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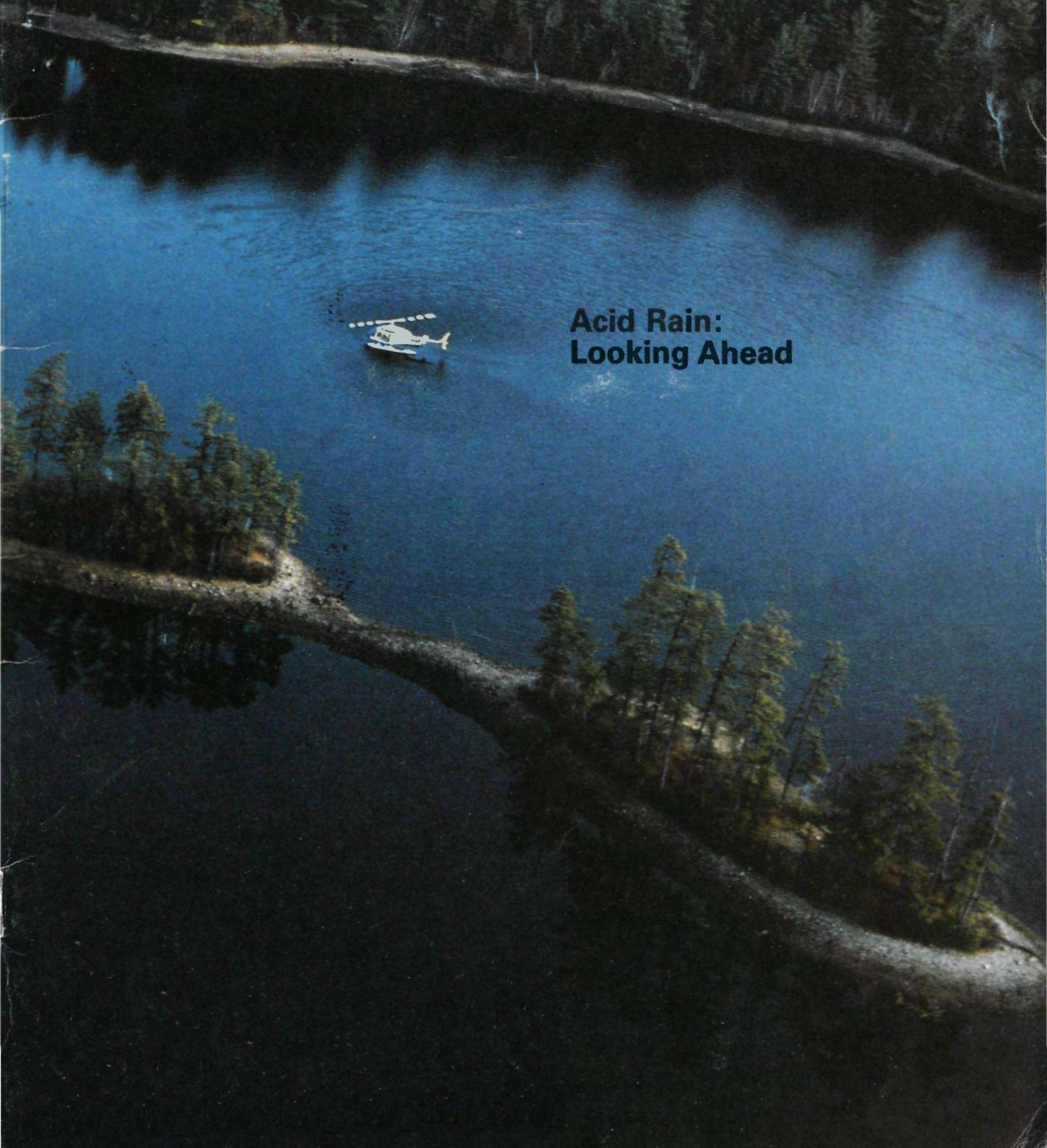
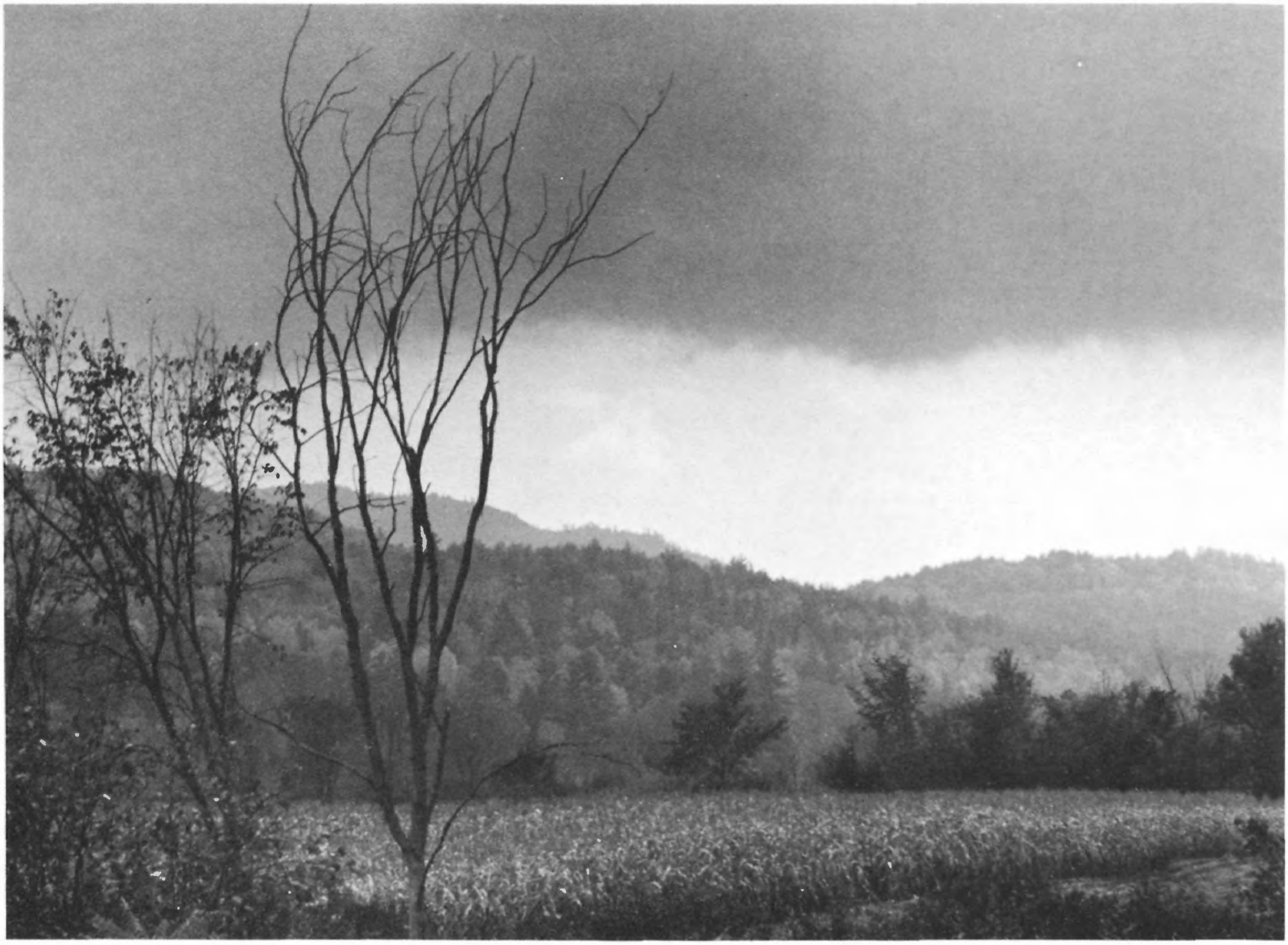


Acid Rain: Looking Ahead



Jay Middleton

Dark clouds cast shadows over the Adirondack Mountains near Lake Placid, NY. As part of the National Surface Water Survey, scientists collected samples from lakes in this area to study the impact of acid rain.

Acid Rain: Looking Ahead

On January 8, the U.S. and Canadian Special Envoys presented their report on acid rain to the President and the Canadian Prime Minister. The report recommended specific actions that could be taken to address the international acid rain problem. For this special issue of the *EPA Journal*, we asked the EPA Administrator, the Canadian Minister of the Environment, spokesmen for industry, and environmentalists to give their impressions of current acid rain policy in light of the *Report of the Special Envoys*. The *Journal* also interviewed Drew Lewis, the U.S. Special Envoy, for his impressions, in hindsight, of the process and impact of the report.

In addition, the issue includes a six-part, 12-page special supplement that provides a current overview of the acid rain problem. The supplement includes a definition and history of acid rain, an international perspective, a summary of current control technologies, and a discussion of studies now underway that are helping EPA prepare to implement an acid rain control program if and when such a program is necessary.

Other articles include a piece on the successful and popular effort at EPA to employ older workers in a Senior Environmental Employment program and a report on the effort to save bottomland hardwoods.

The issue concludes with two regular features—Update and Appointments. □

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EPA is charged by Congress to protect the nation's land, air, and water systems. Under a mandate of national environmental laws, the agency strives to formulate and implement actions which lead to a compatible balance between human activities and the ability of natural systems to support and nurture life.

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Front cover: Sampling from a helicopter on an eastern U.S. lake during EPA's National Surface Water Survey. Results of the Survey are helping to determine the extent and distribution of acidic surface waters in regions susceptible to changes from acid deposition. Photo courtesy of the National Surface Water Survey.

Design Credits: Robert Flanagan; Ron Farrah.

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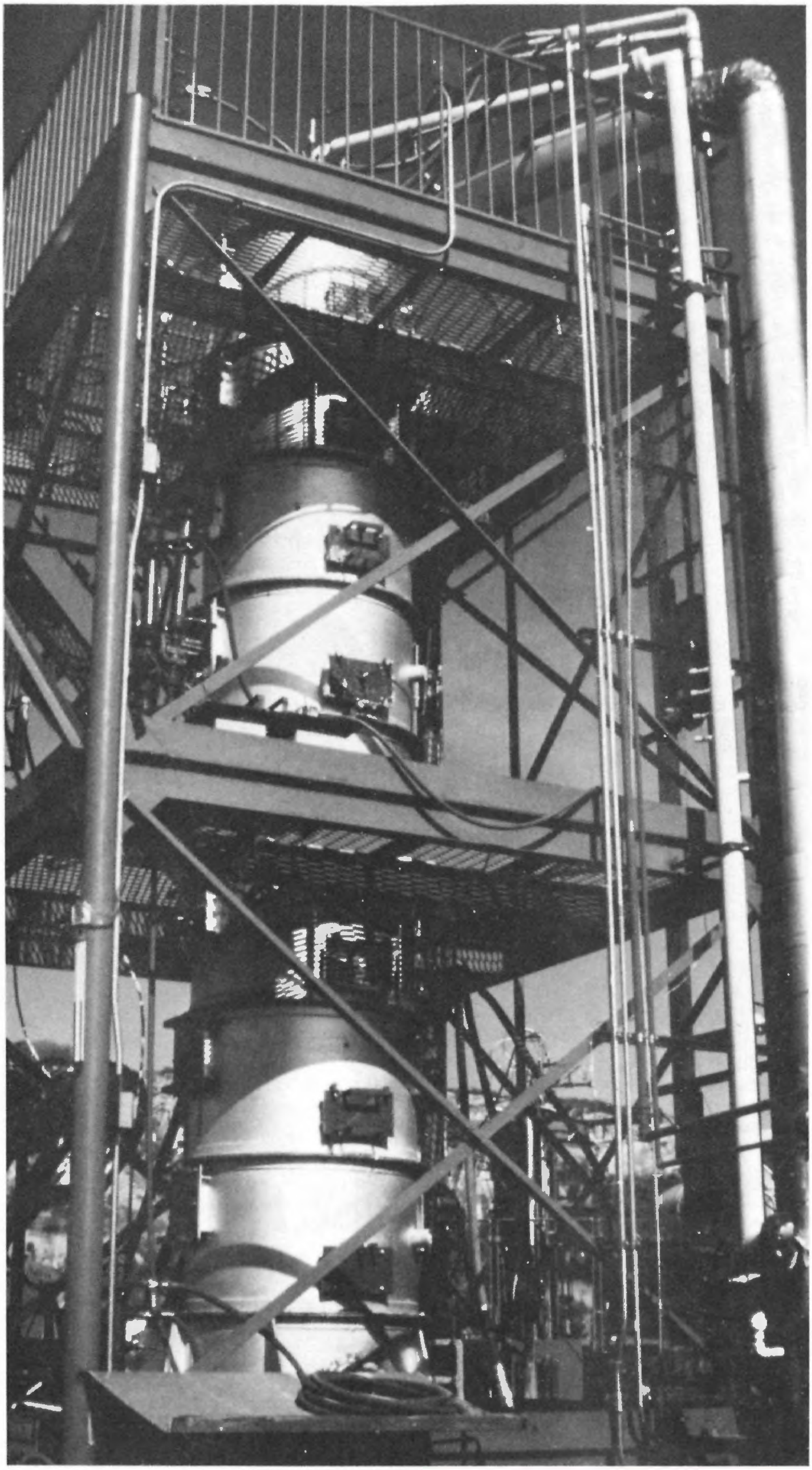


This small pilot scale LIMB combuster, designed to reduce both sulfur dioxide and nitrogen oxides emissions from coal-burning facilities, is being tested with funds from EPA's Air and Energy Engineering Research Laboratory.

The Next Step on Acid Rain

by Lee M. Thomas

At the Environmental Protection Agency, scientific uncertainty is a fact of regulatory life. We always know less than we'd like to about the pollutants we regulate. There is always one more study we'd like to see before we decide on levels of control. But we accept scientific uncertainty as an occupational hazard, and, sooner or later, we make our regulatory decisions based on the best information we have at the time.

Whether we act sooner or later is decided by the nature and severity of the problem at hand. If public health is severely and immediately threatened, we will move quickly despite gaps in our knowledge. In that case, the potential costs of waiting far outweigh any benefits that may be derived from additional studies. If, on the other hand, we believe that human health and welfare are not at immediate risk, we may spend months or even years analyzing the causes, effects, and costs of controlling a problem before we begin to impose controls. In other words, in our efforts to protect the public we have to determine not only *if* health and welfare are threatened, but also *how* and *when* we should act to best alleviate the threat.

Our response to the acid rain problem is shaped by these same considerations. We are committed to protecting public health and welfare from any significant adverse effects of acidic emissions. But the timing, nature, and extent of any program implemented specifically to control acid rain must take into account three factors:

- The immediacy of the acid rain problem.
- The extent of the environmental damage caused by acid rain.
- The economic and social consequences of control.

First, acid rain is without doubt a long-term environmental problem. People were concerned about it 200 years ago, and I suspect we will be concerned about it for as long as we

(Thomas is Administrator of EPA.)

burn large quantities of fossil fuels. We are concerned for good reason: the resources at risk from acid rain are enormous and, in some cases, priceless. But the seriousness of the concern does not in itself argue for immediate control actions. Current scientific data suggest that environmental damage would not worsen noticeably if acidic emissions continued at their present levels for 10 or 20 more years. Acid rain is a serious problem, but it is not an emergency.

Second, although the potential economic and cultural losses due to acid rain are staggering, relatively little damage is occurring at the present time. Early data from our comprehensive National Surface Water Survey indicate that only 3.4 percent of the lakes sampled in the northeastern United States, frequently cited as one of the most acid-sensitive areas in the country, have a pH of 5.0 or less. (A pH of 7.0 is neutral; pH decreases with increasing acidity.) Some studies have linked forest damage in Europe and parts of eastern North America with acid rain, but the scientific evidence is spotty at best. It is not clear that acidity is the cause of the problem, or that reducing acidic emissions would solve it. In short, at this time the damage caused by acid rain is mostly theoretical. Theoretical damage should leave us on our guard, but it should not force us to take premature control actions.

Third, launching a major control program would have serious socioeconomic consequences. The economic costs would be very high—on the order of $30 billion to $70 billion over 20 years. Those costs would not fall evenly on all people across the country. The economic effects would vary depending on the control actions taken, but without careful planning and program design, the heaviest burden would be borne by high-sulfur coal miners and utility rate-payers in upper mideastern states such as Ohio, Indiana, and Illinois.

At the same time, it is difficult, if not impossible, to predict with any certainty to what extent acid deposition in any specific area would be reduced by emissions controls on any specific sources. We can reduce total emissions of sulfur dioxide and nitrogen oxides, and we can be reasonably sure that total acid deposition would be reduced in similar proportion over wide areas and over long times. But we have no way of predicting the degree to which environmental and economic losses would be avoided in the sensitive areas of concern. It seems irresponsible to impose real and substantial costs on real and identifiable groups of people for a control program of uncertain effectiveness and benefit.

Considering what we know and don't know about acid rain, it seems prudent to incorporate a measure of patience into our acid rain policy. For this reason we have not initiated an acid rain control program. Nor have we decided against one. Rather, we have implemented a comprehensive research and analytical process that will provide us with the kind of information needed to make reasonable decisions within a reasonable time. That process emphasizes the completion of research that will help us better understand how much emissions should be reduced, where they should be reduced, and over what time period.

Considering what we know and don't know, it seems prudent to incorporate a measure of patience into our acid rain policy.

When the two Special Envoys handed their report on acid rain to their respective governments last January, they moved that process forward another step. In their report the envoys recognized that the acid rain issue demanded ongoing attention at the highest levels of the U.S. and Canadian governments. They recommended that the two nations continue and expand bilateral research efforts. Most importantly, they recommended that the United States spend $5 billion over the next five years demonstrating the *commercial feasibility of innovative* control technologies.

The Special Envoys understood the long-term nature of the acid rain problem, and the political and economic difficulties inherent in any near-term acid rain control program. They believed the most useful thing we could do to reduce near-term emissions and prepare for a more substantial long-term control effort would be to expand the list of control technology options available to us. If we could cut the cost and/or improve the efficiency of sulfur dioxide and nitrogen oxides controls, then we would indeed move closer to a solution to North America's acid rain problem.

Some people have said that the *Report of the Special Envoys* did not go far enough. Others believe that it went too far. But the expenditure of $5 billion is not inconsequential. It is a sizable investment in our capability to control acidic emissions as needed in the future. Furthermore, an expense of that magnitude is justified both by the extent of the resources at risk and the legitimate concerns of our Canadian neighbors.

The *Report of the Special Envoys* did not solve the U.S.-Canadian acid rain problem. Reasonable people will continue to disagree about the effectiveness of a $5 billion technology demonstration program. EPA and the other involved federal agencies will continue to carry out the research essential to our defining both the problem and the most effective response. But the *Report of the Special Envoys* undoubtedly has moved us a step closer to our goal. The technologies that will be demonstrated will improve our ability to craft an economically feasible and politically defensible control program.

President Reagan has strongly endorsed the *Report of the Special Envoys*. Implementing the report's recommendations is, I believe, the best next step for EPA. □

Special Envoy, Special Task

An Interview with Drew Lewis

For this issue of the *EPA Journal*, Tom Super interviewed Drew Lewis, President Reagan's former Special Envoy on acid rain. Super is in the Policy Office of the EPA Office of Air and Radiation. His report on the interview follows:

Special Envoys Drew Lewis of the U.S., left, and William Davis of Canada meet earlier this year to discuss their report on acid rain. "The fact that the United States and Canada could agree on anything related to acid rain is a real achievement," Lewis said recently.

Canapress Photo Service

The office of the chairman and chief executive officer (CEO) of the Union Pacific Railroad offers a panoramic view of downtown Omaha, the Missouri River, and the Great Plains beyond. But on this rainy spring evening, the CEO has no time to admire the scenery. It's only his second day on the job, and he is working late. In the first week of April 1986, Drew Lewis—former CEO of Warner Amex Cable Communications, former Secretary of Transportation, and former Special Envoy on Acid Rain—has strayed a long way from the Washington-New York corridor.

That Drew Lewis should move from Warner Amex, a cable TV company, to the Union Pacific Railroad is not as improbable as it may seem. As Secretary of Transportation from 1981 to 1983, Lewis worked first-hand with the U.S. railroad industry. Before that, he managed the reorganization of the Reading Railroad, and, as one of two court-appointed trustees, he guided its merger into Conrail. Drew Lewis knows something about railroads.

Less obvious is why President Ronald Reagan chose to name him the U.S. Special Envoy on Acid Rain. In March of 1985, the President met with Prime Minister Brian Mulroney of Canada, and they agreed to appoint Special Envoys to study the transboundary acid rain issue and then recommend a course of action that would help to resolve it. Prime Minister Mulroney named William Davis, a former Premier of the Province of Ontario. President Reagan personally called Lewis to ask him to serve as the U.S. counterpart.

The request came as some surprise to Lewis. "My secretary walked into my office one morning and said, 'The President is on the phone.' I said, 'The President of what?' When I got on the phone, the President asked me to take on the job as Special Envoy. He said that U.S. relations with Canada were very important to him, and we had to resolve our differences over acid rain."

Lewis readily admits that, at the time, he was not especially familiar with the issue. "I had read an article or two about acid rain. I'm from Pennsylvania, and the farmers in my neighborhood sometimes complained about their roofs rusting because of acid rain. Beyond that, I didn't know a thing."

Lewis believes that politics is the art of the possible, and that acid rain is, above all, a political problem.

But, in Lewis' opinion, that may have been an advantage. The President may have picked him precisely because he had no preconceived notions about acid rain. "Don't underestimate the President's concern over U.S./Canadian relations. He knew a key issue dividing us was acid rain, and he knew there was a great deal of uncertainty as to its causes and effects. He told me to look into it and come to my own conclusions about the severity of the problem. Then he wanted me to report back with recommendations for action. In that kind of situation, the fact that I had no prior position on the issue was probably a great advantage.

"The President gave me an enormous amount of latitude. If I saw a significant problem, I was to recommend actions to do something about it, regardless of budget constraints. You have to realize, of course, that our conversation took place before Gramm-Rudman, so in some sense the rules of the game have changed."

Over the next nine months, Lewis immersed himself in the question of acid rain. He spent one to two days per week on the issue, while two of his staff worked virtually full time. They talked to all the major parties with an interest in acid rain, and they listened to virtually anyone who held an opinion on the subject. They met with scientists, environmentalists, the electric utility industry, the coal industry, the timber industry, fishermen, citizens, and politicians on both sides of the border. They toured emissions sources, and they visited acid-sensitive ecological areas.

Lewis emerged from that experience with some strong impressions of the different parties involved. "I was especially impressed by the environmental scientists, people like Gene Likens in New York. They had obviously spent years studying the question. Although some of them had strong opinions about what the government should do about it, they were very capable of answering my questions with scientific detachment. In that sense, they were much better sources of information than the industry lobby."

Lewis was less favorably impressed by environmental organizations. "On this issue at least, the environmentalists are their own worst enemies. They have staked out an all-or-nothing, uncompromising position, which has forced industry to entrench just as deeply. When I talked to industry people in public, they all argued that there was no acid rain problem. When I talked to them privately, many of them said they believed the environment was being affected. But they refused to say so publicly for fear the environmentalists would use that as a way to force a huge control program way out of proportion to the real problem. I don't think too many industry people would fight against a well-reasoned control program, but they don't think the environmentalist lobby is willing to compromise."

Continued to next page

A New Hampshire stream in early spring. When snow melts in the spring, it can release acids that accumulated in the snowpack during the winter. This sudden release can stunt plant growth and destroy newly hatched fish.

Steve Delaney

Nor was Lewis impressed with some of the available control technologies. "We visited a utility plant in western Pennsylvania, and the scrubber there was enormous. It dwarfed the generating facility it was trying to clean up. It cost something on the order of half a billion dollars. I said to myself, if this is the only solution to the acid rain problem, we are never going to solve it. If you ever want to turn the public against acid rain controls, just let them tour a scrubber."

Despite the political and technical pitfalls of the acid rain issue, Lewis and his Canadian counterpart were able to hammer out a series of recommendations that were palatable to both parties. With hindsight, Lewis believes that may have been the most significant achievement of the *Report of the Special Envoys*. "The recommendations themselves are important, but the fact that the United States and Canada could agree on anything related to acid rain is a real achievement."

"Acid rain is not a near-term problem. We're in this—with Canada—for the long haul."

According to Lewis, the Canadians entered the negotiation process with very high expectations. "In Canada, acid rain is one of the most important national public issues. It doesn't attract anywhere near as much attention in the United States. So my first problem was to convince the Canadians to ask for something less, something achievable. Then I had to push the U.S. administration to give more than they were willing to give in the past. That's what politics is all about."

Lewis believes that politics is the art of the possible, and that acid rain is, above all, a political problem. "If you're going to play the game of politics," says Lewis, "you have to get something done." He is proud of the fact that the *Report of the Special Envoys* got something done about acid rain, and he gives a great deal of credit to the Canadian Envoy, William Davis. "Bill Davis is a decent man, a gentleman. He was a great guy with whom to negotiate. He knew when to argue and when to relax. When things got tense, we'd sit back and talk about the prospects of the Toronto Blue Jays. I'm sure he had just as hard a time convincing the Canadians to compromise as I had convincing our administration."

Not surprisingly, the *Report of the Special Envoys* has been criticized by all sides. Sitting in Omaha, Lewis seems unperturbed. "The report made substantial progress. First of all, it marked the first time that this administration admitted publicly that U.S. emissions were causing environmental problems in Canada, and that the United States was going to do something about it. Second of all, we committed ourselves to spending a lot of money doing something about it."

Lewis admits that the recommendation to spend $5 billion on innovative control technologies is a little vague, but he feels the general intention is unambiguous. "We recommended that the United States spend $5 billion, split 50/50 between the federal government and business. The money is to be spent over five years, starting whenever the money becomes available. The money is definitely not to be spent on research and development, but on the costs of retrofitting innovative control technologies on existing plants. We definitely expect those technologies to reduce sulfur and nitrogen emissions to some extent, or why would we fund them? We definitely expect acid deposition in both Canada and the United States to be reduced, but in the report we couldn't specify by how much, or how those reductions would affect the environment. In fact, those are two of the major uncertainties that plague any discussion of acid rain.

"The important thing is, we need to expand the technological options available for controlling acid rain. Right now we either switch to low-sulfur coal or we scrub high-sulfur coal. That's not enough. We need to help give our industry a wider range of control options, and that's what the expenditure of federal funds is meant to do.

"The problem with that recommendation, besides finding the money to do it, is that it doesn't have much of a near-term environmental impact. Five years from now we probably won't be able to measure the environmental improvement that results from spending $5 billion. But that doesn't bother me. Acid rain is not a near-term problem. We're in this—with Canada—for the long haul. Our report

was meant to propose long-term solutions, which is why we were deliberately vague about what technologies should be funded.

"By the way, I wouldn't be too surprised if some of the technologies we funded didn't work very well. The technologies are unproven. That is why the federal government is putting up half the money—to take half the risk. But if we spend the money, take the risk, and develop a wider range of control options, then the money will have been well spent. We'll be that much closer to a long-term solution. We'll have moved the process along a step or two, and like I said, that's what politics is all about."

Drew Lewis delivered the *Report of the Special Envoys* to President Reagan early on the morning of January 8, 1986. He spent the rest of the day briefing members of the Congress. He flew back to New York the next day, and has not spoken about acid rain in public since. On the surface, it appears as if the experience burnt him out. But Lewis denies it, emphatically.

"The day after I delivered the report, Union Pacific announced that I had been named chairman and CEO. At that point, my public credibility, my public objectivity, was threatened. You see, Union Pacific has a large stake in the acid rain issue. The company would love to see a massive coal-switching program. They'd make money mining low-sulfur coal, and they'd make money hauling low-sulfur coal. In fact, a Union Pacific representative flew to New York when I was with Warner Amex to lobby me strenuously about the advantages of low-sulfur coal. His lobbying was persistent, bordering on the abusive. He was probably chagrined to discover a few months later that I was going to be his new boss.

"But my personal situation in some ways neatly exemplifies the complexity of the acid rain issue. Some coal companies would love to see an acid rain control program, and some wouldn't. Some coal miners would love to see an acid rain program, and some wouldn't. The problem is, those who would love it and those who wouldn't live in different places. So the issue becomes polarized, regionalized, and that much more difficult to resolve.

"I dropped out of public sight because I didn't want my new job to prejudice public discussion of the report. My recommendations stand on their own, even though Union Pacific would have preferred that I recommend something quite different. In fact, my new colleagues still give me a lot of good-natured grief about how I sold out Union Pacific in the *Report of the Special Envoys*."

The rain that falls in Omaha in the spring is not very acidic. If it were, it would probably be a boon to the rich, alkaline soils of Nebraska. Omaha is a long way from the Adirondacks.

But Drew Lewis is still interested in acid rain. He still reads about it, and he still talks about it. Occasionally, he calls Washington to find out how the recommendations in his report are progressing, how and when they are going to be implemented. He is not burnt out on acid rain.

Would he do it all over again? "Of course, if the President called again and asked me to help" □

Why Canadians Worry About Acid Rain

by Tom McMillan

Canada rarely impinges on American consciousness except, perhaps, as the home of relatives or a safe destination for tourists. When Canadian and American politicians visit one another's countries, tradition demands a ritual mention of the world's longest undefended border and stresses our mutual bonds of friendship. Surely we are now secure enough with each other to take those familiar signposts as *givens*. Let us consider, instead, complex and more demanding realities: how two genuinely separate countries, with contrasting histories, with subtly but substantially different perceptions and government systems, are dealing with their shared environmental future.

There are increasingly sensitive trade issues that affect both our countries—freer trade proposals, protectionist trends, common market-type arrangements such as the Canada-United States auto pact. And of course, defense matters will always remain high on our bilateral agenda as long as NORAD and our common membership in NATO continue. But it is what we are doing to each other's natural environment that is fast becoming the most contentious issue between our two countries.

That is especially the case in Canada, perhaps because geography and population patterns give rise to perspectives that are different from those in the U.S. Consider the contrast in productivity of our environment compared to that of the United States. With the exception of parts of its Southwest, America's various regions are all potentially productive. In Canada, by contrast, a demanding climate severely limits our productive land to a narrow margin within 150 miles of the U.S. border. As a result, more than 90 percent of our people live along that thin line and are dependent on its environment for their needs.

(McMillan is Canada's Minister of the Environment.)


Fisheries & Oceans Canada

Sport fishing in Canada. Fishing camps that make up an important part of the country's tourism industry may be forced to close because of acid rain damage to fish, according to the author.

Atmosphere and water are resources we hold in common, but our nations are affected unevenly by the condition of those resources. Consider the well-publicized horror of Americans when they learned about Love Canal and the effects of toxic chemicals on the Great Lakes. The attitude of Canadians was influenced by the fact that 50 percent of our total population lives within the Great Lakes-St. Lawrence basin, compared to just 12 percent of Americans.

But toxic chemicals are not our only, or even our most pressing, bilateral environmental issue. That dubious distinction belongs to acid rain. Acid rain, after all, is not an equal opportunity destroyer. Although American weather forecasters delight in grim winter warnings of cold fronts coming from Canada, in reality, global wind patterns place Canada *downwind* of the eastern U.S. As a result, our environment is disproportionately affected by pollutants that originate in the U.S. The U.S. releases more than 20,000,000 tons of sulfur dioxide into the atmosphere, of which 4,000,000 tons find their way across the border into eastern Canada. On the average, of every ton of acid rain that falls onto Canadian territory, only half originates in Canada; the other half comes from the United States. In some Canadian areas immediately downwind of major U.S. emission sources, more than 70 percent of wet acidic depositions are of American origin.

The arithmetic is devastating: if Canada were to eliminate every particle of sulfur dioxide and oxides of nitrogen from Canadian sources, it would do nothing more than cut acid rain overall by half. In some of the most affected areas, however, that cut would not be enough to stem the damage now being visited on Canada. In contrast, Canada bears responsibility for 15 percent of all

acid fallout in New England and 25 percent of all acid fallout in the Adirondacks.

Clearly, we are neighbors who, however friendly, have been throwing garbage onto each other's front lawns for years. The results have been horrendous.

- In Nova Scotia alone, where fishing is a vital industry, 13 salmon-bearing rivers have been killed.
- At least 1,600 of Ontario's lakes are acid-dead; their shimmering stillness may look idyllic in pictures, but in reality it is a sign that they no longer sustain life.
- Almost one million lakes in Quebec and Ontario are in vulnerable condition, and the death toll rises annually.
- By the year 2000, an estimated 600 fishing camps and lodges, part of Canada's vital tourism industry, may be forced to close as a consequence of acid-rain damage to fish.
- About half of Canada's productive forests are in areas of acidic rainfall; according to the most recent figures, these forests generate $14 billion worth of forest products.
- Eighty-six percent of all Canadians (compared to approximately 50 percent of Americans) live where acidic depositions are high, a possible source of health problems. A comparison of school children living in polluted and non-polluted Canadian towns has already shown a direct correlation between respiratory problems and the presence of acid pollutants.

Martin Weaver

Canadian Parliament buildings in Ottawa. Closeup shows damage to buildings' stonework—damage caused in part by acid rain, environmental officials in Canada believe.

Acid rain not only decimates our present and threatens our future, it could also destroy the past in both our countries and, in fact, throughout the world. For example, two of America's most enduring shrines—the Washington Monument and the Lincoln Memorial—have already been acid-rain damaged. In Canada, our Houses of Parliament, the seat of our federal government, have been harmed, as have the legislative buildings of both Ontario and Nova Scotia. Prince Edward Island, my home province, lies in the Gulf of the St. Lawrence, hundreds of miles from any major pollutant source; nonetheless, its distinctive sandstone churches, among our most cherished public buildings, have already been seriously damaged by acidic depositions.

Nor is the damage confined to North America. A statue of the Virgin Mary, revered by devout Poles since the 15th Century, now stands with an eerily blank face, its features having been erased by air-borne pollutants. The Parthenon of ancient Greece, which neither people nor nature could destroy in 2,500 years, may be threatened by acid rain in our own lifetimes.

The facts are not the litany of a theoretical environmental theology. They are examples of how the social and economic well-being of people everywhere is being threatened. For Canadians, moralizing about the actions that others should take, offered this late in the day, would be both shameful and futile. Instead, through our federal and provincial governments, we have taken specific steps on several fronts to ensure that our approaches are the most useful and active possible. Among those steps:

- The federal and provincial governments have agreed on timetables and targets for slashing sulfur dioxide emissions; by 1994, they will be half of their 1980 levels.
- Recently, the province of Ontario announced that it would undertake a massive 67-percent reduction. The province acknowledges that reducing emissions by three large polluters—Ontario Hydro, International Nickel, and Algoma Steel—will mean increased costs to all consumers.
- Ten months ago, the province of Quebec issued regulations that will reduce emissions by 45 percent; a newly elected government in that province has already confirmed its commitment to those levels.
- The federal government has introduced tighter nitrogen oxide emission standards for cars and is planning to do the same for heavy duty vehicles. Recently, I announced a program that will educate Canadian consumers about the dangers of misfueling (deliberately using leaded gas in cars designed for unleaded fuel); by 1992, all automotive fuel sold in Canada will be lead-free.

Our most up-to-date estimate of the capital cost of reducing acid rain-causing emissions is between $1.5 billion and $2 billion dollars by 1994. Yet, repeated polling shows that there is only one major public issue on which Canadians have significantly changed their minds since the end of World War II: the environment. People in this country repeatedly describe themselves as concerned about the environment, as worried that governments will not do enough to protect their environment, and as willing to make reasonable economic sacrifices to safeguard it.

This concern about the environment may explain the lukewarm Canadian media response to President Reagan's acceptance of the report by Drew Lewis and William Davis, the American and Canadian special envoys on acid rain. The media dismissal of the envoys' report and the President's response is unfortunate. Mr. Reagan's acknowledgement that acid rain is a serious trans-boundary problem is, in fact, an important move towards joint action on the issue.

If we ignore acid rain, the greatest damage would be to our mutual sense of trust in each other.

Moreover, acid rain has now become firmly established as a major, continuing item in future summits between Canada and the United States. It is not, as Canadian cynics insisted it would be, a one-summit wonder, to be discreetly buried at the bottom of some diplomatic closet and hauled out on the basis of political expedience. U.S. and Canadian officials now have the same clear-cut understanding that it will remain a key bilateral issue until it is solved.

Canada's overall objectives can be stated as follows: this country wants to reach a Canada-United States accord to solve our mutual trans-boundary air problems once and for all, such an accord to include early reductions in American acid rain-causing emissions falling onto Canada. We expect that the U.S. Administration will act on acid rain. We expect that existing air-pollution programs and legislation will be used to reduce trans-boundary emissions. We expect approval of clean coal demonstration funding that will give priority to projects that would reduce trans-boundary emissions. We expect to cooperate on research and on monitoring that will guide decisions being made on emission cutbacks. Both countries are setting up machinery to begin working towards such measures.

The history of our two countries and our capacity to reach solutions together give me, give the Canadian government, and should give Canadians and Americans alike, cause for optimism. At the same time, Americans must accept the fact that the acid-rain issue is not just an environmental issue to most Canadians. They see it as a litmus test of whether Canadian-United States cooperation works both ways. The chilling fact is that, if we can't make progress on acid rain, with its terrible consequences for all of us, how can we hope to work on other issues where self-interest is less clear-cut?

Acid rain can bring us together in a great victory of common sense and realistic self-interest. Or, it can eat away at our environment and at our economic, social, and physical safety. If we ignore acid rain, the greatest damage would be to our mutual sense of trust in each other. That is why it is urgent for us, on both sides of the border, to build on recent events and to tackle environmental issues that can corrode the genuine goodwill that underlies all those verities about friendship and an undefended border. There is a lot at stake. But, as we have proven so often in the past, both countries are up to the challenge. □

The View from Industry

by William H. Megonnell

Steve Delaney

After a sudden shower, a tree glistens with raindrops. Various interests debate whether acid rain is innocuous or harmful.

(Megonnell is Director of Legislative Affairs [Environment] for the Edison Electric Institute.)

ACID RAIN! You read about it in newspapers. You see and hear about it on television. The very term conjures up all sorts of horrible thoughts—dead fish, stunted crops, dying trees, crumbling structures, rusting bridges, even pockmarked skin and scarred lungs. Those are exactly the images the death-and-destruction doomsayers want you to envision whenever you hear or read about "acid rain."

It is unfortunate that those who speak first, loudest, and most often—no matter how unsubstantiated or outlandish their claims—receive wide attention and are afforded more credibility than those who follow quietly and calmly to present verifiable facts. Once an alarming allegation has captured the headlines, scientific facts that refute, or do not substantiate, preconceived notions do not make catchy news.

For a moment, however, forget the media stories, the political pronouncements, and the statements of professional environmentalists who try to tell you what acid rain is doing to you and your environment. They have done an extremely effective job of building massive public misperceptions by pointing to adverse effects—almost any effect—and screaming "ACID RAIN!" But, from your own *observations*, can you personally attest to any adverse effects of acid rain?

Perhaps you like to fish, but you aren't catching any. If not, why not? Are you using the right bait? Or is it simply that there are no fish where there used to be fish—or where the "old timers" *say* there used to be fish? Assuming the last, why are there no fish? The quick and easy answer, because you remember having read an article on the Adirondack lakes in New York: acid rain!

But careful scientific study has shown that answer is much too quick and much too easy. Although nobody can deny there are a relatively few fishless bodies of water, there is no clear and unambiguous relationship pointing to acid rain as *the* cause, or even a major cause. Even the much touted 1986 report by the prestigious National Academy of Sciences, once you ignore the press releases and wade through its tortuous 506 pages, succeeds only in reaffirming those ambiguities. The academy found that lakes in New Hampshire have remained the same over this century, Wisconsin lakes actually have become less acidic, and New York lakes (depending on one's interpretation of historic measurements) either have experienced no change or may have increased in acidity. The report cautioned that some lakes became much more acidic than could have been accounted for by rainfall.

Or you may be a gardener, and you perceive that your flowers and vegetables don't seem to be growing as well as they did years ago. And, because you've been conditioned by newspaper and television reports, you naturally assume that acid rain is to blame.

But scientific studies of crop damage have been inconclusive. Acidified water may increase or decrease production, depending on the plant or species, and the experts say that acid rain is not a significant factor in agriculture.

If anything harmful is happening, it is quite slow and subtle.

Maybe you live near a forest and you've noticed a few dead trees lately. Again, since you've read or heard about the Black Forest of West Germany allegedly being destroyed by acid rain, your mind automatically concludes: "It's happening in my own backyard!" Would it surprise you to learn that the timber and paper industries, whose very livelihoods depend on thriving trees, have been unable, despite intensive research, to tie forest damage to acid rain? Or that U.S. Forest Service experts, and even the prestigious National Academy of Sciences, could find no conclusive evidence that acid rain is harming forests?

Being a homeowner, you notice that your house needs painting and the gutters are rusting. You recall reading an editorial about acid rain "gnawing away" at the Statue of Liberty. You've seen pictures of eroded gargoyles on ancient European cathedrals, which newspaper articles attribute to "deadly" acid rain. Extrapolation leads you to conclude that acid rain is destroying your residence, too, or at least increasing the upkeep costs.

There is no denying that structural materials deteriorate because of climatic factors—sunlight, freezing, thawing, moisture—no matter where they are located or how pristine the atmosphere, and, intuitively, one would presume that atmospheric contaminants may enhance such deterioration. That does not, however, constitute conclusive evidence that acid rain is the cause, or even a *major* contributing factor. The meager available scientific evidence points primarily to natural causes and local air pollution (not long-distance transport of acid rain) as the principal cause of materials deterioration. (And, incidentally, the Statue of Liberty, has been exposed to *alkaline*—not acid—sea spray and salts for a century.)

But, most importantly, what about your health? Isn't the *possibility* of adverse health effects always included on the list of acid rain's dangers? Indeed it is, but no qualified medical scientist has yet confirmed such charges.

To sum up, there is much misinformation about acid rain. Claims of adverse effects largely are exaggerated, distorted, unsubstantiated, or downright wrong. Generally, it is not competent scientists who are spreading the gloom and doom; if anything harmful is happening, it is quite slow and subtle.

In short, there is ample time, without fear of impending disaster, to complete the ten-year research program that was begun under a 1980 federal law to investigate comprehensively the complex acid rain phenomenon. Ironically, those who pointed to the potential adverse impacts of acid rain appear to be disappointed that the research not only is not verifying many of the original allegations, but actually is refuting or casting grave doubts on them. They are promoting the adoption of control legislation *now* for fear that their claims will be weakened further as research results accumulate.

Equally misleading is the impression that the United States lags behind other countries in controlling sulfur dioxide, which usually is cited as the major contributor to acid rain. When the U.S. refused to join the "30 Percent Club," in which many nations pledged to *begin* reducing their sulfur dioxide emissions by 30 percent over the next decade, editorials suggested that this country should "hang its head in shame." The fact is that, since the peak year of 1973, emissions of sulfur dioxide in the United States already have decreased by nearly 30 percent; instead of condemning, the headlines in this country's newspapers should have shouted in the boldest type: "Welcome to the 30 Percent Club!"

Rainfall is *not* becoming more acidic. There is no massive damage from acid rain. Emissions of sulfur dioxide are declining.

Nevertheless, the control-for-controls-sake juggernaut rolls on. Draconian acid rain bills are pending in both houses of Congress, and their backers are pushing for early action. After all, if they don't act fast, the public may begin to pay attention to the scientists and realize that they will be buying little or nothing for the estimated $100 billion they will pay in electric bills alone for acid rain controls—in addition to the $10 billion per year that is being paid by electric consumers to comply with the present Clean Air Act.

Just as you enjoy basking in the sunshine, you should revel in acid rain. Rain always has been acid.

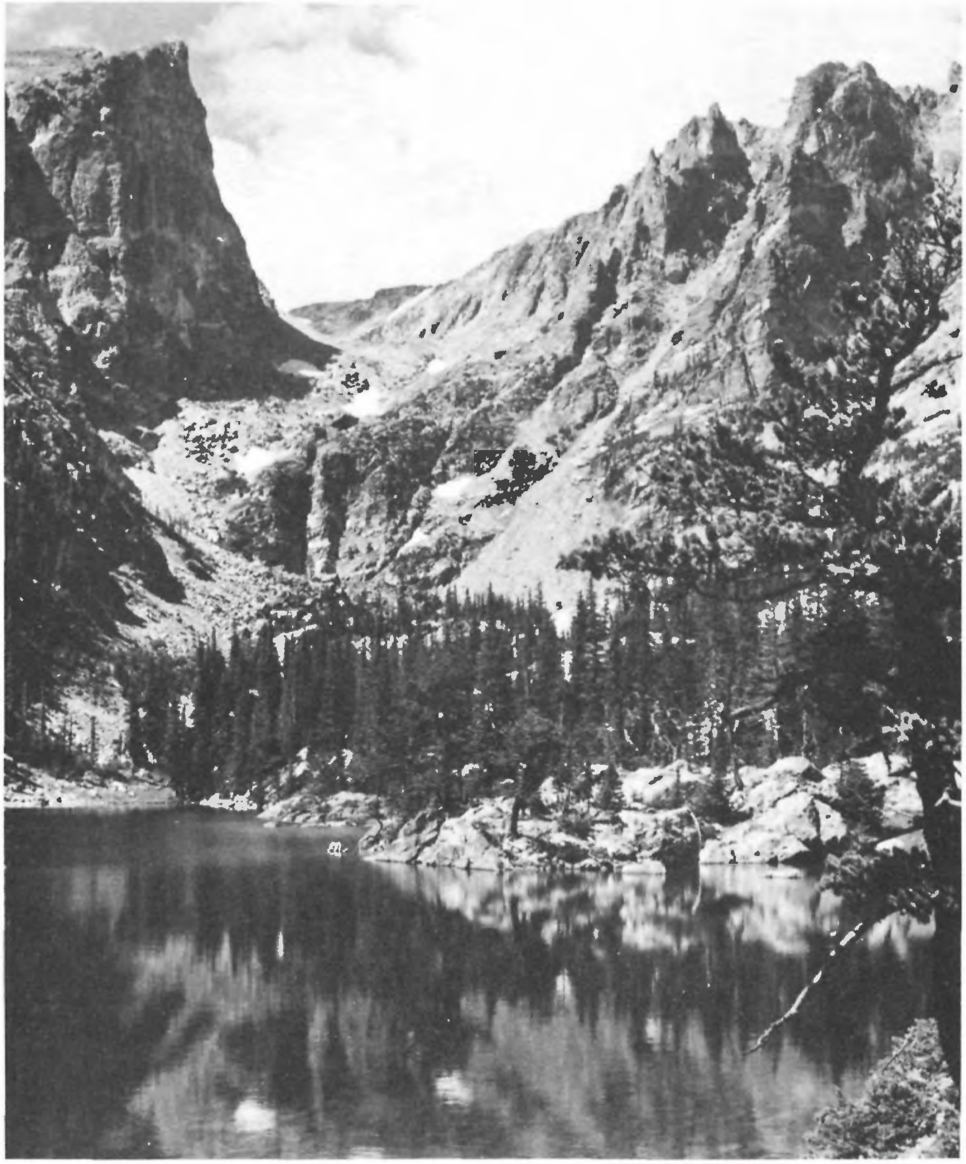
But, for those who still believe that some sort of additional action is needed, there is a reasonable, cost-effective road for our nation to take. There are new coal cleaning technologies which need to be tested at the power plant scale to refine engineering, determine economics, and demonstrate reliability. Unlike the "scrubber" technology that we use today, these new technologies can reduce both sulfur dioxide *and* nitrogen oxide. They offer the most sensible way of addressing our nation's acid rain concerns.

Meanwhile, just as you enjoy basking in the sunshine, you should revel in the acid rain. Rain always has been acid, but your ancestors survived and thrived in it. Rain is acid today, almost anywhere and anytime you measure it, and there is no convincing evidence that it is significantly and adversely affecting you. And it will be acid tomorrow, but your children will be even less aware of it because the U.S. Clean Air Act is working and air quality is improving.

The sky is not falling, despite what the 20th-century Chicken Littles would like you to believe. □

The Perspective of the Environmentalists

by David G. Hawkins and Deborah A. Sheiman



National Park Service

Lake in Colorado's Rocky Mountain National Park. Acid rain is a national problem, say the authors, with signs of damage showing up even in the Rockies.

(Hawkins is a Senior Staff Attorney with the Natural Resources Defense Council [NRDC]. Sheiman is a Resource Specialist with NRDC's Clean Air Project.)

Acid rain kills fish and devastates lakes and streams. It degrades our cultural heritage by eroding the sculptural details of historical monuments and statues. It stains the skies with acid aerosols that dim visibility in the city, the countryside, and in our national parks. It is implicated along with ozone as an agent in the decline of forests. And the pollutants that cause acid rain may be threatening the respiratory health of the American people.

Acid rain is one of the most widespread environmental problems facing our generation. Its effects are cumulative and may be irreversible. We know the cause: 50 million tons of sulfur and nitrogen oxide pollution emitted each year in North America, and we know the cure: pollution control. The technical means to solve the problem are in hand. But pollution reductions will not be accomplished voluntarily. It will require government action to stem the emissions of millions of tons of sulfur and nitrogen oxides that pollute our air, our water, and our land.

The prospects for action on acid rain look brighter now than at any time since the issue first appeared on the national agenda. Several factors—both technical and political—have helped make the issue ripe for resolution.

First, the myths propagated by anti-environmental forces have given way to reason. Opponents of pollution control used to argue that not enough was known about the causes and effects of acid rain to justify doing anything about the problem. This line of argument, that pollution is innocent until proven guilty, is no longer viable in the face of the overwhelming consensus of the international scientific community. Almost monthly, authoritative scientific panels issue new warnings. The latest is a March 1986 report of the National Academy of Sciences, which concluded that there is a direct cause and effect relationship between emissions of sulfur dioxide and the acidification of the environment. According to the report, sulfur dioxide emissions acidify precipitation, degrade visibility, pollute streams, and cloud the air with acid aerosols.

There is also a growing scientific consensus that acid rain is a broad national problem, not just something of concern in New England or Canada. Signs of damage are showing up in the Rockies and in the Boundary Waters, in the Appalachians and the Adirondacks, in Florida and in Chicago.

Continued to next page

Second, politicians are showing increased recognition of the need to take action. On April 10, a bipartisan coalition of 150 members of the House of Representatives introduced H.R. 4567, the Acid Deposition Control Act of 1986. A major victory occurred on May 20, when the House Subcommittee on Health and the Environment voted to approve H. R. 4567. The bill was introduced by representatives from all parts of the country, including a majority of members of the Health and Environment Subcommittee and half the members of the full Committee on Energy and Commerce. The Sikorski (D-MN)/Conte (R-MA)/Richardson (D-NM)/Boehlert (R-NY) bill would require a 10 million-ton reduction in sulfur-oxide emissions from electric utilities and other industrial sources by 1997. Nitrogen-oxide emissions that are precursors to both acid rain and ozone would be reduced by about four million tons annually.

Acid rain is one of the most widespread environmental problems facing our generation.

The Congressional Office of Technology Assessment estimates that average electricity rates would increase by only two to three percent—about $1.00 to $1.50 on the average electric bill—and pegs the annual costs of the legislation at $3.8 billion to $4.9 billion. These are reasonable costs to protect the environment from the ravaging effects of acid rain, and the bill will certainly yield economic and health benefits that far exceed program costs.

Like all consensus legislation, H.R. 4567 is a compromise. Its emission reduction requirements will not achieve the 12 million-ton reduction in sulfur-dioxide emissions needed to halve acid deposition, as recommended by the National Academy of Sciences in 1981. Its timetable, stretching out more than a decade, seems excessive considering the five years that states and utilities have already had to prepare for a control program. Further, the bill's emission limits for many types of motor vehicles simply codify EPA's current, weak standards.

Despite these compromises, environmentalists testified in support of H.R. 4567 as a politically viable measure that can begin to curtail the damage caused by acid deposition.

Legislation introduced in the Senate by Senator Robert Stafford (R-VT) and a majority of members of his Environment and Public Works Committee is even better from an environmental perspective. S.2203, the New Clean Air Act Amendments, is designed to achieve a 12 million-ton reduction in sulfur-dioxide emissions by imposing limits directly on major sources, with stricter limits applicable to power plants that intend to generate base-load electricity far into the future. In addition, sources would have until 1995 to apply the best available technology to reduce nitrogen-oxide emissions.

To control hydrocarbons and nitrogen oxides, the precursors to ozone, and carbon monoxide and diesel particulates, S.2203 requires model-year 1990 cars and light-duty trucks to meet emissions limits that reflect the technology now employed by the cleanest vehicles. Heavy-duty engines, including notorious polluters like trucks, buses, and construction equipment, would be controlled by 1991.

Even the White House has decided to acknowledge the seriousness of the acid-rain problem. For the last five years, the Reagan Administration's position on acid rain has been that we need more study before we can do anything about it; to that end, the government has been funding an $85 million per year research program to investigate causes and effects.

In March 1986, the White House announced the President's "full endorsement" of the U.S. and Canadian Special Envoys' report on acid rain. This report stated:

> "Acid rain is a serious environmental problem in both the United States and Canada. Acidic emissions transported through the atmosphere undoubtedly are contributing to the acidification of sensitive areas in both countries. The potential for long-term socio-economic costs is high."

But rather than urging enactment of controls, the report recommended a five-year, $5 billion research program to "demonstrate" new ways of burning coal more cleanly.

The "clean-coal demonstration" recommendation exemplifies how desperation politics makes bad policy. Reduced to its simplest terms, the recommendation invents a problem and then proposes to spend lots of taxpayers' money to "solve" it. The invented "problem" is the report's implicit claim that adequate means to reduce acid-rain causing pollution are not now available. The "solution" is to spend $5 billion to demonstrate means to control acid rain.

The technical means to solve the problem are in hand.

However, we have adequate techniques now to control acid-rain pollution. The report's recommendation for a program to demonstrate "new" technologies is not likely to help control pollution at old plants. It is likely to produce delay and to waste money.

The utility and high-sulfur coal industries like the "clean coal technology" recommendation because it lets them argue that we should wait for positive results before adopting new controls. These industries have every incentive to apply for and spend taxpayers' money to prove that the "holy grail" of better technology is still just over the horizon.

Viewed in the context of Congress' increasing desire to act on acid rain, the report's recommendation for a "demonstration" program is an attempt by the Administration and several industry allies to delay control legislation by urging instead a new type of research program—this time research into controls. It appears that Congress will not fall for this latest decoy. Members of Congress know that the public is willing to pay for a cleaner environment. Paying for an unnecessary demonstration program with no guaranteed environmental benefits just is not an adequate substitute. □

ACID RAIN

An *EPA Journal* Special Supplement

Acid rain . . .

Few environmental problems have caused so much controversy—and so much confusion . . .

People were worrying about pollution problems related to acid rain hundreds of years ago . . .

Now countries in several parts of the world are working together to control it . . .

Research into many different aspects of acid rain is advancing . . .

And so is the technology to reduce it.

In this special supplement, the *EPA Journal* takes a look at what we know about acid rain—and what we don't know:

The Acid Rain Phenomenon

All rainfall is by nature somewhat acidic. Decomposing organic matter, the movement of the sea, and volcanic eruptions all contribute to the accumulation of acidic chemicals in the atmosphere, but the principal factor is atmospheric carbon dioxide, which causes a slightly acidic rainfall (pH of 5.6) even in the most pristine of environments. (See box for an explanation of pH.)

In some parts of the world, the acidity of rainfall has fallen well below 5.6. In the northeastern United States, for example, the average pH of rainfall is 4.6, and it is not unusual to have rainfall with a pH of 4.0—which is 1000 times more acidic than distilled water. Although precipitation in the western United States tends to be less acidic than in the East, incidents of fog with a pH of less than 3.0 have been documented in southern California.

There is no doubt that man-made pollutants accelerate the acidification of rainfall. We know that man-made emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) transformed into acids in the atmosphere, where they often travel hundreds of miles before falling as acidic rain, snow, dust, or gas. All these wet and dry forms of acid deposition are known loosely as "acid rain," which is now recognized as a potentially serious long-term air pollution problem for many industrialized nations.

Emissions and Deposition

Before the Clean Air Act was passed in 1970, U.S. SO_2 and NO_x emissions were increasing dramatically. (See Table 1.) Between 1940 and 1970, annual SO_2 emissions had increased by more than 55 percent. Over the same period, NO_x emissions had almost tripled.

TABLE 1
Historic U.S. SO_2 and NO_x Emissions (In Millions of Tons)

	1940	1950	1960	1970	1980	1984
SO_2	19.8	22.4	22.0	31.1	25.6	23.6
NO_x	7.5	10.3	14.1	20.0	22.5	21.7

The Clean Air Act helped to curb the growth of these emissions. By 1984, annual SO_2 emissions had declined by 24 percent, and NO_x emissions had increased by only 9 percent. These reductions in historical growth rates took place despite the fact that the U.S. economy and the combustion of fossil fuels grew substantially over the same period.

Acid-forming emissions are not spread evenly over the United States. Ten states in the central and upper Midwest—Missouri, Illinois, Indiana, Tennessee, Kentucky, Michigan, Ohio, Pennsylvania, New York, and West Virginia—produce 53 percent of total U.S. SO_2 and 30 percent of total U.S. NO_x.

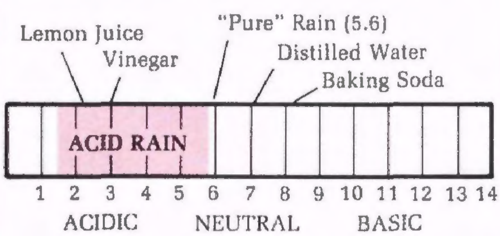
Table 2 lists the top ten SO_2 and NO_x emitting states. SO_2 emissions are concentrated along the Ohio River Valley in Ohio, Indiana, Pennsylvania, Illinois, and West Virginia. These five states, along with Missouri and Tennessee, produce 44 percent of all SO_2 in the United States.

U.S. NO_x emissions tend to be more evenly distributed, but again, states along the Ohio River are especially high producers. Four of the five highest SO_2-producing states—Ohio, Indiana, Pennsylvania, and Illinois—are also among the top ten NO_x-producing states. Thus, the Ohio River Valley and the states immediately adjacent to it lead the U.S. in emissions of both major components of acid rain.

TABLE 2
Top Ten SO2 and NOx Producing States in 1984 (In Millions of Tons)

		SO_2		NO_x
1.	Ohio	2.58	Texas	3.25
2.	Indiana	1.67	California	1.17
3.	Pennsylvania	1.60	Ohio	1.14
4.	Illinois	1.38	Illinois	0.99
5.	Texas	1.24	Pennsylvania	0.92
6.	Missouri	1.18	Indiana	0.83
7.	West Virginia	1.02	Florida	0.70
8.	Florida	0.99	Michigan	0.69
9.	Georgia	0.93	Louisiana	0.68
10.	Tennessee	0.92	New York	0.62

How "Acid" Is Acid Rain?

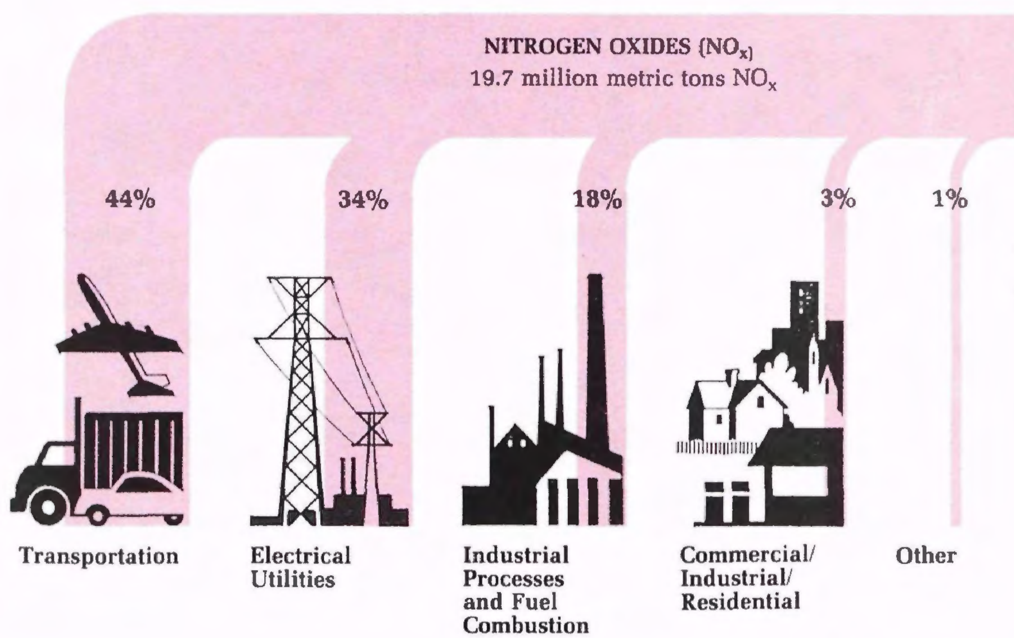


The pH scale ranges from 0 to 14. A value of 7.0 is neutral. Readings below 7.0 are acidic; readings above 7.0 are alkaline. The more pH decreases below 7.0, the more acidity increases.

Because the pH scale is logarithmic, there is a tenfold difference between one number and the one next to it. Therefore, a drop in pH from 6.0 to 5.0 represents a tenfold increase in acidity, while a drop from 6.0 to 4.0 represents a hundredfold increase.

All rain is slightly acidic. Only rain with a pH below 5.6 is considered "acid rain."

Acid Rain Precursors



Although we can't be certain of long-term trends in acid deposition, it is possible to draw conclusions about current patterns. A comparison of the pH of U.S. rainfall with the states producing the greatest SO_2 and NO_x emissions clearly shows the solid link between acidic emissions and acidic deposition. Data collected by several different monitoring networks show that the areas of the U.S. receiving the most acid rainfall are downwind and northeast of those states with the highest SO_2 and NO_x emissions.

Effects of Acid Rain

The environmental effects of acid rain are usually classified into four general categories: aquatic, terrestrial, materials, and human health. Although there is evidence that acid rain can cause certain effects in each category, the extent of those effects is very uncertain. The risks these effects may pose to public health and welfare are also unclear and very difficult to quantify.

The extent of damage caused by acid rain depends on the total acidity deposited in a particular area and the sensitivity of the area receiving it. Areas with acid-neutralizing compounds in the soil, for example, can experience years of acid deposition without problems. Soils like this are common throughout the midwestern United States. On the other hand, the thin soils of the mountainous Northeast have very little acid-buffering capacity, making them vulnerable to damage from acid rain.

Aquatic Effects

The adverse effects of acid rain are seen most clearly in aquatic ecosystems. The most common impact appears to be on reproductive cycles. When exposed to acidic water, female fish, frogs, salamanders, etc., may fail to produce eggs or produce eggs that fail to develop normally.

Low pH levels also impair the health of fully developed organisms. Some scientists believe that acidic water can kill fish and amphibian reptiles by altering their metabolism, but we have little evidence that this is happening now.

We do know, however, that acid rain plays a role in what scientists call the "mobilization" of toxic metals. These metals remain inert in the soil until acid rain moves through the ground. The acidity of this precipitation is capable of dissolving and "mobilizing" metals such as aluminum, manganese, and mercury. Transported by acid rain, these toxic metals can then accumulate in lakes and streams, where they may threaten aquatic organisms.

Some lakes in areas of high acid deposition and low buffering capacity have been found to be both highly acidic and lifeless. Yet other lakes in similarly sensitive areas have not. Different lakes vary in the time it takes to reach an acidic condition, and rates of recovery from acidification also seem to vary.

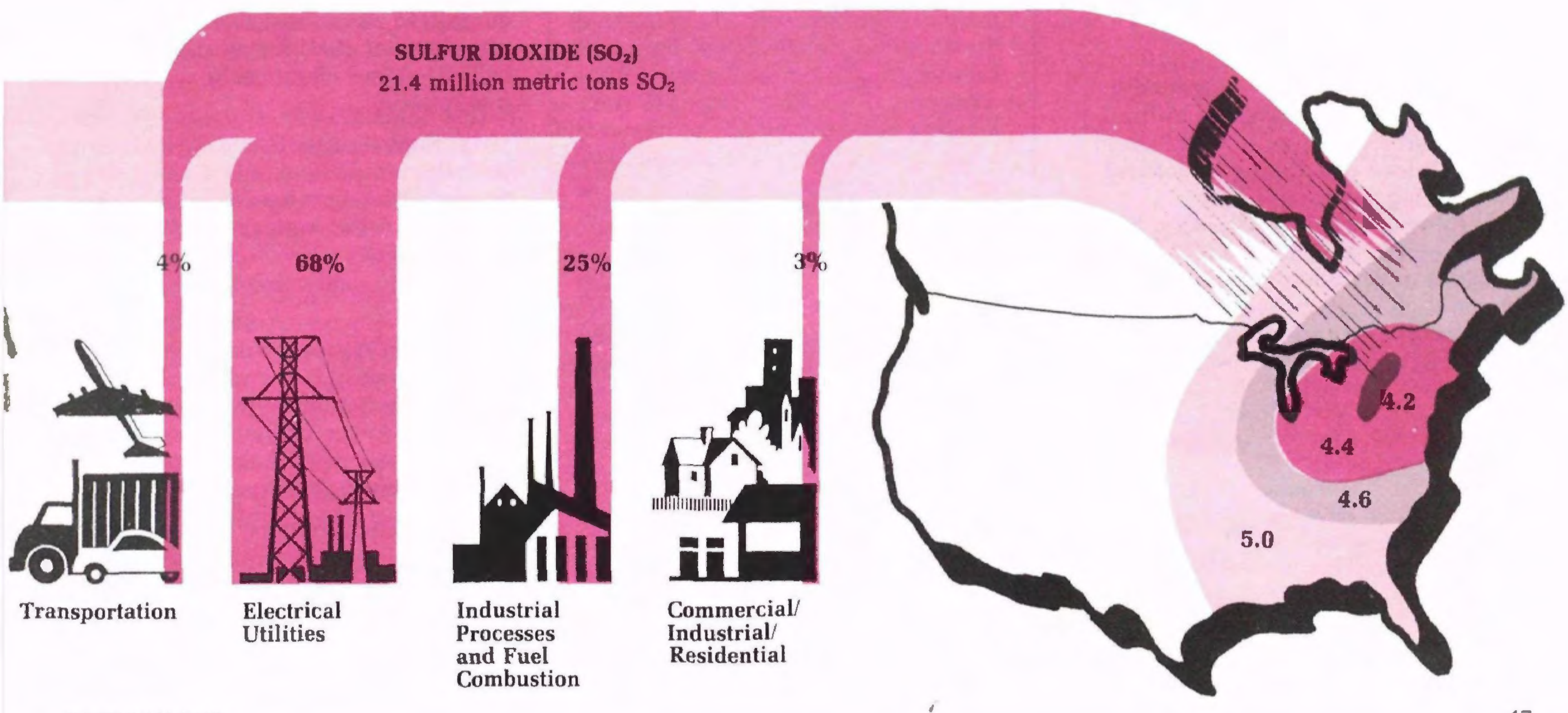
Scientists are using field studies, long-term water quality data, studies of fish population declines, and lake sediment studies to analyze the acidification of various lakes. However, both the data and the theoretical models currently available are unproven in their ability to make an accurate prediction of the effects of continued acidic emissions.

Terrestrial Effects

We know less about acid rain's effects on forests and crops than we do about effects on aquatic systems. The most extreme form of damage some have attributed to acid rain is the phenomenon known as "dieback." Dieback is a term applied to the unexplained death of whole sections of a once-thriving forest. At this time, however, we have little direct evidence linking acid rain to forest dieback.

Scientists do agree that acid rain can lead to other, less extreme effects on soil and forest systems. It can leach nutrients from soil and foliage while inhibiting photosynthesis. Acid rain can also kill certain essential microogranisms. The toxic metals it mobilizes when passing through soil can be harmful not just to aquatic life but to trees and crops as well. But, again, we have little evidence that such damage is occurring now because of acid rain.

Some experts even point to data indicating that acid deposition may actually benefit certain trees and crops. For example, some pitch pine seedlings



have grown better when treated with increasingly acidic water, and exposure to combinations of acid rain and mist has stimulated red spruce growth. It is possible that nitrates derived from the nitrogen oxides in acid rain confer some nutritional benefits on trees and plants.

Materials Effects

Acid rain can also damage man-made materials, such as those used in construction and sculpture. We are all familiar with photographs of statues that are losing their features and shape, with acid rain often cited as the culprit.

The problem is far more than aesthetic. Building materials, too, can be degraded by acidity. For example, limestone, marble, carbonate-based paints, and galvanized steel all can be eroded and weakened by the kind of dilute acids found in acid deposition.

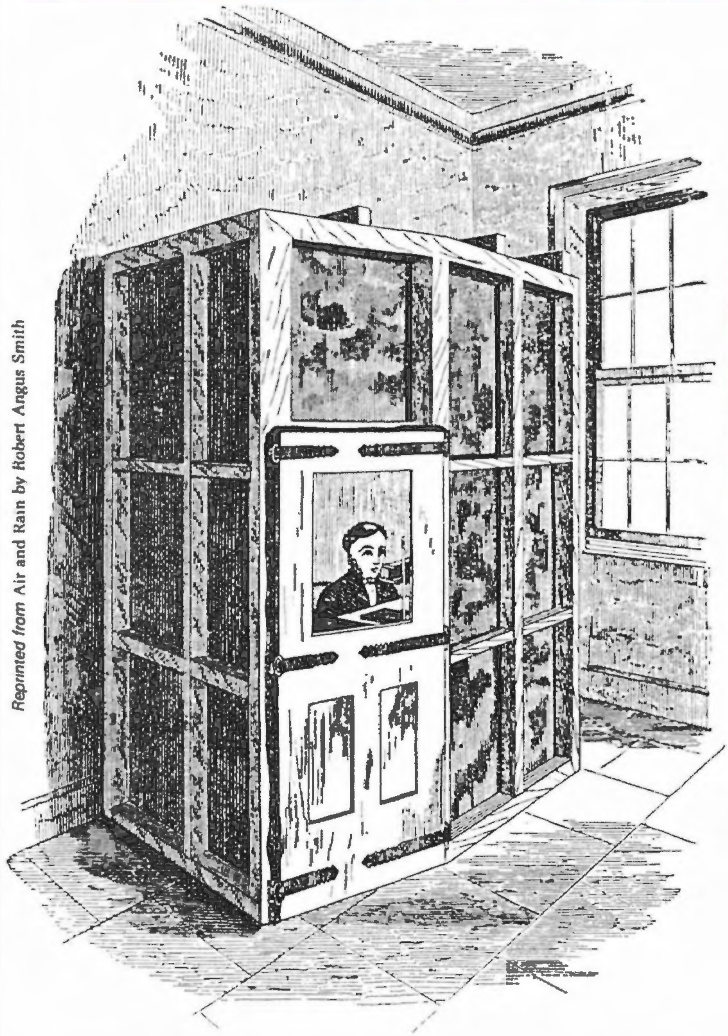
Since materials naturally deteriorate with time, it is difficult to differentiate the effects of acid rain from damage caused by normal weathering. It is also hard to identify the specific damage caused by specific pollutants or combinations of pollutants. As a result, the particular role played by acid rain in the deterioration of materials is still a major unknown.

Human Health Effects

So far, we don't know of any human health problems resulting from direct contact with acid rain. Inhaling acidic particles in acid fog may possibly carry some health risk, but more research is needed to confirm whether this constitutes a real risk.

Acid rain may also indirectly affect human health when it mobilizes toxic trace metals such as aluminum and mercury. When dissolved in acidic water, these metals can be ingested by fish and animals, building up in the human food chain. Acidic water could also leach lead out of pipe solder and into drinking water supplies.

But these are only possibilities. No one has established that current emissions of SO_2 and NO_x are actually causing such damage, or that such damage will continue or increase in the future if SO_2 and NO_x emissions are not reduced.



Reprinted from Air and Rain by Robert Angus Smith

A lead chamber constructed by 19th century English scientist Robert Angus Smith as part of his experimental research into air quality.

1661-2: English investigators John Evelyn and John Graunt publish separate studies speculating on the adverse influence of industrial emissions on the health of plants and people. They mention the problem of transboundary exchange of pollutants between England and France. They also recommend remedial measures such as locating industry outside of towns and using taller chimneys to spread "smoke" into "distant parts."

1734: Swedish scientist C.V. Linné describes a 500-year-old smelter at Falun, Sweden: ". . . we felt a strong smell of sulphur . . . rising to the west of the city . . . a poisonous, pungent sulphur smoke, poisoning the air wide around . . . corroding the earth so that no herbs can grow around it."

1872: English scientist Robert Angus Smith coins the term "acid rain" in a book called *Air and Rain: The Beginnings of a Chemical Climatology*. Smith is the first to note acid rain damage to plants and materials. He proposes detailed procedures for the collection and chemical analysis of precipitation.

1911: English scientists C. Crowther and H.G. Ruston demonstrate that acidity of precipitation decreases the further one moves from the center of Leeds, England. They associate these levels of acidity with coal combustion at Leeds factories.

1923: American scientists W.H. MacIntyre and I.B. Young conduct the first detailed study of precipitation chemistry in the United States. The focus of their work is the importance of airborne nutrients to crop growth.

1948: Swedish scientist Hans Egner, working in the same vein of agricultural science as MacIntyre and Young, sets up the first large-scale precipitation chemistry network in Europe. Acidity of precipitation is one of the parameters tested.

An International Perspective

1954: Swedish scientists Carl Gustav Rossby and Erik Eriksson help to expand Egner's regional network into the continent-wide European Air Chemistry Network. Their pioneering work in atmospheric chemistry generates new insights into the long-distance dispersal of air pollutants.

1972: Two Canadian scientists, R.J. Beamish and H.H. Harvey, report declines in fish populations due to acidification of Canadian lake waters.

1975: Scientists gather at Ohio State University for the First International Symposium on Acid Precipitation and the Forest Ecosystem.

1977: The U.N. Economic Commission for Europe (ECE) sets up a Cooperative Programme for Monitoring and Evaluating the Long-Range Transmission of Air Pollutants in Europe.

1979: The U.N.'s World Health Organization establishes acceptable ambient levels for SO_2 and NO_x. Thirty-one industrialized nations sign the Convention on Long-Range Transboundary Air Pollution under the aegis of the ECE.

1980: The U.S. Congress passes an Acid Deposition Act providing for a 10-year acid rain research program under the direction of the National Acid Precipitation Assessment Program.

1980: The U.S. and Canada sign a Memorandum of Intent to develop a bilateral agreement on transboundary air pollution, including "the already serious problem of acid rain."

1985: The ECE sets 1993 as the target date to reduce SO_2 emissions or their transboundary fluxes by at least 30 percent from 1980 levels.

1986: On January 8, the Canadian and U.S. Special Envoys on Acid Rain present a joint report to their respective governments calling for a $5 billion control technology demonstration program.

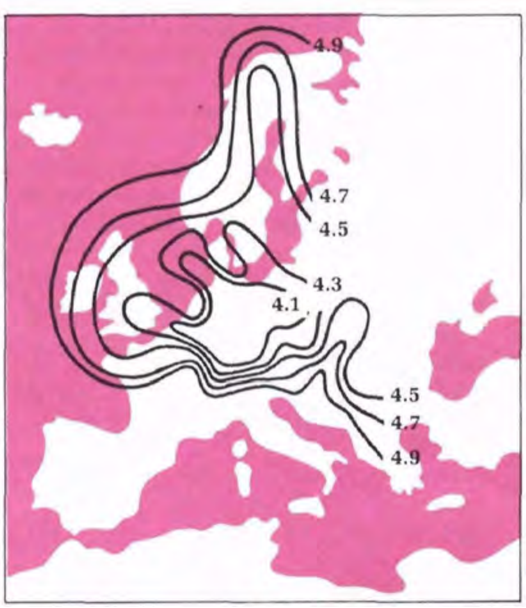
1986: In March, President Ronald Reagan and Prime Minister Brian Mulroney of Canada endorse the *Report of the Special Envoys* and agree to continue to work together to solve the acid rain problem.

Principal source: Ellis B. Cowling, "Acid Precipitation in Historical Perspective," Environmental Science and Technology, *Volume 16, Number 2, 1982.*

Acid rain is not considered a threat to the global environment. Large parts of the earth are not now, and probably never will be, at risk from the effects of man-made acidity. But concern about acid rain is definitely growing. Although acid rain comes from the burning of fossil fuels in industrial areas, its effects can be felt on rural ecosystems hundreds of miles downwind. And, if the affected area is in a different country, the economic interests of different nations can come into conflict.

Such international disputes can be especially difficult to resolve because we do not yet know how to pinpoint the sources in one country that are contributing to environmental damage in another.

Concerns about acid rain tend to be raised whenever large-scale sources of acidic emissions are located upwind of international borders. Japan, for example, has not yet suffered any environmental damage due to acid rain, but the Japanese are worried about the potential downwind effects of China's rapidly increasing industrialization. A similar problem has risen on the U.S.-Mexican border, where some people are worried that Mexico's new copper smelter at Nacozari could cause acid rain on the pristine peaks of the Rocky Mountains. Besides scattered instances such as these, acid rain has emerged as a serious international issue only in two places: western Europe and northeastern North America.



This map shows average pH levels in Europe, based on data gathered between January 1978 and December 1982.

Europe

Diplomatic problems related to cross-boundary air pollution first surfaced in Europe in the 1950s, when the Scandinavian countries began to complain about industrial emissions traveling across the North Sea from Great Britain. Since then, acid deposition has been linked to ecological damage in Norway, Sweden, and West Germany, and low-pH rainfall has been measured in a number of other European countries. (See map on this page for the average pH of rainfall over Europe in 1980.)

The political and scientific controversies over acid rain are multiplied in Europe because so many countries are involved. Table 3 lists the SO_2 emissions of 21 European nations in 1980.

A comparison of the pH map with Table 3 reveals that some countries producing very low amounts of SO_2 are nevertheless experiencing low-pH rainfall and high rates of acid deposition. Norway, for example, produced approximately 137,000 metric tons of SO_2 in 1980, yet received depositions of about 300,000 metric tons. Clearly, Norway, like a number of other European nations, is being subjected to acid deposition that originates outside its borders.

Sweden pioneered the development of extensive and consistent monitoring for acid precipitation in the late 1940s. In 1954, the Swedish monitoring program

TABLE 3

European SO_2 Emissions in 1980
(In Thousands of Metric Tons)

Austria	440
Belgium	809
Bulgaria	1,000
Czechoslovakia	3,100
Denmark	399
Finland	600
France	3,270
Federal Republic of Germany	3,580
Greece	700
Hungary	1,663
Italy	3,800
Netherlands	487
Norway	137
Poland	2,755
Portugal	149
Romania	200
Sweden	450
Switzerland	119
United Kingdom	4,680
USSR	25,500
Yugoslavia	3,000

(Figures from U.S. Department of State)

was expanded to include other European countries. The results of this monitoring revealed the high acidity of rainfall over much of western Europe.

Prompted by these findings, the U.N. Conference on the Human Environment recommended a study of the impact of acid rain, and in July 1972, the U.N. Organization for Economic Cooperation and Development (OECD) began an inquiry into "the question of acidity in atmospheric precipitation." In 1979, a U.N. Economic Commission for Europe (ECE) conference in Stockholm approved a multi-national "Convention" for addressing the problem of long-range transboundary air pollution. Both the United States and Canada joined the European signatories. Since then, a number of European countries, including France, West Germany, Czechoslovakia, and all the Scandinavian countries, have agreed to reduce their 1993 SO_2 emissions by at least 30 percent from 1980 levels.

More recently, ECE members decided in 1985 to broaden their goals to include the control of nitrogen oxides, which have been gaining recognition as important acid rain precursors. Workshops are now underway to determine the nature and extent of NO_x pollution in various countries, as well as possible approaches for controlling it.

North America

The United States and Canada share the longest undefended border in the world and billions of dollars in trade every year. We also share a number of environmental problems, foremost among them the problem of acid rain.

In both countries, acidic emissions are concentrated relatively close to our mutual border. Canadian emissions originate primarily in southern Ontario and Quebec, while a majority of U.S. emissions originate along the Ohio River Valley. Each country is contributing to acid rain in the other. But because of prevailing wind patterns and the greater quantities of U.S. emissions, the United States sends much more acidity to Canada than Canada sends to us. In 1980, for example, the U.S. produced over 23 million metric tons of SO_2 and over 20 million metric tons of NO_x; Canada produced 4.6 million metric tons of SO_2 and 1.7 million tons of NO_x.

White House photo by Bill Fitz-Patrick

Prime Minister Brian Mulroney, left, of Canada, and President Ronald Reagan discuss the Report of the Special Envoys on Acid Rain at the second Shamrock Summit, held in Washington, DC, in March 1986.

In the early 1970s, Canadian scientists began to report on the adverse environmental effects of acidity in lake water, and to link fish kills in acidic lakes and streams in eastern Canada to U.S. emissions. By the late 1970s, acid rain had become a serious diplomatic issue affecting the relationship of the two countries.

In 1980, we took our first joint step towards resolving the issue with a Memorandum of Intent that called for shared research and other bilateral efforts to analyze and control acid rain. One of the most spectacular projects was a high-altitude experiment called "CAPTEX." Trace elements of various chemicals were inserted into SO_2 plumes from coal-fired power plants in the Midwest. Their dispersion was monitored along a path extending across the northeastern United States to Canada. These and other experiments have helped scientists gain new data on the formation and distribution of acid rain.

When Brian Mulroney became Prime Minister of Canada in 1984, he pressed for more than research; he wanted bilateral action to control acid rain. At the first "Shamrock Summit" in March 1985, Mulroney and President Reagan agreed that Canada and the United States would each appoint a high-level Special Envoy to study acid rain. The Special Envoys would be charged with recommending a plan to alleviate both the environmental and the political damage caused by acid rain.

William Davis, former Premier of Ontario, and Drew Lewis, former U.S. Secretary of Transportation, were named Special Envoys. In January 1986, the two men presented their joint recommendations for U.S.-Canadian action. They proposed a $5 billion U.S. technology demonstration program, ongoing bilateral consultations at the highest diplomatic levels, and cooperative research projects.

Western Europe and North America are highly industrialized, and it is likely that acid rain will continue to be a serious concern in both areas for the foreseeable future. But the nations involved are coming to terms with their common problem. In Europe, several nations have already taken steps to reduce transboundary air pollution. In North America, the President of the United States has endorsed the proposal to invest $5 billion to demonstrate innovative technologies that can be used to reduce transboundary air pollution. And in both Europe and North America, the diplomatic groundwork for long-term cooperative activities has been established.

Acid Rain Research

Despite intensive research into most aspects of acid rain, scientists still have many areas of uncertainty and disagreement. That is why the United States emphasizes the importance of further research into acid rain.

Scientific research into acid rain has accelerated significantly in the 1980s. In 1982, the federal agencies (see box) involved in the National Acid Precipitation Assessment Program (NAPAP) budgeted $14.4 million for acid rain research. For 1987, the President is requesting $85 million for acid rain research: a more than fivefold increase in as many years.

The increased funding has shown results. Scientists today have a much greater understanding of the chemistry of acid rain than they did in 1980. But they are still seeking a better grasp of the effects of acid rain on lakes, streams, forests, and construction materials.

Dixon Landers, EPA

The Forest Service used llamas as well as horses and mules to gain access to remote western lakes during Phase I of the National Surface Water Survey. For a press briefing in Lake Tahoe, NV, EPA brought together the most primitive and the most modern sampling vehicles.

National Surface Water Survey

The National Surface Water Survey is EPA's primary source of data on the impact of acid rain on America's lakes and streams. Plans for the project began in 1983, with the first of three planned phases completed by the fall of 1984.

The goal of Phase I was to measure the acidity of U.S. lakes and streams. It was not feasible to sample all the lakes and streams in potentially susceptible areas, so methods of statistical sampling were used to make the final selection.

Phase I data collection was divided into three components: Eastern Lakes, Western Lakes, and Eastern Streams. Preliminary findings from the Eastern Lakes Survey were made public in August 1985.

Many people expected that more acidic lakes would be found in the Northeast than in other parts of the United States. They based this expectation on the fact that Northeast states are downwind of the major generators of acid rain precursors in the Ohio River Valley.

Eastern Lake Survey teams took samples at 763 northeast lakes. On the basis of those samples, EPA scientists estimated that only 3.4 percent of the lakes sampled in the Northeast had pH values of 5.0 or less. The comparable figure for the Upper Midwest was also low: 1.5 percent.

Surprisingly, Florida—far to the south of industrial sources of acid rain—had a much higher percentage of acidic lakes than the Northeast and the Upper Midwest. Over 12 percent of lakes sampled in Florida had pH levels of 5.0 or less.

EPA believes that it is too early to attribute this high Florida figure to the impact of acid rain. Natural processes or land use practices may also contribute substantially to the acidity of many Florida lakes.

The National Acid Precipitation Assessment Program

With a dozen federal agencies involved, acid rain research can be complicated organizationally as well as scientifically. To prevent duplication of effort and foster creative cooperation among the agencies, the National Acid Precipitation Assessment Program (NAPAP) was set up in 1980.

NAPAP is chaired jointly by EPA, the President's Council on Environmental Quality, the National Oceanic and Atmospheric Administration, and the Departments of Agriculture, Energy, and Interior.

EPA plays a major role in several of NAPAP's key research initiatives:

- Expansion of the National Trends Network, which gathers definitive acid rain data at monitoring stations throughout the nation. This network currently monitors wet deposition at 150 locations around the country, and it is being extended to include 100 dry deposition monitoring stations.
- Investigations into "source-receptor relationships," the relation between changes in emissions and changes in deposition levels at distant locations. EPA's Atmospheric Processes Program is developing an ambitious Regional Acid Deposition Model that will enable scientists to predict the amounts of acid rain resulting from given levels of emissions. With the model's predictive powers, policy-makers will be able to weigh the benefits and drawbacks of different regulatory scenarios.
- The Delayed/Direct Response Project, which is working to determine the rate at which lakes acidify and to identify factors that hasten or retard that process, such as the acid-neutralizing capacity of surrounding soil. A "delayed" response is one that takes 10 years or longer. A "direct" response is acidification occurring in fewer than 10 years. Under this program, EPA has sampled 145 watersheds in New England with the help of the Soil Conservation Service.

It took a lot of hard work to gather the data that formed the basis of these findings. Scientists on the helicopter sampling crews had to cope with the pressure of weeks of constant travel as well as the hazards posed by erratic weather conditions. At all times and under all conditions, scientists had to observe rigid test procedures to protect the validity of their data.

Nature didn't help, either. Survey work had to be completed in the fall, because chemical variations within lakes were lowest then. But during the Western Lake Survey, premature winter weather froze many lakes in the Rockies and the Sierra Nevada, and snow and high winds whipped Wyoming and Colorado. Helicopter teams had to curtail their flying schedules to avoid treacherous afternoon wind storms. And some ground teams were trapped in blizzards and had to be rescued.

Ground teams were needed for the Western Lake Survey because many of the 757 lakes sampled in that part of the country were in areas protected by the Wilderness Act. Because the Act forbids any mechanized means of transport in wilderness areas, the U.S. Forest Service would not permit EPA's flotation helicopters to land there. Instead, Forest Service teams had to hike to remote lakes to complete their sampling.

The Forest Service did permit EPA to sample 50 wilderness lakes with both helicopter and ground-access crews, enabling the Agency to check samples obtained by ground crews against those obtained by helicopter teams.

Expertise gained during Phase I of the National Surface Water Survey is already proving useful in Phase II, which was initiated in the Northeast at the end of 1985. Phase II researchers are looking for variations in surface water chemistry from region to region and from season to season. They are also planning to calculate the fish population at selected lakes and streams surveyed in Phase I. This data will be valuable as scientists try to evaluate the impact of acid rain on aquatic life.

For Phase III, EPA plans to modify a long-term monitoring project already in progress. The goal of Phase III will be to identify trends in surface water chemistry using long-term monitoring data. The work, which is planned to continue indefinitely, is being designed to be adaptable to other surface water pollution problems as well as acid rain.

Materials Effects Research

Scientists who specialize in the materials effects of acid rain still don't know how wet and dry acid deposition affects the natural processes of decay. One way to answer this question is to measure tombstones. EPA recently sponsored research into the rates of deterioration of headstones at 18

A Day in the Life of a National Surface Water Survey Helicopter Team

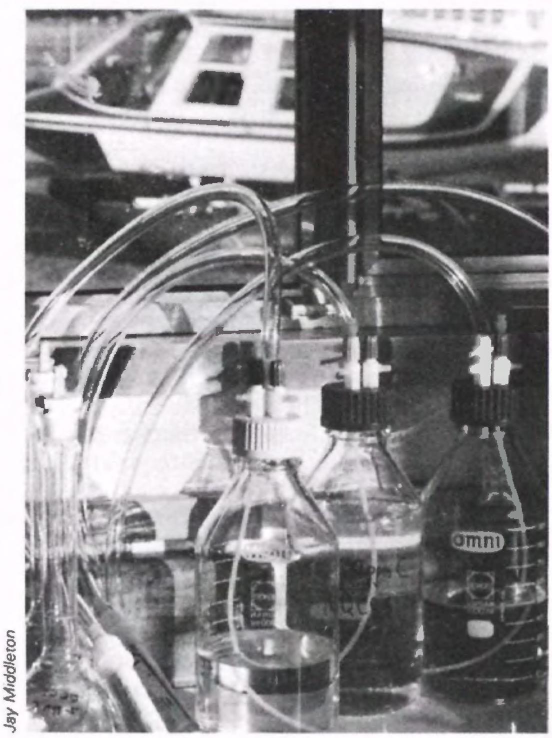
Helicopter teams involved in Phase I of the National Surface Water Survey faced demanding schedules. With nearly 1600 lakes to sample within a few weeks in the fall of 1984, they had to stay on the go constantly.

When flying conditions were good, the teams had daily itineraries that could include as many as six lakes within a hundred-mile radius. Poor weather conditions, on the other hand, could force cancellation of an entire day of sampling.

Just verifying the identities of the lakes to be sampled was a big job. Map coordinates used by the helicopter's navigation system had to be double-checked against U.S. Geological Survey maps, and the lakes had to be photographed to further verify their identities. Once landed on the lake surface, the helicopters had to maintain stable positions in the water while the scientists took samples and measured lake waters for depth, pH, conductivity, temperature, and transparency. The completed samples were then rushed back to mobile field laboratories, usually by 6 or 7 p.m. The helicopter teams could then relax for the evening, although their usually isolated base stations rarely offered much in the way of recreational activities.

But for the chemists in the field lab trailer, the night was just beginning. Procedures for the survey required that the samples be processed and filtered immediately after their delivery to the base station. Work in the lab trailer often stretched long past midnight. Chemists had to put in extra hours to make sure the samples were ready by daybreak for the flight to a cooperating laboratory, where they were further analyzed for 20 chemical variables.

By morning, yesterday's samples were on their way to the lab. Meanwhile, at another set of lakes, the helicopter teams were gathering additional samples. And so the process was repeated until 1592 lakes in four areas east of the Mississippi had been sampled. The thousands of samples collected during Phase I of the Surface Water Survey will help scientists understand much more clearly the effects of acid rain on aquatic ecosystems.



Jay Middleton

Inside a mobile laboratory, water is drawn from bottles to be checked for dissolved organic carbon. The water was collected from New York lakes by the crew of the helicopter seen through the lab window. Each sample was analyzed 20 different ways as part of the National Surface Water Survey.

Veterans Administration cemeteries.

Two of the cemeteries provided particularly valuable data. One was located in an industrial area close to New York City, while the other was in a semi-rural area of Long Island. New York University had previously traced changes in the thickness of tombstones at both cemeteries, as well as the depth of their emblem inscriptions. Using these data to calculate weathering rates at the two cemeteries, scientists compared them with estimates of rates of increase in SO_2 in New York City from 1880 to 1980. They found what is known as a "linear" relation between the two rates. In other words, increased SO_2 concentrations were directly proportional to increased weathering rates.

This correlation enabled scientists to develop a formula for calculating the damage caused to materials in the New York area by SO_2: 10 millimeters of fine grain marble will be worn away every century for every part per million of SO_2 in the air.

This study was the first statistically significant proof of damage to stone from an acid rain precursor. It would be difficult to carry out other experiments of this kind, because historical data on air pollution levels are extremely rare. But it is clear that decay accelerated by acid deposition has ramifications far beyond the graveyard.

Some acid rain concerns are primarily cultural. For example, the rapid deterioration of the Acropolis in modern times prompted EPA to join a recently completed NATO pilot study on the conservation and restoration of monuments. Scientists from 10 countries monitored acid rain damage to monuments, developed formats and procedures for documenting acid rain damage, and evaluated various means of conserving and restoring damaged monuments.

But acid rain threatens more than cultural artifacts. Though experts cannot yet fix an exact dollar value to the materials damage caused by acid rain, they agree that it damages homes, commercial buildings, highways, bridges, and other structures vital to our everyday lives. EPA is now working with the U.S. Army Corps of Engineers to develop a list of materials subject to acid rain damage. This inventory will draw together the data needed to assess the magnitude of acid rain-induced materials damage. Estimates should be ready by 1990.

Forest Response Program

In the early 1980s, experts began to see unexplained growth reductions and foliage damage in U.S. forests. The evidence was first spotted in New York and New England, but similar problems have now been detected in the Appalachians and the Carolinas. Even worse forest deterioration has occurred in Europe, where whole stands of European trees, especially on mountain peaks, have gone into an unprecedented decline.

Scientists are still uncertain of acid rain's role in such instances. Many factors other than acid rain could be responsible for forest damage. Changes in soil or climate could play a role, as could changes in insect or pathogen activity. For these reasons, among others, the evidence for acid rain damage to forests is thought to be weaker than corresponding evidence of damage to aquatic systems.

To clarify the effects of acid rain on trees and other vegetation, EPA began the Forest Response Project (FRP) in 1985. FRP scientists are studying the role of acid rain and other pollutants in causing or contributing to forest damage in the United States. They are also trying to determine the mechanisms causing the damage, and the relationship between various "doses" of acid deposition and the "responses" they are suspected of causing.

Initial research is studying two types of U.S. forests that have experienced damage or decline. The first type of forest, common to New England and New York, contains spruce and fir. The second, known as "Southern commercial," includes several species of pines valuable to the economy of the southeastern United States. At two sites in New England and three sites in the Southeast, trees are being classified and checked for height and radial growth. Scientists are also conducting field experiments to compare the growth of trees in open-top chambers with those in rain-exclusion chambers. Control chambers in laboratories permit comparable experiments with seedlings, although it is still difficult to extrapolate from seedlings to mature trees.

EPA is also setting up a "Mountain Cloud" data-gathering network to study the effects of various acid rain patterns on forests at differing elevations. "Mountain Cloud" sites will be co-located with biological stations that measure plant growth and productivity, as well as soil chemistry.

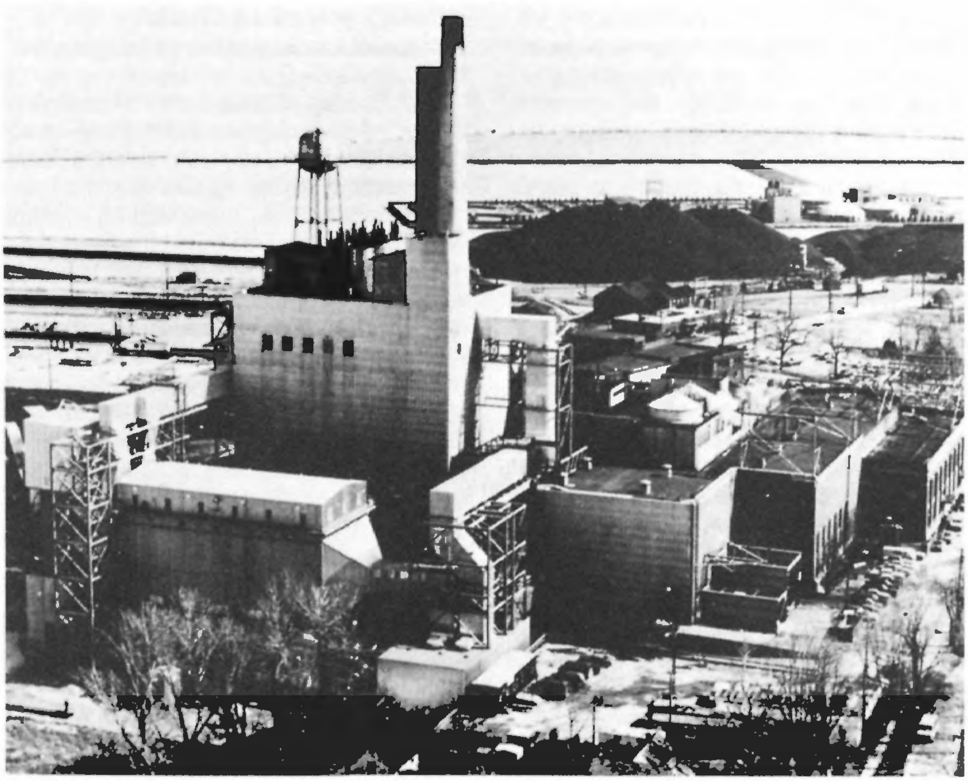
This work and other studies planned for eastern hardwood forests and western conifers should begin to give us a clearer idea of the kind of threat acid rain poses to the $38.5 billion forest products industry.

The Future

Many challenges confront acid rain scientists. There is still a need to increase scientific understanding of the effects of acid rain, and the rate at which those effects occur. As yet, scientists lack reliable methods of extrapolating on a regional level what is known about the effects of acid rain in small-scale environments. They also need to determine the level of acid deposition that is realistically compatible with protecting our valuable resources. As these and other questions are answered, we will have a much clearer understanding of the type of control program needed to protect all the resources at risk from acid rain.

A videotape documentary entitled "The National Lake Survey" is available for loan from the Audio-Visual Division of the EPA Office of Public Affairs (A-107), Room 2435, 401 M Street SW, Washington DC 20460. Phone (202) 382-2044. This 15-minute overview of the lakes portion of the National Surface Water Survey offers a first-hand look at acid rain sampling in action.

Control Technologies



Ohio Edison's Edgewater Station, a coal-fueled power generating plant where an EPA demonstration program features retrofit of a LIMB air pollution control system. The schedule calls for system start-up by March 1987.

Over the last few years, the U.S. Congress has considered several pieces of legislation proposing acid rain control programs. Most of them have called for SO_2 and NO_x reductions of 8 to 10 million tons a year.

To achieve that level of control, many existing sources of SO_2 and NO_x—especially utility and industrial coal-fired boilers—would have to be retrofitted with control equipment. But the availability, cost, and technical complexity of existing retrofit controls leave much to be desired.

Existing Control Options

A number of different methods of equipping new boilers with NO_x controls have been developed and tested. But, overall, NO_x control technologies have not been commercially retrofitted on existing boilers as extensively as SO_2 controls.

At present, there are three techniques available for reducing the amount of SO_2 emitted from existing coal-fired boilers: coal-switching, coal-cleaning, and flue gas desulfurization. Unfortunately, each of these techniques has drawbacks that limit their ability to reduce SO_2 emissions by 8 to 10 million tons per year.

A coal-burning facility could cut down on SO_2 emissions by switching from a high-sulfur to a low-sulfur coal. However, this fuel shift could damage some kinds of boiler equipment. It could also generate regional hostility by causing shifts in existing coal markets.

A second option is for sulfur to be cleaned from coal before it is burned. Physical coal-cleaning technologies are available commercially today. A substantial amount of coal already is being cleaned because of the savings that result from lower shipping costs, lower boiler-maintenance costs, and the higher energy content of the cleaned coal. However, coal is cleaned primarily to rid it of ash and other non-combustibles. Not enough SO_2 could be cleaned from coal to hit the emissions reduction target of a large-scale acid rain control program.

Currently, there is only one technology available that could reduce SO_2 emissions to the extent required by an ambitious acid rain control program: flue gas desulfurization (FGD), a process better known as "scrubbing." FGD uses "sorbents" such as limestone to soak up (or "scrub") SO_2 from exhaust gases. This technology, which is capable of reducing SO_2 emissions by up to 95 percent, can be added to existing coal-fired boilers.

FGD does have several drawbacks. The control equipment is very expensive and very bulky. Smaller facilities do not always have the capital or the space needed for FGD equipment. Even some larger power plants would find it technically very difficult to retrofit FGD systems on older cramped facilities.

Expanding Our Control Options

The *Report of the Special Envoys on Acid Rain*, presented to President Reagan on January 8, 1986, recognized the political and economic problems that stem from having only a limited menu of pollution control options. The report stated: "The availability of cheaper, more efficient control technologies would improve our ability to formulate a national response that is politically and economically acceptable." The Special Envoys went on to recommend a $5 billion U.S. program to fund the commercial demonstration of control technologies that promise greater emissions reductions, lower costs, or applicability to a wider range of existing sources. They also recommended that special consideration be given to projects that have the potential to reduce SO_2 emissions from existing facilities that burn high-sulfur coal.

Over the past several years, millions of dollars have been spent researching a variety of innovative approaches to the control of SO_2 and NO_x emissions from existing coal-fired utility and industrial boilers. Major federal research programs are being funded by the Environmental Protection Agency, the Department of Energy, the national laboratories (Argonne, Brookhaven, Lawrence Berkeley, and Oak Ridge) and the Tennessee Valley Authority. In addition, the Electric Power Research Institute is cooperating with different electric utilities to improve the control of utility boilers. This research and testing have already generated a number of attractive candidates for the kind of commercial demonstrations recommended in the *Report of the Special Envoys*.

The four technologies described here represent just a few of the wide range of potential candidates for funding as commercial demonstration projects. The purpose of these projects will be to determine whether technologies such as these can be proven to work in existing commercial facilities.

LIMB

The Limestone Injection Multistage Burner (LIMB) is an emerging control technology that can be retrofitted on a large portion of existing coal-fired boilers, both utility and industrial. Its broad applicability makes it an attractive candidate for funding under the proposed commercial demonstration program.

In a LIMB system, an SO_2 sorbent (e.g., limestone) is injected into a boiler equipped with low NO_x burners. The sorbent absorbs the SO_2, and the low NO_x burners limit the amount of NO_x formed. Thus, LIMB is capable of reducing both SO_2 and NO_x by about 50 to 60 percent.

LIMB technology will not be applied widely until a number of technical problems are solved. The sorbent injected into the boiler tends to increase slagging and fouling, which in turn increase operation and maintenance costs. Because boilers retrofitted with LIMB tend to produce more particulates of smaller sizes, particulate control becomes more difficult. Furthermore, technical questions remain as to what sorbents are most effective in a LIMB system, and how and where to inject the sorbents.

EPA has a major research and development program in progress to improve LIMB technology. A full-scale demonstration of LIMB is underway on a utility boiler in Lorain, OH. The retrofitted boiler will be started up in the spring of 1987, and the results of early tests will help determine whether LIMB technology is a suitable candidate for funding under the proposed commercial demonstration program.

In-Duct Spraying

LIMB controls SO_2 and NO_x emissions during the combustion process itself. It is also possible to control SO_2 after combustion by cleaning it out of the exhaust gases. The scrubbers now in use apply this kind of post-combustion technology. If ways could be found to reduce the technical complexity and economic costs of scrubbing, post-combustion controls would become a more attractive method of reducing SO_2 emissions.

EPA, DOE, and private industry are involved in efforts to improve flue gas desulfurization (FGD) technology. Much of the research focuses on the development of more effective sorbent materials. In addition, the possibility of injecting a sorbent directly into existing exhaust ductwork is being investigated.

An in-duct spray drying FGD system would improve on traditional scrubbers in several ways. Current scrubbers require the construction of very large reaction vessels where the exhaust gases and sorbent can mix to extract the SO_2. These vessels are very expensive, and sometimes the space they demand simply isn't available at existing facilities.

If, however, the sorbent could be injected into existing ductwork, the cost of the reaction vessel could be eliminated, and it would be much easier to retrofit controls on a wider range of sources. Space constraints would no longer be a limiting factor.

In order to test and improve in-duct scrubbing techniques, a demonstration control system is in the process of being tested at a utility in Beverly, OH. The Department of Energy plans to fund another demonstration project in the near future. Even if this research is successful, it is unlikely that in-duct FGD systems will achieve an SO_2 control rate of much more than 50 to 60 percent. But if they can be retrofitted widely and at relatively low cost, in-duct FBC systems could join LIMB as an attractive candidate for a commercial demonstration program.

Reburning

Another relatively new technology known as reburning, or fuel staging, is capable of reducing NO_x emissions in existing boilers. In a coal-fired boiler, reburning is accomplished by substituting 15 to 20 percent of the coal with natural gas or low sulfur oil and burning it at a location downstream of the primary combustion zone of the boiler. Oxides of nitrogen formed in the primary zone are reduced to nitrogen and water vapor as they pass through the reburn zone. Additional air is injected downstream of the reburn zone to complete the combustion process at a lower temperature.

In general, NO_x reductions of 50 percent or more are achievable by reburning. When combined with other low NO_x technologies, such as low NO_x burners, NO_x reductions of up to 90 percent may be achievable.

Reburning tests have been performed by EPA on gas-, oil-, and coal-fired research combustion systems. EPA and the Gas Research Institute are preparing to co-sponsor reburning tests at a large industrial or utility coal- or oil-fired boiler.

Fluidized Bed Combustion

Fluidized bed combustion (FBC) is an innovative approach to SO_2 and NO_x control in both utility and industrial boilers. In an FBC boiler, pulverized coal is burned while suspended over a turbulent cushion of injected air. This technique is promising from an economic perspective, because FBC boilers allow improved combustion efficiencies and reduced boiler fouling and corrosion. Such boilers also are capable of burning different kinds of low-grade fuels like refuse, wood bark, and sewage sludge.

In addition, FBC offers a number of environmental advantages. If the coal is mixed with limestone or some other sorbent material during combustion, the SO_2 is captured and retained in the ash.

FBC boilers have another environmental advantage over typical coal-fired boilers: they have the potential to control NO_x as well as SO_2. FBC boilers must operate within a narrow temperature range (1500-1600 degrees Fahrenheit) that is substantially lower than typical boiler temperatures. Lower combustion temperatures inherently limit the formation of NO_x. Thus, FBC boilers may be able to control NO_x by 50 to 75 percent at the same time as they control SO_2 by up to 90 percent.

An FBC system does have one major drawback: it requires the construction of a new boiler. Thus, it is more of a replacement technology than a retrofit. The number of existing boilers that could be replaced with FBC boilers at reasonable cost is limited, and its promise is more likely to be realized on new sources.

A Less Limited Future

Limestone injection multistage burners, in-duct sprayers, reburners, and fluidized bed combustion systems: these and several other technologies are capable of expanding the current rather limited "menu" of acid rain control options. If they can be proven to work on existing commercial facilities, state and federal lawmakers will have much more latitude as they frame legislation for controlling acid rain.

Clearly, it would be inefficient and ineffective to try to implement a major acid rain control program before technically viable and economically affordable technologies are available. Thus, the proposed five-year, $5 billion program for commercial demonstration of acid rain control technologies fills a very real need.

Implementation Issues

Solving problems can sometimes create problems. Take, for example, the implementation of a major new regulatory program. Enacted to control one problem, it can generate many problems of its own. If the undertaking is complicated, expensive, and time-consuming, it can catch state governments unprepared.

What would happen if the U.S. Congress passed a law controlling acid rain? Under several bills now being considered, experts foresee the following difficulties:

- New reductions would probably be required in a shorter time—and at greater marginal cost—than those already achieved under the Clean Air Act.
- Requirements for control of acid rain precursors (SO_2 and NO_x) could generate conflict and confusion as to which sources should be controlled. Who would make these choices, and on what grounds?
- It would be hard to develop a convincing rationale, in terms of local costs incurred, for an acid rain control program because most of the environmental benefits would accrue in another state. Existing air pollution programs did not face this problem, because they tended to impose costs in the same areas where environmental quality was improved. Acid rain controls, on the other hand, would be intended to protect whole regions, but the costs would not be spread evenly over the region.

However, some of the cost of controlling acid rain would be felt on a regional scale. Controls imposed on a utility in one state would, to varying degrees, affect utility rates in neighboring states, because electric power is often generated in one state and sold in another. There would also be shifts in the cost of high- and low-sulfur coal, in the cost of manufactured goods, and in employment. These shifts would be felt in the economies of whole regions, not just states.

Policy-makers must consider all these factors as they design a major acid rain control program. They must also recognize that a control effort will have significant impacts on many sectors: electric utilities as well as other industries, public utility commissions as well as state executive and legislative offices. Therefore, the concerns of these and other parties must be incorporated into the decision-making process.

State Acid Rain Programs

To help prepare for the complexity of implementing a major acid rain control program, EPA has committed to work with the states on these kinds of issues. With a special Congressional appropriation EPA established the State Acid Rain (STAR) program to identify and resolve potential problems. It is now funding studies in 36 states on such implementation questions as:

- How should control obligations be allocated to individual pollution sources so that statewide emissions reduction targets can be met?
- What techniques are available to control each source, and what are their economic and social costs?
- How can the gains secured for the environment be maintained in the future without impeding economic growth?

Projects in Progress

Different states and regions are using their STAR grants in different ways. Wisconsin, for example, has substantial SO_2 emissions in excess of the quantitative limitation incorporated in many acid rain control proposals. Therefore, Wisconsin is faced with the possibility of a very substantial emissions reduction requirement. To prepare for whatever may come, the state's air pollution control officials decided to develop complete model programs for hypothetical statewide emissions reductions of 30, 50, and 70 percent. The broad issues of data base, available control techniques, control strategy, and maintenance of achieved emissions reductions are all being studied.

Wisconsin's air officials, together with those of Minnesota and Michigan, are also studying possible tri-state emissions reduction plans. In recognition of the crucial role that existing regulation of utility rates will play in acid rain control, they are also bringing together environmental officials and utility regulatory officials of the midwestern states to pool their knowledge and coordinate their planning.

A group of eight northeastern states decided to look in greater depth at the technologies available for controlling their specific acid rain sources. They wanted to be ready in case they needed to prepare state or regional strategies for controlling acid rain. They are also beginning the essential task of coordinating the ideas, plans, and policies of their environmental agencies with those of their public utility commissions.

These northeastern states are also studying various ways of maintaining environmental goals while permitting economic growth. One approach recommends an initial period of over-control to build up a margin of compliance that permits later economic growth. Another suggests offsetting emissions from new sources with new controls on older sources.

Another noteworthy STAR program is being conducted by the states of Tennessee, Kentucky, and Alabama, in conjunction with the Tennessee Valley Authority. This project is examining alternative emission reduction strategies for a multistate utility system.

State Acid Rain (or STAR) projects are enabling environmental professionals to study the interrelated problems that an acid rain control program is likely to raise, and to search for equitable and efficient solutions. The states involved in the STAR program have very different views of the policy questions raised by acid rain. Their citizens have very different, and very large, interests at stake. Nevertheless, the air pollution professionals in the states and at EPA have agreed to put any policy disagreements to one side while they seek answers to the questions that will have to be resolved if any acid rain control program is to be successfully implemented. □

Seniors Contribute In EPA's SEE Program

by Margherita Pryor

Forget the saying about old dogs and new tricks. The truth is that some of the most important tricks—such as tact, judgment, and skill—are usually acquired only through age and experience. And it's these "people" talents that seem to be increasingly rare even as they become increasingly necessary.

EPA is fortunate. For the last 10 years, it has been able to draw on an enormous and largely untapped source of just these skills: the growing number of retired and older Americans who are participating in the Agency's Senior Environmental Employment (SEE) program.

Retirement and the problems of older people in general have become prominent issues in the last few years. Back in 1935, it made sense for one writer to muse that "old age is the most unexpected of all the things that happen to a man." After all, not many people lived to experience it. Even as late as the turn of the century, most infants died in their first 12 months and the average life expectancy was less than 50 years.

The demographics are different today. Modern medicine and public health measures have combined to extend the average American life span by several decades. Those who reach the age of 65 can expect to live another 15 years or more. In 1980, 25 million Americans were 65 or older. By the year 2000, that number will increase to 32 million—one out of every eight people in the country. And, if current trends continue, most of them will be retired by then.

What do all these projections mean?

On a national level, it means that the number of Social Security beneficiaries is increasing more rapidly than the number of contributors. Today, the ratio of contributors to beneficiaries is 3-to-1; by the next century, the ratio will be 2-to-1. At the same time, the number of young workers entering the labor force will also decline. It doesn't take a crystal ball to predict a financial crunch in the system.

On the individual level, too, there are problems. Even with Social Security, almost one of every seven Americans over 65 lives in poverty; for widowed black women, the number of poor increases to one in two. In addition, many employees don't want to retire. In a 1981 poll, almost 80 percent of employees 55 and over said they preferred to continue working after the normal retirement age, preferably part-time. These stated preferences are borne out by the statistics: 25 percent of all retirees do take jobs again, and many more try to find work but fail.

EPA's SEE Corps could be called a solution ahead of its time.

So EPA's SEE Corps could be called a solution ahead of its time. Since 1976, SEE has grown from a pilot project of about 200 participants to a full-scale program involving 10 times that many. Its success can be gauged by the enthusiasm of Agency officials who have used SEE employees, by the interest of at least five other federal agencies in implementing their own similar programs, and by the fact that EPA receives 100 to 200 inquiries every week from individuals interested in joining the SEE program.

SEE was set up to provide EPA with an experienced, readily available work force for carrying out its environmental tasks, and at the same time provide meaningful employment for older Americans. Under the program, EPA has cooperative agreements with six organizations: the American Association of Retired Persons; the National Association for Hispanic Elderly; the National Caucus/Center on Black Aged, Inc.; the National Council on Aging; the National Council of Senior Citizens; and the National Urban League. These groups act as contractors for the Agency; they recruit the employees, pay their salaries, and handle all paperwork.

In return, according to Jack Everett of

In EPA Region 3, Senior Environmental Employees Kaz Goslawski, left, and Vai Alailima check for signs of asbestos problems. They are among a group of nearly 100 SEE workers around the country who participate in the Asbestos in Schools program.

(Pryor is Contributing Editor of the EPA Journal.)

the American Association of Retired Persons (AARP), "EPA gets a really good deal. For little more than minimum wage, the Agency is getting people with fantastic credentials—people like a former commissioner from the Nuclear Regulatory Commission, or oil specialists from the petroleum companies, even chemists who used to work on the very chemicals EPA is now regulating. How can you lose?"

Pat Powers agrees. She administers EPA's end of the SEE program and is convinced that it gives the Agency the most bang for its buck. "The first year we had to inspect for asbestos," she says, "we paid a regular contractor $900,000. Using SEE employees, who include engineers and architects, we paid $349,000 for a year and a half of work, and the job was done better."

By all accounts, SEE involvement in the Asbestos-in-Schools program has been a success. According to AARP's Everett, "one official in EPA's enforcement office was totally against SEE inspectors, didn't think it was a good idea, didn't think it would work. Now he goes around saying that, in all his years in public life, he's never changed his mind like he did with his experience with SEE." Currently, almost a hundred employees, most of them full-time, are deployed throughout the regions to inspect schools, provide technical guidance on the problem, and speak to parent and employee groups on the hazards of asbestos. One SEE inspector became so expert in the field that he left the program to set up his own inspection and removal contracting firm. A former naval architect, he had intimate knowledge of the dangers of asbestos because of his own asbestosis, developed as a result of shipbuilding work during World War II.

Of course, not everyone brings that sort of direct experience to the job, but many SEE employees also have valuable skills developed over a lifetime. "The problem," says Jack Everett, "is that age discrimination is alive and well. Sometimes I've had young secretaries call me up and express doubts about working with an older person—doubts about their ability to keep up—when, in fact, the older woman has been working like a dynamo for 30 years. Older women particularly have problems getting a foot in the door when they try to get jobs. A lot of them are reduced to going to temporary agencies, and they find themselves discriminated against by younger people."

Ask Dr. Josephine Simons about it. "I was an 'overage' coed," she says. "I got my Ph.D. when I was 50. I was a staff researcher at the National Institutes of Health for five years and a guest scientist there for one year. I never would have left research voluntarily, but at the time (late 1970s), the typical scientific attitude toward women, particularly 'old' women, was—to put it mildly—about as stinky as you can get. The only way to get a permanent position was to turn out reams of papers, and they wouldn't provide the technical support. So I worked for a year with a public interest research group and did some volunteer work for Representative Claude Pepper's subcommittee."

SEE has grown from a pilot project of about 200 participants to a full-scale program involving ten times that many.

"I heard about the SEE program when I joined the AARP. Within two weeks after I applied, I received a letter saying that EPA could use my technical background. Of course, I'm not in research here at all, but I find they're very good to the SEE people here. My family is very important to me, and the flexibility in this job is great. I'm in an artists' cooperative, too, so this gives me time to work on my art shows."

These varied interests are typical of SEE participants. Anna Johnson, for example, is a counselor for EPA's imported car program. As a counselor, she answers questions from the public about how to import foreign cars into the United States and has compiled a training manual about the program to be used by student assistants, contractors, new professionals, and other seniors. That's 20 hours per week. The rest of her time she does free-lance audio/visual production, teaches film animation for the Washington, DC, recreation department, and builds miniatures and custom dollhouses. "But I enjoy the work at EPA," she says, "giving service to the public. There's a maturity aspect in this work. We're able to handle person-to-person situations, and that's basically how we see our job."

Stan Durkee, coordinator of the SEE program in Johnson's office, couldn't agree more. "The SEE people are just great," he says. "They're eager to take responsibility, they're cooperative, they want to be respected and effective. They've reached the age where they want to use their experience. In fact, we've just reorganized the office to use them as positive communications links between our student assistants and their supervisors. This program meets everyone's needs. EPA gets a job done well, and the SEE people get jobs with training and flexibility. As a supervisor, I'm totally enthusiastic."

Another enthusiast is SEEer Bob Cunningham. "I found this opportunity to work with EPA very exciting because I have so much respect for the Agency. I started out a long ways back as a reporter with United Press International, then went into public relations work. I started out here as a writer/editor for the asbestos program and then stayed with the Office of Toxic Substances in a varied capacity. I guess you could say I'm a sort of support service for the program managers. While I don't do any real writing, I'm still pleased and proud to be part of the team."

"I was first interested in SEE because I wanted to keep active. If we keep active, we enjoy better health mentally and physically. I think we're in a transitional period. People have been finding out that we don't have to decay into senility at some particular age. More people will need to work longer, and more people will want to. My peer group over the years has tended to look towards retirement, but some have retired and started their own businesses."

"I see this happening with my children. They don't see themselves as ever retiring. There are more options today. Some companies are no longer asking people to retire at a mandatory age. Not to use people with experience is such a waste."

"You know," says Jack Everett, "AARP is the second-largest membership organization in the world. Right now, we have 20 million members, and we get 100,000 new ones every month. Our magazine, *Modern Maturity*, has the third-largest circulation in the country. That should tell you something about where the population figures are going. Programs like SEE are just the beginning." □

Caring About Bottomland Hardwoods

by Tom Welborn
and Bill Kruczynski

A hardwood forest in Mississippi. Despite their ecological productivity, bottomland hardwood wetlands are being converted to agricultural use at an alarming rate.

Steve Delaney

What's good for the goose is also good for the farmer, and therein lies the dilemma of the bottomland hardwood wetlands, a priority EPA program.

Waterfowl and other migrating birds find food and refuge among the red and white oaks, gum trees, cypress, and other trees in the wetland forests. So do many invertebrates, fish, reptiles, amphibians, and mammals. The forest detritus washed into the adjacent lakes or streams becomes part of various aquatic food chains. Game animal populations are estimated at two to five times higher in bottomland hardwood tracts than in adjacent upland forests, and there are ten times as many birds per acre in these areas of the Lower Mississippi Valley as in surrounding dry ground areas.

Endangered species such as the

(Welborn is a life scientist in the Wetlands Section of EPA Region 4 and Kruczynski is Chief of the Section.)

Eastern Cougar and Bachman's warbler now live only in the wetlands forests of the southeastern United States. Other species of special concern, such as the black bear, bobcat, and wood duck, also depend on the wetlands habitat of these forests.

But farmers, too, find the bottomland hardwood wetlands attractive. There is much more money to be made growing and harvesting soybeans, for example, than in cutting what useable timber remains in the often mismanaged forests. Although some big Southern lumber companies have carefully reforested their lands, in most privately owned wetlands the bigger trees have long since been cut down, leaving marginally valuable forests behind. At one time, wetland forests in the South were important commercial sources of white oak for whiskey barrels; now most of those trees are gone. Although the forest resource has declined in acreage and quality, it remains important for production of veneer and lumber for furniture, flooring, and other products.

One-half of the nation's wetlands have been lost to development, and of these, the overwhelming majority—87 percent—were lost due to agricultural conversion of the land.

Forested wetlands account for approximately half of the total wetlands loss.

In the South, some 30 million acres of bottomland hardwood forests occupy the floodplains of major rivers in the southeastern United States, from Virginia to Texas. The largest single area is in the Mississippi Valley. One hundred thousand acres of these valuable wetlands are being cleared and converted to other uses, mainly agricultural, every year.

The bottomland hardwood wetlands system begins at the headwaters of tributary streams and ends in estuaries, where rivers meet the sea, or in lakes. A cycle of yearly floods from winter and spring rains or melting snowpacks further north maintains the system. In winter and spring, overflowing streams flood the bottomland forests, depositing sediments and associated pollutants, and being cleansed in the process.

The flooding also makes large areas of habitat available to fish for spawning and nursery areas, and provides food and refuge for migratory birds. When the floodwaters recede, they carry organic and inorganic nutrients back to the rivers, streams, and lakes. The forests also improve water quality by filtering nonpoint source runoff from adjacent upland areas and by shading streams, thus mediating temperature changes.

The driving force in the creation, maintenance, and function of bottomland forests is water. An annual flooding cycle maintains the system and periodic inundation and drying are critical to the various functions provided by wetlands. One of these important functions is to ease the flooding of downstream areas during the winter and spring flood seasons. During this period, water overflows the stream channels and spreads throughout the bottomland forest, which becomes a storage reservoir for the excess water. Bottomland vegetation retards the movement of the floodwaters down the flood plain or back into the stream channel, thus reducing the peak level of the floodwaters in downstream farms or residential areas.

EPA programs are critical to the future of the 50 percent of the nation's original wetlands that still remain after generations of uncontrolled conversion or depredations.

Under Section 404 of the Clean Water Act, the Agency has significant responsibilities for wetland protection. Although the U.S. Army Corps of Engineers administers the Section 404 permitting program covering use of wetlands for various developmental purposes. EPA reviews public notices issued by the Corps, provides relevant environmental criteria for wetland protection through issuance of guidelines, uses its authority to prohibit use of discharge sites, and initiates enforcement actions for unauthorized discharges into wetlands. EPA is also responsible for ensuring that the geographical jurisdiction over wetlands by federal agencies is determined in an appropriate manner, and this affects the regulatory requirements that apply to millions of acres of bottomland hardwood forests.

In fulfilling its responsibilities for wetlands protection, EPA has initiated a comprehensive study of bottomland hardwood ecosystems. Each EPA region is required to provide a regulatory plan for the bottomland hardwood wetlands in its jurisdiction.

Final Agency policy on protection of this valuable resource is expected later this year. A number of other agencies, including the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the Soil Conservation Service, and state water quality, natural resources, and conservation departments, have participated in a series of scientific workshops sponsored by EPA to develop the basis for the policy.

Because of concern over loss rates of this major environmental resource, EPA is giving a high priority to protecting bottomland hardwood wetlands.

Communication of this policy is of major importance. Congressional delegations, state and other federal agencies, public interest groups, and the general public will be informed regularly through public meetings, workshops, letters, press releases, and direct contacts.

Regional EPA staff members will meet with Corps of Engineers district personnel to promote coordinated efforts toward wetland protection goals. Wetland training courses and field surveys will be joint EPA-Corps activities, and enforcement will be coordinated with the Corps. Work is under way toward a joint EPA and Corps methodology to establish wetlands boundaries.

It is hoped that through rigorous regional implementation of Agency policy, a strong regulatory program will halt the unnecessary destruction of our nation's dwindling wetland resources and result in their recovery and preservation. □

AIR

Lead-in-Gasoline Violations

EPA announced that it has proposed civil penalties totaling $2,573,090 against Gulf States Oil & Refining Co. of Houston, Texas, for exceeding federal standards for lead content in gasoline.

Gulf States exceeded the allowable lead limits during five calendar quarters from October 1, 1983, through December 31, 1984, at the company's refinery in Pasadena, Texas. Gulf States notified EPA when it discovered that two of its employees prepared false reports of lead usage.

The Agency reported that Gulf States used approximately 300 million more grams of lead than allowed for the volume of leaded gasoline produced during that period.

EPA recently promulgated more stringent gasoline lead standards to protect the public from adverse health effects of leaded gasoline. Since January 1, 1986, refiners have been limited to an average quarterly standard of .10 gram of lead per gallon of leaded gasoline.

GM Recalls

General Motors Corporation is recalling about 133,000 1982 model-year gasoline-powered Chevrolet Chevettes and Pontiac T-1000s to correct a defect in the air injection system. Vehicles with the problem exceed federal limits for hydrocarbons and carbon monoxide emissions.

GM recalled about a half million 1981 model-year Chevette and T-1000 vehicles last September to correct a similar problem.

PESTICIDES

Field Testing

EPA has issued two experimental use permits to Dr. Steven E. Lindow of the University of California at Berkeley to conduct small-scale field tests using two strains of genetically altered bacteria to retard early frost formation on plants.

In the field tests, genetically altered bacteria will be applied to potato seed pieces before planting and will also be sprayed on the plants soon after they emerge from the ground. The experiments will take place on property of the University of California Agricultural Experiment Station at Tulelake in northern California.

The bacterial strains of *Pseudomonas syringae* used by Dr. Lindow are commonly found on plants. They produce a protein which serves as a seed for the formation of ice crystals in a process known as ice nucleation. The Berkeley team deleted the genetic material which instructs ice nucleating active bacteria (INA+) to produce the protein. As a result, the genetically altered bacteria (INA) are incapable of producing the protein, and ice is less likely to form on plant surfaces colonized by the altered bacteria.

TOXICS

Asbestos Protection Rule

The Agency has issued a final rule to protect state and local government employees from the potential hazards of asbestos abatement work.

EPA issued the rule in proposed form on July 12, 1985, and made it effective immediately so it would cover asbestos abatement activities in schools during the school break.

The final rule was issued under authority of the Toxic Substances Control Act. It extends Occupational Safety and Health Administration (OSHA) worker protection requirements for asbestos abatement projects to state and local employees, including school maintenance workers such as janitors.

The EPA regulation is similar to the current OSHA standard. It establishes exposure limits of two fibers per cubic centimeter of air for an eight-hour, time-weighted average and 10 fibers per cubic centimeter as a maximum concentration at any one time. It requires work practices such as the wetting of asbestos, use of personal protective equipment, and provision of special clothing. The regulation also requires environmental monitoring, the posting of caution signs, and the cleanup and proper disposal of asbestos waste. In addition, it requires medical examinations for some employees and the retention of medical examination and environmental monitoring records.

WATER

EPA Bars Shopping Center Plans

Stating that the project would have "unacceptable adverse effects on wildlife and wildlife habitat," EPA has ruled against construction of a shopping center on Sweedens Swamp in Attleboro, Massachusetts.

The ruling, by the EPA's Assistant Administrator for External Affairs, Jennifer Joy Wilson, specifically found that plans by the builder, Pyramid Companies, to "mitigate" its destruction of the swamp by creating an artificial wetland nearby were unacceptable under the Clean Water Act, in view of EPA's findings that the impacts could have been avoided through use of a practicable alternative site.

Wilson added that the agency "did not want to set a precedent across this nation of substituting artificial wetlands for the natural, functioning wetlands without consideration of the need for destroying those natural wetlands."

Section 404 of the Clean Water Act gives EPA a number of responsibilities to assure that the environment will be protected from the discharge of dredged or fill materials.

Funding for Construction Grants

EPA announced that it will provide states with $96 million from construction grants funds to continue managing their wastewater treatment plant construction programs under the Clean Water Act.

The action follows a ruling by EPA's Office of General Counsel that four percent of the full $2.4 billion budgeted for construction grants during fiscal year 1986 could be made available for state management, even though $1.8 billion of this has not yet been made available by Congress.

The construction grants program makes monies available to municipalities to build and upgrade sewage treatment systems. Under the Act, states may reserve up to four percent of the *pro rata* share of the total that Congress provides for construction grants in order to manage the program. □

Appointments

EPA Administrator Lee M. Thomas has announced the reassignment of 11 senior Agency executives as part of an ongoing management program.

Dick Bauer, Director, Environmental Services Division in Region 10, was selected to join the Senior Executive Service (SES) and has been appointed to the position of Deputy Regional Administrator for that region. He brings a broad regional background to this new assignment.

Bill Brungs, the Director of EPA's Environmental Research Lab in Narragansett, is going on a 120-day detail with Region 1. He will chair an interagency task force of state and federal personnel, which will develop a draft model mixing-zone policy to provide a basis for regional action in review of state water quality standards.

Mike Callahan has been selected to join the SES and has been appointed Director of the Exposure Assessment Group in the Office of Health and Environmental Assessment in the Office of Research and Development (ORD). He bring with him broad environmental program experience, having served as the Chief of the Exposure Assessment Branch in the Exposure Evaluation Division of the Office of Toxic Substances and as an environmental scientist in the Office of Water.

Don Clay, Director, Office of Toxic Substances, Office of Pesticides and Toxic Substances (OPTS), has been selected to be Deputy Assistant Administrator for the Office of Air and Radiation. He brings with him broad experience in assessing and managing risks. He has also served as Acting Assistant Administrator of OPTS.

Alan Eckert, who was Senior Litigator in the Office of the General Counsel, has been selected to be Associate General Counsel for the Air and Radiation Division. He will be responsible for advising the Agency's air and radiation programs and defending them in litigation.

Jim Elder, Deputy Director, Office of Water Enforcement and Permits, has been selected to be Director of that office. One of his primary responsibilities will be to carry through on the National Municipal Policy, an initiative for which he was one of the principal architects.

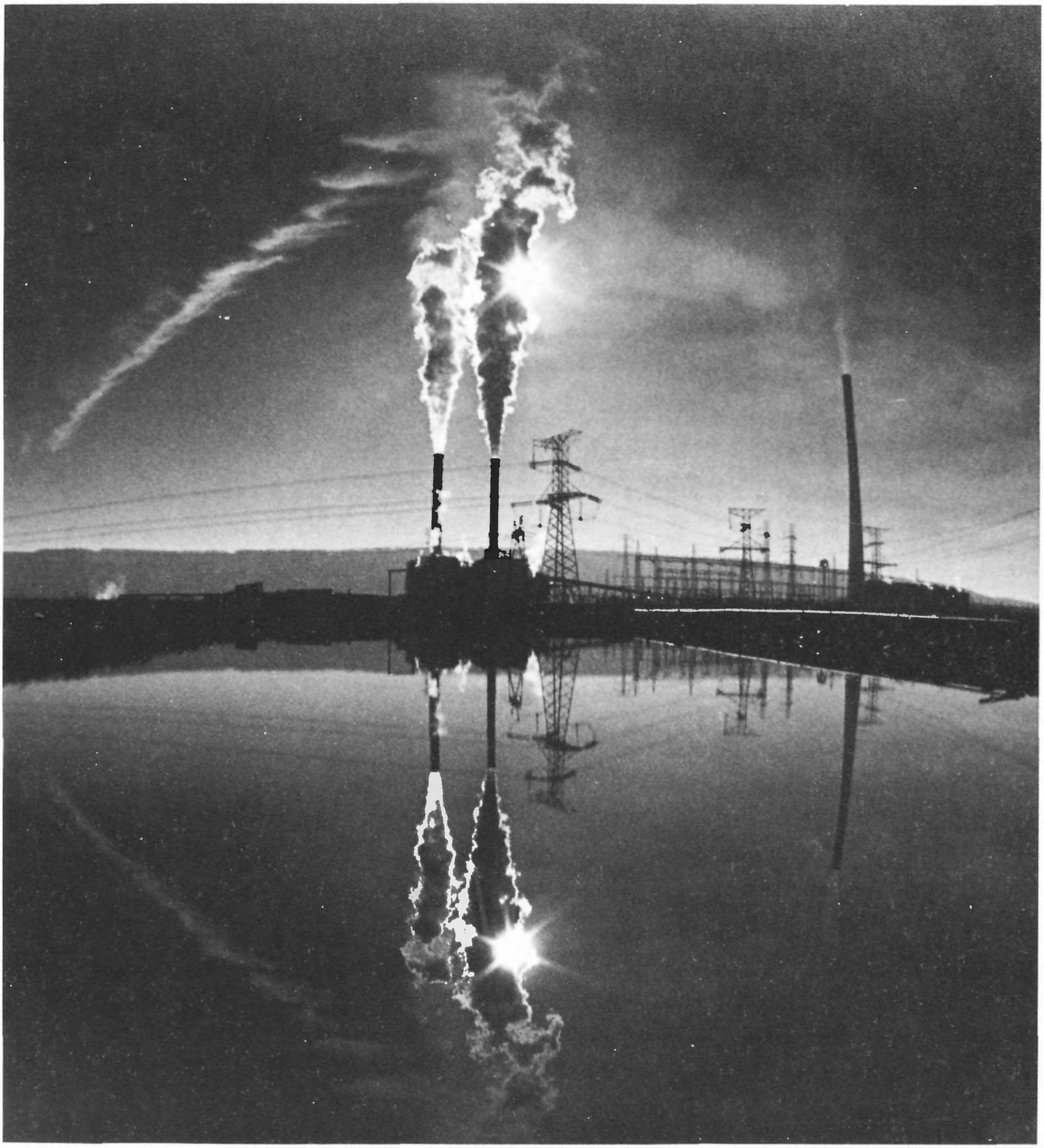
Rebecca Hanmer, Director, Office of Water Enforcement and Permits, has been named Deputy Assistant Administrator, Office of Water (OW). She brings to this position an array of regional and program experiences at different management levels.

Norb Jaworski will replace Bill Brungs as the Director of the Environmental Research Laboratory in Narragansett. He will apply his 26 years of scientific and management experience in the marine and freshwater resources areas to the problems associated with estuarine and ocean discharges.

Mike Quigley, Deputy Director, Office of Municipal Pollution Control, is being named Director of that office. He brings with him broad experience in the environmental field. He will be responsible for keeping the construction grants program running smoothly.

Pat Tobin, Director, Criteria and Standards Division, OW, has been selected as the Director of the Waste Management Division in Region 4. He has been with EPA and the Department of Interior for 18 years.

Bill Whittington, Director, Office of Municipal Pollution Control, OW, will become the Director, Office of Water Regulations and Standards (OWRS). He will direct the office in its post effluent guideline phase. □



Bob Boyer, TVA

Stack emissions at a coal-fired power plant can be a source of sulfur dioxide and nitrogen oxides which can lead to the formation of acid rain.

Correction: The photograph used for the cover of the April, 1986, *EPA Journal* is of a blast furnace operation. EPA does not currently regulate waste from blast furnaces as hazardous. Thus, use of the picture leaves an unjustified impression, inasmuch as the theme of the April issue of the Journal was on controlling hazardous waste. *EPA Journal* regrets the mistake.

Back cover: Horses near Purcellville, Loudon County, VA. Photo by Michael Anderson, Folio, Inc.

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