by synthetic organic chemicals produced by the modern chemical industry. They enter watercourses as effluents from industry and also as residuals from many household and agricultural wastes. These pollutants are called "persistent" because stream biota cannot effectively break down their complex molecular chains. Some degradation does take place, but so slowly that the persistents travel long distances in relatively unchanged form. Detergents, pesticides and phenols (resulting from the distillation of petroleum and coal products) are the most common types of persistent pollutants. Such pollutants seriously affect the aesthetic quality of receiving waters, frequently cause unpleasant taste, and may be toxic to fish and water fowl.

II. Sources of Industrial Pollution

A. Pulp and Paper Industry

No industry has been more harshly criticized for its pollution practices than the pulp and paper industry. This industry consists of some 3,000 firms in the United States and employs more than 600,000 people. American production of paper and paperboard has more than doubled in the last two decades and is now about 40 million tons a year.[12]

Considering the nature and effects of the pollutants from the pulp and paper industry, it is easy to understand why it has been so severely criticized. The worst pollutant is the so-called "sulfite liquor." This contains a non-fibrous material removed from wood chips during the cooking process. The primary result of introducing these wastes into a stream is that the BOD

[10] O. Herfindahl & A. Kneese, *supra* note 6, at 15.
[11] *Id.*
[12] Carr, *supra* note 8, at 95.

soars so high that fish and other water creatures are suffocated.[13] Other wastes from pulp and paper mills include quench water carrying quantities of fine cinder and white water containing a variety of chemicals.[14] Not only do these wastes starve aquatic life of oxygen but they also promote tremendous carpetlike growths of bacterial slime and large numbers of minute sludge worms in the vicinity of the mills.[15]

These are the results when raw effluent is discharged into receiving waters. There are processes available and in use which can treat the waste water before discharge and thereby reduce or eliminate such damaging pollution. One of the nation's large paper manufacturers has devised a system for the disposal of waste liquor. The system consists of filtering the liquor to remove solids, then pumping the clear liquid, under pressure, into massive underground limestone formations.[16] Although the process is efficient, the manufacturer is quick to point out that the system is only a remedial measure until a truly effective means of treating the liquors is developed.[17] Another manufacturer recently announced the discovery of a process for purifying pulp and paper mill wastes, as well as wastes from food processing plants, packing houses, distilleries, and steel mills. The process uses a fluidized-bed technique which consumes the organic portion of the liquor, thus eliminating pollution at the source.[18] One advantage of this technique is that a by-product, pelletized residue consisting of inorganic salts, is usable as a raw material by the pulp and glass industries.[19] Another purification process used frequently in this industry is the lagooning of the waste flow for two to three months.[20] Other processes include evaporation of the liquor and reaeration of rivers by hydro-turbine and spray techniques.[21] The latter is a process whereby oxygen is added to the receiving water in significant amounts so as to permit bacteria to break down the organic matter quickly without reducing the dissolved oxygen in the water to a level which would cause the death of aquatic life.

While there appear to be a number of processes available to control pollution in this industry,[22] construction and operation of these systems is costly. The average cost of primary and secondary waste treatment at a mill constructed today for $65 million is approximately $2 million. The cost of main-

[13] *Id.*

[14] *Water Pollution: The Diagnosis of Industry's Problems and the Treatments To Cure Them*, MILL & FACTORY, Nov. 1966.

[15] Whitney & Spindler, *Effects of Kraft Paper Wastes on a Mountain Stream*, 88 TRANSACTIONS OF THE AM. FISHERIES SOC'Y 153 (1959).

[16] 1 CCH WATER CONTROL NEWS No. 5, at 9 (June 20, 1966).

[17] *Id.*

[18] 1 CCH WATER CONTROL NEWS No. 44, at 2 (Mar. 20, 1967).

[19] *Id.*

[20] Whitney & Spindler, *supra* note 15.

[21] 1 CCH WATER CONTROL NEWS No. 2, at 3 (May 31, 1966).

[22] Major sources of information on new techniques are industry supported associations such as the National Council for Stream Improvement, the Sulphite Pulp Manufacturers Research League, and the American Paper Institute.

taining and operating such facilities including maintenance and amortization costs is approximately one thousand dollars a day.[23]

B. Chemical Industry

The tremendous growth in the production of synthetic chemicals is producing an entirely new pollution problem. Wastes from the manufacture and use of synthetic chemicals are causing significant amounts of pollution in receiving waters.[24] The general types of pollution discharged from chemical producing plants are dissolved metals, alkalies, acids and salts, suspended inorganic solids, and organic and inorganic gases.[25] The effects of these pollutants are poorly understood. Some synthetic chemical pollutants are known to create taste and odor problems that are difficult and costly to solve.[26] Others interfere with aquatic food chains.[27] Although many of the chemicals and their effects remain largely unknown, it is known that a substantial number of them pass through the usual water treatment processes and reach the consumer in his drinking water.[28] Far more research is required on the identification of these chemical pollutants and their effect on water quality.[29]

The problem of developing pollution control processes for this industry was stated by Mr. A. J. von Frank, an officer of the Manufacturing Chemists Association, before a Senate committee:

> [B]ecause of the tremendous diversification of the chemical industry, there is no common denominator of waste treatment technique, such as there is for municipal waste, and therefore it is not accurate to generalize on its water-related problems.[30]

His remarks are substantiated by reports received by the Manufacturing Chemists Association from 101 major chemical companies with 716 plants (representing more than one-half of the chemical industry's total productivity) which showed that 6,730 different water purification processes were being carried on in the plants.[31] In a later survey taken by the same association the processes mentioned most often were: lagooning or settling, 39 percent; neutralization, 25 percent; biological oxidation, nine percent; and flotation and incineration, six percent each.[32]

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[23] Adams, *What the Industry and Its Association Is Doing About Stream Pollution,* 150 PAPER TRADE J. 49 (1966).

[24] ENVIRONMENTAL POLLUTION PANEL, PRESIDENT'S SCIENCE ADVISORY COMMITTEE, RESTORING THE QUALITY OF OUR ENVIRONMENT 73 (1965).

[25] *Water Pollution: The Diagnosis of Industry's Problems and the Treatments To Cure Them, supra* note 14, at 23.

[26] ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 73.

[27] *Id.*

[28] *Id.*

[29] *Id.*

[30] *Chemical Problems in Pollution Is Seen as One of Basic Research, Not Compliance or Capabilities,* 187 OIL, PAINT & DRUG REP., June 28, 1965, at 5.

[31] INDUSTRIAL INCENTIVES 13–14.

[32] Manufacturing Chemists' Association, Inc., *A Survey of Water Use in Chemical Manufacturing,* in WATER IN INDUSTRY 57, 59 (National Association of Manufacturers ed. 1965).

Reporting costs of water pollution abatement in the same survey, the chemical companies showed capital expenditures of $233 million for water control facilities, most of which had been expended within the last fifteen years.[33] The following are specific examples of expenditures for water pollution abatement facilities by chemical companies. In West Virginia one group of chemical companies has invested, since 1958, a total of $19 million in abatement equipment in their facilities on the Kanawha River.[34] The Union Carbide plant on the Kanawha has a $6.7 million pollution abatement investment and the DuPont plant has a $5.1 million investment.[35] DuPont is also spending more than $1 million annually at its Delaware River plants to operate water purification facilities.[36] An official of DuPont feels that these costs, which are being increased annually because of tighter water standards imposed by governmental bodies, could force prices up from fourteen to 40 percent.[37] One way the chemical industry is offsetting costs and speeding up pollution control is by entering into joint treatment plant arrangements with municipalities. An attractive feature of these cooperative ventures is that municipal or regional plants may be eligible for federal or state construction grants. Industrial facilities are not eligible for such grants.[38]

Many industries attempt to offset costs of pollution abatement by recovering valuable materials from the treatment process. Presently, this alternative is not feasible for the chemical industry because recovery of usable materials from water purification processes is insignificant.[39]

C. Utility Industry

The major pollutant of the utility industry is heated water, also known as "thermal pollution." The heated water that causes the pollution is water used for cooling purposes in a power plant's steam condenser. In the condenser, used in both nuclear and conventional power plants, cool water flows through pipes to cool steam leaving turbines. In this process, the water is heated up.[40]

Warm water might seem harmless enough. However, even a few degrees of additional heat can upset the entire plant and animal life in a waterway. Raising the water's temperature produces somewhat the same effect as organic contaminants, since the heat also reduces the quantity of dissolved oxygen in the water.[41] Without sufficient oxygen, bacteria cannot carry on

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[33] INDUSTRIAL INCENTIVES 13.

[34] *Cleaner Water Drive Steps Up,* BUSINESS WEEK, Mar. 13, 1965, at 78.

[35] *Id.*

[36] 1 CCH WATER CONTROL NEWS No. 9, at 5 (July 18, 1966).

[37] This estimate includes air pollution as well as water pollution costs. McManus, *What Price Pollution Control?,* 198 IRON AGE, Oct. 27, 1966, at 48.

[38] *Water Pollution, supra* note 14, at 24.

[39] Watson, *Approaches to Abatement in Five Major Industries,* 4 THE CONFERENCE BOARD RECORD, May, 1967, at 10.

[40] *Hot Water—Generating Plants Pose a "Thermal Pollution" Threat to Rivers, Lakes,* Wall Street J., Dec. 1, 1967, at 1, col. 7.

[41] Chadwallader, *Water Use Problems Confronting Electric Utilities,* 73 PUB. UTIL. FORT., June 4, 1964, at 61.

their usual cleansing actions in breaking down human wastes and other organic matter. The water then becomes ripe for rapid growth of slimy green algae.[42] Also, the digestion and other life functions of fish falter as the oxygen content of water decreases. For example, brook trout can survive only thirty minutes at 83 degrees Fahrenheit and only twelve hours at 77 degrees Fahrenheit. Even if the fish can survive the warming of naturally cold water, the change can prevent spawning and egg-hatching.[43]

So far, thermal pollution by this industry has not been considered one of the more serious forms of pollution by private industry. However, the threat of serious pollution problems in the future becomes apparent when several facts are considered. First, the industry's load generating capacity is doubling every ten years with approximately 80 percent of this load generated in thermal plants.[44] Second, many new generating plants are nuclear powered and cause greater thermal pollution problems than do conventional plants. For safety reasons, nuclear power plants must operate at a lower steam pressure than conventional plants; hence, the nuclear plants are less efficient and discharge 50 percent more heated water through their cooling systems.[45] Today, nuclear plants provide only about one percent of the nation's generating capacity. By 1980, however, this share could grow to 30 percent.[46] Finally, as the supply of water decreases through increased use and reuse of water, less stream and lake water will be available in which to dilute the heated discharge waters.

Thermal pollution is the simplest type to eliminate; the heated discharge water merely has to be cooled. The problem is finding an efficient method for cooling water which is not prohibitively expensive. Today, the primary method for cooling discharge water is by passing heated water through cooling towers where it is exposed to cool air before being returned to the receiving water.[47] The cost of building these cooling towers is high because of their size. To illustrate, a Portland, Oregon, utility is planning to build two giant cooling towers, 370 feet high and 290 feet in diameter at the base, for a proposed one million kilowatt plant. A Vermont utility plans to build a new nuclear plant with a cooling tower system that might cost six million dollars. One government forecast predicts electric utilities may have to spend two billion dollars for cooling towers and related equipment in the next thirteen years.[48]

One Long Island utility has used its "polluted" water to economic advantage by discharging it into a basin where oysters are raised commercially. By mixing this heated water with the receiving water, even water temperature,

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[42] *Hot Water—Generating Plants Pose a "Thermal Pollution" Threat to Rivers, Lakes,* Wall Street J., Dec. 1, 1967, at 16, col. 4.

[43] *Id.*

[44] Chadwallader, *supra* note 41, at 62.

[45] *Hot Water—Generating Plants Pose a "Thermal Pollution" Threat to Rivers, Lakes,* Wall Street J., Dec. 1, 1967, at 1, col. 7.

[46] *Id.* at 16, col. 2.

[47] *Id.* at 1, col. 7.

[48] *Id.*

warm enough for the spawning of oysters, is maintained over a ten month period, rather than the normal three or four months a year nature provides.[49] The utility charges the oyster firm only a nominal sum, but the arrangement obviates the expenses involved in building and operating facilities to cool their discharge water. Unfortunately, this arrangement is available only in rare circumstances and it not a general solution to the thermal pollution problem.

D. Steel Industry

Pollution created by the steel industry is best illustrated by describing several rivers which have been polluted by steel mills. Due to the discharge of heated water from a number of hot rolling mills along its banks, the Mahoning River at one time reached 140 degrees Fahrenheit near Youngston, Ohio.[50] Pollution of the same river by acid, lime, oil, and grease discharged from steel plants has made the river unusable as a source of municipal water, hindered its use by other industries, and destroyed its recreational value.[51] The iron content in the water reaches 30 milligrams per liter, whereas five grams are enough to color it brown.[52] The amount of sulfates and chlorides in the river is doubled.[53] Another river, the Calumet River in Illinois, is polluted primarily by four steel companies. The filth from their mills is carried by the river to nearby Lake Michigan where it sits near the shore and festers because the currents are too sluggish to disperse or float the wastes away. The whole Chicago area is affected.[54]

These conditions are particularly disturbing considering the fact that most of the pollution can be controlled through the use of well known water purification procedures. To remove flue dust and other suspended solids such as scale and oil, the usual remedy is to run water saturated with the dust through a thickener until the dust settles out into a moist sludge which can be hauled away to a sintering plant. There, the sludge is combined with coke and burned, forming a new substance called clinker which is used in blast furnaces.[55] The solution to the thermal pollution problems caused by the steel industry lies in the use of cooling towers similar to those used by the utility industry.[56] Steelmen feel that the cost of building these towers will be particularly high for the steel industry because many of the steel plants are old and cramped and difficult to revamp to accommodate the cumbersome towers.[57]

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[49] *A Utility's Warm Water May Increase Oyster Yield*, Wall Street J., Dec. 1, 1967, at 1, col. 7.

[50] Carr, *supra* note 8, at 96.

[51] *Id.* at 95.

[52] Rohan, *Industry Aims at Water Pollution Standards*, 198 IRON AGE, Aug. 4, 1966, at 28.

[53] *Id.*

[54] Carr, *supra* note 8.

[55] *Industry Finds Water Wears Well (Pollution Abatement Isn't so Painful)*, 176 ENGINEERING NEWS-RECORD, June 30, 1966, at 20.

[56] *See* Rohan, *supra* note 52.

[57] *Does Pollution Control Pay Off? Inland Steel Company Says Outlook for Steel Dim*, 159 STEEL, Dec. 12, 1966, at 77, 79.

Some steel experts feel that waste treatment facilities can be as much as eight percent of the cost of a new mill. One company, Inland Steel, has spent more than $26 million at its Indiana Harbour Works location.[58] Water and air pollution control equipment has cost U.S. Steel approximately $200 million over the past fifteen years and it was estimated that an average annual expenditure in excess of $600 million for the years 1966–68 would be necessary.[59] Offsetting pollution costs through recovery of valuable by-products is in most cases insignificant. One steel company executive states that the value of material recovered from such activities in one of its newest plants is only one-tenth of the operating cost of controlling pollution.[60]

E. Mining Industry

The major pollutant of the mining industry is acid mine water. Acid mine water is normally found near deposits of coal.[61] However it is known to result from other types of ores.[62] The acid is formed when air, water and pyrite (iron sulfate) combine. When air and water reaches pyrite (a common mineral found in the layers of rock adjacent to coal seams) a chemical reaction starts that produces sulfuric acid and ferrous sulfate. These solutions eventually drain into nearby streams. While the process sometimes occurs naturally, the three ingredients are brought together most often by mining operations.[63] It is estimated that active and abandoned coal mines grossly pollute 4,000 miles of the country's streams with an estimated 3.5 million tons of sulfuric acid.[64] One of the unique aspects of this pollution problem is that the pollution does not stop when coal mining stops. In many instances, the acid flow worsens because existing control measures are neglected after a mine is worked out.[65]

The effects of this form of pollution are dramatic. When the acid and sulfate enter receiving streams a chemical reaction takes place which frees sulfuric acid and iron hydrate. The iron hydrate, only slightly soluble in water, collects on the stream bed and banks. These yellow deposits are commonly called "yellow boy."[66] The acid and hydrate cause tangible damage to water supplies, concrete and steel structures, and navigational equipment,

[58] *Id.*

[59] 1 CCH WATER CONTROL NEWS No. 15, at 3, 4 (Aug. 29, 1966).

[60] *Does Pollution Control Pay Off?*, *supra* note 57, at 77.

[61] DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, PUBLIC HEALTH SERVICE, U.S. DEP'T OF HEALTH, EDUCATION & WELFARE, 87th Cong., 2D SESS., ACID MINE DRAINAGE 2 (Comm. Print No. 18, 1962).

[62] "Lead and zinc mines in Missouri, Kansas, and Oklahoma have unusually acid waters. Arkansas has an acid drainage problem associated with the mining of barite and manganese ores in the State. Several tributaries to the Missouri River receive a considerable amount of toxic waste originating from the separation of gold and other ores mined in the Black Hills region of South Dakota. Considerable amounts of silt and toxic materials are discharged to the Yellowstone River from mining operations in Montana." *Id.*

[63] *Mine Acid, Growing Pollution Problem*, 177 ENGINEERING NEWS-RECORD, Dec. 8, 1966, at 26–27.

[64] INDUSTRIAL INCENTIVES 11.

[65] *Mine Acid, Growing Pollution Problem*, *supra* note 63, at 27.

[66] *Id.*

as well as causing intangible damage to water recreation, stream biology, and property values.[67]

There are a number of solutions to this pollution problem. One approach is to treat the symptoms. Neutralization of acid river water is one such method, although it often merely substitutes a sludge and dissolved solids problem for the acid problem.[68] More realistic approaches treat the problem at its source, the mines themselves. Methods such as back-filling mines with waste rock, diverting drainage water, and sealing out the air will work in some places. New methods are also being considered, such as chemical grouting to make soil and rock impermeable and to bind the sulfur and plastic bubbles to fill abandoned mines and seal them against air.[69] These processes are not inexpensive. The fact that the areas where most of the abandoned mines are located lack a substantial tax base compounds the problem. It becomes extremely difficult to raise local or state money to pay for the pollution control.[70]

F. Food Processing Industry

A substantial amount of the pollution from the food processing industry consists of water which has been used as a cleaning agent in the processing plants.[71] When this cleaning water is discharged into receiving waters, it contains small particles or even whole discarded pieces of raw product, including skins, seeds, and juices of the product being processed.[72] Compared to domestic sewage, these waste waters are high in sugars, starches, and acids. Thus their pollutional strength is ten to fifteen times greater.[73] Because of the organic material in the waste, the BOD is generally very high. For example, the average BOD of the effluent from one citrus fruit processing plant in California was 2,100 parts per million where 50 is generally considered acceptable.[74] This high BOD in the effluent results in a loss of dissolved oxygen in the receiving waters and can cause death to fish as well as other ecological changes. Also, with the increase in the use of pesticides by farmers, food processing wastes contain chemicals which have been washed off of the food. These chemicals could be harmful to fish, plants, fowl, and even humans.[75]

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[67] *Id.*

[68] *Id.*

[69] *Id.*

[70] DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, *supra* note 61, at 14.

[71] Mercer, *Water Problems in Fruit and Vegetable Canning,* in PROCEEDINGS: CONFERENCE ON INDUSTRIAL USES OF WATER IN CALIFORNIA 49, 50 (E. Taylor and M. Huberty eds. 1956). The other large use of water in this industry is for steam cooking and cleaning. However, thermal pollution in this industry is not nearly as great a problem as it is in the steel and utility industries. The reason for this appears to be that the volume of water heated in this industry is not as large as in the steel and utility industries.

[72] *Id.* at 52.

[73] *Id.* at 53.

[74] Finley, *Water Problems Associated with Citrus Processing,* in PROCEEDINGS: CONFERENEC ON INDUSTRIAL USES OF WATER IN CALIFORNIA 45, 46 (E. Taylor and M. Huberty eds. 1956).

[75] See text accompanying notes 97–113 *infra.*

The following are a few unpleasant examples of pollution caused by this industry. "The Hudson River at Troy, New York, . . . is a slimy cesspool where eels writhe and fight over chicken entrails."[76] In Sioux City, Iowa, meatpackers in the late 1950's were dumping stinking offal into the Missouri River, thus contaminating the river waters of four states.[77] "Sugar-beet processing wastes, which smell worse than one would expect, polluted the whole North Platte River when these wastes were dumped in the river in Wyoming."[78]

There are several processes used to purify effluents from the food processing industry. One is by discharging the waste water to a land disposal system.[79] The water is pumped to oxidation ponds or lagoons, where it is allowed to purify itself through the natural processes of sedimentation or oxidation. This method, however, is often complicated by odor, fly, and mosquito problems. Where feasible, spray irrigation (use of the effluent for irrigation) as a means of disposal offers many advantages.[80] Another measure used frequently by the industry is treatment of the waste in a plant-operted disposal facility.[81] This amounts to each plant building its own water purification plant. Biological or chemical methods are normally used to give partial or complete treatment. The principal handicap of this solution is the high cost of facilities needed for treatment of the large volumes of waste waters.

G. Petroleum Industry

A major pollution problem in the petroleum industry used to be the percolation of oil-well brines into fresh water wells and streams. The production end of the industry, however, has eliminated most of this source of pollution.[82] One existing serious pollution problem of the industry is thermal pollution.[83] Of the water entering refineries, about 90 percent is used for cooling processes.[84] Also, a substantial portion of untreated waste water from a petroleum refinery contains oil chemicals such as mercaptans, thiophenols, and suspended oil solids commonly called oil sludge.[85] Boats, fishing gear, piers, quays, wharfs, and other marine structures are vulnerable to discoloration or more serious forms of damage by these oily or tarry substances. Floating oily wastes discourage bathing or swimming, and small

[76] Carr, *supra* note 8, at 94.

[77] *Id.*

[78] *Id.*

[79] Mercer, *supra* note 71, at 53.

[80] For a discussion of the advantages of this process, *see* Lunsford, *Effect of Cannery Waste Removal on Stream Conditions,* 29 SEWAGE AND INDUSTRIAL WASTES 428-31 (1957).

[81] Mercer, *supra* note 71, at 53.

[82] Carr, *supra* note 8, at 95.

[83] For a discussion of the effects of thermal pollution, see text accompanying notes 41–43 *supra.*

[84] *See, e.g., Water Conservation—California Style,* 64 OIL AND GAS J., Mar. 28, 1966, at 140.

[85] Carr, *supra* note 8, at 93.

lumps of oily and tarry materials on the sand may adhere to the clothing or skin of bathers.[86]

Many birds are injured when they come in contact with oil deposits. "Their plumage becomes fouled with oil, some of which may penetrate down under the feathers to the skin, thereby displacing air which normally forms efficient insulation against the cold."[87] Severe and prolonged oil pollution can also injure oysters, mussels, clams, and other shellfish. Fish and other aquatic animals may be harmed in localized areas by oily pollutants that coat the gills of fish or engulf smaller organisms.[88]

Modern cooling towers are used by the industry to increase the number of times water can be used and thereby to reduce the volume of water required for process cooling. The size and cost problems of such towers has already been discussed.[89] A primary process of waste treatment, gravity separation, is commonly used to clean refinery wastes. Secondary processes are more efficient than primary processes in the elimination of petroleum wastes. The secondary processes most frequently used are stabilization ponds, distillation, air flotation, filtration, and chemical coagulation.[90]

In a survey taken in 1960 by the American Petroleum Institute, 80 plants reported expenditures on pollution abatement equipment within the past five years totaling $36,833,300.[91] In the past twenty years, one Texas refinery has spent more than ten million dollars to improve the quality of its air and water discharges.[92] In a recent survey, the American Petroleum Institute claims that results show refiners are now spending more than $30 million annually on water treatment.[93]

III. Sources of Agricultural Pollution

Agricultural land is generally rural, so farmers often have the first opportunity to use water from rivers, streams, lakes and dams. After they have used the water, they discharge it back into streams or into the ground, where is becomes available to the next user. The impact and magnitude of agricultural pollution is great because almost all other water users may be affected by it.[94]

Due to increases in population and land costs, the amount of available farm land is rapidly being reduced. To supply agricultural commodities under these conditions, farmers are using more fertilizer and pesticides,

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[86] C. ZoBell, *The Occurrence, Effects, and Fate of Oil Polluting the Sea,* in 3 Advances in Water Pollution Research 91–93 (E. Pearson ed. 1964).

[87] *Id.* at 92.

[88] *Id.* at 93.

[89] *See* text accompanying notes 47–48 *supra.*

[90] American Petroleum Institute, *a Survey of Water Use by Petroleum Refineries,* in Water in Industry 71 (National Ass'n of Manufacturers ed. 1965).

[91] *Id.*

[92] *How Humble Combats Water and Air Pollution,* 64 Oil and Gas J., Mar. 28, 1966, at 132, 133.

[93] *Refiners Join Attack on Water Pollution,* 64 Oil and Gas J., Mar. 28, 1966, at 130.

[94] Webb, *Water Pollution Resulting From Agricultural Activities,* 54 Am. Water Works Ass'n J. 83 (1962).

raising more animals in a smaller area, mechanizing their operations, and modifying practices in other ways.[95] The result is a greater threat of pollution from this sector of the economy.

Generally, there are two ways that polluted water finds its way back to major water courses: runoff and seepage. Runoff is merely the overflow of excess irrigation water. It may contain fertilizers, organic matter, silt, and contamination washed from the land. Seepage is the water which filters through the soil and either returns to streams or accumulates in the ground water supply. Seepage water is significantly changed in quality, especially in mineral content.[96]

A. Pollution by Pesticides

Pesticides are defined generally as "economic poisons employed to regulate the impact of noxious animals and plants upon our lives and economy."[97] The United States is a leader among the nations of the world in the production and consumption of pesticides. By 1961, nearly 700 million pounds of synthetic pesticides had been produced in the United States.[98] As of June, 1962, more than 54,000 formulations of pesticides were registered by the Department of Agriculture.[99] It is predicted that within the next twenty years, the production of pesticides will increase by ten times the present output.[100]

Pesticides find their way into water in two main ways: by transport in surface water runoff, and by direct application, as by wind-blown spray or aerial application.[101] The pesticides that reach watercourses are normally in non-degradable form, and, because the biota in the receiving waters do not break down these substances,[102] the pollutants remain intact for substantial periods of time.[103] The effect of these pesticides on water and its various inhabitants and users is far from clear because the information available on this subject is fragmentary.[104] One serious result of pesticide pollution, about which information is available, is the killing of millions of fish every year.[105] Much of the data on fish kills by pesticides arises from cases in which substantial amounts of pesticides entered a particular stream and, as a result, thousands

[95] *Id.*

[96] Eldridge, *Irrigation as a Source of Water Pollution,* 35 WATER POLLUTION CONTROL FEDERATION J. 614, 617 (1963).

[97] Thoman & Nicholson, *Pesticides, a Hazard to Water Quality,* in WATER: DEVELOPMENT, UTILIZATION, CONSERVATION 21 (R. McNickle ed. 1963).

[98] *Id.* at 22.

[99] *Id.* at 22–23.

[100] *Id.* at 23.

[101] Pesticides also get into water through accidents such as may occur when a spray rig is filled from a creek or when a truck loaded with pesticides is involved in an accident adjacent to a stream and drains into the stream. Such accidents, however, are sporadic and generally cannot be prevented through any conscious water pollution control program. *Id.* at 26.

[102] *See* text accompanying note 10 *supra.*

[103] Webb, *supra* note 94.

[104] Nicholson, *Pesticide Pollution Control,* 158 SCIENCE 874 (1967).

[105] *See* U.S. DEP'T OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION FISH KILLS BY POLLUTION (1966).

of fish were killed. These occurrences are generally local in nature, readily apparent, and sporadic, with partial or total repopulation quickly occurring.[106] Consequently, the solution to abatement in this area is prevention rather than treatment. Little is known about the dangers when pesticides find their way in trace amounts to the drinking water of humans and other animals. There is speculation that these pollutants could have substantial long range effects on the human body. Evidence giving reason for concern in this area was found by researchers who examined penguins in the Antarctic and found traces of DDT in their livers.[107]

A number of controls have been suggested for pesticide pollution. Gross overapplication of pesticides is often the cause of serious pollution;[108] consequently one way to decrease the problem is to make sure that pesticide users are aware of the proper amounts of pesticides to use. Another suggested solution is to substitute more readily bio-degradable pesticides for the non-degradable ones now used.[109] Light traps and sex attractants are also being studied for use in conjunction with pesticides. This technique draws insects to the pesticides, thereby restricting pesticide use to small areas.[110] One solution, called the sterile male release technique, does away with the use of pesticides altogether. Male insects are sterilized and released to mate with the normal population, thus controlling the insects without pesticides.[111] Finally, viruses and bacteria have been used successfully in tests that involved rearing insects, infesting them with viruses, then turning them loose to infest natural populations.[112] None of the standard water treatment techniques is used for pesticides, the reason being that these waste water treatment procedures do not appear to reduce the concentration of many of the pesticides, especially the chlorinated hydrocarbons.[113]

The cost of pesticide pollution control is difficult to determine, primarily because most of the solutions are preventive measures as opposed to subsequent treatment of polluted water.

B. Pollution by Animal Wastes

The excreta of farm animals is a potential major source of water pollution. Animal wastes enter watercourses either in the form of surface runoff or through seepage. In some watersheds, farm animals contribute considerably more wastes than humans,[114] and the drainage from certain land areas

[106] Nicholson, *supra* note 104, at 873.

[107] *Id.*

[108] J. McKee & H. Wolf, Water Quality Criteria 355 (California State Water Quality Control Board, Pub. No. 3-A, 1963).

[109] Nicholson, *supra* note 104, at 875.

[110] 1 CCH Water Control News No. 26, at 10 (Nov. 14, 1966).

[111] *Id.*

[112] *Id.*

[113] Thoman & Nicholson, *supra* note 97, at 26.

[114] For example, a dairyman from a 100-cow dairy operation disposes of at least five tons of waste per day during the year, or approximately 1825 tons in a year's time. Taiganides, *The Animal Waste Disposal Problem*, in Agriculture and the Quality of Our Environment 389 (N. Brady ed. 1966).

supporting large animal populations leads to significant water contamination.[115] Pollution from animal manure has reached such high proportions in some areas that downstream fish kills and ground water contamination have been attributed to the pollution.[116] The problem has grown to the point that probably the major unsolved issue in the confinement of livestock and poultry is the handling and disposal of manure.[117] The practice of raising large numbers of animals in small areas is compounding the animal waste disposal problem. In the past, farmers used barnyard waste as a source of fertilizer. However, with specialized farms, each farm no longer grows its own feed. The manure is not needed, and its disposal presents a problem.[118] Studies of water pollution by animal wastes indicate that the runoff is characterized by a high oxygen demand, high ammonia content, and heavy bacterial populations. Probably the most harmful effect is the reduction of dissolved oxygen in the receiving waters.[119]

There is presently no single method generally satisfactory for the treatment and disposal of animal manure.[120] One method currently used is the lagooning of the waste over a period of time to allow sedimentation and aeration to purify the water. The shortcomings of this process are the possibility of overflow during rainy seasons, unpleasant odor, and breeding of flies and mosquitos.[121] One possible solution is a system now being developed which employs hydroponic beds.[122] Hydroponic beds are small lagoons or ponds in which plants are grown while immersed in water containing the essential nutrients, instead of in soil.[123] The system, being developed by the University of Maryland, traps manure effluent in a series of three hydroponic beds.[124] One advantage of this system is that it produces forage grasses for hay, silage, or green chop.[125]

C. Pollution by Irrigation

In this country irrigation is a major use of water, exceeding the amounts used for domestic and industrial supply. At present, irrigation largely exists in western states; over 90 percent of the irrigated land in this country is located in the arid regions west of the Mississippi River.[126] Some authorities believe that most of the potential area of 51.5 million acres in the western states will be under irrigation by 1970.[127]

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[115] ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 170.

[116] *Id.*

[117] *Id.*

[118] Webb, *supra* note 94, at 84.

[119] See text accompanying note 9 *supra* for a discussion of the effects of the reduction of dissolved oxygen. ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 171.

[120] ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 171.

[121] *See* Webb, *supra* note 94, at 84.

[122] *Hydroponic System for Growing Forage Grasses with Livestock Wastes,* 15 AGRICULTURAL RESEARCH, July, 1966, at 10.

[123] WEBSTER'S NEW COLLEGIATE DICTIONARY 406 (6th ed. 1961). Hydroponics is also referred to as "tank farming" and "water culture." *Id.*

[124] *Hydroponic System for Growing Forage Grasses with Livestock Wastes, supra* note 122, at 11.

[125] *Id.*

[126] Eldridge, *supra* note 96, at 614.

[127] *Id.*

The use of water for irrigation seems harmless enough, yet the process significantly affects the quality of water. The problem is that from the time irrigation water is taken from a watercourse to the time it returns, it is continuously picking up contaminants which degrade the water. In the process, water increases in salinity and nutrients and also picks up quantities of pesticides.[128] "Salinity" refers to the total content of dissolved mineral constituents. When water comes into contact with earth, the process of mineralization begins. Each storage, transmission and use of water increases its salinity.[129] As a result, the water returning from irrigation projects contains from three to ten times as much mineral salts as the original irrigation water.[130] Plant growth can be adversely affected by high salinity. Thus it becomes necessary to leach these salts from the soil by the application of water over and above the plant requirements.[131] This procedure is known as maintaining the salt balance; it assures that the salt output from the irrigation process exceeds the input.[132] As irrigation is a consumptive use of water (approximately two thirds of irrigation water is lost through evaporation and transpiration by plants[133]) the result is that the smaller volume of water returned to the stream is increased significantly in salinity content.[134] The Rio Grande illustrates the effect of irrigation on the mineral content of water. One study showed that the normal flow of the river was reduced by one fifth and the salt concentration increased from 190 to 2,060 mg./1.[135] The effects of the increase in salinity are felt by subsequent industrial and domestic users of the water. There are instances on record where the salinity has increased to such concentration as to render water unfit for most purposes, including irrigation.[136]

Irrigation water also picks up significant quantities of plant nutrients added to irrigated land by the farmer to increase crop production. These nutrients, such as nitrogen, potassium, and phosphorous, produce excessive growths of algae, slime, and other organic organisms.[137] There is presently no feasible way to remove minerals and nutrients from water used for irrigation purposes since low cost water is an economic necessity to the farmer. Keeping the mineral content down must depend on the management of water sources to reduce the input of salts and nutrients.[138]

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[128] *Id.*, at 618. *See also* text accompanying notes 97–113 *supra.*

[129] ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 72.

[130] Eldridge, *supra* note 96, at 619.

[131] *Id.*

[132] For further information, see L. Wilcox, Classification and Use of Irrigation Waters (U.S. Dept of Agriculture Circular No. 969, 1955).

[133] Eldridge, *supra* note 96, at 616.

[134] *Id.* at 619.

[135] The study, made in 1945 by the U.S. Salinity Laboratory, Riverside, California, is described in Eldridge, *supra* note 96, at 619.

[136] For further discussion, see Cunningham, Haney, Bendixen, & Howard, *Effect of Irrigation Runoff on Surface Water Supplies,* 45 J. AM. WATER WORKS ASS'N 1159 (1953).

[137] E. Eldridge, *supra* note 96, at 622–23.

[138] ENVIRONMENTAL POLLUTION PANEL, *supra* note 24, at 73.

IV. Special Considerations in Abating Pollution in the Private Sector

A. Adequacy of Technology for Pollution Abatement

Recognizing that a tremendous pollution problem exists in our country, is the level of technology in the field of pollution control adequate to eliminate water pollution? The position of many of the leaders in the private sector of our economy is that present technological knowledge is not adequate to solve their pollution problems. A recent survey of industry on the subject of pollution abatement revealed attitudes similar to the following:

> There is still much to be learned about abatement techniques. Although equipment is constantly being improved, it is still inadequate for solving certain problems. . . . We [companies] lack comprehension of the intricate interplay of forces prevailing in nature which, when disturbed, bring about pollution. Thus, attempted solutions to pollution may even be self-defeating. Because of such considerations, most companies concur that crash programs will cause undue financial burden on industry.[139]

On the other hand, many government leaders in the field of pollution control feel that lack of technology is not a significant hindrance to pollution control. They feel, in fact, that waste control processes, equipment, and expertise abound.[140] Former enforcement head of the Federal Water Pollution Control Administration, James M. Quigley, summed up his agency's position as follows: "The big lag is doing what is doable. Treatment plants are being built in 1966 that could have been built in 1906."[141] Actually, the answer to the technology question is not as simple as either of these statements makes it sound. A more realistic answer is that in some areas technology is more than adequate to cope with the critical pollution problems, but in other areas, technology is severely difficient. The obvious and obnoxious cases of pollution, for example, suspended matter which leads to sludge and floating matter such as oil slicks, can be taken care of today. Here there is no necessity for detailed analysis of damages or degradation of quality. Our collective senses are adequate. Such pollution is a result of contaminants which exist in a substantially different physical phase than water. This is why they are noticeable and also why they are cheap to remove.[142]

Also, most pollution caused by degradable organic matter can be eliminated through implementation of current technology. The processes for the purification of such organic pollutants are well enough understood to permit

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[139] Watson, *Approaches to Abatement in Five Major Industries*, 4 The Conference Board Record, May, 1967, at 6.

[140] *Industry Joins Battle To Stem Pollution Tide*, Bus. Week, Dec. 31, 1966, at 76.

[141] *Id.*

[142] House Subcomm. on Science, Research, & Development of the House Comm. on Science & Astronautics, 89th Cong., 2d Sess., Environmental Pollution—A Challenge to Science and Technology 12 (Comm. Print 1966).

the construction of facilities which can purify up to 90 percent of these wastes, although even this degree of treatment is inadequate in some situations.[143] However, in many cases, purification of these pollutants is completed naturally after dilution in the receiving water. The treatment of degradable pollution is no longer dependent on the discovery of new techniques. "Elimination of most of this type of pollution can be achieved at any time the public believes that the resulting benefits in terms of providing suitable water for other purposes is sufficiently important to warrant the necessary action. The costs involved, while substantial, are not unreasonable."[144]

Technology is seriously deficient in the area of pollution by chemical and mineral substances. Within the past decade, thousands of new compounds have been synthesized. Many of these wastes remain virtually stable in our water resources.[145] A good example of this is the insecticide DDT. Although it is not known to be toxic to human beings in low concentrations, its worldwide occurrence in animal fat (including the fat of humans) illustrates the mobility of persistent organic compounds.[146] Although many of these compounds are not removed by normal sewage treatment, the more advanced water purification processes under development could separate them, but at a high cost. For example, the methods used for desalting sea water could be used. However, they are at present economically prohibitive.[147]

Even though there are areas where technology must be improved, there is presently no need to slow down and wait for new and better technology. Recent hearings before the House Subcommittee on Science, Research, and Development established that if industry would conscientiously attempt to solve its pollution problems, the major roadblock to effective pollution control would be money, not technology. "The 'catchup' phase of pollution abatement need not wait for research and development."[148]

B. Economic Aspects of Pollution

To understand the economic effect water quality regulation has on industry and agriculture, it is necessary to be familiar with a few basic economic principles. Some of these are summarized as follows:

> All of the factors of production (resources) are to some degree scarce. A free market economy bids scarce resources to their most productive use by establishing prices which reflect the demand for various items. The more valuable a particular end product is esteemed to be in the market (as reflected by its price), the more its producer will be willing to pay for the constituent resources he requires. The producer will thus

[143] SENATE SELECT COMM. ON NATIONAL WATER RESOURCES, 86TH CONG., 2D SESS., WATER RESOURCES ACTIVITIES IN THE UNITED STATES, POLLUTION ABATEMENT 16 (Comm. Print No. 9, 1960).

[144] *Id.*

[145] *Id.*

[146] HOUSE SUBCOMM. ON SCIENCE, RESEARCH, & DEVELOPMENT, *supra* note 142, at 27.

[147] *Id.* at 28.

[148] *Id.* at 13.

> bid the use of these resources away from producers of less valuable end products who would use the same constituent resources but who, because their end product is less valuable, cannot afford to pay the market price of these resources. To an individual producer the price he must pay for the resources he uses are costs. To allow him a profit, the sum of his costs on a per unit basis must obviously be less than the prevailing per unit market price of his end product. When this is the case for all producers, the market is in equilibrium—the aggregate supply of scarce resources will be most productively allocated in accordance with the relative prices established by the aggregate demands of the total economy.[149]

To illustrate these principles, assume an economy with two individual producers and one scarce resource or raw material. Producer A uses the resource, say steel, to manufacture bolts while producer B uses this resource to produce nails. Assume further that the economy is willing to pay 10¢ for each bolt and 5¢ for each nail. If an equal amount of steel is used in the production of each of the products, A will be willing to pay a higher price for steel than B. If A's production cost is 3¢ per unit (including allowances for profits), he would be willing to pay up to 7¢ for each unit of steel required for the production of one bolt. He is motivated to produce as many bolts as possible because he would make a profit on each sale. He would continue to increase his production until he drove the price of steel up to 7¢ per unit. The price of steel would not remain constant as his demand increases because steel is a scarce resource, and, as the demand for it increased, so would its price. B obviously could not pay the 7¢ price because his sale price of 5¢ would not even cover the price of the steel, let alone his other production costs. In this manner, the resource steel would be used for the production of the product that the hypothetical economy desired, *i.e.*, bolts.

Normally, an economy will not express its needs as in the example. More likely, there would be a demand for a certain quantity of each of the alternative products available. Assume that in our economy there was an aggregate demand for 70 units of bolts and 30 units of nails at 10¢ each. Assume also that the costs of production of bolts and nails are the same, and that each producer requires the same amount of the raw material steel. In this case, A would manufacture 70 units of bolts and B would manufacture 30 units of nails. If A produced 71 units, there would be no demand for the 71st unit, except at a price lower than 10¢. Since it would not be profitable to produce and sell this unit, A would manufacture no more than 70 units. A would not produce less than 70 units because he would be losing potential profit. For the same reasons, B would manufacture exactly 30 units of nails. Thus, through the market system, the available resource of steel would be allocated in accord with the demands of purchasers: 70 percent of the available resource would be used for bolts, and 30 percent for nails.

[149] Delogu, *Effluent Charges: A Method of Enforcing Stream Standards*, 19 MAINE L. REV. 29, 39–40 (1967). *See also* P. SAMUELSON, ECONOMICS 57–75 (7th ed 1967).

The problem is that the market system breaks down when one firm is able to shift some of its costs to someone else.[150] This is what happens when producers are allowed to pollute water. Suppose that a firm is not induced to take into account the cost of the pollution it creates.[151] The firm will neglect pollution control costs in deciding how much to produce. From the consumer's viewpoint, the firm is producing too much. The costs associated with the production of another unit (including the costs to downstream users) are now greater than its price. In effect, these goods are being produced artificially cheaply. If all costs are taken into account, including the water purification costs, consumers would purchase less of the higher priced goods which cause the pollution.[152] In the short run, costs of pollution abatement may result in reduced profits for individual producers, but, in the long run, the costs of pollution abatement borne by producers ordinarily would be added to the price of the goods purchased. The higher price of these goods would give them a less advantageous position in the market place, and eventually the resources used in them would decline relative to those used in competitive products.[153]

To illustrate this problem, let us return to the hypothetical economy of two producers, A and B, manufacturing bolts and nails respectively. Instead of only one resource being used in the production of each of these items, assume that a second resource, water, is also used. Suppose that B's factory is located upstream from A, and in producing nails B discharges untreated effluent into the passing stream. Because B does not have to treat the water he pollutes, his production costs would be reduced by the amount he saves, say by 1¢ per unit of nails. A now has to clean water that B polluted before he can use it in the production of bolts. Therefore his production costs are increased by these costs. Instead of nails and bolts each costing 10¢ per unit, the price of nails will decrease to 9¢ per unit and the price of bolts will increase to 11¢ per unit. The result will be that some consumers will purchase nails instead of bolts. The quantity of bolts sold will be less than the original volume of 70 units, and conversely the quantity of nails sold will now be greater than 30 units. Because B has been able to shift some of his production costs to A, the market is no longer efficient in allocating resources. The individual using the water and polluting it is induced to use it more because he can now sell more of his products. The net effect would be an increase in pollution and a failure to allocate resources optimally.

In the example, because some of B's production costs are being borne by someone else, either a downstream water user or the public in general, he has in effect a subsidy.[154] The system of subsidies that exists today has developed in a haphazard manner. The individuals responsible for pollution

[150] Delogu, *supra* note 149, at 40.

[151] These costs are measured by the value of the uses the water could have been put to if not polluted, or by the costs of the pollution abatement. INDUSTRIAL INCENTIVES 34.

[152] O. HERFINDAHL & A. KNEESE, *supra* note 6, at 7.

[153] INDUSTRIAL INCENTIVES 34.

[154] *Id.*

have generally been better politically organized than those groups damaged by pollution, especially when pollution affects only aesthetic and recreational qualities of the water. This system of partial subsidies should not be allowed to continue. The polluter should eventually be asked to pay the cost of his pollution. The sudden removal, however, of a subsidy system is likely to cause hardships to the subsidized companies. The requirement to immediately install expensive pollution abatement equipment would be a financial burden which many of them could not carry. Consequently, there have been many proposals for formal subsidy programs to expedite pollution abatement without dealing a mortal blow to existing polluters. Such a program would replace the existing indirect subsidy system.[155]

From this discussion it is evident that, from the standpoint of the economist, water pollution causes an inefficient allocation of resources in our economy.[156] To correct this allocation problem, the goal is to find some means whereby businessmen, when making decisions on how much to produce, are forced to take proper account of all of the costs flowing from the economic activity in question.[157] If a pollution control system were devised to fulfill this goal, the system would correct the market distortions which the presence of water pollution creates.[158]

It is important to remember that such a system would correct the distortions that now exist in the market system. However, it would not necessarily solve the water pollution problems of the economy.[159] Suppose that in our hypothetical economy where B transfers pollution costs to A, the government decided to force B to pay A his increased production costs caused by B. Such a procedure would correct the distortions in the market system. However the pollution problem would still exist. Pollution may decrease because B would be forced to produce less goods due to the higher prices. However, some nails would still be produced and consequently some of the pollution would continue. It is important then to keep in mind that pollution, in effect, creates two interrelated problems, a distortion in the market system as an efficient allocator of resources and the degradation of our economy's waters. Therefore, when a governmental body makes a decision on the type of system to employ to solve its water pollution problems, it should consider a scheme that will at the same time correct the market distortions incident to water pollution.

V. Alternative Forms of Pollution Control

Society can employ several forms of legal controls to prevent water pollution. Some of these methods have been used extensively with little success and others have been discussed frequently but used little. The systems of legal control discussed in this section are the common-law approach, regulation and enforcement, payments and incentives, and effluent charges.

[155] *Id.* at 35.
[156] Delogu, *supra* note 149, at 40.
[157] O. Herfindahl & A. Kneese, *supra* note 6, at 8.
[158] Delogu, *supra* note 149, at 41.
[159] *Id.*

A. Common Law[160]

At common law, a person whose property is injured due to water pollution ordinarily has a cause of action against the person causing the pollution.[161] The injured party may seek damages for his injuries,[162] or he may seek to enjoin the activity causing him harm,[163] or both.[164] The individual seeking redress through the courts, however, finds many formidable obstacles to recovery. Where the polluter is a large company and the main employer in the community, an individual may be reluctant to bring suit.[165] A recovery by him may have significant economic effect on the community as well as the polluter. Moreover, an individual may not have the financial resources to bring a pollution suit. Proof of pollution is complicated and almost always requires expert opinion, which is expensive[166] and difficult to acquire. Also, the individual may not be able to afford as eminent a lawyer as many large companies employ, thus placing him at a disadvantage in the courtroom.[167]

Even if a suit is undertaken, the plaintiff has many problems in proving his case. As in other public nuisance cases, he must show that he incurred a material harm[168] which was different from that suffered by the general public.[169] The burden is on the plaintiff to show that the pollution which caused the harm was unreasonable.[170] This is a question of fact and frequently must be left up to the judgment of individual juries.[171] Even if the plaintiff has a strong case, there are numerous defenses available to the polluter, such as the statute of limitations[172] or an acquired prescriptive right.[173] The plaintiff's greatest task is to prove that his injury was the result of the defendant's pollution. When the pollution consists of a variety

[160] *See* Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality*, 52 IOWA L. REV. 186, 196–201 (1966); and Note, *Statutory Treatment of Industrial Stream Pollution*, 24 GEO. WASH. L. REV. 302, 305–10 (1956).

[161] *See* PROSSER, TORTS § 90, at 621–23 (3d ed. 1964).

[162] Masonite Corp. v. Steede, 198 Miss. 530, 23 So. 2d 756 (1945); American Tar Products Co. v. Jones, 17 Ala. App. 481, 86 So. 113 (1920).

[163] Cairo Pickle Co. v. Muggridge, 206 Ga. 80, 55 S.E.2d 562 (1949); Indianapolis Water Co. v. American Strawboard Co., 57 F. 1000 (C.C.D. Ind. 1893).

[164] Wright v. Best, 19 Cal. 2d 368, 121 P.2d 702 (1942); Joerger v. Pacific Gas & Electric Co., 207 Cal. 8, 276 P. 1017 (1929).

[165] Note, *Statutory Treatment of Industrial Stream Pollution*, 24 GEO. WASH. L. REV. 302, 309–10 (1956).

[166] *Id.* at 310.

[167] *Id.*

[168] For example, CAL. CIV. CODE § 3493 provides that "[a] private person may maintain an action for a public nuisance, if it is specially injurious to himself, but not otherwise." This section has been held to apply to water pollution cases. Spring Valley Waterworks v. Fifield, 136 Cal. 14, 68 P. 108 (1902).

[169] Columbia River Fisherman's Protective Union v. City of St. Helans, 160 Ore. 654, 87 P.2d 195 (1939).

[170] Punxsutawney Water Serv. Co. v. Saricks, 354 Pa. 106, 46 A.2d 673 (1946).

[171] Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality*, 52 IOWA L. REV. 186, 198. *See also* PROSSER, TORTS § 36, at 206 (3d ed. 1964).

[172] Gulf Oil Corp. v. Alexander, 291 S.W.2d 792 (Tex. Civ. App. 1956), *aff'd per curiam*, 156 Tex. 455, 295 S.W.2d 901 (1956).

[173] *E.g.* W.G. Duncal Coal Co. v. Jones, 254 S.W.2d 720 (Ky. 1953).

of pollutants from several polluters, which is often the case, it is nearly impossible to prove that a particular polluter is responsible for the damage.[174] The problem is further compounded in some jurisdictions which hold that joint polluters may not be joined without their consent.[175] Even if an individual were able to prove his case, the court may grant him damages but allow the pollution to continue.[176]

Looking at pollution control from the viewpoint of the community, the common-law system has serious shortcomings. If a pollution problem is a public nuisance, the action is generally brought by a local official. It is frequently difficult to pin down the person responsible for processing the action, and even if he is found, it may be difficult to persuade him to proceed with the suit.[177] Another problem is that courts do not have the ability systematically to approach pollution problems, since litigation is fortuitous in its timing, in the issues it raises, and in the quality of presentation made for each side.[178] Also, the adversary system does not adequately assure representation of the public interest in pollution cases. Only the parties' interests are before the court in any particular litigation. Finally, courts are unable to administer flexible programs of pollution control. The traditional reluctance of courts to issue an affirmative order illustrates the limited effectiveness of a court pollution control program.[179]

The common law of water pollution was developed when agriculture constituted the basic economic interest, and the courts zealously guarded against the encroachments of a growing but still young industrialism.[180] During the past century new industries have grown large enough to compete politically with farming. With the growth of state and federal legislation in the area of water pollution,[181] interest in studying shifts of power and influence in common-law pollution control has waned, so it is difficult to tell whether the courts have now sided with industry as they once did with agriculture. A few generalizations, however, can be made. In many areas the clash of social interests has been not between the large industrial plant and the farm owner, whose use of water is for the stock and irrigation purposes. More often, the controversy is between two industrial establishments. In most states where industry is powerful enough to be heard in state and local politics and have a subtle influence on the attitude of the bench and bar, it is usually true that diversification of enterprises exists and that no one type of business predominates in importance. Here, the general tendency of the courts has not been to side with any one industry, but to decide controversies

[174] Hines, *supra* note 171, at 198.

[175] Farley v. Crystal Coal & Coke Co., 85 W. Va. 595, 597, 102 S.E. 265, 266 (1920). *Contra,* Warren v. Parkhurst, 92 N.Y.S. 725, 45 Misc. 466 (1904), *aff'd,* 186 N.Y. 45, 78 N.E. 579 (1906).

[176] *See* Hines, *supra* note 171, at 199–200.

[177] *Id.* at 198.

[178] *Id.* at 200.

[179] *Id.* at 201.

[180] Jacobson, *Stream Pollution and Special Interests,* 8 WIS. L. REV. 99, 115 (1933).

[181] See text accompanying notes 185–88, 221–24 *infra.*

according to the accepted rules of riparian rights.[182] However, in areas where one industry is the principal economic enterprise in the community, there are indications that courts have been influenced by the industries.[183] The following discussion of the mining industry illustrates the point:

> A highly important phase . . . of the mining industry is that it is usually the principal economic enterprise of the communities in which it is located. In Pennsylvania, West Virginia, and the bituminous fields of the Middle West, coal is verily king. And the local sheriffs, district attorneys, police, and frequently even judges are members of his majesty's household.[184]

B. Regulation and Enforcement

In a regulation and enforcement system the agency responsible for water pollution control determines how much a particular polluter should be allowed to discharge, conveys this information to the polluter in the form of standards, and uses its authority to punish the discharger if he fails to meet the standards. The effect of such regulation is to place costs of pollution abatement squarely on the polluter, rather than on the downstream users or the public in general. Almost all of the water pollution control laws employed today by the various levels of government can be classified as regulation and enforcement laws.

1. State Regulation and Enforcement Programs

Inadequacies of the common law to control pollution, coupled with a tremendous increase in industrial activity, prompted the states to become involved in water pollution control activities. By 1930, most states had enacted legislation vesting authority to deal with pollution problems in one or more state agencies.[185] In the 1950's a significant change occurred in the course of state control of water quality management. Over half of the states strengthened their pollution laws during this period.[186] One of the major impetuses to these changes was the publication by the United States Public Health Service of the Suggested State Water Pollution Control Act (SSWPCA) in 1950.[187] Today, the majority of state programs are based on comprehensive pollution control statutes, evidenced by the fact that approximately three quarters of the states include all or part of the statutes of SSWPCA.[188]

Many of the state statutory schemes for water pollution control have marked similarities.[189] They are basically regulation and enforcement programs; that is, they involve the setting and enforcement of water quality standards. Most of the states use administrative boards to administer these

[182] Jacobson, *supra* note 180, at 122.
[183] For further discussion, see *id.* at 123–33.
[184] *Id.* at 123.
[185] Hines, *supra* note 171, at 203.
[186] *Id.* at 204.
[187] *Id.*
[188] U.S. DEPT OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, SUGGESTED STATE WATER POLLUTION CONTROL ACT, REVISED (rev. ed. 1966).
[189] Hines, *supra* note 171, at 215.

programs.[190] The powers and functions of these boards vary, but in the majority of the states they have both policy making and enforcement powers.[191] The membership of these boards usually takes one of two forms. They consist entirely of officials in some way associated with the state's water pollution program,[192] or they consist of a mixture of such officials and persons representing the various interests most directly concerned with pollution regulation, such as industry, agriculture, and conservation.[193]

In the majority of the states, these boards have authority to set effluent and receiving water standards.[194] There is, however, a tendency in some states to ignore the establishment of broad standards for the majority of their waters and approach each pollution problem on a case-by-case basis. Each case is decided as it arises, but attempts are made to establish precedents for similar cases.[195] Some jurisdictions have been moving away from a strictly case-by-case approach to the setting of standards and are now using other techniques for classifying receiving waters.[196] Generally, the most populous and industrialized states have been the most active in the adoption of comprehensive standards.[197] The Federal Water Quality Act of 1965, which requires the creation of quality standards for all interstate waters by the states, has forced all of the states to proceed with the establishment of standards.[198]

Most state agencies have a great deal of power and authority, yet enforcement has been a major weakness of state pollution regulation.[199] For example, the state of Maine through a series of legislative enactments beginning in 1941 has created potentially effective pollution control machinery. This machinery, however, has not been fully used; thus, the quality of many of the state's waters has not only failed to improve but has continued to deteriorate.[200]

State enforcement procedures generally follow this pattern: (1) someone petitions for action concerning a certain pollution problem; (2) the agency makes a complete investigation of the alleged pollution; (3) the agency enters into informal negotiations with the alleged polluter; (4) if no agreement is reached in these negotiations, a formal hearing is held and all the evidence concerning the problem is heard; (5) at the conclusion of the

[190] *Id.* at 217.

[191] *See, e.g.*, ARK. STAT. ANN. §§ 82–1904 (Supp. 1967); N.C. GEN. STAT. §§ 143–215.1—.2 (1964).

[192] *See, e.g.*, WASH. REV. CODE ANN. § 90.48.021 (1962).

[193] *See, e.g.*, N.C. GEN. STAT. §§ 143–213 (1964).

[194] *See, e.g.*, MICH. STAT. ANN. § 3.525 (1961). Effluent standards are standards which relate to the quality of the effluent from a particular source. Receiving water standards are standards which relate to the water into which effluents are discharged. Receiving water standards limit the amount of effluent discharge by allowing discharges to lower the quality of the receiving water only by certain prescribed amounts.

[195] Hines, *supra* note 171, at 223.

[196] Gindler, *State Administrative Regulation,* in 3 WATER AND WATER RIGHTS 241 (R. Clark ed. 1967).

[197] Hines, *supra* note 171, at 223.

[198] Water Quality Act of 1965, § 5, 79 Stat. 907–08 (1965).

[199] Hines, *supra* note 171, at 227.

[200] Delogu, *supra,* note 149.

hearing, the board decides on the course of action it is going to take.[201] Action may take the form of a cease and desist order or a requirement of specific alterations in a polluter's waste disposal or treatment methods.[202]

In addition to these control procedures, nearly all the states augment their control agencies with various powers to supervise polluters. Agencies may issue permits to dischargers,[203] compel the filing of reports on waste treatment facilities,[204] and enter private property for investigative purposes.[205]

A few of the state water pollution control laws have provided exemptions or special treatment for certain kinds of waste discharges. For example, certain mining debris is not considered industrial waste in Alaska,[206] and until just last year, fertilizers were treated likewise in West Virginia.[207] Such exemptions are infrequent. Generally the more serious forms of pollution by industry and agriculture are not exempted from state pollution law coverage.

There are several frequently mentioned criticisms of the present system of state pollution control. One weakness of many existing state agencies is unwillingness to recognize the necessity of long range planning. Most of the state laws encourage planning, but too many of the agencies become so involved with day-to-day operations that they neglect their planning duties.[208] Also, states have an inherent inability to deal with pollution problems which exist in interstate or border waters. Finally, a more subtle problem faced by the states relates to the mobility of modern industry. It is argued that a state may be reluctant to enact and enforce strict pollution laws for fear of firms "shopping around" for states with less stringent standards and enforcement practices. There is serious question about the validity of this argument. Other factors, such as availability and cost of labor, raw materials, and transportation, play an important role in making plant location decisions.[209] Also,

> [a] state would be unwise in the long run to be lax in pollution control measures in the short run. Industries not able or willing to bear the cost of curtailing their pollution would be of doubtful desirability in the long run, and attempting to lure industries to the state on the basis of lax enforcement measures would be a pernicious practice. It should be pointed out that the cost of building treatment facilities into a factory during the construction phase is not nearly so expensive as adding them later. Maintaining reasonably high requirements from the start would be actually doing the industry, as well as the public a distinct favor.[210]

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[201] *See, e.g.*, IOWA CODE ANN. § 455B.12.

[202] *See, e.g.*, IND. CODE ANN. §§ 68–525—27 (1961).

[203] *See, e.g.*, MINN. STAT. ANN. § 115.07 (1964).

[204] *See, e.g.*, N.H. REV. STAT. ANN. § 149.4 (1964).

[205] *See, e.g.*, IND. ANN. STAT. § 68–522 (1961).

[206] ALASKA STAT. §§ 46.05.230 (2)–(5).

[207] W. VA. CODE ANN. § 20-5A-2 (1966). A 1967 amendment to this provision eliminated this exemption. W. VA. CODE ANN. § 20-5A-2 (Supp. 1968).

[208] Hines, *supra* note 171, at 233.

[209] INDUSTRIAL INCENTIVES 27.

[210] D. Grubbs & R. Sheridan, Special Memorandum on Water Resources and Related Lands 20 (Tennessee Legislative Council Comm. 1962), quoted in INDUSTRIAL INCENTIVES 27–28.

2. Regional Regulation and Enforcement Programs

Presently there exist less than a dozen regional pollution control agencies created by formal agreements among the states.[211] Most of the active interstate compacts create commissions or boards organized much like state pollution control agencies. Each participating state is represented by one or more members.[212] The jurisdiction of the commissions extends to waters in the interstate drainage basin under the compact.[213] Most compacts grant to an administrative body authority to classify the water according to various uses and to set water quality standards for these classified waters.[214] About one-half of the administrative bodies have authority to issue orders for enforcement of their standards and, if necessary, obtain court orders for compliance.[215] None of the compacts have express language on the authority of the administrative board to require reports or to examine records of waste dischargers.[216]

It is difficult to tell objectively how effective interstate compacts have been in the regulation of water pollution.[217] Generally, the standards promulgated by the various compacts have tended to be low.[218] One reason for this is that several of the existing agencies lack enforcement powers. Yet, even the agencies that do have effective enforcement machinery rely heavily on education and persuasion to enforce their water standards.[219] Another factor contributing to the absence of aggressive action has been the lack of financial resources. The funds made available to the various compacts through their member states have been inadequate to finance the broad programs necessary for effective pollution control.[220]

3. Federal Regulation and Enforcement Programs

Before 1948, the federal government played only a minor role in water pollution control.[221] As a result of increased wartime industrial activity, the pollution problem in the United States became worse and people began to realize that something had to be done about this problem. Consequently, the federal government began enacting water pollution legislation. Today the federal government plays a leading role in the field of industrial and agricultural water pollution abatement. The federal program is designed to motivate the states to undertake more aggressive water pollution abatement programs while complementing existing state programs. The federal program

[211] Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality,* 52 IOWA L. REV. 432, 433 (1967).

[212] *E.g.,* Tennessee River Basin Water Pollution Control Compact art. IV, 72 Stat. 823–24 (1958).

[213] Gindler, *Federal Water Quality Control,* in 3 WATER AND WATER RIGHTS 339 (R. Clark ed. 1967).

[214] *E.g.,* Delaware River Basin Compact art. 5, 75 Stat. 696–97 (1961).

[215] *E.g.,* Tennessee River Basin Water Pollution Control Compact art. VIII, 72 Stat. 826–27 (1958).

[216] Gindler, *supra* note 213, at 343.

[217] For a thorough discussion of interstate compacts, see pages 43–70 *supra.*

[218] Hines, *supra* note 211, at 450.

[219] *Id.* at 451.

[220] *Id.* at 452.

[221] Edwards, *The Legislative Approach to Air and Water Quality,* 1 NAT'L RESOURCES LAWYER 58, 60 (1968).

also includes procedures to abate the pollution of interstate waters which states are unable to handle.

The federal program has two basic functions: it regulates and enforces the quality of certain waters within its jurisdiction (interstate waters), and it provides financial assistance for pollution control.[222] The federal program has extensive contact with industry and agriculture in the area of enforcement. If any individual creates a pollution problem which endangers the health and welfare of persons in another state, the federal government has jurisdiction to proceed against the polluter.[223] The procedure begins with an investigation and informal conference with the polluter, then moves to a public hearing, and ultimately to court proceedings to force a recalcitrant polluter to comply with the demands of federal law.[224]

4. Evaluation of Regulation and Enforcement

One of the major advantages of a system of regulation and enforcement is that it works toward placing the costs of pollution abatement squarely on the polluter, rather than other members of the economy. This has two advantages. First, in terms of equity, the person who creates the pollution problem is forced to bear the financial burden of solving it. Second, the market system as an allocater of recourses operates more efficiently because a polluter can no longer shift some of his costs of production to other members of the economy.

There are a number of criticisms of such a system. One is that enforcement is frequently slow. Federal cases, for example, tend to proceed slowly, some lasting more than five years, ending in complex agreements requiring surveillance for many years.[225] What may frequently happen is that conditions have changed by the time a case is concluded, and the agreed abatement steps are no longer sufficient.[226] Also, once an agreement is reached, there is no longer an incentive for the polluter to try to improve further the quality of his effluent.[227]

A regulation system can also produce inequities to new firms entering a particular river basin. It is easier administratively to restrain proposed activity than to change an established pattern.[228] Consequently, standards for new firms tend to be higher and may even discourage the expansion of industry. If the industry does decide to enter the basin, the system of stream quality standards may constitute a double standard. Existing industries tend to remain more or less protected in their established practices, whereas a more rigorous treatment program may be required of the new industry.[229]

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[222] For a discussion of federal incentives to water pollution control, see text accompanying notes 238–45, *infra*.

[223] 33 U.S.C. § 466g.

[224] *See* pages 88–92 *supra*.

[225] Bramhall, *Alternative Methods of Improving Stream Quality: An Economic and Policy Analysis*, 2 WATER RESOURCES RESEARCH 355, 362 (1966).

[226] *Id.*

[227] *Id.* at 363.

[228] Whipple, *Economic Basis for Effluent Charges and Subsidies*, 2 WATER RESOURCES RESEARCH 159, 164 (1966).

[229] *Id.*

C. Payments and Incentives

Under a payment or incentive system, polluters are paid to clean up the effluents they discharge which cause pollution. The payment may cover all or part of the pollution abatement costs. In a payments system, the regulating body makes a cash payment to the polluting firm. The money is to be used by the polluter to offset his pollution abatement costs. The money for these payments would come from the general tax fund of the regulating governmental body. In an incentive program, the payment would be indirect. For example, a polluting firm could be granted a tax credit, thereby reducing the amount of taxes the polluter would ordinarily have to pay in a particular year. The reason payments and incentives are grouped together as systems of water pollution control is that they have the same net effect to a polluter, an increase in money to be used to offset the costs of pollution abatement. The major criticism of a payments system is the feeling that the polluter should bear the financial burden of pollution control, and not the community in general. Another shortcoming of this system is that the payments are extremely difficult to administer. A payment should depend on the amount by which effluent discharge is less than it otherwise would have been. The problem is to determine what discharges otherwise would have been. This scheme would induce the waste producer to initially produce more waste than he ordinarily would have so that when he does abate his pollution, the reduction in pollution would be greater, resulting in a larger payment to him.[230]

To date, no governmental agency has used a payments system to control pollution. Incentive programs, on the other hand, are currently being used by several states and by the federal government. These programs are not used as complete water pollution control schemes, but are used in conjunction with a regulation and enforcement system.

1. State Incentive Programs

One incentive program designed to induce private individuals to invest in water pollution control facilities is a property tax exemption. Approximately one-sixth of the states currently employ such a system.[231] A majority of these states apply the exemption to any treatment facility or device, whether real or personal property, placed in operation for the purpose of controlling pollution.[232] A few of these states apply the tax exemption only to land, buildings, and equipment permanently attached to buildings.[233] To illustrate how a property tax exemption works, assume a firm had $100,000 worth of property which qualified for an exemption under the state program. Assuming that the property tax rate was 1½ percent, the firm would be relieved of $750 in taxes in the current year.

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[230] Bramhall & Mills, *A Note on the Asymmetry Between Fees and Payments*, 2 WATER RESOURCES RESEARCH 615 (1966).

[231] INDUSTRIAL INCENTIVES 66.

[232] *E.g.*, N.H. REV. STAT. ANN. § 149:5-a (1964).

[233] *E.g.*, N.Y. TAX LAW § 208. (McKinney 1966).

There are several shortcomings to property tax exemptions which raise questions as to whether they provide very strong motivation for a firm to invest in pollution control equipment. The exemption is an expensive device for a municipality. Property taxes may be deducted as an expense in computing a firm's federal income tax. Consequently, for every dollar that a municipality provides through an exemption, a firm in the 50 percent bracket benefits only 50 cents.[234] Also, the financial advantage to private individuals appears to be small since the property tax rate, after allowing for deductibility of local property taxes from federal taxable income, is usually less than two percent.[235]

In addition to property tax exemptions, several states provide for accelerated depreciation on pollution control facilities.[236] Overall, the value of these incentives at the state and local level is quite limited. Many states do not have corporate income taxes, and, for those states that do, writeoffs provide only a small degree of relief.[237]

2. Federal Incentive Programs

The federal government provides financial assistance for research,[238] training,[239] state pollution control programs,[240] and waste treatment construction.[241] Nearly all of this assistance, however, is available only to regional, state or local governmental agencies. Thus far, the federal spending programs have left intact the problem of industrial and agricultural waste discharges. The only significant benefit for private firms is the federal government investment tax credit on water pollution control facilities.[242] Under this provision, a firm is allowed a seven percent credit on corporate income taxes for capital investments (other than land) used for water pollution control. One problem is that not every firm is able to take advantage of the provision because the amount of taxes owed the government may be less than the credit allowed.

Another typical federal incentive program is accelerated depreciation. Legislation to enact an accelerated depreciation program for water pollution equipment has often been proposed but never enacted.[243] Under such a scheme, a firm investing in water pollution control facilities would be allowed to depreciate the facilities over a period significantly shorter than its useful life. Since depreciation for any given year constitutes a business expense, taxable income is reduced by the amount of that expense. Consequently, a firm investing in water pollution control facilities would receive an indirect cash benefit in the amount of his reduced income taxes.

Other federal incentive programs proposed in the past are low cost loans

[234] INDUSTRIAL INCENTIVES 66.
[235] *Id.*
[236] *E.g.*, WIS. STAT. ANN. § 70.11 (Supp. 1968).
[237] INDUSTRIAL INCENTIVES 79.
[238] 33 U.S.C. § 466c.
[239] 33 U.S.C. § 466c.
[240] 33 U.S.C. § 466d.
[241] 33 U.S.C. § 466e.
[242] INT. REV. CODE of 1954, §§ 38, 46, 48.
[243] *E.g.*, S. 736, 88th Cong., 1st Sess. For a discussion of the legislative history of accelerated depreciation, see INDUSTRIAL INCENTIVES 46–51.

and cash grants. An act allowing both grants and low cost loans was passed by both houses in 1937 but vetoed by President Roosevelt.[244] Subsequent bills have been introduced numerous times but have never been made law.[245]

3. Evaluation of Payments and Incentives

Each of the incentive and payment programs mentioned is, in effect, a payment to the polluter. The program provides money in one way or another to invest in pollution abatement equipment. As mentioned earlier, individuals have been allowed to pollute, at least to some extent. Immediately requiring these polluters to abate would place an undue economic hardship on these individuals, which may have a resounding effect on the economy.[246] The justification for the use of incentives is that they would cushion this financial blow by having the government pick up a portion of the initial pollution control bill and, at the same time, provide an incentive to polluters to clean up the nation's waters.

It is argued that incentives deal more directly with the pollution than other schemes which would require time consuming hearings and conferences before pollution control programs are implemented.[247] Once incentive legislation is passed, each polluter would immediately be induced to proceed with pollution control activities. This would in turn, so the argument goes, stimulate the creation of waste treatment equipment. The resultant demand for facilities could result in findings and achievements in research being more quickly considered, tested and supplied on a bigger scale. These techniques would be available to all, which would be a definite help to the small polluter.[248]

The major criticism of incentive programs is that payments which depend on variables other than the waste discharge itself are undesirable because the incentives are related to the wrong variable.[249] The problem is that the incentives relate to pollution control facilities and equipment, but there are many other ways to improve effluent quality.

> The most important of these other possibilities is the substitution of industrial processes that produce little waste for those that produce much waste. Very often a complex process change, which can be partially justified on grounds of increased productive efficiency, is the most economical way to abate industrial waste discharges. . . . The most economical combination (of process changes and conventional treatment) will depend on the precise mix of products the firm produces, the kind and age of existing plants and equipment, relative prices and transportation costs of new equipment, and the kinds of markets in which the firm sells its products.[250]

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[244] H.R. 2711, 75th Cong., 1st Sess., passed Senate Aug. 16, 1937, and House, Aug. 18, 1937.

[245] *E.g.*, S. 737, 88th Cong., 1st Sess. For a discussion of the legislative history of low interest loans, see INDUSTRIAL INCENTIVES 56–62.

[246] INDUSTRIAL INCENTIVES 35.

[247] Nebolsine, *Today's Problems of Industrial Waste Water Pollution Abatement*, 1 NAT'L RESOURCES LAWYER 39, 53 (1968).

[248] *Id.* at 53, 54.

[249] Bramhall, *supra* note 225.

[250] *Id.* at 356.

Also, tax concessions on treatment equipment do not provide a real profit incentive for abatement of discharges, but merely reduce the losses that treatment equipment entails. They do not make pollution equipment profitable to the firm as other control programs such as effluent charges do.[251]

Another problem inherent in the use of incentives is the allocation of financial assistance in light of the basic principle that each polluter should pay the social cost of his pollution.[252] The main justification of incentives is to assist firms to avoid severe economic harm and to induce them to act. If the assistance is too low, there is no real incentive. If the assistance is too high, it may violate the basic principle by having the government absorb too large a portion of the cost of pollution control. A final criticism is that preferential tax legislation to provide incentives just adds complexity to an already complicated Internal Revenue Code.[253]

D. Effluent Charges

The third major way to control pollution is through the use of effluent charges.[254] The concept of effluent charges originated with the Germans who use this technique to control pollution in the Ruhr River Valley.[255]

In an effluent charge scheme, the waste purification systems on an entire river basin are integrated under one master plan to assure minimum levels of water quality. The controlling governmental agency builds necessary waste treatment facilities, reservoirs, and dams and locates them strategically in the river basin to achieve maximum water quality for the system. The pollution control facilities are financed by charges levied against individual polluters, the amount of the charge based on the quality of the effluent discharged.[256] The charges assessed against the polluting firms reflect the damage which its effluents would cause to downstream users.[257] Each potential polluter is given an option of paying the effluent charge or treating the waste himself.[258]

There are a number of advantages to an effluent charge system of pollution control. The foremost reason advanced in favor of the system is that there is a constant incentive for a firm to adopt new techniques in waste reduction as techniques become more feasible, and to consider waste output in making other decisions. This effect is valuable when one considers that the allowable discharge load must remain constant in order to maintain a particular stream quality during a time of economic growth.[259] When effluent

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[251] *Id.* at 362.

[252] INDUSTRIAL INCENTIVES 46.

[253] *Id.*

[254] *See* generally A. KNEESE, ECONOMICS OF REGIONAL WATER QUALITY MANAGEMENT 54–98, 191–206 (1964).

[255] Hines, *Nor Any Drop To Drink: Public Regulation of Water Quality,* 52 IOWA L. REV. 799, 848 (1967).

[256] *Id.*

[257] INDUSTRIAL INCENTIVES 84.

[258] Hines, *supra* note 255, at 849.

[259] Johnson, *A Study in the Economics of Water Quality Management,* 3 WATER RESOURCES RESEARCH 291, 302 (1967).

charges are used, pollution control decision making is transferred from public officials to the management of an individual firm, who are generally better placed to acquire data and make adjustments that will be best suited for the firm.[260] Theoretically, the management of a particular firm will continue to search for means of further abatement as long as it must pay for discharging wastes. Firms would be motivated to save effluent fees by using new technology, making process and product changes and new investment which produced relatively little waste.[261] Some economists feel that an effluent charge system would be more capable of adjusting to future growth than other control schemes, due to the difficulty involved and time required to establish and enforce a new set of effluent standards.[262]

Another desirable aspect of effluent charges is that they place the financial burden of pollution abatement on the individual causing the pollution. This prevents a polluter from passing some of his production on to other members of the economy as is now done.[263] With each producer being forced to take into consideration all of his production costs, the market system becomes more efficient in allocating resources in accord with the demands of the economic community.[264]

Generally, the effluent charge schemes are more expensive to operate than other programs due to billing costs, an increased level of surveillance, and need for additional data and analysis to initiate the program. In terms of anticipated gains in efficiency and equity, it appears that additional costs of operating an effluent charge system would not be so high as to preclude its adoption.[265]

It is argued that if not exactly constituting a "license to pollute for a fee," effluent charges may well have a delaying effect on the actual cleaning up of waters. Some may try to clean up their effluent only just enough to prevent having to pay excessive charges.[266] One answer to this problem would be to establish an appropriate schedule of fees to ensure that a firm's adjustment would meet the minimum water quality goals of public policy.[267]

The only comprehensive effluent charge system in use today is the German Genossenschaften (cooperative water associations) located in the highly industrialized Ruhr Valley. The basic political power of these associations lies in the members of its governing board, which consists of owners of businesses and industries, community officials, and a representative of the waterworks facilities. The political organs of the associations are the assembly and the board of directors. The assembly members elect the board of directors, approve assessment of discharges, and decide on the basic method for calculating levels of effluent charges.

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[260] Bramhall, *supra* note 225, at 362–63.
[261] *Id.* at 363.
[262] Johnson, *supra* note 259.
[263] *See* text accompanying notes 150–53 *supra.*
[264] *See* text accompanying notes 156–58 *supra.*
[265] Johnson, *supra* note 259.
[266] Nebolsine, *supra* note 247.
[267] Bramhall, *supra* note 225, at 363.

In the course of its 50 year history, the Ruhrverband, the major association in the Ruhr Valley, has built over 100 treatment plants on the Ruhr and its tributaries. The Ruhrverband also operates water power facilities and a series of shallow lakes in the Ruhr itself which provide retention and oxidation for the water source and are part of the regional treatment system. The cost of these facilities is financed through a system of charges. These charges are contingent on the amount and quality of the effluent discharged by industries and municipalities in the region.

Although the Ruhr area contains a heavy concentration of industry, still the Ruhr River is kept suitable for a variety of uses, including the production of drinking water and recreation. The drinking water in the area receives no unusual treatment and is among the least costly of German urban water supplies.[268]

A number of questions have been raised concerning the feasibility of successfully implementing such a system in the United States. It is argued that the German project is on a small scale compared to the dimensions of the United States, and therefore it is not necessarily workable here.[269] Also, some feel that the success of the approach is vastly overrated.[270] Finally, there is concern whether such an organizational scheme would work in the United States where the political history is so different.[271] The weight of these arguments is left to the judgment of the reader; however, it is the opinion of the author that none of these arguments is substantial enough to prevent the development of an effluent charge system in the United States.

VI. Conclusion

Pollution created by farms and industries contributes substantially to the degradation of the quality of our nation's water. Many of these pollution problems could be easily cured with available equipment and technology. It is true that some pollution problems, especially from chemical industries and pesticides, are so complex that the available technology is inadequate to solve them. But this is no excuse for allowing the avoidable pollution problems to remain unsolved. The problem is finding the best way to force pollution abatement by private manufacturers and producers. The common law as a system of water pollution control is clearly inadequate. The present statutory schemes of pollution control employed by state, regional and the federal government have contributed substantially to the abatement of pollution, but everyone agrees that more has to be done.

In the last section, several systems of water pollution control were discussed: regulation and enforcement, payments, and effluent charges. The present laws, both state and federal, are based primarily on the regulation

[268] The discussion of the Genossenschaften was taken from A. Kneese, Approaches to Regional Quality Management 5–9 (Resources for the Future Reprint No. 64, 1967).

[269] *The German Scheme Conservationists Are Urging on the Government,* Mill & Factory, Nov. 1966.

[270] *Id.*

[271] *Id.*

and enforcement theory. Payments have been used, especially by the federal government, but only to assist in the abatement of pollution by public bodies. There have been numerous proposals for incentive legislation to aid pollution control in the private sector. These incentives would be useful on a short-term basis; however, in the long run they have serious drawbacks. The proposed incentives encourage a polluter to invest in pollution control facilities, but there are many alternative methods of pollution abatement which should be considered if the most economical form of pollution control is to be achieved. The incentives also violate the general feeling that the person who should pay for pollution is the polluter himself, and not the public in general.

Effluent charges as a system of pollution control have been discussed frequently, especially by economists, but have never been employed in the United States. Effluent charges have the advantage of placing the burden of pollution costs on the polluter. They also provide a continuous incentive for the firm to improve the quality of its effluent, allowing each individual firm to make its own decisions on how it can best improve the quality of its effluent. One problem with this scheme is that the governmental agency must necessarily have basin-wide control. This creates problems in areas where river basins cross state boundaries. The problem is not insurmountable, as multistate water control agencies can be created, and in fact are encouraged by the federal government.

It is not suggested that an effluent charge scheme is the best or the only way to control pollution. However, it is important to consider effluent charges as well as regulation and payments as alternative systems representing the range of possibilities that must be considered if greater efficiency is to be achieved. Each system has its advantages and disadvantages, but all should be considered in developing a comprehensive pollution control system. For example, regulation and enforcement could be used to ensure certain health standards, and also should be available in case some dischargers fail to respond to effluent fees. Incentives could be considered on a short-term basis to avoid undue financial hardship to those firms which have, until now, been allowed to pollute. In those areas where firms are concentrated and a basin wide control agency could be established, effluent charges should be considered.

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