



Summer 1979

## Air Quality Issues and Approaches in the Southwest

Allen V. Kneese

Michael Williams

### Recommended Citation

Allen V. Kneese & Michael Williams, *Air Quality Issues and Approaches in the Southwest*, 19 Nat. Resources J. 537 (1979).

Available at: <https://digitalrepository.unm.edu/nrj/vol19/iss3/5>

This Article is brought to you for free and open access by the Law Journals at UNM Digital Repository. It has been accepted for inclusion in Natural Resources Journal by an authorized editor of UNM Digital Repository. For more information, please contact [amywinter@unm.edu](mailto:amywinter@unm.edu), [lsloane@salud.unm.edu](mailto:lsloane@salud.unm.edu), [sahrk@unm.edu](mailto:sahrk@unm.edu).

# AIR QUALITY ISSUES AND APPROACHES IN THE SOUTHWEST

(A REPORT OF THE SOUTHWEST REGION UNDER  
STRESS POLICY PROJECT)

ALLEN V. KNEESE\*\*† and MICHAEL WILLIAMS\*\*†

## I. THE BROAD PERSPECTIVE

The natural resources of the Southwest, and more generally of the Rocky Mountain region, are an actual and potential source of national wealth. Coal, uranium and oil shale appear to be the next generation of basic energy resources. As this is also the most mineralized region of the United States the remaining stores of hard rock minerals such as copper and molybdenum are also located here. Economic growth and efforts to reduce dependency on foreign minerals and energy sources could eventually lead to the development of these resources on an enormous scale. Because the nation must call upon natural resources which are progressively more difficult to exploit, the potential environmental implications are extreme. Moving from a one percent copper ore concentration to half of one percent ore requires the processing of twice as much material with proportionally larger landscape disruption and application of energy. Moreover, future energy sources will be more environmentally destructive than present ones. At present natural gas is used as a fuel. In the future coal is a likely energy source. Thus, electric utility boilers now fired by gas will soon have to be converted to coal. Furthermore, the production of synthetic gas and oil threatens to be much more costly in both monetary and environmental terms than the earlier production of petroleum gases and liquids.

Superimposed on the natural resources picture is an evident shift of the United States population to the South and the West. The region as a whole, but particularly Colorado and Arizona, has experienced rapid population growth for reasons other than the development of extractive resource industries. Metropolitan centers like Denver and Phoenix have multiplied in size in recent decades.

Of all the environmental impacts of these developments, degradation of air quality may be the most severe. For reasons to be detailed

---

\*Senior Fellow, Resources for the Future and Adjunct Professor of Economics, University of New Mexico.

\*\*Air Quality Specialist, the John Muir Institute.

†We appreciate the support of the National Science Foundation for the preparation of this paper. The authors are, however, solely responsible for its contents.

in this report the atmosphere of this region of deserts and mountains is especially delicate. As a result even cities of modest size and great charm and beauty, such as Santa Fe and Aspen, occasionally have air pollution episodes. The largest cities have persistent and sometimes severe air quality degradation.

The rate and level of future development of the region is very uncertain. It depends upon the extent to which efforts to conserve energy succeed, the degree to which less dependence on foreign sources of minerals is accomplished, and the extent to which the "sunbelt" phenomenon continues to induce a southerly and westward migration of population and industry. This uncertainty creates difficulties in the crafting of environmental policy since it must be prepared to cope with a variety of possible circumstances and stand ready to be flexible in response. But the development of an effective and efficient environmental policy, and especially an air quality policy, is imperative. The alternative is aggravation of the existing poor air quality situation where it already exists, if development proceeds at a measured pace, or disastrous conditions over enormous areas if development should occur very rapidly and on a large scale.

The air quality problem in the Southwest region has two major sources. The first is emissions from giant heavy industry sources, power plants, copper smelters, and potentially, synfuel plants and oil shale facilities. The second is a very large number of small sources, automotive vehicles.

In this report we will consider possible policies with respect to these two types of sources in the particular context of the Southwest region. We begin with some background on national policy and then turn more specifically to what actions might be taken by governments in the region itself.

## II. BACKGROUND ON NATIONAL AIR POLLUTION LEGISLATION

### *A. Early History*

In 1950 researchers at the California Institute of Technology established a link between automobile emissions and photochemical smog in the Los Angeles Basin. A short time later the Los Angeles Air Pollution Control District began calling for action from the automobile companies and the state government. Despite company claims that the requisite technology was not available, a study group was set up under the auspices of the Automobile Manufacturers Association and reached a cross-licensing agreement for emission control devices. Over the same period a number of resolutions were introduced in the Congress, though not passed, calling for federally sponsored research

on the air pollution problem. Senators Thomas H. Kuchel of California and Homer E. Capehart of Indiana took a leading role in this new effort; in 1955 Senator Kuchel introduced legislation authorizing a federal program of research, training, and demonstrations. In the meantime President Eisenhower had received a report from an interdepartmental study committee recommending the same steps. Congress passed the legislation and the President signed the first federal law on air pollution in July 1955.<sup>1</sup> The level of activity authorized by the 1955 Air Pollution Control Act, however, was very low: five million dollars annually for five years to support all its functions.

By this time the problem in California had worsened, and the state took the initiative in establishing automobile emission controls. A new law requiring recirculation of crankcase blow-by on new 1963 cars (reducing hydrocarbons by about 20 percent) induced the industry to begin installing the simple crankcase device on some 1961 models. In 1963, over objections by the automobile industry that such technology did not exist, California legislation required exhaust control devices on vehicles once two such devices were approved by the State Motor Control Board. When four devices produced by independent manufacturers were approved in 1964, the industry discovered that it could indeed introduce its own devices on cars sold in California starting with the 1966 model year. In that year the first California emission standards were set.

Meanwhile, back in Washington, nothing much happened for quite a while. The main reason was that air pollution was widely regarded as an exclusively state and local problem, as exemplified by the official position of the Department of Health, Education and Welfare (HEW) toward the 1955 Act. Accordingly, eight years elapsed between this act and the first permanent air pollution legislation, although in 1959 the 1955 Act was extended for four more years.

In 1962 President Kennedy asked the House to pass a bill sponsored by Senator Kuchel that had passed the Senate in 1961. It authorized the Surgeon General to hold hearings on particular interstate air pollution problems. Some features relating to the research program and grants to state and local governments were added. The House again deferred action. Meanwhile, another major incident, the deadly smog that hit London in the winter of 1962, underlined the dangers of air pollution.

A recommendation by the administration in February 1963 finally produced the Clean Air Act, signed by President Johnson in Decem-

---

1. P.L. No. 84-159, 69 Stat. 322.

ber of that year. This law for the first time gave the federal government enforcement powers. They followed closely the pattern of the procedures earlier legislated concerning water pollution. At the request of a state, HEW could call a conference on air pollution problems in a particular region or airshed; then hold hearings; and if no satisfactory result followed, finally bring court action. In interstate cases, HEW could act on its own initiative. The bill also specifically mentioned the need for additional attention to the auto exhaust problem.

Hearings held in 1964 by the Senate Public Works Subcommittee on Air and Water Pollution underlined the inadequate attention that had been given to automobile emissions in federal legislation. The administration held that voluntary cooperation should be sought from the industry, and so it opposed enforcement legislation proposed by Senator Edmund S. Muskie of Maine in 1965. But his position was widely denounced in the press, leading to a legislative reversal by the administration. Thus a second title to the 1963 act was passed in 1965 as the Motor Vehicle Air Pollution Control Act authorizing HEW to set emission standards for automobiles as soon as practicable.<sup>2</sup> The first standards were for 1968 models and were roughly the same as those applied in California in 1966. Many believed that the federal program was unimaginative and lagged behind the progressive California program.

Exacerbating the matter, the automobile industry took a series of bewildering actions that destroyed—almost as if intentionally—the favorable public image that it had so long held. An attempt by General Motors to intimidate Ralph Nader backfired spectacularly, and its president was forced to apologize before a congressional committee and a national television audience. During the same period the Los Angeles County Board of Supervisors charged that the Automobile Manufacturers Association committee, established ostensibly to exchange emission control information, was really a scenario for collusion to prevent or delay controls. They cited evidence and asked the attorney general to take action. The ensuing Justice Department investigation ended in 1969 with a consent decree providing for an end to possible conspiratorial activities while not officially conceding their existence. The year before representatives of the industry had given testimony on alternatives to the internal combustion engine which, to put it mildly, was inaccurate.<sup>3</sup> The image of the auto

---

2. P.L. No. 89-272, 79 Stat. 977.

3. *Automobile Steam Engine and Other External Combustion Engines, Joint Hearings Before the Senate Committee on Commerce and the Subcommittee on Public Works*, 90th Cong., 2d Sess. (1968).

industry had hit rock bottom. These events contributed heavily to the political climate in which the 1970 Act, which is still the governing law, was passed. But first it will be useful to review briefly the 1967 Air Quality Act which was the basis for the far reaching amendments enacted in 1970.

### *B. The 1967 Air Quality Act*

In the move toward control of air pollution, a dramatic incident once again proved to be a factor. A four-day inversion episode in New York in 1966 was estimated to have caused eighty deaths. A month later a National Air Pollution Conference was held, which HEW hoped to use as a stimulus to new legislation embodying regional control organizations and national emission standards. Senator Muskie, Chairman of the Pollution Subcommittee at that time, conceded that stronger legislation was needed, but he opposed national standards. In 1967 President Johnson delivered a message to Congress dealing primarily with air pollution matters and, despite Muskie's opposition, proposed legislation including national emission standards for major industrial sources and establishment of regional air quality commissions for enforcement.

After hearings that reinforced Senator Muskie's misgivings about national emission standards, the Senate Public Works Committee delayed a decision, and reported a bill that provided for a two year study of such standards and that transformed the regional agencies from devices to enforce them into organizations involved with the states in setting them. HEW was charged with issuing "criteria" which set forth the relationship of concentrations of specific pollutants in the atmosphere to damages to "health and welfare." Ninety days after publication of the criteria, each state had to file a letter of intent that within six months it would establish standards for ambient air quality and, within six more months, implementation plans for each of those pollutants in the airsheds over which it had jurisdiction. The secretary of HEW could establish such standards himself if the state failed to comply. The final version, which left these elements intact, was passed and signed by the President in November 1967 as the Air Quality Act.<sup>4</sup> The act also authorized a greatly expanded research effort and for the first time set national standards for automobile emissions.

HEW was slow to provide the criteria that were the first step in the state-regional approach dictated by the act, and the states in turn were slow to act once the criteria were issued. By 1970 not a single

---

4. P.L. No. 90-148, 81 Stat. 485.

state had a full-scale plan of standards and implementation in effect for any of the pollutants, and a Nader study estimated that the process would not be concluded until well into the 1980's.<sup>5</sup> The report from this study not only roundly condemned HEW's National Air Pollution Control Administration and all its works but also contained an attack on the Subcommittee on Public Works. Other Senators and committees were trying to push into the environmental arena and the President boarded the now fast-rolling environmental bandwagon. 1970 was the year of Earth Day, and the credibility of the automobile industry was shattered. This was the dramatic political setting for the Clean Air Amendments of 1970.<sup>6</sup>

### *C. The 1970 Amendments on Automotive Emissions*

By 1970 Congressional framers of legislation had come to the conclusion that motor vehicle emissions would not be lowered to levels sufficient to protect public health unless Congress specifically established emission standards and set schedules for obtaining those standards. The Congressional standards set in the amendments of 1970 were intended to assure attainment of health related air quality levels according to calculations supplied by the National Air Pollution Control Administration in HEW. The deadlines for meeting those standards were 1975 and 1976 model years, which gave some recognition to industry's need for lead time to develop the necessary control technologies and equipment. The standard for automobiles sold during model year 1975 and thereafter called for a reduction in hydrocarbons and carbon monoxide emissions of 90 percent from levels produced by 1970 cars, which already had achieved a modest degree of control. Similarly in model year 1976 a 90 percent reduction in nitrogen oxide emissions was required by the Act as compared to the 1971 standard. As will be demonstrated presently, delays and new legislation have caused these requirements not to be met.

### *D. The 1970 Amendments and Stationary Source Emissions*

The 1970 Clean Air Act Amendments sharply expanded the fed-

---

5. J. C. Esposito, VANISHING AIR, THE RALPH NADER STUDY GROUP REPORT ON AIR POLLUTION (Grossman for the Center for the Study of Responsive Law, 1970) 158. An informative discussion of enforcement problems in the air pollution field is found in *Assessment of Federal and State Enforcement Efforts to Control Air Pollution from Stationary Sources, Report to the Congress by the Comptroller General of the United States* (U.S. General Accounting Office, 1973).

6. P.L. No. 91-604, 84 Stat. 1676.

eral role in setting and enforcing standards for ambient air quality. The Act embodies the concept of a "threshold value"—a level of ambient concentration below which it is assumed that no damage occurs to health. Materials subsequently designated to have threshold values include the major pollutants by mass: sulfur dioxide, carbon monoxide, nitrogen oxides, particulates and oxidants. The notion of threshold value can be regarded as a politically convenient fiction that permits the law to appear to require all pollution damage to health to be reduced to zero—a totally unambiguous number.

Congress directed the Environmental Protection Agency (EPA) to use scientific evidence to determine threshold values for pollutants. Those values minus an adequate margin of safety become primary standards. Those standards that relate to injury to human health are to be met first. More rigorous standards, to be met later, relate to public welfare and aim to protect property, crops, public transportation, and aesthetics, from pollutants. The states were to prepare implementation plans assuring that the primary standards would not be violated anywhere in the state after mid-1975. The act also expressed the intent that the quality of the air be maintained or enhanced. This has since been interpreted by the courts to mean that no new source is permitted to degrade significantly air quality anywhere.

Congress did not rely solely upon the established standards for ambient air quality to control stationary source pollution. It also gave the EPA power to set specific limits on emissions of certain kinds of pollutants. It recognized a category of substances called "hazardous pollutants" which are considered to have especially serious health implications (some of the heavy metals are examples). The EPA was directed to prepare a list of such substances and to issue regulations limiting their emissions, by both new and existing sources. These standards were to be enforced at the federal level. It should be noted that very little progress has been made in implementing this part of the act. The act also directed the EPA Administrator to set new source performance standards which limited the emissions of pollutants from new industrial plants to an amount no greater than that obtainable with "the best adequately demonstrated control technology."

Implementation and enforcement of national clean air policy, with the exception of automotive emissions control, is primarily the responsibility of the states. Their performance in carrying out this mandate has been variable but weak overall when judged in terms of the objectives of the Clean Air Act, and none of the goals of the Act have been fully met.



### III. OPERATION OF STATIONARY SOURCE REGULATIONS IN THE SOUTHWEST—SOME ILLUSTRATIVE CASES

#### A. Introduction

As indicated, national law endeavors to lay two types of restrictions on the discharge of residuals to the atmosphere: (1) emission regulations and (2) ambient standards. Emission regulations prescribe the allowable emission rate from the source, usually as a function of the amount of input material used by the source. Thus a power plant may emit a certain number of pounds of sulfur dioxide for each million Btu's of heat input. Examples of emission regulations are the Federal New Source Performance Standards (NSPS's). States also have NSPS's which in many but not all cases are equal to the federal standards.

Under federal law states are required to establish compliance plans pertaining also to existing sources. These involve emissions regulations which in some instances are more restrictive than federal emissions standards or which apply to existing sources not covered by these standards. In the Southwest, New Mexico's new source standards are far more restrictive than the federal standards or those of other states.

Ambient standards, as contrasted with emissions standards, specify the allowable concentrations of pollutants at ground level for various time periods. The major goal of the Federal Clean Air Act is to achieve those ambient air standards and to prevent deterioration of air quality. Related to the ambient standards are "non-deterioration increments." These are defined permissible increases in the ambient air concentrations associated with new industrial sources which are taken to be consistent with non-deterioration. The increments are different for each geographical area classification.

Under present interpretation of the law a geographical area may be classified as Class I, II or III.<sup>7</sup> All areas are initially classified Class II, except for areas specified in the legislation as Class I. This approach is presumed to permit moderate growth of polluting industries. Class I includes areas such as national parks over 6,000 acres, wilderness areas and international parks over 5,000 acres. These are areas where small changes in air quality may be detrimental,<sup>8/9</sup> areas where industrial facilities are presumed to be inconsistent with current land use. The 1977 Amendments to the Clean Air Act for the first time establish the protection of visibility in designated Class I

---

7. 39 Fed. Reg. 42510-42517.

8. 38 Fed. Reg. 18993.

9. 39 Fed. Reg. 32000-31009.

areas as a national goal. They also provide procedures for permits and modifications to state implementation plans to attain the goal.

The regulatory program which is designed to achieve ambient standards is thus based on two components: (1) emission restrictions under state law for old plants, in addition to an across the board restriction on new plants under federal law; and (2) construction permits under state law for new plants. In the case of the latter, in principle no new plant may be constructed if its operation will result in a violation of ambient standards or if its emissions will aggravate an existing violation of ambient standards. In theory, emission regulations for existing sources in addition to emissions control and siting considerations for new sources are designed to meet ambient standards.

In practice both technical and legal difficulties have limited effective implementation of this principle. There is also an important question about whether state agencies may control existing sources to levels below ambient standards in order to permit location of other sources in the interest of economic development. In New Mexico an appellate court struck down regulations applicable to existing coal-fired power plants because the regulations were designed to provide room for new sources. The State Supreme Court upheld the appellate court decision, and a proposed amendment to the State Clean Air Act to deal with the question was defeated in the last session of the state legislature.

New source emission regulations at the federal level (NSPS) are supposed to represent best available control technology for the type of source in question. However, NSPS have rarely been revised and since they are usually set for the worst combination of plant type and coal, frequently they do not represent the best available control technology at a given time for a source with anything but the worst of conditions.<sup>10</sup> These emission regulations are set without regard to plant size (the larger the plant the greater the permissible emissions),

---

10. EPA has implicitly admitted that a higher degree of control is achievable in the case of western low sulfur coals. Materials provided by EPA to the Congress during deliberations on the non-determination clause of the rejected 1976 Clean Air Act Amendments used the assumptions of 90% SO<sub>2</sub> removal. EPA is currently holding hearings on a reconsideration of the current NSPA Citation for EPA 90% feasibility—U.S. ENVIRONMENTAL PROTECTION AGENCY AND FEDERAL ENERGY ADMINISTRATION, AN ANALYSIS OF THE IMPACT ON THE ELECTRIC UTILITY INDUSTRY OF ALTERNATIVE APPROACHES TO SIGNIFICANT DETERMINATION (1975). *See also* SUPPLEMENT REPORT 2, GENERAL EDITION: ANALYSIS OF HOUSE DISCUSSION DRAFT RULE OCTOBER 16, 1975 (1975).

Under the 1977 Amendments, NSPS continues to exist but a requirement has been added that each new plant must comply with "best available control technology" on a case by case basis.

meteorology, existing ambient air quality, or terrain. Thus compliance with ambient standards does not necessarily occur when emissions standards are met, indeed there is no logical connection between them. Efforts to implement NSPS with respect to sulfur compounds has resulted in a standoff between industry and the regulators about what devices are "technically feasible."

For a source where non-deterioration is pertinent the existing air quality is not a consideration as long as the air quality is better than the standards minus the allowable increment. In this case the relevant question is whether or not the proposed new source plus all other new sources that were not under construction by 1975 will produce increases of the pollutant in question by more than the permissible increment.<sup>11</sup> In this context any point no matter where located, which may reasonably be expected to receive significant pollution from this source, must be considered. In some cases the source may be in an area classified in one fashion while associated degraded air may be in an area classified in another fashion. In this case the source is still required to meet the increment appropriate to the point where the increased concentrations are expected. Thus, for example, with Bryce Canyon classified Class I, if a plant were to be located on the Kaiparowits Plateau which was classified Class II, the plant would in principle not be permitted to produce concentrations beyond the Class I increment at Bryce Canyon.

For any new source the effective criterion is whether or not a computer model of the distribution through space of the emission from the proposed source (called an air dispersion model) predicts a violation of either the ambient standards or the non-deterioration increments. In the case of the ambient standards actual measurements may be used to confirm the modeling predictions, but there are few locations where monitoring networks are adequate for this purpose. If the model predicts that standards will be exceeded, further control may be required.

Even with existing sources, air dispersion modeling plays an important role in relating emission regulations to ambient standards. For point sources whose emissions are expelled far above the land surface and therefore spread out over large areas, it is costly to put enough monitors in the field and operate for long enough periods of time to determine the actual highest short-term concentrations which may

---

11. OFFICE OF TRANSPORTATION AND LAND USE POLICY, ENVIRONMENTAL PROTECTION AGENCY, GUIDELINES ON RECLASSIFICATION OF AREAS UNDER EPA REGULATIONS TO PREVENT SIGNIFICANT DETERIORATION OF AIR QUALITY (1975).

occur. Thus modeling is frequently used to extend monitoring results in both space and time.

Air dispersion modeling is at best a rather imprecise science. This is especially so in the mountainous west where high terrain may be affected by emissions. Taking account of other than flat terrain greatly complicates air dispersion models but predictions which do not consider high terrain may be greatly in error. Recent experiments have shown that flat terrain models may dramatically underestimate actual concentration.<sup>12/13</sup> For this reason the present study developed a high terrain dispersion model to analyze regulatory alternatives.<sup>14</sup> As well as being complex, such models have difficult data input problems. A discussion of how these were handled is made elsewhere.<sup>15</sup>

### *B. The San Juan Basin Example*

In order to examine some of the implications of various regulatory options we have taken the San Juan Basin in northwestern New Mexico as one of our case studies. This area has large coal and available water resources. Currently there is one 2175 Megawatt (Mw) coal fired plant (Four Corners Power Plant) and a 660 Mw coal fired plant (New Mexico Public Service Company's San Juan Power Plant). The San Juan plant will soon have another 1000 Mw added to its capacity. Construction permits have been obtained for the new units. In addition 4 coal gasification plants with a total output of 1750 million cubic feet of syngas have been proposed.<sup>16/17</sup>

The first plant, owned by Western Coal Gasification Company (WESCO), if constructed will be composed of two 250 mcf/day units located south and slightly west of the Four Corners plant. The regu-

---

12. ROCKWELL INTERNATIONAL, AIR MONITORING CENTER, NAVAJO GENERATING STATION SULFUR DIOXIDE FIELD MONITORING PROGRAM (1975).

13. M. WILLIAMS & R. CUDNEY, PREDICTIONS AND MEASUREMENTS OF POWER PLANT PLUME VISIBILITY REDUCTIONS AND TERRAIN INTERACTIONS, presented at the Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality—American Meteorological Society, Raleigh, North Carolina (1976).

14. The modeling of the examples given in the text was accomplished prior to the passage of the 1977 Clean Air Act Amendments which designates certain areas pertinent to the analysis as Class I areas. Some of the results might be changed if this were taken into account. However the examples are used merely to illustrate the interrelations among development, control technology, and environmental impact.

15. See A. KNEESE & M. WILLIAMS, AIR QUALITY ISSUES AND APPROACHES IN THE SOUTHWEST (1977).

16. U.S. DEPT. OF INTERIOR, DRAFT—EXPERIMENTAL IMPACT STATEMENT WESCO GASIFICATION PROJECT AND EXPANSION OF NAVAJO MINE BY UTAH INTERNATIONAL INC., SAN JUAN BASIN, NEW MEXICO (1974).

17. U.S. DEPT. OF INTERIOR, DRAFT—ENVIRONMENTAL IMPACT STATEMENT EL PASO COAL GASIFICATION PROJECT, NEW MEXICO (1974).

lations for WESCO I have lapsed and must be reconsidered from scratch. The San Juan permits are active. However, they were granted under the assumption that high level SO<sub>2</sub> control was required at Four Corners (the regulations struck down by the appellate court), so their status is not clear. A second plant consisting of two 250 mcf/day units is planned about 5 kilometers to the northeast. The second plant does not have a new source construction permit. There are two plant sites proposed by El Paso Natural Gas Company located east of the WESCO sites. There are no construction permits granted for these sites except for small pilot units. Figure 1 shows pertinent features of the San Juan region together with proposed developments.

Prominent high terrain features virtually surround the area. The Chuska and Carizo mountains form a barrier on the western side of the basin which is broken only at the northern end where the San Juan River flows out. To the north the foothills of the San Juan Mountains include the Mesa Verde Plateau. On the southern and eastern borders there is also high terrain, although not as steeply rising nor as high as that which forms the western and northern boundaries.

The actual and projected situation with respect to the regulation of emissions and plant siting in the San Juan Basin is rather intricate, and a detailed discussion of the regulatory assumptions of the modeling of various alternatives is not discussed in this paper. The interested reader can find such a discussion elsewhere.<sup>18</sup> In general the initial modeling assumes that state and federal emissions standards are met by all new sources, that the sites of such sources can be effectively controlled, and that retrofitting at all existing sources can be instituted in an effective and timely manner. This is indeed a strong set of assumptions in view of the historical record of regulation.

Figure 2 schematically sketches the range of physical legal assumptions currently tenable and their range of implications.

Under these assumptions we will estimate how much development could occur in the basin without violating existing standards and what other environmental consequences related to emissions might be associated with such development. Later we will explore the situation which might prevail if existing regulations are violated.

(1) When ambient standards are met

It appears that the San Juan and Four Corners power plants, four

---

18. KNEESE & WILLIAMS, *supra* note 15.

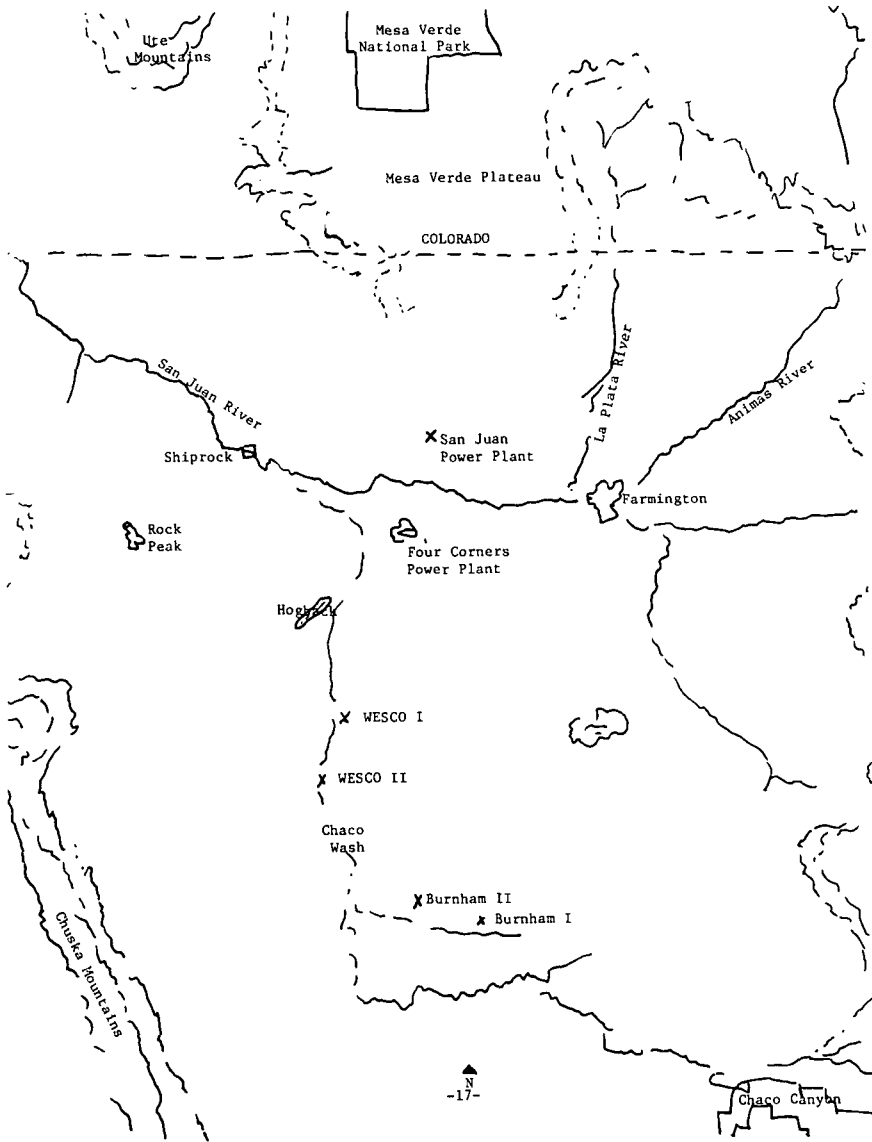


FIGURE 1.  
THE SAN JUAN BASIN

Calculated Concentrations Under Current Regulations (24-hour Period)	Required Control Efficiencies	Other Implications
205 - 255ug/m <sup>3</sup>	0 - 47% for units 4 & 5	Exclusion of new sources within 35km 314 tons/day SO <sub>2</sub> emissions
170 - 215ug/m <sup>3</sup>	0	379 tons/day SO <sub>2</sub> emissions
350ug/m <sup>3</sup>	60 - 75% for units 4 & 5	Exclusion of new plants within 50km ENE to ESE of hogback 133*-173*tons/day SO <sub>2</sub> emissions
280ug/m <sup>3</sup>	54% for units 4 & 5 and San Juan 2	202 tons/day SO <sub>2</sub> emissions
260ug/m <sup>3</sup>	50% for units 4 & 5 and San Juan 2	213 tons/day SO <sub>2</sub> emissions
595ug/m <sup>3</sup>	86% for units 4 & 5	142 tons/day SO <sub>2</sub> emissions
575ug/m <sup>3</sup>	82% for units 4 & 5	150 tons/day SO <sub>2</sub> emissions

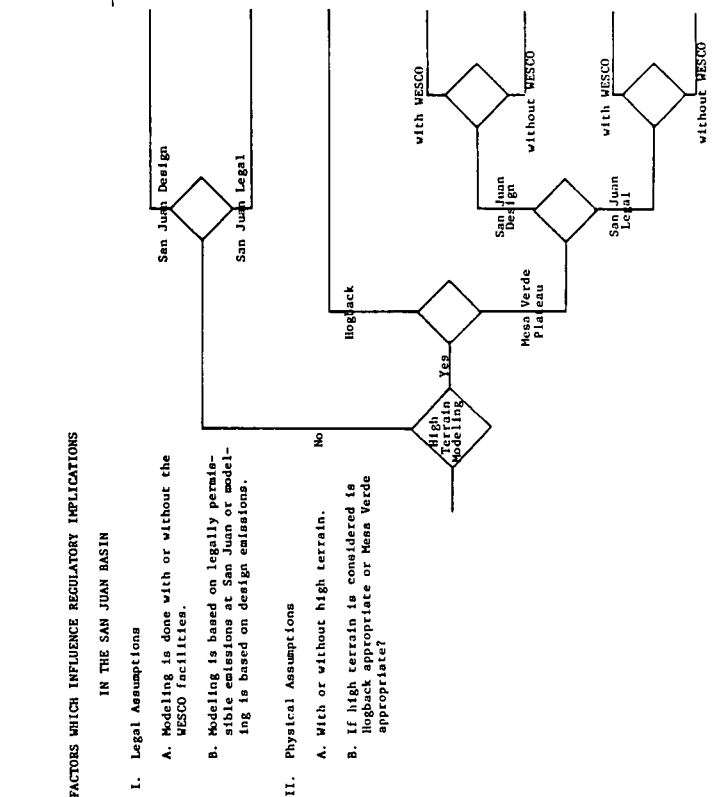
FACTORS WHICH INFLUENCE REGULATORY IMPLICATIONS IN THE SAN JUAN BASIN

I. Legal Assumptions

- A. Modeling is done with or without the WESCO facilities.
- B. Modeling is based on legally permissible emissions at San Juan or modeling is based on design emissions.

II. Physical Assumptions

- A. With or without high terrain.
- B. If high terrain is considered is hogback appropriate or Mesa Verde appropriate?



\*San Juan is not involved in this situation, these values assume San Juan design values.

FIGURE 2.

IMPLICATION TREE FOR RESTRICTIONS ON SO<sub>2</sub> EMISSIONS POSED BY AMBIENT STANDARDS

coal gasification plants, plus an additional seven new 2000 Mw plants could be accommodated without violating primary ambient standards in the region. The proposed WESCO II facility would have to be resited because of contributions to excessive NO<sub>2</sub> levels on the Mesa Verde Plateau. Furthermore NO<sub>2</sub> standards would be exceeded on the Hogback, a promontory in the region, and the Mesa Verde Plateau. However, the new sources would make no significant contribution to the excessive levels. This analysis assumes that Four Corner's SO<sub>2</sub> emissions would be reduced enough to meet standards at all points. If existing emissions at this plant were permitted to continue, an effective block on development within tens of miles of the plant would occur because any new source might aggravate an existing violation.

There is one circumstance that has not been modeled and that may prove very important—air stagnation. In this situation a high pressure system is stationary over an area and one or more day's emissions may be trapped within a confined area. Light and variable winds slosh the pollutants around but they are not carried out of the basin. Unfortunately there are no generally accepted models to deal with this circumstance. But stagnation does occur and could result in violation of standards.<sup>19</sup>

Other possible implications of development include acid rain, elevated sulfate concentrations, elevated nitrate concentrations, and visibility reductions. In addition trace element deposition and contribution to downwind ozone production are also potential areas of concern. All this can occur while ambient standards are being met.

There are no adequate models yet developed to address the acid rain question. It is clear that coal fired power plants will raise the sulfate concentrations in rainfall and lower the pH.<sup>20</sup> Furthermore it seems evident that in one case emissions of approximately 410 tons/day of SO<sub>2</sub> contributed to widespread damage of Christmas tree plantations in mountainous West Virginia.<sup>21/22</sup> The damage was related to direct acid attack on the plant surfaces and thus did not

---

19. It should also be noted that the modeling assumed normal plant operation whereas during a cold start up of operations, emissions are many times higher than during normal operation. Thus the model does not capture the extreme events which could occur. Cold starts occur 18-20 times per year and last 8-10 hours.

20. J. HALES, et al., FINAL REPORT ON FIELD INVESTIGATIONS OF SULFUR DIOXIDE WASHOUT FROM THE PLUME OF A LARGE COAL-FIRED POWER PLANT BY NATURAL PRECIPITATION (1971).

21. E.P.A., MT. STORM, WEST VIRGINIA—GORMANN, MARYLAND, AND LUKE, MARYLAND—KEYSER, WEST VIRGINIA AIR POLLUTION ABATEMENT ACTIVITY—PRE CONFERENCE INVESTIGATIONS, APRIL (1971).

22. Gordon, *Plantations vs. Power Plants*, XVI AMER. CHRISTMAS TREE J. (1972).



involve a change in soil characteristics. Thus this damage would not be confined to acid soils, which are uncommon in the Southwest. The expected emissions after control in the San Juan Basin would be 300-485 tons/day of  $\text{SO}_2$ . In addition, the  $\text{NO}_x$  emissions would be 350 tons/day.

With respect to visibility the principal effects within the basin would be expected during low wind speed stable conditions. Under these circumstances a significant plume would probably be visible as one looked across the basin. With low wind speed conditions and winds out of the west an observer looking to the NNE from the southwestern corner of the basin would be unable to see beyond the plumes. With higher wind speeds and winds out of the east an observer near the southeastern corner and looking NNW would be able to see only about 60 kilometers (about 35 miles) as opposed to a normal pre-power plant background range of 160 kilometers (around a hundred miles). The result will be a striking brown plume as seen against a blue sky. Such plumes have been observed to be associated with the Navajo Power Plant. During startup when the particulate emissions are greatly increased the adverse effects would occur under a greater variety of conditions.

It is also possible that significant effects on visibility and elevated nitrate and sulfate levels may occur outside of the basin. For example, with winds out of the west in the early evening the pollutants could probably be transported to the Rio Grande Valley with little loss of pollutants to ground uptake. Visibilities would be significantly reduced—probably to 50-60 kilometers or less in the valley.

## (2) When ambient standards are relaxed

Thus far we have been considering the situation where ambient standards have been essentially met. Now consider what happens if ambient standards are relaxed and emission regulations are also relaxed, or equivalently if the administrative legal process is not successful in implementing the standards. Under these conditions the  $\text{SO}_2$  from Four Corners would probably remain at its present 328 tons/day. If the Public Service Company of New Mexico stopped its emission control the level of  $\text{SO}_2$  emissions would probably reach 330 tons/day from the San Juan units. The coal gasification units would also have increased  $\text{SO}_2$  emissions of perhaps 200 tons/day. In addition, another new 2000 Mw plant would probably produce emissions of 400 tons/day of  $\text{SO}_2$ . These levels would total over 1200 tons/day of  $\text{SO}_2$  emissions. Maximum  $\text{SO}_2$  concentrations would reach approximately 1100 micrograms per cubic meter as a 24 hour

average on the Mesa Verde Plateau. This is approximately *five times* the New Mexico standard and about three times the federal standard. Near Hogback the values would be 550-750 micrograms per cubic meter for 24 hour average. In addition on flat terrain values of 335-420 micrograms per cubic meter of SO<sub>2</sub> would be expected.

Total NO<sub>x</sub> emissions would probably also increase as measures required to minimize NO<sub>x</sub> formation were dropped. This would probably mean increases in the order of 30 percent in the NO<sub>x</sub> emissions. Nitrate levels would increase correspondingly.

Particulate emissions would also be increased. The exact level is difficult to specify, but current particulate emissions from Four Corners are about 90 tons/day as opposed to the 5 tons/day assumed in this analysis. In the case of San Juan, since the equipment is already in or under construction and there is little energy penalty associated with it, the values would probably only increase to 5 or 6 tons/day. It is also possible that Four Corners would decide to quit using the existing scrubbers on units 1-3 with consequent large increases in particulate emissions. Under currently existing conditions total suspended particulates probably approach the standards at Hogback. Visibility effects would extend to a greater variety of circumstances and effects would be severe on distant locations.

Thus, large scale energy development in the San Juan will have severe adverse effects on the environment unless both emissions and site locations are carefully and successfully controlled. Even with such controls development based on existing ambient standards could cause serious environmental deterioration, especially in terms of visibility deterioration, acid rain, and deposition of hazardous materials.

The dramatic impact which even small (compared with ambient standards) amounts of atmospheric particulates can have on the Southwestern landscape is illustrated by the accompanying photograph. The view is from Los Alamos across the Rio Grande Valley to the Sangre de Cristo Mountains.

### *C. The Price-Green River Power Corridor Example*

As an example of an area outside New Mexico where only new sources will be involved, we have examined the siting of three 1000 Mw plants between the towns of Price and Green River in Utah. This area has been suggested as an energy corridor with approximately 3000 Mw of coal fired capacity. Objections to the plan have been raised because of concern for air quality in Arches National Monument. A schematic of the region involved is shown in Figure 3.



1960



1968

Source: *The Atom*, Los Alamos Scientific Laboratory, December 1968.

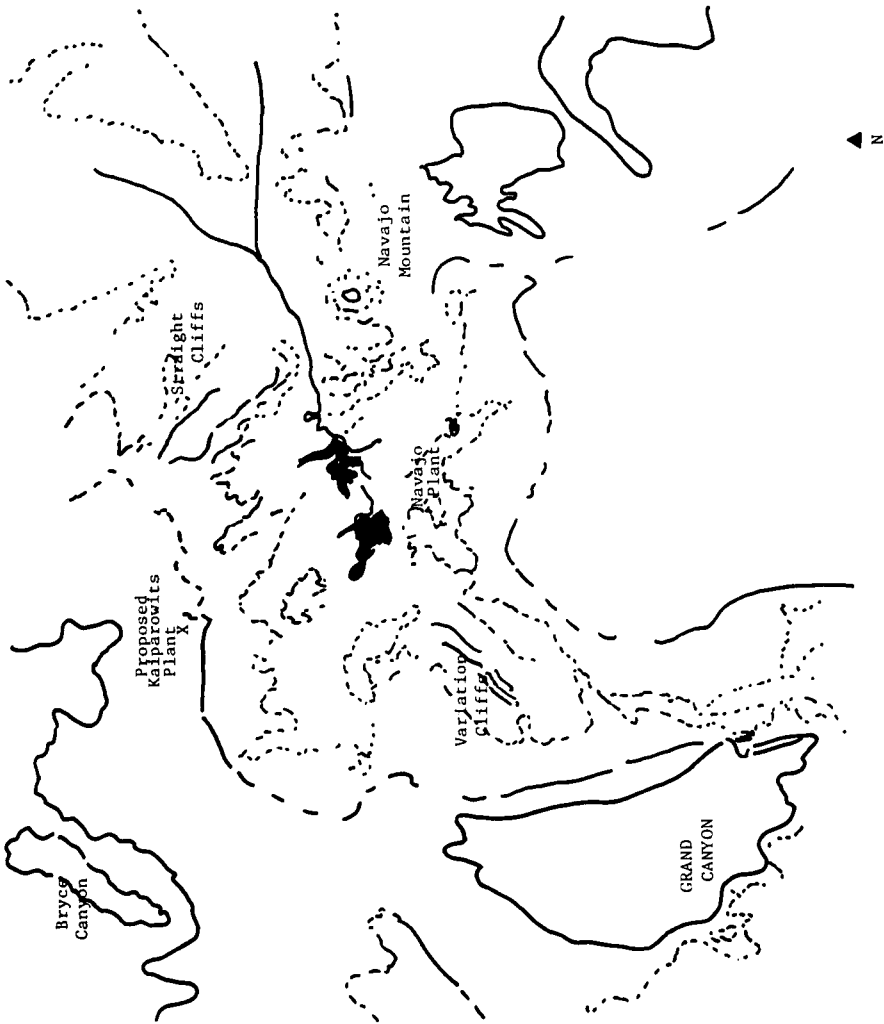


FIGURE 3.  
SCHEMATIC OF THE PRICE-GREEN RIVER REGION

As a first possible option the Price River Valley and the area near the town of Green River could be classified as Class III while Arches National Park is left as Class II. In this case no control of  $\text{SO}_2$  would be required since coals in this region would meet New Source Performance Standards. Furthermore the only restriction on siting would be to site the plants 10 kilometers or more away from high terrain. This option would be expected to occasionally produce marked visibility reductions in Canyonlands and Arches National Parks. Three plants near the towns of Wellington, Woodside, and Green River are assumed.

Option II represents the current status quo plus Class I designation for Arches and Canyonlands National Parks. The Woodside and Wellington plants would then be required to reduce emissions by about 50 percent and 30 percent respectively to meet Class II increments. The Green River Plant would have to reduce emissions by about 75 percent to meet Class I increments in Arches National Park. Visibility would still be impaired, but to a lesser degree in Arches. The siting of the Woodside plant would exclude some of the possible sites for the Wellington plant unless it was designed to consume less than the full increment.<sup>23</sup>

Finally, the third option would be 90 percent control of  $\text{SO}_2$  required either by a revised NSPS or through interpretation of the Utah Air Conservation Committee's "best practicable pollution control" requirement for new sources. In this circumstance siting would be very easy and the degradation in Arches would be much less marked. The remaining degradation would be associated with nitrates or nitrogen dioxide.<sup>24</sup>

---

23. With the passage of the 1977 Act Option One has been foreclosed and Option Two may have been foreclosed because of the new "best available control" technology provisions. Also visibility reductions assume much greater significance in the new Act.

24. For this case visibility reductions were explicitly modeled. For this purpose winds of 4 meters/sec with an effective  $\sigma_z$  (defined below) of 1000 meters were assumed for all three plumes. Normally smoke plumes are treated with a gaussian model. In these models the concentrations are assumed to be normally distributed about the plume centerline with standard deviation in the vertical of  $\sigma_z$  and in the horizontal of  $\sigma_y$ . In the case where one is viewing across the plume the key parameter is  $\sigma_z$  which is a measure of the vertical extent of the plume. The total plume depth is approximately  $4.3\sigma_z$ . A smaller  $\sigma_z$  means that the plume is less dispersed in the vertical and thus visibility is more restricted. This case is referred to a moderately severe circumstance. The very severe case uses a  $\sigma_z$  of 500 meters. Measurements at distances of 190 km have produced  $\sigma_z$ 's as low as 250 meters. James A. Heinbach, Arlin B. Super, and John T. McPortland, "Dispersion from an Elevated Source over Colstrip, Montana" paper #75-26.6 presented at the annual meeting of the Air Pollution Control Association in Boston, June 1975. The most distant plant used here is the Wellington plant at 140 km. These values appear to be reasonable estimates. The visibility estimates assume a  $\text{NO} + \text{NO}_3$  half life of 24 hours with a  $\text{SO}_2$   $\text{SO}_4$  half life of 69 hours. The ratio of extinction coefficient to mass is based on the work of White and Roberts, the values are  $9.62 \times 10^6 \text{ m}^2/\mu\text{g}$  for  $\text{SO}_4$  and  $4.40 \times 10^6 \text{ m}^2/\mu\text{g}$  for  $\text{NO}_3$ . W. WHITE & P. ROBERTS, THE NATURE AND ORIGINS OF VISIBILITY-REDUCING AEROSOLS IN LOS ANGELES presented at the Annual Meeting of the Air Pollution Control Association in Boston (1975).

Under Option I, sketched in Table 1, the maximum concentrations may be as high as the primary standards for  $\text{SO}_2$  in high terrain near the plant. These values would be somewhat higher than those permitted in similar areas in the states of New Mexico, Colorado, and Arizona. The  $\text{SO}_2$  concentration in Arches National Park would exceed the Class I increments by a factor of five. Visibility would be significantly reduced in the park. Under this option no  $\text{SO}_2$  control would be required and the third plant would contribute some 330 tons per day of  $\text{SO}_2$  to the atmosphere. This amount is somewhat larger than that produced by all sources in Los Angeles County, but a little less than amounts which produced acid rains from a power plant in the east.

Under Option II the maximum  $\text{SO}_2$  concentration would be 100  $\mu\text{g}/\text{m}^3$  over the background. In this case the  $\text{SO}_2$  emissions are reduced to 155 tons per day. In addition maximum  $\text{SO}_2$  concentrations in Arches National Park are limited to 5  $\mu\text{g}/\text{m}^3$  (the Class I increment) above the background. Visibility reductions are significant but less severe than those for Option I.

Under this option siting must be carefully done to avoid exceeding Class II increments. Furthermore the siting of one plant may restrict siting options for the other plants.

Under Option III siting is easier and peak concentrations are on the order of 20-30  $\mu\text{g}/\text{m}^3$ . In addition the effects on Arches National Park are further reduced. Maximum 24 hour  $\text{SO}_2$  concentration would be increased by less than half of the Class I increment. Furthermore, the visibilities would be reduced to 127 km under moderate conditions and 94 km under severe conditions. These reductions are primarily the result of  $\text{NO}_x$  emissions. Total  $\text{SO}_2$  emissions would be only 33 tons per day under this option.

#### *D. Case Study for Kaiparowits*

Another area which has been examined is that of the Kaiparowits Plateau in Arizona. Southern California Edison (SCE) had proposed that a 3000 Mw coal fired power plant be built near Glen Canyon National Recreation area northwest of Page, Arizona. Concern was expressed that the Kaiparowits plume would combine with the plume from the Navajo plant and produce excessive concentrations of pollutants in high terrain. For this reason Secretary of Interior Morton rejected an application for a permit to provide federal water and land to this plant.

SCE then chose a new site which was free of some of the difficulties of the earlier site and reapplied for a permit. The new site met opposition because the plant would impair air quality in Glen Can-

TABLE 1.  
SUMMARY OF THE PRICE RIVER VALLEY DEVELOPMENT IMPLICATIONS

<i>Option</i>	<i>Siting Effects</i>	<i>Required SO<sub>2</sub> Emission Reductions</i>	<i>Maximum SO<sub>2</sub> Concentrations</i>	<i>Total Emissions of SO<sub>2</sub></i>	<i>Effects on Arches National Park</i>
I. Class III & Class II for Arches &	Plants restricted to greater than 10 km from high terrain	0 for all plants	210 - 365	331 tons/day at full load	24 hr. SO <sub>2</sub> > 25ug/m <sup>3</sup> above background visual range reduced from 160 to 102km under moderately severe conditions 160 to 43km under very severe conditions.
II. Class II & Class I for Arches & Canyonlands	Careful siting at Woodside 15km from high terrain. Wellington may be precluded from siting NE of line between Woodwide Mounds unless Woodside does not consume entire increment.	Green River 74% Woodside 53% Wellington 31%	100 ug/m <sup>3</sup> + background	155 tons/day at full load	24 hr. SO <sub>2</sub> < 5ug/m <sup>3</sup> above background visual range reduced from 160 to 115km under moderately severe conditions 160 70 km under very severe conditions.
III. 90% control	Sites should be 4.5 km or more from high terrain	90% for all plants	21ug/m <sup>3</sup> + background for a site 1.5 km from high terrain	33 tons/day	24 hr. SO <sub>2</sub> < 2.5ug/m <sup>3</sup> above background visual range reduced from 160 to 127km under moderately severe conditions 160 to 94km under very severe conditions.



yon National Recreation area, Bryce Canyon National Park, Capitol Reef National Park, and possibly Grand Canyon National Park.<sup>25</sup> Values in excess of Class I increments for SO<sub>2</sub> and possible visibility impairment were cited as evidence of air quality effects. Eventually SCE withdrew its permit request, but they later suggested that a coal gasification plant be constructed at the same site.

In this case study both options, a 3000 Mw coal fired power plant and a 500 million cubic foot per day high Btu synthetic gas plant, were considered. The coal fired plant follows the design described by SCE with 90 percent SO<sub>2</sub> control of particulates. A stack height of 600 feet was used. Under these circumstances SO<sub>2</sub> emission would be approximately 54 tons per day, particulate emissions would be 12 tons per day, and NO<sub>x</sub> emissions would be approximately 240 tons per day.<sup>26</sup>

The modeling results suggested that Class II increments for SO<sub>2</sub> would be met, but particulate levels might approach or exceed the Class II increments on high terrain. In the latter case a key concern was with the nitrates produced in the plume through chemical reactions with the atmosphere. The highest concentrations would occur on high terrain, 21 kilometers NNE of the plant. The 24 hour concentrations would be 60 ug/m<sup>3</sup> for SO<sub>2</sub>, 232 ug/m<sup>3</sup> for NO<sub>x</sub>, 2.6 ug/m<sup>3</sup> for SO<sub>x</sub>, 14 ug/m<sup>3</sup> for fly ash, and 13 ug/m<sup>3</sup> for NO<sub>3</sub>.

In Bryce Canyon National Park 24 hour concentrations would be 23 ug/m<sup>3</sup> for SO<sub>2</sub>, 103 for NO<sub>2</sub>, 5 for fly ash and 21 for nitrates. One hour concentration of NO<sub>2</sub> would be 560 ug/m<sup>3</sup>. Similar values would be expected on high terrain within Glen Canyon National Recreation area. Furthermore with light winds (2 meters/sec) and morning atmospheric conditions, visibilities could be significantly reduced when winds carried the pollutants toward the National Park. Nitrogen dioxide and fly ash would reduce visible ranges from 160 km to 24-60 km over a sector of 85°. The plume would have a marked brownish appearance against a blue sky.

For the gasification plant the effects would be considerably different. The plant is modeled after the WESCO facility, already mentioned, in the Four Corners Region. The assumed emissions are 30 tons/day SO<sub>2</sub>, 35 tons/day of NO<sub>x</sub> and 3.6 tons/day of particulates. Stack height is 200 feet. In this case the highest concentrations occur very close to the plant, within .8 kilometers, with SO<sub>2</sub> concentration of 223 ug/m<sup>3</sup>. However this particular situation is somewhat unlikely. Other circumstances more generally accepted would put 24

25. The aforementioned national parks were designated Class I under the 1977 Clean Air Act Amendments.

26. A visibility model was also constructed for this case.

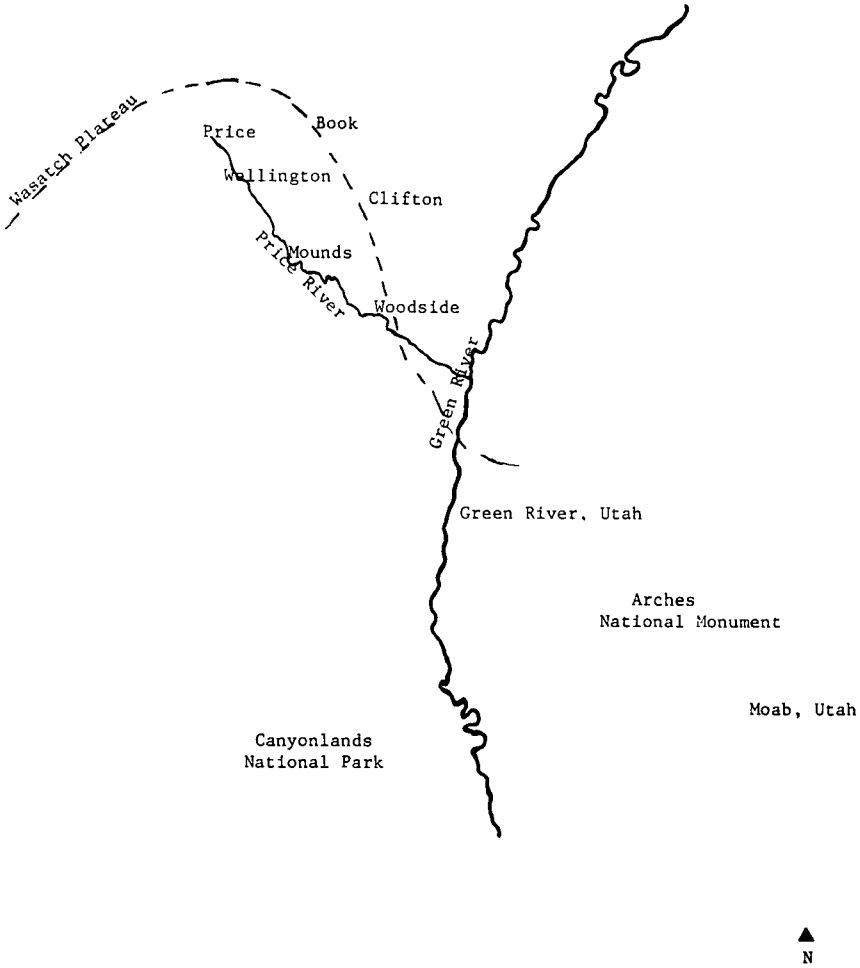


FIGURE 4.  
SCHEMATIC MAP OF LAKE POWELL REGION

hour SO<sub>2</sub> concentration of 140 ug/m<sup>3</sup> at 1.4 km and 112 ug/m<sup>3</sup> at 2.2 km. Thus Class II increments would be exceeded under this configuration. Either a taller stack or reduced emissions similar to those of the El Paso Natural Gas Company's Burnham facility would resolve this problem.

In Bryce Canyon National Park the concentrations would be about 12.8 ug/m<sup>3</sup> for SO<sub>2</sub>, 34 ug/m<sup>3</sup> for NO<sub>2</sub>, 1.5 ug/m<sup>3</sup> for fly ash and 3 for NO<sub>3</sub>. The visible ranges would be reduced from 160 kilometers to 130 to 154 over an 85° sector during light winds and stable conditions. Thus the impacts would be greatly reduced in Park areas, but Class I increments would still be exceeded. Using the procedures at the Burnham facility would also resolve this problem.

### *E. Legal Conditions in Other States*

We have mentioned some aspects on the legal situation in New Mexico as a kind of benchmark. A few comments should also be made about the states of Colorado, Utah, and Arizona. In all of these states the legal requirements for control of nitrogen oxides is less strict than in New Mexico. Furthermore the specified control of SO<sub>2</sub> in Utah and Arizona is less stringent than in New Mexico. In Utah new sources are held to Federal NSPS, while in Arizona a slightly more restrictive regulation is in effect. However, both Utah and Arizona have regulatory language which permits a higher degree of control. In Utah the language provides:<sup>27</sup>

In areas of present high air quality when measured or estimated ambient levels of controllable pollutants are below the levels specified by applicable standards, any emission of pollutant to this ambient air must be shown to result in pollution levels . . . within applicable ambient air standards, and will be prohibited in any case unless shown to be controlled to afford the highest efficiencies and lowest discharge rates that are reasonable and practicable as specified in section 1.7 below.

However in section 1.7 it is required that "cost benefit relationships" be considered. It is not clear what protection this affords. It does appear that this provision is also applicable to NO<sub>2</sub> and particulates.

Utah's ambient standards are the same as the federal standards. Depending upon the interpretation of the phrase above there may be a problem, similar to the one in New Mexico, with existing sources excluding new ones in non-degradation regions.

---

27. UTAH AIR CONSERVATION COMMITTEE, AIR CONSERVATION REGULATIONS (1975).

In Arizona the standards are also less restrictive than in New Mexico. The Arizona regulation contains the phrase:<sup>28</sup> "These standards shall not be construed as permitting the preventable degradation of air quality in any area of this state." This would seem to imply that regulations may be written to require something more than mere meeting of ambient standards. However, as it stands now there exists the potential for one source to take up this increment and exclude others.

In Colorado the new source regulation after 1980 requires that new sources control approximately 70 percent of the SO<sub>2</sub> which would be discharged if no controls were in effect. In terms of ambient standards they have chosen to follow an increment plan for areas with clean air. Most of these clean air areas of the state are currently designated category I. With the relatively lax emission standards exclusion of new sources is once again possible.

All of the states have less strict particulate regulations than New Mexico and thus there is significant likelihood that visibility effects would be worse with a given level of development. Similar conditions and considerations hold with respect to NO<sub>x</sub> standards.

#### IV. AN ALTERNATIVE TO REGULATIONS

##### A. Introduction

As noted above, meeting the federal primary ambient standards in the region, much less protecting against visibility deterioration and other ill effects, places heavy demands on the regulation process. Careful location of activities with implied land use planning and precise programs of control, including successful and timely retrofitting of existing facilities would be required to do the job. In practice the regulatory process has been cumbersome, slow, and litigation ridden and, rather than having induced technological innovation it has spawned endless arguments about the availability of control technologies. In light of this it is hard to be optimistic about how successful and efficient the regulatory process can be in the region, especially if pressure to develop energy resources is strong.

Moreover, as the earlier discussion indicates, the effects of large emissions in the Southwest region on visibility, on rainfall acidity, and possibly on the dispersal of toxic substances, may extend over great distances. These effects are only partially covered by existing legislation but they point to the need for effective control at all

---

28. ARIZONA DEPARTMENT OF HEALTH SERVICES, RULES AND REGULATIONS FOR AIR POLLUTION CONTROL (1976).

sources, especially at the largest sources, if the quality of the atmosphere is to be protected.

Many students of environmental policy<sup>29</sup> have concluded that the system of economic incentives must be changed if we are to attain a more successful environmental policy. A suggested procedure is to levy a regulatory fee on polluting residuals which are released to the environment. The idea is to make it in the economic interest of the industrial enterprise—be it an old or a new plant—to control the discharge of pollutants to the environment rather than to discharge freely as is now the case.

Such a fee also would have the effect of inducing the highest degree of control at those sources where control costs are lowest, and frequently these are the largest sources. It would be in the economic interest of those facilities where control costs are low to attain greater control and avoid paying a fee on those units not discharged. Where control costs are high it will pay to control emissions to a lesser extent. A number of studies have shown that when such a pattern of control occurs a given ambient condition can be obtained at a much lower cost to society than when uniform requirements are laid on all dischargers to the environment.<sup>30</sup> Moreover, and perhaps more important, the profit will be taken out of polluting the environment and the powerful system of economic incentives will work for the environment rather than against it, as is now the case when the valuable environmental resources of the region are used at zero cost.

This being the case, the states of the Southwest Region should consider implementing a system of emission fees for polluting substances which are discharged into their atmospheric environment: (1) to supplement efforts to enforce regulations already in effect; (2) to compensate for social costs imposed upon their citizens; (3) to provide a continuing incentive to the industries of the region to use clean technologies and to control the discharge of polluting substances which are nevertheless generated; and (4) to provide an economic incentive to develop more cost-effective control technologies.

### *B. A Sulfur Emissions Fee*

The best starting point is the establishment of emission fees for the discharge of sulfur compounds. There are two reasons for this. First, sulfur compounds are discharged to the Southwest's atmo-

---

29. See A. KNEESE & C. SCHULTZE, *POLLUTION, PRICES AND PUBLIC POLICY* (1975).

30. *QUANTITATIVE COMPARISON OF POLICY INSTRUMENTS FOR ENVIRONMENTAL IMPROVEMENT*, Vol. 116 *DECISION MAKING IN THE ENVIRONMENTAL PROTECTION AGENCY* (selected working papers) (1977).

sphere in very large amounts by industries whose products most often are almost entirely exported. Therefore, the uncompensated social costs are under the present system imposed heavily on Southwesterners (although others enjoying the Southwest environment bear them too), while beneficial products are in most cases consumed by others. Second, the monitoring which would be necessary to effectively implement a discharge fee is considerably simpler for sulfur compounds than for most other polluting substances discharged to the environment. Before proceeding further to a discussion of specifically how such a fee could be designed and implemented it is useful to examine whether there exists a defensible legal basis for such fees at the state level.

### *C. A State's Authority to Levy a Sulfur Emission Fee*<sup>31</sup>

The threshold legal question concerning a state sulfur fee is whether the state has legal authority to make such a levy. States do have such authority under the police power and probably also under the taxing authority.

First let us consider the police power. It is well established that the police power provides authority for a state to take steps to control air pollution. The Supreme Court has held that a state effort to combat air pollution "clearly falls within the most traditional concept of what is compendiously known as the police power." *Huron Cement Co. v. Detroit*, 362 U.S. 440, 442 (1960).

Given the authority of the state to combat air pollution, the question remains whether a regulatory sulfur emissions charge is an appropriate exercise of the police power to meet this end. There appears to be no reason why it would not be. For instance, the Oregon Supreme Court upheld a law setting a mandatory deposit on returnable beverage containers (in effect a charge on failure to return the containers) as a valid exercise of the state's police power. The court stated:

Selection of a reasonable means to accomplish a state purpose is clearly a legislative, not a judicial function, to which the admonitive language from *Firemem v. Chicago R. I. & P. R. Co.*, *supra*, 393 U.S. 129, 143 (1968), quoted above is clearly applicable. In particular, the courts may not invalidate legislation upon the speculation that . . . additional and complementary means of accomplishing the same goal may also exist. The legislature may look to its imagination rather than to traditional methods . . . to develop suitable means of

---

31. Material for this section is based on F. ANDERSON, A. KNEESE, P. REED & S. TAYLOR, ENVIRONMENTAL IMPROVEMENT THROUGH ECONOMIC INCENTIVES (1978).

dealing with state problems, even though their methods may be unique. Each state is a laboratory for innovation and experimentation in a healthy federal system. *American Can Company v. Oregon Liquor Control Commission* 517 F.2d 691, Environmental Law Reporter, vol. 4, p. 20218 (Ct. App. Ore. 1973).

The question of whether the courts of the relevant state (e.g., Utah) have taken as broad view of the legislature's freedom to experiment with innovative techniques under the police power must be addressed in each individual case by one familiar with relevant state law.

We must now examine the taxing authority. States, like the federal government, have the authority to lay and collect taxes. The primary purpose of taxation is to raise revenue, but a number of federal and state taxes have been upheld that have a regulatory purpose as well. The leading federal cases in this area are *Sunshine Coal Co. v. Adkins*, 310 U.S. 381 (1940) and *U.S. v. Sanchez*, 340 U.S. 42, 44 (1950). New York courts upheld a "tar and nicotine" tax designed to create an incentive to smoke less harmful cigarettes in *Long Island Tobacco Co., Inc. v. Lindsay*, 348 N.Y.S.2d 122 and the Vermont Supreme Court upheld a tax on land sales designed to deter speculation in rural land in *Andrews v. Lathrop*, 315 A.2d at 866, 4 LER 20571 (1973).

The question then arises: is it preferable to base the sulfur levy on the police power or the taxing power? While bills which have proposed emissions fees have usually referred to the proposed fees as "taxes," e.g., the bill introduced in New Mexico in 1972 and in Montana in 1974, it appears to be preferable to set up the program as a regulatory charge rather than as a tax. The following discussion of various legal constraints on state sulfur emissions charges indicates, among other things, whether the constraint applies to a tax, a regulatory fee or both. The potential problems with the tax approach are significantly greater.

#### *D. Possible Constraints*

1. Uniformity of excise taxes. The constitutions of the United States and "nearly all" states require that excise taxes must be levied uniformly within the relevant jurisdiction, and a sulfur tax would fall in this category. This requirement is aimed at preventing discrimination against one or more states or regions by the federal government, or against one or more localities by a state government. It does not require that the same tax rate apply to everyone, but rather that any differences in rate must be based on reasonable, non-discriminatory grounds.

A state scheme would not have a uniformity problem if it set up such a tax so long as all sources of a given type paid at the same rate or according to the same schedule, wherever they are located in the state.

2. Tax immunity. Some state and local governmental functions are immune from federal taxation. This suggests that they may also be immune from state taxation. Whether this is true in a given state would have to be ascertained if the charge were to be a tax and were to be applied to any state or municipally owned sources. A state sulfur tax aimed only at very large sources would not affect such smaller sources. There is a related question, however, that warrants attention by each state: are there limitations in state law on the power of the state to tax public utilities? If so, there could be a problem because power plants are very major sources of sulfur emissions.

3. Legislative procedure for adopting tax legislation. Tax legislation must generally originate in the lower house of state legislatures and in finance-oriented committees, committees that in some states are hostile to tax programs with regulatory purposes.

4. Improper delegation of authority to the executive branch. This constraint, stemming from the separation of powers doctrine, affects both tax and regulatory charge programs, but it creates more serious problems for the former.

Under federal law, Congress cannot delegate to an administrative agency the authority to set a tax rate. The same requirement may apply to a state legislature under state law. If so, then there is some problem. It might be desirable to delegate rate setting to an agency that would take into account technical and economic considerations that bear upon whether the charge will be effective in cutting emissions or internalizing external costs (economists refer to costs, such as pollution damage, generated by an economic entity but not borne by it, as "external costs").

A regulatory charge scheme would also have to clear certain delegation hurdles. So long as the charges were not deemed to constitute a criminal penalty (a problem discussed below) there is probably no reason why a legislature could not delegate to an agency the power to select the charge rate or schedule. This question should, however, be given some attention by someone familiar with the law of the relevant state. Furthermore, it is important to be sure that emissions charge legislation complies with state law in terms of the extent to which powers can be delegated to an agency and the standards prescribed for the exercise of those powers.

5. It is very important that the fee, whether a charge or a tax, is



not set up so that a court might consider it to be a criminal penalty. Federal law prohibits Congress from enacting a penalty under the label of a tax. *U.S. v. Constantine*, 296 U.S. 287 (1935). A regulatory charge held to be a criminal penalty would be unconstitutional unless it provided for elaborate procedural safeguards. This is an area in which the law is not clear and it should be investigated within the affected state.

It should be fairly easy to avoid the "criminal penalty" trap in drafting a charge proposal. Courts have often wrestled with the question whether a penalty in a statute is criminal or civil in nature, and while no clear cut rules emerge from these decisions, it is clear that a well drafted charge system would not be considered a criminal penalty.

To avoid the criminal penalty problem, the charge rate should be set on the basis of reasonable criteria such as internalizing external costs or achieving desired levels of abatement. A charge on all emissions from a source avoids several possible problems, but a charge on emissions over a standard would not be a problem if the rate were rationally based on the costs of achieving the standard and were designed to be a reasonable approximation of the minimum necessary to achieve compliance.

6. Any emission charge legislation enacted by a state must meet due process standards in the Fourteenth Amendment to the U.S. Constitution and, in all probability, similar provisions in the state constitution. The basic due process requirement of the Fourteenth Amendment is spelled out in *Nebbia v. New York*, 291 U.S. 502, 525 (1933).

The Fifth Amendment, in the field of federal activity and, the Fourteenth, as respects state action, do not prohibit governmental regulation for the public welfare. They merely condition the exertion of the admitted power by securing that the end shall be accomplished by methods consistent with due process. And the guaranty of due process, as has often been held, demands only that the law shall not be unreasonable, arbitrary or capricious, and that the means selected shall have a real and substantial relation to the object sought to be attained.

The Supreme Court has found this to be a very limited restriction on otherwise valid state action. There only needs to be some rational basis for the legislation, and the Court does not look into whether the particular measure enacted is the wisest or most appropriate response possible for the particular problem addressed. *Olsen v. Nebraska ex rel. Western Ref. and Bond Ass'n*, 313 U.S. 326 (1941).

A sulfur emission charge would clearly pass this test if it is not set with complete indifference to its effect on abatement or to the external costs generated by sulfur emissions. It would be wise, however, to make sure that the charge scheme satisfies the specific due process requirements of the state constitution as well.

7. The charge (or tax) scheme must also satisfy federal and state Fifth Amendment requirements that private property shall not be taken for public use without just compensation. There is no property right to discharge pollutants into the air. While "taking" has not been clearly defined, the most common test for taking is whether a regulation causes a drastic reduction in the economic value of property. Further research on the exact criteria for taking under federal and state law would be useful in this area, since a charge might drive some marginal firms out of business.

8. The equal protection claim of the Fourteenth Amendment prohibits states from implementing legislation that discriminates unfairly against certain classes of persons (corporations included). Again, the state constitutions probably contain a similar provision. Legislation does not violate this requirement if statutory categories of regulation are based on differences that are reasonably related to the legitimate purposes for which the statute was enacted. The courts generally allow a great deal of leeway except where particularly suspect classifications, such as race or nationality, are involved. Any reasonable basis for a classification will be upheld. See *Allied American Co. v. Commissioner*, 219 Md. 607, 623 (1971). The Vermont Land Gains Tax, which provided for a variable tax on sales of land depending on the length of time it was held; the Oregon bottle bill, which banned non-returnable beverage containers and required a deposit on returnables, and the Illinois sanitary ordinance levying a sewer surcharge on only industrial users were all upheld as not in violation of the equal protection clause. See *Andrews v. Lathrop*, 315 A.2d at 864 (1973); *American Can Company v. Oregon Liquor Control Commission* 517 F.2d 691, Environmental Law Reporter, vol. 4, p. 20218 (Ct. App. Ore. 1973) and *Chicago Allis v. Sanitary District*, Environmental Reporter Cases, vol. 4 (Ill. Sup. Ct. 1972), pp. 1642, 1646 (1972).

There is some possibility that a sulfur emission charge scheme that applied only to one class of source such as power plants, and not to smelters or the other large sources, might run afoul of the equal protection clause. Is there a rational basis for such a distinction? It appears that political feasibility alone would not suffice. The reason should relate to the aims of the statute, that would control sulfur protection or cause industry to internalize its costs. Thus setting a rational size limit emission should cause no problem. This is an area

that may need substantial research if smelters or other very large sources are to be exempted.

9. An emission charge or tax enacted by state must not unduly interfere with interstate commerce. The basic commerce clause test is spelled out in *Pike v. Bruce Church, Inc.*, 397 U.S. 137, 142 (1970).

... where the [state] statute regulates evenhandedly to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits. If a legitimate local purpose is found, then the question becomes one of degree. And the extent of the burden that will be tolerated will, of course, depend on the nature of the local interest involved, and on whether it could be promoted as well with a lesser impact on interstate activities.

In the case of a state sulfur emissions charge or tax, the validity of the local purpose of controlling air pollution is well recognized. The effect on interstate commerce, i.e., higher costs on sources that sell their products in other states, is incidental—that is, it is not related to the main purpose of the legislation. Thus, a court will look to see how heavily the program burdens commerce, and balance that against the demonstrably strong interest in controlling sulfur emissions. The latter should prevail, especially since alternative means of achieving the goal have been tried without success and do not seem to involve any less a burden on interstate commerce.

Furthermore, the main evil protected against by this application of the commerce clause—state programs designed to favor in-state business at the expense of out-of-state business—is not present. In New Mexico the charge, for instance, would apply to two large power plants both located instate, one selling electricity in New Mexico and one selling it elsewhere. It should be noted that if the charge applied only to businesses selling out of state, there could be commerce clause problems.

10. A final legal constraint that applies to both a tax and a charge has to do with emissions monitoring necessary to implement either. Self-monitoring requirements might violate the Fifth Amendment protection against self incrimination. This protection does not apply to corporations or to required records for business, however. Furthermore, the protection does not apply where there are no applicable criminal sanctions for the activity about which self-monitoring information is required. It is possible that the Fourth Amendment prohibition against unreasonable searches and seizures might require warrants for administrative monitoring inspections. (This protection,

unlike that against self-incrimination, applies to corporations.) While the law in this area is not entirely clear, warrants have been held to be unnecessary where administrative inspections were required as part of a valid regulatory (as opposed to penal) program and the inspection would not be effective if warrants were required. *United States v. Biswell*, 406 U.S. 311, 316 (1972). This is another area where research into specific state law would be useful.

11. The last constraint appears to apply only to a regulatory charge scheme. It is the question of whether federal legislative action in an area in which the federal government and states have concurrent authority (such as pollution control) has pre-empted state action. It is clear from the Clean Air Act and regulations adopted under that act that the states have not been pre-empted from establishing sulfur emission charge schemes.

The Act leaves the states a great deal of leeway to enact measures to control emissions except in specified areas not relevant here (section 116). In 40 CFR 51.1 (n)(2), EPA included federal or state emission charges or taxes among strategies which could be used to implement federal air quality standards.

In summary, states have a clear legal basis for enacting charges systems. It is probably better to use the police power rather than taxing power as such a basis, and carefully drafted legislation should not run into legal or procedural difficulties.

#### *E. The Proper Level of a Sulfur Charge*

How high would a charge have to be to provide a genuine incentive to control emissions? We use some examples from New Mexico to estimate the needed level of the charge.

During August 1974 the New Mexico Environmental Improvement Board held a hearing on SO<sub>2</sub> regulations for coal fired power plants. Milton Beychok, an expert who is frequently employed by industry testified that 90 percent control of SO<sub>2</sub> at Four Corners would cost 2.4 to 3.7 mills/kwhr.<sup>32</sup> This number includes capital costs. The higher figure amounts to 34 million dollars a year for units 4 and 5 while the lower amounts to 23 million dollars a year. Arizona Public Service Company (APS) estimates of operating costs were apparently about the same<sup>33</sup> as the upper value used by Beychok and their estimates of capital costs were perhaps slightly lower. With a 70

---

32. This value is taken from the transcript of the August 1974 EIB hearings on regulation 902 and 504 held in Farmington, N.M. page 616.

33. This value is from the transcript page 775 which is a supplement to the testimony of Tom Woods of Arizona Public Service Company.

percent load factor, total Four Corners emission would be about 84,000 tons per year. These values could be increased slightly with higher sulfur coals as exist in the field being mined for the plant, or decreased with the lower sulfur coals in the field. The emission of units 4 and 5 comprise 82 percent of this total of 68,800 tons per year. Thus a charge of 350-550 dollars per ton of SO<sub>2</sub> or 18 to 28 cents per pound of SO<sub>2</sub> would probably induce cleanup of units 4 and 5. Significant cleanup of units 1-3 would probably occur at a lower value.<sup>34</sup>

APS has fought to prevent any cleanup in two major court actions. Currently they are required to clean up about 35 percent of their potential emissions from units 4 and 5 and 65 percent of the emissions from units 1-3. They currently remove about 40 percent of the SO<sub>2</sub> emissions from units 1-3 as a byproduct to particulate control. Thus under current regulations they would emit 44,720 tons per year from units 4 and 5 and 8866 from units 1-3. At 25 cents per pound this would produce revenues of 26.8 million dollars per year from Four Corners. EPA has ruled that 35 percent control on units 4 and 5 is inadequate to achieve ambient air standards.

Thus further regulations can be expected; however, based on past history it is likely that APS will attempt to delay enforcement of any new regulations. It should be emphasized that while at present levels of emissions a regulatory fee would yield substantial revenues, the primary purpose of the fee is not to yield revenues but to induce abatement action. Thus the revenues from a well designed fee system should drop drastically as companies like APS find it in their economic interest to stop fighting regulation and get on with the job of emission control.

The other major coal fired power plant in the San Juan region is Public Service Company of New Mexico's (PSCNM) San Juan Plant. Apparently the sulfur content of its coal is slightly higher than that of APS so that total emissions from a 1660 Mw plant (to be completed in 1983) would be about 84,300 tons per year at 70 percent load factor.<sup>35</sup> However, PSCNM is committed to control 90 percent<sup>36</sup> of its SO<sub>2</sub> emissions. Thus PSCNM would emit only 8,400 tons per year while APS under current regulations would have emis-

---

34. Testimony at the hearings indicated that their cost is approximately linear with control efficiency up to about 90%.

35. The sulfur value is reported in a booklet "San Juan Generating Station PSCNM" which also gives ISC tons per hour coal consumption for a 330 Mw unit out of a total of 1660 Mw.

36. The booklet above also describes 90% control of SO<sub>2</sub>.

sions of 53,600 tons per year, and PSCNM's emissions would be only 16 percent of APS's emissions.

A fee of 25 cents per pound on PSCNM's San Juan plant would net only 4.2 million dollars per year. Furthermore PSCNM is in the process of installing equipment on its units while APS continues to stall. The much lower payments which PSCNM would have to make would be an economic reward for its much stronger commitment to control, while the fact that it would still have to pay for all units discharged would provide a continuing incentive to improve and would provide some compensation for the external costs associated with the controlled level of emissions.

The other major set of sources of sulfur emissions in the Southwest are the large copper smelters scattered throughout the region. In a percentage sense high level control of sulfur emissions from smelters can be achieved much more cheaply (on a per pound basis) than is the case for power plant emissions. Mead and Bonem<sup>37</sup> have done some estimates of copper smelter emission fees which would produce high percentage control. At charges of .6 cents (6 mills) per pound of SO<sub>2</sub>, smelter emissions would be reduced by about 60 percent, as compared with an uncontrolled situation. Charges of .8 cents (8 mills) per pound of SO<sub>2</sub> would result in reduction of emissions by about 95 percent. These estimates are in 1975 dollars. It should be pointed out that there are reasons to believe that these estimates are somewhat low; in fact, an emission charge of 1½ to 2 cents per pound of SO<sub>2</sub> might be required to reduce smelter emissions by 90 percent. Even if the actual charge needed were double this amount it would still be small when compared with that needed for power plants.

The large discrepancy between required emission charges for smelters as opposed to power plants is the result of copper smelters having very large sulfur emissions, most of which can be controlled by process changes involving the recovery of sulfuric acid. But uncontrolled emissions from a large smelter are perhaps 6 to 8 times as large as those of a 400-500 Mw power station. This means that a high level of control in percentage terms still leaves a large amount of emissions in absolute terms.

Furthermore, achieving sulfur emission reductions above 90-95 percent appears to be extremely costly. For copper smelters, very high sulfur reduction levels can be achieved only by methods such as

---

37. R. MEAD & G. BONEM, RESIDUALS MANAGEMENT IN THE COPPER INDUSTRY (1976).

installing a two-stage sulfuric acid plant instead of a one-stage plant, or scrubbing tail gases from an acid plant with limestone. Kellogg and Henderson<sup>38</sup> estimate that the removal efficiency of a single-stage acid plant on a converter might be 97.3 percent and for a two-stage acid plant, 99.3 percent. But the two-stage acid plant uses 40 percent more power (electric requirements in acid plants are quite high) and requires a capital outlay at least 15 percent higher than a single stage plant. Limestone scrubbing of tail gas from an acid plant would probably involve even larger costs. Consequently, at high removal levels, costs of treatment are high and probably comparable to those from a power plant.

In summary it appears that a regulatory fee of about 25 cents per pound of SO<sub>2</sub> would provide a strong incentive to both power plants and copper smelters in the Southwest to clean on a high level. Of course, given the rapid cost escalation which has occurred in recent years the fee would have to be raised over time to account for inflation.

#### *F. Monitoring Emissions*

A prerequisite for any sort of reasonably accurate emissions control system, whether based upon standards or charges, is a suitable means of monitoring emissions. There are two major questions in this respect: (1) who will do the monitoring; and (2) whether there is an acceptable technology available for making the measurements.

One of the first questions which must be answered in designing a monitoring scheme is whether the initial burden of making the quantitative and qualitative measurements on which the charges are to be based will lie on the discharger or on the charging authority. When one considers the expense and the practical difficulties of allocating the entire measurement task to the government, the answer comes rather easily. The bureaucratic burden that would result from exclusive reliance on monitoring by the regulators would be enormous, but fortunately this is a problem that is easily avoided by requiring each major pollution source to monitor and report its own discharges. Moreover, equity and economic efficiency suggest that the costs of monitoring be imposed on the sources of the problem rather than on the public at large.

But would not self-reporting provide too great a temptation for under reporting? Is it realistic to expect dischargers to be completely

---

38. H. KELLOGG & J. HENDERSON, *Energy Use in Sulfide Smelting of Copper* in J. YANNAPOULOS & J. AGARWAL (ed.), *EXTRACTIVE METALLURGY OF COPPER* (1976).

honest in their measurements? What happens when the measurement device breaks down (either accidentally or with assistance) and produces no data about pollutants? The answers to these questions are not so difficult as they may seem. To begin with, there is a precedent for the viability of a self-reporting approach in the income tax system. While it cannot be denied that there is some income tax cheating, the majority of business tax returns are entirely honest; the amount of false reporting is not nearly great enough to threaten the viability of the system.

The application of a self-reporting system to charges would require occasional verification by the authorities (analogous to income tax audits) and penalties for intentional misreporting, but such provisions are hardly novel to our legal system. They might be supplemented in the environmental field by provisions for "bounties" to private citizens who developed evidence leading to the exposure of a polluter for false reporting.

Nevertheless, no matter who does the monitoring someone must produce acceptable estimates of emissions. In general the measurement of gaseous discharges from large stacks is rather tricky but instrumentation does exist, and for large sources such as would be involved in sulfur emissions fees in the Southwest, the cost is relatively small.

However, one of the reasons for starting with sulfur components in the development of a regulatory fee approach is that a very simple method can be used for monitoring emissions. It is a simple matter to determine by chemical analysis the sulfur content of a fuel, and the sulfur content of the ash material, and therefore the proportion of sulfur going up the stack. If a plant installs abatement equipment to remove sulfur from the stack gases, it is again a relatively simple matter to determine the amount removed and deduct that from the total sulfur burned to arrive at the amount that goes up the stack.

## V. MOBILE SOURCES OF AIR POLLUTION

### A. Introduction

At the outset we mentioned that air quality degradation is the result of two main sources in the Southwest: the very large industrial emitters, and automotive vehicles. We turn now to a discussion of the latter. In an earlier section a bit was said about the history of legislation pertaining to mobile sources of airborne residuals. Before turning to a discussion of the problem of automotive emissions specifically in the Southwest context, it will be useful to fill in the more



recent history of automotive emissions' regulatory efforts at the national level.

Prior to the passage of the Clean Air Act of 1970 federal legislation had very little impact on automotive emissions. By 1970 Congressional framers of legislation had come to the conclusion that motor vehicle emissions would not be lowered to levels sufficient to protect public health unless Congress specifically established emissions standards and set schedules for reaching those standards. The Congressional standards set in the amendments of 1970 were intended to assure attainment of health related air quality levels according to calculations supplied by the National Air Pollution Control Administration in the Department of Health, Education and Welfare. The deadlines for meeting those standards were 1975 and 1976 model years, which gave some recognition to industry's need for lead time to develop the necessary control technologies and equipment. The standard for automobiles sold during the model year 1975 and thereafter called for a reduction in hydrocarbons and carbon monoxide emissions of 90 percent from levels produced by 1970 cars, which already had achieved a modest degree of control. Similarly in model year 1976, a 90 percent reduction in nitrogen oxide emissions was required compared to the 1971 standard.

Congress also authorized the EPA Administrator to grant a one year delay of these standards. The Administrator did grant a delay, and thus the 1975 requirements for HC and CO were pushed back to 1976 and the 1976 requirement for NO<sub>x</sub> was pushed back to 1977. When the delay was granted, interim standards were set for 1975 as was required by law. One set of standards was set for 49 states, a more stringent standard was in effect for California in 1975, and both were more lenient than the full 90 percent reduction requirement.

In June 1974 Congress amended the Clean Air Act by adopting the Energy Supply and Environmental Coordination Act. That act further delayed new car emission standards, and the interim standards prescribed by the Administrator were carried over through model year 1976. In addition Congress authorized the Administrator to grant an additional one year delay of the HC and CO standards to model year 1977. Furthermore, Congress postponed the full 90 percent NO<sub>x</sub> reduction requirement until model year 1978. The automobile industry has thus already received a moratorium of three years through 1978 from the initial compliance date written into the 1970 Act. This came as a consequence of both legislative and administrative actions. In 1977 the Congress once again amended the Clean Air Act, further weakening standards and delaying deadlines.

The Clean Air Act also specifies that a fine of up to \$10,000 per vehicle be levied on any manufacturer who is not in compliance with the standards. This extreme penalty, which if applied would shut down the industry, has been one of the causes for reluctance to enforce deadlines. Furthermore, the control which has been achieved up to this point has come at the cost of fuel penalties vis-a-vis that which could be achieved presently if such controls were not implemented. If the original 1976 NO<sub>x</sub> requirements were implemented now, it appears that they could be met, if at all, only at the cost of substantial further fuel penalties.

Since the 1970 amendments there have been several detailed studies of government policies toward automotive emissions control. These are carefully and exhaustively reviewed in a paper by Edwin S. Mills and Lawrence J. White entitled *Government Policies Toward Automotive Emissions Control*.<sup>39</sup> The authors conclude that while a certain amount of progress has been obtained in emissions control, it has been a slow and costly process involving tinkering with present technologies rather than any substantial change in the basic technology which would lead to lower emissions by power plants.

Several such technologies have been in existence since the 1920's and 1930's: the stratified-charge engine; Stirling and Rankine cycle engines; fuel injection; the diesel engine; lean-burn engines and various other devices that can be employed to regulate the combustion process more precisely. More recent developments include the use of sophisticated electronics and computer technology. The succession of gradually tighter year by year requirements in the current legislation has encouraged small modifications of the standard internal combustion engine rather than more fundamental changes.

Another related and well documented aspect of the current situation (see Mills and White) which is very pertinent to the situations in the Southwest, is that automobiles which meet the test requirements of the legislation in their prototype stage do not do nearly so well on the road. In part this is because the manufactured models cannot perform as well as the prototype, but even more important is poor maintenance and tampering with control devices by consumers.

### *B. The Situation in the Southwest*

In the Southwest both new and old cars have failed to achieve the new car standards because of the higher altitude. The altitude also

---

39. APPROACHES TO CONTROLLING AIR POLLUTION (Ann F. Friedlaender, ed.) (1978). (Paper presented at MIT Conference on Air Pollution and Administrative Control, Cambridge, Mass., December 2, 1976.)

aggravates the production of oxidants through the increased ultra-violet radiation which speeds chemical reactions. The relatively rapid growth of Southwestern metropolitan areas tends to negate gains made in emission reductions. Furthermore the meteorology of the western mountain valleys is marked by frequent and strong inversions which further aggravate the situation. At the present time newspapers are reporting Denver to be the "second most polluted" city in the country.

Emissions of oxides of nitrogen are of special concern and are especially difficult to control. Early gas chamber studies suggested that control of hydrocarbons alone was adequate to prevent the formation of photochemical smog. However, recent analyses<sup>40</sup> have suggested that methane and hydrocarbons from natural sources may be sufficient to combine with  $\text{NO}_x$  to form photochemical smog. In addition, recent and as yet unpublished measurements in the Lake Powell Research Project show a depletion of methane and ethane in the plume of a small town. Existing photochemical models would not have predicted effects the magnitude actually found. This suggests that our current knowledge of photochemistry has some serious shortcomings. In view of the increasing proportion of  $\text{NO}_x$  in our urban effluents this is cause for concern.

To illustrate the relatively high rate of emissions in the Southwest Region, Table 2 shows emissions from 1966-72 automobiles in use in six cities. In 1973, more than half of the 1972 vehicles in five cities failed either the HC or the CO test; only 39 percent passed both. In Denver *only 3 percent* passed both.

A combination of high emissions and fragile atmospheric conditions is producing a notable deterioration in urban air quality in several Southwestern cities. The situation in Albuquerque (population  $\approx 300,000$ ), while not as bad as that in larger cities in the region is illustrative.

A summary of recent Federal primary ambient standard violations is presented in Table 3. It is apparent from Table 3 that CO, ozone, and particulates present the most immediate problem to the area, at least of those substances measured fairly regularly.<sup>41</sup> Table 4 indicates the 1973-1975 maximum concentrations of these airborne residuals in Albuquerque. For comparison, Federal, New Mexico, and Albuquerque-Bernalillo County Air Quality Control Board ambient air quality standards for these pollutants are presented in Table 5.

---

40. W. CHEMAIDES & J. WALKER, *A Time-Dependent Photochemical Model for Ozone Near the Ground* 81, J. GEO. RESEARCH 413-20.

41. With the exception that the ambient standards may underrate the importance of nitrogen oxides as discussed above.

TABLE 2.  
IN USE EMISSIONS FROM 1966-72 AUTOMOBILES IN SIX CITIES USING 1975 CVS-CH TEST (in 1976)

Model Year	Number of Cars	Average Mileage	HC				CO			
			Federal Standard	Mean Emissions	Estimated Standard Deviation of Mean		Federal Standard	Mean Emissions	Estimated Standard Deviation of Mean	
1966-67	140	69,300	—	8.67	0.59	—	93.5	3.39		
1966-67 Denver	35	65,300	—	11.91	1.41	—	141.0	9.30		
1968	105	59,300	5.9	6.34	0.50	50.8	63.7*	3.29		
1968-Denver	21	51,400	5.9	6.89	0.81	50.8	101.4*	14.36		
1969	110	50,900	5.9	4.95	0.31	50.8	64.2*	3.25		
1969-Denver	22	46,100	5.9	5.97	0.27	50.8	97.8*	8.13		
1970	135	37,500	3.9	5.24*	0.41	33.3	58.3*	3.30		
1970-Denver	27	31,600	3.9	5.56*	0.30	33.3	87.5*	6.01		
1971	150	27,300	3.9	3.95	0.18	33.3	52.8*	2.88		
1971-Denver	30	18,200	3.9	5.19*	0.32	33.3	80.3*	6.80		
1972	175	15,400	3.0	3.13	0.21	28.0	28.8*	1.84		
1972-Denver	35	14,100	3.0	4.75*	0.41	28.0	80.4*	5.49		

\*Significantly above the applicable Federal Standard at a 95 percent confidence level.

Source: Bernard Donovan and H. T. McAdams (1975), "Automobile Exhaust Emissions Surveillance—Analysis of the FY 1973 Program," CALSPAN Corporation for USEPA, office of Air and Waste Management, Ann Arbor, Michigan, July, p. 57.

TABLE 3.  
PRIMARY STANDARD VIOLATIONS\* IN ALBUQUERQUE  
(number of days in which violations occurred)

<i>Year</i>	<i>CO**</i>	<i>Ozone†</i>	<i>NO<sub>2</sub>‡</i>	<i>Particulates</i>
1975	149	57	0	N/A
1974	55	8	0	4
1973	86	109	0	4

\*Source: Tom Busch, Air Quality Control Division, Albuquerque Environmental Health Department.

\*\*In 1975 there were 3 stations measuring CO. In 1974 and 1973 there were two stations measuring CO.

†The 1975 figure is for 7 months at one station only. 1974 and 1973 figures are for 3 stations.

‡The 1975 figure is for 6 months.

It is believed that transportation generates approximately 95 percent of CO emissions and 61 percent of HC emissions in Albuquerque. Therefore, the EPA is requiring that Albuquerque commit itself to implementing a strategy for the control of automotive air pollution. Consequently, an Air Quality Plan devised by TRW Industries under an EPA contract addressed methods for minimizing automobile engendered pollution. A key program involved retrofitting air pollution control devices to older cars and periodic inspections of them. However, the funding for inspection stations was defeated in a bond election and the State government has shown little interest in funding the program. Consequently, utilizing transportation planning to improve air quality is at an impasse.

In fact, functional transportation planning (planning to meet pro-

TABLE 4.  
MAXIMUM CONCENTRATIONS\*

<i>Year</i>	<i>8 hr. CO(PPM)</i>	<i>1 hr. CO(PPM)</i>	<i>1 hr. Ozone(PPB)</i>	<i>24 hour Particulates(ug/m<sup>3</sup>)</i>
1975	29.8	45	137	N/A
1974	20.5	35	N/A	622
1973	28.3	43	135	334

\*Source: Information provided by Tom Busch, Air Quality Control Division, Albuquerque City Environmental Health Department.

TABLE 5.  
 AMBIENT AIR QUALITY STANDARDS

Pollutants, units/ Averaging Time	National*		New Mexico**	Albuquerque-Bernalillo County†
	Primary	Secondary		
Carbon Monoxide, mg/m <sup>3</sup> (ppm)				
8 hours	10(9)	10(9)	10(8.7)	
1 hour	40(35)	40(35)	15(13.1)	15(3)
annual mean				4.6(4)
Oxidants, μg/m <sup>3</sup> (ppm)				
1 hour	160(0.08)	160(0.08)	120(0.06)	20(0.01)
Total Suspended Particulates, μg/m <sup>3</sup>				
1 year (geo- metric mean)	75	60	60	60
24 hours	260	150	150	150

\*Source: Gary C. Thom and Wayne R. Ott, *Air Pollution Indices* (Washington, D.C.: Council on Environmental Quality, December 1975).

\*\*Source: Environmental Improvement Agency, *Ambient Air Quality Standards and Air Quality Control Regulations*, (Santa Fe: State of New Mexico, March 1976).

†Source: "Air Pollution Control Regulations" adopted by the Albuquerque-Bernalillo County Air Quality Control Board on May 21, 1973.

jected demands and to relieve bottlenecks) is oriented towards expanding access points and the capacity of the interstate highways (I-25 has a North-South orientation and I-40 has an East-West orientation). Additional near term highway planning includes pieces of a beltway which will eventually circumvent the present developed portions of the city and service developing or planned leap-frogging subdivisions in the Southwest, West and Northwestern portions of the city as well as the continuous expansion of numerous smaller scale subdivisions to the Northeast. These piecemeal highway developments are a replacement for an inner beltway conceived of approximately ten years ago but never implemented.

This piecemeal policy of an outer loop will aid in further encouraging low density sprawl making any effective and efficient mass transit system a virtual impossibility. This sprawl configuration is universal among the newer cities in the Southwest. Furthermore, studies of several cities including Boston and Chicago in their parts of the country and Colorado Springs and Albuquerque in the Southwest show that while urban form can be designed to influence air quality,

radical and probably impractical restructurings are necessary in order to have much effect.<sup>42</sup> Accordingly emissions control remains the chief means for protecting the atmospheric environment. The problem of the poor emissions performance of motor vehicles already in service is a central one in this regard.

We have also examined the role of city size on the concentrations of carbon monoxide. In this context Albuquerque has been used as the model. The average emission density is that appropriate to 1970. The emission density is assumed to decline linearly with distance in each direction.<sup>43</sup> The table below summarizes the results.

Peak 1 Hour Average CO Concentrations

<i>Approximate Population</i>	<i>Site Relation to Albuquerque</i>	<i>Estimated Maximum Concentrations</i>
75,000	.25	21 ppm
300,000	1.00	42
675,000	2.25	58
1,200,000	4.0	68
1,686,000	5.62	79

It is clear that peak concentrations increase much more slowly than city size. Increasing city size does produce higher concentrations of CO, but the more obvious role is to vastly increase the area over which excessive concentrations may be found. The model calculations suggest that carbon monoxide concentrations are most closely related to the peak emission density. For this reason even relatively small cities such as Santa Fe can experience excessive concentrations if traffic patterns give rise to high emission densities.

### *C. An Alternative to the Present Approach*

How can the two problems of insuring automobile and emission control equipment maintenance and stimulating new, less polluting, automotive technology be solved? Fifteen years ago economists at the RANN Corporation proposed an answer, which administrative and distributive problems aside, appears to be the economically ideal situation.<sup>44</sup> The proposal is that cars in service be tested periodically

42. See A. CHURCH, et al. *THE EFFECT OF LOCAL GOVERNMENT POLICY TOOLS ON LAND USE AND ENVIRONMENTAL QUALITY—A CASE STUDY OF ALBUQUERQUE, NEW MEXICO* (1976).

43. A gaussian model with Turned dispersion parameters for E stability with an area source made up of grids 1 km on a side was used. When cities of different sizes were considered the average emission density was kept the same and the area was enlarged or decreased to achieve the desired population level.

44. D. FORT, et al., *Proposal for a Smog Tax*, reprinted in tax recommendations of the President, hearing before the House Committee on Ways and Means, 91st Cong., 2d Sess., 1970, pages 369-70.

and assigned a smog rating indicated by a seal or coded device attached to the car. When the driver purchased gasoline he would pay a fee over and above the basic gasoline tax that would vary with this smog rating. Changing the fee based on final user of the car has the advantage of stimulating responses all along the chain from driver decisions to the manufacturer. An individual could reduce his smog tax bill in several ways:

(1) Tuning or overhauling his engine to reduce emissions and to obtain better gas mileage would be an economical alternative to paying the tax. Since poor tuning of automobiles on the road is an important contributor to actual emissions this could be quite important.

(2) The car owner has many options that would allow him to drive fewer miles per year—living closer to his job, using mass transit, or participating in car pools. Standards based on emissions per vehicle mile do nothing whatsoever about miles driven, but a smog fee could affect this extremely important variable as well as emissions per mile.

(3) Control devices could be installed on older cars. In 1970 in a market test, General Motors offered control kits for pre-1968 models at about \$20.00 installed, but no one bought them. Clearly it was nonsensical to expect anyone to make this investment since, without assurance that others would make it, any one person's effect on the situation would be negligible. A smog fee would introduce a new persuasive element into this calculation. It is unlikely and, for various reasons, perhaps undesirable that a pure full scale smog fee system of the type proposed will ever be enacted. But there is evidence of strong interest in the use of economic incentives for automotive emissions control in the Congress, led by Senators from the Southwest region, and there are initiatives that the states could effectively take along these lines.

As a result of frustration with the present approach to automotive emissions control an effort was made to embody some sort of emissions fee on new cars into the 1977 Clean Air Act Amendments.<sup>4 5</sup> The attempt failed. In any case it would not have helped with the problems of existing vehicles, and the states have a real opportunity to innovate in this area that is so important to the major urban places in the Southwest.

#### *D. Possible Action by States*

As a first step the states could levy an emissions fee on new cars which would amount to several hundred dollars on the heaviest

---

45. Letter from Senators Domenici and Hart to President Carter dated January 5, 1977.



polluters currently being sold. This fee would be payable at the time of registration, and would be levied on average emissions of a particular vehicle type as determined by the testing of prototype fleets which EPA is doing now. The fee would be based on emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen. Mills and White's report, based on rough damages data and an assessment of control costs, suggests that the total fee, based on a per unit of emissions assessment for emissions of uncontrolled cars in a high damage area, should be about \$900. Applying the same fee schedule to an automobile meeting the 1975 interim standards would yield about \$400. If emissions are less than these standards the total fee would be proportionately lower. This policy would encourage persons to select the lowest emissions models available and would give a powerful marketing advantage to those producers able to beat the federal standards. (It should be possible to control the bootlegging of new cars from other states through the registration process.)

For the existing population of cars a pure smog fee applied to all vehicles based on tests performed at the time of vehicle inspection, and taking into account the mileage driven (a variant of the smog tax discussed above), would have some highly desirable features. But there are some potential weaknesses too. First, there may be a substantial time and inconvenience cost to automobile users in administering a program of fees on automobiles already in use. Secondly, since it is probably true that poorer people drive the most polluting cars, the effect of fees on the automobile users will be at least somewhat regressive with respect to income. There are several ways one could attempt to come to grips with these problems in framing legislation.

One alternative to direct fees on automobiles in use would be to levy a pollution surcharge on the sale of gasoline, and provide rebates to those who offer their vehicles for inspection and meet emission standards specified for cars of a particular age. A surcharge, of say 10 cents a gallon, would yield on the average revenues of \$100 per vehicle. Since not all automobile owners would find the time and convenience cost of bringing cars in, keeping necessary documents, etc., worth the rebate, the actual amount available for rebates would be in excess of a \$100 per car minus whatever administrative costs the program would need. This would cover the cost of major tuneups and, with a time perspective of several years, major overhauls. It could also result in significant gasoline savings. The noncoercive aspect of this proposal is attractive.

Since in general it would seem that less affluent people would be

more willing to incur the time and inconvenience cost of bringing their cars in for inspection, the program would most probably be progressive in its cost incidence vis-a-vis a pure smog charge. The problem of the oldest cars which cannot be brought into compliance without a very large expenditure of funds, for example engine replacements, could be handled by initially making the emission standard zero for cars beyond some age, say eight years. But the age of cars to which standards apply should be increased progressively to encourage emissions reduction techniques which are lasting.

In addition, an emission fee based on a somewhat reduced scale from that applicable to new cars could be levied at the time of sale of every used car from an organized dealership. The purpose of this proposal is to make it economically worthwhile for dealers to sell only cars that have been tuned and repaired. Moreover, such a fee program would confer higher resale value on cars containing long lasting control technologies such as stratified-charge engines. Initially, to avoid adverse distributive effects on poor people driving heavily worn automobiles, the fee could apply only to cars built in fairly recent years. Eventually the fee should be applied to all cars of whatever age, which should lead to a choice of major repairs or earlier scrapping. The latter would permit an earlier rolling in of less polluting technology to the automobile stock.

## VI. CONCLUDING STATEMENT

The Southwest region, defined for our purposes to be the Four Corners states of Arizona, Colorado, New Mexico, and Utah, faces a particularly difficult problem of air quality degradation. The two main sources of emissions are large heavy industries and automotive vehicles. In both cases regulatory approaches based on federal and state law have met with only limited success. In both cases there are significant opportunities for the states to take major initiatives to change the system of economic incentives which now makes pollution profitable. Failure to do this implies that the atmospheric quality of the region will get progressively worse, and if rapid development of the extractive industries occurs without regulations it will get drastically worse.