deal of uncertainty exists concerning materials damage, due to lack of knowledge of damage functions, mechanisms of degradation and the types and amounts of material actually exposed. Thus while it seems apparent that acid deposition may affect a variety of architectural materials, little is known about the damage mechanisms or the actual costs involved.

Materials effects studies sponsored under NAPAP have been proposed, but according to a recent review by the General Accounting Office (GAO 1987) have made relatively little progress. The materials effects task group recently initiated paint damage research, but does not expect credible results for damage functions by 1990. Damage functions may be available by 1990 for galvanized steel and limestone, but probably not for other materials.

C. Levels of Emissions and Deposition in Maryland

Monitoring studies to measure acid precipitation ("wet deposition") in rural areas are underway at both the national and state level. Figure VIII-7, a plot of the annual average pH for 1986 based on the national network of monitoring stations, shows that Maryland is included in the region of low pH (< 4.4), which is roughly 10 times as acidic as natural rain. Figure VIII-8, a plot of the annual wet sulfate deposition for 1986, similarly shows that much of Maryland is in the region of highest wet deposition, amounting to about 20-30 kg/ha (NADP/NTN 1986; Maxwell and Mahn 1987). Wet nitrate deposition in Maryland is estimated to be between 14-26 kg/ha(Maxwell and Mahn 1987). Limited wet deposition measurements taken in urban environments in the Middle Atlantic states indicate that sulfate and nitrogen deposition rates may be higher in and downwind of cities (NADP/NTN 1986).

Maryland contributes about nine percent of the sulfur oxides (principally SO_2) and 12 percent of the nitrogen oxides (NO_x) emitted into the atmosphere in the five-state area that includes Maryland, Virginia, West Virginia, Delaware, and Pennsylvania.

Table VIII-4 displays the most currently available (1985) annual SO_2 and NO_x emissions and emission rates from Maryland power plants. The percentages of

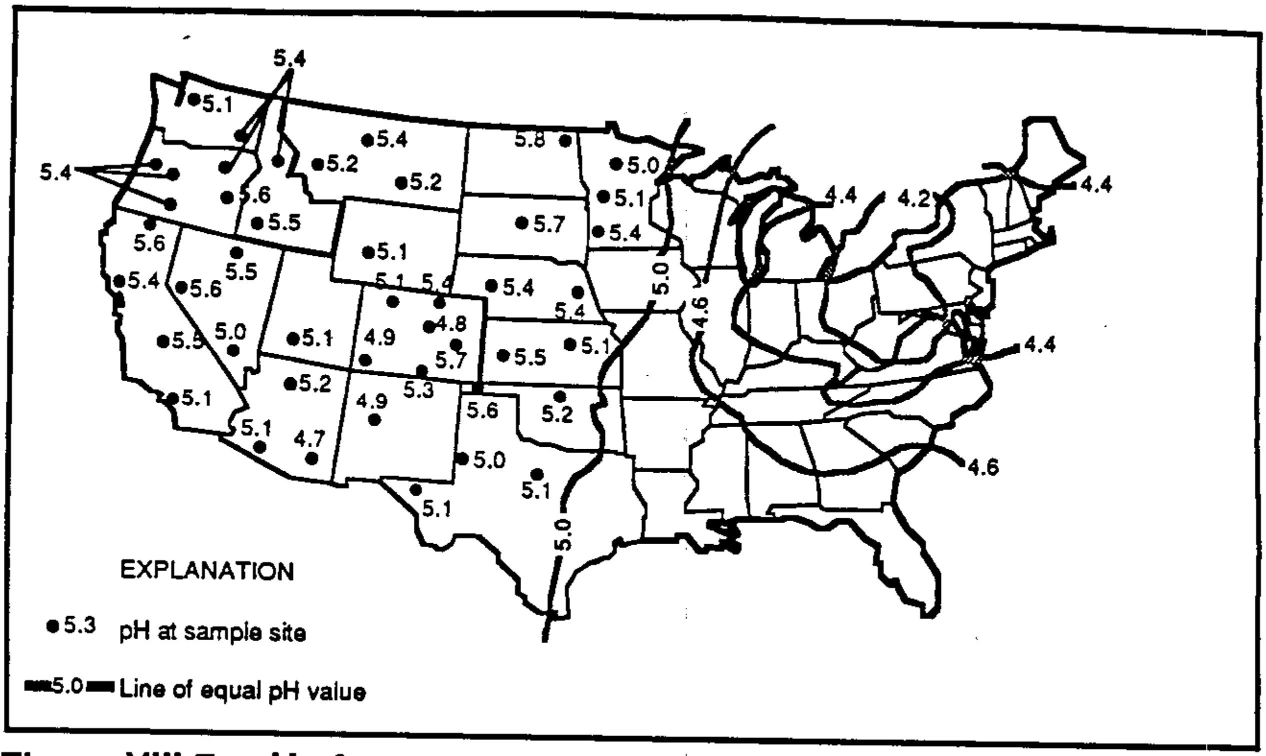

Figure VIII-7. pH of wet deposition in 1986 (precipitation-weighted annual average)

Source: NADP/NTN 1986

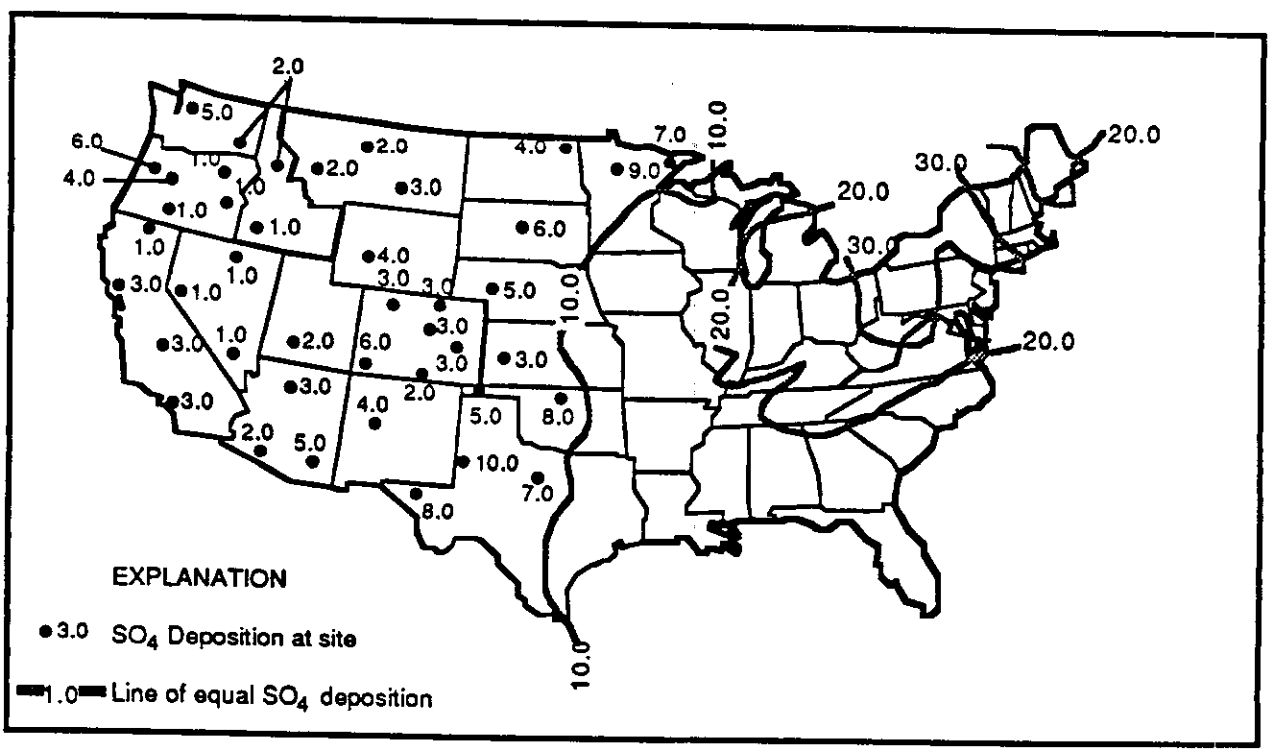

Figure VIII-8. Annual sulfate ion deposition (kg/ha) in 1986

Source: NADP/NTN 1986

Table VIII-4
1985 SO_2 and NO_x emissions by power plant for Maryland utilities

	SO_2 Tons	SO_2 lbs/MMBtu	NO_x Tons	NO_x lbs/MMBtu
BG&E				
Gould	567	1.06	237	0.44
Riverside	1,353	1.09	559	0.45
Westport	440	1.06	184	0.44
Wagner				
Oil	3,782	1.07	1,579	0.45
Coal	9,623	1.26	6,113	0.80
Crane	18,769	2.69[1]	9,848	1.45[2]
Brandon Shores	13,775	1.06	5,835	0.45
Combustion Turbines	37	–[3]	104	--[4]
Total	48,346		24,459	
PEPCO				
Morgantown	67,400	2.66	15,200	0.6
Dickerson	33,900	2.19	9,300	0.6
Chalk Point				
Coal	47,600	2.56	15,500	0.85
Oil	11,900	1.29	2,600	0.28
Combustion Turbines	0	0	0	0
Total	160,800		42,6000	
APS				
R.P. Smith	3,249	1.49	1,944	0.87
Total	3,249		1,944	
DP&L				
Vienna	1,784	1.64	354	0.32
Crisfield	1.45	0.19	4	0.49
Total	1,785		359	
Total Utility Emissions	214,181		69,362	
Statewide Total Emissions	310,910		231,587	

Source: Maryland 1975-85

Footnotes:

1 -SO_2 emission rate for Crane 1 (Oil) equals 2.74 lbs/MMBtu; Crane 2 (Coal) equals 2.64 lbs/MMBtu

2 -NO_x emission rate for Crane 1 (Oil) equals 1.4 lbs/MMBtu; Crane 2 (Coal) equals 1.5 lbs/MMBtu

3 -SO_2 emission rate ranges between 0.16-0.24 lbs/MMBtu

SO_2 and NO_x that the utilities contribute to the statewide total are also provided. The data indicate that power plants contributed over 69 percent of the SO_2 and approximately 30 percent of the NO_x emissions in the state. PEPCO is the major contributor of emissions followed by BG&E; APS and DP&L contribute relatively little to the statewide total.

Power plants built between 1950 and 1975 produce the bulk of all sulfur dioxide emissions in Maryland as well as the rest of the northeastern U.S. These plants were originally designed with nominal expected lifetimes of 30-40 years, implying retirement dates in the mid-1990's to early 2000's. However, because of the cost of building new plants, as well as the overall structural and mechanical integrity of the existing plants, utilities such as PEPCO and BG&E are considering life extension programs that may extend the operational life of these plants to about 60 years. A recent study (ERM 1986) reviewed the effects of potential life-extension programs for existing power plants on power plant sulfur dioxide emission trends. Using a linear extrapolation of the available projections of electrical generation sales, retirement ages of 55, 60, and 65 years, and SO_2 emission rates of 0.6 lb/MMBtu, 0.2 lb/MMBtu, and 0.0 lb/MMBtu for plants built after the year 2000, the study estimated the sulfur dioxide emissions for the combined PEPCO/BG&E systems through the year 2025 (Figure VIII-9). These projections indicate that sulfur dioxide emissions will continue to rise over the next thirty to forty years until retirement of the older plants. Even if no additional increases in emissions occurred after the year 2000 (the lowest estimate on the graph), total emissions would not decline significantly until the retirement of large older units such as those at the Morgantown, Dickerson, Crane, and Chalk Point sites. Projections of emissions (Figure VIII-10) indicate that overall emissions of nitrogen oxides are expected to remain constant between now and the year 2000. Increased emissions by power plants will be offset by decreased emissions from mobile sources.

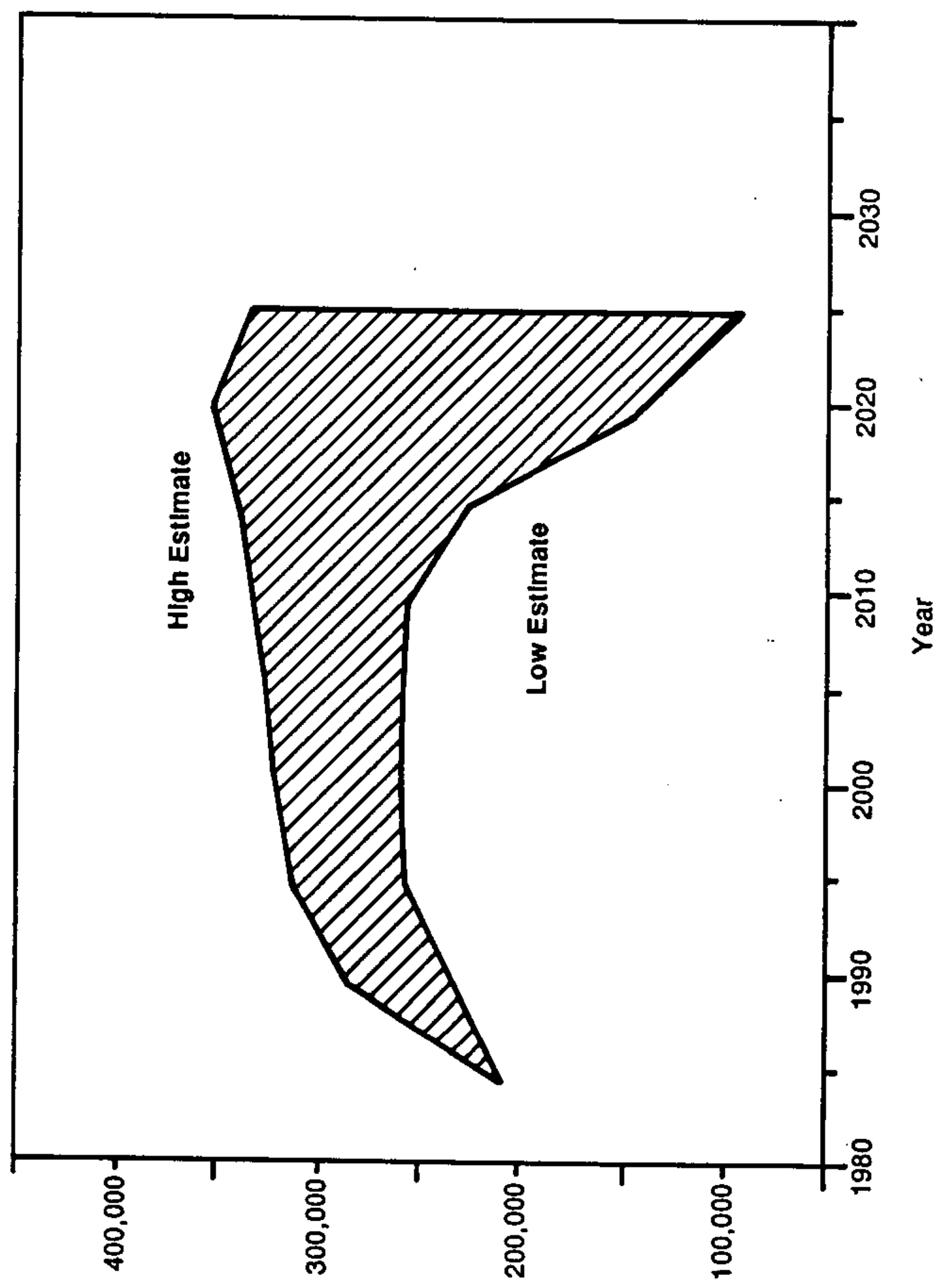

Figure VIII-9. Projected utility sulfur dioxide emissions in Maryland

Source: ERM 1986

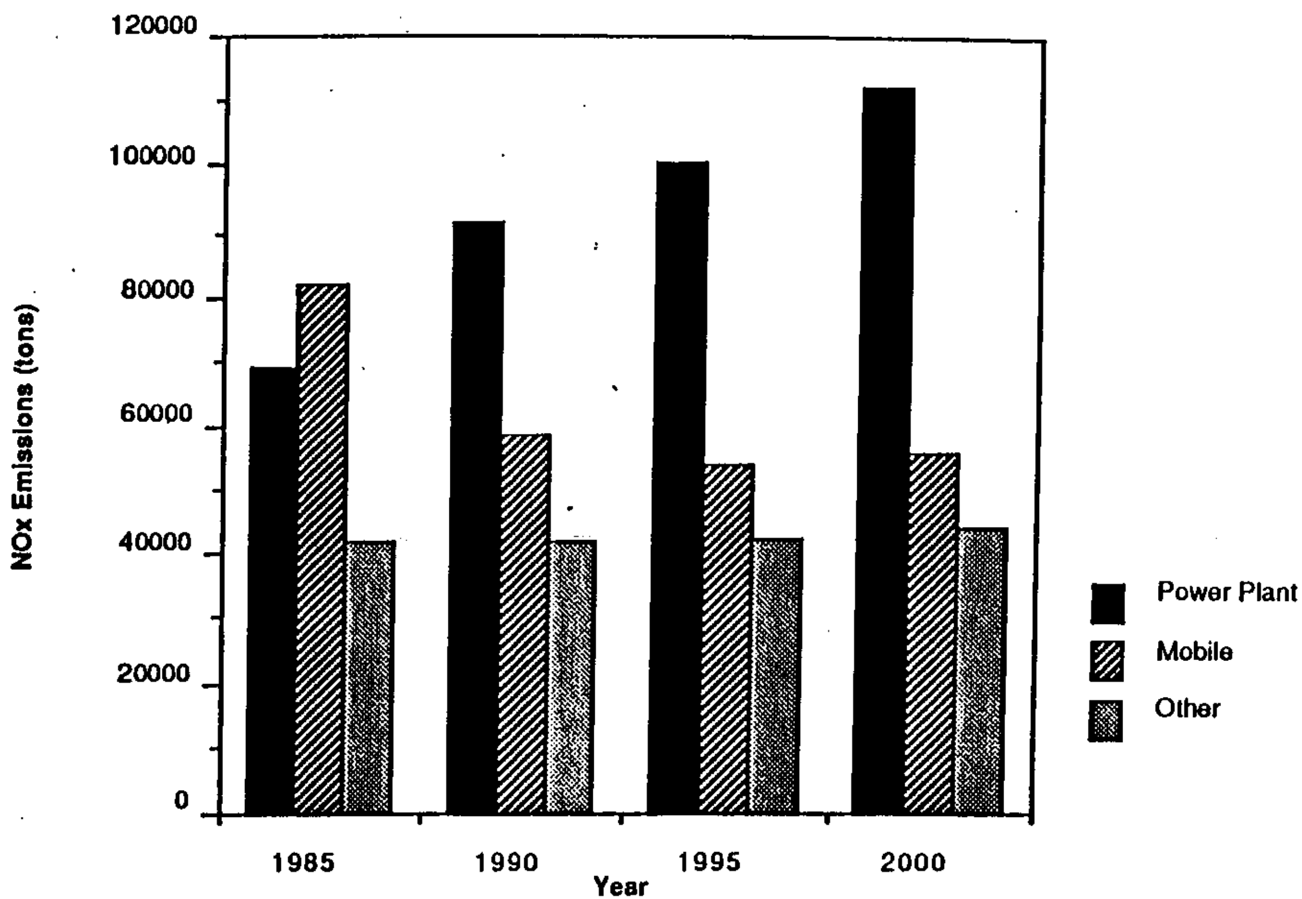

Figure VIII-10. Projected nitrogen dioxide emissions in Maryland, 1985-2000

Source: Ferreri 1986, Lodge 1986, Manor 1986, Shockey 1986, Widom 1986

D. Controlling Acid Deposition

Emission Control

The effort to control acid deposition precursors (sulfur and nitrogen oxides) has focused almost entirely on the reduction of emissions from fossil-fuel electric generating stations and, to a lesser extent, from industrial facilities. Control technologies fall into three major categories: 1) pre-combustion, 2) combustion, and 3) post-combustion. (See also Chapter III, Section D.) Pre-combustion technologies involve various ways of cleaning coal to remove sulfur. Physical coal cleaning is a mature technology, and little additional work is being done in this area. However, investigations into biological, chemical, and physical/chemical coal-cleaning technologies are continuing.

Combustion technologies control emissions in the burner itself. Unlike pre-combustion methods, many combustion technologies, e.g., coal gasification combined cycle, can remove or reduce both SO_2 and NO_x compounds. The Department of Energy is sponsoring programs led by several industrial companies to test several technologies: gas reburning/sorbent injection, staged combustion, and pressurized fluidized bed systems. Commercialization of each of these new technologies has begun or is expected to begin in the near future.

Post-combustion technologies remove SO_2 from the flue gas using an absorbent material. This process is commonly referred to as flue gas desulfurization (FGD), or "scrubbing." Several new post-combustion technologies e.g., wet limestone or lime scrubbers, magnesium oxide wet scrubbing, non-catalytic reduction, selective catalytic reduction, that remove SO_2 or both SO_2 and NO_x are being tested by industrial manufacturers. At present, few of these new technologies for NO_x removal are ready for commercial use.

Potential Emissions Reductions from Conservation, Load Management, and Alternative Power

An alternative approach to reducing emissions of SO_2 and NO_x from power plants involves programs to modify or reduce customers' power demands and to increase the generation of power from non-conventional sources. Evaluation of the contribution of energy management, conservation, and alternative energy sources, however, suggests that these approaches have a low potential to reduce sulfur dioxide emissions in the state (ESRG 1981; SERI 1981; Urban Institute 1982; PNPC 1985).

The conservation potential for BG&E and PEPCO is estimated at 5 to 10 percent of 1986 electrical usage, while load management practices may actually increase emissions. The increased emissions from load management are attributed to the operation of base-load plants for longer time periods. These plants have lower operating costs than cycling or peaking plants, and typically burn higher sulfur coal, with consequently increased emissions. Regarding conservation and alternative power development, the estimated reduction in sulfur dioxide emissions to the combined BG&E and PEPCO utility systems from an extremely aggressive conservation and alternative power development program is about 46,000 tons per year (about fifteen percent of total projected utility sulfur dioxide emissions in the year 2000) (MD- PPRP 1987). The majority of this reduction (30 to 50 percent) is a result of residential conservation, including the introduction of high-efficiency appliances through a mandatory appliance efficiency program.

Maryland utilities, particularly BG&E and PEPCO, participate as full members of an integrated interstate power pool as well as acting as independent inter-regional buyers of capacity and energy. Because the pool operates on the principle of integrated economic dispatch, it is unclear whether conservation, use of alternative energy, or emission reduction techniques in Maryland would have any effect on Maryland emissions: the reductions in power production may occur elsewhere in the power pool region or in adjacent regions. Quantification of this emission exchange is not possible without a knowledge of the emission reduction plans of all multi-regional utilities.

Non-Control Mitigation Programs

Surface water liming is the only common mitigation practice aimed specifically at remediating an acid receptor. Surface water liming programs have been in effect in northern Europe and Canada for several years. They generally report success in maintaining suitable water quality following mitigation efforts. In the United States, several programs have been initiated within the last five years, primarily as research and demonstration projects. A variety of techniques and materials is presently being used for lake and stream neutralization. A very fine calcium carbonate (calcite) slurry appears to be one of the most effective liming materials, and is being used in both lake and stream programs.

Two ongoing projects in Maryland are addressing surface water liming. One is evaluating the use of stream dosers to ameliorate episodic acid events. This technology controls the release of liming materials as a function of water level or stream chemistry. It is especially important for tributaries of the Chesapeake Bay, where streams serve as spawning grounds for commercially and recreationally important anadromous fish species. The other project is evaluating the use of limestone-filled gabions for surface water treatment. Initial results of the doser study show that stream chemistry can be improved by addition of calcite, but the reliability of the dosers has not yet been established.

A common problem reported in many of the ongoing mitigation programs is that the nearshore or littoral zones of lakes and streams, which are often inhabited by acid-sensitive early life stages of fish and invertebrates, are commonly not mitigated by whole-lake or stream liming. In addition, studies have shown that episodic acidic events associated with snowmelt or runoff and high flow conditions may not be treated completely with static stream mitigation techniques (e.g., limestone barriers).

Legislative Action

Since 1980 Congress has considered many amendments to the Clean Air Act to control and reduce acid deposition. These bills have generally proposed reducing sulfur dioxide emissions by between 8 and 12 million tons and nitrogen oxide emissions by between 4 and 6 million tons. To date, no bill has been enacted into law. The cost to Maryland utilities of complying with emissions limits imposed by a 12 million ton SO_2 reduction was recently estimated to be $3.7 billion in 1987 dollars over a 20-year period (Kahal 1987). Monthly residential consumer cost inceases for the SO_2 reduction vary with the utility, but are estimated to range from $1.52 for DP&L customers to $4.64 for Potomac Edison customers.

F. References

Bachman, L.J., and B.G. Katz. 1986. Relationship between precipitation quality, shallow ground water geochemistry, and dissolved aluminum in eastern Maryland. Prepared by the U.S. Department of the Interior Geological Survey for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. PPRP- AD-14.

Baker, J.P. 1981. Effects on fish of metals associated with acidification. Paper presented at the Acid Rain/Fisheries symposium of the U.S. Fish and Wildlife Service, 2-5 August, Ithaca, New York.

Baker, J.P. 1982. Effects on fish of metals associated with acidification. In: Acid rain/fisheries, 165-176. T.H. Haines and R.E. Johnson, eds. American Fisheries Society, Bethesda, MD.

Baker, J.P. and C.L. Schofield. 1981. Aluminum toxicity to fish in acidified waters. Paper presented at the AMS/CMOS conference on Long Range Transport of Acetone Pollutants. 27-30 April, Albany, New York.

Bates, D.V. 1986. Study of hospital admissions and air pollutants in southern Ontario. In: Proceedings of the Second U.S.-Dutch International Symposium: Aerosols, May 19-24, 1985, Williamsburg, VA.

Bates, D.V., and R. Sitzo. 1983. Relationship between air pollutant levels and hospital admissions in southern Ontario. Canadian Journal of Public Health. 74:117-122.

Bockheim, J.G. 1984. Acid deposition on forest soils and site quality. Paper presented at U.S.-Canadian Forest Response to Acid Deposition Conference. Orono, Maine.

Campbell, S., J. Bartoshesky, D. Heimbuch, A. Janicki, and H. Petrimoulx. 1987. Relationships between acid deposition, watershed characteristics and stream chemistry in Maryland coastal plain streams. Prepared by Versar, Inc., Columbia, MD, and Environmental Resources Management, Inc., West Chester, PA, for Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. AD-87-8.

Conkwright, R.D. 1984. A preliminary assessment of the effects of acid precipitation on geological resources of Maryland. In: The Potential Effects of Acid Deposition in Maryland, 93-103. Report of the Maryland Interagency Working Group on Acid Deposition, Annapolis, MD.

Driscoll, C.T. 1980. Chemical characterization of some dilute acidified lakes and streams in the Adirondack region of New York State. Ithaca, New York: Cornell University. Ph.D. dissertation.

Ecological Analysts. 1983. Survey of water quality and flow in Maryland coastal zone streams: A data report. Prepared by Ecological Analysts, Inc., Sparks, MD, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. PPSP-MP-50.

ERM (Environmental Resources Management, Inc.) 1986. Emission projections for Maryland utilities 2000-2030. Technical Memorandum prepared for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. PPRP AD-87-3.

ESRG (Energy Systems Resource Group) 1981. The Conservation Investment Alternative for New York State.

Evans, L.S., K.F. Lewin, C.A. Conway, and M.J. Patti. 1981. Seed yields (quantity and quality) of field grown soybeans exposed to simulated acidic rain. New Phytologist 89:459-470.

Evans, L.S., N.F. Gmur, and J.J. Kelsch. 1977. Perturbations of upper leaf surface structures by simulated acid rain. Environmental and Experimental Botany 17:145.

Fairfax, J.A.W. and N.W. Lepp. 1975. Effect of simulated acid rain on cation loss from leaves. Nature 255:324-325.

Ferreri, G. 1986. Letter from G. Ferreri, Maryland Air Management Administration, to M. Bowman, PPRP. May 29, 1986.

Fine, J. M., T. Gordon, J. Thompson, and D. Sheppard. 1986. Acid aerosol-induced bronchoconstriction in asthmatics. Paper presented at the 1986 Annual Meeting of the American Lung Association, and American Thoracic Society.

Forsline, P.L., R.C. Musselman, R.J. Dee, and W.J. Kender. 1983. Effects of acid rain on grapevines. Amer. J. Enol. Vitic. 34(1):17-22.

Fraser, J.E., and D.L. Britt. 1982. Liming of acidified waters: A review of methods and effects on aquatic ecosystems. U.S. Fish and Wildlife Service, Division of Biological Services, Eastern Energy and Land Use Team. FWS/OBS-80/4013.

Fritz, E.S. 1980. Potential Impacts of Low pH on Fish and Fish Populations. U.S. Fish and Wildlife Service, Biological Services Program, National Power Plant Team. FWS/OBS-80/40.2.

GAO (General Accounting Office) Resources, Community and Economic Development Division. 1987. Acid rain: Delays and management changes in the federal research program. Washington D.C. Report No. B-226428.

Haines, T.A. 1981. Acidic precipitation and its consequence for aquatic ecosystems: a review. Trans. Amer. Fish Soc. 110:669-706.

Haines, T.A., and C.L. Schofield. 1980. Responses of fish to acidification of streams and lakes in eastern North America. In: Restoration of Lakes and Inland Waters: Proceedings of International Symposium on Inland Waters and Lake Restoration, 467-471. U.S. Environmental Protection Agency, EPA 440/5-81-010.

Hall, L.W. Jr., A.E. Pinkney, and L.O. Horseman. 1986. Mortality of striped bass larvae in relation to contaminants and water quality in a Chesapeake Bay tributary. Trans. Amer. Fish Soc. 114:861-868.

Harman, G. 1984. Assessment of Maryland's surface water sensitivity to atmospheric acid deposition. In: The potential effects of acid deposition in Maryland. A Report of the Maryland Interagency Working Group on Acid Deposition, Annapolis, MD.

Heagle, A.S., R.B. Philbeik, P.F. Brewer, and R.E. Ferrell. 1983. Response of soybeans to simulated acid rain in the field. J. Environ. Qual. 12(4):538-543.

Hultberg, H. and S. Johansson. 1981. Acid ground water. Nordic Hydrology. 12:41-64.

Hutchinson, T.C., C.M. Adams, and B.A. Gaber. 1986. Neutralization of acidic raindrops on leaves of agricultural crop and boreal forest species. Water, Air, and Soil Pollution. 31:475-484.

Irving, P.M. 1983. Acidic precipitation effects on crops: A review and analysis of research. J. Environ. Qual. 12(4):442-453.

Irving, P.M. and J.E. Miller. 1981. Productivity of field grown soybeans exposed to acid rain and sulfuric dioxide alone in combination. J. Environ. Qual. 10(4):473-478.

Janicki, A. and H. Greening. 1987. A summary of Maryland stream pH and alkalinity data: An analysis of its application to assessing the impacts of acidic deposition. Prepared by Versar, Inc., Columbia, MD, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. AD-87-11.

Janicki, A. and R. Cummins. 1983. An analysis of survey data on the chemistry of twenty-three streams in the Chesapeake Bay watershed: Some implications of the impact of acid deposition. Prepared by Martin Marietta Environmental

Center, Baltimore, MD, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. PPSP-MP-51.

Johnson, A.H., T.G. Siccone, R.S. Turner and D.G. Lord. 1983. Assessing the possibility of a link between acid precipitation and decreased growth rates of trees in the northeastern United States. In: Proceedings of the American Chemical Society Meeting: The Effects of Acidic Deposition on Vegetation. AnnArbor, MI: Ann Arbor Science.

Johnston, J.W. Jr. and D.S. Shriner. 1986. Yield response of Davis soybeans to simulated acid rain and gaseous pollutants in the field. New Phytologist 103:695-707.

Johnston, J.W. Jr., D.S. Shriner, and C.H. Abner. 1987. Design and performance of an exposure system for measuring the response of acid rain and gaseous pollutants in the field. In: Acidic Deposition: Effects on agricultural crops, 4-1--4-16. Electric Power Research Institute, Palo Alto, California. EPRI EA-5149.

Johnston, J.W. Jr., D.S. Shriner, and C.K. Kinerly. 1986. The combined effect of simulated acid rain and ozone on injury, chlorophyll, and growth of radishes. Environmental and Experimental Botany 26:107-113.

Jones, K.A., S.B. Brown, and T.J. Hara. 1987. Behavioral and biochemical studies of onset and recovery from acid stress in Arctic char (*Salvelinus alpinus*). Can. Journal of Fish Aquat. Sci. 44:373-381.

Joyner, K.C. and B.A. Hood. 1985. Report on the third annual review meeting of the National Acid Precipitation Assessment Program, sponsored by the Interagency Task Force on Acid Precipitation, Washington, D.C.

Kahal, M.L. 1987. The costs to Maryland utilities and ratepayers of an acid control strategy -- an updated analysis. Prepared by Exetic Associates Inc., Bethesda, MD, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Klauda, R.J., and R.E. Palmer. 1986. Laboratory and field bioassay experiments on blueback herring from Maryland coastal plain streams. Prepared by the Applied Physics Laboratory of John Hopkins University, Columbia, MD, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. PPRP-AD-15.

Knapp, C.M., D.S. Heimbuch, M.S. Greening and G.S. Philbin. 1988. Maryland synoptic stream chemistry survey - estimating the number and distribution of streams affected by or at risk from acidification. Prepared by International Science and Technology, Inc., Reston, VA, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. PPRP-AD-88-2.

Koenig, J.Q., M.S. Morgan., M. Horike, and W.E. Pierson. 1985. The effects of sulfur oxides on nasal and lung functions in adolescents with extrinsic asthma. Journal of Allergy and Clinical Immunology 76:813-818.

Leben, C. 1954. Influence of acidic buffer sprays on infection of tomato leaves by *Alternaria solani.* Phytopathology 44:101-106.

Lee, J.J., G.E. Neely, S.C. Perrigan, and L.C. Grothaus. 1981. Effect of simulated sulfuric acid rain on yield, growth, and foliar injury of several crops. Environ. Exp.Bot. 21:171-185.

Linn, W.S., E.L. Avol, D.A. Shamoo, J.D. Whynot, K.R. Anderson, and J.D. Hackney. 1986. Respiratory responses of exercising asthmatic volunteers exposed to sulfuric acid aerosols. Journal of the Air Pollution Control Association. 36:12 (1323-1328).

Lodge, J. R. 1986. Letter from J. Lodge, BG&E, to M. Bowman, PPRP. June 19, 1986.

Lord, D.G., and G.R. Kish. 1985. Chapter III: Ground water processes. In: Acidic Deposition in New Jersey. For the Governor's Science Advisory Committee, Trenton, NJ.

Lovett, G.M. 1983. Atmospheric deposition to forests. U.S. Department of Energy. Washington, D.C. Report No. Conf-8308115.2.

Manor, C.R. 1986. Letter from C.R. Manor, PEPCO, to M. Bowman, PPRP. June 10, 1986.

Maryland Office of Environmental Programs. 1984. The potential effects of acid deposition in Maryland: Report of the Maryland interagency working group on acid deposition. State of Maryland, Office of Environmental Programs. Department of Health and Mental Hygiene and Department of Natural Resources. Annapolis, MD.

Maryland 1975-85. Annual fuels and emissions totals for state. State of Maryland, Department of Health and Mental Hygiene, Air Management Administration, Baltimore, MD.

Maxwell, C. and S. Mahn. 1987. The spatial and temporal distribution of precipitation chemistry across Maryland in 1984, Volume 1. Prepared by the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. Report No. AD-87-10.

MD-PPRP (Maryland Power Plant Research Program). 1986. Power Plant cumulative environmental impact report for Maryland. Prepared by the Maryland Department of Natural Resources, Power Plant Research Program. Annapolis, MD. PPSP-CEIR-5.

MD-PPRP. 1987. Acid deposition in Maryland: a report to the Governor and General Assembly. Prepared by the Maryland Department of Natural Resources, Power Plant Research Program. Annapolis, MD. AD-87-1.

MD-PPRP. 1988. Acid deposition in Maryland: the status of knowledge in 1987. Prepared by the Maryland Department of Natural Resources, Power Plant Research Program. Annapolis, MD. AD-88-1.

Mehrle, P., and D. Bucher. 1984. Impacts of contaminants on striped bass in the Chesapeake Bay: A summary of research on pH/contaminant interactions in laboratory and field investigations. U.S. Fish and Wildlife Service, Columbia National Fisheries Research Laboratory, Columbia, MD.

Mehrle, P., S. Finger, D. Buckler, and L. Ludke. 1985. Striped bass decline in Chesapeake Bay may be related to acidic environments. U.S. Fish and Wildlife Service, Columbia National Fisheries Research Laboratory, Columbia, MD. Research Information Bulletin No. 85-21.

Mierle, G., K. Clark, and R. France. 1986. The impact of acidification on aquatic biota in North America: A comparison of field and laboratory results. Water, Air, and Soil Pollution. 31:593-604.

NADP/NTN (Natural Atmospheric Deposition Program) 1986. 1984 Annual Report. National Resource Ecology Laboratory, Fort Collins, Colorado.

NAS (National Academy of Sciences). 1983. Acid deposition: Atmospheric processes in eastern North America. Committee on Atmospheric Transport and Chemical Transformation in Acid Precipitation. Washington D.C.: National Academy Press.

Norby, R.J. and R.J. Luxmoore. 1983. Growth analysis of soybean exposed to simulated acid rain and gaseous air pollutants. New Phytologist 95:277-287.

Norby, R.J., B.K. Takemoto, J.W. Johnston, and D.S. Shriner. 1986. Acetylene reduction rate as a physiological indicator of the response of field grown soybeans to simulated acid rain and ambient gaseous pollutants. Environmental and Experimental Botany 26:285-290.

Norby, R.J., D.D. Richter, and R.J. Luxmoore. 1985. Physiological processes in soybeans inhibited by gaseous pollutants but not by acid rain. New Phytologist 100:79-85.

Norton, S.A., J.J. Akielaszek, T.A. Haines, K.L. Stomber, and J.R. Longcore. 1982. Bedrock geologic control of sensitivity of aquatic ecosystems in the United States to acidic deposition. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Maryland.

PNPC (Pacific Northwest Planning Council). 1985. Northwest Conservation and the Electric Power Plant. Volume I.

SERI (Solar Energy Research Institute) 1981. A New Prosperity, Building A Suitable Energy Future. Brick House Publishing.

Shriner, D.S., and E.B. Cowling. 1980. Effects of rainfall acidification on plant pathogens. In: Proceedings of the NATO Conference on Effects of Acid Precipitation on Vegetation and Soils, 435-442. T.C. Hutchinson and M. Havas, eds. New York: Plenum Press.

Stokes, P.M. 1986. Ecological effects of acidification in primary products in aquatic systems. Water, Air, and Soil Pollution 30:421-438.

Takemoto, B.K., D.S. Shriner, and J.W. Johnston. 1987. Physiological responses of soybean (*Glycine max* L. Merr.) to simulated acid rain and ozone in the field. In: Acidic deposition: Effects on agricultural crops, 7-1--7-6. Electric Power Research Institute, Palo Alto, California. EPRI EA-5149.

Tukey, J. 1980. Some effects of rain and mist on plants with implications for acid precipitation. In: Proceedings of the NATO conference on effects of Acid Precipitation on vegetation and soils. T.C. Hutchinson and M. Havas, New York: Plenum Press.

Urban Institute. 1982. The economic feasibility of alternative utility sponsored weatherization programs; the case of Baltimore Gas and Electric Company.

Volume 1. Prepared for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. PPES-6.

Widom, S. 1986. Letter from S. Widom, Delmarva Power & Light, to M. Bowman, PPRP. June 3 , 1986.

Witters, H.E. 1986. Acute acid exposure of rainbow trout, *Salmo gairdneri*: Effects of aluminum and calcium on umbalance and haematology. Aquat. Toxicol. 8:197-210.

Wood, C.M., and D.G. McDonald. 1982. Physiological mechanisms of acid toxicity to fish. In: Acid Rain/Fisheries, 197-226. T.A. Haines and R.E. Johnson, eds. Bethesda, MD: American Fisheries Society.

APPENDIX A

ECONOMIC AND DEMOGRAPHIC GROWTH IN MARYLAND

This Appendix provides a discussion of the historical and projected trends in economic and demographic growth in Maryland, with emphasis on those characteristics that most importantly influence the demand for electricity. The Power Plant Research Program (PPRP), together with the Maryland Department of State Planning (DSP), has conducted a program of independent load forecasts since the mid-1970's. The electric load forecasts developed through this program help to ensure that future power supplies are adequate for consumer demand and to mitigate the costs associated with excess capacity.

The PPRP/DSP forecasts, as well as those prepared by the Maryland utilities themselves, are based upon sets of economic models of the demand for electricity. These models (described in the 1982 CEIR) quantify the historical influence of such factors as employment, income, weather, number of households, and the price of electricity and other fuels upon the demand for electricity. The historical data required to develop the econometric models are obtained from a variety of sources, including the Maryland utilities; the DSP; the Bureau of Economic Analysis (BEA) and the National Oceanic and Atmosphic Administration (NOAA), both of the U.S. Department of Commerce; the Bureau of Labor statistics of the U.S. Department of Labor; and the Maryland Office of Employment Security.

To forecast future power demands with these models it is necessary to formulate assumptions about the future values of the explanatory variables (i.e., income, employment, population, etc.). DSP periodically prepares and publishes long-range projections of two of the most important of these, population and employment. (It does not currently prepare projections of income.) The DSP projections, prepared for each of the Maryland counties and for Baltimore City, have been incorporated into the PPRP/DSP forecasts of power demands for the major electric utilities serving Maryland. DSP also provides data and projections of household size and population by demographic subgroup (e.g., males and females).

This appendix presents a description of the economic/demographic historical trends in the State and DSP's outlook through the year 2005.[1] To put these historical trends and projections in perspective, Maryland data are compared to the performance and projected outlook for the U.S. as a whole.

It is important to understand that the Maryland utilities plan all generating capacity additions on the basis of total system load growth, including the non-Maryland portions of their service areas. Three of the four major electric utilities in the State (PEPCO, DP&L, and Potomac Edison) sell significant portions of their power outside Maryland. However, the State's largest electric utility, BG&E, is entirely within Maryland. PEPCO is the second largest utility in Maryland with slightly more than half of its service territory in the State. Only approximately 20 percent of APS (which includes Potomac Edison) and 25 percent of DP&L are in Maryland. Thus, projections of economic/demographic trends in Maryland are only part of the information needed for all but BG&E.

DSP develops its projections of Maryland employment and demographic variables at the county level. This is particularly useful for utility planners because investments in distribution plant (such as substations) and certain kinds of transmission capacity are based upon small-area growth prospects.

The sections which follow examine the aggregate historical and projected trends in employment, population, and income for the State and break down those trends for the principal regions within the State. This appendix identifies five distinct regions within Maryland, as indicated on Table A-1, rather than the seven regions used by DSP. Whereas DSP identifies Frederick County as a separate region, here it is included as part of Western Maryland. In addition, a single Eastern Shore region is used in this appendix rather than the "Upper" and "Lower" Eastern Shore regions used by DSP. These changes have been made for simplicity and to make the regional definitions conform more closely with the State's electric utility service territories.

---

1 Appendix A of the 1984 edition of the CEIR includes a brief overview of the methods and models employed by DSP to forecast employment and population (MD-PPRP 1984).

Table A-1

Principal regions in Maryland

Region	Counties	Predominant Electric Utility
(1) Baltimore	Baltimore City Baltimore County Anne Arundel Harford Howard Carroll	BG&E
(2) Washington Suburban	Montgomery Prince George's	PEPCO
(3) Eastern Shore	Cecil (a) Caroline Kent Queen Anne's Talbot Dorchester Somerset Wicomico Worcester	DP&L (and Choptank)
(4) Southern Maryland	Calvert Charles St. Mary's	SMECO (and PEPCO)
(5) Western Maryland	Allegheny Frederick Garrett Washington	PE

(a) Most of Cecil County is served by Conowingo Power Company.

A. Employment Trends

Table A-2 shows the trends in total civilian employment for Maryland and the U.S. for the time period 1970 to 1986. Over this 17-year period, average annual growth in employment in Maryland has been slightly more rapid than that for the nation as a whole. These statistics, however, are somewhat misleading. As the far right column on Table A-2 indicates, Maryland's share of national employment declined from 1.87 percent in 1970 to 1.84 percent in 1982. However, between 1982 and 1986 Maryland experienced employment growth of 3.9 percent compared to a 2.9 percent increase nationwide. As of mid-1986, the state's unemployment rate stood at 4.3 percent, which is far stronger than the national average of 6.9 percent. Thus, over most of the historical period, Maryland's employment growth has lagged the nation, and only in recent years has outpaced it.

Table A-3 breaks down total employment into major sectors for 1970 and 1986. Employment structure in 1986 is fairly similar for the U.S. and Maryland except that Maryland has somewhat more government and less manufacturing than the rest of the nation. Table A-3 indicates that the most dramatic employment change between 1970 and 1986 is in the manufacturing sector, whose share of total employment in Maryland declined from 16.7 to 9.1 percent. This was principally offset by gains in the service sector (in 1986 the largest sector), from 19.5 percent in 1970 to 28.8 percent in 1986. The decline in manufacturing has been a nationwide trend, falling from 23.1 percent in 1970 to 16.0 percent in 1986.

With the decline of manufacturing, Maryland's economy is now dominated by the commercial sector. Based on 1986 data, trade, services and government account for over 70 percent of total civilian employment. The comparable figure for the U.S. is 64.7 percent.

A detailed picture of economic trends in Maryland is provided through an examination of employment patterns among the several regions. Table A-4 presents manufacturing, non-manufacturing and total employment for each of the five regions for 1970 and 1984, the latter being the most recent year for which these data are available at the county level.

Table A-2

Total employment in the U.S. and Maryland 1970-1986 (thousands)

Year	Maryland	U.S.	Maryland as a % of U.S.
1970	1,678.1	89,753	1.87%
1975	1,818.7	97,177	1.87
1976	1,841.7	99,860	1.84
1977	1,898.4	103,324	1.84
1978	1,985.8	108,092	1.84
1979	2,043.1	111,632	1.83
1980	2,050.9	112,257	1.83
1981	2,080.9	113,313	1.84
1982	2,070.9	112,565	1.84
1983	2,138.7	114,147	1.87
1984	2,238.2	119,485	1.87
1985	2,330.7	123,167	1.89
1986	2,415.0	126,166	1.91
Annual Rates of Growth			
1970-198	2.3%	2.2%	-
1976-1986	2.7	2.4	-
1981-1986	3.0	2.2	-

Sources: BEA 1987a, 1987b

Table A-3

Structure of nonagricultural employment in Maryland and the United States, 1970 and 1986

Sector	Maryland 1970	Maryland 1986	United States 1970	United States 1986
Mining	0.1%	0.1%	0.8%	0.9%
Construction	6.4	7.1	5.2	5.5
Manufacturing	16.7	9.1	23.1	16.0
Transportation, Communications & Utilities	5.5	4.4	5.7	4.9
Trade	20.9	22.9	20.9	22.1
FIRE(a)	6.8	7.5	5.8	7.9
Services	19.5	28.8	19.5	26.5
Civilian Government	25.3	19.9	19.2	16.1
TOTAL(b)	100.0%	100.0%	100.0%	100.0%

Sources: BEA 1987a, 1987b.
(a) Finance, insurance and real estate.
(b) Totals may not sum to 100 percent due to independent rounding.

Table A-4
Employment and employment shares by region

Region	1970 Number	1970 % of Region	1984 Number	1984 % of Region	Annual Rate of Growth In Number Employed 1970-1984
Baltimore					
Total	983.3	-	1,205.7	-	1.5%
Manufacturing	197.0	20.0%	145.2	12.0%	-2.2
Nonmanufacturing	786.3	80.0	1060.5	88.0	2.2
Washington Suburban					
Total	416.9	-	680.3	-	3.6
Manufacturing	16.2	3.9	28.9	4.2	4.2
Nonmanufacturing	400.7	96.1	651.4	95.8	3.5
Western Maryland					
Total	119.2	-	145.8	-	1.4
Manufacturing	31.9	26.8	23.2	15.9	-2.2
Nonmanufacturing	87.3	73.2	122.6	84.1	2.5
Southern Maryland					
Total	40.5	-	60.5	-	2.9
Manufacturing	1.1	2.7	1.1	1.8	0.0
Nonmanufacturing	39.4	97.3	59.4	98.2	3.0
Eastern Shore					
Total	118.1	-	145.8	-	1.5
Manufacturing	26.9	22.8	25.0	17.1	-0.5
Nonmanufacturing	91.2	77.2	120.8	82.9	2.0
Maryland					
Total	1,678.1	-	2,238.2	-	2.1
Manufacturing	273.3	16.3	223.3	10.0	-1.4
Nonmanufacturing	1,404.8	83.7	2,014.9	90.0	2.6

Source: MD-DSP 1987a.

Manufacturing employment is listed on this table because it tends to be the most unstable sector, i.e., the one that has changed the most over time. The far right column lists the annual average rate of growth for all of these employment measures over the period 1970 through 1984.

The most rapidly growing region has been suburban Washington (Montgomery and Prince George's counties) which now accounts for more than 30 percent of total state employment. One of the reasons this region has been able to grow as rapidly as it has is its lack of a manufacturing base. In contrast, the Baltimore region lost over 50,000 manufacturing jobs during this period, an annual decline of 2.2 percent. However, that region's non-manufacturing sector grew at a healthy 2.2 percent annual rate. Western Maryland and the Eastern Shore, with their substantial manufacturing sectors and lack of substantial commercial centers, were the slowest-growing regions in Maryland. Despite the decline in manufacturing, however, all regions in Maryland have exhibited at least modest employment growth since 1970.

The outlook for growth in total employment in Maryland (by region) and the U.S. is shown on Table A-5. The Maryland projections on that table were prepared by DSP, while the U.S. projections were prepared by BEA. These projections indicate relatively slow employment growth of approximately 1.0 percent per year. Over the 1990 to 2005 time period, DSP projects that the Maryland economy will create approximately 417,000 additional jobs, or a 16.4 percent increase.

B. Population and Household Trends

Year to year, population tends to be far more stable than employment. However, over longer periods of time, significant changes do occur in both the total amount and composition of population within a region. Moreover, for small geographic areas (e.g., counties) large and important changes can occur even within the period of a few years.

Table A-6 presents total population for Maryland and the U.S. since 1960. Over the entire period 1960-1986, population in Maryland increased at a slightly more rapid rate than in the nation as a whole, at 1.4 percent versus a 1.1 percent annual rate. However, Maryland's more rapid growth was entirely confined to the 1960's. Since

Table A-5

Employment projections for Maryland and the U.S.
(thousands)

Region	**1990**	**1995**	**2005**	**Average Annual Rate of Growth 1990-2005**
Baltimore	1,324	1,373	1,447	0.6%
Washington Suburban	827	908	1,059	1.7
Southern Maryland	74	80	89	1.2
Western Maryland	159	167	181	0.9
Eastern Shore	166	176	191	0.9
Total State	2,550	2,704	2,967	1.0
United States	135,200	143,600	157,700	1.0

Source: MD-DSP 1987b.

Table A-6

Maryland and United States population, 1960-1986 (thousands)

Year	Maryland	U.S.	Maryland as a % of U.S.
1960	3,101	179,323	1.73%
1970	3,924	203,302	1.93
1980	4,217	226,546	1.86
1981	4,256	229,637	1.85
1982	4,272	231,996	1.84
1983	4,299	234,284	1.83
1984	4,348	236,477	1.84
1985	4,393	238,741	1.84
1986	4,461	241,096	1.85
Annual Rates of Growth			
1960-1986	1.4	1.1%	-
1970-1986	0.8	1.1	-
1980-1986	0.9	1.0	-

Sources: 1960-1980: USDC 1985; 1981-1986: USBC 1987b.

1970, Maryland's population growth has slowed to 0.8 percent per year compared to a 1.1 percent U.S. annual growth rate.

Historical population growth in Maryland is presented by region on Table A-7. The state's population is primarily concentrated in two regions, the Baltimore and Washington Suburban regions, which together in 1986 accounted for approximately 81 percent of the total. The rates of population growth among the various regions in the State have been fairly similar with one exception. Growth in the Southern Maryland region has been 3.2 percent per year, compared to the statewide average of 0.8 percent. However, even with this very rapid growth, that region accounts for less than 5 percent of the State's population.

Regional aggregations can sometimes mask important county-level demographic trends. The Baltimore region provides the most important example of this. The annual rates of growth of total population for the city and five surrounding counties for the period 1970 through 1986 are as follows:

Baltimore City	-1.1%
Anne Arundel	1.8
Baltimore County	0.5
Carroll County	2.8
Harford County	1.8
Howard County	5.2
Region	0.5%

The suburban counties have been increasing at a rate of 1.8 to 5.2 percent per year compared to the considerably slower 0.5 percent per year rate for Baltimore County and the 1.1 percent per year decline for Baltimore City. The overall regional growth rate of only 0.5 percent per year reflects the fact that Baltimore City and County contain the majority of the region's population. A similar situation arises in the Washington Suburban region. Montgomery County's population has been growing by 1.4 percent per year compared to 0.2 percent growth over the last decade and a half in Prince George's County. The two counties are roughly equal in size.

Table A-7

Population in Maryland by region, 1970-1986 (thousands)

Year	Baltimore	Washington Suburban	Southern Maryland	Western Maryland	Eastern Shore
1970	2,071	1,185	116	294	258
1980	2,174	1,244	167	335	297
1981	2,189	1,260	172	337	299
1982	2,194	1,263	175	337	301
1983	2,205	1,278	179	338	304
1984	2,217	1,300	185	340	308
1985	2,220	1,315	191	344	313
1986	2,244	1,337	198	347	318
% of 1986 Total Maryland Population	50.5%	30.1%	4.5%	7.8%	7.2%
Annual Rates of Growth					
1970-1986	0.5%	0.7%	3.2%	1.0%	1.2%
1980-1986	0.5	1.0	2.5	0.5	1.0

Source: MD-DSP 1987c.

Table A-8 presents DSP's population projections for the state and the five regions through the year 2005. That table also includes the latest projection of U.S. population from the Bureau of the Census for purposes of comparison. DSP expects Maryland's population growth rate to approximate the actual rate of growth over the historical period 1970 to 1986. The DSP projections reflect the same basic outlook for population in each of the five regions except for Southern Maryland, which DSP expects to slow somewhat from its very rapid growth rate of the last 15 years. The U.S. Census projects a nationwide population growth rate of 0.7 percent per year, identical to DSP's projections for Maryland. The projected pace of growth within regions, however, is not uniform. Baltimore City's population decline is expected to continue, though at a diminishing rate. Over the 1986 to 2005 period, the city's population is projected to decline by about 40,000 compared to a loss of over 150,000 during the 1970-1984 period. The majority (nearly three-fourths) of the population growth in Western Maryland is expected to occur in one county, Frederick County.

In addition to population, DSP projects the number of households for each county. This variable is particularly important to utility planners, because the number of residential customers has historically been very closely related to the number of households. Those projections, along with historical data, are presented on Table A-9. The upper portion of the table presents the number of households (by region) for 1970, 1985, 1990 and 2000, and the lower portion of the table indicates the corresponding average household size.

Table A-9 reveals several patterns of importance for utility system planning. In every region, the number of households is expected to increase more rapidly than population, thus reflecting declines in average household size. This is a very long-term trend that was clearly present during the 1970-1986 period. In each region, DSP projects the rate of growth in households to exceed that of population by about 0.3 to 0.5 percentage points.

Table A-8

Projections of total population for Maryland regions and the U.S., 1986-2005 (thousands)

	1986	1990	1995	2000	2005	Rate of Growth 1986-2005 (%)
Baltimore	2,240	2,324	2,380	2,437	2,40	0.4%
Washington Suburban	1,337	1,421	1,501	1,550	1,59	0.9
Southern Maryland	198	221	244	265	283	1.8
Western Maryland	347	362	376	389	400	0.7
Eastern Shore	318	338	352	364	373	0.8
Total State	4,444	4,666	4,854	5,006	5,135	0.7
United States[a]	241,096	249,659	259,559	267,955	275,677	0.7%

Source: MD-DSP 1987c; USBC 1987a.

[a]The 1986 census figure for U.S. population is actual.

Table A-9

Historic and projected number of households and average size of households in Maryland by region, 1970-2000

Region	Households (thousands)				Annual Rate of Growth	
	1970	1985	1990	2000	1970-1985	1985-2000
Baltimore	624	809	881	972	1.6%	1.2%
Washington Suburban	350	477	535	621	2.0	1.7
Southern Maryland	30	61	75	95	4.5	2.8
Western Maryland	92	123	134	149	1.8	1.2
Eastern Shore	80	115	128	144	2.4	1.5
Total State 1	1,175	1,586	1,752	1,982	2.0	1.5%
Average Household Size						
Baltimore	3.22	2.68	2.58	2.44	-1.2%	-0.6%
Washington Suburban	3.32	2.71	2.62	2.46	-1.3	-0.6
Southern Maryland	3.77	3.08	2.93	2.77	-1.3	-0.7
Western Maryland	3.16	2.67	2.61	2.52	-1.1	-0.4
Eastern Shore	3.12	2.65	2.56	2.45	-1.1	-0.5
Total State	3.25	2.70	2.60	2.47	-1.2%	-0.6

Source: MD-DSP 1987c.

The tendency toward smaller household size may be due to a variety of factors, including the overall aging of the population and more single-parent households. It also should be noted, however, that this phenomenon is gradually abating. For example, during the 15-year period 1970 to 1985, average household size in Maryland declined from 3.25 to 2.70, or 1.3 percent annually. Over the next 15 years, DSP expects the average household to decline in size from 2.70 to 2.50, or 0.5 percent annually. The DSP household size projections are fairly uniform across regions in Maryland. In the year 2000, DSP projects average household size in four of the five regions to range from 2.46 to 2.58 persons. Southern Maryland is the exception, with a projected average household size of 2.76 persons.

C. Population and Employment Interactions

Population and employment interact in a complex manner. Recognition of this interaction is important for electric load forecasting. Because forecasts of electric power requirements depend on independent forecasts of population (to reflect growth in the number of customers) and employment (to reflect growth in business activity), the population and employment projections used for electric load forecasting must be consistent to help ensure the reliability of load projections.

Increases in population tend to increase labor supply, and ultimately increase total employment as businesses make use of the increased pool of labor. Moreover, population increases tend to spur the demand for goods and services. To the extent that these goods and services are locally produced, the new demand also serves to increase local employment. While higher population levels will tend to result in higher employment, increased employment opportunities in the state (for example, from new investment) also tend to attract job seekers from out of state, thus resulting in further population increases. Over the past approximately 20 years, employment has tended to increase more rapidly than population. This has been due primarily to two factors. The first is that a larger percentage of the population is of young working age (i.e., 16-24) than in the past; and second is that there has been an increased tendency for women to enter the work force. Nationwide, the "working age" percentage increased from 60.0 percent in 1970 to 64.8 percent in 1983. In 1970, women accounted for 37.7 percent of total civilian employment in the U.S. compared to 43.7 percent in 1984. Over this 14-year period, female civilian employment in the U.S. has increased by 3.2 percent per year.

Table A-10 summarizes historic employment/population trends and projections for the U.S., Maryland and regions within Maryland. The Maryland projections were prepared by DSP and the U.S. projections by the Bureau of Census. For the U.S., the Census Bureau projects that 57.3 percent of the population will be employed in the year 2005 compared to 44.1 percent in 1970: an increase of 30 percent.

The state of Maryland and most of the regions in the state also show a clear trend toward a higher employment/population ratio that is somewhat more pronounced than for the U.S. as a whole. The state's ratio in the year 2005 exceeds its 1970 ratio by 35 percent.

This same basic pattern is exhibited by all regions in the state except Southern Maryland, which displays a noticeable downward trend on both an historical and projected basis. From a purely mechanical standpoint, this is because the region's population has been growing and is expected to continue to grow rapidly, while employment has been increasing much more gradually. This reflects the fact that the Southern Maryland counties (Charles County in particular) have been undergoing rapid suburbanization, with the region's residents commuting to employment centers in the Washington and Baltimore areas. This pattern of development makes Southern Maryland an exception to the statewide trend.

D. Personal Income Growth

Personal income is an economic measure that utility forecasters track carefully because it is believed to play an important role in determining the demand for electricity. Increases in personal income induce consumers to purchase more electricity-using appliances and to utilize their existing stock of appliances more intensively. Moreover, consumers tend to spend at least a portion of their incomes on locally-produced goods and services, which stimulates greater nonresidential electricity demand.

At present, DSP does not publish projections of personal income. However, BEA publishes them for the U.S. as a whole and for each of the 50 states. On a per-

Table A-10

Historic and projected employment/population ratios for the U.S. and Maryland, 1970-2005 (percentages)

Region:	1970	1980	1990	2000	2005
Baltimore	7.5%	52.2%	57.0%	58.0%	60.2%
Washington Suburban	35.2	47.6	58.2	63.6	66.4
Southern Maryland	34.9	29.9	33.4	32.2	31.6
Western Maryland	40.5	41.9	44.0	44.8	45.2
Eastern Shore	45.8	45.2	49.1	50.5	51.1
Total State	42.8	48.6	54.7	56.8	57.8
United States(a)	44.1	49.6	54.3	56.7	57.3

Sources: MD-DSP 1987b; USBC 1987a.

(a) Projections prepared by U.S. Bureau of the Census.

and inflation-adjusted basis, growth in personal income in Maryland has slightly outpaced that of the U.S. as a whole. Over the period 1983-2000, BEA projects an increase in per capital income for the U.S. of 1.8 percent per year, a rate of growth virtually identical to that which occurred from 1969 to 1983. Per capita income for Maryland is projected by BEA to increase by 1.7 percent per year. Whereas Maryland had previously slightly outperformed the U.S., BEA expects Maryland to slightly underperform the U.S. in the future.

E. References

BEA (Bureau of Economic Analysis, U.S. Department of Commerce). 1987a. Employment (jobs by place of work). Washington, DC: U.S. Government Printing Office, August 1987.

BEA. 1987b. Total full-time and part-time employment. Table SA25. Washington, DC: U.S. Government Printing Office, August 1987.

MD-DSP (Maryland Department of State Planning). 1987a. Employment (jobs by place of work). August 1987.

MD-DSP. 1987b. Total employment projections for Maryland subdivisions. September 1987.

MD-DSP. 1987c. Unpublished data. September 1987.

MD-PPRP (Maryland Power Plant Research Program). 1984. Power plant cumulative environmental impact report. Prepared by Maryland Department of Natural Resources, Power Plant Siting Program, Annapolis, Maryland. PPSP-CEIR-4.

USBC (U.S. Bureau of the Census). 1987a. Series P-25, No. 952. Washington, DC: U.S. Government Printing Office, 1987.

USBC. 1987b. Series P-25, No. 1010, 1987.

USDC (U.S. Department of Commerce). 1985. Statistical abstract of the United States, 1985.