- The planned construction of a coal-fired station at the Perryman site in 1998 will increase the total coal-fired generating capacity to 6,006 MW.

Air Quality Impact of Increased Coal Use

In general, for the same heat input rate, use of coal results in greater potential emissions of particulates, sulfur oxides, and nitrogen oxides (in lbs/million Btu) than oil. Emissions of particulates from coal combustion can be reduced to levels comparable to or below those resulting from fuel oil combustion by use of emission-limiting devices (e.g., precipitators). However, in the absence (as in Maryland) of add-on control systems for sulfur and nitrogen oxides, use of coal will (as in Maryland), result in greater emissions of these pollutants. The incremental increase in emissions from the oil-to-coal conversion will vary with power plant, and will depend on such factors as the ash or sulfur content of the coal, and the designs of the boiler and control systems. Table III-7 presents a comparison of representative emission factors for the two fuel types, based on typical fuel characteristics.

An evaluation was made of the impact a conversion of the C.P. Crane power station to coal would have on the air quality of the Baltimore area(21). The conversion involves changing from 1 percent sulfur oil to a higher sulfur content coal (3.5 lb $SO_2/10^6$ Btu, which is equivalent to 2.3% S coal).

The evaluation, based upon one year of meteorological data, was made with an EPA-approved Gaussian plume model (CRSTR) and included the SO_2 and TSP stack emissions of the major Baltimore-area power plants, i.e., Crane, Gould, Riverside, Wagner, Westport, and Brandon Shores.[1] "Baseline" and post-conversion emission conditions are listed in Tables III-8 and III-9.

The models were used to calculate ground-level concentrations of sulfur dioxide and particulates and estimates of PSD increment consumption. The increase of the TSP ground-level concentration in the non-attainment area due to the coal conversion of Crane was calculated to be negligible. The analysis assumed efficient particulate collection equipment, i.e., a baghouse, for stack emissions. With fugitive particulate emissions from coal storage piles and coal-handling operations however, local impacts are more significant, but fall within PSD guidelines.

Applicable ambient air quality standards for TSP and SO_2 were shown to be met. However, the model predicted that a maximum of 62 percent of the available 24-hr PSD increment for

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[1]Brandon Shores, Unit 1, will be operational in mid 1984; Unit 2, in 1988.

Table III-7. Uncontrolled Emission Factors for Major Pollutants from Coal and Fuel Oil Combustion (from Ref. 22)

Pollutant	Coal[a]		Fuel Oil[b]	
	lb/ton	lb/10^6 Btu	lb/10^3 gal	lb/10^6 Btu
Particulates	16xA[c]	6.0	10xS+3	0.12
Sulfur Oxides	38xS[d]	2.375	159xS	1.59
Nitrogen oxides	18.0	0.75	50[e]	.33

(a) Coal is assumed to have $24x10^6$ Btu/ton.

(b) Fuel oil is assumed to have 150,000 Btu/gal.

(c) 'A' is the percent ash in the fuel, assumed to be 9% for the lb/10^6 BTU column.

(d) 'S' is the percent sulfur in the fuel, assumed to be 1.5% for the lb/10^6 BTU column.

(e) 105 for other than tangentially fired boilers.

Table III-8. "Baseline" Nominal Emission Conditions for Major Baltimore Area Power Plants

Plant	Fuel Sulfur Content (%)	Fuel Type	Exit Velocity (ft/sec)	Exit Temp. (`F)	SO_2 Emission Rate (lb/hr)	TSP Emission Rate (lb/hr)	TSP Rate / SO_2 Rate
Crane 1	1	oil	80	340	1367.3	48.8	0.036
Crane 2	1	oil	78	330	1139.2	40.6	0.036
Gould 3	1	oil	59	290	538.3	19.2	0.036
Riverside 1, 2	1	oil	39	330	409.0	14.6	0.036
Riverside 3	1	oil	39	330	79.1	2.8	0.036
Riverside 4, 5	1	oil	54	280	630.8	22.5	0.036
Wagner 1	1	oil	57	259	590.1	21.1	0.036
Wagner 2	1	oil	57	259	878.5	31.3	0.036
Wagner 3	1	coal	68	295	2104.3	84.2	0.040
Wagner 4	1	oil	104	567	1764.9	62.9	0.036
Westport 1, 2	1	oil	38	285	78.2	2.8	0.036
Westport 3	1	oil	45	340	192.4	6.9	0.036
Westport 4	1	oil	44	340	159.7	5.7	0.035
Brandon Shores 1, 2	1	oil	105	600	6770.0	241.4	0.036
Crane 1, 2	2.3	coal	86.1	335	7710.8	132.5	0.017

Table III-9. Maximum Emission Conditions for the Coal Conversion at the C.P. Crane Power Plant

Plant[a]	Fuel Sulfur Content (%)	Fuel Type	Exit Velocity (ft/sec)	Exit Temp. (°F)	SO2 Emission Rate (lb/hr)
Crane 1,2	2.2[b]	coal	118.0	325	11,984

(a) All additional power plants have model input conditions which are equivalent to those corresponding to the "baseline" configuration (see Table III-9)

(b) 3.5 lb SO2/m Btu coal

SO_2 would be consumed at one particular location near the plant. The highest annual predicted SO_2 PSD consumption was $4 mg/m^3$, or 21 percent of the allowable increment.

The increase in annual SO_2 ground-level concentrations between "baseline" and post-conversion, based on model results, is depicted in Figures III-10 and III-11. An overall increase is observed particularly near the Crane plant.

Questions have been raised regarding increased emissions of trace inorganic elements (including radionuclides) along with the particulate emissions from coal. During the combustion process, certain elements present in the coal tend to get enriched in the fly ash, and can be emitted with it. Arsenic and lead, for example, can have an enrichment ratio (concentration of element in suspended fly-ash divided by concentration of element in coal) as high as 5. The new PSD regulations set de minimis values for several pollutants, including lead and mercury. New power plants have to demonstrate that their emissions of such pollutants are below de minimis values in order to avoid PSD review for those pollutants. If emissions exceed de minimis levels, additional air quality analyses and control technologies may be required. However, EPA has recently determined that there is no basis for promulgating emission standards for radionuclides emitted from coal-fired boilers. Given the very low levels of these and other trace element emissions and the absence of specific control technologies for them (other than overall particulate control), no regulatory requirements applicable to such emissions have been deemed necessary.

Coal conversions also result in increased particulate emissions from the transport, handling, storage, and preparation of coal, and from the handling and disposal of fly ash and bottom ash. Wind erosion fugitive emissions result from the transport of coal in open barges and railcars. Unloading operations, e.g., at railcar dump stations, cause additional emissions. Perhaps the major sources of fugitive emissions result from outdoor coal storage piles, wind erosion, vehicular traffic, and stacking and reclaiming operations. Fly ash is generally disposed of either by wet techniques (ash impoundments or ponds) or dry techniques (landfilling). Fugitive emissions can result from dried ash ponds and landfills, and also from the ash handling operations.

G. Acid Rain

Measurements of the ion content (or acidity) of rainfall in the eastern United States, including Maryland, suggest that the presence of high concentrations of hydrogen ion (as evidenced by low pH) is associated with large amounts of sulfur and nitrogen oxides in the rain. These oxides, released in significant quantities by both natural and man-made sources, can be converted chemically in the atmosphere to strong acids. If not

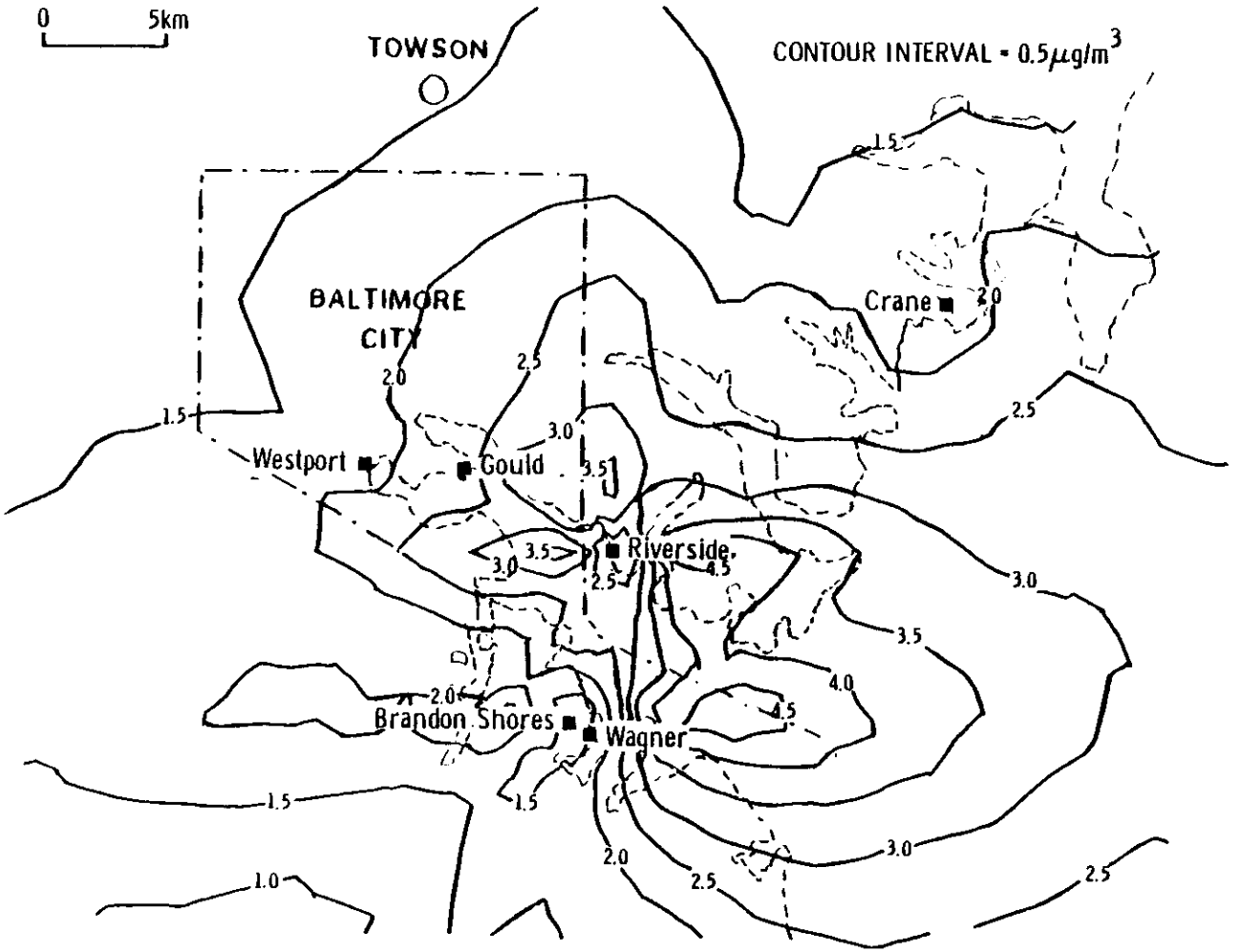


Figure III-10. Baseline annual SO_2 ground-level concentrations for various Maryland power plants (from Ref. 21).

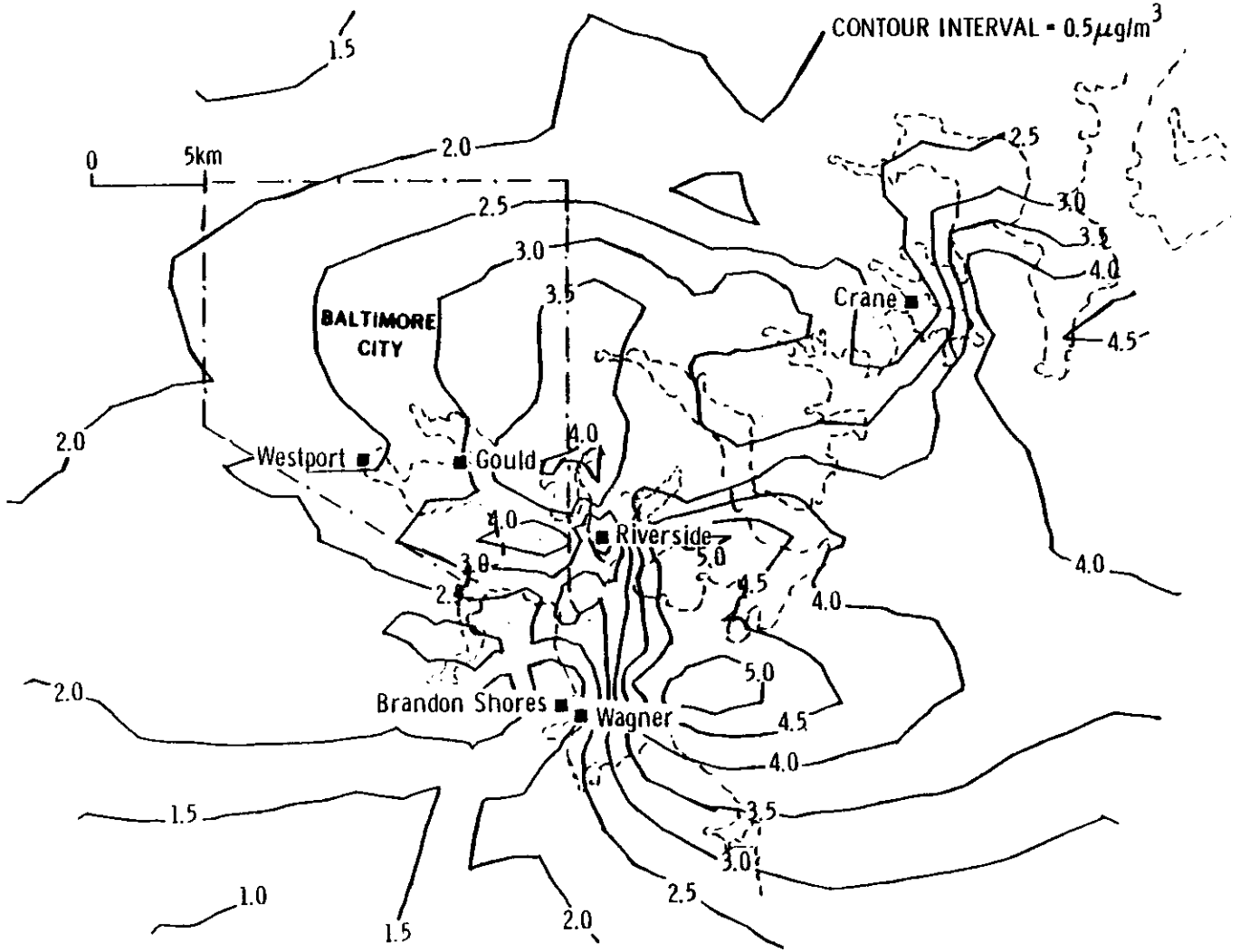


Figure III-11. Annual SO_2 ground-level concentrations for various Maryland power plants including the impact of Crane coal conversion (from Ref. 21).

neutralized by alkaline substances also present in the atmosphere, these acids ultimately fall to the earth's surface as wet and dry depositions. The transformation and transport of these acids in the atmosphere (sometimes for as long as two to four days and as far as 600 miles) can lead to region-wide episodes of both suspended particulate matter (the "summer-time haze" effect on the eastern seaboard)(23) and acidic precipitation.

In recent years, power plants have come under increasing surveillance as sources of the SO_2 and NOx that may lead to the acidification of precipitation(24). Maryland power plants contributed aproximately one-half of the State's total sulfur oxide emissions and one-fifth of the State's total nitrogen oxide emissions during 1979 (see Table III-1).

Several investigators have studied the distribution of wet deposition of sulfur around power plants. Data from an oilfired power plant in Sweden indicated that 1 to 6 percent of the sulfur emitted during periods of precipitation was deposited within 15 km(25). A study conducted near a copper smelter and power plant in Washington State suggested that about 8 percent of the sulfur emitted by the smelter during a rain storm was deposited within 40 km of the source(26). An investigation of sulfur oxide deposition patterns from the city plume of Uppsala, Sweden (2/3 of which could be attributed to a large heating station), led to the conclusion that about 50 percent of the sulfur emitted during precipitation was deposited as acid sulfate within a 90 km radius of the city(27).

From these reports, it appears that the proportion of newly emitted sulfur deposited in the immediate vicinity (15-30 km) of the sources during periods of rain probably is 5 to 10 percent of the total sulfur emissions. From this result, the maximum impact to be expected in the vicinity of a large Maryland power plant can be estimated. In 1981, the highest SO_2 emissions reported at any location in the State occurred at the Morgantown power plant in Charles County -- about 92,000 ton/yr. Assuming that rain occurs 6 percent of all hours(28), that SO_2 emission rates are independent of rainy conditions, and all SO_2 is converted to sulfate, the annual wet sulfate deposition in the vicinity of Morgantown due to local deposition from the plume would be about 414 to 828 tons. With a deposition radius of 30 km and a uniformly distributed deposition density, the average sulfate deposition density in the affected region due to these emissions would be about 0.4 to 0.8 ton/sq mi/yr (1.4 to 2.8 kg/ha/yr).

Statewide average acid deposition rates can be estimated from estimated annual average rainfall amounts and from estimated and measured precipitation hydrogen ion content. Precipitation rates vary across Maryland (Figure III-12) with somewhat higher amounts occurring on the Appalachian plateau and the Eastern Shore (up to 48 inches annually) and lower amounts occurring in the Cumberland area (due to the shadow effect caused by orographic influences of the elevated plateau to the

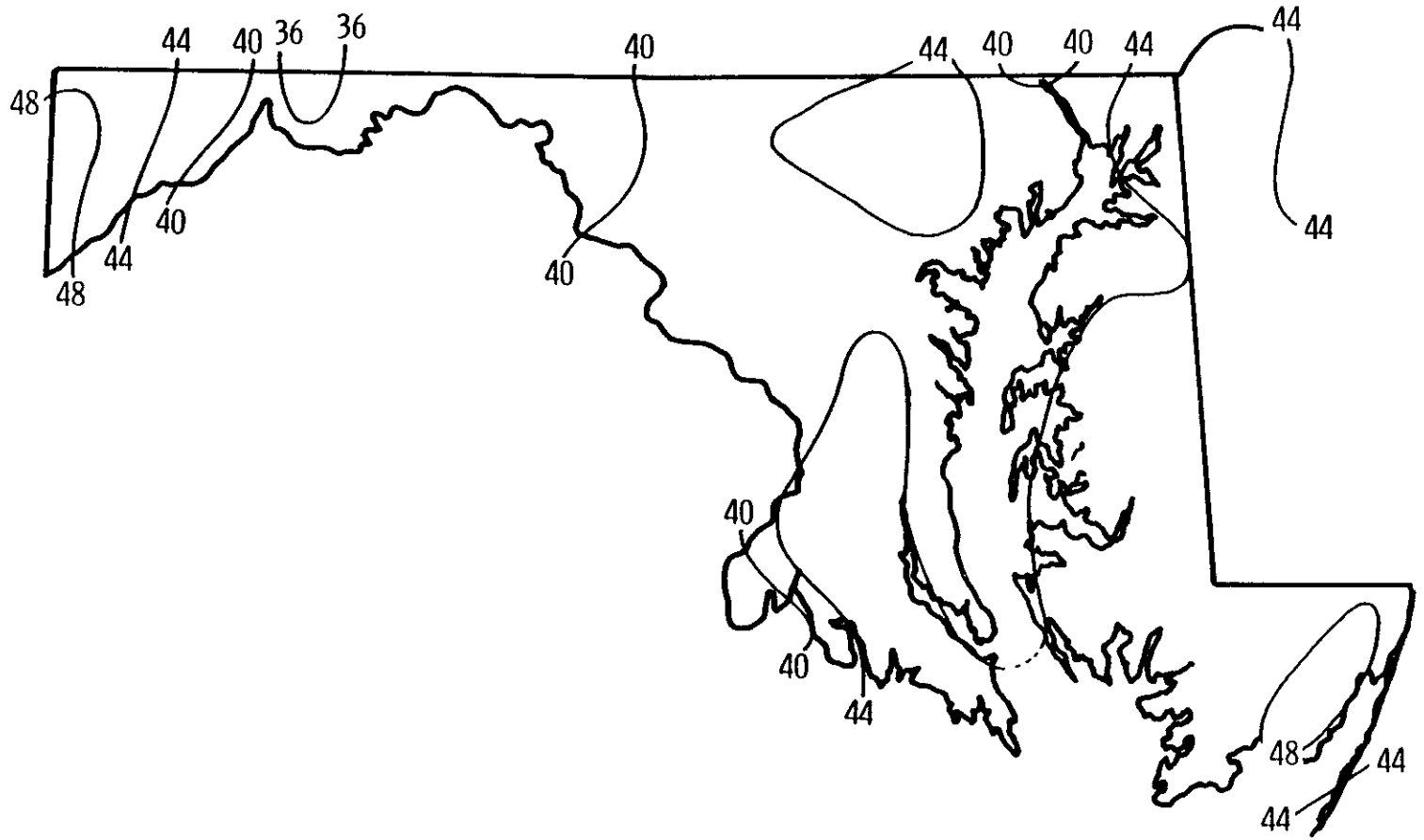


Figure III-12. Mean annual precipitation (inches) in Maryland. Isolines are drawn through points of approximately equal value. Caution should be used in interpolating on these maps, particularly in mountainous areas (from Ref. 29).

west). However, the average annual precipitation in Maryland is 43 inches(30). This amount, which has an average hydrogen ion content of 100μM/l (based on data collected throughout the State), is equivalent to a total annual hydrogen ion deposition of 0.28 ton/sq mi/yr (.98 kg/ha/yr)(31). Since the statewide, average sulfate, wet deposition rate (determined from NADP data for sites not impacted by local sources) is about 6 to 11 ton/sq mi/yr (21 to 38.5 kg/ha/yr), it is evident that the spatially averaged impact of local sources on the annual average will be small relative to the regional effects previously reported(31).

The measurement of the pH of precipitation in close proximity to a Maryland power plant was the subject of a study in 1973(24). Precipitation samples were collected from a dense network of rain collectors stations surrounding Chalk Point, a 710-MW coal-burning power plant with two 122-m stacks. The lowest pH values for precipitation events between July and September 1973 were found to occur in the immediate vicinity of the stacks, and increased irregularly outward (see Figure III-13). The station mean pH values ranged from 3.7 to 4.4, with individual measurements ranging from 3.0 to 5.7.

Several other studies conducted at Chalk Point had similar results(32,33). Bulk rain collections yielded hydrogen ion concentrations up to 100μM/l (pH=4) in the immediate vicinity of the plant. The lowest pH values were observed at the onset of precipitation. Passage of the power plant plume over the sampler led to sharp decreases in pH (from 5.6 to 4.0 in one experiment). The lowest observed short-term average pH was 3.2.

In recent years the number of acid deposition monitoring programs in Maryland has increased. The majority of these have been of relatively short duration and oriented toward individual sets of objectives.

The objectives generally fall into four broad areas:

- Assessment of sources of acid-forming pollutants
- Determination of loadings of various precipitation components (such as sulfate and nitrate)
- Temporal and spatial trends in precipitation chemistry
- Study of the chemical transformations of various atmospheric pollutants.

Although these general objectives are not necessarily mutually exclusive, the design of the program does depend on the objectives, or combination of objectives, to be addressed. For example, precipitation samples collected for a period of a week will suffice for determination of annual precipitation chemistry trends but this frequency is insufficient to examine the variability of chemistry among and between events. Spatial

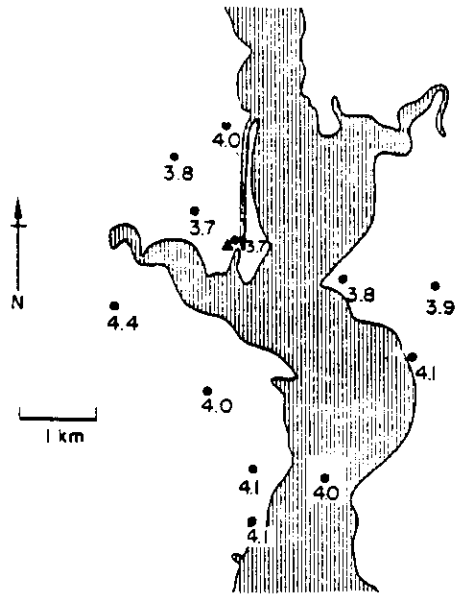


Figure III-13. Mean rainwater pH for six events during July-September in the vicinity of the Chalk Point, Maryland, power plant. The positions of rain collectors are indicated by ●; the plant is located at ▲.

variability cannot be determined by one monitoring site alone. Thus, the objectives of a monitoring program must be defined prior to program design.

The parameters measured, and sampling frequencies of each study are summarized in Table III-10. See Figure III-14 for location of stations. There is only one program currently active in the state with a data record longer than four years (the Smithsonian Environmental Research Center Rhode River project), although another project collected data around metropolitan Washington, DC for the period from 1975-1981. The remaining projects have existed for a shorter time period than these two, and several of them have been terminated.

Comparison of the data produced by these studies is possible but somewhat difficult since: (a) each program has used methods which in most cases are not consistent between the studies; (b) estimates of the error associated with the measurements are not reported in some cases; and, (c) the types of precipitation samples collected (e.g., bulk vs wet-only precipitation samples) are not consistent between programs. For further details on these and national acid precipitation monitoring effects see Reference 43.

To help improve data comparability, sample collection and handling methods, as well as analysis techniques, must be rigorously defined and followed. Replicate analyses, spiked and blind samples, and quality assurance and control procedures are recommended by National Bureau of Standards (41) in order to reduce uncertainties that exist in the chemical analyses of precipitation due to the relatively dilute nature of the components and the generally small sample volumes involved.

Efforts toward standardization in these areas are underway nationally within the American Society for Testing and Materials and the National Bureau of Standards through the development of a set of standard precipitation samples and certain standard analysis technique methods to be used on a voluntary basis.

From the monitoring programs discussed above, it is clear that precipitation in Maryland has an annual average pH in the range of 3.9 to 4.2, comparable to or below levels observed in Pennsylvania and New York (42). However, the effects of this deposition on the environment is far less clear. In early 1983, an interagency working group was formed to address this issue within Maryland. A summary of their results (43) is indicated below.

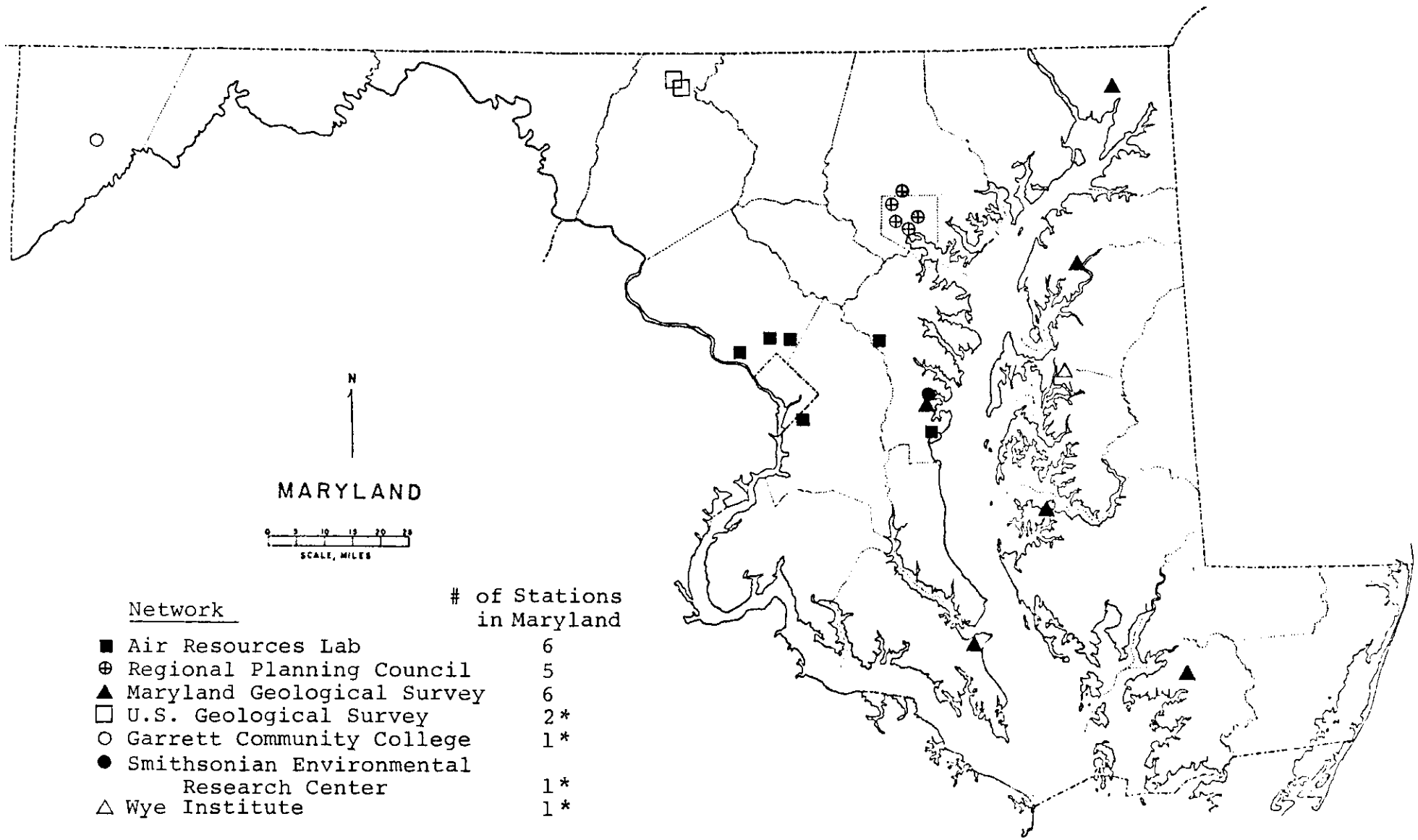
One of the major concerns often raised with acid precipitation is the effect upon fishery resources. This potential was assessed in three ways: (a) evaluation of a study being conducted at Deep Creek Lake to determine the potential for acidification, (b) an assessment of surface water sensitivity was completed using the record of alkalinity measurements available through monitoring programs conducted by the Depart-

Table III-10. Summary of Acid Deposition Monitoring in Maryland

	Project[a]	Location	Years of Record	Sampling Frequency and Type	Number of Stations	Parameters Measured	Yearly Average	pH Range
(34)	Air Resources Laboratory	Washington, DC area	1975-1982	Daily/bulk	10[b]	Precip. amount, pH, conductivity[c]		4.09-4.38
(35)	Regional Planning Council	Baltimore, MD (Jones Falls Watershed)	1980-1982	Event/wet Monthly/dry	5	Precip. amount, pH, conductivity, SO_4, NO_3, NH_4 metals	3.5-3.7[d]	2.9-5.2
(36)	Maryland Geological Survey	Chesapeake Bay area	1980-1981	Event/wet Quarterly/dry	6	Precip. amount, pH, acidity, major ions, metals conductivity, organics	4.0[d]	3.83-4.90
(37)	U.S. Geological Survey	Catoctin Mountains (Hunting Creek Watershed)	1981-Present	Weekly/wet	2	Precip. amount, pH, conductivity, major ions	4.03[d]	3.4-4.6
(38)	Garrett Community College	Deep Creek Lake	1980-Present	Event/wet and bulk	1	Precip. amount, pH, conductivity, major ions	4.0 ± 0.03[d] 3.9 ± 0.04[e]	3.6-4.6[d] 3.0-4.5[e]
(39)	Smithsonian Environmental Research Center	Rhode River	1974-Present	Event/wet and bulk	1	Precip. amount, pH, conductivity, major ions, NO_3 SO_4, NH_4, Cl organic N, total P, orthophosphate	3.8-4.45[d]	3.0-*[d]
(40)	Wye Research & Education Center	Wye Institute	1983-Present	Weekly/wet bimonthly/dry	1	Precip. amount, pH, conductivity So_4, NO_3, NH_4+, metals	*	3.95-4.3[f]

(a) Reference number in parenthesis
(b) 6-8 stations operated at a given time
(c) Plus major ions at McLean, VA station
(d) Wet
(e) Bulk
(f) For the period from March through early July, 1983.

* Data unavailable



Network	# of Stations in Maryland
■ Air Resources Lab	6
⊕ Regional Planning Council	5
▲ Maryland Geological Survey	6
□ U.S. Geological Survey	2*
○ Garrett Community College	1*
● Smithsonian Environmental Research Center	1*
△ Wye Institute	1*

* Presently operating

Figure III-14. **Precipitation Chemistry Monitoring Station Locations.**

ment of Health and Mental Hygiene, and (c) an assessment of an instream monitoring study was conducted during Spring 1983 to evaluate the potential for impact on coastal feeder streams used for spawning by anadromous fish.

The report indicates that two areas of the State are most likely to be sensitive to acid precipitation: the Allegheny Plateau (with the exception of Deep Creek Lake and the Little Youghiogheny River) which has low alkalinities, probably because of acid mine drainage and poor buffering capacity and the Coastal Plain which had low alkalinities and low pH in several streams during the spring spawning period. Some streams had elevated values of aluminum whose toxicity is increased by high acidity. In neither area was any direct impact of acid precipitation observed on fish.

Little data is available to address acidification of groundwater resources and its corresponding effects on forests, agriculture, or drinking water supplies. A review of various soil sensitivity studies (43) indicated conflicting results as to the potential for acidification, given Maryland soil types. However, it is generally agreed that the coastal plain, particularly Maryland's Eastern Shore, is the area most likely to be affected.

The Working Group has recommended (43) several items for further study. These include review and possible establishment of a precipitation monitoring network and specific studies to allow a more complete evaluation in regions most likely to show adverse environmental impact.

Discussions are underway at the national level to consider various types of control strategies and research programs. Control strategies range from small programs aimed at reducing emissions at a few large sources to larger programs requiring up to 50 percent reductions in total sulfur oxide emissions. Because of the wide range of suggested action, the effect on Maryland utilities is unclear. However, it is likely that any control program will increase electric rates for Maryland either through a surcharge for control costs, raised costs of purchased power, or direct requirement of controls on existing plants which serve the State.

H. Research

Coal Conversion

Several new technologies pertinent to the combustion of coal are presently in the pilot plant stage under EPRI and DOE auspices. Some have achieved commercial-scale operation but, because of lack of widespread applicability, must still be considered to be in their infancy.

Fluidized bed combustion of coal may limit emissions of various pollutants. As greater operating experience is gained, this technology will undoubtedly be used more widely. Addition of limestone feed to pulverized coal boilers is being studied as a way of reducing both SO_2 and NOx emissions.

In terms of control technologies, the first few commercial units employing dry flue gas desulfurization (FGD) systems are now in operation, and initial results have been good. This technology can also be expected to find wider use in the future.

Research is also continuing on new wet FGD systems, particularly those employing regenerative scrubbing slurries. New processes for SO_2 removal being studied include one using potassium tartrate as the scrubbing solution, from which concentrated SO_2 can be recovered. Two processes with potential for simultaneous removal of SO_2 and NOx include the electron beam irradiation process, and the $Cu/CuSO_4$ process.

Although present day regulatory efforts have concentrated primarily on the control of particulate and sulfur dioxide emissions, greater emphasis is expected to be placed on control of NOx emissions in the future. Research efforts in the U.S. have focused on reducing NOx formation in boilers by combustion modifications, rather than removing NOx by add-on controls. The most promising NOx removal process appears to be selective catalytic reduction with ammonia injection. Also of interest is noncatalytic reduction by ammonia. Processes for simultaneous removal of SO_2 and NOx include use of a dry regenerative adsorption bed of alkalized alumina or an aqueous solution of NaOH and Na_2SO_3 as the scrubbing medium.

Particulate control research is continually improving the performance of demonstrated control systems, (e.g., better electrodes for collecting high resistivity dust in electrostatic precipitators) and developing new control techniques (e.g., electrostatic enhancement of fabric filtration and moving granular bed filters).

Work is also being directed toward the quantification of fugitive emissions. Since coal conversions invariably lead to an increase in fugitive particulate emissions, quantification of potential emissions from various operations involving coal handling is essential before a regulatory and control strategy can be developed. Recognizing the lack of a technically acceptable data base for fugitive emissions, the State of Maryland sponsored a study (44) directed toward establishment of a data base from which an accurate emission factor could be developed. The study revealed that the widely-used fugitive dust emission factors used for predicting emissions from railcar dumping operations (such as those at a coal-fired power plant) lead to significant overpredictions of fugitive dust emissions. The results of the program showed maximum particulate emissions were on the order of Ø.Ø18 lbs per ton of coal dumped. The average of 61 tests for which an emission rate was determined

was 0.003 lbs per ton of coal dumped. This emission factor is to be used in predictive modeling for proposed coal-fired facilities in Maryland.

Air Quality Modeling

Recent State-sponsored plume modeling research falls into three main areas: 1) improved dispersion formulations, 2) identification and parameterization of key meteorological variables for input to models, and 3) transport and dispersion in complex terrain.

A key purpose of recent modeling research has been to incorporate into simple dispersion models the advances in understanding of atmospheric boundary layer structure and plume physics gained in the past 10 years. This activity includes the formulation of up-to-date dispersion parameters and stability criteria for Gaussian models as well as the development of non-Gaussian models for convective conditions; the latter models have received much recent attention.

During daytime dispersion usually occurs within a strongly convective (unstable) mixing region, the mixed layer, which is capped by an elevated inversion (stable) layer wherein vertical dispersion is suppressed. The dispersion of stack effluents in the mixed layer is governed by convective updrafts and downdrafts. Laboratory(45) and numerical(46) simulations with neutrally buoyant tracers show that for an elevated source, the centerline of the "average" plume descends until it intercepts the ground; in addition, the vertical distribution of pollutants is not Gaussian. The above characteristics, which were recently confirmed in a field experiment,(47) are at variance with the popular Gaussian plume model. PPSP studies are aimed at incorporating these research findings into simple non-Gaussian models for elevated sources(47,49); current work is focused on incorporating source buoyancy into the model. In addition, research is underway(50) to explore plume behavior, and models for dispersion as convection becomes weak and approaches a "neutral" condition.

For stable nighttime conditions, a modest effort is underway to update the dispersion parameters for use in the Gaussian plume model. The intent is to base the prediction of these parameters on more relevant meteorological variables (e.g., friction velocity, heat flux, boundary layer height) than the Turner "stability classes," which is used almost exclusively in Gaussian models.

The newer diffusion models described above are based on up-to-date descriptions of the convective and stable atmospheric boundary layers; thus, they require meteorological inputs characterizing these boundary layers. These inputs include surface heat flux, friction velocity, boundary layer height (over which mixing takes place), and the vertical temperature

gradient (for stable conditions). The boundary layer height generally must be calculated because its measurements do not exist routinely. Methods were recently developed for estimating the input variables for convective conditions(47); a significant feature is that these methods only require such routine measurements as wind speed at some height, insolation, and an early morning temperature profile. Present plans are to develop similar methods for the stable boundary layer.

Plume transport and dispersion in complex terrain have been of interest primarily for power plant siting in Western Maryland. Research efforts have focused on application of simple methods for predicting the wind field about hills. In one study,(52) two limiting stratification regimes -- neutral and strongly stable -- around arbitrarily shaped hills were investigated. For neutral conditions, three-dimensional potential flow is used to describe the wind field. For strongly stable conditions, two-dimensional potential flow is used to describe the wind field for that portion of the airstream that passes around the hill in nearly horizontal planes. In another study(53), theoretical methods were developed for predicting flow of an arbitrarily stratified airstream about low hills; prediction methods were also given for several other problems, including flow over groups of hills. Further work is required to generalize these flow modeling methods, to develop useful engineering formulas, and to test the methods against both field observations and laboratory experiments.

I. Conclusions

Power plant emissions have fluctuated during the past ten years showing no clear trend. Monitoring data reveal no trends in ground-level concentrations which can be attributed to emissions changes at power plants during the period. Increased use of coal in power plants in the future may lead to increased ground-level concentrations of pollutants at locations near coal-fired plants, with little or no change elsewhere.

Recent changes in the regulatory environment which may affect power plant siting and operations include changes in the PSD regulations, the State's acquisition of PSD authority, and the current deadlines for achieving NAAQS. The PSD changes may restrict options as plants seek to expand or modify their facilities. The transfer of PSD authority from Federal to State will allow Maryland somewhat more control over the State's air quality. Maryland has met the December 31, 1982 deadline for achievement of NAAQS for particulates, sulfur dioxide and nitrogen oxides, and has submitted the necessary extensions for ozone and carbon monoxide. As a result, the State should not be subject to the regulatory consequences of not achieving the standards by deadline dates.

The EPA requirement that air quality models be used in certain regulatory circumstances has led to greater standardization of models. The increased consistency was necessary to provide air pollution control agencies, industry and the general public with a common basis for estimating air quality, assessing emission control strategies, and determining specific emission limitations. However, in some circumstances, i.e., complex terrain, no acceptable models exist. Work is continuing to develop better models through improved dispersion formulations, and identification and parameterization of key meteorological variables for input to the models. Improved emissions factors for fugitive dust sources, when used as model input, will result in more accurate predictive modeling for proposed coal-fired facilities.

Efforts are continuing at the State and National levels to evaluate the acidity of precipitation and its effect on our natural resources. The areas of the State with the most potential for impact are the Allegheny Plateau in Western Maryland and the eastern coastal plain. Present results indicate that local power plant emissions are not a major source of acid deposition (on an annual basis). Control strategies, if required, will therefore probably have to include out-of-sate sources. Legislation being considered in Congress addresses these inter-state concerns.

REFERENCES - CHAPTER III

1. Smith, F. Emission Inventory Case Studies - Policy Aspects, Journal of the Air Pollution Control Association, Vol. 32, No. 10, 1982, pp. 1017-1020.

2. Maryland Air Quality Data Reports, State of Maryland, Department of Health and Mental Hygiene, Bureau of Air Quality and Noise Control, Baltimore, MD. (Annual)

3. 1976 Emissions Inventory Report, State of Maryland, Department of Health and Mental Hygiene, Bureau of Air Quality and Noise Control, Baltimore, MD. BAQNC-TM 76-09 (1976) and 77-21 (1977).

4. Fuels and Emissions Totals for State, State of Maryland Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD. 1977.

5. Fuels and Emissions Totals for State, State of Maryland Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD. 1978.

6. 1979 Emissions and Fuels Use Report, State of Maryland, Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD. AMA-TM 82-06. 1982.

7. Fuels and Emissions Totals for State, State of Maryland, Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD. 1980.

8. Fuels and Emissions Totals for State, State of Maryland, Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD. 1981.

9. Code of Federal Regulations 40 CFR 50.

10. Baltimore Area TSP Non Attainment Area by Transportation Zones, State of Maryland, Department of Health and Mental Hygiene, Air Management Administration. 1983.

11. Environmental Reporter, The Bureau of National Affairs, Inc., Washington, D.C., October 1, 1982, 121:0969-121:0970.

12. Federal Register, U.S. Environmental Protection Agency, 48 FR 4987, February 3, 1983.

13. The Clean Air Amendments of 1977, U.S. Environmental Protection Agency. P.L. 95-99, August 7, 1977, with Technical Amendments to the Clean Air Act, P.L. 95-190, November 16, 1977.

14. Federal Register, U.S. Environmental Protection Agency, 43 FR 26380-26410, June 19, 1978.

15. Federal Register, U.S. Environmental Protection Agency, 45 FR 52676-52748, August 7, 1980.

16. Overview Results and Conclusions for the EPRI Plume Model Validation and Development Project: Plains Site. Electric Power Research Institute, EA-3074, 1983.

17. The Maryland Power Plant Siting Program (PPSP) Air Quality Model User's Guide, Prepared by Martin Marietta Environmental Center for Maryland Department of Natural Resources, Power Plant Siting Program, PPSP-MP-38. 1982.

18. Weil, J.C., and R.P. Brower. The Maryland PPSP Dispersion Model for Tall Stacks. Prepared by Martin Marietta Environmental Center for Maryland Department of Natural Resources, Power Plant Siting Program, PPSP-MP-36. 1982.

19. Federal Register, U.S. Environmental Protection Agency, 47 FR 15076-15086, April 6, 1982.

20. Federal Register, U.S. Environmental Protection Agency, 47 FR 7834, February 23, 1982.

21. Brower, R. Air Quality Impact of Converting the C.P. Crane Power Plant to Higher Sulfur Content Fuels. Prepared by Martin Marietta Environmental Center for the Maryland Power Plant Siting Program, Annapolis, MD, PPSP-MP-29. 1979.

22. Compilation of Air Pollution Emission Factors (with supplements 1-7), U.S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, AP-42. 1977.

23. Weiss, R.E., T.V. Larson, and A.P. Waggoner. In Situ Rapid-response Measurement of $H_2SO_4/(NH_4)_2SO_4$ Aerosols in Virginia. Environmental Science and Technology, Vol. 16, 1982, p. 525.

24. Li, T.-Y., and H.E. Landsberg. Rainwater pH Close to a Major Power Plant, Atmospheric Environment, Vol. 9, 1975, pp. 81-88.

25. Granat, L., and H. Rodhe. A Study of Fallout by Precipitation Around an Oil-fired Power Plant, Atmospheric Environment, Vol. 7, 1973, pp. 781-792.

26. Larson, F.V., R.J. Charlson, E.J. Knudson, G.D. Christian, and H. Harrison. The Influence of a Sulfur Dioxide Point Source on the Rain Chemistry of a Single Storm in the Puget Sound Region, Water, Air, Soil Pollution, Vol. 4, 1975, pp. 319-328.

27. Hogstrom, A. Residence Time of Sulfurous Air Pollutants from a Local Source During Precipitation, Ambio, Vol. 2, 1973, pp. 37-41.

28. Niemann, B.L. The 1980 Data Set for Further Evaluation of Regional Air Quality/Acid Deposition Simulation Models, U.S. Environmental Protection Agency, 1982.

29. Climates of the States, U.S. Department of Commerce, Vol. 1-Eastern States, 1974.

30. Moyer, W.J. The Climate of Maryland, 1974, Water Information Center, Inc. Port Washington, NY. pp. 157-174.

31. Campbell, S., and M. Arlauskas. Comparison of Sulfur and Nitrogen Oxide Emission Rates with Wet Deposition Rates in the State of Maryland. Prepared by Martin Marietta Environ mental Center for the Maryland Power Plant Siting Program, Annapolis, MD, PPSP-MP-45. 1983.

32. Li, T.-Y. Continuous Records of Precipitation pH Close to a Major Power Plant, Institute for Physical Science and Technology, University of Maryland, College Park, Technical Note BN 841, August 1976.

33. Anderson, D.E. Continuous Measurement of pH Using an Automatic Precipitation Collector and Analyzer. Meteorology Program, University of Maryland, College Park, Publication No. 78-178, 1978.

34. Miller, J.M., D.H. Pack, and K. Telegadas. The pH of Precipitation in the Washington, D.C. Area: 1975-1981. Prepared by the Air Resources Laboratory for the National Oceanic and Atmospheric Administration, NOAA Technical Memorandum ERL ARL-118, 1983.

35. Regional Planning Council. Jones Falls Watershed Urban Storm Water Runoff Project. Interim Report. September 1982.

36. Conkwright, R.D., J.M. Hill, and M.V. Chattey. Chesapeake Bay Aerial Precipitation Survey: Wet Fall Precipitation Chemistry Basic Data Report. Prepared for the U.S. Environmental Protection Agency. May 1982.

37. Katz, B.G., and O.P. Bricker. Water Quality Effect of Acid Precipitation on a Forested Watershed, Catoctin Mountains, Central Maryland. To be presented before the American Chemical Society, Division of Environmental Chemistry, Washington, D.C. August 1983.

38. Ferrier, M.D., and M.L. Risoldi. Assessment of Acid Inputs to Deep Creek Lake, Garrett County, Maryland. Prepared for the Maryland Power Plant Siting Program, Annapolis, MD, 1982.

39. Correll, D. Information on the Rhode River Study, presented at the Second Maryland Workshop on Research and Acid Deposition, Sponsored by the State of Maryland, Department of Health and Mental Hygiene, Office of Environmental Programs, and Department of Natural Resources, Power Plant Siting Program, May 25, 1983.

40. Brinsfield, Russell (USDA) to Mike Bowman (PPSP) Personal Communication, July 15, 1983.

41. Koch, William F. and George Masinenko. Atmospheric Deposition Reference Materials: Measurement of pH and Acidity. National Bureau of Standards. 83-32.3. June 1983.

42. Acid Deposition. Atmospheric Processes in Eastern North America, National Academy Press. Washington, DC. 1983.

43. Report of the Maryland Interagency Working Group on Acid Deposition. Annapolis, November 1983.

44. Carnes, D.H., P.A. Catizone, and K.J. Kelley. Determination of Fugitive Coal Dust Emissions from Rotary Railcar Dumping. Prepared by TRC Environmental Consultants, Inc. for the Maryland Power Plant Siting Program, Annapolis, MD. Draft. 1983.

45. Willis, G.E, and J.W. Deardorff. A Laboratory Study of Dispersion from an Elevated Source Within a Modeled Convective Planetary Boundary Layer. Atmospheric Environment, Vol. 12, 1978, pp. 1305-1312.

46. Lamb, R.G. A Numerical Simulation of Dispersion from an Elevated Point Source in the Convective Planetary Boundary Layer. Atmospheric Environment, Vol. 12, 1978, pp. 12971304.

47. Moninger, W.R., W.L. Eberhard, G.A. Briggs, R.A. Kropfli, and J.C. Kaimal. Simultaneous Radar and Lidar Observations of Plumes from Continuous Point Sources, to be presented at 21st Conference on Radar Meteorology, 19-23 September 1983, Edmonton, Alberta, Canada.

48. Weil, J.C., and W. Furth. A Simplified Numerical Model of Dispersion from Elevated Sources in the Convective Boundary Layer, Proceedings of 5th Symposium of Turbulence, Diffusion, and Air Pollution, American Meteorology Society, Boston, MA, 1981, pp. 76-77.

49. Weil, J.C. Application of Advances in Planetary Boundary Layer Understanding to Diffusion Modeling, Proceedings of 6th Symposium on Turbulence and Diffusion, American Meteorological Society, Boston, MA, 1983.

50. Venkatram, A. Modeling Tall Stack Releases, work in progress at Environmental Research and Technology, Concord, MA for Maryland Power Plant Siting Program, Annapolis, MD, 1983.

51. Weil, J.C., and R.P. Brower. Estimating Convective Boundary Layer Parameters for Diffusion Applications, prepared by Martin Marietta Environmental Center for Maryland Department of Natural Resources, Power Plant Siting Program, Annapolis, MD, PPSP-MP-48, 1983.

52. Weil, J.C., S.C. Traugott, and D.K. Wong. Stack Plume Interaction and Flow Characteristics for a Notched Ridge. Maryland Power Plant Siting Program, Annapolis, MD, PPRP-61, 1981.

53. Hunt, J.C.R., S. Leibovich, and J.L. Lumley. Prediction Methods for the Dispersal of Atmospheric Pollutants in Complex Terrain. Prepared by Flow Analysis Associates, Ithaca, NY, for Maryland Power Plant Siting Program, Annapolis, MD, 1982.