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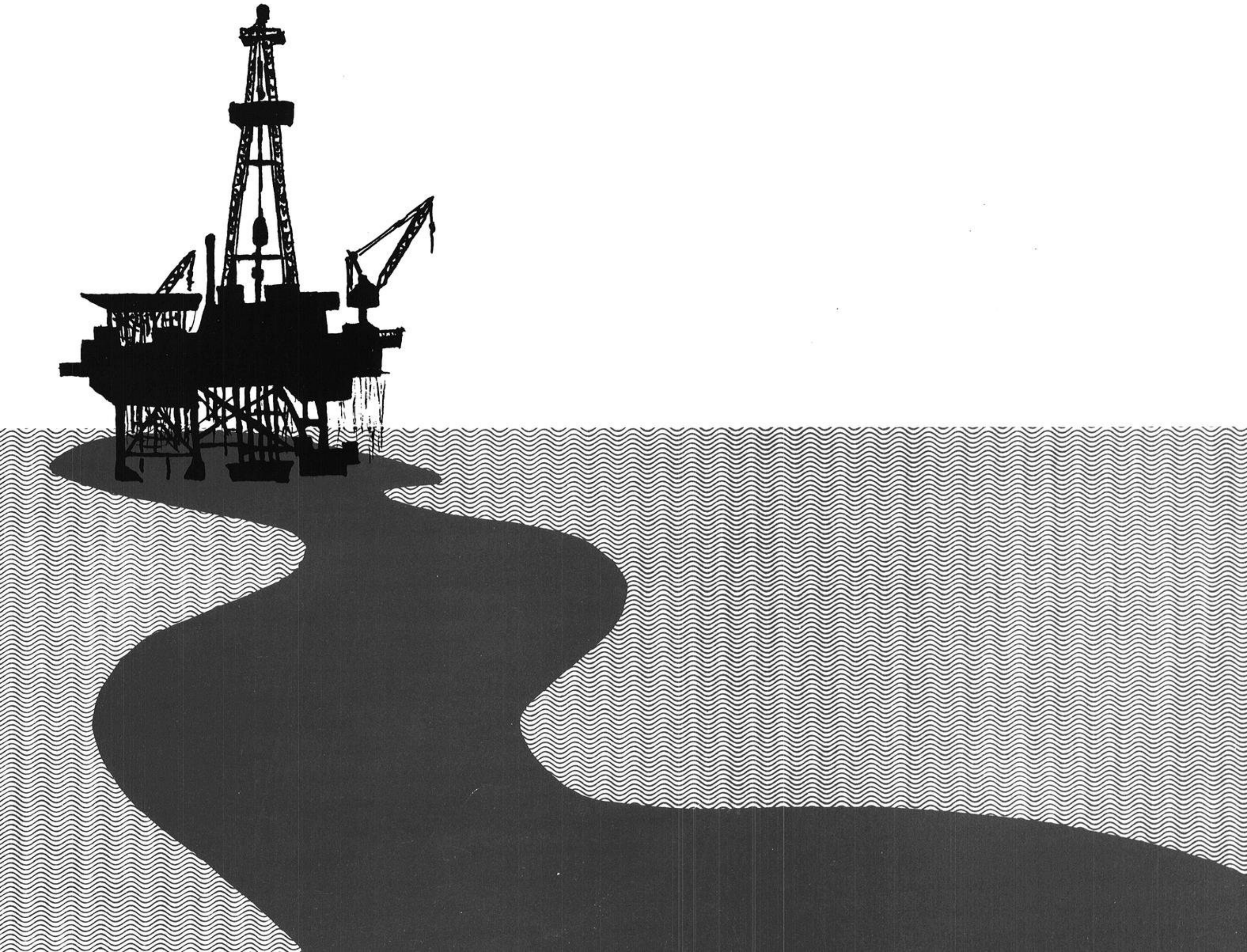

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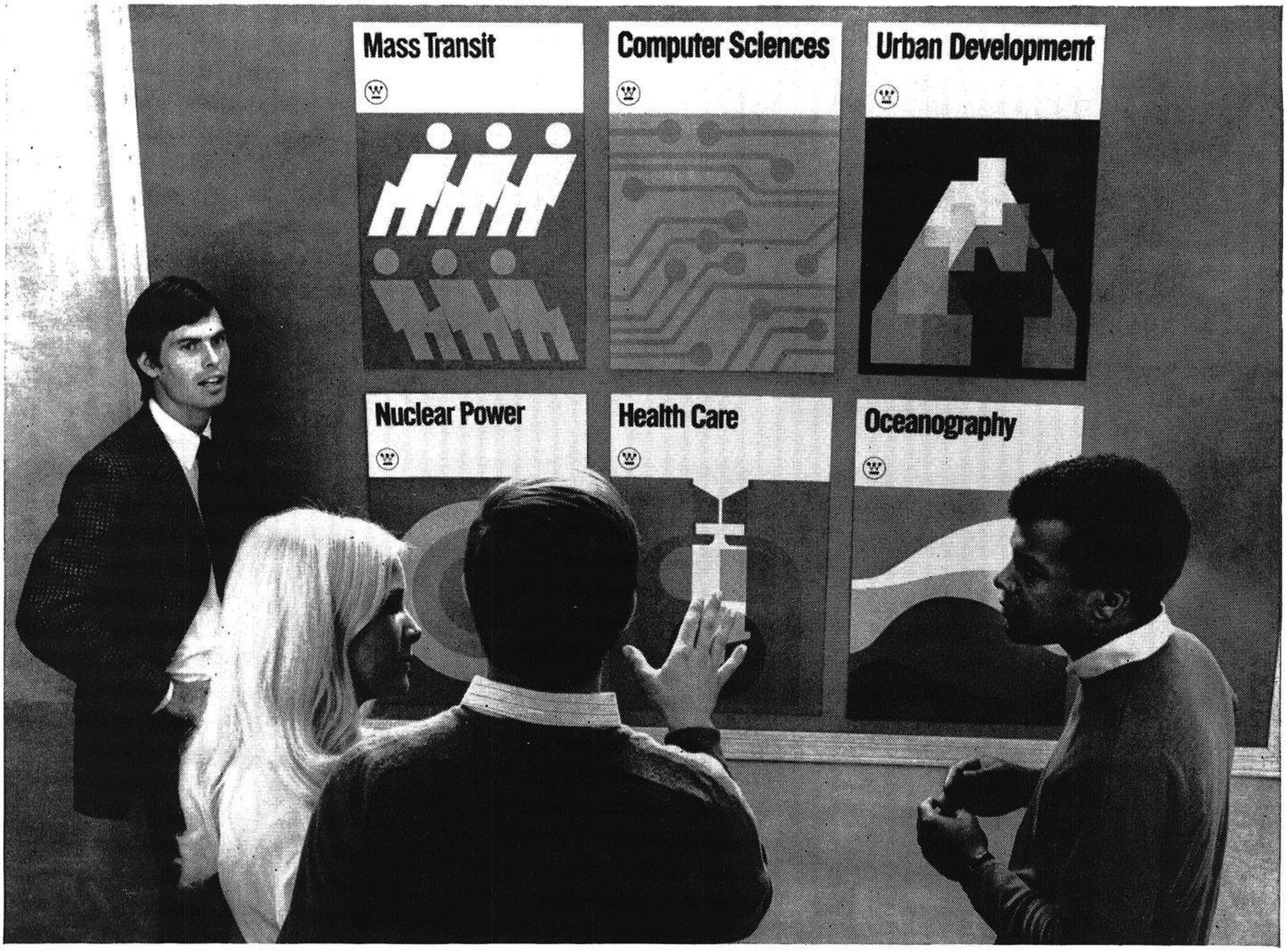

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"We are drifting toward a catastrophe beyond comparison. We shall require a substantially new manner of thinking if mankind is to survive." – (Albert Einstein)

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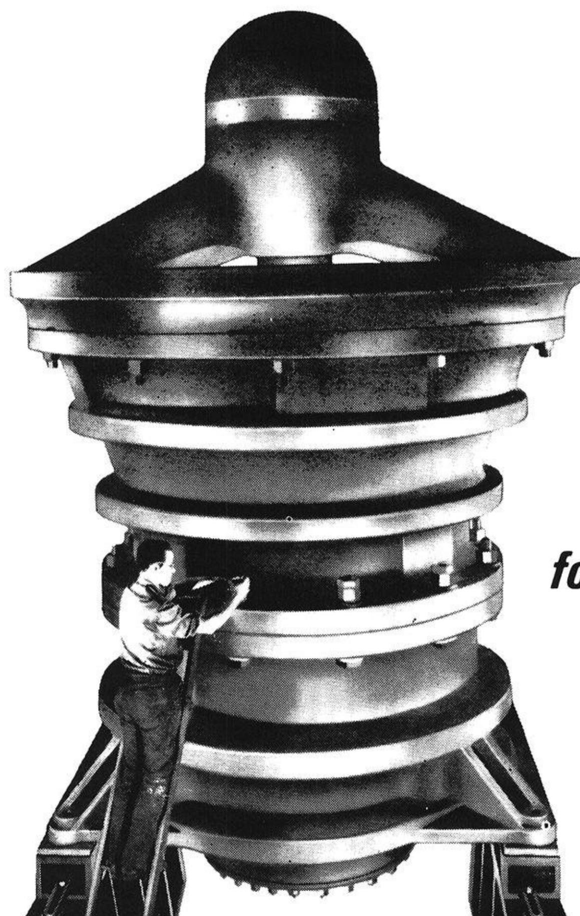

Editorial --

Idealism and Realism

The verdict of Earth-Week's trial of man versus himself, exemplified in programs such as "Life Style on Trial" and engineering's "Project Awareness" was undisguised: unless Homo-sapiens take direct and concerted action immediately, the prospects of the next generation's survival are grim. To reposit: if persistent social issues such as racism and poverty, the Vietnam war, an expansionist foreign policy inviting more Vietnams, or a runaway arms race don't initiate a speedy end to civilization, fundamental environmental issues such as air and water pollution will slowly and surely stifle man and his friends.

Besides enumerating and quantifying toxic substances, immediate 'direct and concerted action' will involve isolating those politicians who will legislate their undying ecological devotion from those quasi-environmentalists who will typically pledge the conciliatory rhetoric.

Identifying the concerned should not be a difficult task. They will be the ones who realize that the environment's co-opting of divergent political philosophies will never transpire. Their politics of survial will dictate expansion of public controls combating pollution, massive penalties for pollutors, scrupulous enforcement of anti-pollution laws, and all of this tied to a rigorous ascending timetable.

Opposition to environmental reform by big business, as long as proposed legislation remains "reasonable" (in their eyes) will be a token effort. The profits made by polluting corporations will be increased by their "anti-pollution subsidiaries" whose projected growth rate for the 70's is unparallelled in business history. Should proposed legislation become "unreasonable," for example, mandatory clean-up consumables such as air and water or removal of the internal combustion engine from the market, unseen lobbying forces will use the great equalizer, $, in attempting the necessary exceptions.

Conservative political opposition to environmental (social) reform should be taken as a matter of course, for their efforts to maintain the status quo and their "personal freedoms" will assuredly be in contravention to the reining of the rampaging cowboy of American industry. An early example was *Human Events* defamation of E-Day as picked to coincide with Lenin's hundredth birthday and "radically infiltrated."

A question now appears in the differentiation between idealism and realism in just how "clean" can a "viable republic" become? Will cleanliness include a revamped government? Will opposition allow it? As you see the future, do you envy the next generation's living conditions?

Roy Johnson

[***]

Water Pollution -- an Overview

Professors Hoopes and Boyle, as members of an ecologically aware Civil Engineering faculty, are concerned as to the future of the world's most sought after resource, water. The following article outlines and highlights a very complex problem which man will shortly encounter.

**Prof. J. Hoopes
and Prof. Wm. Boyle**

Historical Development

The measures taken for water sanitation control can be found as early as the days of the Roman empire. In 97 A.D., nine aqueducts carrying a total of 84 mgd of water and similar structures carrying wastewater were in existence. Although supply of water and transportation of wastewaters have a long history, the hygienic control of waters and wastewaters is of recent origin. Prior to about 1840, sewers were constructed only to carry storm runoff. Sanitary wastes were placed in heaps in front of homes or in vaults or privies adjacent to them. The foul conditions caused by this disposal method were soon alleviated, in part, by allowing these wastes to be discharged to the storm sewer system. Soon, the nearby receiving streams became open sewers and larger bodies of water began to "seethe and ferment under a burning sun, in one vast open cloaca".[1] As a result, "large territories were at once, and frequently, enveloped in an atmosphere of stench so strong as to arouse the sleeping, terrify the weak, and nauseate and exasperate everybody".[2] During the mid-nineteenth century, doctors, lawyers, engineers, writers and statesmen were actively involved in the awakening of the social and sanitary conciousness of the people. This period was coincident with the very important work of Pasteur.

Following the discoveries of Pasteur, the control of disease resulted in rapid urbanization. Soon after this, the period of technological growth, the Industrial Revolution, precipitated greater population densities resulting in a magnification of the pollution problem. The hygienic problems attendant with water supply and wastewater disposal were being controlled and there was a greater concern regarding environmental responses to wastewater disposal. At the turn of the twentieth century, engineers were beginning to study the effects of wastewaters on receiving waters. The classical work of Streeter and Phelps on the Ohio River[3] in 1914 and 1915 initiated the concepts of stream assimilative capacity and oxygen sag. From the early 1900's up to about 1960, wastewater treatment consisted primarily of separation of solids and floatables, removal of oxygen demanding materials and disinfection. Although as early as 1943,[4] other sewage nutrients, namely nitrogen and phosphorus, were known to be detrimental to certain receiving waters, it wasn't until about 1960 that a significant effort was made to develop practical systems to remove these nutrients. Much of the pioneering work in nutrient removal was done here at the University of Wisconsin even before this time. We are now in an era of environmental sensitivity and awareness of the fact that we live on a finite planet in which there are limited resources and in which there is a delicate ecological balance between man and his environment. Many of the concerns and the fundamental and technical efforts now being proposed to solve today's and tomorrow's problems were developed by investigators several decades ago; at that time, however, the general public had a different environmental concept.

What is Pollution?

Pollution may be defined in as many ways as there are people to define it. The purist might define it as "the addition of any material to the environment which is foreign to it". Possibly, a more analytical definition would be, "the discharge of a material which will directly or indirectly result in physical, chemical or biological degradation of the receiving environment". In either case one must be in a position to further define "foreign" or "degradation" to the satisfaction of politican, conservationist, industrialist, writer, engineer or the layman. It is of interest to note that in a recent survey [5] of 574 persons in the State of Wisconsin, the three most commonly used descriptions of pollution were: algae and green scum; dark, murky water; and suds and foam. Relatively few people cited disease organisms, pesticides and DDT, fish kills, or closed swimming beaches. Most certainly, one must define pollution in relation to the use of the resource being polluted. Thus to a fisherman, pollution of water means dead fish, tainted fish, rough fish or no fish at all. To an industry pollution might mean high concentrations of certain inorganics, or organics, or pathogenic microorganism, or turbidity, or temperature, depending upon how it wants to use the water. This is why it is essential for experts in engineering, economics, planting, institutions and law to work together to plan and develop our resources to the best advantage of all.

Who Pollutes?

It would be naive to point the finger at any one segment of our society as the principle polluter, for, in fact, each person is himself a polluter through the materials he discards, the substances he uses and the conveniences he demands. The cold, hard statistical facts would indicate that industry's contribution of organic load to the U.S. rivers is about 34% of the total or about 50% of the domestic equivalent. Some reports, however, state that two-thirds of the pollution of the U.S. waters derives from industry. The conflict between these two statements lies in the differences in the characteristics of industrial wastewater, which may contain a wide spectrum of compounds such as organic chemicals, heat, radioactive substances, refractory materials, and other minerals and chemicals. In addition, the runoff from agricultural, mine, and urban areas contributes to organic, sediment and nutrient loads. Suffice it to say, an assessment of all sources must be made for each watershed before any gross statements, regarding principle polluters is made. An example of one such study was recently published for Lake Mendota.[6]

Effects of Pollution on Receiving Waters

Pollutants may be generally described as conservative or nonconservative depending upon whether or not they degrade (change to a stable, mineral form) in the natural environment. Thus, chloride, would be considered a conservative material whereas glucose or heat would be nonconservative. The discharge of nonconservative materials into a receiving body (stream, river, lake or ocean) may result in certain biochemical energy transformations of the substance as well as chemical and physical reactions. Eventually, unless the substance volatilizes, decays or is otherwise removed from the water environment, microbial attack will proceed. The substance is oxidized through a multitude of steps to a lower energy, ideally resulting in carbon dioxide, water, and oxidized nitrogen, phosphorus, sulfur, etc. During these energy transformations, microorganisms will conserve some of the energy released and produce new cells. In addition, other elements in the water, for example oxygen, are consumed in these biochemical reactions – thus the term biochemical oxygen demand.

It is these complex series of reactions which so often result in the production of visual "pollutants" commonly named by the layman. These indirect forms of pollution include plant and algal growths, fish kills, odor, scum, solids (turbidity) and the like. It should be emphasized, however, that other nonvisible forms of pollution such as hygienic quality, grease, nutrients, pesticides, radioactive materials, high temperature and other characteristics, which may be the direct result of wastewater discharge, are also of paramount concern.

Streams and lakes have been used for many years for the treatment of wastewaters. This inherent quality of a stream to "treat" wastes is often called its assimilative capacity. The old phrase, "the solution to pollution is dillution," exemplifies the philosophy of the early 20th century. Even today, there is considerable controversy as to whether the use of stream as a waste treatment process should be continued. As long as pollutants do not interfere with other uses of a stream, this concept may be tenable, it is economically justifiable; however, it may not be justifiable in view of the subsequent concentration of the waste materials in the total water and ecological systems.

Control of Water Pollution

The responsibility for establishing water quality standards, for monitoring the adherence to these standards, and for the enforcement of these standards rests chiefly in the hands of local and state authorities with backup support, financial aid and national policy being provided by the Federal Government. The Federal Government's interest and policy regarding water pollution control dates from the Water Pollution Control Act of 1956 which was subsequently amended in 1961 and again in 1965. The original act and subsequent amendments (the 1965 amendment is known as the Water Quality Act of 1965) have the following chief provisions: 1) The Department of Health, Education and Welfare is responsible for administering the act through the Federal Water Pollution Control Administration: 2) water quality standards for interstate waters or portions thereof are to be developed by local and state authorities, subject to the approval of the Federal Water Pollution Control Administration; 3) comprehensive water pollution control programs (for example, to deal with combined storm and sanitary sewer overflows, agricultural wastewaters, land erosion, vessel waters, nutrient or mineral removal) are to be developed in cooperation with the states, municipalities, and industries involved; 4) federal grants are to be made to assist these groups in meeting the cost of such programs (such programs may involve research and demonstration grants and grants for construction of new sewage treatment facilities); and 5) violators of water quality standards are subject to prosecution by the State and by the Federal Government in the case of interstate waters and also in the case of intrastate waters if so requested by the governor or water pollution control agency of that state.

In January of 1968, Wisconsin received approval on its water quality standards by the Federal Government. These standards, which are applied equally to interstate and intrastate waters, were developed and are enforced by the Division of Environmental Protection in the State's Department of Natural Resources. The development of these water quality standards has necessitated: (1) the establishment of present and future water uses (such as water supply, recreational, agricultural, fish and wildlife, industrial) and the requisite quality criteria (dissolved solids, bacteria, temperature, pH, dissolved oxygen, etc.) for all of its streams, rivers and lakes; (2) the determination of compliance and noncompliance with the standards; (3) the development of a time table for compliance with the standards (for example, 2-3 years to complete a secondary, sewage treatment program), coupled with penalties and a program for pollution abatement; and (4) the development of a water quality surveillance program to provide incentives for water pollution control, a state financial assistance program has been authorized to encourage municipalities to construct new or improved pollution prevention and abatement facilities. Legislation provides that industry may acquire land by condemnation for construction of waste disposal facilities. Tax laws permit writing off waste treatment plant construction costs in the year of expenditure and exemption of these facilities from real estate tax. Thus, the implementation and enforcement of the adopted water quality standards will involve financial assistance, industrial incentives, increased surveillance, orders and legal action.

Solution to Pollution

Presently, this country has the technical know-how to solve its major pollution problems. Ion exchange, membrane processes (including reverse, osmosis and dialysis), absorption, distillation and many other processes are available for removing contaminants from wastewaters. Thus, the nutrient removal requirements of today can be replaced by the ultimate demineralization of wastewaters. Such technological achievements would result in high quality water flowing from our wastewater treatment plants and would make possible the recycling and hence the conservation of these mineral and water resources.

The application of such technology to wastewater treatment will require, however, that we face significant problems in motivation, education, and economics. The cost of such ultimate recycling of waste materials will be at least an order of magnitude greater than the present day costs of wastewater treatment. Hence, political leaders and the general public must not only be aroused but educated concerning the delicate ecological balances in nature and on the consequences of various waste treatment schemes on the environment in which we live. [***]

FOOTNOTES

1. W. Budd, **Typhoid Fever,** 1873, relative to the condition of the Thaines during the hottest months of 1858 and 1859.
2. E. C. Clark, **Report on the Main Drainage Works of the City of Boston, 1885.**
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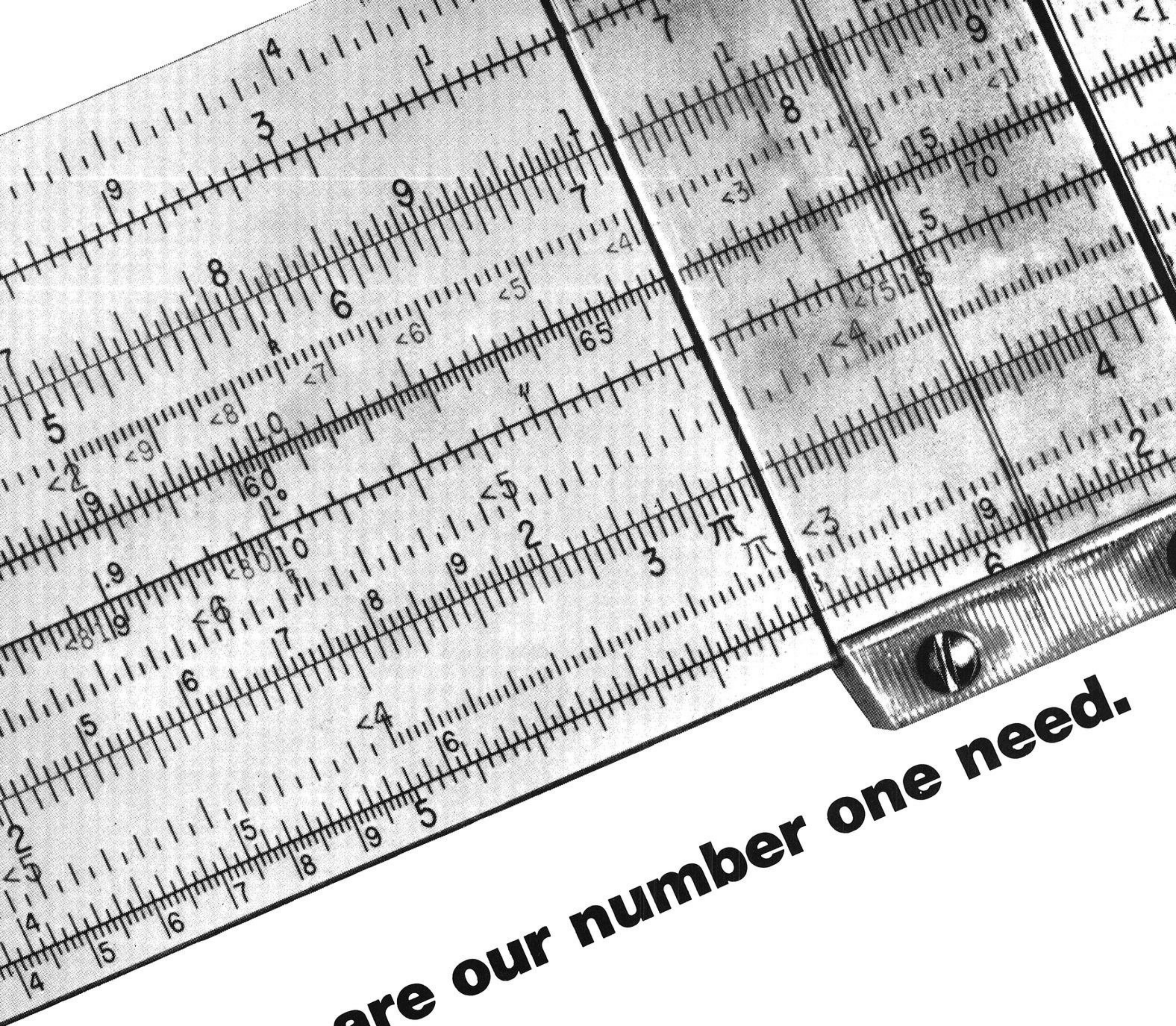
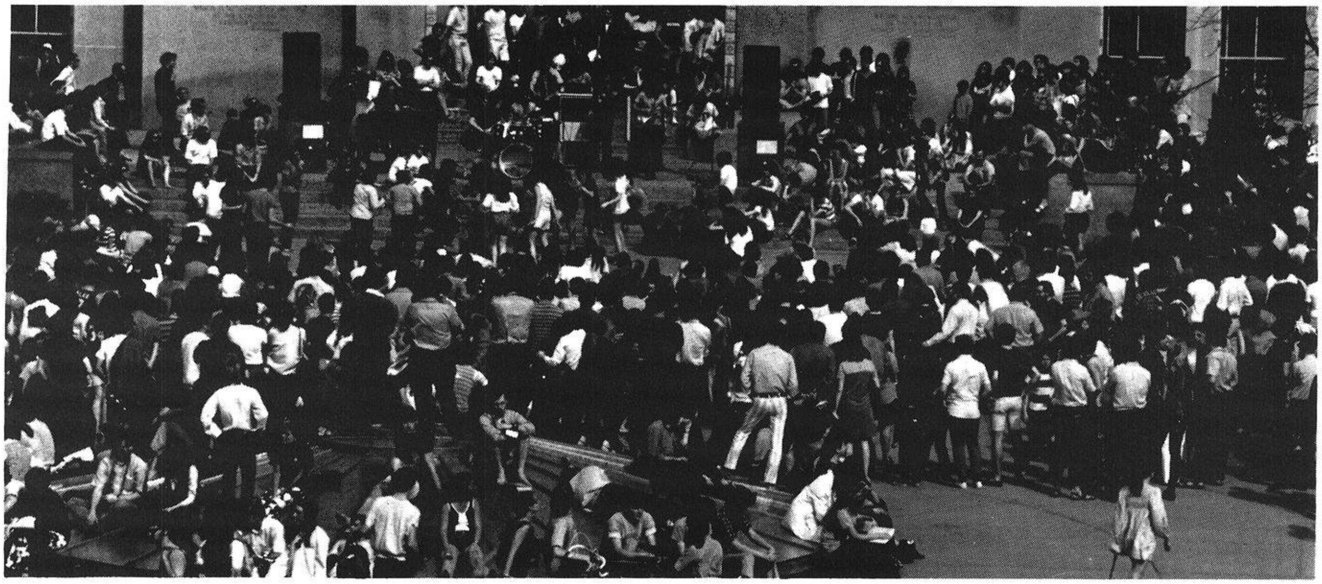
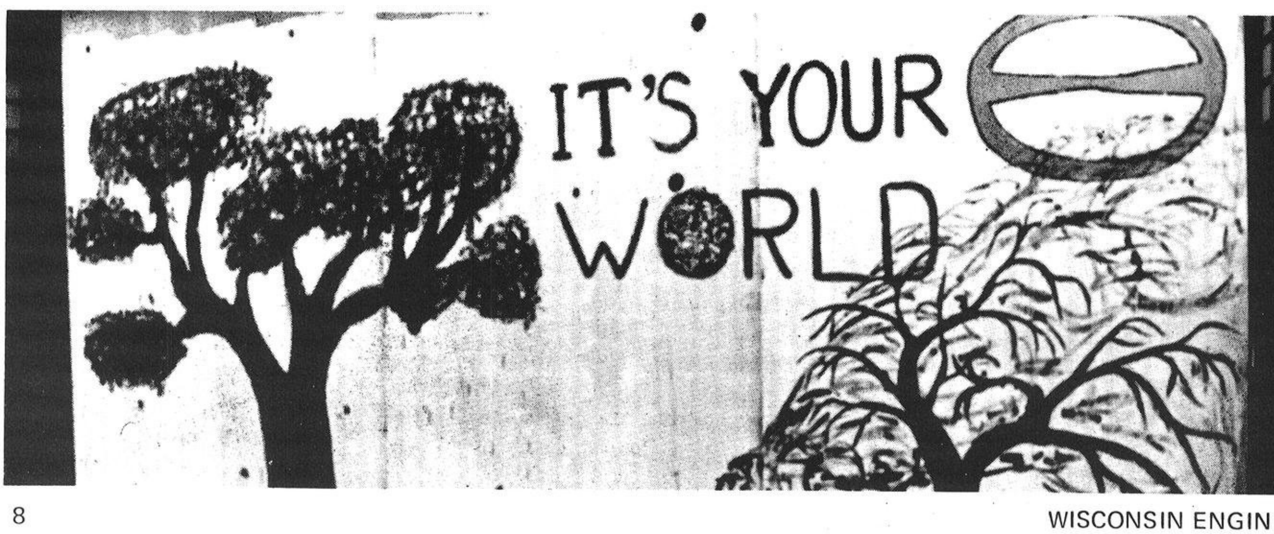


E-Day Fair



The much maligned E-Day Fair celebrated spring on one of the season's first breezy balmy days. The feared trashings never evolved as people danced, sang, rapped, and relaxed. Numerous booths illustrated and distributed free and informative pamphlets dealing with various environmental and social ills. The potential of a State Street Mall in place of polluting automobiles seemed very titillating.



PHOTOS BY
Jim Haberman

The ensuing articles, "Sewage Treatment in Madison" and "The Quality of Madison's Air" (p. 12) were prepared by members of Engineers and Scientists for Social Responsibility in an effort to quantitatively determine pollution problems in Madison and surrounding areas. These articles are part of a comprehensive set released by E.S.S.R. to specify the relative quality of Madison's environment.

Sewage Treatment in Madison

Jim Stevenson

Once you've turned off your electric garbage disposal or flushed your toilet, you probably don't give much thought to what happens next. Maybe you should.

You have just made a small contribution to the more than 10,000,000,000 gallons of raw sewage that is processed annually by the Madison Metropolitan Sewage District (MMSD). Eventually this sewage is treated and ends up as a clear, but nutrient-rich effluent which pollutes Badfish Creek or as dark, murky sludge which is dumped precariously close to Nine Springs Creek.

To understand the sewage treatment problem in Madison, one must have some knowledge of the sewage treatment process. Sewage treatment can be carried to any of three levels: primary treatment which removes most of the suspended particulate matter, secondary treatment in which bacteria break down most of the organic matter, and advanced or tertiary treatment which, among other things, can be designed to remove the plant nutrients nitrogen and phosphorus. A sewage treatment plant essentially carries out within a confined area the natural biological breakdown that would occur along many miles of a stream.

Table 1.
Comparison of Effluent Quality for Madison's Existing Sewage Treatment Plant and Lake Tahoe's Advanced Treatment Plant

	Madison 1968(2,3)	Lake Tahoe(5)	Unpolluted Stream
BOD mg/1	29.5	1	2-3
Organic N mg/1	3.4*	0.3-2	
Inorganic N mg/1	17.5*	0.3-1.5	1-3
Soluble P mg/1	6.7*	0.04.2	.03-.07
Capacity MGD	29.3	7.5	

*1965 average figures. More recent figures indicate a decrease in organic nitrogen and an increase in phosphorus.

Madison's sewage receives primary sedimentation treatment by passing through settling tanks where coarse particulate matter settles out. Secondary treatment is accomplished by trickling filtration (30% of the total volume) and the activated sludge process (70%). During secondary treatment the sewage is exposed to air and the organic material oxidized by aerobic bacteria.

These treatments remove about 89% of the suspended solids and 88% of the BOD but only 30% of the nitrogen and 22% of the soluble phosphorus. BOD stands for Biochemical Oxygen Demand and is a rough measure of the amount of oxygen required to oxidize organic material in water. High BOD meassurements are associated with pollution. The quality of Madison's treated sewage is compared with an unpolluted stream and with the effluent from an advanced sewage treatment plant in table 1.

Since 1958 Madison's treated effluent has been diverted by an underground pipe and open ditch to a point 12 miles south of Madison where it flows into Badfish Creek. This diversion avoids nutrient enrichment of Lakes Waubesa and Kegonsa and has resulted in some improvement in the conditions of these lakes.

Although there are less problems associated with dumping treated sewage into a flowing river system than a relatively stationary lake system, Madison is only dumping her nutrient-rich effluent on her neighbors to the South.

A second, even less appetizing product of Madison's sewage treatment plant is sludge. Sludge is composed of the sediments resulting from the various settling processes and the harvested bacteria resulting from secondary treatment. The sludge is digested (biologically degraded) and discharged onto slightly more than a half square mile of marshy land. This sludge disposal field is separated from Nine Springs Creek by low dikes.

Professor, W.J. Blaedel (**Wisconsin Engineer**, January 1970) points out that the daily discharge of 150,000 gallons of sludge which contains 20 tons of solids and large amounts of organics and nutrients may contribute significantly to the problems of Lakes Waubesa and Kegonsa. High concentrations of chloride, sulfate, and phosphate reported near the mouth of Nine Springs Creek are cited as strong evidence of pollution caused by sludge disposal (Ref 4). Professor Blaedel concludes that MMSD'S present method of sludge disposal violates at least the intent of the Water Resources Act of 1965.

Fortunately there are better means of sludge disposal and new techniques for removing nutrients. Here are some recommendations.

1. The Madison Metropolitan Sewage District should immediately start work on a better method of sludge disposal.

Several alternative methods are currently in wide use. Sludge can be mechanically dewatered by vacuum filtration or centrifugation. The dewatered sludge can be heat dried and used as landfill or incinerated in furnaces with appropriate air pollution controls. The Porteous process, in which sludge is cooled under pressure and mechanically dewatered, transforms the murky liquid into a sterile, relatively dry cake. Any one of these alternate procedures would substantially alleviate the pollution threat posed by Madison's current method of sludge disposal.

2. Madison should start planning tertiary treatment facilities to remove the plant nutrients phosphorus and, if found necessary, nitrogen from Madison's treated sewage.In the meantime, nutrient removal should be optimized for the existing facilities.

It is hypocritical of Madison to protect her own lakes and streams while nourishing unwanted plants in those of her downstream neighbors. Although expensive, several tertiary treatment plants are now operating and many more are under construction. This year Chicago will have in operation a 30 million gallon–per day (MGS) sewage treatment plant capable of removing both nitrogen and phosphorus. A 7.5 million gallon–per–day advanced treatment plant is presently operating in Lake Tahoe, California. This plant removes phosphate with lime, nitrogen by ammonia stripping and organic materials by adsorption on activated carbon. Although it may not by necessary for Madison's sewage treatment to match Lake Tahoe's, a comparison of the effluent quality for the two plants in Table 1 shows ample room for improvement on Madison's part. in 1958 Madison spent over $3 million to divert treated, but nutrient-laden sewage around her own lakes. Now that nutrient removal techniques are available, shouldn't at least a comparable amount be spent to preserve the waterways of our neighbors to the South?

Madison is prepared to spend another $3 million for interception lines to carry sewage from DeForest, Windsor, and Waunakee around Lake Mendota and eventually dump it into Badfish Creek. This money might be better spent upgrading the existing plants and removing phosphorus from the effluent.

3. Recommendations 1 and 2 are expensive. Implementing them will significantly increase the total cost of sewage treatment in Madison. A petition should be circulated to MMSD and city governments voicing public support for better sewage treatment and a willingness to pay for it. A second petition to the federal government should urge full funding for pollution control programs and a shift of priorities to environmental human resources.

4. The first two recommendations require expert knowledge and long range planning. MMSD should immediately hire consultants and start engineering studies.

5. Ultimately an informed and demanding public will make the difference between having a clean environment and trying to exist in a polluted one. You can learn about existing sewage treatment by touring the Nine Springs Sewage Treatment Plant. Let your alderman know you want better sewage treatment and work with public interest groups to influence legislation. You can initiate a public hearing on a potential pollution problem by signing a complaint with five other citizens. (Water Resources Act, s.144.536)

Sewage treatment for Madisonians is really a case of water over the dam, but it's polluted water from our not giving a damn for our downstream neighbors.

[***]

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The Quality of Madison's Air

Bill Rock, Steve Sargent, and Julie Redding

Madison, Wisconsin, like all cities in industrialized countries, has an air pollution problem. Compared with that of large cities such as Chicago and Los Angeles, the situation is still within manageable limits. The purpose of this report is to outline the extent of air pollution in Madison and identify the primary sources and amounts of this pollution, and to suggest some remedies. This survey is not all-inclusive. For example, we have not included data on such air pollutants as smoke from burning leaves or open dump burning, or from such natural processes as grass or forest fires. Instead, we have concentrated on the primary sources of man-made pollutants for which data are available. This is not to imply that the pollutant sources listed are the only ones worth worrying about.

Is There A Problem?

Unfortunately, the Madison public does not appear to be aware that there is in fact an air pollution problem. Such an attitude is understandable in view of the rosy picture of Madison's present air quality painted by the local press (Refs. 3,4,5). For example, the *Capital Times* began its Nov. 20, 1969, story on Madison's air quality with the sentence, "Stop trying to hold your breath, Madison residents. Your air is as clean as ever." The basis for this optimistic assessment was a report in November, 1969, by the Madison Department of Public Health titled "Madison's Air." (Ref. 3). Specifically, the report covered the levels of particulates (including among others, dust and ragweed pollen), sulfur oxides (SO_x), and benzpyrene. It was the data on particulates, which had not shown a significant increase over ten years despite the 33% population growth, which led to the soothing news stories.

However, the report did **not** include figures on carbon monoxide (CO), ozone (O_3), nitrogen oxides (NO_x), and hydrocarbons (HC), which from a health standpoint can be more serious pollutants than particulates. No known data exist on concentrations of nitrogen oxides, ozone, or hydrocarbons in Madison, but the Wisconsin Department of Natural Resources carried out a study of carbon monoxide in Madison, and released it on August 7, 1969 (Ref. 2. For a fuller account, see Ref. 8: David Thompson's series of articles on carbon monoxide in the *Daily Cardinal,* Feb. 5-7, 1970.) This study found a very high level of CO on State Street during rush hour under unfavorable weather conditions. This level, 70 parts per million of air (ppm), is as high as those found in very heavily polluted urban areas. Averages were considerably below 70 ppm, ranging from 13 to 22 ppm depending on location and season of year. The high CO concentration found on State Street, however, indicates that dangerous levels can build up under the right (or wrong) combination of adverse conditions. This DNR study alone is sufficient evidence to indicate that Madison does have an air pollution problem, even though it may not affect all Madison citizens all the time.

Primary Madison Air Pollutants

The specific air pollutants to be examined quantitatively in this report are particulates, sulfur oxides, nitrogen oxides, hydrocarbons, and carbon monoxide.

Air-borne particulates are produced by nature in the form of dust storms, plant pollens, volcanic eruptions, salt sea spray, and so forth. In addition, man adds to this natural load by burning things –

coal, oil, natural gas, wood, rubbish, agricultural wastes, gasoline, and junked cars, to name a few – and from countless industrial operations. Particulates form the most immediately noticeable aspect of air pollution, since they reduce visibility, soil laundry and buildings, and generally cast an unsightly pall over the landscape, as in Los Angeles and Gary, Indiana. Particulate pollution can cause deteriorіation of materials, irritation of human and animal tissues, and long-term damage to health (e.g., coal miners "black lung").

Sulfur oxides result primarily from the combustion of sulfur contained in other materials, such as coal and oil, and to a lesser extent, trash. In addition, industrial and manufacturing process contribute sulfur oxides to the air. Sulfur dioxide, the most common combustion product, can react directly with atmospheric water to form sulfurous acid; more commonly it reacts first with water to form small suspended droplets of sulfuric acid (H_2SO_4). Sulfur dioxide itself can cause damage to vegetation and bronchial constriction in humans, and at higher concentration can induce severe human distress (Ref. 6). Sulfuric acid droplets cause coughing and general respiratory irritation.

Nitrogen oxides are formed by the reaction of nitrogen and oxygen, the two primary components of the atmosphere, at high temperatures. Such high temperatures occur in automobile engines and furnaces burning coal or natural gas. Nitrogen dioxide, the most common form, is a brown gas which can cause a decrease in atmospheric visibility, respiratory effects in humans and animals, and damage to sensitive plants (Ref. 6).

Hydrocarbons are added to the atmosphere in large amounts by nature, but man outproduces nature in the urban areas, where pollution effects are greatest. Man–made HC sources include combustion of fuels and waste, evaporation of industrial solvents and gasoline, and the processing and use of petroleum. In this latter class, gasoline is the major source, with emissions coming largely from evaporation of liquid gasoline and the exhaust of unburned fuel from internal combustion engines. HC pollutants by themselves are not especially harmful to humans in moderate concentration; however, a number of HC products can react photochemically with sunlight and other atmospheric components to form irritating and toxic substances.

Carbon monoxide is formed in nature in very small amounts, but man is by far the chief producer, and the automobile accounts for about 80% of man–made CO on a global basis (in Madison the percentage is higher). CO is produced by combustion processes when carbon is oxidized incompletely to CO instead of CO_2. CO is harmful to humans by combining chemically with the blood to carry oxygen to the body. In large concentrations (1000 ppm or more) CO produces fatal effects; running a hose from a car exhaust pipe into the car is a well–known (and relatively nonviolent) method of suicide.

Additional pollutants not covered qualitatively in this report are lead particles, ragweed pollen, and benzpyrene. Benzpyrene results from the

Table I
Estimated Madison Air Pollution Sources
In Tons Per Year

Pollutant Source	Sulfur Oxides (mainly SO_2)	Particulates	Carbon Monoxide (CO)	Nitrogen Oxides (NOX)	Hydro-carbons (HC)	Total Pollutants
Automobiles	175 (1)	233 (12)	48,100	2,480 (34)	3,700	54,688 (70)
UW Steam Plant	5,100 (31)	410 (21)	23	900 (12)	7	6,440 (8)
Oscar Mayer	3,085 (19)	229 (12)	16	650 (9)	9	3,989 (5)
Mad. Gas and	6,500 (39)	585 (30)	31	1,220 (17)	12	10,056 (13)
Electric (oil)	1 (*)	neg. (*)	neg.	2 (*)	neg.	
(gas)	2 (*)	63 (3)	neg.	1,640 (22)	neg.	
Gisholt	456 (3)	208 (11)	12	80 (1)	4	760 (1)
House and (oil)	621 (4)	105 (5)	26	158 (2)	40	987 (2)
Office (gas)	neg. (*)	5 (*)	neg.	32 (*)	neg.	
St. of Wis. Hilldale	551 (3)	36 (2)	15	100 (2)	5	707 (1)
Forest Prod. Lab	91 (*)	78 (4)	7	48 (1)	2	226 (*)
Sub Totals	16,582	1,952	48,230	7,310	3,779	77,853

*less than 1 percent
Figures in parentheses are percent of total to nearest percent.

distillation and combustion of fuels. It is important as an air pollutant because it is carcinogenic (cancer– producing) to experimental animals, and is suspected of being carcinogenic to man. It is estimated that an individual in Madison inhales about 34 micrograms of benzpyrene per year, in Milwaukee 60, and in London 150 (Ref. 1). By way of comparison, a pack-a-day person from the standpoint of lung cancer probability.

Lead particles enter the air primarily through the combustion of gasoline with anti-knock lead additives (e.g. lead tetra-ethyl). An estimated 110 tons of lead particles enter Madison's air each year from automobiles. Physiological effects of lead particles are not known precisely, but indications are that increased atmospheric lead levels can give rise to further concentration in some food chains, leading ultimately to toxic doses for man or animals. (Ref. 6).

Ragweed pollen must be considered an important air pollutant, as it has a direct effect on a significant number (about 5%) of Madison's citizens. While not a man–made pollutant in the usual sense, it has been suggested that ragweed grows much more readily in areas where man has destroyed the natural vegetation, such as construction sites. A ragweed "chop–in" sometime around the end of July each year would probably provide the greatest short–term relief from the detrimental effects of air pollution on health.

Sources of Madison Air Pollutants

The primary sources and estimated amounts of the five main Madison air pollutants are shown in Table I. The pollutants considered are sulfur oxides, particulates, carbon monoxide, nitrogen oxides, and hydrocarbons. The sources considered are automobiles, U.W. steam plant, Oscar Mayer plant, Madison Gas and Electric Company generating plant, Gisholt Co., house and office heating, Wisconsin State office Building complex at Hilldale, and U.S. Forest Products Lab.

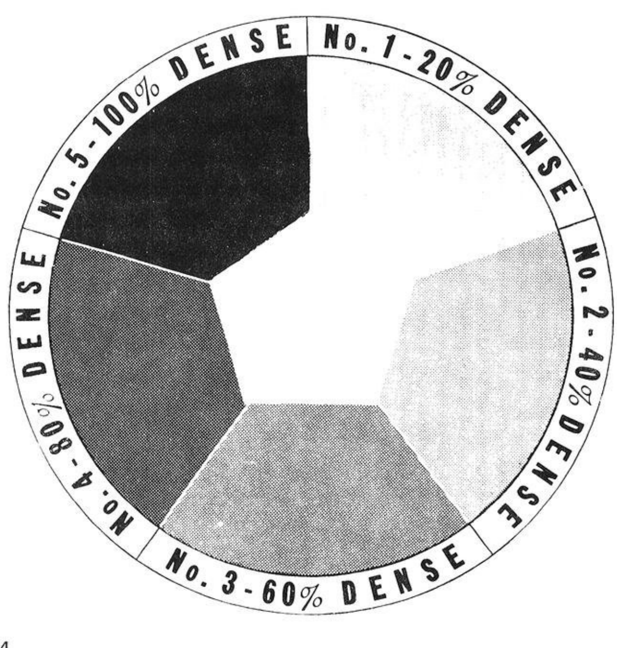
The amount of pollutant in tons per year is shown for each source, with a percentage of the total given in parentheses. It should be emphasized that these are estimates only, based on handbook values of pollutant emission factors for various kinds of furnaces, car engines, etc., and data compiled for Madison on the amounts of fuel burned, number of vehicle miles driven, and so forth. We made no actual measurements.

The automobile, or more precisely, the sum of all automotive vehicles in Madison, is by far the largest producer of air pollution in Madison. It contributes 70% of the approximately 78,000 tons of air pollutants added to Madison's atmosphere each year. This is not surprising in view of the small number of high-polluting industries in the city. The auto contributes virtually all the carbon monoxide and hydrocarbons, as well as 34% of the nitrogen oxides and 12% of the particulates. The next largest air polluter is Madison Gas and Electric Co., followed by the U.W. steam plant, Oscar Mayer, home and office heating, Gisholt Co., State of Wisconsin Hilldale building, and the Forest Products Lab.

As indicated earlier, Table I is not an exhaustive survey of all Madison air pollution sources. No data have been included for such activities as open dump burning, domestic leaf and refuse burning, miscellaneous industrial processing and manufacturing, evaporation of cleaning solvents and stored gasoline, as well as other lesser sources. These may well be significant, but data on these sources are difficult to assemble. An additional factor to consider regarding particulates from coal burning is that the amount of particulate omission depends on the amount of coal burned and/or stack collector efficiency. These efficiencies, as stated by the spokesmen for the operation involved, are shown in Table II.

The highly visible particulate pollution constitutes only about 2½% of the total, which indicates that there is more to Madison's pollution problem than meets the eye: the nose and throat must be consulted also. Particulate pollution is most visible when a coal–burning plant, such as the U.W. steam plant, develops a mechanical malfunction in the combustion air control, giving rise to very incomplete combustion. Large amounts of unburned carbon are then spewed out the stack, producing a thick black smoke plume. This continues until the malfunction is corrected, which generally takes a least several minutes. Occasional malfunctions of this type seem to be pretty much unavoidable with coal plants.

RINGELMANN SMOKE SCALE



Air Pollution Control Laws

The few existing air pollution laws are old and therefore obsolete when attempts are made to apply them to situations created by modern technology. Those which have been proposed recently promise to be little better. While the new laws can be applied to modern situations, definitions of pollutants and what consitutes a pollution problem are vague, enforcement provisions and penalties are almost non–existent.

The City of Madison has only one air pollution control law, the "black smoke" ordinance, found Madison General Ordinances, Section 30.50. This ordinance sets standards for smoke emission using the Ringelmann chart, a graded set of gray shades against which smoke density can be compared. When passed, this ordinance was aimed at coalburning trains passing through town, and the gradations from light gray to black are often inapplicable to measurement of smoke density when substances other than coal are being burned. An additional shortcoming of this ordinance is that since it depends on visual observations of the offending smoke, violations during night–time are virtually undetectable. The emission of any form of gaseous pollutant, such as carbon monoxide, is not curtailed by this ordinance. The main method of enforcement is through citizen complaints.

The City of Madison has in the past demonstrated that it can act to protect its citizens from the harmful effects of air pollution. As early as 1940, the city required the Celon Company, makers of viscose products, to install an absorption tower to remove hydrogen sulfide ("rotten egg gas") from its stack emissions. Unfortunately, actions of this kind have been few and far between.

The Wisconsin laws appear to leave air pollution control largely to the county and municipal governments. Chapter 83 of the Wisconsin Laws of 1967 sets up the Bureau of Air Pollution Control and Solid Waste Disposal of the Division of Environmental Protection under the Department of Natural Resources. An interesting aspect of the rules governing this body (Section 144.33) is that the names of air polluters must be kept confidential; that is, the public is not able to obtain information on who is doing what kind of polluting. The Bureau is empowered to hold hearings and set pollution standards, and at the moment is considering a set of proposed air pollution control rules (Ref. 9). These deal mainly with particulate emission (such as dust, ash, soot, etc.) and concern themselves only passingly with gaseous emission. Density of smoke is, again, measured against a Ringelmann chart. The proportion of various pollutants allowed in the ambient air is nowhere quantified, but is allowed so long as it does not create a "public nuisance." Pollutants are spoken of in general terms, such as "smoke," and "dust," and only in the case of dust is any attempt made to regulate the amount released into the atmosphere by various processes and plants. Gaseous emissions "are to be limited so as not to cause air pollution or public nuisance." The one further control over gaseous emission is the regulation against citizens' failure to maintain automobile antipollution devices. Provision for enforcement is practically non-existent. No penalties for non-compliance are specified and no provision is made for installation inspections or for check on the quality of the state's atmosphere.

Table II
Particle Collector Efficiencies

Source	Type	Stated Efficiency
Madison Gas and Elec.	Cyclone	85-90%
Oscar Mayer	Cyclone	94%
UW Heating	Cyclone	90%
Gisholt	Expanded Chimney Base	25%
State of Wisconsin	Mechanical	80%
Hilldale	Long Cone	
Forest Products Lab	None	0%

Recommendations

In order to keep atmospheric pollutants at a safe level, changes must occur in our laws, priorities, and personal attitudes. We must realize that even very small quantities of certain pollutants are harmful to the human body, and orient ourselves toward insuring the maintenance of safe levels in our atmosphere.

We must have new legislation aimed at protecting our air, as well as strict enforcement of existing laws, such as the "black smoke" ordinance:

1. A city pollution ordinance should be adopted which states specific quantities of various pollutants which may be released into the air. Measures should be taken toward monitoring such established pollution levels and toward provision for enforcement of such an ordinance. This law might be modeled on the California Standards for Ambient Air Quality (Ref. 6).

2. Strict emission control laws modeled on the California 1971 model standards should be adopted. Periodic inspection of automotive emission control devices should be compulsory, and should be done in addition to random vehicle checks now carried out by the state police. Vehicle licensing fees should be restructured to charge proportionally for engine displacement and vehicle weight.

Attitudes toward pollution and personal responsibility for pollution must be changed. In order to do this, people should be made aware of the ways in which they contribute to the problem and ways they can contribute to the solution:

1. On the most individual level, a first measure is to stop smoking. Smoking increases the amount of carbon monoxide in the blood and can contribute to increased sensitivity to CO in the air (Begin by saving your own neck.)

2. The next thing a person can do is to decrease the amount of pollution released by his or her method of transportation. Cycling or walking are the best solutions to this problem, but they may not always be feasible. The next best solution is to ride a bus or other form of public transport. If the individual is dependent upon an automobile, he or she should be sure that it has an emission control device which is in good working order and which is connected. The car's engine should be kept in good condition so that it will burn fuel as efficiently as possible, and the gasoline it uses should have as little lead as possible.

3. People can work on a more encompassing level by keeping themselves informed of the present state of affairs and on proposed legislation, and by indicating to local, state and national lawmakers their support for implementation of strict and enforceable pollution control legislation. They can also form groups to petition for new laws, express support for the passage of proposed laws and regulations, and persuade their neighbors to become informed and interested. Such efforts can accomplish much on the local level.

Pollution control must begin to have a high priority in planning for the future of the Madison area:

1. Dependence on the private automobile must be decreased immediately. This can be done by halting construction plans on all downtown parking ramps and all freeways into the downtown area, and by improvement of public transportation. Buses should be regarded as a public necessity. The city should go ahead with its planned purchase of the bus company and improvements should be made in scheduling and service. Improved bus service should be subsidized with funds obtained through a city licensing fee or wheel tax.

2. Immediate implementation of the State Street mall plan should take place in order to reduce CO and other automobile contaminants and to provide a safe pedestrian environment.

3. Future plans, especially for the central city, should provide for natural circulation of air so that pollutants will not be trapped in streets between tall buildings and build up to dangerous levels. When such provision is not possible, automobiles should be kept out of the area.

4. Heating systems in new buildings should be powered by natural gas or some other fuel which produces a minimum of atmospheric pollutants.

5. All new industrial installations should provide for the disposal of waste in manners which would not contribute to further atmospheric pollution, especially in the cases of SO_2 and CO.

6. The development and use of reduced-pollution vehicles, such as those powered by steam, natural gas, and electricity should be encouraged. A first step in this direction might be the conversion of our mass transit system and government-owned vehicles to such power systems.

7. The University of Wisconsin heating plant should be totally converted to natural gas.

Changes in governmental priorities and in the attitudes of the people can do much to save Madison's environment, but such changes must take place soon. We can no longer ignore pollution control because it costs too much money or because it causes inconvenice. We must realize that our atmosphere is not limitless or infinitely renewable, and we must begin to live within the limitations of our environment.

[***]

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