ISSUES IN CLUSTERED NUCLEAR SITING:

**A Comparison of a Hypothetical Nuclear Energy Center
in New Jersey With Dispersed Nuclear Siting**

Peter M. Meier and David Morell

September 1976

**POLICY ANALYSIS DIVISION
NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973**

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PETER M. MEIER AND DAVID MORELL*

*Center for Environmental Studies, Princeton University

September 1976

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CHAPTER I

INTRODUCTION

1.1 Ocean County as a Hypothetical Energy Center Location

This report is one of several analyses of hypothetical nuclear energy centers (NEC) conducted in support of the recently completed study by the Nuclear Regulatory Commission, mandated by the Congress in the Energy Reorganization Act of 1974.¹ The intent of these analyses of hypothetical, or "surrogate", sites was to inject a local and regional perspective into the overall national assessment of energy centers. Many of the technical, environmental, institutional, and socioeconomic issues could be adequately addressed only by reference to specific sites. Thus, a number of potential areas throughout the U.S. were selected for more specific analysis;² each of these areas was selected as typical of a range of siting attributes.

A hypothetical NEC site in Ocean County, New Jersey (Figure 1-1), was chosen to illustrate the problems and impacts of potential energy centers in coastal and near-coastal sites in relatively close proximity to large metropolitan areas; other sites illustrated remote locations (Fort Drum, on the St. Lawrence River in upstate New York), arid locations using dry cooling (in Eastern Nevada), and river locations relatively distant from large load centers (Kentucky Lake, Tenn.). Earlier studies of hypothetical energy centers on the Mississippi River at River Bend, La. and on the Columbia River near Hanford, Washington were also re-examined for their relevance to this new study effort.

Neither Ocean County, nor any of the other surrogate sites, has been considered for actual construction of an NEC, nor does their selection for study purposes imply any judgement of desirability. Indeed, the major finding of this report is that Ocean County is a relatively poor location for an energy center, and this may well be true of many coastal locations similar to the Jersey shore. The objective in selecting surrogate sites, then, was not to find the best locations, but to select sites that would illustrate the broadest range of potential public policy and siting issues.

Figure 1-1. The study area: Ocean County, New Jersey.

1.2 Background to the Nuclear Energy Center Site Survey

Historically, locations for electric generating facilities in the United States have been determined by individual utilities operating in a relatively passive national and state regulatory framework. As electric generating stations have grown larger and their technology more complex, however, and as we have become more aware of the broader social impacts of electricity generation, society has recognized the need to create broader and more responsible regulatory functions and agencies. Nuclear power is a particularly important case in point. On the one hand, it provides a major new energy source of potentially great importance in a time of dwindling domestic resources and unsure foreign supplies. On the other hand, while avoiding air pollution problems associated with fossil fueled plants, it introduces a set of unfamiliar and esoteric environmental and public safety hazards.

The critical role of nuclear power and the importance of managing it properly were clearly recognized by Congress in 1974 as it debated the reorganization of the institutions dealing with energy in the U.S. The Energy Reorganization Act of 1974 established two new energy agencies, the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC). The Atomic Energy Commission was taken out of existence, its research and development activities transferring to ERDA and its regulatory responsibilities to NRC. Thus, the reorganization accomplished two primary objectives: centralization of responsibility for energy R & D and separation of the regulation of nuclear power from its promotion and development.

Congress directed the new NRC to carry out a national survey to identify possible sites for nuclear energy centers, to be called the Nuclear Energy Center Site Survey (NECSS). Such centers were first conceived as including up to 40 large (1200 Mwe) nuclear power reactors, in contrast to current sites which are typically planned for one, two, or four reactors. As a result of NRC's subsequent analyses, however, 20 reactors per site was identified as a feasible upper limit, and this is the size NEC studied in New Jersey. Such NEC's would comprise some 40 square miles and would be built over approximately two decades, perhaps at the rate of one reactor per year over a time frame

of 1987-2007. They could also include facilities for fabricating nuclear fuel, for reprocessing fuel after irradiation, and for storing waste products, at least temporarily. Some sites could also contain facilities for uranium enrichment. The focus of this report is an energy center containing only power reactors, without any fuel cycle facilities.

At the inception of the NEC's study, a number of advantages to nuclear energy centers relative to widely dispersed sites seemed reasonable: they would allow employment of a relatively stable labor force; a higher level of attention could be directed to safety considerations during construction and operation; possibly better control could be maintained over materials (particularly plutonium) that could be made into nuclear weapons; and, once the center was established, power plants could be brought on line more expeditiously. A number of potential drawbacks to nuclear energy centers, relative to dispersed siting, also seemed reasonable. These factors seemed even more uncertain than did the advantages; they included questions of environmental impact (particularly large water consumption and concentrated heat dissipation), transmission requirements, regional and local economic impact, anti-trust considerations, and problems of ownership and rate regulation.

The implications of a national policy to mandate or encourage nuclear energy centers in one form or another are far-reaching indeed.³ Such a policy could have profound influence not only on the technical aspects of electricity generation but on regional development patterns, the structure and ownership of energy industries, and the country's entire electric regulatory framework. The potential costs and benefits to the nation are large and must be understood in all their complexity before such a policy is promulgated. It is in this spirit that the current work on a hypothetical New Jersey NEC was undertaken, with no preconceptions concerning the ultimate desirability of NEC's.

1.3 Relationship of this Report to Other Studies

This is the third, and final, report to be published by BNL in conjunction with the NRC's overall study of nuclear energy centers. The first report, BNL 50465,⁴ was a preliminary assessment of energy centers in New Jersey, including some analysis of a Salem County site, as well as one in Ocean County. This report considered energy centers of up to 48,000 Mw(e).

The second report, BNL 20064,⁵ was published as a supplement to the first, and examines patterns of dispersed nuclear siting in a comparison to an Ocean County site for a hypothetical energy center of up to 24,000 Mw(e). This is the same focus selected for this final BNL report on a hypothetical New Jersey nuclear energy center.

Four technical studies prepared under auspices of the BNL Regional Energy Studies Program (RESP) are closely related to this report. These cover Electrical Transmission Issues of Energy Centers,⁶ Noise Analysis of Energy Centers,⁷ Optimization of Water Conveyance Systems,⁸ and Regional Economic Impacts.⁹ These reports, which provide the basis for some of the technical analyses summarized in this study, are scheduled for publication during the last six months of 1976.

Finally, frequent reference will be made to the overall 5-volume NRC Report to Congress.¹⁰ Many of the technical assumptions used for the surrogate site analysis have been taken directly from this report. Moreover, coverage of several important energy center issues that are of generic rather than site-specific importance (such as anti-trust issues, questions of sabotage and plutonium safeguards, and national defense issues) are covered at some length in that NRC study, and are not reiterated in this detailed analysis of actual (if hypothetical) sites in New Jersey.

1.4 Scope of This Report

We turn first, in Chapter II, to an examination of probable patterns of energy growth in the Northeast, postulating a scenario for implementation of an NEC in New Jersey. A major question that must be posed in this regard concerns the sufficiency of load growth in New Jersey for an NEC to serve that state alone. If this is not the case, with power to be produced for export to other states, then, as we shall discuss, a whole spectrum of additional interstate political issues enter the dialogue. In Chapter III, we develop a dispersed siting scenario for the Mid-Atlantic Area Council (MAAC), the electric reliability council region that encompasses New Jersey, most of Pennsylvania, Maryland, Delaware, and the District of Columbia. The corresponding cluster scenario was then developed by replacing 20 of the dispersed reactors with the Ocean County NEC.

Chapter IV presents general background information on Ocean County; we examine existing and planned land use, population distribution and economic

characteristics, since these set the stage for the detailed examination of socio-economic impacts in later chapters. In Chapter V, we introduce the three actual locations chosen for closer analysis within Ocean County. One should stress, once again, that these locations were chosen only for analytical purposes, in the same way that Ocean County itself was chosen as a surrogate region. Identifying these specific locations within Ocean County proved necessary to allow closer analysis of physical environmental impacts, construction management issues, and engineering computations (for water conveyance systems and transmission costs). Our choice of these three locations for study purposes certainly does not imply any initial judgement or recommendation of their desirability.

The next seven chapters focus on the physical environment and its relationship to an Ocean County NEC. In Chapter VI, we examine overall water resource constraints and the choice of a cooling system for the NEC, and, as in all of the analytical chapters that follow, make appropriate comparisons between the cluster and the dispersed siting pattern. Chapter VII looks more closely at water conveyance systems. This is necessary because of the significant distance between the three NEC sites and the Atlantic Ocean, our cooling water source, along with the very high costs of tunnelled conveyance systems (which prove to be necessary for reasons of unacceptable environmental impact of the surface alternative). In Chapter VIII, we examine some site-specific construction management issues, particularly problems of access for heavy components and tunnel construction. Problems of aesthetics, noise, and ecology are then examined in Chapters IX, X, and XI, respectively.

Transmission issues are examined in Chapter XII. Because the MAAC area is operated as a single network, analysis of transmission requires that the entire regional transmission grid be examined, not merely the links from generating units to their nearest grid substations.

We then turn to socio-economic issues. In Chapter XIII, we examine the entire spectrum of issues associated with construction and operation of an NEC, and its associated influx of thousands of workers into the Ocean County region. Utility taxation patterns in New Jersey and their implications for implementation of the NEC concept are studied in Chapter XIV.

The remaining chapters are devoted to institutional and policy questions. In Chapter XV, we pose questions of organization: who would plan, build, and

operate a NEC in New Jersey? Since such a facility would far exceed the capabilities of a single utility company, what forms of inter-utility arrangements must be appropriate, and what forms of State and Federal involvement should one consider?

The political and institutional ramifications of an NEC are examined in Chapters XVI and XVII. Clearly the existing regulatory framework would be inadequate to address properly the many new problems posed by an NEC. Our particular interest is focused on the existing institutional framework in New Jersey, and the interface with Federal constraints. The wider questions of public attitudes and the reaction to an NEC are discussed in Chapter XVIII. Here we report on a series of interviews with 22 community leaders in Ocean County, and summarize public attitudes toward the NEC which emerged during the course of this study. In Chapter XIX we explore some special problems of population proximity and nuclear facility siting in coastal New Jersey, the popular recreation area of the nation's most densely-populated state. Our intent is to analyse the compatibility or inconsistency between a nuclear facility and concentrations of large numbers of people.

Finally, the conclusions of our analysis are drawn together in Chapter XX.

NOTES TO CHAPTER I

1. U.S. Nuclear Regulatory Commission, "Nuclear Energy Center Site Survey--1975", Report NUREG-0001, 5 Volumes, January 1976 (Hereinafter cited as NRC-NECSS).
2. The Kentucky Lake site was chosen on the basis of being representative of an inland river site, cooled by evaporative towers, with power transmitted in all directions from the Center. The New York Site was representative of a remote site, with power transmitted over relatively long distances to one or two major load centers. The Eastern Nevada site was representative of a very remote site cooled principally by dry towers. (See NRC-NECSS, Note 1, *supra*, Executive Summary, p. 10.)
3. For further discussion of the policy ramifications of Energy Centers, see P.M. Meier and P.F. Palmedo, "Planning Nuclear Energy Centers Under Technological and Demand Uncertainty", presented at the ORSA/TIMS 1976 Joint National Meeting, Philadelphia, April 2, 1976 (Report BNL 21205).
4. Energy Policy Analysis Group, "Preliminary Assessment of a Hypothetical Nuclear Energy Center in New Jersey", BNL 50465, Brookhaven National Laboratory, Upton, New York, November 1975.
5. P.M. Meier and P.F. Palmedo, "Preliminary Assessment of a Hypothetical Nuclear Energy Center in New Jersey--Supplement", BNL 20664, Brookhaven National Laboratory, Upton, New York, December 1975.
6. S. Linke and D. Chu, "Transmission Studies of Dispersed vs. Clustered Generating Facilities", Forthcoming Report, Brookhaven National Laboratory, Regional Energy Studies Program.
7. F. Moore and J. Zakaria, "Noise from Cooling Towers of Power Parks", Forthcoming Report, Brookhaven National Laboratory, Regional Energy Studies Program.
8. P. Meier, "Optimization of Water Conveyance Systems for Nuclear Energy Centers", Forthcoming Report, Brookhaven National Laboratory, Regional Energy Studies Program.
9. Regional Science Department, University of Pennsylvania, "Regional Economic Impacts of Nuclear Power Plants", Forthcoming Report, Brookhaven National Laboratory, Regional Energy Studies Program.
10. NRC-NECSS, note 1, *supra*.

CHAPTER II*

ENERGY DEMAND ANALYSIS

2.1 Energy Demand Forecasts

Although the main NRC study devotes considerable attention to energy demand forecasts, and in particular to development of consistent forecasts for the nation and the various reliability council regions, some additional attention to this topic is necessary in this present study. The question of whether or not load growth in New Jersey would be sufficient to require an NEC to serve just this State is of profound significance in terms of the political implications and citizen acceptance of the NEC concept.¹ There would, for example, be much greater resistance if a New Jersey NEC were to be designed primarily to serve electricity needs in the New York City area, a condition that would be unlikely to apply to conventional dispersed siting modes.²

In order to derive an estimate of the peak load growth to be expected in New Jersey, we initially utilized estimates supplied to us by the major New Jersey utilities for the period after 1990: 4.25% per year for Public Service Electric and Gas, 4.5% per year for Jersey Central Power and Light, and 5.4% per year for the Atlantic Electric Company.³ Rates prior to 1990 were not uniform, but also were taken directly from utility sources. In regard to reserve capacity, we again used utility estimates up to 1990, and assumed a 20% margin thereafter. After adjusting for capacity retirements,⁴ the resulting total New Jersey capacity projection is shown on Figure 2-1, rising from 13 Gw(e) in 1975 to 37 Gw(e) in 2000 and 58 Gw(e) in 2010.

This derivation refers to peak system capacity, and only part of this represents base load which can be supplied by an NEC. The portion of the total capacity estimated for nuclear power is derived below in Section 2.2; we note here, however, that an NEC located in New Jersey could in fact be designed in such a way as to serve primarily the needs of that state.

* Prepared with the assistance of Saifur Rahman, Energy Policy Analysis Division, Brookhaven National Laboratory.

From Figure 2-1 we note that if one adds nuclear capacity at the assumed NEC construction rate of 1 reactor per year, onto that capacity which would already exist in 1986 at the start of NEC implementation, then the total available capacity would just exceed the base case projection. Given the need for peaking capacity as well as nuclear base load capacity additions, this implies that reactor construction in the NEC might need to be slowed somewhat if an NEC were to be designed to meet only the needs of the State of New Jersey. In view of the uncertainties of long-term load and capacity projection, such a methodology and the conclusions which are based on it may well be open to some question. Indeed, if we assume that growth beyond 1980 is one percent less than the base case, a situation we shall term the conservation case, then NEC reactor construction would need to be slowed considerably to meet a "no export" criterion. We note, of course, that the magnitude of even a small 1% drop in growth rate is highly significant, resulting in a 2005 demand of around 43 Gw rather than 58 Gw.

Only a massive program of energy (electricity) conservation in New Jersey over the next 25 years could change these demand growth calculations in any major way; such a program would require implementation of major new incentives and sanctions to reduce energy demand by the State's industrial, commercial, and residential consumers. This kind of revolutionary public policy may well be possible, but it certainly does not seem likely as of this writing (June 1976).

One of the realities of modern electric utility practice is the use of the power pool as the basic unit for planning and operation. Consequently, from a technical standpoint, it may not be too meaningful to speak in terms of an NEC designed to serve exclusively the needs of New Jersey, because this NEC would necessarily be connected to the PJM Interconnection, the power pool arrangement that covers not only New Jersey, but also Pennsylvania and Maryland utilities.⁶ For planning and reliability purposes, the utilities that participate in the PJM Interconnection have entered into a further agreement known as the Mid-Atlantic Area Council (MAAC).⁷ In view of the fact that MAAC compiles the relevant projection and capacity data, an analysis of the capacity provided by a New Jersey NEC as compared to the total MAAC system's capacity projections is thus of some interest. Using the same methodology as in the case of New Jersey alone in regard to reserve requirements and capacity retirements, but using system-wide MAAC load projections up to 1990⁸ and a 4.25% load growth rate from 1990-2010,⁹

resulting capacity demands for the MAAC system are shown on Figure 2-2. With load growth of this magnitude, there would be scope for several NEC's within the MAAC area, again of political significance in terms of an NEC supplying power "across state lines". This conclusion, too, changes little under the above-described conservation case (1 percent less growth per year).

Finally, it may be useful to examine load growth conditions in the New York City area. Calculations using the above procedure for the three southernmost utilities of the New York Power Pool (NYPP)¹⁰ --Consolidated Edison, Long Island Lighting (LILCO) and Orange and Rockland Utilities--are shown on Figure 2-3. We note that under such load growth projections, there would be sufficient demand for an NEC to serve primarily the New York City area with some net export capacity in the conservation case.¹¹ This implies that both New Jersey and New York may each require their own NEC's, thereby avoiding the problem of finding a mutually agreeable single NEC site serving both areas. In sum, these various projections suggest that if the NEC concept were indeed implemented, a scenario would be entirely plausible in which a New Jersey NEC served primarily that state, one or two NEC's located in Pennsylvania served the remainder of the MAAC and PJM area, and a site in New York served the New York City metropolitan area.

This is, of course, a very difficult time in which to make energy projections of any kind. Electricity demand projections are particularly uncertain due to substantial long-term substitutability for other fuels, itself dependent on uncertain future price structures. Indeed, many recent estimates of energy demand and necessary installed capacity show very broad ranges, depending on the assumptions made for the projection;¹² and a whole spectrum of issues emerges from a more detailed analysis of planning responses to demand uncertainty.¹³ Nevertheless, only a massive energy conservation effort would alter these calculations in any major way.

2.2 Generation Mix Projections

One must next make estimates of the likely mix of electricity generating units. The mix for 1975-1984 can again be taken from the MAAC Systems plans. Simple extrapolation of the 1975-1984 trend, however, would lead to unreasonable results, producing an approximately 80 percent nuclear portion by 2006, a most unlikely figure. Therefore further assumptions had to be made.

Figure 2-1. New Jersey capacity projection.

Figure 2-2. MAAC capacity projection.

Figure 2-3. New York City area capacity projection.

Figure 2-4 shows the generation mix plan assumed for this study. We have used the MAAC projections for 1975-1984, and have then assumed that 50 percent of capacity additions in the years 1985-1994 will be nuclear, an assumption consistent with the current MAAC projections. From 1995-2006, we have assumed that the proportion of nuclear additions would increase somewhat, reaching about 60 percent by 2006. If one assumes further that hydro-electric generation decreases from about 5% to 2%, and that the fraction of combustion turbines (and diesels) falls from around 20 percent to around 10 percent,¹⁴ the generation mix as shown in Figure 2-4 results.¹⁵ The corresponding system totals in Gw(e) for each type of capacity, by year, are shown in Figure 2-5, and capacity additions by generation type for 1975 and after are shown in Figure 2-6.

It is possible to envision other approaches which would rely far less on nuclear energy. Three examples are: (1) much greater reliance on coal; (2) extensive use of cogeneration of electricity with industrial process steam;¹⁶ and (3) much more rapid introduction of solar energy, including wind. The nuclear projections we have used for this study, however, are consistent with present plans and attitudes of the utilities, and of most state and national public policy decision-makers. It seems only prudent to explore on an explicit basis the probable impacts of a nuclear energy cluster, rather than to place all one's faith in alternatives which, though possible, must continue to be rated as unlikely.

2.3 Development Plan

Having set forth an assumed generation mix and total system capacity, by year, one can then construct a schedule for the addition of required new generating units. Nuclear units are assumed to be 1200 Mw (1.2Gw) and new fossil and hydroelectric units 800 Mw (0.8 Gw).¹⁷ In the interest of clarity, combustion turbine increments are assumed to be of 200 Mw, although we recognize that each 200 Mw installation might consist of several modular units, each of much lower unit size. The resulting schedule of new unit additions is shown in Table 2-1.

We have not made any allowances for capacity retirements other than for the interval 1975-1984 for which utility forecasts were available from the MAAC systems' plans. Such a simplification can be justified on several grounds. First, in all likelihood none of the large nuclear units would need replacement by 2006; at that time the oldest in the MAAC system would be the 37-year old Oyster Creek

Figure 2-4. Assumed generation mix (as fraction of total system capacity).

Figure 2-5. Assumed system totals of each generation type.

Figure 2-6. Assumed capacity additions since 1975 by generation type.

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS									
YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADDINGS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1974	30.20						0.00	39.30	30.13
1975	31.90	PHIL.ELEC.	MISC.RTY.	•	FOSSIL	.24			
		DELARVA	MCKEE RUN	•	FOSSIL	.14			
			EDGEWOOD	•	FOSSIL	.20			
		PENN P&L	MARTINS CREEK	•	FOSSIL	.80			
		PENN P&L	HUNLOCK	•	FOSSIL	.03			
		BALTIMORE	CALVERT CLIFFS	• 1	NUCLEAR	.88			
		POTOMAC E	CHALK POINT	•	FOSSIL	.63			
							2.39	41.69	30.69
1976	33.60	PSE&G	SALEM	• 1	NUCLEAR	1.09			
		PHIL.ELEC.	EDDYSTONE	• 3	FOSSIL	.06			
		PHIL.ELEC.	EDDYSTONE	• 4	FOSSIL	.40			
		GPU	GILBERT	•	FOSSIL	.12			
							1.67	43.36	29.04
1977	35.60	PSE&G	SALEM	• 2	NUCLEAR	1.12			
		PENN P&L	MARTINS CREEK	•	FOSSIL	.80			
		BALTIMORE	CALVERT CLIFFS	• 2	NUCLEAR	.89			
		GPU	HOMER CITY	• 3	FOSSIL	.33			
							3.13	46.48	30.57
1978	37.70	ACE	UNASSIGN	•	GAS TURB	.12			
		GPU	THREE MILE ISL.	• 1	NUCLEAR	1.06			
		ACE	DEEPWATER	•	FOSSIL	.11			
							1.07	47.56	28.14

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS, CONTINUED

YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADDNS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1979	39.90	ACE	UNASSIGN	*	GAS TURB	.06			
		DELMARVA	INDIAN RIVER	*	FOSSIL	.40			
		DELMARVA	EASTON	*	DIESEL	.01			
		BALTIMORE	UNASSIGNED, MD.	*	GAS TURB.	.25			
		GPU	MISC. FOSSIL RET.	*	FOSSIL	-.16			
		POTOMAC	CHALK POINT	*	FOSSIL	.63			
							1.19	40.75	22.17
1980	41.70	PHIL. ELEC	BARBADOS	*	FOSSIL	.03			
		ACE	UNASSIGNED	*	FOSSIL	.12			
		ACE	DEEPWATER	*	GAS TURB.	-.11			
		PENN P&L	SUSQUEHANNA	* 1	NUCLEAR	1.09			
		BALTIMORE	BRANDON SHORES	*	FOSSIL	.61			
							1.70	50.44	20.97
1981	43.90	CONSORTY,	HOPE CREEK	* 1	NUCLEAR	1.10			
		DELMARVA	SUMMIT	* 1	NUCLEAR	.77			
		PHIL. ELEC.	BARBADOS	*	FOSSIL	.03			
		PHIL. ELEC.	LIMERICK	* 1	NUCLEAR	1.09			
		PHIL. ELEC.	RICHMOND	*	FOSSIL	-.13			
		ACE	UNASSIGNED	*	FOSSIL	.24			
		POTOMAC	DICKERSON	*	FOSSIL	.80			
							3.86	54.30	23.70
1982	46.08	CONSORTY,	HOPE CREEK	* 2	NUCLEAR	1.10			
		PHIL. ELEC.	LIMERICK	* 2	NUCLEAR	1.09			
		ACE	UNASSIGNED	*	FOSSIL	.06			
		PENN P&L	SUSQUEHANNA	* 2	NUCLEAR	1.09			
		BALTIMORE	BRANDON SHORES	*	FOSSIL	.61			
		GPU	FORKED RIVER	*	NUCLEAR	1.17			
							5.04	59.34	20.78
1983	48.30	PHIL. ELEC.	CHESTER	*	FOSSIL	-.12			
		ACE	UNASSIGNED	*	GAS TURB.	.06			
		BALTIMORE	UNASSIGNED	*	GAS TURB.	.25			
		GPU	RETIRED,	*	FOSSIL	-.30			
							-.11	59.23	22.63

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS, CONTINUED									
YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADDTNS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1984	50.60	DELMARVA	SUMMIT	2	NUCLEAR	.77			
		PHILTELEC	FULTON	1	NUCLEAR	1.16			
		ACE	UNASSIGNED		GAS TURB.	.12			
		BALTIMORE	UNASSIGNED		GAS TURB.	.30			
		GPU	SEWARD		FOSSIL	.80			
							3.15	62.38	23.28
1985	53.80	PSE+G	N 001		NUCLEAR	1.20			
			H 001		PUMP-ST.	.86			
							2.06	64.43	19.76
1986	56.50		N 002		NUCLEAR	1.20			
			N 003		NUCLEAR	1.20			
			F 001		FOSSIL	.80			
			G 001		GAS TURB	.20			
							3.40	67.83	20.06
1987	59.20	PSE+G	N 004		NUCLEAR	1.20			
			F 002		FOSSIL	.80			
			F 003		FOSSIL	.80			
			G 002		GAS TURB	.20			
			H 002		PUMP-ST.	.86			
							3.86	71.69	21.09
1988	62.00		F 004		FOSSIL	.80			
			F 005		FOSSIL	.80			
			F 006		FOSSIL	.80			
			N 005		NUCLEAR	1.20			
							3.60	75.29	21.43

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS, CONTINUED

YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADDTNS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1989	64.90		N 006	*	NUCLEAR	1.20			
			N 007	*	NUCLEAR	1.20			
			F 007	*	FOSSIL	.80			
			G 003	*	GAS TURB	.20			
							3.40	78.69	21.24
1990	67.80		F 008	*	FOSSIL	.80			
			F 009	*	FOSSIL	.80			
			F 010	*	FOSSIL	.80			
			N 008	*	NUCLEAR	1.20			
			G 004	*	GAS TURB	.20			
							3.80	82.49	21.48
1991	71.00		N 009	*	NUCLEAR	1.20			
			N 010	*	NUCLEAR	1.20			
			F 011	*	FOSSIL	.80			
			F 012	*	FOSSIL	.80			
			G 005	*	GAS TURB	.20			
			G 006	*	GAS TURB	.20			
							4.40	86.89	22.38
1992	74.40		N 011	*	NUCLEAR	1.20			
			N 012	*	NUCLEAR	1.20			
			F 013	*	FOSSIL	.80			
			F 014	*	FOSSIL	.80			
			G 007	*	GAS TURB	.20			
			G 008	*	GAS TURB	.20			
							4.40	91.29	22.78
1993	77.50		N 013	*	NUCLEAR	1.20			
			F 015	*	FOSSIL	.80			
			F 016	*	FOSSIL	.80			
			G 009	*	GAS TURB	.20			
			G 010	*	GAS TURB	.20			
							3.80	94.49	21.92

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS, CONTINUED

YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADD'TNS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1994	81.31		F 017	.	FOSSIL	.80			
			F 018	.	FOSSIL	.80			
			N 014	.	NUCLEAR	1.20			
			N 015	.	NUCLEAR	1.20			
			G 011	.	GAS TURB	.20			
			G 012	.	GAS TURB	.20			
							4.40	98.89	21.62
1995	84.76		N 016	.	NUCLEAR	1.20			
			F 019	.	FOSSIL	.80			
			F 020	.	FOSSIL	.80			
			G 013	.	GAS TURB	.20			
			G 014	.	GAS TURB	.20			
							3.20	102.09	20.44
1996	88.36		N 017	.	NUCLEAR	1.20			
			N 018	.	NUCLEAR	1.20			
			F 021	.	FOSSIL	.80			
			F 022	.	FOSSIL	.80			
			G 015	.	GAS TURB	.20			
			G 016	.	GAS TURB	.20			
							4.40	106.49	20.52
1997	92.11		N 019	.	NUCLEAR	1.20			
			N 020	.	NUCLEAR	1.20			
			F 023	.	FOSSIL	.80			
			F 024	.	FOSSIL	.80			
			G 017	.	GAS TURB	.20			
			G 018	.	GAS TURB	.20			
							4.40	110.89	20.39
1998	96.03		N 021	.	NUCLEAR	1.20			
			N 022	.	NUCLEAR	1.20			
			F 025	.	FOSSIL	.80			
			F 026	.	FOSSIL	.80			
			F 027	.	FOSSIL	.80			
			G 019	.	GAS TURB	.20			
			G 020	.	GAS TURB	.20			
							5.20	116.09	20.89

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS CONTINUED									
YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADD'NS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
1999	100.11		F 028	-	FOSSIL	.80			
			F 029	-	FOSSIL	.80			
			N 023	-	NUCLEAR	1.20			
			N 024	-	NUCLEAR	1.20			
			G 021	-	GAS TURB	.20			
			G 022	-	GAS TURB	.20			
							4.40	120.49	20.36
2000	104.36		N 025	-	NUCLEAR	1.20			
			N 026	-	NUCLEAR	1.20			
			N 027	-	NUCLEAR	1.20			
			F 030	-	FOSSIL	.80			
			F 031	-	FOSSIL	.80			
			G 023	-	GAS TURB	.20			
			G 024	-	GAS TURB	.20			
							5.60	126.09	20.82
2001	108.80		N 028	-	NUCLEAR	1.20			
			N 029	-	NUCLEAR	1.20			
			N 030	-	NUCLEAR	1.20			
			F 032	-	FOSSIL	.80			
			F 033	-	FOSSIL	.80			
			G 025	-	GAS TURB	.20			
			G 026	-	GAS TURB	.20			
							5.60	131.69	21.04
2002	113.42		N 031	-	NUCLEAR	1.20			
			N 032	-	NUCLEAR	1.20			
			N 033	-	NUCLEAR	1.20			
			F 034	-	FOSSIL	.80			
			F 035	-	FOSSIL	.80			
			G 027	-	GAS TURB	.20			
			G 028	-	GAS TURB	.20			
							5.60	137.29	21.04
2003	118.24		N 034	-	NUCLEAR	1.20			
			N 039	-	NUCLEAR	1.20			
			N 036	-	NUCLEAR	1.20			
			F 036	-	FOSSIL	.80			
			F 037	-	FOSSIL	.80			
			G 029	-	GAS TURB	.20			
			G 030	-	GAS TURB	.20			
							5.60	142.89	20.85

Table 2-1: Assumed Schedule of New Unit Additions 1974-2006

DISPERSED CASE SCENARIO

UNIT IDENTIFICATIONS, CONTINUED

YEAR	PEAK LOAD GW(E)	UTILITY	FACILITY	UNIT	TYPE	NEW UNIT CAPACITY GW(E)	YEARLY ADD'NS GW(E)	TOTAL SYSTEM GW(E)	RESERVE MARGIN PERCENT
2004	123.27			N 037	NUCLEAR	1.20			
				N 038	NUCLEAR	1.20			
				N 039	NUCLEAR	1.20			
				F 038	FOSSIL	.80			
				F 039	FOSSIL	.80			
				G 031	GAS TURB	.20			
				G 032	GAS TURB	.20			
							5.60	148.49	20.46
2005	128.31			N 040	NUCLEAR	1.20			
				N 041	NUCLEAR	1.20			
				N 042	NUCLEAR	1.20			
				N 043	NUCLEAR	1.20			
				F 040	FOSSIL	.80			
				F 041	FOSSIL	.80			
				G 033	GAS TURB	.20			
				G 034	GAS TURB	.20			
							6.80	155.29	20.84
2006	133.97			N 044	NUCLEAR	1.20			
				N 045	NUCLEAR	1.20			
				N 046	NUCLEAR	1.20			
				F 042	FOSSIL	.80			
				F 043	FOSSIL	.80			
				G 035	GAS TURB	.20			
				G 036	GAS TURB	.20			
							5.60	160.89	20.09

Plant, which started operation in 1969. Second, one can simply assume that any capacity retired at several locations would be replaced by a single larger facility also located at one of the old sites.

One should note that the foregoing level of detail is necessary for a realistic specification of dispersed sites to be used in comparative analyses with the clustered NEC scenario. A simple selection of five sites in the study region, each adequate for, say, reactors totalling 4.8 Gw, is, in our judgement, overly simplistic and likely to lead to misleading results. In particular, the 24 Gw of capacity in an NEC must be cast in light of the MAAC system's total capacity additions of approximately 100 Gw anticipated for the period 1987-2006. Unless load growth were to be significantly less than assumed, this means that sites for some 46 nuclear units (1.26 Gw each) and 43 fossil units (0.8 Gw each) must be found during this interval. To simply select the five best sites for those nuclear units to be used in the dispersed-NEC comparison, without regard for the siting demands of all the other power facilities needed (and particularly for fossil steam electric plants), is thus clearly simplistic. Only if one considers all of the needed fossil sites can one make judgements as to the available sites for nuclear plants. For example, in the area of consumptive water use, fossil plants compete directly with nuclear plants; sites that might be suitable for mine-mouth coal fired plants, therefore, clearly should not be preempted by nuclear plants.

NOTES TO CHAPTER II

1. We return to this point in several later sections of this report, particularly in Chapters XV, XVI, and XVII.
2. It should also be kept in mind, however, that power generation and dispatching are integrated to a high level in the New Jersey-Pennsylvania area within the PJM Power Pool. Power generation in New Jersey to serve local demand in Pennsylvania or vice versa is thus quite common under existing arrangements. Small amounts of electricity also are exchanged at times between PJM and the New York utilities.
3. For a comparison to national projections, see BNL 50465, Appendix A.
4. The figures supplied by individual utilities for generating capacities include the planned retirements and capacity additions up to 1985. In determining the retirement schedule, an average life of 40 years has been assumed for fossil fueled and nuclear steam electric power plants. In case of others, the assumption is that the plants are never totally retired. Therefore, the retirement schedules for 1986-2020 are, in fact, the lists of in-service data of steam electric power plants for the period 1946-1980.
5. Gw = 1000 Mw. Unless otherwise noted, capacity is given in terms of electrical output.
6. See Section 15.2 for details on PJM.
7. See Section 15.2 for details on MAAC.
8. MAAC System Plans, Mid-Atlantic Area Council Report, Philadelphia, PA, April 1, 1975.
9. This is consistent with the Case A National Projection in Nuclear Power Growth: 1974-2000, WASH-1139 (1974).
10. See BNL 50465, Appendix C, for details of NYPP organization.
11. Load growth to 1990 is based on the recent Report of Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law, (1975) Vols. 1 and 2. A 3.69% annual load growth is used for 1990-2010.

12. P. Meier, M. McCoy, and S. F. Rahman, "Perspectives on the Energy Future of the Northeast U.S.: The Electric Sector", BNL 50553. Brookhaven National Laboratory, Forthcoming Report.
13. P. Meier and P.F. Palmedo, "Planning Energy Centers Under Technological and Demand Uncertainty", Presented at the ORSA/TIMS Joint National Meeting, Philadelphia; April 1976.
14. One might note that one of the reasons for the relatively large fraction of combustion turbines in the current generation mix was the very small lead time, allowing utilities to meet capacity deficiencies at short notice without undue problems. In the past few years, however, the equipment manufacturers are no longer building gas turbines for stock, but only on receipt of orders. This has almost doubled the lead time to about three years. Coupled with the increasing fuel shortages, it would seem unlikely that conventional combustion turbines will maintain its large generation mix fraction. For further discussion on this point, see e.g. Meier, et al, Note 12, supra.
15. The decrease in gas turbine and hydro does not imply radical changes in peak load characteristics; rather it reflects the judgement that combined cycle and peaking fossil plants will carry more of the peak load.
16. See Robert H. Williams, "The Potential for Electricity Generation as a Byproduct of Industrial Steam Production in New Jersey", Report to the New Jersey Cabinet Energy Committee from the Princeton University Center for Environmental Studies, June 1976.
17. The 800 Mw size for fossil units is consistent with the size anticipated by MAAC; and the 800 Mw for hydro, while somewhat arbitrary, is based on the unit size of the proposed Stony Creek Project on the Susquehanna (see "Master Siting Study, Susquehanna River Basin") Report to the Susquehanna River Basin Commission, March 1974).

CHAPTER III

NUCLEAR SITING SCENARIOS: CLUSTERED AND DISPERSED

3.1 Assumptions and Siting Constraints

The NRC has identified three major siting guidelines which govern the determination of nuclear sites: plants must lie in seismic zone I,¹ must be outside the 0.2 SPF population density zone,² and must be near an adequate source of water.* For fossil fueled steam electric plants, we have assumed that only adequacy of water supply and proximity to fuel sources need be considered at the level of detail required here; combustion turbine facilities need consider only proximity to load centers.

It was quickly apparent that water availability is the most restrictive of these criteria. The water resource constraint specified by the NRC, however, was ambiguous and incomplete. First, a mere restriction on using no more than 10 percent of low flow would not prevent a series of plants spaced, say, every 10 miles and each using only 10 percent of the flow at its location, but in the aggregate consuming almost the entire low flow. It was assumed, therefore, that the criterion should reference the river basin unit, and should, in fact, read that total consumptive use of water for power generation in any river basin should not exceed 10 percent of the low flow of record (7 day/10 year or 30 day/20 year) available at the most downstream point on that river basin. Even this definition, however, poses difficulties when applied to specific river basins. The Delaware River Basin Commission, for example, has set a minimum flow objective of 3000 cfs at Trenton, which is significantly higher than the low flow of record, some 1300 cfs. Any consumptive use which would lower the 3000 cfs objective will not be approved by the DRBC.

Available low flow can be augmented by additional upstream storage development, thus permitting location of new consumptive water

* Using no more than 10 percent of the 7 day/10 year or 30 day/20 year low flow.³

users without reducing low flows. Indeed, as we shall note below, the problem in the study area is not the inadequacy of total rainfall or mean annual flow, but rather summer low flows. Thus, because annual flows are more than adequate, storage could be used to equalize these fluctuations and hence to provide additional safe yield during periods of low flow. The feasibility of developing major new upstream storage development projects in the study area must be open to considerable doubt, however. The controversy over and subsequent demise of the proposed Tocks Island Dam Project on the Delaware River are typical of the difficulties to be anticipated. Thus, the acceptability of upstream storage development, not the overall availability of water, acts as the crucial constraint on consumptive use at potential freshwater energy facility sites.

Table 3-1 shows the ability of the major freshwater basins in the study area to support evaporative cooling with no further storage development, based on the rigorous 10 percent of low flow constraint.⁴ The numerous thermal power developments using cooling towers already planned for the 1975-84 period can be seen to use about two-thirds of the available low flow. Because of diversions from the Delaware to the Schuylkill, we have treated the Schuylkill as part of the Delaware; and we have also merged all of the Western Pennsylvania Basins for reasons of incomplete flow data.

A number of significant conclusions can be drawn from this analysis. First, the most desirable category of sites, comprising inland freshwater sites characterized by sufficient low flow that do not require additional upstream storage, are almost all spoken for already. Less than 10 percent of the total 89.6 Gw of thermal capacity additions projected as necessary to meet assumed load growth for the interval 1986-2006 can be placed in this category,⁵ given the criterion that only 10 percent of drought flow may be used for evaporative cooling in any river basin, and that no additional low-flow augmentation storage will be available.

It could, of course, be argued that 15 or even 20 percent of drought flow should be held available for power generation. Even if the higher figure were accepted, however, the shortfall still would be very large, some 58 percent of total requirements (89.6 Gw).*

* 20% drought flow allows 50.4 Gw of evaporative cooling capacity, less the 21.05 requirements installed, leaving 37.35 Gw available for the interval 1986-2006.

TABLE 3-1

EVAPORATIVE COOLING CAPACITY (MW (e)).

<u>Freshwater Basin</u>	<u>Evap. Cooling Potential Calculated at 10% Drought Flow</u>	<u>Evap. Cooling Re- quirements Installed by 1985</u>	<u>Available Evap. Cooling 1986-2006</u>
Delaware (above Trenton)	6200 ^a	4636 ^b	1564
Potomac	2600	800 ^c	1800
Susquehanna	12000	9820 ^d	2180
W. Penn. Basins	8400	5796 ^e	2604
TOTAL	29200	21052	8148

^aIncludes the Schuylkill low flow of 230 cfs.

^bMartins Creek 3+4(1600) + Limerick 1+2(2110) + Gilbert 8+9(926) = 4636.

^cDickerson (800).

^dTMIsland 1 (840) + TMIsland 2 (930) + Montour (1500) + Fulton 1 (1160) + Fulton 2 (1160) + Susquehanna 1 (1050) + Susquehanna 2 (1050) + Peach Bottom 3 (1065) = 9820. (There is some uncertainty over the Fulton Site, due to cancellation of the proposed HTGR. The two proposed HTGR units at Summit have also been reported as cancelled. See Electrical World, November 15, 1975, p. 34).

^eHomer City (1650) + Keystone (1646) + Conemaugh (1700) + Seeward (800) = 5796.

Development of additional storage, of course, would increase cooling capability substantially. However, at least as far as the immediate study area is concerned, the precedents are not encouraging. The already-noted demise of the Tocks Island Dam Project on the Upper Delaware bodes ill for the success of any siting strategy based on development of significant amounts of upstream storage. Moreover, a single-purpose flow augmentation project for consumptive use of electric utilities may be even more controversial

than was the multi-purpose Tocks Island Dam Project. It would, therefore, seem prudent for planning purposes to assume that the amount of storage that can be developed be held to rather low levels. We assume in our dispersed case scenario that 39.2 Gw of the additional thermal capacity in the years 1985-2006 will be located inland on fresh water, implying that additional storage must be developed for some 31 Gw.⁶ Many people would argue that even the availability of this amount of additional storage is overly optimistic.

It is thus clear that other site categories must be found. Estuaries offer some potentially good sites (such as the Artificial Island site on the Delaware), but some storage for flow augmentation may be necessary even for such sites in order to prevent salinity intrusion.⁷ Lower estuary sites--for example, on the lower part of Delaware Bay--would likely not require such storage, but suffer instead from some serious environmental drawbacks. Coastal and offshore facilities could use once-through cooling, but again several unresolved environmental questions remain. Finally, one might move to dry cooling, which eliminates serious water resource problems; but here the economic penalty would be significant.

Because each of the available siting options has serious drawbacks, and because none appears to have any over-riding advantage over the others, the prudent planning assumption is a compromise siting plan involving some amount of all of these somewhat undesirable site categories (or involving lowered demand growth through accelerated energy conservation strategies). We have thus elected to include in our dispersed case scenario some 14.4 Gw of Atlantic offshore sites (nuclear), 2.4 Gw on Lake Erie, 33.6 Gw on Chesapeake, Raritan, and Delaware Bays, and the remaining 39.2 Gw inland, for a total of 89.6 Gw of thermal capacity to be provided between 1986 and 2006. This assignment of capacity follows from the assignment of a certain number of units to selected sites, the sites themselves being based on our best judgement of a rough balance between location of loads and location of generation, along with the water resource constraints. Certainly no detailed siting analysis was performed for this assignment, and the scenario is suitable only for the specific analyses of this report. Nevertheless, the results do not appear unreasonable.

3.2 Dispersed Site Scenario

Having thus determined the thermal capacity permissible on each water body, one may then proceed to designation of actual sites. This is necessary, at least in an approximate manner, for purposes of the transmission analysis, which requires that each generating station be designated a specific location. However, it should be stressed that the site locations assumed for this purpose are indicative only of a general region along a particular water body. Specific locations are given only for illustrative purposes, and should not be construed as recommendations for actual sites, or as indicative of any detailed site analysis showing the selected locations as particularly desirable.

Assignment of combustion turbine peaking units was a relatively straightforward matter, units being assigned to existing generation sites in close proximity to major load centers.

It was assumed, somewhat arbitrarily, that 50 percent of the fossil units would be coal fueled, and 50 percent oil fueled; and that each site would contain three 800 Mw units (except for one site in Pennsylvania, assigned four 800 Mw units). The coal units were assumed to lie in the coal districts of Pennsylvania, with specific sites taken from the Gilbert Associates Site Survey conducted for the Pennsylvania Power Park study.⁸ It was assumed that any site identified in that study as being suitable for a 10 Gw mixed fossil and nuclear power park would also be suitable for a 2.4 Gw coal-fired fossil station. The remaining oil-fired fossil plants were located nearer the load centers on the East Coast, and in accordance with the previously noted restrictions on water resources. Because of the proximity of Raritan Bay to the New York metropolitan area, oil-fueled units were located here in preference to nuclear units.

The initial premise of the nuclear site selection was that each existing nuclear site in the study area could be expanded from two to four units (within the limitations of the water resource constraints already developed). Thus, Three Mile Island, Fulton, Peach Bottom, Susquehanna, Limerick and Calvert Cliffs each were expanded from two to four units. Salem-Hope Creek already comprises a planned 4-unit site. No additional units were placed at the 2-unit Oyster Creek-Forked River site, however, in view of the cooling water difficulties imposed by Barnegat Bay and the continued concentration of population

in this New Jersey coastal area. Also, despite the uncertainty over the HTGR and the Fulton and Summit sites, we continue to refer to these sites as "Fulton" and "Summit", on the assumption that these sites or a close replacement would in fact be utilized for nuclear capacity at some time during the next 30 years, at least under the load-growth scenario that underlies this analysis.

One 2-unit site was placed on the shores of Lake Erie, on a site located by the previously mentioned Gilbert Associates study. Anticipated growth of the Erie, Pennsylvania, metropolitan area makes such a site location not unreasonable, even though far removed from the load centers of the East Coast.

Twelve reactors in this dispersed scenario, were located offshore, grouped into clusters of four reactors each. In discussions with PSE&G, the utility currently planning a 2-unit offshore facility near Little Egg Harbor Inlet off the Atlantic coast of New Jersey, it was pointed out to us that the utility currently considered only 2-unit sites to be feasible. However, to the extent that two units do prove to be the largest number that can be grouped together offshore, our three 4-unit clusters could be changed to six 2-unit clusters without significantly changing most of the comparisons based on the 4-unit clusters. The 16 nuclear units remaining in our scenario were placed in four new sites on Delaware and Chesapeake Bays, in accordance with the previous contention that siting on the lower estuaries would be part of the compromise dispersed siting pattern.

Figure 3-1 shows the sites selected for nuclear units, along with the requisite 0.2 SPF contours. (See Footnote 2) All of the new sites are seen to lie outside these defined population density areas.

The resulting assignment of all of the generating capacity to specific sites is given in Table 3-2, with site locations shown on Figures 3-2 to 3-5. Table 3-3 summarizes the assignment of sites to specific water bodies and river basins and Table 3-4 shows these locations by state. Note that Column 4 of Table 3-3 indicates the implied amount of upstream storage necessary for each of the freshwater basins. The three numbers represent the Gw of capacity for which storage must be developed, the additional cfs that would be required, and the acre-feet of storage necessary to provide these additional cfs.⁹ These figures are preliminary, but their order of magnitude is correct. For

SPF AT 30 MILES

SPF CONTOUR

0.2	—————
0.4	- - - - -
0.5	—————
0.7	—————
1.0	—————

KEY

1. L. ERIE
2. SUSQUX
3. OFFSHORE A
4. OFFSHORE B
5. OFFSHORE C

6. LOWER DELAWARE BAY
7. NEC
8. CHESAPEAKE BAY
9. LOWER CHESAPEAKE BAY

Figure 3-1. Relationship of new nuclear sites to population density centers.

*
* GENERATION PLANNING PROBLEM FOR MAAC AREA, 1985-2005
*

*
* DISPERSED CASE SCENARIO
*

Table 3-2: Assignment of New Units to Sites

LOCATION	BUS	ASSIGNED UNITS
VALLEY CLIFFS	176	N 042,N 010,
THREL MILE ISL.	41	N 011,N 043,
FULTON	210	N 014,N 032,
DELAWARE BAY	205	N 020,N 023,N 028,N 034,
LIMERICK	230	N 030,N 031,
SUSQUEHANNA	F0	N 009,N 012,
ATL B,OFFSH	203	N 013,N 015,N 016,N 025,
ATL C,OFFSH	204	N 036,N 037,N 040,N 044,
L,DELAWARE BAY	205	N 004,N 005,N 006,N 008,
L,CHESAPEAKE BAY	210	N 017,N 019,N 021,N 024,
SUSGX	271	N 022,N 027,N 042,N 045,
CHESA	208	N 025,N 033,N 041,N 039,
LERIE	207	N 038,N 046,
PEACH BOTTOM	48	N 003,N 018,
ATL A,OFFSH	202	N 001,N 007,N 029,N 035,
STONY CREEK	299	H 001,H 002,
WASHINGTON PEAK	172	G 001,G 008,G 015,G 022,G 029,
BALTIMORE PEAK	142	G 002,G 009,G 016,G 023,G 030,
PHILADEL,PEAK	139	G 003,G 010,G 017,G 024,G 031,
N.E.N.J. PEAK	104	G 004,G 011,G 018,G 025,G 032,
NORTH N.J. PEAK	102	G 005,G 012,G 019,G 026,G 033,
TRENTON PEAK	126	G 006,G 013,G 020,G 027,G 035,
HARTFORD PEAK	73	G 007,G 036,G 021,
ATLANTIC CITY PE	300	G 028,G 034,G 014,
COAL1	274	F 001,F 003,F 005,
COAL2	273	F 007,F 009,F 011,
COAL3	275	F 013,F 015,F 017,
COAL4	276	F 019,F 021,F 023,
COAL5	277	F 025,F 029,F 031,
COAL6	278	F 033,F 035,F 037,F 027,
COAL7	279	F 039,F 041,F 043,
CIL 1	200	F 002,F 004,F 008,
OIL 2	201	F 006,F 010,F 012,
OIL 3	202	F 014,F 016,F 018,
OIL 4	203	F 020,F 022,F 024,
OIL 5	204	F 026,F 028,F 030,
OIL 6	205	F 032,F 034,F 036,
OIL 7	206	F 038,F 040,F 042,

BUS=Node Number Used in Transmission Analysis

ASSIGNED UNITS Correspond to Unit Identifications
shown on Table 2-1 (N=Nuclear, F=
Fossil, G= Gas Turbine, H= Hydro)

U.S. DEPARTMENT OF COMMERCE Social and Economic Statistics Administration BUREAU OF THE CENSUS

Figure 3-3. Location of New Jersey sites.

Figure 3-4. Location of expansion sites.

Figure 3-5. Location of lower Chesapeake Bay site.

TABLE 3-3

ASSIGNMENT OF NEW UNITS TO WATER BODIES

<u>Water Body</u>	<u>New Sites (or Expansion of Existing Sites), Gw in Parentheses</u>	<u>Type of Site^a</u>	<u>Total Gw</u>	<u>Implied Up- stream Storage Development^b</u>
Lake Erie	Lake Erie (2.4)	N	2.4	-----
Western Pennsylvania	Coal 3 (2.4)	F		5.396 Gw
	Coal 6 (2.4)	F		= 108 cfs
	Coal 7 (3.2)	F	8.0	=43170 Af
Susquehanna	*Peach Bottom 3+4 (2.4)	N		
	*Fulton 3+4 (2.4)	N		
	*Three Mile Island 3+4(2.4)	N		
	*Susquehanna 3+4 (2.4)	N		
	Susqx (Leraysville)(4.8)	N		
	Coal 1 (2.4)	F		
	Coal 5 (2.4)	F	19.2	17.02 Gw
				= 412 cfs
				=164800 Af
Potomac	Oil 1 (2.4)	F	2.4	.6 Gw
				= 12 cfs
				=4800 Af
Chesapeake Bay	Lower Ches. Bay (4.8)	N		
	Ches. Bay (4.8)	N		
	*Calvert Cliffs 3+4 (2.4)	N		
	Oil 2 (2.4)	F		
	Oil 5 (2.4)	F	16.8	-----
Delaware Bay	Delaware Bay (4.8)	N		
	Lower Delaware Bay (4.8)	N		See Footnote 7
	Oil 7 (2.4)	F	12.0	
Offshore Atlantic	Offshore A (4.8)	N		
	Offshore B (4.8)	N		
	Offshore C (4.8)	N	14.4	-----
Raritan Bay	Oil 3 (2.4)	F		
	Oil 6 (2.4)	F	4.8	-----
Delaware	*Limerick 3+4 (2.4)	N		
	Coal 2 (2.4)	F		
	Coal 4 (2.4)	F		
	Oil 4 (2.4)	F	9.6	8.036 Gw
				= 173 cfs
				= 69200 Af
TOTAL			89.6	

*Expansion of an existing site.

^aN=Nuclear; F=Fossil^bBased on Table 3-1

TABLE 3-4

LOCATIONS OF NEW GENERATING UNITS, BY STATE

<u>State</u>	<u>Overall New Capacity (Gw)</u>	<u>Number & Size of New Nuclear Units</u>		<u>Number & Size of New Fossil Units</u>	
		<u>#</u>	<u>Gw</u>	<u>#</u>	<u>Gw</u>
<u>New Jersey</u>	24.0	16 (12 are offshore)	19.2	6	4.8
<u>Pennsylvania</u>	39.2	16	19.2	25	20.0
<u>Maryland</u>	16.8	10	12.0	6	4.8
<u>Delaware</u>	7.2	4	4.8	3	2.4
<u>D.C./Va.</u>	2.4	---	---	3	2.4
TOTALS	89.6	46	55.2	43	34.4

example, the dispersed case scenario requires development of some 70,000 acre-feet of storage on the Delaware. This storage requirement is compared to the size of storage projects presently contemplated for the Delaware in Table 3-5. The required storage is thus less than the Tocks Island Dam project, but substantially larger than most of the remaining

3.3. The Clustered (NEC) Scenario

The nuclear energy center prototype studied here consists of twenty 1,200 MW reactors, brought together at one site in Ocean County, New Jersey. These reactors would be constructed at a rate of one per year, with the first reactor commencing commercial operation in 1987. The time period under examination then roughly includes the years 1979-2006. The NEC is not assumed to

TABLE 3-5

RESERVOIR PROJECTS IN DRBC COMPREHENSIVE PLAN

Name of Project	Sub-Basin No.	River	Location	Drainage Area (sq. mi.)	Usable Storage (acre-ft)	Min. Monthly Unreg. Flow 1961-66 (cfs)	Dependable Gross Yield (cfs) ^{1/}	Remarks
Prompton Dam	1	Lackawaxen	4 miles west of Honesdale, Pa.	60	28,000	5.2	68 ^{2/}	Existing flood control project will be modified.
Tocks Island Dam	2	Delaware	7 miles N.E. of Stroudsburg, Pa.	3827	425,600	563	2850	
Hackettstown Dam ^{3/}	2	Musconetcong River	3 miles north of Hackettstown, N.J.	70	22,000	0	46	Initial construction to be for recreation.
P. E. Walter Dam	3	Lehigh	4 miles north of White Haven, Pa.	290	69,500	46	235	Existing flood control project will be modified.
Beltzville Dam	3	Pohopoco Creek	4 miles east of Lehigh, Pa.	96	39,830 ^{4/}	16	81	
Aquashicola	3	Aquashicola Creek	3 miles east of Palmerton, Pa.	66	24,000	12	60	
Trexler Dam	3	Jordan Creek	8 miles N.W. of Allentown, Pa.	52	40,000	1	45	
Nockamixon ^{3/}	4	Tohickon Creek	About 1 mile S.W. of Otisville, Pa.	75	30,000	1	4	Initial construction to be for recreation.
Maiden Creek Dam	6	Maiden Creek	12 miles north of Reading, Pa.	161	74,000	7	50 ^{5/}	
Blue Marsh Dam	6	Tulpehocken Creek	6 miles N.W. of Reading, Pa.	175	19,900 ^{6/}	32	155	
Evansburg Dam ^{3/}	6	Skipack Creek	2 miles S.W. of Collegeville, Pa.	54	23,500	^{7/}	^{8/}	Initial construction to be for recreation.
Newark Dam ^{3/}	8	White Clay Creek	1.5 miles north of Newark, Delaware	67	30,000	^{7/}	^{8/}	

^{1/} Dependable gross yield is the sustained constant draft which utilizes all the active long-term storage during a repetition of the severest drought of record. Values except as noted were estimated from results of the computer study (see Section VIII).

^{2/} Reference 126, p.49.

^{3/} Non-Federal project.

^{4/} Includes 27, 830 AF of water-supply storage and 11,950 AF of water-quality storage.

^{5/} Yield based on mass curve of inflow for the drought period July 1964 through June 1967.

^{6/} Includes 8,000 AF of water-supply storage, 6,620 AF of water-quality storage and 5,280 AF of temporary usable storage available April through August.

^{7/} Not available.

^{8/} From draft of revised DRBC Comprehensive Plan, July 1970.

Source: "Water Resources Study for Power Systems", Tippetts-Abbott-McCarthy-Stratton, July 1972.

have within its scope of operations any elements of the fuel cycle other than the power reactors and immediately associated facilities.

The NEC scenario has been constructed by replacing 24 Gw of nuclear capacity, or 20 reactors, from dispersed sites into the NEC. In so doing, the question as to which dispersed units should be transferred clearly plays a key role in subsequent comparisons of environmental impact and political and institutional reaction.

Because only 43% of the total 1985-2006 MAAC nuclear capacity additions would be in the NEC,¹⁰ dispersed sites must still be found for the other nuclear capacity. It follows, therefore, that the 20 worst dispersed sites should be replaced by the NEC, rather than the 20 best. Since the dispersed scenario is a compromise incorporating some number of sites from each of the least desirable site categories (i.e., some offshore, some estuary, and some inland freshwater requiring storage development), it would seem appropriate to adopt a similar posture regarding the NEC, assuming that the NEC would be a replacement for a similar mix of site categories. We have, therefore, postulated that the NEC would replace the following sites in the dispersed scenario:

--two of the three off-shore sites, denoted Offshore B and Offshore C	8 reactors
--two of the lower estuary sites,	
**one from Delaware Bay, denoted Lower Del-Bay . . .	4 reactors
**one from Chesapeake Bay, denoted Lower Ches- Bay.	4 reactors
--expansion from 2 to 4 reactors each at the Limerick and Susquehanna sites, both of which would require additional storage development	4 reactors
	<hr/> 20 reactors

The remaining "preferred" reactors in the dispersed scenario (26 in number) and the 43 fossil fuel plants would be built in either case within the time span in the MAAC region, under our load-growth assumptions. What the 20 reactors here identified have in common is only that they would not be built if an NEC were built. A tentative construction schedule through the year 2006 has been established, and is represented in Figure 3-6.

Figure 3-6. Assumed construction schedules.

To be sure, it could be argued that the NEC might replace merely a single category of site; and that, for example, the NEC might be posed as the siting alternative that would make offshore nuclear plants unnecessary. However, at the present time, it appears that no one of the available site categories offers any clear advantages (or alternatively that offshore, estuary and inland sites requiring freshwater storage all presently appear to have roughly equal disadvantages). Thus it seems unlikely that one of these site strategies would be pursued to the exclusion of all others. To that extent, therefore, using the NEC to replace only a single site category could well result in biased comparisons.¹²

The resulting assignment of units to sites is shown on Table 3-6, and important characteristics of the dispersed sites to be eliminated under the NEC scenario are presented in Table 3-7.

TABLE 3-6

ASSIGNMENT OF NEW UNITS TO SITES,NEC SCENARIO

<u>Location</u>	<u>Assigned Units</u>
Calvert Cliffs	N 002,N 010,
Three Mile Island	N 011,N 043,
Fulton	N 014,N 032,
NEC A Cluster	N 004,N 005,N 006,N 008,
NEC B Cluster	N 009,N 012,N 013,N 015,
NEC C Cluster	N 016,N 017,N 019,N 021,
NEC D Cluster	N 024,N 025,N 039,N 031,
NEC E Cluster	N 036,N 037,N 040,N 044,
Delaware Bay	N 020,N 023,N 028,N 034,
Susox	N 022,N 027,N 042,N 045,
Chesb	N 026,N 033,N 041,N 039,
L. Epie	N 038,N 046,
Peach Botton	N 003,N 010,
Atl. A, Offsh	N 001,N 007,N 029,N 035,
Stony Creek	H 001,H 002,
Washington Peak	G 001,G 008,G 015,G 022,G 029,
Baltimore Peak	G 002,G 009,G 016,G 023,G 030,
Philadelphia Peak	G 003,G 010,G 017,G 024,G 031,
N.E.N.J. Peak	G 004,G 011,G 018,G 025,G 032,
North N.J. Peak	G 005,G 012,G 019,G 026,G 033,
Trenton Peak	G 006,G 013,G 020,G 027,G 035,
Harrisburg Peak	G 007,G 036,G 021,
Atlantic City Peak	G 028,G 034,G 014,
Coal 1	F 001,F 003,F 005,
Coal 2	F 007,F 009,F 011,
Coal 3	F 013,F 015,F 017,
Coal 4	F 019,F 021,F 023,
Coal 5	F 025,F 029,F 031,
Coal 6	F 033,F 035,F 037,F 027,
Coal 7	F 039,F 041,F 043,
Oil 1	F 002,F 004,F 008,
Oil 2	F 006,F 010,F 012,
Oil 3	F 014,F 016,F 018,
Oil 4	F 020,F 022,F 024,
Oil 5	F 026,F 028,F 030,
Oil 6	F 032,F 034,F 036,
Oil 7	F 038,F 040,F 042,

TABLE 3-7

DISPERSED SITING SCENARIO----SOME GENERAL CHARACTERISTICS OF SURROGATE SITES^a

	BAY SITES (NEW)		OFFSHORE SITES (NEW)		EXPANSION SITES	
	Lower Delaware Bay	Lower Chesapeake Bay	Offshore B	Offshore C	Susquehanna	Limerick
Number of reactors	4	4	4	4	2	2
Location:						
State	New Jersey	Maryland	offshore	offshore	Pennsylvania	Pennsylvania
County	Cumberland	Calvert ^b	---- ^c	---- ^c	Columbia	Montgomery
City/Town	-----	Lusby	----	----	Berwick	Pottstown
Projected dates of commercial operation:						
#1	1987	1996	1993	2003	-----	-----
#2	1988	1997	1994	2004	-----	-----
#3	1989	1998	1995	2005	1991	2001
#4	1990	1999	2000	2006	1992	2002
Cooling water source	Delaware Bay	Chesapeake Bay	Atlantic Ocean	Atlantic Ocean	Susquehanna River	Schuykill River/ Delaware River
Approximate incremental upstream storage required (acre-feet) ^d	-----	-----	--	--	24,000	24,000
Approximate road distances from some nearby major urban centers:						
Philadelphia	60	--	-- ^c	-- ^c	120	30
New York	--	--	-- ^c	-- ^c	---	--
Washington D.C.	--	55	--	--	---	--
Wilmington	50	--	-- ^c	-- ^c	---	--
Scranton	--	--	--	--	40	--
Wilkes-Barre	--	--	--	--	25	--
Median land values, \$/acre ^e	541	722	-- ^f	-- ^f	255	1,677
Median value of owner-occupied, single family dwellings, \$ ^g	13,743	17,116	-- ^h	-- ^h	11,156	21,662

^a See the text for discussion of the meaning of the term "surrogate site".

^b Approximate location of existing Calvert Cliffs Nuclear Power Plant being used for study purposes.

^c Land onshore will be required for supporting facilities (e.g., warehousing, docking, electrical switching, etc.). For moment, we are allowing that this land may be in Atlantic, Ocean, or Monmouth Counties. Road distances to New York and Philadelphia will be from 50 to 120 miles and from 60 to 80 miles, respectively.

^d An estimated storage need of one acre-foot/Mw has been used per Section 2 of the draft report, "A Preliminary Assessment of a Hypothetical Nuclear Energy Center in New Jersey--Supplement", October 1, 1975, by the Energy Policy Analysis Group, Department of Applied Science, Brookhaven National Laboratory.

^e County-wide average per 1972 County and City Data Book for value of agricultural land (including buildings).

^f Values for Atlantic, Ocean, and Monmouth counties are \$757, \$924, and \$1636, respectively.

^g County-wide per 1972 County and City Data Book.

^h Values for Atlantic, Ocean, and Monmouth counties are \$14,860, \$18,493, and \$23,348, respectively.

NOTES TO CHAPTER III

1. The NRC seismic zones represent staff judgment with respect to the seismic stability of various land areas. The zones differ according to the relative difficulty of establishing the design value for the horizontal motion of the ground at the foundation of Category I structures, based on relative seismic risk maps and licensing experience. Consideration is given only to historical earthquake activity and known faulting; other geological factors such as karst regions and subsidence are not considered. Zone I includes areas of low seismicity with no known capable faults; seismically suitable sites would be found with little difficulty. Zone II includes two categories: (1) areas with moderate seismicity and complex geological structures, having numerous, old, incapable faults, and (2) areas close to zones of high seismic risk, which may lend to controversial risk assessment. Detailed site-specific studies would be necessary to determine geologic/seismic site suitability. And finally, Zone III is characterized by high seismicity, accompanied in most cases by intense, recent faulting.
2. SPF, or Site Population Factor, is a newly-developed population density siting criterion described in J.E. Kohler et al, "The Site Population Factor: A Technique for Consideration of Population in Site Comparison", AEC, Directorate of Licensing, October 1974 (Report WASH 1235).
3. The 7 day/10 year low flow is defined as the lowest mean flow over 7 consecutive days expected to occur once every 10 years. For most of the river basins in the Northeastern U.S., this definition is approximately equal to the 30 day/20 year low flow definition.
4. This assumes an evaporative loss of 25 cfs per 1000 Mw, without distinction between nuclear and fossil. The subsequent tables, however, do differentiate between the two evaporative demands and assume nuclear at 25 cfs/1000 Mw, fossil at 20 cfs/1000 Mw.
5. This capacity is calculated as follows: 46 nuclear plants at 1200 Mw plus 43 fossil plants at 800 Mw = 89600 Mw or 89.6 Gw of thermal capacity.
6. This figure is derived from Table 3-1, since only some 8.1 Gw are available in 1986 to 2006, $39.2 - 8.1 = 31.1$ Gw requiring flow augmentation storage.

7. The Hope Creek Nuclear Generating Station at the Artificial Island Site on the Delaware, for example, needs to provide only 18 percent of the flow augmentation storage of a comparable facility located at Trenton. However, in view of the demise of the Tocks Island Dam project, upon which the Hope Creek plant was dependent, the utilities will have to find alternative sites for a smaller storage project on one of the Delaware tributaries (see Electrical World, September 1, 1975, p. 26).
8. "Energy Park Development: Site Identification Study", Report by Gilbert Associates, Inc., November 1974.
9. In this analysis, we have assumed that 400 acre-ft.(Af) of storage would be necessary to provide one additional cfs of safe yield. One should note, however, that the amount of safe yield that can be developed from a given unit of storage decreases as the safe yield approaches the annual flow of the basin. In the Northeast about 100 Af is required to produce 1 cfs for development of 10 percent of the mean annual flow, rising to 400Af to produce 1 cfs for development to 50 percent of mean annual flow, the figure assumed here. For further discussion and justification of this assumption, see e.g., J. Edinger and P. Meier, "Water Resource Constraints on Energy Facility Siting in the Northeast", BNL Regional Studies Program, Forthcoming Report.
10. From Table 2-1, we note that 46 nuclear reactors are needed from 1985-2006, of which only 20 would be in the NEC.
11. A reviewer of an early draft of this study expressed concern over our use of Limerick as a site for 4 reactors, in view of the difficulties in providing water even for the 2 units presently planned. However, as previously noted, when looking at PJM as a whole, it is clear that few inland dispersed sites will have no water supply difficulties. Limerick thus typifies the likely water supply problems of the dispersed scenario, and on this premise its use seems warranted. Indeed, a site that has no water supply difficulties would be a good site, and thus not a candidate for replacement by an NEC.
12. Indeed, if it were argued that the NEC would replace only offshore nuclear units, there might almost be minimal differences between the two. Certainly the necessary transmission network for an offshore case would, with the obvious exception of the connecting undersea cables, be little different from that of a coastal NEC; and water resource impacts, too, would also be quite similar, with the trade-offs between the costs of breakwater construction for the off-shore units compared to the costs of water conveyance systems (tunnels) for the on-shore NEC.

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CHAPTER IV*

OCEAN COUNTY: LAND USE, POPULATION AND ECONOMIC CHARACTERISTICS

4.1 Introduction

In order to assess the range of impacts likely to be associated with an NEC in New Jersey, a hypothetical facility of 20 reactors (24,000 MWe) has been studied as if it were actually to be located in one of three specific sites in Ocean County, where cooling water would be available from the Atlantic Ocean. The characteristics of these three specific--if hypothetical--sites, and of alternative cooling systems, are described in later chapters; in this chapter we examine overall patterns of land use, economy and population in Ocean County, as background for these site-specific analyses.

Choice of a specific county for this study in no way implies any judgment as to its desirability as a potential location for an NEC relative to other counties in the state, or to other sites outside New Jersey. The choice of Ocean County was dictated largely by its proximity to the Atlantic Ocean. As discussed above, of the various surrogate sites selected for analysis by the Nuclear Regulatory Commission, the New Jersey site provides the only example of a coastal location. As shown in Figure 4-1, part of a map prepared by the NRC for its NECSS report, Ocean County lies on the edge of the dense belt of population which some now call "the Bos-wash Metropolis." In fact, Ocean County itself has experienced explosive growth since about 1960, although its average population density in the mid-1970's remains lower than in neighboring counties to Ocean's northeast. The fact that this county already is the location of an operating nuclear power plant (the Oyster Creek facility), and of the proposed Forked River plant, should be regarded as incidental to its choice as a study area¹, although this fact obviously is not irrelevant to the local public's reaction to the NEC concept.

*Prepared with the assistance of Patricia Fingerhood and Mark Hainline, Center for Environmental Studies, Princeton University.

Figure 4-1. NECSS site screening map.
Source: NRC-NECSS, Part V, Plate 7.2.

4.2 Ocean County as a Candidate Region: Overall Location

Assessment of the potential impact of an NEC on Ocean County depends first on an understanding of the overall structure of the candidate region. Figures 4-2 shows the principal governmental jurisdiction and transportation features of the county.

Ocean County is some 68 miles south of New York City and about 60 miles east of Philadelphia. Because of this position, nearly equidistant from these two major metropolitan areas, Ocean County receives development pressures from both directions. In area, it is the second largest county in New Jersey. A large portion of the county is occupied by the Pinelands, an important and sensitive ecosystem already threatened by development.²

4.3 Population Patterns in Ocean County

Ocean's population is concentrated in a series of sprawling suburban-style communities along the Atlantic coast and on its two major off-shore islands. Recreational opportunities remain the county's biggest attractions. The construction spawned by the demand for second homes, retirement villages, and inexpensive suburban housing made Ocean the fastest growing county in New Jersey throughout the 1960's; in fact, during this decade it achieved the questionable distinction of being the fastest growing county in the United States. In the 1970's the recession, rising costs due to inflation, and decreased mobility due to the increased price of gasoline have slowed Ocean's growth rate. Because of the latter two effects, and because of increased state regulation over land use in the coastal area, growth probably will not resume at the earlier high pace even after the economy recovers fully.

Once a fairly remote resort area, Ocean County has begun to exhibit one of the particular effects of suburban sprawl, a phenomenon which makes residents willing to travel farther to and from places of employment in order to enjoy the benefits of an affordable home of their own, with suburban amenities of various kinds. Added to this trend in Ocean County is another, more recent phenomenon: the retirement home community. In 1974 alone, this type of development accounted for 20% of all housing starts in the county. As of 1975 there were 20 retirement communities in Ocean County, with a total population of

Figure E-2
OCEAN COUNTY N.J.
MUNICIPAL BOUNDARIES

This map illustrates the municipal boundaries of Ocean County, New Jersey. The county is bordered by Monmouth County to the north, Burlington County to the west, and Atlantic County to the south. Major roads are shown, including State Routes 70, 9, 138, 139, 72, and 195. Municipalities labeled include Jackson, Lakewood, Pt. Pleasant, Pt. Pleasant Beach, Bayhead, Mantoloking, Brick, Lakhurst, Dover, Island Heights, Lavallette, Seaside Heights, Seaside Park, Berkeley, Lacey, Ocean Union, Stafford, Surf City, Ship Bottom, Long Beach, Beach Haven, Tuckerton, Little Egg Harbor, and Great Bay. The map also shows the Atlantic Ocean to the east and the Garden State Parkway running through the county. A legend in the bottom left corner defines the symbols for county and municipal boundaries, limited access roads, state roads, county roads, and rail lines. A scale bar indicates distances in miles (0 to 4), and a north arrow is present.

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29,318 residents housed in 15,871 dwelling units. These communities have had distinct social, economic and political impacts upon the county.

Table 4-1 describes major land uses in the county by acreage.

Table 4-1
OCEAN COUNTY LAND USES
JANUARY, 1973

<u>Land Use Category</u>	<u>Acres</u>	<u>% of Total</u>
Residential	79,400	19.3
Commercial	3,550	0.8
Industrial (including mining)	5,000	1.2
U.S. Government Military Installations	22,850	5.8
Federal, State, County, Municipal and Quasi-Public Roads	90,000	22.0
Marine Tidal Marsh	22,000	5.3
Vacant and Agriculture	23,825	5.7
	<u>162,325</u>	<u>39.9</u>
TOTAL	408,950	100.0%

(does not include water bodies)

SOURCE: Ocean County Planning Board, January 1973

The county's population nearly quadrupled between 1950 and 1970. Data for 1960, 1970, and 1974 are presented in Table 4-2 and Figure 4-3. As shown, between 1960 and 1970 the county as a whole grew from 108,241 to 208,461, an increase of nearly 93%. Since 1970, it has increased by almost another one-third; the 1975 population is estimated at some 270,000.

With a land area of 639 square miles, the county's average population density in 1975 was 423 persons per square mile; because the Pinelands remain so sparsely settled, other areas--especially along the shore--show much higher population density.

Table 4-3 presents additional data on population characteristics in the county. Of particular importance are the following facts:

- Between 1960 and 1970, nine of Ocean County's 33 municipalities experienced population growth rates in excess of 100%; 12 others exceeded a 50% rate of increase for the same period.

Table 4-2
POPULATION GROWTH IN OCEAN COUNTY, 1960-1974

	1960	1970	% Change 1960-70	1974	% Change 1970-74
<u>New Jersey</u>	6,066,782	7,168,164	18.2	NA	--
<u>Ocean County</u>	108,241	208,461	92.6	257,785	23.7
<u>Townships</u>					
Berkeley	4,272	7,918	85.3	12,270	55.0
Brick	16,299	35,057	115.1	44,795	27.8
Dover	17,414	43,751	151.2	50,185	14.7
Eagleswood	766	823	7.4	860	4.5
Jackson	5,939	18,276	307.7	21,000	14.9
Lacey	1,940	4,616	137.9	7,560	63.8
Lakewood	16,020	25,000	57.4	32,550	29.0
Little Egg Harbor	847	2,972	250.9	4,675	57.3
Long Beach	1,561	2,910	86.4	3,645	25.3
Manchester	3,779	7,550	99.8	12,835	70.0
Ocean	921	2,222	141.3	2,680	20.1
Plumsted	3,281	4,113	25.4	4,525	10.0
Stafford	1,930	3,684	90.9	4,595	24.7
Union	1,270	1,539	21.2	4,180	171.6
<u>Boroughs</u>					
Barnegat Light	287	554	93.0	620	11.9
Bay Head	824	1,083	31.4	1,090	0.6
Beach Haven	1,041	1,400	42.9	1,640	10.2
Beachwood	2,765	4,390	58.8	5,170	17.8
Harvey Cedars	134	314	134.3	500	59.2
Island Heights	1,150	1,397	21.5	1,440	3.1
Lakehurst	2,780	2,641	-5.0	2,930	10.9
Lavallette	832	1,500	81.4	1,545	3.0
Mantoloking	160	319	99.4	315	-1.3
Ocean Gate	706	1,081	53.1	1,115	3.1
Pine Beach	905	1,395	41.6	1,480	6.1
Point Pleasant	10,182	15,968	56.8	16,760	3.0
Point Pleasant Beach	3,873	4,882	26.1	4,945	1.3
Seaside Heights	954	1,248	30.8	1,400	12.2
Seaside Park	1,054	1,432	35.9	1,505	5.1
Ship Bottom	717	1,079	50.5	1,195	10.8
South Toms River	1,603	3,981	148.3	4,240	6.5
Surf City	419	1,129	169.5	1,275	12.9
Tuckerton	1,586	1,926	25.4	2,265	17.6

Sources: US Census of Population, 1960, 1970.
NJ Office of Business Economics: July 1, 1974, estimates.
Compilations by Ocean County Planning Board, April 1975.

- The fastest growth rates in the 1960's were found in Jackson Township (308%), Little Egg Harbor Township (251%), Surf City (170%) and Dover Township (151%).
- Six areas expanded by over 50% in the 1970-74 period alone: Union Township (172%), Manchester Township (70%), Lacey Township (64%), Harvey Cedars (59%), Little Egg Harbor Township (57%), Berkeley Township (55%).
- As of 1974, three municipalities in Ocean County reported a population in excess of 25,000: Dover Township (50,185), Brick Township (44,795), Lakewood Township (32,550).
- The county has an overwhelmingly white population. Overall, only 4% are non-white, compared to 11.4% in New Jersey as a whole. Only two townships exceed 10% in non-white population.

Figure 4-3. Population trends in Ocean County 1965-1972.

Forecasts of future population growth for Ocean County indicate a range of 305,000 in 1980, 410,000 to 430,000 in 1990, and 490,000 to 520,000 in 2000.³ Forecasts more than a decade into the future are quite unreliable for

Table 4-3

SELECTED POPULATION CHARACTERISTICS: OCEAN COUNTY

	<u>Ocean County</u>		<u>New Jersey</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
1. <u>Age Distribution</u>				
Under 5	17,792	8.5	589,226	8.2
5-14	19,600	19.5	1,403,057	19.6
15-19	15,181	7.3	611,831	8.5
20-24	12,120	5.8	509,198	7.1
25-64	89,847	43.1	3,357,863	46.8
65 and over	32,920	15.8	696,989	9.7
Median Age		36.5		30.1
2. <u>Income Distribution</u> <u>by Families</u>				
Less than \$4,000	7,827	13.7	170,198	9.2
\$4,000-9,999	23,959	42.1	573,705	31.2
\$10,000-24,999	23,358	41.0	966,056	52.5
\$25,000-49,999	1,537	2.7	110,045	6.0
\$50,000 & over	313	0.5	19,436	1.1
Mean Income		\$10,312		\$13,025
Median Income		\$ 9,246		\$11,407
3. <u>Education</u> (25 years of age and over)				
High School Graduates	60,579	49.2	1,928,114	47.6
8th grade education or less	16,263	13.2	604,633	14.9
4. <u>Race</u>				
White	199,660	96.0	6,263,222	87.4
Negro	6,323	3.0	769,245	10.7
Other	2,487	1.0	135,676	1.9
5. <u>Sex</u>				
Male	100,895	48.4	3,467,373	48.4
Female	107,575	51.6	3,700,791	51.6
6. <u>Occupation</u>				
Prof., Tech., & Kind. workers	65,841	14.6	2,858,967	16.1

Source: US Census of Population, 1970

smaller areas, and a number of variables may alter the 1990 and 2000 forecasts. In particular, it is difficult to predict future highway and transportation patterns, not to mention family size preferences. Beyond the mid-1980's an acute land shortage on the fringes of New Jersey's present metropolitan areas seems almost certain to develop, posing the likelihood of strong growth pressures on Ocean County.

The Pinelands Regional Plan indicates that, even if no new major economic generator were to be introduced into the area, population growth of some 100,000 would take place in this region of Burlington and Ocean Counties by the mid-1980's because of land shortages elsewhere. If the Pinelands Plan for major transportation-industrial inputs along the Burlington-Ocean boundary south of Route 72 were carried out, an additional population increment of at least 200,000 would be introduced into Ocean County, primarily into its southern half. It is also quite possible, of course, that major regional sources of migration in the last decades of this century will be substantially different from what can be predicted now.

The population base in the now-developed regions of northern Ocean County will probably be large enough by the 1980's to generate considerable growth on its own through natural increase. This area could become a source of migration to southern areas of the county.

Not only has Ocean County grown very rapidly in absolute terms, but it has grown in a particular direction: toward the over-50 age group. This has created a peculiar trend within the county's population: the age-skew.⁴ Nearly one-third of Ocean County's total population is aged 50 or over; comparable state and national figures are closer to one-quarter of the total population. The county's overall median age in 1970 was 32.5 years, compared to 30.1 years in New Jersey as a whole and 28.1 in the nation. The median age in Manchester Township, site of several large retirement villages, was 58.6 years.

4.4 Housing Patterns in Ocean County

Ocean County is one area in New Jersey where a moderate-income family can still afford to buy a single-family detached house. While the state's median housing value (owner-occupied) is \$23,500, Ocean's median housing value is \$18,500, 21% lower than the state average.⁵

An indication of the explosive growth of residential construction in Ocean County can be seen in the number of building permits issued for various types of housing. In 1972 over 11,500 permits were issued in Ocean County (with single-family detached dwellings the dominant type), compared to 5,100 in 1965. Table 4-4 shows the total number of building permits issued in the county between 1960 and 1973. Despite this level of activity, Ocean is still considered by the New Jersey Department of Community Affairs to suffer from a housing shortage for low and moderate income families. While building permits issued are not an assurance that the units have actually been constructed--especially since the economic down-turn--they do provide an indication of the marketability of an area, and of developers' desire to construct new housing.

4.5 Economic Activity in Ocean County

Because of its scenic qualities and related rural nature, Ocean County's economic base until quite recently centered on recreation, tourism, marine industries, and the economic activities stimulated by military installations such as Lakehurst Naval Air Station and Fort Dix. More recently, however, the county's economic base has expanded to include construction and associated service industries, reflecting Ocean's rapidly growing population and housing needs.

In fact, the county's economic base has changed dramatically from a resort-marine orientation to one dominated by the construction-service sector. Ocean County's third largest employer (with a 1973 total of 450 employees) is now Leisure Technology, Inc., a firm specializing in the construction of retirement home communities.

A major proportion of Ocean County's industrial activity has been involved in conversion of its farmland and other vacant land to housing and related uses. Between 1964 and 1969, 50.2% of Ocean County's farmland was lost to development and other related services.

Median family income in Ocean County in 1970 remained well below the state average, \$9,246 versus \$11,407. The county ranked 20th among New Jersey's 21 counties in median family income, ahead of only Atlantic County. The percent of families with incomes above \$15,000 was 17.2 in Ocean versus 29.5 in the state as a whole.

Ocean County witnessed an increase in total employment of 82.7% between 1959 and 1970. Employment growth is expected to continue with a projected

Table 4-4

Building Permits Issued in Ocean County
Aggregate Totals by Household Type, 1960 to 1973

<u>Housing Type</u>	<u>Ocean County</u>	
	<u>#</u>	<u>%</u>
Single Family	53,151	69
Two Family	6,562	8
3-4 Family	5,072	6
5 or more Family	12,123	15
Total	80,212	

Table 4-5

Selected Economic Characteristics, Ocean County

	<u>State Average</u>	<u>Ocean County</u>	<u>Ocean County's rank among 21 N.J. Counties</u>
Employed Persons			
% in Manufacturing	32.0	18.6	19th
% in White-collar occupations	52.7	50.3	11th
% Government workers	13.8	17.8	4th
% Working outside County of residence	32.7	32.3	14th
Unemployed	3.8	4.7	4th

employment increase of 63.7% for the decade of the 1970's. This is the highest figure for any county in the state for the same period, and reflects the gradual but continuous transition from a tourist-marine oriented economy to a broad-based residential and services economy. Table 4-5 provides further data on employment in the county, in contrast to the rest of the state.

The New Jersey Department of Labor and Industry estimated Ocean County's total work force in 1973 to be 74,000. In 1963, total employment had been 38,600. Thus there has been an almost 100% increase in the total work force in Ocean County in that ten-year period, a direct result of Ocean's rapid residential development. The gap between employed county residents and jobs within the county was roughly 21,000 for 1970, illustrating the pattern of commuters driving some distance from Ocean to their jobs in Northern New Jersey or elsewhere in the state.

Construction employment increased by 72% over the ten-year period 1960 to 1970, with further increases until 1972, the peak year to date for construction in Ocean County. Since 1972, construction in Ocean County, as elsewhere, has declined considerably, due to major economic problems in the construction industry as a whole. With a change in the money market, and a change in emphasis of the state towards providing housing for low and moderate income groups,⁵ this trend could swing upwards again, not only in Ocean County but across the state.

Agricultural employment dropped from 1177 in 1960 to 671 in 1970, a loss of 57%. Crop production reflects this decrease, with all types except soybeans being cultivated at roughly 50% of their 1960 acreage. Table 4-6 shows percentage shares of all crops grown in the county in 1969.

Projections of employment patterns are shown in Table 4-7, and data related to Ocean County's fiscal condition are shown in Tables 4-8 and 4-9.

4.6 Infrastructure and Municipal Services

Transportation Facilities

A major factor in industrial location decisions, transportation is an important element in any analysis of the Ocean County economy. U.S. Routes 9, 37, 70, I-195, the Garden State Parkway and the Central Railroad of New Jersey are important existing transportation corridors. Business and industry have located along these corridors because of ease of distribution and supply and proximity to population concentrations.

TABLE 4-6

AGRICULTURAL PRODUCTION IN OCEAN COUNTY
(Percentage of Total Acreage Cultivated)

<u>Crop</u>	<u>Percentage</u>
Field corn	18
Wheat	1
Soybeans (for beans)	17
Hay	24
Vegetables	18
Berries	15
Other	7

Source: U.S. Bureau of the Census, 1969.

TABLE 4-7

TOTAL EMPLOYMENT = 1980 FORECASTS FOR OCEAN COUNTY

<u>Industry Title</u>	<u>1970</u>	<u>1980</u>	<u>Employment</u> Change 1970 - 1980	
			<u>Number</u>	<u>Percent</u>
TOTAL MANUFACTURING	4,569	13,200	8,631	188.9
TOTAL PRIVATE NON-MANUFACTURING	31,193	46,042	14,849	47.6
Contract Construction	4,318	5,066	748	17.3
Transportation and public utilities	2,275	3,422	1,147	50.4
Wholesale trade	1,070	805	-265	-24.8
Retail trade	12,253	20,478	8,225	67.1
Finance, insurance and real estate	2,403	4,933	2,530	105.3
Services	8,874	11,338	2,464	27.8
TOTAL GOVERNMENT	8,383	13,009	4,626	55.2
Federal	1,804	2,177	373	20.7
State	447	666	219	49.0
Local	6,132	10,166	4,034	65.8
TOTAL (ALL)	44,145	72,251	28,106	63.7

Note: Numbers may not add due to rounding.

Source: Center for Urban Policy Research Projections, 1972.

TABLE 4-8

FISCAL DATA FOR OCEAN COUNTY

	<u>Ocean County Average</u>	<u>New Jersey Average</u>
Net debt, as % of equalized value	0.95%	1.68%
% of municipal budget drawn from surplus	7.9%	4.9%
Revenue - expenditures	+2.7 million surplus	+39.4 million deficit
Average (equalized) tax rate	\$3.10/\$100	\$4.62/\$100
% of taxes, for county use	17.4%	20.3%
% of total municipal revenues derived from property tax	71.4%	73.3%
% of taxes, for the purpose of education	67.1%	59.1%
% of total municipal valuation, that is:		
residential	73.6%	63.0%
commercial	10.2%	14.5%
industrial	1.3%	10.4%
vacant	10.6%	4.5%
<u>Ocean County Government</u>	<u>1964</u>	<u>1969</u> <u>1974</u>
Tax rate/\$100		\$0.52 \$0.44
Sources of revenue		
Taxes	79.4%	69.8%
Surplus	3.6%	7.7%
Misc.	17.0%	14.0%
Federal funds	--	8.3%
Debt limit (\$million)		32.7 (1973)61.4
Net debt (\$ million)		1.5 (1973)10.2
% Utilization		4.6% (1973)16.6%

Source: State of New Jersey, Department of Community Affairs, Division of Local Government services, Thirty-fifth Annual Report, 1972.

Figure 4-4 shows existing and proposed highway and rail lines which have had or will have a major impact on growth in Ocean County. Route I-195, extending into the northern fringe of the county, provides direct access to the New Jersey Turnpike at Hamilton Township in Mercer County; it connects with Route I-295. The Governor Driscoll Expressway, an extension of the New Jersey Turnpike to connect the Toms River area with New Brunswick, remains in the planning stages. If developed as proposed, it would be another major north-south corridor spurring business and industrial development along its route.

Municipal Administration

Ocean County is divided into 14 townships and 19 boroughs. Table 4-10 provides information on a variety of municipal functions and services in the county.

Parks and Recreational Areas

Although the County's seaside beaches are well known, its lakes and forests are also popular. Approximately 10% of its 409,000 acres are held by the State. Four State parks cover more than 4,500 acres. State forests range from the 43-acre Jackson State Forest to the 8,600 acres of Lebanon and Bass River Forests that lie within the county. There are also three State marinas and nine fish and game preserves. County parks, ranging in size from 1/2 acre to the 232 acre Ocean County park on the former John D. Rockefeller estate in Lakewood, form the nucleus of an expanding park system.

Education

Of the 33 municipalities in Ocean County, 24 maintain their own elementary schools, and 5 maintain their own secondary school; there are three regional high schools.

A recent survey made by the Ocean County school system indicates that 54% of those graduating from high school attended college, and 7% obtained further education in business, trade, and technical schools.

In addition to the 62 public schools in the county, there are 15 private nursery schools, 6 parochial schools, and 1 private school. There are two local colleges in Ocean: Georgian Court College for Women, in Lakewood; and Ocean County College, in Toms River.

Figure 4-4. Existing and proposed major transportation routes in Ocean County.
Source: New Jersey Dept. of Transportation.

Table 4-9
MUNICIPAL ADMINISTRATION OCEAN COUNTY:

MUNICIPALITY	MASTER PLAN	ZONING ORDINANCE	POLICE ^a PROTECTION	FIRST AID SQUAD	FIRE ^b INSURANCE RATING	SEWAGE ^c SYSTEM	WATER ^c SYSTEM
<u>Townships (14)</u>							
Berkeley	No	Yes	11 regular 10 special	Yes	G	Yes	Yes
Brick	Yes	Yes	20 regular	Yes	F	Yes	Yes
Dover	No	Yes	77 regular 30 special	Yes	E	Yes	Yes
Eagleswood	No	Yes	3 special	Available	G	No	No
Jackson	Yes	Yes	26 regular 8 special	Yes	E	Yes	Yes
Lacey	No	Yes	16 regular 3 special	Yes	G	No	No
Lakewood	Yes	Yes	55 regular 15 special	Yes	E	Yes	Yes
Little Egg Harbor	Yes	Yes	2 regular 30 special	Available	G	Yes	Yes
Long Beach	Yes	Yes	22 regular 6 special	Available	F	Yes	Yes
Manchester	Yes	Yes	16 regular	Yes	G	Yes	Yes
Ocean	No	Yes	5 regular 1 special	Yes	G	Yes	Yes
Plumsted	No	Yes	2 regular 8 special	Yes	G	No	Yes
Stafford	No	Yes	7 regular	Yes	G	Yes	Yes
Union	Yes	Yes	2 regular 2 special	Yes	F	No	No
<u>Boroughs (19)</u>							
Barnegat Light	Yes	Yes	Long Beach Twp.	Yes	E	No	Yes
Bay Head	Yes	Yes	5 regular 1 special ^d	Available	D	Yes	Yes
Beach Haven	Yes	Yes	10 regular ^d	Yes	D	Yes	Yes
Beachwood	No	Yes	6 regular 5 special	Yes	E	No	Yes
Harvey Cedars	Yes	Yes	3 regular 2 special	Available	E	Yes	Yes
Island Heights	Yes	Yes	1 regular 5 special	Yes	E	Yes	Yes
Lakehurst	No	Yes	4 regular 3 special	Yes	F	Yes	Yes
Lavallette	Yes	Yes	8 regular 5 special ^d	Yes	D	Yes	Yes
Mantoloking	No	Yes	6 regular 3 special ^d	Available	D	No	Yes
Ocean Gate	No	Yes	1 regular 2 special	Yes	E	No	Yes
Pine Beach	No	Yes	2 regular 2 special	Available	D	No	Yes
Pt. Pleasant	Yes	Yes	23 regular 30 special	Yes	E	No	Yes
Pt. Pleasant Beach	Yes	Yes	18 regular 1 special ^d	Yes	D	Yes	Yes
Seaside Heights	No	No	17 regular 22 special	Yes	E	Yes	Yes
Seaside Park	No	Yes	13 regular 12 special ^d	Yes	E	Yes	Yes
Ship Bottom	No	Yes	8 regular	Yes	E	Yes	Yes
South Toms River	No	Yes	2 regular 5 special	Yes	F	No	Yes
Surf City	Yes	Yes	7 regular ^d	Available	E	Yes	Yes
Tuckerton	No	Yes	3 regular ^d	Yes	G	Yes	Yes

^a Areas where no local police force exists are serviced by the New Jersey State Police.

^b Alphabetic ratings by Fire Insurance Rating Organization of New Jersey indicate rating assigned to most areas of the municipality. Higher or lower ratings will exist according to conditions and facilities available in certain areas.

^c Sewage and Water Systems -- indicates whether or not a system exists in the municipality. Information for specific locations will be furnished upon request.

^d Additional special police in summer.

4.7 Major Federal Actions and Proposed Energy Developments in Ocean County

A number of actions by the Federal government--past and pending--have direct relevance to patterns of land use and development in Ocean County. Several of these federal activities are related to energy or to environmental quality. Because Ocean County is located on the fringe of the New York (and Philadelphia) metropolitan complexes, it has sizeable amounts of relatively open land available at comparatively low prices, and borders directly on the Atlantic Ocean in the center of the state, it has been the target of a number of energy-related schemes: off-shore oil, floating nuclear power plants, and a deepwater port, as well as the hypothetical NEC.

Leasing for oil and gas exploration in the Atlantic Ocean's Outer Continental Shelf (OCS) is scheduled to take place in mid-1976, under the aegis of the U.S. Department of the Interior. Ocean County has been viewed in many studies both by government agencies and by the petroleum industry as a likely site for various on-shore facilities needed to support OCS oil and gas operations, including some or all of the following:

- (1) facilities to support energy construction activities, particularly off-shore (e.g. breakwater construction, rig fabrication, pipeline laying);
- (2) facilities to provide direct support to the on-going operations of these energy facilities (post-construction);
- (3) facilities designed to store and transmit the energy being developed (e.g. storage tanks, on-shore pipelines, switching stations, pumping stations, high-voltage transmission lines);
- (4) facilities specifically designed to utilize products of these energy sources (e.g. refineries, petro-chemical plants);
- (5) secondary growth induced by some or all of the above (industrial, commercial, residential);
- (6) new infrastructure required in an area due to the construction of some or all of the above (e.g. highways, sewers, schools, sewage treatment plants, hospitals).

In addition, a variety of proposals have been put forth for construction of a deepwater port off the coast of New Jersey, designed to receive oil from today's huge supertankers. Federal legislation has already been passed in order to define the regulatory posture within which a deepwater port would

have to operate. Such a facility, perhaps accommodating a throughput of one million barrels of oil per day, would be certain to stimulate construction of large new oil storage facilities in coastal New Jersey -- including Ocean County -- and might well induce construction of one or more large new refineries in the area.

The floating Nuclear Power Plant proposed by Public Service Electric & Gas Company to be located about 2.8 miles off the shore from Little Egg Harbor Inlet would, if constructed, produce further land use impacts on the county. Again this is primarily a federal rather than a state or local decision, one which could have a measurable effect on the county.

Obviously, construction of such energy facilities -- and their multiplier effects within the county -- may well further stimulate population growth and the economy in Ocean County if a number of such facilities were constructed. The area would shift in tenor from a focus on resort/retirement/services to energy-related industrialization. Summer tourists might well go elsewhere for their sun-seeking vacations, with construction workers and oil-industry employees taking their place in the local economy. Levels of population proximate to a large nuclear facility certainly would be high under either of these models.

One specific constraint on future growth in Ocean County came from the Federal government, in the form of a restriction on sewer construction funds from the U.S. Environmental Protection Agency. This is one of the very few examples to date of direct federal involvement in local land use decisions.

In 1972, the Ocean County Sewerage Authority sought to expand the facilities in its Central Service Area to serve a 1990 population estimated at 400,000 by the Division of State and Regional Planning. The U.S. Environmental Protection Agency, in its draft environmental impact statement responding to that proposal, indicated that it would not give approval or funds to a facility exceeding a service capacity in this area for a population of 250,000. Furthermore, it required establishment of a joint relationship between the Ocean County Planning Board, the municipal boards, and the Ocean County Sewerage Authority to decide on overall land use strategy; this relationship, however, had no statutory authority in New Jersey planning legislation. EPA reasoned that approval of a larger sewerage system would induce

population to grow to a level that would seriously lower air quality in this area, given existing technology. The Ocean County Sewerage Authority disputed EPA's draft statement, since it had hoped for funds and approval for facilities with a 60% larger capacity. A map showing natural drainage basins in Ocean County is presented in Figure 4-5.

In its final Environmental Impact Statement issued in October 1974, EPA approved funds for a facility which would serve not more than a population of 250,000 in the Central Service Area.⁶ One should note, however, that in 1974 the population of this area already stood at 156,000, 63% of the specified upper limit.

4.8 Recreation in Ocean County and the New Jersey Shore

Ocean County's economy has been based on the attractiveness of its natural resources, especially its seashore. In general, public demand for recreation in the United States has been skyrocketing for the past two decades or more. Studies have projected up to a ten-fold increase in visits to the shore between 1970 and 2000. Since only 3% of the nation's coast remains open for public use, this means that fantastic pressure will be placed on vacation spots already straining to serve adequately those now using them.

Ocean County is a microcosm of this national trend. Its rapid growth has been fueled largely by the rapidly increasing demand for shore-related recreation. Its old economic dependence on tourism has now broadened into reliance on construction and service industries; but these, too, are based to a great extent on persons coming to Ocean for its outdoor amenities. Although more people are locating permanently in the county now, many of the newcomers commute daily to jobs out of the area. As gasoline costs continue to rise and reduce mobility, Ocean's natural resources will regain some of their relative importance to transient visitors instead of commuters.

Ocean County's most important resource is the beach on its two long islands which separate Barnegat Bay from the Atlantic Ocean. One study has calculated that in 1967 some 8.5 million visits were made to Ocean County's beaches. Island Beach State Park is situated on the more northern of the two islands and serves primarily the populations of northern and central New

Jersey. Presently its facilities are crowded, although reportedly they are not filled to capacity. Barnegat Bay is second only to the beaches in significance to the county's recreation economy. People sail, water ski, fish, and use power boats on the bay, and the presence of some 30 private yacht clubs and numerous docks and public launching ramps attest to the bay's popularity. Lesser attractions for tourists are the coastal wetlands which still exist in the southern part of the county and the Pinelands, which begin a few miles inland from the coast.

In 1967, county non-manufacturing business receipts totaled \$34,079,000. Hotels, motels, and camps contributed 30.6% of this amount, and amusement facilities, including movie theatres, constituted 25.8%. A recent study by the U.S. Travel Data Center identified 2,111 permanent jobs in Ocean County associated with the resort and travel industry.⁷ A special commission chaired by New Jersey State Assemblyman John Paul Doyle of Ocean County has been conducting hearings to obtain further details on the resort industry's economic importance in New Jersey.

If Ocean County were to be seriously considered as the site for an NEC, this facility's impact on the recreational base of the county's economy would have to be considered in some detail, using far more information than is available at present.

4.9 Ocean County as an NEC Location

Population proximity clearly is a serious, and significant issue with respect to an NEC in Ocean County. This policy issue is dealt with in some detail in Chapter XIX.

In terms of its infrastructure and ability to be physically ready to absorb the influx of workers and families who would build an NEC and support its work force, Ocean County seems to be in a relatively good position. Many communities have water and sewage systems, sizeable police forces, and adequate fire protection. However, congestion from growth already afflicts these places, and the NEC's impacts might become unmanageable. The school system, to choose one example, does not have sufficient capacity to accommodate many more children; Ocean County's voters have rejected school bond referenda on several different occasions in recent years. New roads probably would have

to be built to take traffic to the NEC site. Ocean's chief economic activity has been the creation of new residential communities out of farmland. The construction industry is correspondingly important to its economy. The county and its municipalities are in generally good financial standing, although the revenues from an energy center would be so great that they would tempt any municipality not totally consumed by the purchase of land for its construction.

Those who believe an NEC could seriously harm Ocean's recreation-based economy present four arguments: (1) It would be impossible to hide the facility. The cooling towers would be visible for the length of the county's coast line, throughout Barnegat Bay and on the beaches. The plumes might shadow the area.* Some fraction of potential visitors might refuse to come near the reactors, or near Ocean County. (2) Ocean is already plagued by flooding consequent to careless development of the land. Further development on a large scale would worsen this situation and drive away tourists. (3) If visitors refuse to come to the beach or to buy a new home because of proximity to the nuclear center, a drop in demand would destroy land values. (4) The decision to construct an NEC in Ocean County would represent an inexorable commitment to industrialization of this part of the shore, at least. Construction activities and the general tenor of life will attract other industrial and energy facilities, which will gradually drive out most resort-oriented activities as fundamentally incompatible.

Others can argue persuasively that an NEC would not ruin Ocean County's recreation-based economy: (1) Workers coming into the county will create new demands for housing and recreation. They are known to prefer exactly those activities which Ocean County now offers. Presumably they will not be disturbed by the knowledge that nuclear reactors are operating a few miles away. (2) Careful planning will alleviate or prevent any flooding. (3) U.S. demand for shore-based recreation is likely to be so high that eventually any beach space will be utilized, even that proximate to nuclear reactors. Whether there would be a drop in attendance at Ocean's beaches is a moot point. This would depend on whether people ignored the presence of the reactors, as well as on whether there were alternative recreational areas to which they would

*These issues of visual impact of the NEC are dealt with directly in Chapter X of this report.

choose to go instead. Serious attitudinal and behavioral research is needed to assess these probabilities.

On balance, it seems likely that Ocean County's aggregate economy would not be disrupted greatly by NEC construction. The principal result would be a transfer effect, from transient tourists to construction workers. Whatever occurred in Ocean County if an NEC were to be built there--or at any site similar to Ocean--the agencies responsible for its construction would have to pay careful attention to both the public's right to recreational opportunity, the environment which makes recreation enjoyable, and the impact of NEC construction on both.

4.10 Land Use Plans and Population Projections

Future development patterns in many areas of Ocean County are relatively fixed as a result of existing development patterns and location of wetlands, flood plains, critical environmental areas and large publicly-owned lands. In such areas, few if any significant changes should occur from the character of current conditions of development.

Ocean County's planners have identified eight major categories in establishing their goals for future development: county identity, human resources, infrastructure, natural resources, housing, transportation, communications, and economic development. Specific guidelines are outlined in detail under each category. Utilizing these categories, the planners have projected growth patterns to the year 2000.

The proposed 25-year plan is aimed at a year 2000 permanent population of 630,000 persons in Ocean County. This figure represents more than a doubling of the 1974 county population of 258,000 residents. Table 4-10 presents data on the likely dispersion of this population in the year 2000 between the coastal beaches, bay corridor and western (inland) section of the county.

Major expansion in coastal beach areas will evolve primarily out of conversions from seasonal to year-round dwellings, rather than from major new construction. The bay corridor area is expected to continue as the main focal point for new housing construction in the period 1975-1980, although restrictions on wetland development have reduced the amount of developable land. State legislated and administered limits to development in the coastal beach and bay areas will create new pressures for development west of the Garden State Parkway, as land

Table 4-10

PROJECTED POPULATION IN OCEAN COUNTY AND ITS DISTRIBUTION

Region of the Country	1974 Population Characteristics			2000 Population Characteristics			
	Population	Percent of County Population	Population Per Square Mile	Population	Percent of County Population	Population Per Square Mile	Percentage Population Increase, 1974-2000
Coastal Beaches	23,900	9%	1664	34,500	5%	2432	44.4%
Bay Corridor	154,300	58%	832	347,800	55%	1856	125.4%
Western Region (Inland)	85,800	33%	192	247,700	39%	576	188.7%
Totals	264,000	100%	413	630,000	99%	986	139.0%

east of the Parkway becomes fully developed.

Three alternate concept plans have been devised. All assume continued development of the coastal beaches where feasible, and varying growth (depending on the alternative) of the smaller boroughs and communities in the western parts of the county. The distribution of population along the coastal beaches and in the bay and inland areas is assumed to be the same; the major differences between alternatives are the distribution and density of development rather than the anticipated county-wide population levels. The most important features of the three plans are as follows:

(1) Trend Alternative. This concept illustrates the future urban pattern likely to occur from a continuation of present developmental policies. Most of the development would be related to the already formed north-south Route 9/Garden State Parkway corridor. Because of the anticipated general availability of sewers along this corridor, development would tend to leapfrog, leaving gaps of vacant land and promoting a spread of generally low density development.

(2) Bi-Nodal Alternative. This concept emphasizes more concentrated development in the northern and southern sections of the county, with a broad, low density corridor separating the two development nodes. This alternative would result in higher densities in the developed areas and further east-west expansion than under the Trend alternative.

(3) Satellite Alternative. This alternative is basically similar to the 1966 Ocean County Master Plan. New development is concentrated as logical extensions outward from established centers. Densities of built-up areas are generally highest in this alternative.

The overall concept plan proposes four densities of population development:

- (1) Conservation Areas - less than one unit per 5 acres
- (2) Rural Areas - one unit per acre
- (3) Low Density Residential Areas - from one to five units per acre
- (4) Suburban Residential Areas - five or more units per acre.

Utilizing these four categories to analyze current and future demographic characteristics of Ocean County, the following patterns emerge:

Figure 4-6. Future development alternatives,
Ocean County.

Suburban density areas include the older, built-up communities in the county and several of the boroughs on the coastal beaches which are more intensely developed. Most of the new suburban density areas would have access to major north-south highways, the east-west crossings, or the bays. Low density residential areas are primarily located on the coastal beaches, the corridor between the Garden State Parkway and the coastal wetlands, and the east-west corridor along I-195 in the northern section of the county. These two development areas will have access to central sewers.

Rural density areas include much of the land west of the Garden State Parkway, exclusive of publicly-owned lands. These areas are currently accessible and are already experiencing scattered development. Conservation areas include the extensive aquifer and aquifer recharge areas and the practically uninhabited regions of the Pinelands, and the headwaters of major streams flowing from the upland plateau areas of the county.

Projected growth rates forecast suburban and low population densities for the coastal beaches and bay areas. Inland areas are planned to have low (rural and conservation) densities.

The concept plan proposes three basic types of commercial development:

1. Community shopping centers, ranging in size from a large regional center currently under construction at Toms River to small rural shopping centers;
2. highway commercial development, particularly along Routes 9, 37, 72, 88, and 528;
3. coastal resort commercial development.

Highway commercial development and shopping centers have become the major commercial form in Ocean County, and this trend is expected to continue, developing principally along sections of and at major intersections and interchanges of the county's principal highways. Coastal resort development is expected to continue to grow in its characteristic scattered strip fashion.

Several sites have been proposed for industrial development, primarily in the northern section of the county where there is ready access to major highways and railroads. Some sites have been proposed in the southern region of the county as well. However, industrial development in the county has been limited, and the county's rural and recreational character has predominated.

It is unlikely that significant industrial development will occur in the future at present growth rates, which are below those experienced during the late sixties and early seventies.

Finally, the concept plan proposes to expand and re-organize the current patterns of federal, state and county-owned parks, forests, refuges and military reservations, as well as coastal wetlands and riverine areas subject to flooding. In this plan, top priority is devoted to the bays and beaches, Pinelands and Forked River Mountain areas.

Past development within the county has concentrated heavily in the coastal beach and bay areas. This pattern is expected to continue throughout the next several decades. The interior rural regions will not undergo any major expansion until the close of the century, and then will expand primarily because opportunities for further growth in the beach and bay corridors will have been exhausted. The projections testify to the enormous impact that these recreational areas have upon the county's development. Ocean's rate of growth is expected to continue at a level well above that of New Jersey as a whole, but is not projected to attain the very high rates experienced during the 1962-1972 period.

State regulatory and planning functions will also affect the type and distribution of future development in the county. Under the Coastal Area Facilities Review Act (CAFRA), the state's Department of Environmental Protection now regulates large housing, commercial, and industrial developments in those portions of the county east of the Garden State Parkway, south of Toms River and generally east of the intersection of routes 70 and 530 north of Toms River. CAFRA also requires that a plan for the entire New Jersey coastal area be prepared by September 1977.*

In the interim period before adoption of this plan, "Density Guidelines" are being used as a basis for review of individual permit and applications. These density guidelines favor cluster development, discourage building in environmentally sensitive areas, and set strict guidelines for construction of declining urban areas.⁸ The guidelines should lead to land use patterns in which relatively dense residential clusters are the rule,

*Details on CAFRA, including a map of the regulatory area, are presented in Chapter XVII.

separated by open areas for environmental protection, recreation and conservation. They could also have the effect of shifting development pressures to the inland portions of Ocean County where developers can escape CAFRA's stringent regulations and requirements.

The CAFRA density guidelines include estimates of near term (1980) population growth and distribution for those portions of Ocean County regulated by CAFRA. The guidelines project a 23% increase in population in Ocean County by 1980, adding an additional 56,300 to the county's 1974 population. The basic state report includes this summary:

Even with slowdowns in economic activity and the housing industry, we project an increase for 1974-1980 between 20 and 29 percent. This growth rate would add 50-75,000 persons to the county during this six year period. The bulk of their increase would be in the range of 309,000 to 332,000. This range is considerably below the 440,000 in 1980 used by the Ocean County Sewerage Authority in their planning for the new regional sewage treatment system

The major areas for growth for Ocean County are likely to be: Brick, Dover, Lakewood, Manchester, Berkeley, and Jackson Townships

Growth will mainly be in the northeast corner expanding west and south from existing developed areas.⁹

These projections cover permanent population only. There were 42,000 seasonal housing units in Ocean County in 1970; therefore, peak season population is about 120,000 higher than year-round population.

* Note the assumption that infrastructure and proximity to the shore and transportation routes will continue to bring the vast majority of Ocean County's new population into the CAFRA area, despite the more burdensome design and environmental requirements placed on developers there.

NOTES FOR CHAPTER IV

1. From the viewpoint of easing the burden of analysis within the confines of this initial study, however, the fact that extensive environmental analyses are available for this nuclear facility (and for the proposed Forked River and Atlantic generating stations) has, of course, been of some significance.
2. A further source of information on Ocean County is to be found in "Coping with Growth--Ocean County," Report of the Urban Planning Study Workshop, Princeton University, Fall 1974.
3. Ocean County Planning Board, Ocean County Population, January 1972.
4. "The Retired Now a Force in Jersey Counties," The New York Times, Sunday, December 8, 1974.
5. In a 1975 N.J. Supreme Court decision (the Mount Laurel decision), it was decreed that the state had to devise a plan for regional allocation, throughout the state, of housing for low and moderate income sectors of the population; or face litigation, area by area, for exclusionary zoning. Impacts of this decision on Ocean County remain to be seen.
6. U.S. Environmental Protection Agency, Region II, Environmental Impact Statement on a Wastewater Treatment Construction Grant for the Central Service Area of the Ocean County Sewerage Authority in Ocean County, New Jersey, Volume 1, Final Report, New York: EPA, October 1974, p. 176-180.
7. U.S. Department of the Interior, Draft Environmental Statement, Proposed 1976 OCS Oil and Gas Lease Sale: Off-shore the Mid-Atlantic States, OCS Sale #40, Volume I of III, p. 416.
8. Rivkin Associates, "Draft Interim Land Use and Density Guidelines for the Coastal Area of New Jersey," February 1976.
9. Ibid, p. 64.

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CHAPTER V*

SITE SELECTION AND SITE CHARACTERISTICS

5.1 Introduction

A variety of potential sites for a nuclear energy center exist in Ocean County, at least from the hypothetical perspective of this study. Since the county contains several distinct ecological and social provinces, analysis of a single site would not have portrayed fully the richness and variety of technological options and potential effects of an NEC within this coastal area. Therefore, three hypothetical sites were identified to illustrate the range of issues, impacts, and risks associated with siting such a facility in this part of the Mid-Atlantic coast.

Together these three sites represent as complete a picture as possible of siting and technological options available within the region:

--One site, located inland, is evaluated in terms of an NEC equipped with mechanical draft evaporative cooling towers--it is located primarily in Lacey Township, and is termed the Inland Site.

--A second site, also inland, is located on the grounds of that part of the existing military reservation in Ocean County comprised of part of the Army's Fort Dix and all of the Lakehurst Naval Air Station--it is termed the Fort Dix Site, and has natural draft evaporative cooling towers.

--The third site is located as close as possible to the ocean, and uses once-through cooling--it is called the Bay Site.

5.2 Major Features of Ocean County's Physical Environment

A massive facility like an NEC would constitute a substantial intrusive impact in Ocean County. Therefore the physical environment placed distinct constraints on our choice of three specific sites. This section is by no means a full environmental assessment, which would require detailed baseline studies, a comprehensive data collection effort, and a complete design and layout of the generating stations themselves. The intent here is narrower: to sketch

*This section was prepared with the assistance of Thomas O'Neill, Dyche Kinder and Stuart Sender, Center for Environmental Studies, Princeton University.

the major features of the physical environment, particularly those that have special bearing on issues studied in subsequent chapters and those that affected the selection of our three hypothetical NEC sites within Ocean County.

Geology and Physiography: Of the county's total area of 639 square miles, 536 may be classified as upland; the rest is beaches, salt marsh, and water surfaces. The soil is classified as a true podisol, the coarseness of which causes rapid percolation and low soil moisture retention. Ocean County is in the Atlantic Coastal Plain physiographic province. The coastal plain sediments of the area dip in a south-eastern direction toward the sea, increasing in total thickness from 1000 to 4000 feet within the county. Figure 5-1 shows the surface geology of the county. The topography is undulating plain with low relief. Three-fourths of the county lies below 150' mean sea level (MSL). Relief in the county is low.

The barrier beach extending south from Point Pleasant is the county's most significant physiographic feature. It is an unstable geologic feature indicative of an emerging shoreline, and has been formed from sands transported by long-shore currents and maintained in the shape of a bar by waves breaking offshore. Dunes stabilize and protect the bar from erosion during storms. The barrier islands, divided in Ocean County by Barnegat Inlet, range in width from a few hundred yards to a mile. They are formed of natural sand dunes held in place by grasses. Between the barrier islands and the mainland lies Barnegat Bay, a shallow estuary rich in fish, shellfish, and birdlife. The intra-coastal waterway passes through Barnegat Bay, the western edge of which consists of wetlands.

This ecosystem of barrier beach, bay, and wetlands is fragile and sensitive:

...the sand dune is a very recent formation. It will change its configuration in response to autumn hurricanes and winter storms and will sometimes be breached...During storms the bay is likely to fill and flood the bayshore and trough. In severe winter storms the sea may cross over the entire sandbar...The New Jersey shore...is continuously involved in a contest with the sea; its shape is dynamic. Its relative stability is dependent upon the anchoring vegetation.¹

Portions of Ocean County lie in the Atlantic drainage basin and portions in the Delaware basin. The divide separating the two drainage areas follows

Figure 5-1. Geologic map of Ocean County.
Source: Oyster Creek Environmental Report.

irregular north south line through the western part of the county. (See Figure 4-6 for a map of major drainage basins).

The Quaternary, Tertiary, and Cretaceous sediments underlying the county include 20 formations, many of which are aquifers. The formations consist of gravel, sand, and clay at the surface and sand quartz and clay in deep Raritan formation. These deposits are underlain by precretaceous crystalline bedrock ranging from -1000 ft. MSL in the northern part of the county to 3000 ft MSL in the southern portion. The lithology of the upper 65 feet of the bedrock is weathered gneiss. The artesian aquifers mentioned supply Ocean County's present water needs.

Seismicity and Fault Structures: Seismicity is clearly a major locational consideration in nuclear facility siting, and, as noted earlier, constituted one of the criteria in the coarse screening process that identified coastal New Jersey as a candidate region for a hypothetical NEC. Due to the limited time and resources available to this study, however, we have not been able to confirm or deny, by independent study and analysis, the seismic suitability of the region for an NEC.

We have reviewed the Environmental Reports submitted by the utilities for the Oyster Creek and Salem nuclear facilities, and in particular have reviewed the reports on regional tectonics and seismicity prepared by Dames and Moore for the Oyster Creek plant. The salient conclusions of the Dames and Moore analysis indicate that no known major faults lie in the study area, the closest lying in the Appalachian highlands some 40 miles northwest of the coastal plain in which the hypothetical NEC has been located.² This is indicated on the regional tectonic map shown in Figure 5-2.

Similarly, in regard to seismic activity, a mapping of known epicenters and an analysis of their seismic intensity led Dames and Moore to the conclusion that "...based on the geology and seismic history of the region, it appears unlikely that the site (Oyster Creek) will experience significant ground motion during the economic life of the plant. The maximum horizontal ground acceleration, if any historical earthquake should reoccur, would only be a few percent of gravity."³ A map showing the location of known epicenters in the region is reproduced in Figure 5-3.

Figure 5-2. Regional tectonic map.
Source: Oyster Creek Environmental Report.

Figure 5-3. Regional epicenter map.
Source: Oyster Creek Environmental Report.

The largest earthquake in the region (a Modified Mercalli Intensity VII) took place in June 1927 in the vicinity of Asbury Park and Long Branch, N.Y. (the postulated Cornwall-Kelvin Wrench Fault intersects the New Jersey coast near its epicenter). Other Intensity VII earthquakes of lesser strength than the 1927 shock have been reported at Wilmington, Delaware (1891) and New York City (1737 and 1884). Smaller earthquakes have been reported in the region surrounding the site but in no case is there documentation of surface fracture due to induced ground motion.

The zone of major seismic activity closest to Ocean County is the Cape Ann, Massachusetts area, some 275 miles to the northeast, while the only zone of major seismic activity in the Coastal Plain Province of the eastern United States is near Charleston, South Carolina.

Ground Water: As shown in the New Jersey Coastal Plain Geologic Column (Table 5-1), at least seven distinct bodies of fresh ground water are thought to exist in the vicinity of Ocean County. The most important of these are the Recent and Cape May Formations, the Cohansey Sands, and the Kirkwood Formation. Of increasing importance (as one moves inland) is the Raritan-Magothy, which is believed to be within the zone of salt water intrusion near the coast.⁴

The unconfined Recent and Cape May Formations are replenished directly by precipitation. Runoff is minimal in Ocean County, most precipitation percolating directly to the water table. Part of this ground water is lost through evapotranspiration, part passes through aquitards to lower aquifers, the remainder is discharged to streams or directly to Barnegat Bay.

The major aquifers utilized in the vicinity of the sites are the Kirkwood Formation and the Cohansey Sands. Ground water flow in the Kirkwood and Cohansey aquifers is to the east or south in Ocean County. Recharge to these aquifers is through precipitation and percolation over the exposed surface and from the downward movement of water from overlying aquifers through aquitards. Some water is apparently also discharged vertically upward from the Kirkwood to the Cohansey where the piezometric head is greater than that of the overlying water table aquifers. Local groundwater recharge may be induced to the Cohansey Sands where it is dissected by overlying water bodies.

TABLE 5-1

Geologic Column

Source: Oyster Creek Environmental Report

System	Series	Group	Formation	Lithology	Thickness
Quaternary	Holocene		Alluvium, beach sand and gravel	Gravel, sand, and clay	0-50
	Pleistocene		Cape May Formation		0-20
			Pensauken Formation		
			Bridgeton Formation		
Tertiary	Miocene(?) and Pliocene(?)		Beacon Hill Gravel	Sand, quartz, fine-to coarse-grained; locally clayey and clay.	0-200
			Cohansey Sand		
	Miocene		Kirkwood Formation	Sand, quartz, very fine to medium and coarse grained, micaceous, lignitic, silt, gray clay, and fine gravel lenses.	0-500
	Eocene		Manasquan Formation	Sand, Quartz-glaconite medium to coarse-grained, clayey, fossiliferous.	18-392
	Paleocene	Rancocas	Vincentown Formation	Upper - calcarenite, fine to medium-grained, glauconitic, quartzitic, fossiliferous. Lower - sand, quartz, glauconitic, fine to coarse-grained, clayey. Downdip - clay, glauconitic, fossiliferous.	25-328
			Hornertown Sand	Sand, glauconitic, medium- to coarse-grained, clayey, fossiliferous.	30-50
Cretaceous	Upper Cretaceous	Monmouth	Red Bank Sand	Sand, quartz-glaconite, fine- to coarse-grained, clayey, lignitic.	10-50
			Navesink Formation	Sand, glauconite, fine- to coarse-grained, clayey, fossiliferous.	1-100
			Mount Laurel Sand	Sand, quartz, fine- to coarse-grained, glauconitic, fossiliferous.	40-128
		Marlwan	Wenonah Formation	Sand, quartz, fine-grained, micaceous, lignitic and silt, clayey.	10-25
			Marshalltown Formation	Sand, glauconitic and quartz, fine- to medium-grained, clayey, fossiliferous.	
			Englishtown Formation	Sand, quartz, fine- to medium-grained, micaceous, lignitic, clay seams.	
			Woodbury Clay	Clay and silt, glauconitic, fossiliferous.	100-212
			Merchantville Formation		
			Magothy Formation	Sand, quartz, very fine- to medium-grained, glauconitic, micaceous, clay.	600-2,000
			Raritan Formation	Sand, quartz, fine- to coarse-grained arkosic, sideritic, clay. Calcareous and kaolinitic downdip.	
Pre-Cretaceous	Precambrian and early Paleozoic rocks - schist, gneiss, pegmatitic, and gabbro. Triassic sandstone, shale, and basalt.			Weathered gneiss	65
				Biotite gneiss with pegmatite veins	-----

Though the movement of groundwater in the vicinity of the sites is generally to the east or south, streams or rivers which intersect the upper ground water body are augmented by ground water flow and in the vicinity of the sites divert water to the west or south.

Kirkwood Formation: This formation extends across New Jersey for approximately 100 miles and increases in thickness from 50 feet at the outcrop area to 900 feet at Beach Haven. The outcrop area is a northeast trending band one to six miles wide extending through the central portions of Camden, Burlington, Ocean and Monmouth Counties.

The Kirkwood Formation has one or more clay members in its upper portion that act as confining beds. Thus, downdip of the outcrop area of ground water is generally under confined or semiconfined pressure. Near the outcrop area silt and fine grained facies predominate, however with downdip thick clays and shoestring sand beds predominate. These shoestring-sand beds have high hydraulic conductivity and are the major water bearing bodies of the aquifer.⁵

The Kirkwood aquifers are the most intensely developed in Ocean County; pumpage in 1974 amounted to approximately 5 mgd in Ocean County alone. From 1910 to 1960 the piezometric surface of the ground water in the Kirkwood Formation dropped 20 feet at Tuckerton, more than 30 feet at the extreme southern tip of Ocean County, and more than 80 feet at Atlantic City. In 1960 the level of the piezometric surface ranged from 20 feet below mean sea level at Beach Haven to 100 feet above mean sea level at Webbs Mill.

Cohansey Formation: The Cohansey Formation immediately overlies the Kirkwood Formation. The thickness of sedimentary beds in the Cohansey changes rapidly with distance due to the lenticular and discontinuous nature of sand and clay members of the formation. Two aquifers apparently exist in the Cohansey Formation. The uppermost is semi-confined by a thin and apparently discontinuous clay layer. The lower is fully confined. However, in some areas of Ocean County these confining clay layers may be absent and the Cohansey functions as a water-table aquifer.⁶

In Ocean County in 1960 static water levels in the unconfined aquifer (of which the Cohansey is a part) varied from zero along the Bay to 120 feet above mean sea level in the western side of the county.

The major water-table aquifer over the freshwater zone of Ocean County is the Cohansey Formation. Approaching the coast and in isolated pockets inland the water table aquifer is a combination of the Cohansey, Pensauken, Bridgeton, and Cape May Formations. The Halocene sand deposits on the island beaches sometimes act as shallow, unconfined fresh water aquifers.

Water Quality: The quality of water in the Kirkwood aquifer is generally good, low in hardness and dissolved solids. These waters are usually of the bicarbonate type; showing a sodium or potassium type cation and no dominant anion. Excessive drawdown on the sand dune barrier beach or along the coast may induce movement of brackish or salt water into the aquifer. However, there appears to be an effective impermeable barrier in the upper Kirkwood as there is no evidence of salt water intrusion in island wells.

In Ocean County the Cohansey aquifer yields poorer quality water than that in Burlington or Atlantic Counties, though the overall quality is good. The dominant cation content is similar to that of the Kirkwood where sodium-potassium facies predominate. The chloride anion facies occur more frequently than do the sulfate facies.

Indications of saline or slightly saline water inland of the coast have been noted. Beneath the island beaches the Cohansey aquifer contains brackish water, the result of sea water intrusion, local aquifer recharge by tidal streams, or residual salt water not completely flushed seaward by fresh water.⁷

The quality of water in the unconfined, recent Cape May water table aquifers in Ocean County is the poorest of all fresh water obtainable from the coastal plain aquifers; in many areas these waters are acidic.

Information on the chemical composition of water in these various aquifers is summarized in Table 5-2.

Surface Water: Relatively little is known of the water body and stream flow characteristics of the surface waters found in or flowing through the sites; only Cedar Creek, Rancocas Creek and Crosswicks Creek have gauging stations anywhere along their length. Nor are the water quality characteristics explicit as ground water is used for consumption.

The Fort Dix Site has three standing water bodies ranging from 70-320 acres in size; it is drained by Rancocas and Crosswicks Creeks and has a

Table 5-2 Chemical Composition of Water in the Major Aquifers in the Oyster Creek Area.

<u>AQUIFER</u>	<u>TEMPERATURE</u> (°F)	<u>TOTAL</u> <u>IRON *</u> (Fe)	<u>CALCIUM</u> (Ca)	<u>MAGNESIUM</u> (Mg)	<u>CHLORIDE</u> (Cl)	<u>TOTAL</u> <u>DISSOLVED</u> <u>SOLIDS</u>	<u>pH</u>
Unconfined, Recent Cape May Formation	56 to 59	.2 to 10	(12 to	300)**	15 to 44		6.1 to 8.4 mostly acidic
Confined, Lower Cape May Formation	58 to 62	.5 to 1.4	9 to 26	1 to 8	11 to 17	80 to 170	6.9 to 7.6
Cohansey Sand	57 to 62	.1 to 4.0	6 to 98	2 to 56	11 to 64	100 to 400	6.9 to 8.2
Kirkwood Formation (Upper and Lower zones)	60 to 67	.1 to 1.7	9 to 43	2 to 12	4 to 42		6.1 to 8.3

* With the exception of temperature and pH, all values for constituents are given in parts per million.

** values given are for combined total of calcium and magnesium.

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number of cedar marshes and open swamps. The Bay Site is cut through by numerous small tidal streams; other than salt and brackish water marshes there is no standing water on the site. The Inland Site is drained by the East Branch of Wading River, Oyster Creek and the North Branch of Forked River. There are no standing water bodies on the site other than cedar marshes and open swamps.

There are no major fresh water flooding problems for any of the sites. Water pollution problems are essentially non-industrial wastewater from municipalities, institutions, and federal institutions; runoff containing agricultural chemicals; and, for tidal creeks, changes in the freshwater/saltwater interface.

The surface waters of southern Ocean County are generally of the sodium-potassium type; hardness is moderate, as are suspended sediment concentrations. Annual sedimentation rates average approximately 51 tons per square mile.

Meteorology: The Atlantic Ocean is the main influence on Ocean County's weather. Woodward-Clyde Consultants summarize the meteorology of the area on the basis of data from the National Weather Service Office at Atlantic City:

The climate...can be classified as humid-temperature (sic), with warm and humid summers and relatively mild winters. The moderating influence of the Atlantic Ocean is apparent throughout the year...Consequently temperatures of 90° and higher are recorded three times per year at Atlantic City...(but) about 36 times per year at more inland location...The absolute extremes (of temperature) recorded at the Atlantic City airport were 106°F and -8°F.

The dominant winds are westerlies, varying between west and west-northwest in fall, winter, and early spring. In later spring and summer the prevailing direction is southerly, while in September it is east-northeasterly. The annual average wind speed is 10.8 mph; the frequency of calms (2 mph or less) is 5 percent. Wind speeds are generally greater from January through April. The fastest speed on record is 60 mph with an estimated peak just of 78 mph. Gusts of 130 mph would be expected to recur every 100 years...

The average annual rainfall is 45.5 inches. The precipitation is fairly distributed throughout the year with a minimum monthly normal of 2.99 inches in September and a maximum monthly rainfall was 14.87 inches occurring in August 1882 and the minimum was 0.01 inches in September 1941.⁸

5.3 The Overall Site Selection Process

The location of population and of environmentally-important natural resources acted as the primary constraints on site selection. Use of these two constraints--i.e., keeping the sites as far away as possible from areas of dense population now or during the next few decades, and avoiding, to the extent possible, ecologically important areas--made site selection for such a large facility in Ocean County particularly difficult. In areas where there are few people, such a large site intrudes into coastal marshes, the Pinelands or publicly-owned parks, forests, natural areas, or wildlife refuges. Therefore, despite strong efforts to identify sites which, if not "good", were at least suitable for honest evaluation, each of the three sites chosen poses difficult problems and threatens unacceptable risks and impacts.

The sites were selected through development of a constraints map of scale sufficiently large to allow identification of major features. This map is shown as Figure 5-4. Using the New Jersey Topographic Series sheets for the area,⁹ several locations were evaluated as potential sites. Four general rules were used in the screening process.

1. No site should lie inside a circle with a radius of 8 miles centered in Toms River. The area inside this circle is likely to be intensively developed for residential and commercial facilities during the next two decades.¹⁰

2. The site itself should not contain within its borders any significant levels of population, nor should the area of the site be likely to be developed during the next decade. If an NEC were actually considered for this area, which it is reiterated is not the purpose of this study, land acquisition and initial construction would not likely begin until after 1980.

3. No major transportation routes, in this case highways, should pass through the site.

4. To the extent possible, an acceptable site would not intrude upon sensitive ecosystems

As can be seen from Figure 5-4, application of these criteria almost automatically selected the hypothetical sites for evaluation in this report. However, the criteria had to be modified somewhat to allow for selection of a site

Figure 5-4. Constraints map and site selection.

in each of the three categories previously described. In particular, any good map of the New Jersey coast makes clear that, because of the barrier beaches, the shore of the Ocean County mainland is a bay shore, not an ocean shore. Thus, in finding a site close to the ocean, a bayside site had to be selected, despite the problems this would raise concerning wetlands.

5.4 Characteristics of the Bay Site

The entire bayfront of Ocean County was, at one time, coastal wetlands or marshes of some 37,000 acres in area. Over the past 25 years, 30% of these marshes have been lost to development, and the county's remaining wetlands are regarded as ecologically fragile and important. In the findings section of New Jersey's Coastal Area Facility Review Act (NJSA 13:19-i), the political as well as ecological importance of such wetlands was recognized:

The legislature finds and declares that New Jersey's bays, harbors, sounds, wetlands, inlets, and tidal portions of fresh, saline, or partially saline streams and tributaries and their adjorns upland fastland drainage area nets, channels, estuaries, barrier beaches, near shore waters and intertidal areas together constitute an exceptional, unique, irreplaceable and delicately balanced physical, chemical, and biologically acting and interacting natural environmental resource. . .

Nevertheless, a wetlands, bayside hypothetical NEC site was chosen: the 3,600 acre site in Eagleswood Township in the southern portion of the county shown on Figure 5-5.

Eagleswood Township is a very sparsely settled community (823 people in 16.5 square miles) in the southernmost portion of Ocean County. It is located on the main transportation route along the bayshore, U.S. Route #9, which parallels the Garden State Parkway in Ocean and Atlantic Counties. Above Eagleswood, Route 9 is characterized by strip commercial development, but in Eagleswood this type of land use is infrequent. The town's major center of population is West Creek, located on Route 9, and the center of this unincorporated community is at the intersection of Dock Road and Route 9. The community consists of several commercial buildings, a State Police barracks, and a mixture of moderately-priced seasonal and year-round housing. Much of the housing is built along Westecunk Creek, a tidal waterway flowing through the town.

LONG REA

Of the site's 3,600 acres, approximately 70% are wetlands and the remainder uplands. The site, a rough square, is bordered on the northwest by Route 9, on the southwest by Dock Road, on the northeast by the Eagleswood Township line, and on the east by Barnegat Bay. The community of West Creek lies at the southwest corner of the site.

This site is a typical New Jersey coastal "meadow" or saline wetland. It is characterized by a vegetative community within which salt marsh cord grass (low vigor) (spartina alterniflora) and salt meadow grass (spartina patens) are the dominant types. Together these two types of grasses account for 70% of the wetlands portion of the site. Because of the intrinsic ecological importance of these wetlands, further detailed description seems imperative. Although construction of a single nuclear power plant in coastal wetlands obviously would cause some damage, the massive size of an NEC threatens much greater impact in a sensitive environmental location of this kind.

Under the Wetlands Act of 1970, the State Department of Environmental Protection has mapped and placed under regulation all of the state's coastal wetlands. This act defines wetlands as:

Any bank, marsh, swamp, meadow flat or other low land subject to tidal action in the State of New Jersey. . .including those areas formerly connected to tidal waters where surface is at or below an elevation of 1 foot above local extreme high water, and upon which may grow or is capable of growing some, but not necessarily all of the following (a list of grasses and other vegetation found in wetlands).¹¹

Excerpts from the Basis and Background document prepared by the state D.E.P. to accompany its Wetlands Regulations explain the importance of these coastal wetlands:

New Jersey's estuarine zone, the area between the sea and the land; is unique; it is related to the sea and the land, but it is different from either. The "estuarine zone" is composed of bays, harbors, lagoons, channels, inlets, barrier beaches, sounds, estuaries, WETLANDS (tidal marsh), submerged lands (riparian), tidal portions of many fresh water streams and tributaries, and coastal and intertidal areas. Complex physical, chemical, and biological forces act and interact within this zone and create an exceptional but delicately balanced environment.

Estuaries, those semi-enclosed areas in which the land meets the sea and in which fresh water and salt water mix, are fertile and productive. In New Jersey, WETLANDS adjacent to estuaries yield up to five (5) to six (6) tons of dry organic matter per

year. In comparison, the world average wheat production is only 0.5 tons per acre. The sustained high fertility of WETLANDS depends on many natural factors:

1. The mixing of the waters of different salinities produces efficient vertical mixing that results in nutrient traps. Consequently, valuable nutrients are not swept out to sea but move within the WETLANDS and cycle rapidly between organisms, water, and bottom sediments. . . .

2. Tidal flow is essential to continually supply food, chemical nutrients, and oxygen. Waste products may be removed automatically, and clams, oysters, and other sessile organisms need not waste energy coping with purification processes.

3. In some areas, land drainage from surrounding farmland is rich in minerals and organic material; additional nutrients are added to coastal WETLANDS through runoff from rivers and streams.

Plant life occurs in all WETLANDS as marsh grasses and algae. These plants grow and die. Decay transforms their tissues into minute fragments of food and vitamin-rich detritus. This detritus is suspended in the water and forms a nutritious "soup" that is carried into tidal creeks, bays, and offshore waters. Nearly all species of sport and commercial fish, shellfish, and other marine creatures in the estuarine zone are dependent on this "soup" for food, directly or indirectly.

Marsh detritus is transported back and forth by tidal action into sounds and bays and, eventually, to nearshore waters. This "outwelling" of nutrients and materials into the sea is similar in mechanism and magnitude to oceanic upwellings that support valuable fisheries in various parts of the world. Outwelling provides nutritional materials that may support marine life at long distances from our coast. Thus, there is a continuum from the WETLANDS to the open seas. Some fish that never enter or utilize WETLANDS are dependent on the estuarine zone for the continuous enrichment of their oceanic habitat.

Many aquatic animals feed on WETLAND plants, detritus washed from WETLANDS, and the algae that float in the water and coat marsh and channel surfaces. Other animals, including man, prey on animals that have eaten these plant foods; all, directly or indirectly, derive their energy from WETLAND (estuarine zone) flora.

SALINE WETLANDS, found along the ocean shores of New Jersey, are characterized by very low species diversity. Many zones contain only a single species and occur over large areas.

The most abundant plant species occurring within the reach of daily tidal flow is spartina alterniflora (Saltmarsh cordgrass or Smooth cordgrass). It grows virtually without competition in this region and is an excellent indicator of the extent to which a given marsh is inundated by the sea. . . .

BRACKISH WATER WETLANDS are quite similar to saline marshes; however, they do contain some plant species characteristic of fresh water marshes. These WETLANDS are common along estuaries and tributaries where incoming tidal waters are still saline. . . .

WETLANDS, physically, act as a buffer between the sea and the land; they help protect man. They absorb a portion of wind and storm wave energies, and they provide large storage areas for flood and storm waters. These functions, in turn, reduce mainland erosion rates and lessen social and economic hardships caused by upland flooding and high winds.

WETLANDS are dynamic and everchanging. Storms and winds may rip their turf and, for a time, alter natural drainage and contour; but the marsh is resilient--it survives and adjusts to new combinations of physical forces.

Filling WETLANDS may reduce their capacity to store storm or flood waters. Non-storable storm waters could infringe on neighboring marshes or uplands and cause extensive damage which otherwise may not have occurred.

Developments in WETLANDS are particularly vulnerable to wave and water damage because of their proximity to the sea. Ocean County storm record observations taken in the general vicinity of Mystic Islands, west of Tuckerton, show that Mystic Islands is subject to periodic flooding (Mystic Islands is between 2.1 and 2.5 feet above mean sea level):

DATE	YEAR	WATER HEIGHTS ABOVE MEAN SEA LEVEL (FT.)*
1/26	1932	8.1
9/16	1935	7.3
11/17	1935	8.5
9/30	1943	7.2
10/20	1943	7.7
9/14	1944	11.6 (hurricane)
11/25	1952	9.95
11/7	1953	8.1
1/23	1966	7.0 (at Radio Road Bridge)

* Excerpted from a topographic survey submitted by the Mystic Islands Surveyor.

The WETLANDS constitute an ecosystem. Each plant species or species association is not individualistic or self-sustaining; species interact and are interdependent. This holds true also for the animal life (snails, amphipods, worms, and insects) of the marshes which depend on the plant life. The larger and more evident

animals at the top of the intricate food chain are dependent upon the productivity of the WETLANDS for their survival. Man can easily destroy the delicate balance of the WETLANDS triggering changes which infringe upon and decimate waterfowl populations.

The WETLANDS support wintering, migratory, and summer breeding waterfowl. Brant winter in its brackish bays and adjacent areas; Ducks and Geese migrating along the Atlantic Flyway feed in the WETLANDS. The Mallard and the Black Duck breed in the WETLANDS and even remain in small numbers through the winter. Waterfowl productivity could be seriously depleted if the WETLANDS and their vegetative cover were destroyed or seriously encroached upon by man. During heavy wintertime freezes, certain food organisms of the WETLANDS are inaccessible to fowl, and the birds must forage for food wherever it can be found. Encroachment lessens their chance for survival.

Department of Interior statistics for 1967 indicate that New Jersey's commercial coastal fisheries landed 117 million pounds of seafood having a dockside value of \$10 million. About 3,000 fishermen were employed either full or part time on boats and on the shore. Approximately 2,000 other persons were employed fulltime in seafood wholesaling and in processing plants. The value of processed products has been estimated to be near \$30 million.

About two-thirds of the commercial fish catch on the Atlantic Coast is believed to be WETLANDS (estuarine)-dependent (McHugh 1966). Department of Environmental Protection studies in the Great Bay-Mullica River estuary tend to confirm that many finfish species, at some stage in their life cycle, utilize estuarine waters. At Cape Horn, Great Bay, thirty-one species of fish were taken over a year's time; the Bay Anchovy was most abundant, Silversides were second, and other seined species included the Silver Perch, Northern Pipefish, Northern Puffer, Winter Flounder, Red Hake, and Black Sea Bass. The fisheries yield from the U.S. Atlantic Continental Shelf has been estimated to be equivalent to about 535 pounds per acre of estuary (Stroud). Loss of estuarine habitat could cause substantial losses of fisheries products to those dependent on high sustained yields for their economic well-being.

WETLANDS are ecosystems and are integral to larger estuarine zone ecosystems. WETLANDS support plant species and species communities which are in dynamic but delicate balance. The biophysical environment determines that balance. This complex environment is subject to and is shaped by those natural, physical, chemical, and geological principles governing the tides, ocean currents, coastline slope, climate, river flows, and sedimentation patterns. The object of the proposed order is to control man's impact on this complex environment and on the WETLANDS themselves so that these vital lands can continue to serve man and nature.¹²

About three-quarters of the land area of the hypothetical Bay Site is a mapped and regulated coastal wetland. These are not the most valuable type of wetlands in the state. Only about 15% of the land supports the most biologically productive vegetation, high vigor Spartina Alterniflora. The land has been ditched for mosquito control, thus altering the flow of water through the site and decreasing its productivity. Nevertheless, the Bay Site still must be considered a valuable wetlands.

A recent communication from the Fish and Wildlife Service of the Department of the Interior describes the importance of this particular wetland:

The 4000 acre Little Egg Harbor Division was purchased in the Fall of 1974 at a cost of \$1.4 million for the purpose of protecting and preserving high quality tidal marsh for migration and wintering habitat important to Atlantic brant and black ducks. . . .The land was acquired by the Nature Conservancy in early 1974 and held for resale to the Service when funds were available later in the year.¹³

Were this site actually considered for an NEC, several troublesome issues would arise; these same issues (except for the ownership question) would arise over the use of any New Jersey wetlands for this purpose.

There are about 200,000 acres of wetlands in New Jersey. Twenty years ago there were about 263,000 acres. The wetlands within the Bay Site represent 15% of the remaining coastal marsh in Ocean County. Conversion of wetlands to lagoon development, dredge spoil disposal areas, highways, and garbage dumps during the 1960's threatened the integrity of the estuarine ecosystem not only objectively but subjectively. A constituency of concerned citizens and public officials exists for wetlands in New Jersey, and any proposal to actually convert the Bay Site to an NEC would meet strong resistance from this large and vocal group.

An NEC located on wetlands would have only one benefit; closer to the sea than a more inland site, the cost of providing ocean cooling water to the facility would be reduced. In contrast with this advantage, there are many drawbacks. The site would have to be completely filled, perhaps partly with the spoil derived from the tunnels to be used for cooling water. The Bay Site probably would have to be filled to a height of 10 to 12 feet above its present grade to avoid periodic flooding from hurricanes. The filling operation would,

of course, kill all vegetation on the site with damaging effects on-site in terms of loss of wildfowl area, and off-site in terms of reduced nutrient flow to the estuarine system. It would also alter drainage from the uplands, perhaps with adverse consequences for neighbors. Finally, tidal or hurricane-induced flooding would displace substantial amounts of water onto adjacent properties.

Potential mitigating measures exist for some of these adverse consequences. Careful engineering practice could reduce or eliminate the adverse effects of altering drainage patterns. The effect of displacement of flood waters could conceivably be reduced by diking adjacent property, but the diking itself would have adverse environmental impacts. The loss of nesting area and of nutrients caused by filling could also be mitigated. In recent years, techniques have been developed to build new marshes; these techniques have been used experimentally in Chesapeake Bay. They involve filling an area of open water with clean dredge spoil. Filling would be to a level just above the mean high water line. Seedlings of the proper grasses--spartina alterniflora and spartina patens--would be planted and nurtured on the fill. Over time, such an artificial marsh could conceivably replace the habitat and nutrient flow destroyed by the filling of a wetlands site for an NEC. The practicality of this approach depends upon the availability of a body of water for filling without loss of shellfish, boating, or other water recreation activities.

To summarize this discussion, wetlands pose special and conceivably insurmountable difficulties for the Bay Site hypothetical NEC location. Location on wetlands would require the complete despoliation of the natural features and values of the marsh. The filling of the marsh would have adverse effects on the site, and off-site as well. The active, vocal constituency for wetlands in New Jersey would contest any conversion of wetlands at the scale required for an NEC.

During the site selection phase of this study, investigation of property ownership in the Bay Site area indicated that until recently wetlands and uplands had been in the hands of land developers and speculators. Because of New Jersey's Wetlands Act, however, it appeared that development would not be taking place in the wetlands portions

of the site. In 1974, in fact, the wetlands portions of the site were acquired by the Fish and Wildlife Service, U.S. Department of the Interior, as a wildlife refuge. This change of ownership does not, of course, alter the ecological value of the lands, but would pose certain additional institutional obstacles to converting the land to an NEC. Those sections of the site in private ownership could probably be acquired for about \$1500 to \$2500 per acre.

5.5 Characteristics of the Inland Site

The hypothetical site for an NEC with mechanical draft cooling towers is located in central Ocean County in portions of Lacey, Union, and Ocean Townships (predominantly in Lacey). The center of the site is about 12 miles from the surf line. This region has been the most rapidly developing in the New Jersey coastal area, principally as an outer-ring suburb of the New York metropolitan region. To date most of this rapid development has occurred east of the Garden State Parkway.

This hypothetical site is located west of the Parkway and is approximately 40 square miles (25,600 acres) in area. Figure 5-6 is a map of the Inland Site and its environs. It is bounded on the east by the Garden State Parkway, on the south by State Route 72 and County Road 532, on the west by a line running generally north by north-northeast from a point on Route 72 about 7 miles from the Parkway, and on the north by a line running easterly from a point about 6 miles north from its beginning on the western border.

The site, to the extent discernible from aerial photographs with a scale of 1:24,000, contains only one settlement of about 20 buildings. Much of the site is held by land developers or speculators in relatively large parcels, some of more than 3000 acres.

The Inland Site consists entirely of pinelands and associated stream corridors. The pinelands, also called the Pine Barrens, are a special and unique part of New Jersey, not only environmentally but politically and socially as well. John McPhee put it this way: "A visitor who stays a while in the Pine Barrens soon feels that he is in another country, where attitudes and ambitions are at variance with the national norm."¹⁴ New Jersey's pinelands cover almost 2000 square miles. Much of the area remains undeveloped, including significant portions in the state-owned

Figure 5-6. The inland site and environs.

Wharton Tract (a forest and water reserve area), Lebanon State Forest, Greenwood Forest (a fish and wildlife management area), and the Colliers Mill Game Preserve. Essentially all of Ocean County west of the Parkway, including the hypothetical Inland (and Fort Dix) NEC sites, lies in the pinelands.

In addition to its indigenous and unique vegetation, the pinelands area is important as a headwater for streams flowing to the Delaware River in the west and the Atlantic Ocean to the east. These streams are pure, as no (or very little) development exists along them. They transport to the sea about half of the annual 45 inches of rain that fall on the area.

Almost 11 trillion gallons of potentially potable water is estimated to lie in the aquifers beneath the pinelands. The hydrologic cycle and the vegetation of the pinelands are closely linked. Extensive portions of the areas are dominated by a fire ecology, which results from rapid drainage of water through the upper levels of the Cohansey formation. The rain is increased in acidity (to about pH4) as it passes through the soil, leaching out the decomposed soil nutrient. Because of this leaching action, dry plant remains accumulate on the surface of the ground and provide kindling for the fires which frequently sweep the area. The dwarf pine trees which dominate the plains section of the pinelands just to the west of the hypothetical Inland Site are overrun by fire every six to eight years. Indeed they are dependent on these fires for reproduction, since the heat of the fire explodes their cones and spreads their seeds.

In the lower portions of the pinelands the water table lies near the surface, and swamps exist along stream corridors. Hardwoods and cedar stands predominate. Particularly important here are the stands of white cedar,¹⁵ which serve an important ecological function:

The dense cedar swamps of southern New Jersey are excellent deer wintering areas providing quality cover and food. . . White cedar areas serve as habitat for a number of rare and endangered species of plants and animals of New Jersey. Such rare plants as the Broom Crowberry, Sand Myrtle, Turkey Beard, and eight uncommon varieties of orchids have been reported. . . White cedar stands can cause modification of their environment, a "microclimate" effect. These trees transpire water into the atmosphere, cooling hot summer air and also protect against soil freezing. . . . Cedar swamps also impede the flow of storm water run-off thus smoothing out abrupt changes in stream flow and flooding.¹⁶

Two well-defined phases of vegetation exist in New Jersey's pinelands: lowland types and upland types. The Inland Site is characterized by both of these phases in nearly equal proportions, with the lowland type slightly predominant (perhaps 55 percent).

The lowland type of vegetation is concentrated in two areas of the site and is characterized by the pitch pine forest, consisting of a tree canopy which is almost exclusively pitch pine, averaging a height of approximately 15 to 20 feet off the ground. Over 20 kinds of shrubs may be found in the undergrowth, the most prominent of which are black huckleberry, sheep laurel and dangleberry. Sheep laurel is by far the most common. The pitch pine forest is known for an exceptionally well-developed herbaceous layer. Turkey beard is the most typical species; wintergreen and bracken fern are also common, and more than a dozen other species appear with great frequency.

Upland vegetation covers the remaining 45 percent or so of the Inland Site. Two major associations of upland vegetation are to be found: the pine-oak forest and the oak-pine forest. The pine-oak forest covers approximately 10% of the entire territory of the site, the oak-pine approximately 35%.

In the pine-oak forest, 10 to 20% of the trees are black oaks, or, in small areas, scarlet, white or chestnut oaks. Blackjack oak may also be quite common. The canopy of this forest is approximately 35 feet tall. The oak-pine forest usually has fewer trees per acre than the pine-oak forest. Black oak is predominant, but white oak, chestnut and scarlet oaks may be prominent as well. These trees have canopies ranging from 35 to 50 feet in height.

The lower layers of the upland forests are much less diverse than those of the lowland forests. Undergrowth in these upland forests is very uniform, averaging from 1 to 2 feet tall and changing only slightly from one upland forest to another. Lowbush blueberry and huckleberry are the most common species of shrubs. Scrub oak (or bear oak) is also typical of these upland forests, ranging from 3 to 15 feet in height.

In summary, the Inland Site is characterized by an almost even division between lowland and upland forms of vegetation. The lowland type occurs in two separate areas within the site, one in the northwest corner and the second

principally in the eastern and central sectors. Oak-pine vegetation of the upland type dominates the southern and western parts of the site, in a narrow band running southwest to northeast. The remainder of the vegetation to be found within the site is coastal marshland in the northeast corner.

There is also a significant intrusion of interior wetlands into the Inland Site. Oyster Creek, the South, Middle and North Branches of Forked River, and Factory Branch Creek all have their headwaters within the Inland Site's borders. The Southeast corner of the site also touches a small portion of the stream corridor of the East Branch of the Wading River. All these streams flow into the bay, and stands of white cedar may be found associated with them. Because of these streams, an NEC at the Inland Site could also have adverse effects on coastal wetlands. The viability of coastal marshes is dependent upon a balanced flow of water: freshwater from uplands, salt or brackish water from the bay. Unless carefully planned, construction work at the Inland Site could alter freshwater flows to Barnegat Bay and the coastal wetlands in a manner injurious to the viability of these marshes.

The vegetation found on the Inland Site, like all vegetation to be found within the pinelands, is subject to the frequent fires which sweep the area, and represents species which are readily adaptive to this environmental condition.

It is expected that the animals found at the Inland Site will exhibit similar population densities found elsewhere throughout the region where similar environmental conditions exist. Likewise, the fauna to be found at this site will probably reflect pinelands characteristics; namely, a rich variety and abundance of insect life, an abundant but small variety of birds, a healthy variety and distribution of mammals, and a fish population which is neither diverse nor healthy in size. The variety of fauna in this area easily may be richer and more complex due to the presence of marshland in addition to the two major types of vegetation, as well as the greatest (though still modest) altitude fluctuation to be found anywhere in the pinelands.

The environment at the hypothetical Inland Site would pose a complex set of difficulties in siting an NEC. Thorough examination would be required to determine if sound engineering practices exist to mitigate or avoid potential adverse effects on streams from construction activities of the scale envisioned in their headwater areas. Ground water protection would also pose problems.

There are issues beyond the troubling questions of what happens to the groundwater resources and to downstream flooding conditions from paving over significant land areas in headwaters. What will be the effect on water quality, particularly its chloride content, from salt blowdown of cooling towers? What steps would be taken to prevent leakage of radioactive materials into the groundwater in case of an accident? Forest fires pose a special danger in the pinelands. What steps would be taken to mitigate whatever dangers may arise to an NEC from a massive forest fire? Will it be possible to locate the individual plants within an NEC so as to protect fragile or unique types of vegetation during construction? Presumably the entire NEC would be fenced in. What steps would be taken to manage deer and other species inside the fences?

Special difficulties would arise in terms of obtaining title to land at the Inland Site. In the twenties a number of newspapers gave deeds to small plots of the pinelands as a premium for subscription. Clear title to this land would be difficult to obtain in many locations. As McPhee relates:

In every decade for more than a century, there have been men of vision who could see...urban skylines in the pines...The long succession of instant paradises has made the Pine Barrens the scene of what is perhaps the country's only permanent non-existent land boom. Over the years, more than a million people have bought or otherwise acquired lots in the Pine Barrens on which no houses have ever been built...In the Depression, deeds to lots in the Pine Barrens were given away as door prizes at movie theatres and to purchasers of encyclopedias. In many areas of the Pine Barrens, titles are so cloudy that about twelve thousand acres of the woods are virtually a no man's land.¹⁷

There is a constituency for the Pine Barrens, and, moreover, parts of this Inland Site also include portions of the area under jurisdiction of the Pinelands Environmental Council, which is dominated by agricultural¹⁸

and environmental interests. Portions of a state park (Greenwood Forest) are included in the site, but it would be permissible to redraw the boundaries around these areas if necessary.

Route 539 passes through this site. Approximately ten miles of new road might have to be constructed to route it around the southeastern corner of the site. At a cost of \$2.5 million per mile (Characteristics of Urban Transportation, May 1974), the rerouting would cost around \$25 million. Inflation, type of road, and terrain would cause deviations from this figure. Land within the site, held in large parcels by developers and speculators, has assessed values of approximately \$1000 per acre. Sale prices would be considerably higher, perhaps \$3000-\$5000 an acre or even more. For the 40 square miles involved, a purchase figure of about \$100 million could be assumed.

An NEC at the hypothetical Inland Site, whatever the care with which it is designed, would be a massive, negative intrusion into the area. Creating a buffer zone around the facility might compensate to some degree for lost natural areas of the pinelands within the site itself.

5.6 Characteristics of the Fort Dix Site

This site also consists of pinelands, although its natural values already have been modified in many places by military construction and activities. The site is located in Jackson, Plumstead and Manchester Townships and consists of those lands in Ocean County now within the Fort Dix Military Reservation and the Lakehurst Naval Air Station (sections of Fort Dix in Burlington County, and all of McGuire Air Force Base, are excluded from the NEC site). Actual use of this site would require transfer of these two military uses to other locations. Lakehurst is now the largest employer in Ocean County, with 5,600 people working there.

Located in the sparsely settled northwest section of Ocean County, the Fort Dix Site is more removed from Ocean County's population centers, but is much closer to major cities such as Trenton (16 miles) and Philadelphia (25 miles). Figure 5-7 shows the site and its environs.

Two main roads pass through the site: Routes #539 and #70. Route #539 could be moved just around the northeast corner, 1000 yards from its present course. In moving Route #70, it would be most economical to connect it at one point with an existing road, Buckingham Road. If it were to split off from

Figure 5-7. The Fort Dix site and environs.

its present path in the Lebanon State Forest and go east until joining with Buckingham Road, which becomes Whiting Road, and there going north on 539 to rejoin 70, only 4 1/2 to 5 miles of new road would have to be constructed. This would cost about \$12 million. If an entirely new stretch of road were preferred (which would, of course, be more damaging to the environment), 8 or 9 miles of new road would have to be constructed at a cost of some \$20 million.

The headwaters of Rancocas Creek, which flows into the Delaware River, lie within the Fort Dix Site.

5.7 Population Proximity and the Three Sites

The issue of population proximity to these three hypothetical NEC sites has been deemed of sufficient importance to the overall formulation of public policy with respect to nuclear energy clusters that it is assessed in some detail in a separate chapter (XIX). Nevertheless, it may be useful to present here some summary data on the population issue.

Table 5-3 presents data on the 1973 population in each of the 13 Ocean County municipalities in which the NEC would be located, or which are immediately adjacent to one of the three sites. As shown, a total of 150,750 people reside in these jurisdictions. Differences between the Bay Site (about 10,000), Inland Site (about 40,000) and Fort Dix Site (about 130,000) are immediately apparent.

Another perspective on population proximity is provided in Table 5-4, which shows the results of our counts of population (interpellated from dwelling units) in concentric circles around the three NEC sites, regardless of municipal boundaries. Differences in the numbers of people within a given range at each site vary considerably. The Inland Site is lowest at 2.5 and 5 miles, Bay Site is lowest thereafter. The Fort Dix Site consistently ranks highest in population proximity at all five ranges from 2.5 to 30 miles.

TABLE 5-3

POPULATION PROXIMITY AND AN OCEAN
COUNTY NEC IN SUMMARY,
BY MUNICIPALITIES
(1973 data)

BAY SITENEC Location

Eagleswood Twp.	855
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Adjacent Municipalities

Little Egg Harbor Twp.	4,355
Stafford Twp.	<u>4,330</u>

<u>Total</u>	9,540
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INLAND SITENEC Location

Lacey Twp.	7,285
Ocean Twp.	2,620
Union Twp.	2,240

Adjacent Municipalities

Stafford Twp.	4,300
Manchester Twp.	11,570
Berkeley Twp.	<u>11,685</u>

<u>Total</u>	39,730
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FT. DIX SITENEC Location

Plumsted Twp.	4,465
Jackson Twp.	20,285
Manchester Twp.	11,570

Adjacent Municipalities

Lakehurst Boro	2,940
Dover Twp.	48,895
Lakewood Twp.	29,205
Berkeley Twp.	<u>11,685</u>

<u>Total</u>	129,045
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TOTAL POPULATION, AFFECTED MUNICIPALITIES:	<u>150,750*</u>
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* Double-counting avoided when a municipality appears more than once.

Source: New Jersey Department of Community Affairs, Thirty-Sixth Annual Report of the Division of Local Government Services, 1973.

TABLE 5-4

POPULATION PROXIMITY AND AN OCEAN COUNTY NEC,
BY CONCENTRIC CIRCLES*

(1970 data)

	<u>2.5</u> <u>miles</u>	<u>5</u> <u>miles</u>	<u>10</u> <u>miles</u>	<u>20</u> <u>miles</u>	<u>30</u> <u>miles</u>
Bay Site	2,250	5,554	16,885	33,079	227,540
Inland Site	500	1,450	24,981	103,732	314,460
Ft. Dix Site	3,100	13,700	43,000	436,000	3,070,100

* See Chapter XIX for details.

NOTES TO CHAPTER V

1. Ian McHarg, Design With Nature, Garden City; Natural History Press, 1969, p.12.
2. "Oyster Creek Nuclear Generating Station, Environmental Report" Jesrey Central Power and Light Company.
3. Ibid., at 2.4-7.
4. Anderson, H.R. and Appel, C.A. "Geology and Ground Water Resources of Ocean County, New Jersey" (1969), State of New Jersey Department of Conservation and Economic Development, Special Report Num. 29.
5. "Oyster Creek...Environmental Report," note 2, supra.
6. Ibid.
7. North Atlantic Regional Water Resources Study, Appendix L." (1972 Corpsof Engineers, U.S. Army.
8. Woodward-Clyde Consultants, "Mid-Atlantic Regional Study" October 1975, p. 291-293.
9. State of New Jersey, "Topographic Series", sheets 28, 29, 32, and 33, original survey 1880-1883 and revised periodically. Scale is 1 mile to the inch.
10. See Rivkin Associates, Guiding the Coastal Area of New Jersey, February 1976, p. 58-66.
11. NJSA 13:9A-2.
12. NJDEP, "Basis and Background of New Jersey Wetlands Order."
13. Letter dated April 19, 1976 from Acting Regional Director, U.S. Fish and Wildlife Service, to David Morell, Center for Environmental Studies, Princeton University.

14. John McPhee, The Pine Barrens, New York: Farrar, Strauss and Giroux, 1969, p. 55.
15. Rivkin Associates, note 10, supra, p. 17.
16. Richard A. Kantor, "The Value of Atlantic White-Cedars, chamaea japonica thyodes, to New Jersey," Department of Environmental Protection, 1976, p.4-6.
17. McPhee, note 14, supra, p. 147-148.
18. Cranberry and blueberry growers.

CHAPTER VI*

WATER RESOURCE CONSTRAINTS AND COOLING METHODS

6.1 Introduction

Choice of cooling technology lies at the heart of an environmental assessment of an NEC. Not only the primary environmental impacts, such as temperature and salinity changes, but also indirect impacts on the biota resulting from these primary, physical impacts, follow directly from the choice of cooling technique. Similarly, many of the atmospheric impacts follow from the choice between once-through, evaporative or dry cooling.

Alternatively, certain environmental standards may preclude certain cooling technologies, and the severity of such constraints may well extend to complete rejection of an NEC at a particular location on grounds of unacceptable environmental impact or excessive cost to achieve environmentally-responsible cooling.

Two major water supply considerations constrain the cooling choice at the hypothetical sites in coastal New Jersey. The first concerns once-through cooling, wherein the major limitation is the amount of dilution available to maintain the mixed cooling water discharge within acceptable excess temperature limits. Dilution in an estuary or a bay is a function of the fresh water inflow, mixing due to tides, and circulation due to salinity or density gradients. These factors can be estimated from the properties of the observed salinity distribution. The effect of the additional evaporative water loss on salinity distribution throughout the estuary also must be examined with once-through cooling. Compensation for the potential increase in salinity can be made by an increase or augmentation of the fresh water inflow.

*Prepared with the assistance of John Edinger, J.E. Edinger Associates Inc., and Frank Moore, Department of Mechanical Engineering, Cornell University.

The second limitation applies to evaporative cooling, and is concerned with the point demand of consumptive water use. In an inland, freshwater context the evaporative cooling losses create concern for water quantity, whereas in an estuarine or coastal context, concern focuses on the resulting salinity changes (to which many ecosystems may be as sensitive as to temperature changes). The potential increase in salinity due to evaporative or "wet" cooling can again be compensated for by an increase or augmentation of the freshwater inflow into the estuary, or by treatment of the cooling tower blowdown for removal of the excess salt.

One can readily estimate the quantitative effect of such constraints by use of the appropriate physical relationships available in the technical literature. Thus we shall examine: (1) the upper limit to once-through heat rejection; (2) the additional or augmentation flow required to balance the potential change in salinity due to once-through cooling evaporation; (3) the consumptive water loss that must be provided for with on-site evaporative cooling; (4) the percent increase in salinity at the site if no compensation is made for the evaporative water loss; (5) the augmentation flow required to balance the salinity change due to on-site cooling; and, alternatively, (6) the amount of salt removal or blow-down treatment required to maintain the natural salinity. These quantitative estimates then provide the background for the proper choice of cooling technology.

6.2 Analysis of Barnegat Bay

Barnegat Bay has a limited fresh water drainage area for fresh water inflow and is connected to the ocean through Barnegat Inlet. As shown on Figure 6-1, the salinity profile indicates ocean salinities in the vicinity of the inlet and little upstream dilution of ocean salt. Some of the dilution may be provided by ground water infiltration to the bay. For purposes of this comparative analysis, the fresh water inflow of $5.1 \text{ m}^3 \text{ s}^{-1}$ is assumed to be concentrated at the head of the bay. The estuarine characteristics of the bay are summarized on Table 6-1.

Eight cooling options might realistically be considered, as indicated schematically on Figure 6-2. Note that at this point, we need not be

Figure 6-1. Barnegat Bay salinity profiles.

concerned with the distance of the NEC from the bay, and thus the options indicated apply to all three hypothetical sites.

Alternative A, once-through cooling discharging to Barnegat Bay, must be rejected on grounds of inadequate heat capacity, even if flow augmentation could be provided for salinity control. The maximum allowable heat rejection rate, based on a 1.5°F excess temperature rise, is 1200 MW (t), about equivalent to the Oyster Creek plant presently operating on a tributary to the bay.

Indeed, none of the evaporatively cooled alternatives that would rely on Barnegat Bay, plus flow augmentation, prove to be feasible. There appears to be no available surface freshwater sources to provide either freshwater makeup (Alternative G) or salinity control flow augmentation (Alternative B). The nearest sources of sufficient freshwater would be the Delaware River, 75 Km distant, or the Susquehanna River, 150 Km distant. Quite apart from the conveyance cost involved, use of either of these rivers to provide consumptive water for use by a coastal NEC seems quite unlikely. Use of the Pinelands Aquifer as a makeup source also would seem to be out of the question. One might, however, consider the possibility of some innovative schemes of multi-purpose benefit, including, perhaps, use of secondary sewage effluents for cooling water makeup, or other forms of multi-purpose system.

The other options for evaporatively-cooled systems with blowdown discharge to the bay, Alternatives C and D, are dependent on blowdown treatment;

TABLE 6-1

COMPARISON OF REQUIREMENTS FOR ONCE-THROUGH
COOLING AND ON-SITE EVAPORATIVE COOLING FOR BARGEGAT BAY

1. Estuarine Properties

a. Fresh water inflow, $m^3 s^{-1}$	5.1
b. Cross-sectional area, m^2	18.2×10^3
c. Longitudinal Dispersion Coefficient, $D m^2 s^{-1}$	7.2
d. Distance from mouth to plant, Km	7
e. Distance from mouth to river, Km	25
f. Ocean or bay salinity, $kg m^{-3}$	

2. Once-Through Cooling

a. Fully mixed temperature limit $^{\circ}C$	$083.0^{\circ}C (1.5^{\circ}F)$
b. Maximum allowable heat rejection rate MW(t)	1,200
c. Maximum plant size, MW(e)	600
d. Augmentation flow required to maintain salinity $m^3 s^{-1}$	0.08

3. On-Site Evaporative Cooling

	Plant Size, MW(e)		
	600	10,000	20,000
a. Heat rejection rate, MW	1200	20,000	40,000
b. Consumptive water loss, $Q_w m^3 s^{-1}$	0.50	8	16
c. Percent increase in salinity	<1%	<1%	<1%
d. Augmentation flow required to maintain salinity $m^3 s^{-1}$	0.15	2.4	5
e. Salt removal at blowdown to maintain salinity $kg s^{-1}$	16	250	510

Figure 6-2. Cooling configurations.

however, this option proves to be prohibitively expensive. Of the remaining options, we are inclined also to reject Alternative H, which would take water from the bay but return the blowdown to the Ocean. At full capacity, even an evaporatively cooled NEC would incur a 600 cfs evaporative loss,¹ and, on the assumption of a concentration factor of 1.45, require a make-up flow of some 1933 cfs. Withdrawal of this quantity of water from Barnegat Bay would not only significantly alter circulation patterns, especially at low tide, but would be likely to change the salinity profile to an environmentally unacceptable extent.

One is led, then, to the inescapable conclusion that only two cooling options would be available to an NEC in Ocean County: (1) evaporative cooling that communicates with the ocean for both make-up and blowdown (Alternative F); and (2) once-through cooling that used ocean water with discharge some miles offshore (Alternative E). Since much of the Atlantic coastline has barrier islands separated from the shoreline by shallow bays quite similar to the situation in Ocean County, one would expect these conclusions to be quite typical of many potential NEC sites all along the Atlantic Coast.²

6.3 Cooling Technology Choices and their Environmental Impacts

Evaporative Cooling:

Of the various options for evaporative cooling using ocean water, several technologies can quickly be dismissed. On-site cooling ponds appear quite unlikely and an order of magnitude calculation shows a land requirement of some 25 square miles.³ Aside from the fact that this would represent a drastic land use change over much of the area of the NEC, several water resource problems call for rejection of this option. First, since evaporation is the major heat dissipation mechanism even in a cooling pond, a source of make-up water still would be required. In a coastal region, this cannot generally be available from any underlying aquifer, for reasons of salt-water intrusion. In the New Jersey case, the aquifer represents one of the highest quality water supply sources in the state, for which use as a cooling pond water make-up is hardly appropriate. Moreover, the pond would need to be lined in order to prevent leakage of saltwater into the aquifer. Finally, since a cooling pond might be operated at as much as 50°F. above ambient temperature, and since the make-up would necessarily be saline, the pond would represent a rather hot brine in summer, and be plagued by problems of supersaturation

and salt deposition in winter. In view of these difficulties, the saline cooling pond option must be rejected.

Spray canals or ponds are another option now in use at some large generating stations which might, conceivably, be considered for a coastal NEC. According to one estimate, the land requirement for spray ponds is between 50 to 100 acres per 1000 MW(e)⁴ or some 1000 to 2000 acres for the entire NEC. This is considerably less than for cooling ponds. However, the major objection is salt drift, estimated to be about 5 times that of evaporative cooling towers.⁵ As we shall note below, the impact of salt drift from even the best designed evaporative tower is of some concern, and for this reason we would reject spray ponds from further consideration.⁶

Choice among the remaining alternatives is governed not only by relative cost, but by the trade-offs between the secondary environmental impacts of the different tower types. Of concern in this regard are visual impact, of the towers themselves as well as of the distant visibility of plumes and the possibility of significant sunlight reductions, salt drift, noise, land consumption, and other ecosystem impacts.

In assessing the degree of visual impact (see Chapter X), the number and size of towers that might be required is of some interest. For natural draft evaporative cooling towers, Dickey and Cates indicate that the Marley tower of 400 feet height designed for Chalk Point would handle a heat load of 3.9×10^9 Btu/hr.⁷ Thus, one would need 8 such towers per cluster of four reactors, or 40 for the entire NEC. The base diameter of each tower would also be about 400 feet. Mechanical-draft towers are much lower--about 50 feet, and occupy about 1 square ft/kw, or about 120 acres per 4.8 Gw cluster. The mechanical tower, then, has a much smaller visual impact than natural draft towers.

The issue of plume visibility is more difficult. The main NRC report addresses this question in some detail, together with associated questions of fogging and icing in the vicinity of the towers.⁸ The difficulty is that experience in the United States is limited to cooling tower clusters of four or less, although the lessons of the European experience with larger clusters are, of course, appropriate. However, because individual clusters would be spaced at about 2.5 miles distance from each other in order to guard against

the possibility of more serious meteorological impact resulting from the concentration of heat and water vapor discharge, the likelihood of plume coalescence is probably reduced. Indeed, one should point out that the issue of atmospheric impacts remains the major area of environmental uncertainty regarding energy centers--as opposed to other issues such as water and land impacts, for which current methodologies appear quite adequate to make reliable predictions of impact. This uncertainty has probably the greatest impact on the New Jersey surrogate site, since the economy at this location is most dependent on recreation. Here questions surrounding the uncertainty of atmospheric impacts would likely constitute some of the more serious objections to implementation of the NEC concept in New Jersey. No one, at the present time, can be absolutely sure that persistent, coalescing plumes affecting sunlight conditions over the beaches would not occur, although the evidence and prudent engineering would make this an unlikely event, especially in summer when weather conditions would be least likely to cause severe fogging. However, the very possibility of the event, however small the probabilities are judged to be on the basis of engineering calculation, would likely induce vigorous opposition to an NEC from the recreation industry. It is thus for this reason that dry cooling (or wet-dry hybrid towers),⁹ or indeed once-through cooling, merit serious consideration.

In terms of quantitative analysis, the only available estimates of plume incidence are those made in connection with the Forked River Unit No. I, a 1100MW(e) nuclear unit proposed for a site adjacent to the existing Oyster Creek Plant.¹⁰ Ground level fog was estimated as occurring 155 hours per year, of which only 26 hours would be expected in the three summer months (June, July, and August). Long visible plumes were estimated as occurring on average of 825 hours per year, of which 56 hours might be expected to occur in the same summer months. Thus, the visibility of plumes during the most sensitive summer months would be expected only 2.5 percent of the time. Although this is a rather small impact, the conclusion that a 20-unit NEC would exhibit a similar frequency of visible plumes in the summer months is somewhat questionable because of the possibility of interactive effects.¹¹

The other issue at saltwater cooling towers concerns drift. Again the study that applies most directly to the potential NEC sites in Ocean County is that conducted for Forked River Unit 1.¹² Figure 6-3 shows the measured

Figure 6-3. Ambient sea salt concentration as a function of distance from the shore. Source: Cooling Tower Environment 1974, note 10, p. 534.

level of airborne salt concentration as a function of the distance from the shore; stations 7 and 8 correspond roughly to the locations of the Inland and Fort Dix hypothetical sites. We note that the sharp concentration gradient experienced at the coast falls rapidly to a flat gradient further inland, from which follows that natural salt levels appear to be little different at the two evaporatively cooled NEC sites.

In a computer analysis the average annual air concentrations of salt from the Forked River cooling tower were superimposed on natural sea salt concentrations, as illustrated on Figure 6-4. Inspection of this figure allows a number of interesting conclusions. First, because of prevailing wind patterns, maximum salt concentrations due to the towers tend to occur to the east of the tower location; but natural salt concentrations also increase to the east with decreasing distance to the ocean, which makes the relative impact of the tower contribution less than the position of the tower might otherwise suggest. On the assumption that concentration levels are linear, the impact of the 20-unit NEC might be extrapolated by multiplication of the data shown by 20; this would suggest that in the due west direction, salt concentrations from the towers might double the natural rate for some distance. However, because of the interactive effect, and likely increases in plume bouyancy, salt would tend to be dispersed over much greater distances than this linear extrapolation would suggest, implying a smaller relative effect but spread over a greater area. However, recent advances in cooling tower design have drastically reduced drift rates from both natural and mechanical draft tower designs, in some cases by as much as an order of magnitude since the Forked River computations were made.¹³ Making these adjustments, the data shown on Figure 6-4 might thus well be a not unreasonable picture, albeit optimistic, of salt concentrations from a 20-unit NEC at the Inland Site location, using the most recent technology. However, it is quite clear that only detailed quantitative analysis, free from any such debatable assumptions, can really answer the salt drift questions in an adequate manner.

Airborne salt concentration, moreover, is only an incomplete characterization for purposes of assessing the environmental impact, for which the deposition rate is of more consequence. However, it is important to differentiate between the two distinct mechanisms by which deposition actually occurs;

Figure 6-4. Comparison of predicted average annual air concentrations of salt from Forked River Unit No. 1 cooling tower with that from the sea. Figure produced by computer but has been relettered for clarity. Source: Cooling Tower Environment 1974, note 10, p. 531.

dry deposition by vertical fall, and wet deposition by "washout" from rainfall. Moreover, although studies have shown that the dry deposition of salt, due to gravity, is only some 25 percent that due to rain,¹⁴ it is generally acknowledged that salt deposited by rainfall tends to be washed from the leaves of vegetation and diluted into the soil. Thus dry deposition may be more important from the environmental impact standpoint.

Once-Through Cooling:

For the once-through cooled option, estimates of dilution available approximately 3 km offshore based on the coastal circulation model of Stommel and Leetma¹⁶ indicate a capacity of 100Mw of waste heat per km of shoreline per °C of fully mixed excess temperature. For an NEC of 20 Gw(e) with 40,000 Mw of waste heat, a 1°C allowable fully mixed temperature thus would require a diffuser outfall some 25 km in length.

Detailed analysis would show some interesting trade-offs; obviously the further out the diffuser, the greater the length of tunnel or conduit that is necessary. Yet, due to the slope of the seabed, greater distance from shore implies greater depth, which in turn means a shorter diffuser to meet given temperature excess at the surface. On the other hand, heat diffusion might be promoted by longshore currents nearer the shore. Although time and resources have not allowed a detailed examination of diffuser design, one likely choice would be multi-port diffusers parallel to the coast.¹⁷

Proper diffuser design would result in environmental impacts no greater than those projected for the off-shore Atlantic Generating Station (AGS). However, whatever impacts are identified for the AGS obviously would be more widespread, given the circumstance that 10 times the amount of water would be withdrawn and returned in the NEC case. Extensive studies have been conducted on the likely impacts of the Atlantic Generating Station,¹⁸ to which the reader is referred for more detailed discussion. Only field examinations of a similar scale could yield any additional information on the impact of an NEC, investigations certainly beyond the scope of this study. However, we see no reason why proper engineering design of diffuser system could not meet current temperature standards in the Atlantic Ocean, though costs might be quite high.

Cooling Technologies and the Three Sites

In assessing the environmental impact of the various NEC alternative in other sections of this report, we shall restrict each NEC location to a single

cooling technology. The three sites allow us to examine the different advantages and disadvantages of the three cooling alternatives: once-through cooling, and natural draft and mechanical draft evaporative cooling towers.

The Bay Site is assumed to have once-through cooling; in view of the high cost of water transmission (to be documented in the next chapter), this is the only one of the three locations at which once-through cooling might realistically be proposed. The motivation for such a location, even though destroying a certain amount of valuable wetlands, would be the elimination of secondary effects associated with cooling towers--the aesthetic impact of the towers and plumes, noise, and salt drift. Moreover, the site could be relatively compact, since the spacing requirement of 2.5 miles between clusters would not apply. The price for these advantages, however, is the loss of wetlands, probably more significant than the loss of a larger acreage of inland property; plus the ecological impacts associated with once-through cooling--entrapment-entrainment problems and thermal impacts off-shore.

The Inland Site is assumed to be cooled by mechanical draft, wet/dry hybrid towers. This site is still very close to recreational areas, and it is here that the aesthetic impact of towers and plumes is in greatest need of mitigation. Also, although mechanical draft towers have higher rates of salt drift than natural draft towers, the natural rate of salt deposition is somewhat higher here than at the Fort Dix Site, and thus the incremental salt drift effect of mechanical draft towers might be less here than at the Fort Dix Site. Mechanical draft towers do have somewhat higher noise levels than natural draft towers, but this is regarded as an acceptable price to pay for the reduction in aesthetic intrusion near the shore.

Finally, we assume that the Fort Dix Site would be cooled by natural draft cooling towers. Here the distance to the coastal recreation areas makes the aesthetic impact of natural draft towers somewhat less objectionable; and, because of their lower drift rates than mechanical draft towers, natural draft towers are the indicated choice for reasons of salt deposition.

For convenience, the three cooling options for the three hypothetical NEC sites in Ocean County are summarized in Table 6-2:

TABLE 6-2

NEC SITES AND THEIR COOLING METHODS

<u>Site</u>	<u>Cooling Method Assigned</u>
Bay Site	Once-through Cooling
Inland Site	Evaporative Cooling-- mechanical draft, wet/dry hybrid towers
Ft. Dix Site	Evaporative Cooling-- natural draft towers

The requirement that all of the cooling alternatives communicate with the ocean imposes some severe limitations, however. We regard cut-and-fill construction of a conventional pipeline conduit across Barnegat Bay and the barrier island as environmentally unacceptable, apart from which there are serious questions relating to the ability of the shifting sand beds to provide adequate structural support to a conduit buried near the surface. Indeed, the barrier island itself is a geologically rather short-lived phenomenon, and there is no guarantee that the island will be in its current location in 20 years time.¹⁹ A cut-and-fill construction method would need to cross the intensely developed mainland shoreland; adequate rights-of-way might be very difficult to obtain, and the surface construction impact in such close proximity to the beaches would, in all probability, be regarded as unacceptable by the recreation industry.

The only realistic option, in our judgement, would be a bored tunnel. This would avoid any environmental impact on Barnegat Bay and the barrier island, and the associated construction activity would be confined to the NEC site

itself.²⁰ Unfortunately, the geology of the coastal plan consists of mainly unconsolidated sediments, sands and some smaller clay horizons (see Chapter V). In conjunction with the fact that much of the tunnel length would be below the water table, this makes tunnelling a possibly very costly proposition, for which accurate cost estimates require much more detailed knowledge of engineering geology than is currently available. Nevertheless, in our judgment the surface conduit alternative is environmentally unacceptable, which leaves only the tunnelled alternative as a realistic choice.

6.4 Comparisons to Dispersed Case

Three important issues must be addressed in a comparison of NEC cooling and heat dissipation to the dispersed case. The first concerns the atmospheric impacts--particularly the possibility that NEC's might provoke severe local thunderstorms or even tornado activity. However, there is still so much uncertainty here that useful comparisons are not possible. It is quite likely that if adequate spacing were maintained between NEC clusters, atmospheric impacts would be no more severe than in the dispersed case, where four or even more reactors might also occupy a single site. In any case, the issue remains a generic one, quite beyond the focus of this report.

The second issue concerns the relative ability of NEC and dispersed cases to meet water quality standards--thermal as well as salinity. It is our judgment that with proper engineering design, an NEC in Ocean County could meet whatever thermal and salinity standards apply to coastal waters; although the cost of meeting these standards will likely be much higher than in the dispersed case. Certainly the current 1.5°F excess temperature standard could be met even in the once-through cooled case by appropriate diffuser design. Short of detailed three-dimensional mathematical modelling of thermal plumes at all of the dispersed and NEC sites coupled with extensive environmental field surveys, however, it would seem that little more can be added to these admittedly somewhat broad generalizations.

Finally, in terms of consumptive use, the NEC would appear to have significant advantages over the dispersed case. Even if evaporative cooling were used for the NEC, the associated consumptive losses would be of little concern, since it is ocean water that is being lost. In contrast, four of

the reactors in the dispersed scenario would be located inland (the two units at Susquehanna and two at Limerick); these would definitely require wet cooling and hence impose consumptive use demands on a freshwater river (except in the unlikely event of dry cooling being used at these sites). The four reactors on Delaware and Chesapeake Bays in the dispersed scenario would in all probability also require salt towers but since these would be located some way down the Bay, little impact on saltwater intrusion into the estuary would be expected. The eight off-shore reactors of the dispersed scenario, of course, also pose no consumptive use problem. The magnitude of the difference, therefore, is a function of the number of the dispersed sites dependent on inland, freshwater river sites which would instead be located in the coastal NEC. Thus the consumptive use advantage of an NEC would be considerably greater under alternative dispersed scenarios not as dependent on off-shore and Bay siting as the one selected for closer study in this particular report.

NOTES TO CHAPTER VI

1. Assuming an evaporate loss of 30 cfs per 1200 Mw(e) or 25 cfs per 1000 Mw(e).
2. Most of the southern shore of Long Island, and most of the Atlantic coastline of New Jersey, Delaware, and North Carolina have such barrier islands.
3. If an average temperature difference from ambient of 50°F is maintained and the surface heat-exchange coefficient is $100 \text{ Btu/ft}^2\text{-day-}^{\circ}\text{F}$; clearly to reject $140 \times 10^9 \text{ Btu/hr}$ would require 25 square miles of water surface.
4. NRC-NECSS, Vol. III, p. 2-45.
5. D. P. Hoffman, et al., "Spray Cooling for Power Plants," Proceedings, 1973, American Power Conference.
6. One might also note that spray ponds require a substantially higher amount of electric power for operation.
7. J. B. Dickey and R. E. Cates, "Managing Waste Heat with the Water Cooling Tower", 2nd Ed., the Marley Co., April 1973.
8. NRC-NECSS, Vol. III, Part 3.
9. For a detailed description of wet/ dry cooling, see e.g. "Economics of Wet/Dry Cooling Towers Show Promise", Electrical World, December 15, 1972.
10. J. C. Devine, "The Forked River Program: A Case Study in Saltwater Cooling", Cooling Tower Environment--1974, Report CONF 74030, U.S. ERDA, 1975, p. 550.
11. Indeed, it might be speculated that because of enhanced buoyancy, ground fog frequency would be somewhat lower, and the frequency of visible plumes somewhat higher.

12. DeVine, note 10, supra.
13. J. D. Holmberg, "Drift Management in the Chalk Point Cooling Tower", Cooling Tower Environment-1974, Report CONF 74030, U.S. ERDA, 1975.
14. C. E. Junge and P. E. Gustafson, "On the Distribution of Sea Salt Over the United States and its Removal by Precipitation", Tellus, Vol. 9, p. 164-173 (1957).
15. DeVine, note 10, supra, p. 534.
16. H. Stommel and A. Leetma, "Circulation on the Continental Shelf", Proc. Nat. Acad. Sci. USA, Vol. 69, 1972.
17. Essentially nothing more than a large pipe laid on the ocean floor with openings at suitably spaced intervals.
18. See e.g., "Draft Environmental Statement, Atlantic Generating Station, Units 1 and 2", U.S. Nuclear Regulatory Commission, NUREG 0058, April 1976.
19. The last hurricane to strike at this part of New Jersey Coast resulted in some significant changes in the topography of the island, including the cutting of a new inlet.
20. Construction aspects of the tunnelling operation are addressed in Section 8.3, below.

CHAPTER VII

WATER CONVEYANCE SYSTEMS

7.1 Technical Analysis

A number of factors make optimization of the water conveyance system for the New Jersey hypothetical NEC more important than at other surrogate sites being evaluated for the NECSS Study: (1) the substantial distance of likely NEC sites to useable water sources (in this case at least 5 miles to the ocean); (2) the fact that environmental and land-use factors force use of bored tunnels rather than open channel or near-surface conduits; (3) the use of ocean water itself, which, in an evaporatively cooled system, requires use of low-concentration factors, which in turn makes the required volume of make-up water, and hence the size and cost of the facilities, much greater than in the fresh-water case; and, finally; (4) the fact that the blowdown, if untreated, has a salinity in excess of ocean-water levels, which in turn demands that the blowdown be returned to the ocean in an additional conduit rather than discharged to a nearby surface freshwater body.

Since water conveyance costs are thus likely to be much higher than those assumed in the generic NRC assessment of NECs,¹ detailed consideration of such systems seemed to be warranted as part of the New Jersey NEC evaluation. Moreover, in our preliminary assessment we rejected once-through cooling for an Ocean County NEC location on grounds of excessive water transmission cost,² and verification or refutation of this assertion was one of the more important objectives of this additional analysis.

Because of the large number of variables involved in analysis of a water conveyance system, a mathematical optimization model was formulated to determine the optimal conduit diameter, the number and timing of tunnels, and to examine the sensitivity of water conveyance system configurations to other major design variables. This model, and the subsequent analysis, are described fully in a separate technical report,³ and we summarize here only the major conclusions.

Use of such a mathematical model, however, rests upon accurate formulation of cost functions for the major system components. While this presented no difficulty for pumping stations, intake-discharge structures, diffuser system and energy operating costs, the cost of tunneling is so dependent on details of the geological conditions encountered that no well-defined summary of cost functions could be found in the literature.⁴ Some rather sophisticated computer programs for preliminary engineering cost estimates do exist, but the amount of geological and design information required went beyond the resources of this NEC assessment.⁵ We resorted, therefore, to the simple expedient of a statistical analysis of data contained in a published survey of soft ground tunnels.⁶ A multiple regression of construction cost in dollars per foot of length,⁷ y , on tunnel diameter in feet, ϕ , using those observations in the survey of comparable geology, resulted in the equation:

$$y = 4.0195 \phi^{2.15}$$

with correlation coefficient .74 and 54% of the variation in unit cost explained by variation of tunnel diameter.⁸ The numerical value of the exponent is rather interesting; if tunnel costs were an exact function of the excavation volume, the exponent would be exactly 2. Although use of this function indicates costs of about \$560/ft for a 10ft. diameter tunnel rising to \$6900/ft for a 32 ft. diameter tunnel, in all of the results that follow one should bear in mind that there is significant uncertainty in the tunneling cost function employed in the model.

Tables 7-1, 7-2, and 7-3 show the results of this computerized analysis for the Fort Dix, Inland and Bay sites, respectively.⁹ In the two evaporatively cooled sites, the optimum tunnel diameter is in the vicinity of 10ft, the minimum feasible diameter assumed in the computations; for the once-through cooled bay site, the optimal diameter is at the assumed upper bound of 32 feet. In all three cases, the optimal number of conduits is two (as indicated by a comparison of the total present worth for each of the alternatives shown). If one adds the cost of cooling towers, the following total system costs emerge, expressed as construction costs per kw electric:

TABLE 7.1 SYSTEM COSTS USING BORED TUNNELS, FT. DIX

EVAPORATIVE COOLING SYSTEM									
THETA	0.00						FORCED OUTFALL RATE		.20
SCHEDULED MAINTENANCE, DAYS/YR	36.50						CONDUIT SCALE FACTOR		2.15
RUSGAR ENERGY COST, \$/KWH	.00470						SYSTEM ENERGY COST, \$/KWH		.00470
ENR-INDEX	1896.00						INTEREST RATE		.10000
AVE. DISTANCE TO OCEAN, MILES	20.00						DELTA		1000.00
FRICTION COEFFICIENT	.0140						PUMP EFFICIENCY		.85
STATIC HEAD, FT.	100.00						MINIMUM DIAMETER, FT.		10.00
CONCENTRATION FACTOR, N	1.45						CONSUMPTIVE USE AT FULL OUTPUT		600.0
MAXIMUM DIAMETER, FT.	32.00						AVERAGE AVAILABILITY		.72

M= 1									
	Q-PEAK	Q-AVER.	OPTIMAL	CONSTRUCTION			PUMPING	FRICTION	TOTAL
	CFS	CFS	DIAM, FT.	CONDUIT	INTAKE	PUMPS	ENERGY	HEAD, PER	PRESENT
					DISCHARGE		COST	CONDUIT	WORTH
INTAKE	1740.0	1392.0	10.84	75.841	4.177	43.421	.587	890.650	124.026
DISCHARGE	1260.0	960.0	10.00	64.423	0.000	21.366	.197	655.933	85.926

CAPITAL COST PER KW	8.72								

M= 2									
INTAKE	870.0	696.0	10.00	63.825	3.393	14.044	2.779	341.571	115.426
DISCHARGE	600.0	480.0	10.00	64.423	0.000	2.503	.119	163.983	92.849

CAPITAL COST PER KW	12.35								

M= 5									
INTAKE	386.7	309.3	10.00	63.825	2.660	3.705	2.427	67.471	190.942
DISCHARGE	266.7	213.3	10.00	64.423	0.000	0.000	.000	32.392	173.027

CAPITAL COST PER KW	28.34								

M=10									
INTAKE	193.3	154.7	10.00	63.825	2.164	1.682	2.144	16.868	334.082
DISCHARGE	133.3	105.7	10.00	64.423	0.000	0.000	.000	8.098	316.024

CAPITAL COST PER KW	55.04								

M=20									
INTAKE	96.7	77.3	10.00	63.825	1.755	.918	2.100	4.217	624.844
DISCHARGE	66.7	53.3	10.00	64.423	0.000	0.000	0.000	2.024	603.319

CAPITAL COST PER KW	109.16								

TABLE 7.2 SYSTEM COSTS USING BORED TUNNELS, INLAND

EVAPORATIVE COOLING SYSTEM									
THETA		0.10					FORCED OUTAGE RATE		.20
SCHEDULED MAINTENANCE, DAYS/YR		36.50					CONDUIT SCALE FACTOR		2.15
BUSBAR ENERGY COST, \$/KWH		0.0470					SYSTEM ENERGY COST, \$/KWH		0.0470
ENR-INDEX		1896.30					INTEREST RATE		.10000
AVE. DISTANCE TO OCEAN, MILES		10.30					DELTA		1000.00
FRICTION COEFFICIENT		.0140					PUMP EFFICIENCY		.85
STATIC HEAD, FT.		80.00					MINIMUM DIAMETER, FT.		10.00
CONCENTRATION FACTOR, N		1.45					CONSUMPTIVE USE AT FULL OUTPUT		600.0
MAXIMUM DIAMETER, FT.		32.00					AVERAGE AVAILABILITY		.72

M= 1									
	Q-PEAK	Q-AVER.	OPTIMAL	CONSTRUCTION		PUMPING	FRICTION	TOTAL	
	CFS	CFS	DIAM, FT	CONDUIT	INTAKE	PUMPS	ENERGY	HEAD, PER	PRESENT
					DISCHARGE		COST	CONDUIT	WORTH
INTAKE	1740.6	1392.0	11.14	40.590	4.177	24.767	.287	388.606	69.820
DISCHARGE	1200.0	960.0	10.00	32.810	0.000	11.842	.001	334.063	44.736

CAPITAL COST PER KW	4.76								

M= 2									
INTAKE	876.0	696.0	10.40	32.212	3.393	9.258	1.646	172.387	63.805
DISCHARGE	600.0	480.0	10.00	32.810	0.000	2.84	.004	83.516	45.856

CAPITAL COST PER KW	6.50								

M= 5									
INTAKE	386.7	309.3	10.80	32.212	2.660	2.778	1.693	34.052	102.818
DISCHARGE	265.7	213.3	10.40	32.810	0.000	0.600	.003	16.497	88.121

CAPITAL COST PER KW	14.68								

M=10									
INTAKE	193.7	154.7	10.00	32.212	2.161	1.366	1.635	8.513	176.946
DISCHARGE	133.7	106.7	10.00	32.810	0.000	0.800	.000	4.124	160.940

CAPITAL COST PER KW	28.56								

M=20									
INTAKE	96.7	77.3	10.00	32.212	1.755	.768	1.655	2.128	326.940
DISCHARGE	66.7	53.3	10.00	32.810	0.000	0.000	0.000	1.031	307.266

CAPITAL COST PER KW	56.29								

TABLE 7.3 SYSTEM COSTS USING BORED TUNNELS, BAY

ONCE-THROUGH COOLING									
THEIA		0.00			FORCED OUTAGE RATE		.20		
SCHEDULED MAINTENANCE, DAYS/YR	36.50				CONDUIT SCALE FACTOR		2.15		
BUSBAR ENERGY COST, \$/KWH	.00420				SYSTEM ENERGY COST, \$/KWH		.00470		
ENR-INDEX	1896.00				INTEREST RATE		.10000		
Ave. DISTANCE TO OCEAN, MILES	5.00				DELTA		1000.00		
FRICTION COEFFICIENT	.0140				PUMP EFFICIENCY		.85		
STATIC HEAD, FT.	5.00				MINIMUM DIAMETER, FT.		10.00		
MAXIMUM DIAMETER, FT.	32.00				AVERAGE AVAILABILITY		.72		
M=1									
	Q-PEAK	Q-AVER.	OPTIMAL	CONSTRUCTION		PUMPING	FRICTION	TOTAL	
	CFS	CFS	DIAM, FT	CONDUIT	INTAKE- PUMPS	ENERGY	HEAD, PER	PRESENT	
					DISCHARGE	COST	CONDUIT	WORTH	
INTAKE	35010.0	20000.0	32.00	305.422	22.205	266.797	6.294	554.098	686.748
DIFFUSER-SYSTEM	SURFACE TEMP. EXCESS 1.50 F			DISTANCE OFFSHORE, FT.			5200.0		
	LENGTH, FT. 39614.3			WATER DEPTH, FT.			22.1		
CAPITAL COST PER KW 24.35									
M=2									
INTAKE	17505.0	14004.0	27.09	269.364	15.936	109.276	10.020	337.000	505.447
DIFFUSER-SYSTEM	SURFACE TEMP. EXCESS 1.50 F			DISTANCE OFFSHORE, FT.			5200.0		
	LENGTH, FT. 39614.3			WATER DEPTH, FT.			22.1		
CAPITAL COST PER KW 32.80									
M=5									
INTAKE	7780.0	6224.0	20.14	153.295	8.002	50.280	65.065	269.411	636.477
DIFFUSER-SYSTEM	SURFACE TEMP. EXCESS 1.50 F			DISTANCE OFFSHORE, FT.			5200.0		
	LENGTH, FT. 39614.3			WATER DEPTH, FT.			22.1		
CAPITAL COST PER KW 44.26									
M=10									
INTAKE	3090.0	2112.0	16.76	91.146	6.234	27.007	70.776	244.601	693.873
DIFFUSER-SYSTEM	SURFACE TEMP. EXCESS 1.50 F			DISTANCE OFFSHORE, FT.			5200.0		
	LENGTH, FT. 39614.3			WATER DEPTH, FT.			22.1		
CAPITAL COST PER KW 52.16									
M=20									
INTAKE	1945.0	1556.0	12.79	53.619	4.627	15.686	92.074	220.010	705.716
DIFFUSER-SYSTEM	SURFACE TEMP. EXCESS 1.50 F			DISTANCE OFFSHORE, FT.			5200.0		
	LENGTH, FT. 39614.3			WATER DEPTH, FT.			22.1		
CAPITAL COST PER KW 61.65									

	Construction Cost, \$/Kw(e)		
	Conveyance System	Cooling Towers	Total
Ft. Dix Site ^a	12.66	21.8 ^c	34.46
Inland Site ^b	6.63	20.0 ^d	26.63
Bay Site	32.88	—	32.88
Once-through Cooling at Inland Site	60.95	—	60.95

^a Assumes a reduced plant capability of 1170 MW, consistent with NRC-NECSS, Vol. III, pg. 3-48. The cost shown on Table 7-1 is thus divided by .975 to adjust to a basis comparable to once-through.

^b Assumes a reduced plant capability of 1177 MW, consistent with NRC-NECSS, Vol. III, pg. 3-48. The cost shown on Table 7-2 is thus divided by .98.

^c Assuming Natural Draft Towers--1973 cost as per NRC-NECSS Report, Vol. III, pg. 3-48.

^d Assuming Mechanical Draft Towers--1973 cost as per NRC-NECSS Report, Vol. III, pg. 3-48.

We have also added the results of an additional run, namely once-through cooling at the Inland Site, since this would correspond roughly to the conditions assumed in our preliminary report (BNL-50465). We note from the above table that evaporative cooling at the Inland Site involves the lowest construction costs; and that once-through cooling, even at the Bay Site, is more expensive. Evidently the cost of the large tunnels needed for once-through cooling outweighs the expense of evaporative cooling towers.

Moreover, one must also consider operating costs over the lifetime of the NEC. This emphasizes even further the comparative advantages of evaporative cooling. In terms of the total evaluated present worth including operating costs, the following estimates emerge:

Total Present Worth in Million \$			
	<u>Conveyance System</u>	<u>Cooling Towers</u>	<u>Total</u>
Ft. Dix Site	208	217	425
Inland Site	109	200	309
Bay Site (once-through)	-585	—	585
Once-through Cooling at Inland Site	1098	—	1098

Inspection of this table shows once-through cooling at the Bay Site to be almost twice as costly as evaporative cooling at the Inland Site; and in confirmation of the assertions made in the preliminary assessment, once-through cooling at the Inland Site would appear economically unjustifiable. Clearly, the pumping costs for large quantities of once-through cooling water exceed by far the energy cost for the smaller quantities of make-up water, fans, and tower circulation necessary in the evaporatively cooled case.

One should note that the above calculations assume that a tunnel would exist over the entire distance between the NEC and the ocean. While this would necessarily be so for the Bay and Inland Sites, some portion of the Fort Dix conduit might well be above ground, say between the NEC and the coast; in this event, the above costs for Fort Dix should be viewed as an upper bound.

The NRC-NECSS makes no computation for an evaporatively cooled, 20-unit NEC; however, they estimate a present worth of \$33.3 million for the conveyance system for a 40-unit NEC located 10 miles distant from its water source.¹⁰ Since our present worth for the Inland Site, also at 10 miles distance from the water intake, but for only 20 units, is \$109 million, we note a substantial discrepancy. This, too, may be expected, as the cost of tunnelling in the type of coastal sediments encountered in the New Jersey coast is clearly far higher than the cut and fill pipeline construction assumed in the generic NRC report.

7.2 Siting Trade-offs

A question of some interest concerns the trade-offs between electrical transmission and cooling water conveyance. Electric utilities appear to be

quite sensitive to the transmission distance between a new generating facility and its load points, and have on numerous occasions objected to a more distant site location mandated on environmental grounds, citing significant increases in transmission cost.¹¹ In the case of an Ocean County NEC, it is clear that the Fort Dix Site is closest to the load centers, and the Bay Site the most distant. The germane question here, then, is how the increase in water conveyance cost incurred by a move from the Bay Site to the Fort Dix Site compares with the decrease in transmission costs of the same relocation. In other words, which is the cheaper to move, electrons or water?

The General Electric analysis of transmission for an Ocean County NEC includes a detailed schedule for construction of 500Kv lines from the NEC to the Deans, Larabee, and New Freedom substations.¹² The location of these substations in relation to the PJM 500 Kv Network is illustrated on Figure 7-1, which is taken from the G.E. Report. The G.E. analysis assumes straight line distances to these substations from the NEC (assumed to be at the Inland Site location).

For purposes of this analysis, we have recomputed the distances from each of the three NEC locations studied in this report to the G.E. specified substations, routing the lines in such a way as to avoid State Forest lands. As can be seen from Figure 7-1, this does result in somewhat longer than straight line distances in some cases. Using the construction schedule stated by G.E., and using their cost data for circuit miles,¹³ one can compute the present worth of the transmission investments over the twenty-year period. One can similarly compute the present worth of the water conveyance system investments over the same time period to each of the three sites.

Tables 7-4 and 7-5 show the results of this analysis. In both evaporatively and once-through cooled cases, water transmission costs dominate electrical transmission costs. Thus, for example, in the case of evaporative systems (Table 7-4), moving from the Inland Site to Ft. Dix provides a transmission cost saving of \$12.3 million, completely outweighed by the additional water conveyance cost of \$99 million. In the once-through case, this effect is even stronger (see Table 7-5).

A final comparison of some interest is between the assumed tunneling cost and that incurred by a cut-fill conduit at the surface. Using the same parameters (for right-of-way, excavation and pipe costs) as in the NRC-NECSS, the computed water conveyance system costs are displayed on Tables 7-6 and

Figure 7-1. Transmission routes.

7.7. We note first that the surface conduit cost is about 30% lower than the tunnel cost for evaporatively cooled systems (compare Table 7.6 with 7.4), but almost an order of magnitude lower in the once-through case (compare Table 7.7 with 7.5).¹⁵ Also note that the water conveyance cost again dominates the electrical transmission costs in both the evaporative and once-through case.

This comparison between the two modes of water conveyance system is extremely tenuous, however, in view of the great uncertainties that underlie the cost functions used in analysis. In particular we would stress again that use of an average cost function for tunnelling poses some difficulty in an area of uncertain engineering geology; but by the same token, use of an average figure for right-of-way cost (\$500/acre) may be equally inappropriate. What can be said with some assurance, however, is that for crossing Barnegat Bay and the barrier island the surface cut-fill alternative is not a feasible alternative for reasons of environmental impact.

7.3 Comparison to Dispersed Case

The dispersed sites to be used in comparative analysis, and the construction dates for their reactors, are as follows:¹⁵

Limerick (1997, 1998)

Susquehanna (1991, 1992)

Lower Delaware (1987, 1988, 1989, 1990)

Lower Chesapeake Bay (2000, 2002, 2004, 2006)

Offshore B (1993, 1994, 1995, 1996)

Offshore C (1999, 2001, 2003, 2005)

The major difference between the dispersed and NEC cases in regard to their water conveyance systems is the need for flow augmentation storage reservoirs for Limerick, Susquehanna, and the Delaware Bay Sites, and the absence of long conduits in all of the dispersed sites.

Table 7-8 summarizes the cost of Reservoir and Intake-Discharge structures for the dispersed case. j indicates the year of construction from the start of NEC operation. $j=0$ denotes that the corresponding facility would be complete at the beginning of the first year. Because the dispersed sites are all so close to their water sources, implying minimal static head differences, and, due to the very short length of the necessary conduits,

Tables 7.4 - 7.7

TABLE 7.4

COMPARISON OF TRANSMISSION AND WATER CONVEYANCE COST
FOR EVAPORATIVELY COOLED NEC'S AND BORED TUNNELS

NEC Site	Transmission			Water Conveyance System (Evaporative)			Total System Costs
	Circuit Miles	Construction Costs	Acres of R.O.W. ^a	Pipe Miles ^b	System Costs		
Bay	789	165	16569	10	60		225
Δ	-175		-30.7		+20	99	
Inland	614	134	12894	20	109		243
Δ	-164		-12.3		+40	49	
Ft. Dix	448	122	9408	40	208		330

NOTES: (a) assumes 175 ft. width per circuit = 21 acres/mile
(b) assumes M=1.

TABLE 7.5

COMPARISON OF TRANSMISSION AND WATER CONVEYANCE COSTS
FOR ONCE-THROUGH COOLED NEC'S AND BORED TUNNELS

NEC Site	Transmission			Water Conveyance System ^b (Once-Through)			Total System Costs
	Circuit Miles	Construction Costs	Acres of R.O.W. ^a	Pipe Miles ^b	System Costs		
Bay	789	165	16569	10	585		750
Δ	-175		-31		+10	513	
Inland	614	134	12894	20	1098		1232
Δ	-164		-12		+20	987	
Ft. Dix	448	122	9408	40	2085		2207

Notes: (a) assumes 175 ft. width per circuit = 21 acres/mile
(b) assumes M=2.

TABLE 7.6

COMPARISON OF TRANSMISSION AND WATER CONVEYANCE COSTS
FOR EVAPORATIVE SYSTEMS AND BURIED CONDUITS

NEC Site	Transmission			Water Conveyance System Evaporative, Buried Conduits			Total Costs
	Circuit Miles	Construction Costs	Acres of R.O.W.	Pipe Miles	System Costs		
Bay	789	165	16569	10	41		206
Δ	-175		-31		+10	+34	
Inland	614	134	12894	20	75		209
Δ	-164		-12		+20	+65	
Ft. Dix	448	122	9408	40	140		262

TABLE 7.7

COMPARISON OF TRANSMISSION AND WATER CONVEYANCE COSTS
FOR ONCE-THROUGH SYSTEMS AND BURIED CONDUITS

NEC Site	Transmission			Water Conveyance System Once-Through, Buried Conduits			Total System Costs
	Circuit Miles	Construction Costs	Acres of R.O.W.	Pipe Miles	System Costs		
Bay	789	165	16569	10	108		273
Δ	-175		-30		+10	+90	
Inland	614	134	12894	20	198		332
Δ	-164		-12		+20	+173	
Ft. Dix	448	122	9408	40	371		493

TABLE 7-8
THE DISPERSED CASE

	Assumed Construction year	j	Makeup, Q cfs	Intake-Discharge structure cost x 10 ⁶	Consumption use of cfs	AF of Storage required	Reservoir cost x 10 ⁶ \$	Total present worth, x 10 ⁶
Limerick 3	1997	10	40 (2)	.165	30	25260	\$22.68	
4	1998	11	40 (2)	(j=10)	30		(j=10)	8.79
Susquchanna 3	1991	4	40 (2)	.165	30	25260	\$ 8.7m	
4	1992	5	40 (2)	(j=4)	30		(j=4)	6.05
Lower Delaware Bay 1	1987	0	97 (b)	.216	30			
2	1988	1	97 (b)	(j=0)	30			.216
3	1989	2	97 (b)	.216	30	9093 ^e	\$13.99	13.99
4	1990	3	97 (b)	(j=2)	30		(j=0)	.178
Offshore B 1	1993	6	38800	1.30				.667
2	1994	7	38800	(j=6)				
3	1995	8	38800	1.30				.606
4	1996	9	38800	(j=8)				
Offshore C 1	1999	12	38800	1.30				.414
2	2001	14	38800	(j=12)				
3	2003	16	38800	1.30				.282
4	2005	18	38800	(j=16)				
Lower Chesapeake Bay 1	2000	13	130 (c)	.263	30			.076
2	2002	15	130 (c)	(j=13)	30			
3	2004	17	130 (c)	.263	30			.052
4	2006	19	130 (c)	(j=17)	30			
								\$31.321

(a) based on N = 4 (as used in NRC Report, Table 3.15)

(b) based on N = 1.45

(c) based on N = 1.3

(d) Assumes a storage requirement of 421 AF/cfs

(e) Assumes a storage requirement of 18% of the full 421 AF/cfs. See BNL-20664, p. 32

minimal friction losses, pumping and conduit costs would be quite nominal and can be ignored. Indeed, they would be of the same order of magnitude as the local, within-park conduit costs of the NEC case, which we have also ignored.

The dispersed case total present worth of Table 7.6, and the present worth of the NEC alternatives (Tables 7.1, 7.2, and 7.3), can be summarized as follows:

<u>Site</u>	<u>Present Worth, x 10⁶</u>
Fort Dix	208
Inland	109
Bay	585
Dispersed Case	31

This confirms the perhaps rather obvious observation that an NEC located several miles inland would necessitate substantially higher water conveyance costs than comparable dispersed sites located close to their water sources. Even the significant cost of reservoir construction for flow augmentation, necessary for the freshwater dispersed sites, is small in comparison to the NEC conduit costs.

NOTES TO CHAPTER VII

1. Nuclear Regulatory Commission, "Nuclear Energy Center Site Survey--1975", Report NUREG-0001, V Volumes, January 1976.
2. EPAG, "A Preliminary Assessment of a Hypothetical Nuclear Energy Center in New Jersey", BNL 50465, November 1975, Chapter VII.
3. P. Meier, "Optimization of Water Conveyance Systems for Nuclear Energy Centers", Forthcoming Report, Regional Energy Studies Program, Brookhaven National Laboratory, Upton, NY.
4. The assistance of Dr. D. McCreath, of Acres American, Inc., on matters of tunnelling technology, is gratefully acknowledged.
5. See e.g., F. T. Wheby and E. M. Cikanck, "A Complete Program for Estimating Costs of Tunnelling (COSTUN)" NTIS Report 229 865/1 WX, and PB 228 740/7 WX, October 1973.
6. C.T. Brandt, et al., "A Systems Study of Soft Ground Tunnelling" Felix and Scission, Inc., Tulsa, Oklahoma, May 1970 (NTIS PB 194 769).
7. All cost estimates were adjusted, as usual, to 1973 dollars.
8. The addition of tunnel length ℓ , in 1000 ft., into the regression increased the proportion of variance explained to 57 percent. The augmented equation was:

$$y = 4.10\ell^{2.03} - .2333$$

As expected, longer tunnels decreased the unit costs. However, in view of the ambiguity in defining tunnel length in our application (would, for example, intake and discharge conduits count as one or as two tunnels?), the simpler dependency of cost on diameter alone was used in the mathematical model.

9. All costs are computed to mid-1973 levels for consistency with the main NRC-NECSS Report--equivalent to the Engineering News Record Index (ENR-Index) of 1896.

10. NRC-NECSS, Part III, p. 3-88.
11. For further discussion on this point, and some specific examples, see e.g. P. Meier, "Energy Facility Location: A Regional Viewpoint", Report BNL 20435, Energy Policy Analysis Group, Brookhaven National Laboratory, Upton, New York, August 1975.
12. L. L. Garver, et al., "Transmission Expansions as Affected by Energy Centers", Report by the Electric Utility Systems Engineering Department of the General Electric Company to NRC, Office of Special Studies, Washington, D.C., November 1975.
13. The cost per circuit is given as $(0.38 \times \text{distance} + 9.2)$ million dollars. By the time of completion, 10 500 Kv lines would go to Larabee, 2 to Deans, and 3 to New Freedom.
14. See Meier, Note 3, supra. Other variables examined included interest rate, pipe friction factor, evaporation rate, pumping energy costs, reactor outage rates (since the average water demand in a group of 20 reactors will be significantly affected by both scheduled and forced outage rates) and diffuser system design, as well as extensive comparisons of tunnelled conduit costs with cut and fill construction of surface-laid pipelines.
15. See Chapter III, above.
16. Compare this to the analysis at the Seabrook Nuclear Station, where the cost of a buried system was estimated at \$81 million, as opposed to \$57 million for a system tunnelled through hard rock. Since the Seabrook tunnel for a two unit once-through facility is of comparable capacity to that required for a 20 unit evaporatively cooled NEC, our results appear to be reasonable, at least in order of magnitude.

See Seabrook Station Units 1 and 2, Final Environmental Statement, U.S. Atomic Energy Commission, Directorate of Licensing, December 1974, p. 9-13.

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CHAPTER VIII*

CONSTRUCTION MANAGEMENT ISSUES

8.1 Accessibility of Sites

The accessibility of a site for delivery of major power plant components affects its suitability for a nuclear energy center. In addition, comparison between nuclear energy centers and dispersed sites requires analysis of costs for bringing such components to the areas where they are to be erected.

The number and weight of components in each case is a function of the Nuclear Steam Supply System (NSSS) actually selected. Since it is unlikely that a single NSSS would be procured for all power plants in the NEC, it was impossible to specify either the weight of individual components or the number of shipments per reactor. A maximum weight of 1000 tons for an individual component, however, was assumed. Such a weight is not sufficiently in excess of weights currently moved by heavy riggers in the power plant construction industry so as to represent a serious problem.

For the purpose of this study, the cost of bringing heavy components by barge to a location in a navigable waterway nearest a barge off-landing facility is omitted since it is unlikely that costs will be significantly different from site-to-site or that there will be measureable economies of scale.

8.2 Construction Management at the Bay Site

The Bay Site is bordered to the northwest by U.S. Highway #9 and to the southeast by the waters of Barnegat Bay. Westcunk Creek flows northward through the area from Barnegat Bay, a creek with a fairly large mouth. (See Figure 5-5). The waters of the bay are shallow in this vicinity, having a depth of two feet. To bring a barge having a draft of 5 1/2 feet, loaded, to the mouth of

*Prepared with the assistance of Jack Allentuck, Energy Policy Analysis Division, Brookhaven National Laboratory.

the creek would require dredging estimated at a cost of some \$300,000. To maintain the channel would require redredging at 12-month intervals at a cost of \$50,000 each time.¹ While unloading a single reactor system from barges could be accomplished for some \$1.1 million, significant economies could be effected by construction, at the mouth of the creek, of an unloading facility including a barge slip. Such a facility could be built at an estimated cost of \$1.5 million. With such a facility in place, each off-loading of a reactor system and loading onto an overland transporter could be accomplished at an estimated \$200,000. In addition, if the turbine generator were to be shipped by barge, the facility could be used for off-loading of that equipment at an estimated cost of \$100,000 each.²

Dock Road is parallel to Westecunk Creek and runs from its mouth to a junction with U.S. Highway #9, a distance of some three miles. It is indicated on maps as a medium duty road, and appears to be well maintained and not worse than U.S. Highway #9. About halfway between its termini, its bed is intersected by a small branch of Westecunk Creek where the roadway is carried by a short bridge or culvert. A row of utility poles lines the north side of the road and there are scattered clusters of cottages alongside. It is estimated that this road could be brought to a condition suitable for moving reactor components at an estimated cost of less than \$380,000.

An overland transporter (not self-propelled) suitable for a 1000 ton reactor component load could be procured at a cost of \$800,000; and labor costs for overland transportation are estimated at \$3,000 per day during which some 6 miles of travel is accomplished. Including a turbine generator and pressurizer, seven such shipments would be required for a four-loop pressurized water reactor.

The costs for delivery of major components at the Bay Site are summarized in Table 8-1:

TABLE 8-1

ESTIMATED COSTS FOR DELIVERY AT THE BAY SITE

(Million \$)

1. Sunk Costs

Dredging	.3
Unloading Facility	1.8
Road	.4
Transporter	.8
	<hr/>
	\$3.5

2. Per Unit Cost

Reactor Components (offloading)	.2
Turbine Generator (offloading)	.1
Over Road Transportation	.03
Channel Maintenance/year	.05
	<hr/>
	\$.38

8.3 Construction Management at the Inland Site

The Inland Site is located some five miles inland at the same latitude as the Oyster Creek Nuclear Generating Station and to the west of the Garden State Parkway. (See Figure 5-6). Ocean County Route 532 starting at its junction with U.S. Route #9 at Waretown passes into or adjacent to this area after crossing over the Garden State Parkway. Route 532 is indicated on maps as a medium-duty road, and appears to be well maintained.

The junction with U.S. Route #9 is approximately one mile south of the bridge which carries that route over the outflow channel of the Oyster Creek plant. As of March 1976, this channel is providing access for barges with reactor components for the Forked River Nuclear Generating Station, located adjacent to the Oyster Creek plant. Requirements for maintenance dredging of the channel are minimal (once every five years), apparently because of the steady flow of condensor cooling water.

Present restrictions on use of the shoreline of this waterway allow erection of only temporary off-loading facilities and constrain procedures away from the most efficient. Should it be desirable to use this location for repetitive off-loading of power plant component carrying barges for a nuclear energy center, a permanent facility would be desirable. Costs for such a facility would be the same as those listed for the Bay Site.

The most significant single cost in providing accessibility to the Inland Site would be to strengthen the structure supporting the Route 532 crossing of the Garden State Parkway or, if required, to build a parallel crossing. This is estimated conservatively at \$4 million. In addition, if substantial upgrading of Route 532 were required, this might be accomplished for 4.5 miles of its length westward from the intersection with Route #9 at a cost of \$1.2 million.

Costs for the Inland Site are summarized in Table 8-2:

TABLE 8-2

ESTIMATED COSTS FOR THE INLAND SITE
(Million \$)

<u>Sunk Costs</u>	
Unloading Facility	1.8
Road Improvements	1.2
Highway Bridge	4.0
Transporter	.8
	<hr/> \$7.8
<u>Per Unit Cost</u>	
Reactor Components (offloading)	.2
Turbine Generator (offloading)	.1
Over Road Transportation	.06
	<hr/> \$.36

8.4 Construction Management at the Fort Dix Site

The southeast corner of the Fort Dix Site is located some seven miles west of Toms River, New Jersey (See Figure 5-7). Both the Central Railroad of New Jersey (CRRNJ) and New Jersey Route 37 connect the site with that locality.

A barge facility near the mouth of Toms River could be provided, possibly with some dredging required. A route for over-the-road transport could be developed if necessary through the less congested areas of the town joining Route 37. A crossing over the Garden State Parkway would also be required. A possible alternative would be use of the CRRNJ. This might be proven desirable depending on a detailed route survey of both the railroad and over-the-road access.

Estimating on the basis of developing an off-loading facility at the mouth of Toms River and over-the-road transportation around the southern edge of the town, expenditures for the Fort Dix Site are shown in Table 8-3. Sunk costs at the Fort Dix Site are the highest of the three, 177% higher than the Bay Site and 24% more than the Inland Site. Per unit delivery costs are nearly the same at all three sites. In comparison to the cost of the reactors, however, none of these expenses are very significant.

TABLE 8-3

ESTIMATED COSTS FOR THE FORT DIX SITE
(Million \$)

Sunk Costs

Unloading Facility	2.4
Road Improvements:	
Toms River Vicinity	1.3
State Route 37	1.2
Highway Bridge	4.0
Transporter	.8
TOTAL	\$9.7

Per Unit Cost

Reactor Components (offloading)	.2
Turbine Generator (offloading)	.1
Over-Road Transportation	.1
TOTAL	\$.4

8.5 Tunnel Construction

The other major site-specific construction management issue concerns tunnel construction for the water conveyance system.³ A host of other construction issues must be addressed, to be sure, but these would be common to all NEC surrogate sites and are covered in the main NRC report.⁴

Perhaps the first point to be stressed is that the degree of construction activity involved in tunnelling would be rather small in comparison with the activity at the NEC site itself. The necessary work force might be on the order of 100-150 men per tunnel, small by comparison with the reactor construction work force. Moreover, most of the necessary surface activity could readily be accommodated at the NEC site near the tunnel entrance--the major surface requirements would be for an aggregate batch plant, stockpile area for supports, and muck disposal facilities. There would need to be, at periodic intervals along the length of the tunnel, vertical shafts for ventilation purposes; but these would involve rather minor construction efforts, whose environmental impact would not be of major concern.

Given the substantial uncertainty in geological conditions, a major concern would be the tunnelling schedule. Especially if compressed air becomes necessary,⁵ fast advance rates may be very expensive, and thus tunnel construction should be commenced at the earliest possible time. Five to seven years for a tunnel of the length probable at an Ocean County surrogate site might be quite typical.⁶

Tunnel muck disposal should not pose any insurmountable problems. Since tunnel construction would commence at the earliest stage of the NEC, some uses at the NEC site--say for construction fill--would be quite likely. As shown in Table 8-4, the volumes are not that great, especially when spread over several years. Even if the muck required road transport to a distant disposal site, typical advance rates in a 10 foot diameter tunnel of, say, 25 ft/day,⁷ would result in only 87 cubic yards per day, no more than a few loads per day in a large dump truck. At the Bay Site, where the volume of muck is greatest, the need for fill material is also greatest, as this site would require filling of some substantial area of wetlands. Even if a full square mile required filling, tunnel muck at the Bay Site would be adequate only for some two feet of depth.

TABLE 8-4

VOLUME OF TUNNEL MUCK

	Inside ^a Diameter (ft)	Total Length of Tunnels (mi)	Volume (cu. yds.)	Volume (AF)
Fort Dix Site	10	80	1,769,200	1096
Inland Site	10	40	884,600	548
Bay Site		20	3,324,000	2060

^aOutside diameter used for calculation = $1.2 \times$ Inside Diameter

8.6 Comparison with Dispersed Sites

The costs of bringing heavy components to the New Jersey surrogate site have been compared with similar costs for our dispersed siting pattern. For the offshore locations, it has been assumed that all sunk costs for making these sites accessible for barges and for off-loading barges is properly chargeable to the project as a whole, not to the delivery of the major components as such. The marshland sites on the Delaware and Chesapeake Bays are assumed to require installations identical with the Westecunk Creek site reviewed above.

On-site fabrication was the alternative to over-the-road transportation from the nearest barge access for the two units at Limerick and Susquehanna, where vessel fabrication for the currently planned units is being performed

at an on-site facility. The cost of such fabrication at Limerick incremental to off-site fabrication is some \$600,000 for a fabrication shop and \$750,000 per reactor for on-site labor.⁸ The NSSS at these sites are BWR's. It will be assumed for this study that additional power plants at these sites would utilize the existing fabrication facilities and that labor costs at Susquehanna are the same as at Limerick.

Table 8-5 shows average costs per reactor at the above sites for delivery of major components on the basis of assumptions discussed in the foregoing paragraphs. By comparison, Table 8-6 summarizes the corresponding costs for the NEC case. Inspection of these data shows that NEC access costs are not significantly different from the dispersed case.

TABLE 8-5

DISPERSED CASE AVERAGE COSTS PER REACTOR, 10^6 \$

	<u>Offshore</u>	<u>Cheaspeake Bay</u>	<u>Delaware Bay</u>	<u>Limerick</u>	<u>Susquehanna</u>
Sunk Costs	0	.8	.8	0	0
Per Unit Costs	.33	.35	.35 ^a	.75	.75
TOTAL	.33	1.15	1.15	.75	.75
No. of Reactors	8	4	4	2	2

^aIncludes \$.02 million estimated annual cost for channel maintenance.

TABLE 8-6

NEC CASE AVERAGE COSTS PER REACTOR, 10^6 \$

	<u>Bay Site</u>	<u>Inland Site</u>	<u>Fort Dix Site</u>
Sunk Costs	.18	.39	.485
Per Unit Cost	.33	.36	.4
Channel Maintenance	.02	a	a
TOTAL	.53	.75	.885

^aChannel maintenance required for other purposes and not charable to heavy equipment access.

NOTES TO CHAPTER VIII

1. The assistance of S. B. Palmeter, GPU Service Corporation and Personnel of the New York District, U.S. Corps of Engineers in estimating dredging costs in Barnegat Bay is gratefully acknowledged.
2. Estimates of the cost of an off-loading facility and overland transport of NSSS components were arrived at with the assistance of S. Nowinski, Hoffman International Corporation.
3. Dr. D. McCreath, of Acres American, Inc., was of invaluable assistance to the study team in assessing the problems associated with the water conveyance tunnels.
4. NRC-NECSS, Vol. III, Chapter V.
5. Compressed air is used to control water infiltration into the tunnel--but this in turn means that a significant proportion of each work-shift must be spend in decompression.
6. For example, the tunnels to the Inland Site are 10 miles long, or 52,800 feet. At 25 ft/day, 6 days per week, 7800 ft/yr can be achieved, making for a total construction time of 6.76 years.
7. There is however, substantial variation in advance rate, depending on geological conditions and the method of tunnelling employed. The survey of soft ground tunnels in C.T. Brandt et al., "A Systems Study of Soft Ground Tunnelling" (NTIS Report PB 194 769, May 1970) indicates advance rates in the range of 3 to 100 ft/day.
8. Fabrication costs for Limerick were furnished by Philadelphia Electric Co.

CHAPTER IX

NOISE ISSUES*

9.1 Noise Impact of the NEC

Although the noise which might result from operation of cooling towers at an NEC has not been identified as a significant factor in most of the major studies on energy centers conducted thus far, the proximity of large numbers of cooling towers to major recreation areas at a New Jersey surrogate site could very likely become one of several potential environmental issues requiring careful attention. One should note that since the tunnels necessary for the water conduits are through soft ground, no blasting would be involved in an Ocean County NEC.

Details of the noise analysis, a somewhat complex technical subject, can be found in a separate technical study.¹ In this report we shall summarize only the major findings of that analysis.

Figure 9-1 shows the assumptions used in the analysis of natural draft towers. We assume 2 towers per reactor, or 8 towers per cluster, and 40 towers for the complete NEC. This cooling tower corresponds to that being installed at the Chalk Point, Maryland, generating plant, which, using brackish water for make-up, is comparable to what might be required at an Ocean County NEC.²

Using the model developed in the technical report, the acoustic power for a single cooling tower of this size computes to about 1.474 watts, considerably lower than that for mechanical draft towers (about 8.1 watts).³ This measure also must be adjusted for atmospheric absorption and for so-called A-weighting. The A-weighting curve, shown on Figure 9-2, adjusts noise levels according to the human ear sensitivity to different frequencies. Figure 9-3 then shows the noise levels from single towers as a

*Prepared with the assistance of Frank Moore and J. Zakaria, Department of Mechanical Engineering, Cornell University.

Figure 9-1. Natural-draft wet tower for a 600 MW power plant.

Figure 9-2. The internationally standardized A-weighting curve for sound level meters.

function of distance,⁴ as predicted by our model, and also shows some observed noise measurements of Campano.⁵ Figures 9-4 and 9-5 show the noise spectra at various distances for natural draft and mechanical draft towers, respectively.

For the purpose of analysis, the NEC site is assumed to be circular of radius C, and the cooling towers are uniformly distributed over a smaller concentric circle of radius r. The shaded area on Figure 9-6 is thus assumed to act as a uniform source of acoustic power.⁶ Using the methodology described in the technical report, one may then compute the Sound Pressure Level (SPL) at the site boundary as shown on Figure 9-7.

For natural draft towers, we notice that the noise level at the site boundary increases significantly beyond an r of about 10,000 feet. At large r, sound energies from the far side of the park are relatively ineffective, and the major effect is from the nearest sources. As r decreases, the area source behaves more like a point source; but since that point source is more distant from the site boundary (for small r), overall noise levels are less.

For mechanical draft systems, atmospheric absorption is negligible, and it is the A-weighting that reduces actual sound levels by some 16 DB's. The attenuated levels prove to be almost constant over the range of r considered.

Figure 9-3. Behavior of sound pressure levels (with A-weighting and atmospheric absorption) with increasing distance from single isolated cooling towers.

Figure 9-4. A-weighted noise spectra at S ft. from the natural-draft tower for a 600 MW power plant.

Figure 9-5. A-weighted noise spectra at S ft. from the mechanical-draft tower for a 600 MW power plant.

Figure 9-6. Site definition.

Finally, we should indicate the central radius for which sound levels at the site boundary would not exceed 45 DBA, the level considered by EPA to be acceptable,⁷ and comparable with the following noise levels defined as acceptable for various situations:⁸

	<u>DBA</u>
ultra critical areas	38
suburban residential areas	43
urban residential areas	48

For mechanical draft cooling systems, this level of 45 DBA would be reached at a central radius of 21,000 feet, and 24,000 feet for natural draft towers. Thus, beyond about four miles from the edge of the cluster, nearest the site boundary, noise from both natural and mechanical draft towers will be at EPA's "acceptable" level.

Figure 9-7. Variation of sound pressure levels at the site boundary with radius of power park.

One may conclude that the greater the degree of dispersion of towers within the site, the higher will be the noise levels at the site boundary, with the effect being more pronounced for mechanical than for natural draft towers. But since maximum dispersion of cooling towers is desirable from the viewpoint of minimizing atmospheric heat impacts, it would seem that at least some of the clusters would be quite near the site boundary. Since this in turn implies that most of the perceived noise at the site boundary would be from the nearest cluster, the noise level would be little different to that of a dispersed quad. Of course, within the radius r, noise levels in the NEC case would be higher, but it is the noise levels beyond the cluster that are of prime concern, since land use within the site would in any case be restricted.

9.2 Comparison to Dispersed Siting

With some assurance one can predict that noise from operation of cooling towers at an Ocean County NEC would not be of major concern. Certainly at the once-through cooled Bay Site, no major noise sources exist. The Fort Dix Site is sufficiently remote for noise to be of any consequence. The most sensitive site would be the Inland Site; but since this is located west of the Garden State Parkway, noise levels in the beach areas would more likely result from nearby traffic noise than from cooling tower operation.

Since neither tunnelling nor reactor construction would involve any blasting, it thus appears that the most serious noise impact would be an indirect one, resulting from increased traffic levels along routes travelled by construction related traffic (workers commuting, heavy equipment transport, etc.). Quantifications in this regard are somewhat difficult, but there seems little prior basis for expecting the noise intrusion of an NEC to be any greater, nor any less, than the aggregate noise intrusion associated with the dispersed siting pattern.

NOTES TO CHAPTER IX

1. J. Zakaria and F. Moore, "Noise From Cooling Towers of Power Parks," BNL Regional Energy Studies Program, Forthcoming Report.
2. For further details, see J. Dickey and R. Cates, "Managing Waste Heat with the Water Cooling Tower, " 2nd Ed., The Marley Company, April 1973.
3. Zakaria and Moore, Note 1, supra, p. 11.
4. Assumptions for this figure: For Mechanical-Draft Towers for a 600 MW Power Plant, rated fan power = 3625 hp; and an efficiency of conversion from rated fan power to acoustic power = 3 PPM. For Natural-Draft for a 600 MW Power Plant, data used is: one wet tower; cooling water flow rate = $.23 \times 10^6$ gal per min; pumping head = 60 ft; tower base dia. = 400 feet; efficiency of conversion from cooling water potential energy into acoustic power = 0.47 PPM.
5. G. Campano and W. Bradley, "Radiation of Noise from Large Natural Draft and Mechanical Draft Cooling Towers," American Society of Mechanical Engineers, Paper 74-WA/HT-55, 1974.
6. Work is under way to extend the methodology to discrete sources within the park, and will be included in Zakaria and Moore, Note 1, supra.
7. "Noise Conference 73," Proceedings of the National Conference on Noise Control Engineering, Washington, D.C., October 1973, p. 433-438.
8. "Summary of Noise Programs in the Federal Government," U.S. Environmental Protection Agency, Washington, D.C., December 31, 1971.

CHAPTER X*

AESTHETIC IMPACTS

10.1 Introduction

The visual impact of a nuclear energy center in coastal New Jersey would depend primarily -- though not entirely -- on the type of cooling technology associated with the facility. Each of our three hypothetical NEC sites in Ocean County would employ a different cooling technology; therefore variations in aesthetic and visual impacts can be evaluated, at least on a comparative basis. In general, the impacts would range as follows:

Bay Site: Once-through cooling would have limited visual impact;

Inland Site: Mechanical draft cooling using hybrid wet/dry towers would have modest visual impact;

Ft. Dix Site: Evaporative cooling using natural draft cooling towers would have maximum visual impact.**

The visual impact of these cooling towers and their plumes of water vapor is an issue about which the recreation industry in the area is especially sensitive.

Another aesthetic issue concerns the visual impact of the transmission links between the NEC and the regional electricity transmission grid.¹

10.2 Visual Impact of Transmission Lines

Very little can be said about the transmission line impact in the absence of detailed routing studies, a task beyond the scope of the present assessment. Some very crude comparisons between dispersed and NEC siting can, of course, be made by considering the miles of line of given voltage required; this comparison is deferred to Chapter XII. It should be pointed out, however, that the location of all three Ocean County

* Prepared with the assistance of Elizabeth English, Center for Environmental Studies, Princeton University.

** That constitutes the primary reason for using such towers at the Ft. Dix Site rather than the Inland Site, thus keeping them further away from the beaches.

NEC locations with respect to the Pinelands is such that significant problems might be expected in linking the NEC to the transmission grid substations that lie on the other side of this fragile ecosystem. To the extent that the Pinelands represent one of the few remaining wilderness areas, almost completely devoid of development and yet in close proximity to the urban centers of the Northeast, strenuous opposition might be expected to a direct crossing of these areas by transmission lines. It may well be possible, therefore, that some of the transmission lines might need to be very much longer than the straight line routes assumed in Chapter XII for purposes of technical analysis, further exacerbating problems of their aesthetic impact.²

10.3 Aesthetic Impact of Cooling Towers and Plumes

While transmission lines crossing the Pinelands would probably provoke opposition from environmental groups in nearby cities, there seems little doubt that the major local concern, within Ocean County itself, stems from the potential impact of the NEC's cooling towers and plumes on the recreation industry. This theme emerged repeatedly from our interviews with community leaders, as documented in Chapter XVIII. Indeed, therein lies part of the motivation for postulating a once-through cooled Bay Site, since such a cooling option would have little adverse aesthetic impact. For the same reason, we believe that an array of 40 natural draft cooling towers, which we have identified in a previous chapter as being perhaps 400 ft. in height and base diameter each, must be placed some distance inland, away from the shore recreation areas. Each of these towers is as tall as a 40-story skyscraper, and considerably wider. The Ft. Dix Site is sufficiently further away from the shore than is the Inland Site, and thus natural draft towers were assumed at that location.

The plumes perhaps constitute an even more serious problem than do the towers themselves. These plumes of condensing water vapor, an inherent product of evaporative cooling systems, may rise to 10 times the height of the towers, and at times be of considerable length. The height to which the plumes would rise depends on the air temperature and relative humidity. The plumes may dissipate immediately, but on occasion they may rise as high as 7,000 ft. above the cooling towers. At times, the plumes would form clouds which may extend as much as 20, 30 or even 50 miles downwind from

the cooling towers, casting large shadows on the ground below.³

As noted in Chapter VI, the state of the art of plume modelling is such that definitive predictions of plume coalescence and persistence are most difficult. The possibility of plumes drifting over the beaches, blocking out sunlight, may well be the major aesthetic issue, rather than the merely passive impact of towers and plumes seen in the distance. Clearly the former would be a significant impact, whereas the latter might well be perceived as inconsequential (though it might not).

The visually aggravating effects of cooling towers and their plumes are compounded in an NEC by the magnitude of the project and correspondingly large number of towers required. Cooling towers have been built singly or in clusters of two, three, or four; but a complex of 40 towers, in 5 clusters of 8 towers each would represent a significant increase in visual impact in terms of both the number and size of the units.

The NEC may have three basic aspects when viewed from a distance, depending on the types of plumes, themselves a result primarily of weather conditions: (1) no plumes, or very short plumes; (2) plumes which rise a sizeable distance but dissipate without forming clouds; and (3) plumes which rise and join together, forming clouds which may extend for many miles.

How dominant an impact would natural draft cooling towers themselves represent? The human eye has a field of vision which spans 180 degrees laterally and covers about 50 degrees above the horizontal. As shown in Figure 10-1, at a point just outside the NEC boundary the cooling towers would range over 145 degrees of the lateral field of vision and the towers and plumes would occupy about 26 degrees of the vertical field. At a distance of six miles from the towers (five miles from the NEC's boundary), these angles would be reduced to 65 degrees and 6 degrees, respectively.

Although the NEC cooling towers certainly would be less visually offensive at six miles than at one mile, nevertheless it may still be an unpleasant sight at that distance and for many miles beyond. One option might be to encourage people to plant many trees to block the view. From the aesthetic viewpoint, a more effective alternative would be to use a type of cooling tower other

Figure 10-1. Field of vision occupied by NEC.

than the natural draft type assumed in this analysis for the Ft. Dix Site; this was done for the Inland Site. Comparative scales for these two kinds of towers are shown in Figure 10-2, along with other objects. The difference in aesthetic impact between the towers assumed at these two sites are readily apparent.

As noted in Chapter VI, wet/dry hybrid towers can be used for plume control; but the problem here lies not only in a substantial cost penalty, but also in the fact that the dry tower sections would be somewhat larger than the evaporative sections they replace (See Figure 10-2). This can be avoided by employing mechanical rather than natural draft dry towers, but this step further increases costs of construction and operation. The trade-off, then, is between somewhat larger structures seen all the time, with little possibility of really large plumes, against smaller structures seen all of the time, but with the occasional possibility of a larger persistent plume. In the absence of detailed mathematical modelling of plume behavior, these questions remain unanswerable at the present time. It seems reasonable, however, to predict great difficulty in convincing potential NEC opponents, especially those connected with the recreation industry, that there is a negligible probability of plumes interfering with recreational activity. Only a commitment to dry towers, or to once-through cooling, both demonstrably without plumes, would be sufficient to convince skeptics.

Figure 10-2. Scalar comparisons.

For the Inland Site, and at most times for the Ft. Dix Site when no plumes were formed, only the clusters of cooling towers themselves would be visible at any great distance from the NEC. Just how far the NEC would have a visual impact depends on several factors. A 100 ft. structure can be seen clearly for 10 miles when the ground is flat and trees do not block the viewer's line of sight. In Ocean County's flat terrain, it is not unreasonable to expect that the 400 or 500 ft. cooling towers would be visible for a radius of at least 20 miles. As shown in Figure 10-3, the towers themselves thus could be seen along a 45-mile stretch of the New Jersey shore between Point Pleasant and Atlantic City. Although the NEC would be situated among trees in the Pinelands, these would do nothing to limit the visibility of the towers from the treeless, densely populated coastline. Thus one of the aesthetic disadvantages of an Ocean County NEC would be its sight to the thousands of tourists on the shore islands, a constant reminder of the nuclear center's proximity.

The NEC would become even more unpleasantly visible during those periods of unknown frequency and duration when sizeable plumes rose from its towers (Ft. Dix Site only). Although the height of these plumes would vary widely, 2,000 ft. above the tops of the towers may be considered a representative height. The height of the plumes is not the only characteristic which affects their visibility, for a single 2,000 ft. plume would not present much of a problem. Several other factors contribute to their high visibility: the number of plumes, the tendency of the plumes at a cluster to clump together into a single broad plume, and the large area of the site over which the plumes are spread. The plumes might combine to an overall height of almost a half a mile, and the broad combined plumes from each of the five clusters might be spaced over a distance of five to ten miles. In clear weather an affected area of such enormous size would probably be distinguishable on the horizon for a distance of 40 miles in places where trees or changes in elevation did not block the viewer's sight. An NEC with natural draft cooling towers placed at the Ft. Dix Site thus might be visible on occasion from areas as far away as Newark and Philadelphia (See Figure 10-3).

Figure 10-3. Range of visibility of cooling towers and plumes.

Clouds formed by the plumes would comprise a further unpleasant visual effect of an NEC. Usually the clouds would disperse after a few miles. Even so, a four-mile cloud extending from each of ten large plumes over the five to ten mile span of the site would form a sizeable bank of man-made clouds. These clouds would shadow the earth below them just as effectively as naturally caused clouds. On less frequent occasions the clouds would persist for many miles and shade extensive areas of land downwind from the towers. This condition would be particularly unpleasant for sunbathers at the Ocean County beaches, although it seems unlikely that such clouds would form when weather conditions were conducive to sunbathing. Most would be expected during the winter months. Nevertheless, it appears probable that the visual impact of an NEC in Ocean County would have a decidedly detrimental effect on the resort industry there. For a region economically dependent on its appeal as a recreation area, such visual blight would represent a financial as well as aesthetic loss.

Placing a five or ten-mile buffer zone of preventive land use controls around the NEC might improve the situation somewhat. By moving the Ocean County Site farther inland, its visibility from the beaches would be reduced to some degree. A buffer zone would have little if any other effect on the long range visibility of an NEC. However, for the people living or working near the site, there would be a great difference between being at a distance of one mile as compared to six or eleven miles from the cooling towers.

An NEC poses aesthetic problems because of its huge scale and the degree of repetition of its elements. Natural draft cooling towers are not in themselves ugly structures, but they lack scalar references. Although the concrete shells are actually very thin in comparison to the width of the towers, the towers appear solid, heavy, and absolutely enormous. Placed in a location which does not provide some sort of visual transition, the towers' size becomes overbearing. A skyscraper is less subject to this kind of problem because the detailing of its facade gives it reference to human scale and the transition from low buildings to very tall ones is usually gradual. Aesthetic incongruity becomes compounded when the same potentially objectionable element is

repeated many times without modification, as with 40 natural draft cooling towers in a single location like the Ft. Dix Site. Plume control to avoid unpleasant visual impacts, in fact, may become so important as to rule out entirely the possible natural draft cooling towers at least in coastal New Jersey.

10.4 Comparison of Visual Impacts of an NEC and Dispersed Siting

As noted above, the cooling towers and their plumes hold the key to the degree of potentially intolerable visual impact from a nuclear energy center, at least in proximity to New Jersey's coastal resort areas. On this criterion, at least, there seems to be a definite disadvantage to clustering 40 cooling towers into one site as compared to dispersed siting. This is particularly true when comparing the hypothetical Ocean County NEC to our dispersed nuclear siting scenario, for the offshore plants would have little if any aesthetic impact (though these Floating Nuclear Power Plants do raise serious perceptual questions with respect to their impact on the attitudes of potential tourists and therefore on the shore-based recreation industry). Clearly, 40 natural draft evaporative cooling towers at an Ocean County nuclear energy center would have a massive visual impact, far greater than would be associated with several smaller dispersed nuclear sites. This aesthetic and visual impact, and its political connotations, may be the single most negative feature of clustered nuclear siting. The NEC would proclaim its presence constantly, in a particular location, whereas an equal number of cooling towers in five or six sites would represent a much smaller visual impact.

NOTES TO CHAPTER X

1. A case could be made that the NEC might require a large fence around its entire perimeter with a substantial cleared area on either side to allow efficient surveillance, and that such fences would be a somewhat forbidding aesthetic experience. However, by comparison to the more important visual effects resulting from cooling towers and transmission lines, the fence issue seems somewhat less significant.
2. See e.g. Figure 12-2.
3. American Electric Power Service Corporation, Cooling Towers and the Environment, October 1974.

CHAPTER XI

ECOLOGICAL ISSUES*

A nuclear energy center would produce a number of potentially serious impacts on the ecology of the area in which it was located. This chapter does not purport to be a comprehensive environmental impact statement, but does identify the principal ecological issues associated with an Ocean County NEC.

11.1 Vegetation

Five principal types of vegetation are characteristic of the coastal pine barrens:

- salt and brackish water marshes
- fresh water marshes and swamps
- hardwood forests
- pine forests
- mixed pine/hardwood forests.¹

These vegetation types represent "core environments" whose characteristics--such as species abundance, dominance patterns, and areal distribution--distinguish them from other "core environments" found in Ocean County. Transition from one type to another may be abrupt or gradual, in which case the boundary vegetation cannot be clearly categorized as one or the other. This is particularly true where a saltwater/freshwater marsh interface is subject to traumatic changes in saltwater intrusion, or in the merging of "pure" pine and hardwood stands to form a mixed hardwood/pine environment.

Each of the three hypothetical NEC sites in Ocean County is comprised of more than one "core environment" vegetation pattern. In turn, each "core environment" differs in its ability to regenerate vegetation lost through

* Prepared with the assistance of Steven Munson, Evergy Policy Analysis Division, Brookhaven National Laboratory.

traumatic changes. Where the existing vegetation pattern is primary or secondary growth the return may be fairly rapid. Indeed, the periodic fires which sweep through the pinelands play an important role in the reproducing cycle of the dwarf pine trees (the fires burst their cones, thus spreading seedlings) and in developing browse vegetation. However, where the vegetation type is representative of later stages of development (tertiary or climax), regeneration will occur slowly if at all. More details on vegetation in the three sites are provided in Chapter IV.

Salt and Brackish Water Marshes. Three types of cordgrass are found in these areas. Salt marsh cordgrass (Spartina alterniflora) is found in sites regularly flooded by tides; salt meadow cordgrass (Spartina patens) grows at slightly higher elevations; and a large cordgrass (Spartina cynosuroides), less tolerant of salt water, grows in scattered stands along banks and other high areas. Changes in vegetation type, abundance, dominance, and distribution result from many factors. Traumatic changes may be natural: floods, fires, and changes in the freshwater/saltwater interface; or they may be induced for agricultural, housing, mineral extraction and other purposes. Natural succession from primary to climax vegetation also accounts for some of the differences in vegetation. The giant reed (Phragmites communis) can tolerate both fresh and salt water, and strands are found well upstream in tidal creeks. A fifth species, a salt marsh bullrush (Scirpus robustus), grows in and around patches of the salt marsh and salt meadow cordgrass. These five species predominate in salt and brackish marsh areas.

Fresh Water Marshes and Swamps. Fresh water marshes and swamps are found in lowland areas and occasionally along stream beds. The dominant members of the overstory are white cedar (Chamaecyparis thyoides) intermingled with red maple (Acer rubrum) and sweet bay magnolia (Magnolia virginiana) on higher ground. The understory includes dense bayberry (Myrica pennsylvanica) and high bush blueberry (Vaccinium corymbosum), with white swamp azaleas (Rhododendron viscosum), and leatherleaf (Chamaedaphne calyculata) in the bogs. Other components of the understory are virginia creeper (Parthenocissus quinquefolia), poison sumac (Rhus vernix), sweet pepperbush (Cluthra alnifolia) and curly grass fern.

Hardwood Forests. The hardwood communities are completely dominated by black, scarlet and white oaks (Quercus velutina, coccinea and alba). The understory is principally scrub oak (Quercus ilicifolia), mountain laurel (Kalmia latifolia) and bracken fern, though it also includes deerberry (Vaccinium stamineum) and sassafras (Sassafras albidum).

Pine Forests. The overstory of the pine forests is completely dominated by pitch pine (Pinus rigida). The understory may be high, reaching perhaps fifteen feet, and is composed of red maple (Acer rubrum), white, black and willow oaks (Quercus alba, velutina and phellos), black gum (Nyssa sylvatica), black cherry (Prunus serotina), sassafras (Sassafras albidum) and persimmon (Diospyros virginiana). A lower shrub layer is well defined and dominated by chestnut and scrub oak (Quercus prinoides and Quercus ilicifolia). It also includes bayberry (Myrica pennsylvanica) and sheeps laurel (Kalmis augustifolia).

Mixed Pine and Hardwood Forests. The dominant overstory in these forests includes white and black oaks (Quercus alba and Quercus velutina) and clusters of pitch pine (Pinus rigida). Less common are the scarlet oak (Quercus coccinea) and the black gum (Nyssa sylvatica). The dense understory includes sassafras (Sassafras albidum), highbush blueberry (Vaccinium corymbosum), shadbush (Amelanchier canadensis) and sweetfern (Comptonia peregrina). Mountain and sheep laurel (Kalmia latifolia and augustifolia), greenbrier (Smilax rotundifolia) and scrub oak (Quercus ilicifolia) also occur, but to a lesser extent.

Depending on its specific location, an NEC in Ocean County would affect these five core environments to a greater or lesser extent.

11.2 Wildlife in Ocean County

The varied habitats found in this part of New Jersey provide excellent foraging and breeding grounds for resident and migratory animal life. For example, more inland Fish and Wildlife Management Areas exist within 20 miles of Fort Dix than throughout all the rest of New Jersey. In addition, the U.S. Fish and Wildlife Service recently purchased the 4000 acre Little Egg Harbor Division of Barnegat National Wildlife Refuge for the purpose of protecting and preserving high quality tidal marsh for migration and wintering

habitat important to Atlantic brant and black ducks; this area is our hypothetical Bay Site.²

Rare and Endangered Species. This area of Ocean County falls within the range of several forms of animal life which are considered rare or endangered. The osprey (Pandion haliaetus) and the red shouldered hawk (Buteo lineatus) are thought to nest in the vicinity, though specific sites have not been spotted. Evidence of the pine barrens tree frog, a species endemic to cedar swamps, has also been noted.

Mammals. The largest game mammal in the area is the white tailed deer, most abundant in areas associated with understory vegetation of the pine, hardwood, and mixed sites which provide year round diverse and abundant browse. Gray and red squirrels are common, primarily wherever deciduous trees are found. Grading towards more open areas, a number of smaller mammals become important, including: raccoons, skunks, opossums, cottontail rabbits, and the house mouse. The gray fox is found frequently in areas where small game is abundant, white and red fox becomes more common in the northern part of the county. However, the fox population fluctuates with changes in the abundance of small prey.

The muskrat is the only economically important mammal found in the vicinity of the sites, although local residents also report trapping beaver in the coastal marshes of Barnegat Bay. Weasels, mink, and otter also are found in the marshland or along tidal creeks, but are not numerous enough to be economically important.³

Birds. Important gamebirds of the area are the ruffed grouse, the bobwhite quail, and waterfowl. Ruffed grouse utilize small pockets of low-land hardwoods while the bobwhite quail are attracted by edge vegetation formed by partially open understory that border openings in the pine and hardwood areas. The ringnecked pheasant associated with open farmland is also a gamebird of some importance in Ocean County.⁴

Coastal estuaries provide habitat for migrating waterfowl. Barnegat Bay is within the Atlantic Flyway which receives ducks traveling from the Maritime Provinces to winter along the Atlantic Coast. The Corridor funnels over 250,000 ducks, including lesser scaup, greater scaup, and canvasbacks past Barnegat to wintering points in Delaware Bay and further south. In

addition, over 100,000 mallards, teals, widgeons, redheads, and gadwells have been recorded in the Barnegat area, and approximately 180,000 brant are reported to winter between Barnegat Bay and Cape May.⁵

Varied habitats found in this part of New Jersey provide an excellent environment for many species of birds. Such environments are a source not only of food and (in many cases) protection, but are also breeding grounds for many species of birds not found in the area all year round. Over 120 species of birds occur in the pinelands. Not all of these birds are permanent residents; many are migratory and found only during specific periods of the fall and spring. Others, such as the red crossbill, the white throated sparrow, the pline siskin, and myrtle warbler, the American woodcock, the short-eared owl, the common loon, and the brown creeper, are found only during the winter. Birds which summer in this area include the morning dove, the eastern kingbird, the simipalinated plover, the wood thrush, the robin, several types of vireo and warbler, the Baltimore oriole and the scarlet tanager. Permanent residents include the starling, the purple finch, the marsh hawk, the golden crowned kinglet, the loggerhead shrike, the Carolina wren, the fish crow, several types of chickadee, woodpeckers and crows, and the great horned owl, the American goldfinch, and the song sparrow.

Amphibians and Reptiles. A relatively small number of reptiles have been observed in the vicinity of the sites. Those known to occur include: the eastern box turtle, the snapping turtle and the diamondback terrapin. The snapping turtle is the only economically important species; trapped during May and June. In addition, the bog turtle has been observed further south and may encroach on the formlands in the vicinity of the sites. Apart from the pine barrens tree frog and the four-toed salamander, all amphibians recorded locally have extensive distribution throughout the United States. Common species include the leopard frog and the green frog.

Fish. Little information is available on freshwater fish found inland in the vicinity of the sites. A number of species are known to occur, including: the chain pickerel, the redbfin pickerel, the yellow bullhead, the pirate perch, the golden shiner, the American eel, the creek chubsucker, and the mud and orangespotted sunfish common to small moderate temperature water bodies of the coastal plain.

The NEC's impacts on this wildlife would again depend on its specific location and on possible measures introduced to minimize these impacts.

11.3 Flora and Fauna of Barnegat Bay

Barnegat Bay is bordered by salt marshes, with an estuarine zone on the west and a sand dune barrier beach on the east. The shallow bay has a relatively small tidal amplitude, contains both sand and mud bottom areas, and in shallower regions has a dense growth of rooted plants. Such estuarine areas are recognized as being among the most complex and productive sites in the world.

Flora. The estuarine zone and adjacent bay waters have abundant stands of eel grass (Zostera marina) and widgeon grass (Ruppia maritima), both of which are primary producers providing food for aquatic organisms and waterfowl. Over 130 species of benthic algae were identified between June 1965 and June 1968. Of these, only 16 occurred more than 50% of the time, though their relative ranking and frequency changed (Table 11-1).

Phytoplankton demonstrate a seasonal cycle of species occurrence and abundance common to temperature estuaries. Peak summer and fall temperatures are accompanied by dinoflagellate dominance. A bloom of diatoms (mainly Thalassiosira nordenskioldi, detonula supp., and Skeletonema costatum) occurs with the vernal light increase and disappearance of ice and continues until higher water temperatures plus increased numbers of copepods caused reduction.

Zooplankton. The spring flowering of phytoplankton provides abundant forage which will support a large population of zooplankton. Zooplankton numbers remain fairly high during the spring but the dominant species change with time. Early in March the population is chiefly composed of the Calanoid copepods (mainly Acartia spp.). In April small Medusae (Perigonemus equora) begin to appear, and when water temperature exceeds 15°C the large Coelenterate (cyanea capitata) becomes abundant.

The Ctenophore (mnemiopsis leidyi) which appears each spring is the dominant zooplankton and feeds with particular selectivity on the Calanoid copepod (acartia sp). Mnemiopsis is eventually replaced, to some extent, by a second Ctenophore species (Beroe ovata). Both species apparently cease predation by mid-fall.

Zooplankton populations decrease through the fall and winter. Consequently, during the fall, the Rotifers asplanchna and Synchaeta along with the Tintinnid protozoa become the major species. A significant population increase in zooplankton takes place by the end of February, associated with an increase in Phytoplankton population.

Benthic Fauna Benthic collections in Oyster Creek, Forked River, and Barnegat Bay produced a total of 170 animal species, the dominant forms being the golden bristled worm (Pectinaria gouldi) and the little mactia (Mulinia lateralis). The frequency of occurrence of various benthic organisms is shown in Tables 11-1 and 11-2.

Commercial and sports catches of oysters (Crossostrea virginica), bay scallops (Acquiptera irradians), and blue mussels (Mytelus edulis) have declined in comparison to peak years, as have landings of hard blue crabs (Callinectes sapidus) and soft shelled clams (Mya arenaria). Hard clam (Mercenaria mercenaria) landings were fairly stable through 1969 despite the increased number of acres closed to fishing due to pollution. Scallops, which are motile, tend to cluster, and are often associated with eel grass communities, also provide some sport and commercial harvest in the bay.

Finfish. Barnegat Bay and its estuaries are prime spawning and nursery grounds for many marine finfish species. The early life stages (eggs and larvae) of fish are known to be most susceptible to changes in the environment (temperature, salinity, oxygen content, etc.). Of 57 species collected for one study, perhaps 24 (42%) used the bay as spawning and nursery grounds.⁶ Though the majority have demersal eggs (which sink to the bottom or are attached to a fixed object) as apposed to pelagic eggs (which float), all early larval stages spend time in the water column and would be affected by changes in the regimen of the bay or its estuaries associated with construction or operation of an NEC.

As indicated in Table 11-3, eight species of fish which occur in Barnegat Bay are migratory for spawning purposes. Only one, the American eel, is catadromous; that is, it matures in freshwater and then migrates to the ocean to spawn. Four species--the American shad, the alewife, the gizzard

Table 11-1

BENTHIC ALGAE FOUND IN 50% OR MORE OF 1965-70 COLLECTIONS

<u>Species</u>	<u>(1965-1968)</u>	<u>Rank</u>	<u>(1969-1970)</u>
Ulva lactuca	1		1
Agardhiella tenera	2		6
Ceramium fastigiatum	3		5
Champia parvula	4		10
Gracilaria verrucosa	5		2
Polysiphonia harveyi	6		7
Acrochatium sp.	7		19
Polyshpionia negresceng	8		(not present)
Gracilaria fulifera	9		8
Codium fragile	10		4
Entocladia veridis	*		
Polysiphonia denudata	*		
Enteromorpha intestinalis	*		
Callithamnion sp.	*		
Enteromorpha linza	*		
Desmatrichium undulatum	*		

*Not ranked

Source: Oyster Creek Environmental Report, note 6, p. 2.7-1.

Table 11-2

FREQUENCY OF OCCURENCE OF DOMINANT BENTHOS

<u>Species</u>	<u>Percent</u>
Tollina agilis	34.8
Idothea bactica	7.2
Neopanope texana	6.1
Mulina lateralis	4.9
Billium alternatum	4.1
Mitrella lunata	3.7
Pectinaria gouldii	3.5
Maldanopsis elongata	3.4
Glycera disbranchiata	3.1

Source: Oyster Creek Environmental Statement, Note 11, p. 2-30.

TABLE 11-3

FINFISH COLLECTED IN THE BARNEGAT BAY AREA (1966-68)

Species	No. Captured	Species	No. Captured
Alewife ^(a)	8	Northern pipefish	1,407
American eel ^(a)	98	Northern puffer ^(b)	7,113
American shad ^(a)	1	Northern searobin	8
Atlantic herring	1,405	Orangespotted sunfish	
Atlantic menhaden	7	Oyster toad fish	271
Atlantic needlefish	242		
Atlantic round herring		Pollock	3
Atlantic silversides	69,594		
		Rainwater killifish	157
Banded killifish	416	Red grouper	1
Bay anchovy	25,950	Roughtail stingray	1
Black drum	2		
Blueback herring ^(a)	81	Sheepshead minnow	110
Bluefish	153	Shorthorn sculpin	
Butterfish	1	Silver perch	3,126
		Smallmouth flounder	2
Chain pickerel	1	Spot	6
Creville jack	2	Spotted burrfish	
Cunner	14	Spotted seahorse	1
		Squirrel hake	
Fourspine stickleback	20,169	Striped bass ^(a)	1
		Striped blenny	4
Gizzard shad ^(a)	3	Striped burrfish	3
Golden shiner	1	Striped killifish	1,506
Grubby	13	Striped mullet	2
		Summer flounder	1
Hogchoker ^(a)	6		
Horse-eye jack	52	Tautog	118
		Threespine stickleback	48
Lookdown	13	Tidewater silversides	1,977
Mummichog	1,940	Weakfish	2
		White mullet	1
Naked goby	64	White perch ^(a)	155
Northern kingfish	247	Window pane	-17
		Winter flounder	1,296

(a) Migrants

(b) 6,833 in 1966-67, and 280 in 1967-68

Source: Oyster Creek Environmental Statement, note 11, p. 2-32.

shad, and the blueback herring--are anadromous, moving to fresh water to breed. The remaining three--the white perch, striped bass and the Hogchoker--spawn in the area of the saltwater-freshwater interface. Thus, any changes that would eliminate this interface or block passage between salt and fresh water would dramatically alter use of the estuarine area as spawning grounds.

As is common to other mid-Atlantic estuaries, seasonally abundant baitfish (Atlantic silverside and bay anchovy) were the most numerous species collected and comprised the majority of the total catch. Three sport species (northern puffer, silver perch and winter flounder) were in the top 10% during both collection years, and 13 other sports species appeared in the collection. Commercial fish catch statistics from 1960-1969 are shown in Table 11-4.

11.4 Ecological Impact of an NEC

Determination of the range and scale of possible impacts of a Nuclear Energy Center on the flora and fauna of Ocean County is complicated. Attempts to link impacts to specific segments of the NEC process such as site preparation, plant construction, or plant operation compound the difficulty when carried out both sequentially and simultaneously. In addition, climatic and hydrologic changes induced by development and operation may also result in ecologic changes. While determination of the extent of impacts resulting from distinct processes has been done in the past, development of an NEC presents three distinctive questions. First, what are the initial traumatic affects of site preparation? Second, what are the cumulative affects of a series of processes prolonged over 30-50 years? Third, what is the ability of the ambient environment to recover from the initial traumatic changes and from impacts resulting from a prolonged series of processes?

Evaluation of changes in the environment as being either positive or negative is often beyond the scope of this report. As will be pointed out, a number of changes may benefit many species of flora and fauna and the relationship of man to the environment. However, changes in habitat beneficial to one species are often inimical to others, and an increase in the abundance of one species may be a sign of "eco-instability".

TABLE 11-4

COMMERCIAL FINFISH CATCH STATISTICS, 1960-1969

Year	Shad	Mullet	Eels	(Winter Flounder) Black Back	Alewives	(Black Fish) Tautog	W. Perch	Mixed
1960	0	0	8,200	23,100	0	0	7,000	0
1961	0	0	12,600	27,300	0	0	17,000	0
1962	0	0	6,700	12,300	4,900	0	8,500	0
1963	0	18,000	6,400	18,100	0	0	4,700	400
1964	500	16,000	29,000	22,300	6,600	0	12,000	0
1965	200	9,400	35,400	12,500	7,800	100	10,900	0
1966	0	7,900	51,900	35,200	5,800	200	6,900	0
1967	100	13,600	38,100	32,800	3,000	100	10,400	0
1968	0	10,200	42,300	24,300	4,300	0	18,900	0
1969	0	0	70,000	2,100	200	0	4,100	0

Source: Oyster Creek Environmental Statement, note 11, p. 2-34.

Traumatic Impacts. The activities which initiate traumatic changes in the environment take place during site preparation and plant operation. They include land clearing, land filling, construction of access roads, housing and institutional development resulting from population increases, and effluent discharges.

Changes in habitat resulting from land fill and land clearing activities are likely to decrease in intensity and extent from the Bay Site to the Fort Dix Site. The central principle for this observation revolves around the degree of change necessary to adapt the present environment in these areas to an environment suitable for construction and operation of nuclear power plants. Landfill necessary to prepare the Bay Site would be extensive; less would be required at the Inland Fort Dix Sites. Land clearing operations required at the Inland Site are not required at Fort Dix. While development of access roads for all sites would present minimal problems, the influx of labor would increase from the Fort Dix Site to the Bay Site. Those areas least suited to handle large population increases and requirements (for water, sewerage, housing, schooling and transportation) will experience the greatest growth.

Changes in habitat would be most extensive at the Bay Site, which is now part of an extensive coastal marshland with one of the highest productivity rates in the world. Landfill operations raising the level of land above mean sea level and filling tidal channels will diminish use of the immediate environment as a productive area, if not ending it entirely. Sediment runoff and silt loading in Little Egg Harbor may change the light penetration and heat absorption qualities of the harbor's waters, further decreasing productivity. Blockage of tidal penetration will affect salt water intrusion, hence altering the biota found in brackish water marshes inland of the coast.

Land clearing and landfill operations at the Inland Site would cause extensive changes in present vegetation patterns. The filling of white cedar swamps and marshes may result in complete loss of that habitat. Clearing operations in forest areas may have mixed affects; while decreasing the forest area (mainly scrub pine and oak) they may result in creation of open or semi-open grasslands and shrub environments. Such areas, excellent habitats for many animals, are not extensive at this site. Where such changes are artificially or naturally induced they ultimately attract a variety of animal life.

The Fort Dix Site is better prepared for an NEC than either the Bay or Inland Sites. It has large areas of moderately well drained open land; an extensive network of access roads, and an existing labor force within commuting distance. It also displays the greatest variety of plant and animal life and plant and animal habitat. While some habitat may be lost through land-fill activities, such changes are not completely detrimental; for example, loss of insect breeding grounds will diminish the need for the application of biocides to control insect populations.

Apart from the loss or change of vegetation patterns and habitat, other traumatic impacts may result from thermal or biocide loading from effluent discharges. Though the discharge outlet for coolant would be several miles offshore, and the assimilative capacity of the ocean is great, local impacts might be severe. Better knowledge of coastal circulation patterns, including tidal flow and circulation into Barnegat Bay and Little Egg Harbor, would be necessary to guard against pollution of these shallow water bodies.

Cumulative Impacts. Three major concerns are involved in evaluating changes occurring over a long period of time: To what extent are traumatic impacts prolonged or aggravated by new activities? What new changes can be expected to result from new activities? And how do these activities effect the regenerative and assimilative capacity of the environment?

The major activities that might initiate cumulative impacts include air emissions, waste discharge (other than cooling water), noise resulting from operation of heavy machinery and the plants, increased traffic in the region and the vicinity of the site, and presence of human activity in areas previously relatively undisturbed. These activities are not uniform in their affects on plant and animal life. Each may effect a range of changes depending on intensity and duration. Some of these activities (such as emissions) have been recognized as potential dangers and been accounted for in the regulatory process. Yet the present regulatory process certainly is not designed to deal with the cumulative impacts of a cluster of nuclear plants, and the potential impacts of a number of plants may be greater than the impact of any one plant.

Operation of an NEC creates several new problems associated with atmospheric emissions. Radiological impacts of a number of nuclear plants

operating in conjunction have not been measured. Research done at Brookhaven National Laboratory suggests that over a period of time small dosages of radiation can have an attributable impact on vegetation.⁷ While both dosage levels and types of dose do not correspond to those from nuclear power plant operations, the possibility of corresponding impacts should not be overlooked.

Of more immediate concern is the impact of salt drift on the site and its environs. Changes in the surface loading of salt should be measured against the ambient background levels of salt, which decrease inland from the coastal marshland to Fort Dix. Changes in salt loading should also be correlated against the salt tolerance of plants and animal life likely to be affected. Current salt loading at the Bay Site is heavy. Salt loading decreases at the Inland Site, but does not cease; vegetation found at this site is relatively hardy and tolerant. The Fort Dix Site presents a stark contrast to the other two sites. The local vegetation, both natural and induced, is not highly tolerant, and the presumed cooling system (natural draft evaporative cooling towers) and local atmospheric circulation would produce increases in salt deposition. Decreases in soil fertility and changes in the abundance patterns of vegetation could be expected throughout this area. Although not a problem for mammals and birds found in the area, salt deposition to standing freshwater bodies might decrease their utility as a habitat for game fish or as breeding grounds for reptiles and amphibians.

Other air emissions need to be considered in relation to their potential impact, including:

- particulates generated by construction activities
- carbon monoxide associated with automobile congestion
- photochemical oxidants
- biocides used to control vegetation growth or insect populations.

Of immediate concern is the effect of such emissions on both plant and animal life. Biocides (if applied) will have an immediate and traumatic affect; repeated applications have the potential for food chain disruption and are known to cause reproductive harm to animals at the apex of the local food chain. Photochemical oxidants are recognized to have similar traumatic impacts if the duration of smog incidence is prolonged. Repeated incidents or heavy concentrations may cause health problems for animal life found in the vicinity.

Runoff and silt loading would continue at all sites and could be aggravated by effluent discharges resulting from consumptive activities (this does not include water used in the cooling process). Heavy groundwater use at the site or in housing facilities might cause local drawdown. The impact of effluent discharges would depend on their contaminant content and thermal qualities as well as the quality and assimilative capacity of the effluent sink.

Regenerative Capability. The regenerative ability of plant and animal life must also be considered. The effects of landfill activities cannot be easily changed. Vegetation and animal life existing in wetlands are intolerant of changes in their environment. On the other hand, each site has differing abilities to regenerate the ambient vegetation pattern lost as a result of land clearing operations. The Inland Site could (conceivably) regenerate its scrub forest over a fairly short time. Cleared areas of Fort Dix have the same potential for regeneration, except for several large stands of climax vegetation, which, if lost, might be missing forever.

Repopulation by animal life presents a slightly different problem. Many animals are tolerant of human activity and coexist in relative equanimity, particularly where changes in habitat are beneficial. This is dependent on several factors: the return of favorable vegetation, the level of activity at the nuclear power plants, and the tolerance of animals to noise.

11.5 Conclusions and Comparison With Dispersed Nuclear Siting

Land filling and clearing activities would have the largest immediate impacts on both vegetation and wildlife. In comparison to these activities, development of access roads, operation of heavy machinery, and increased traffic in the vicinity of the sites would have less obvious changes. However, evaluating potential changes resulting from atmospheric emissions, wastewater discharge, noise levels, consumptive water use, and particulate loading have a longer lifetime and possibly a greater cumulative affect than either land clearing or filling. Tunnelling activities carried out completely subsurface (except for air venting) would have negligible impacts on both surface and water areas. Impacts related to population loading would vary depending on the extent to which air emissions and wastewater discharges are controlled, the extent of water and land consumption, and changes in the industrial and recreational use of the surrounding environments.

While the assimilative or regenerative capacity differs at each site, the method of development may inhibit or encourage repopulation by animal life and growth of vegetation. Undesirable impacts may be attenuated by proper staging of development activities; by encouraging grasslands^{*} or forage habitats; by restricting human activity to the immediate construction or operational site; by adequate treatment of effluents and emission; and by protection of local water resources.

Impacts which result from construction and operation of nuclear power plants in a dispersed siting pattern would display very different characteristics. Site preparation and plant construction of dispersed plants are neither prolonged nor concentrated, as would be the case for an NEC. Thus, the aggravation potential of a series of land clearing and construction activities which hinder the return of vegetation and wildlife for the NEC would be of measurably shorter duration and magnitude for dispersed sites. In the same vein, smaller land requirements would decrease the potential for loss of unique habitats or endangered flora and fauna.

As with the three surrogate NEC sites in Ocean County, the magnitude of traumatic impacts would depend on the specific location of dispersed sites. Marshland and estuarine areas have a low tolerance for intense development; lacustrine or riverine sites have a variable capability to assimilate development (depending on specific conditions); while marine sites have a moderate tolerance for siting. Specific conditions at each site, as well as care taken in selection and development, would define the potential impacts.

The potential for impacts resulting from operation of nuclear power plants with water intakes and discharge outlets in estuarine, riverine or lacustrine environments is greater than that of the NEC discussed previously or of reactors located at offshore locations. Thermal shock, pressure changes, mechanical damage, and chemicals are expected to cause (essentially) 100% mortality to organisms which pass through intake screens.⁸ Where the fraction of water withdrawn for cooling purposes is large, and the intake rate is also large, drift population mortality would be considerable. Thermal and chemical discharges would have variable impacts depending on the unacceptability of aquatic biota to the particular mix of pollutants and the mixing qualities and loading at each site. A seasonal phytoplankton blooms and species shifts have been observed to occur and are correlated with thermal discharge.⁹

Secondary effects are difficult to predict. Fish stressed by disease, parasitism, or pesticides are more susceptible to thermal loading.¹⁰ Similarly, such stress may decrease the reproductive potential or spawning patterns of some species.

Other possible changes include salt deposition and changes in the fresh-water/saltwater interface (at estuarine locations), interruption or loss of habitat for migratory wildlife, bird kills as a result of transmission lines or cooling towers, and animal population fluctuations and distribution resulting from changes in habitat.

A correlation of impacts resulting from an NEC and an equal number of dispersed plants is dependent on the location and technology of each specific dispersed site and of the NEC. The traumatic impacts resulting from an NEC are measurably greater than those of individual dispersed sites but in the balance, dispersed sites may engender impacts of equal, if not greater, extent and duration. Different water requirements and technologies are likely to cause the aquatic impacts at dispersed siting to be greater than that of the NEC.

NOTES TO CHAPTER XI

1. "Environmental Report: Forked River Nuclear Generating Station, Unit#1", Sterns and Rogers, Inc., Denver, Colorado, March 1972.
2. Letter, dated April 19, 1976, from Acting Regional Director, U.S. Fish and Wildlife Service, to David Morell, Center for Environmental Studies, Princeton, N.J.
3. Paul F. Connor, "Notes on the Mammals of a New Jersey Pine Barrens Area", Journal of Mammology 34 (1) (1953).
4. David Fables, "Annotated List of New Jersey Birds", (1955), Urner Ornithology Club, Newark, N.J.
5. Frank C. Bellrose, "Waterfowl Migration Corridors East of the Rocky Mountains in the United States", Ill. Nat. Hist. Survey, Bio. Notes No. 61 (1968).
6. "Oyster Creek Nuclear Generating Station; Environmental Report", Jersey Central Power and Light Co, March 1972.
7. G. Woodwell, "Ionizing Radiation and Forests", McGraw Hill Yearbook of Science and Technology (1968).
8. "Environmental Statement: Limerick Generating Station, Units 1 and 2", Philadelphia Electric Company, November 1973.
9. F. J. Trembley, "Research Projects on the Effects of Condensor Discharge on Aquatic Life: Progress Report, 1956 to 1959", Lehigh University, 1960.
10. "Environmental Statement: Susquehanna Steam Electric Station, Units 1 and 2", Pennsylvania Power and Light Company, June 1973.

CHAPTER XII*

TRANSMISSION AND ITS IMPACTS

12.1 Introduction

The complexity of the many technical issues involved in a detailed comparison of electrical transmission from an energy center or a dispersed siting pattern goes beyond the scope and probable readership of this report. The major problem, of course, is that a consideration of just the direct links between generating facilities and the existing grid is quite insufficient, because even a single additional link can affect in a major way the electrical characteristics of the entire transmission network. Thus, an analysis of the entire MAAC-PJM transmission grid is necessary to assess adequately the transmission impacts of the two siting modes. Moreover, at issue are not merely the number of miles of transmission line, or their right-of-way requirements, but also network stability and reliability. In an alternating current (AC) network, where capacitance and inductance play as important a role as resistance, network analysis is considerably more complex than a mere matching of generation and load points in terms of megawatts. For further technical information, the reader is referred to the main NRC report on nuclear energy centers for a general discussion of transmission issues and a fairly comprehensive bibliography,¹ and to the forthcoming detailed Brookhaven report on this topic.²

In general, transmission line planning in the electric utility industry consists of two phases. The first, or conceptual planning stage, simulates only the resistive loads by specifying generation and demand at a number of network nodes, and uses the optimization techniques of Operations Research to determine network configurations that are of adequate reliability.³ This type of analysis was performed by the General Electric Company for all

* Prepared with the assistance of Simpson Linke and Donald Chu, School of Electrical Engineering, Cornell University.

of the surrogate sites analyzed as part of the NRC study, using a linear programming model developed by Garver.⁴ Results of this first-order analysis are summarized below in Section 12.2.

The conceptual plans, then, are an acceptable first-estimate of network conditions, and these form the starting point for the much more sophisticated network studies, called "load-flow" studies, that analyze the actual AC (rather than DC) characteristics of the network. This second stage of analysis is currently underway at the Cornell University School of Electrical Engineering under contract to Brookhaven's Regional Energy Studies Program.⁵ Some preliminary results of this analysis are presented in Section 12.3.

Both of these analyses are based on overhead, AC transmission. The time horizon of the energy center, however, is such that one could reasonably expect some of the newer transmission technologies to play a significant role. Thus the Cornell work in the near future will extend to DC transmission and compressed-gas-insulated (CGI) underground cables, again using the New Jersey surrogate site as a case study example.

12.2 The Basic Transmission Analysis

The methodology used by the GE analysis requires first that the entire MAAC-PJM network be expanded from 1987 through 2006 in accordance with the assumptions of the dispersed siting scenario.⁶ Specification of new generation units, as shown in Table 2-1, is thus the first part of the input. The second major component is the specification of load at each point in the network; in first approximation, each node of the network showing load in the 1985 MAAC Load Flow Study was extrapolated to 2006 by apportioning the total system load (see Figure 2-3) in proportion to expected 1985 loads.⁷ This, admittedly, is a considerable simplification, but the large number of network nodes involved, and the absence of any established methodology for projecting node loads far into the future, made proportional extrapolation the only tractable procedure. Finally, the third major input to the methodology is the network configuration itself; each link in the 230 and 500 Kv network of 1985 (as forecast by MAAC), plus any adjacency relationship between nodes that would be allowable in a system expansion, were thus

specified. Some of the other major assumptions are displayed on Table 12-1.

The analysis, then, proceeds as follows. First, computations are performed for the dispersed case expansion of the network. Then in accordance with the requirements of the NEC scenario developed in Section 3.3, a second network is constructed for the clustered case; in effect, this differs from the dispersed case only in the location of 20 reactors selected for the NEC. However, the analysis of transmission cost clearly is dependent on the reliability constraints imposed on the system, and thus computations were made for three different NEC cases. Case A assumes that the completed NEC would be electrically interconnected, and served by 10 lines rated 2400 Mw normal, and 3000 Mw with 2 lines on outage. Case B also assumes electrical interconnection, but the NEC is served by 15 lines rated 1600 Mw normally and 2400 Mw with two lines on outage. Case C assumes the completed center to consist of 5 electrically isolated groups of 4 units each, each group served by 4 lines, 20 lines total, rated 1200 Mw and 2400 Mw with two lines on outage.

The results of the GE model for each of the three NEC configurations and the dispersed case are shown on Table 12-2. Note, however, that right-of-way costs are excluded. Table 12-3 summarizes the results by the year of NEC completion, including the estimated number of miles of 230 and 500 Kv line and the corresponding right-of-way estimates (given the assumptions of Table 12-1). Figures 12-1 and 12-2 indicate configuration of the transmission network for the dispersed case and NEC Case B.

These results indicate that transmission investments for the NEC would differ little from those required in the dispersed case. The differences range from \$83m, or 5%, less than the dispersed case (NEC Case A) to \$102m, or 7%, more than the dispersed case (NEC Case C). Right-of-way requirements show similar orders of magnitude of difference. G.E. has expressed the judgement that the NEC Case B, with 1600 Mw line loadings, would correspond to a likely compromise between reliability and cost. Under this premise, one can conclude that differences in transmission cost would not significantly affect the overall benefit-cost calculus for an Ocean County NEC. Indeed, the order of magnitude of differences shown on Tables 12-2 and 12-3

TABLE 12-1

ASSUMPTIONS^aLAND USE ASSUMPTIONS

	<u>Route Width</u>	<u>Acres/Mile</u>
230Kv	125 Ft	15
345	150	18
500	175	21
765	200	25

COST ASSUMPTIONS

(1973 dollars)

	<u>M\$/Mile</u>	<u>M\$/Terminal</u>
230Kv	0.16	1.40
500	0.38	4.60

CIRCUIT CAPACITY ASSUMPTIONS^b

	<u>At 50 Miles</u>	<u>At 200 Miles</u>
230Kv	320Mw	160Mw
345	1000	500
500	2400	1200
765	5500	2750

a Source: Garver et al, note 5

b These are maximum loadings. Economic loadings approach the values "At 200 Miles".

TABLE 12-2

TRANSMISSION INVESTMENT
(Cumulative)

Millions of Dollars (Excluding Land)

Year	Dispersed Sites	Energy Center in New Jersey		
		Case A 10 lines	Case B 15 lines	Case C 20 lines
0	0.	0.	0.	0.
1	107.	105.	105.	105.
2	229.	206.	206.	206.
3	281.	257.	257.	257.
4	386.	342.	342.	342.
5	415.	372.	372.	372.
6	447.	416. 0	433.	466.
7	603.	555.	555.	588.
8	646.	555.	571.	605.
9	662.	597.	597.	630.
10	762.	681.	698.	764.
11	825.	720.	753.	803.
12	870.	806.	839.	889.
13	1031.	936.	969.	1019.
14	1087.	987.	1020.	1103.
15	1087.	1031.	1081.	1147.
16	1187.	1143.	1215.	1281.
17	1192.	1228.	1278.	1344.
18	1322.	1252.	1324.	1437.
19	1457.	1415.	1487.	1576.
20	1507.	1415.	1511.	1600.
21	1535.	1452.	1548.	1637.

TABLE 12-3

SUMMARY COMPARISONS

<u>kV</u>	<u>Miles</u>	<u>Acres</u>	<u>Millions of Dollars</u>	
DISPERSED SITES				
230	178	2670.	43.	
500	1724	<u>36204.</u>	<u>1492.</u>	
		38874.	1535.	TOTAL
ENERGY CENTER, Case A (Electrically Interconnected, 2400Mw Line Loadings)				
230	152	2280.	33.	
500	1580	<u>33180.</u>	<u>1419.</u>	
		35460.	1452.	TOTAL
		-9%	-5%	Increase or
		0		Decrease from Dis-
				persed Pattern
ENERGY CENTER, Case B (Electrically Interconnected, 1600Mw Line Loadings)				
500	131	<u>2751.</u>	<u>96.</u>	
		38211.	1548.	TOTAL
		-2%	+1%	Increase or
				Decrease from Dis-
				persed Pattern
ENERGY CENTER, Case C (Isolated Groups of 4 Units, 1200Mw Line Loadings)				
500	111	<u>2331.</u>	<u>89.</u>	
		40542.	1637.	TOTAL
		+4%	+7%	Increase or
				Decrease from Dis-
				persed Pattern

probably lies within the range of accuracy of the assumptions and cost functions used in the analysis.

12.3 Highlights of the Detailed Load-Flow Study

The overall results of the Cornell load-flow study may be summarized in terms of the miles of transmission line that must be added to the entire system in the years 1986-2006 to meet the projected demand and generating capacity in 2006.⁸ The numerical results, however, are strongly dependent on whether one limits the system to 500kV, or allows expansion to 765kV. Table 12-4 shows the results for the 765kV system (which, of course, still contains substantial lengths of 500kV); Table 12-5 shows the results when 500kV remains the highest allowable voltage.

Examination of the results of the steady-state load-flow studies reveals that the electrical behavior of the two modes of operation are quite similar, differing only in that the dispersed case has approximately 9% greater var loss due to the greater length of 500kV transmission.⁹ Adequate var compensation could be accomplished by means of static capacitors with little increase in overall cost.

TABLE 12-4

TRANSMISSION LINES BY 2006 FOR SYSTEM ALLOWING 176kV

	Miles of <u>500kV</u>	Acres of <u>R-O-W^b</u>	Miles of <u>765kV</u>	Acres of <u>R-O-W</u>	Total of <u>Acres R-O-W</u>
NEC Case	1750	36750	1030	4120 ^a	40870
Dispersed Case	2200	46200	600	2400 ^a	46800

^a Based on 4 acres per mile added for upgrading 500kV lines to 765kV.

^b Right-of-way.

Figure 12-1. NEC case 500 kV network.
 Source: G.E., note 5, p. 2-54.

Figure 12-2. Dispersed case 500 kV network.
Source: G.E., note 5, p. 2-55.

Comparative estimates of transmission-line costs also may be obtained from the data in Tables 12-4 and 12-5. Table 12-5 shows only the line cost for the sake of simplicity. Cost estimates per mile are the same 1975 figures used in the G.E. analysis (see Table 12-1).

TABLE 12-5

COST COMPARISON FOR TRANSMISSION IN 2005

<u>Scenario</u>	<u>500kV (M\$)</u>	<u>765kV (M\$)</u>	<u>Totals (M\$)</u>	<u>500kV Alone (M\$)</u>
NEC	665	227 ^a	892	1444
Dispersed	836	132 ^a	968	1292

^a Line cost of upgrading from 500kV to 765kV.

The data in Table 12-7 indicate that, under the assumptions of the Cornell study, the line cost of a two-voltage-level dispersed site scenario is about 8% greater than the equivalent NEC scenario.¹⁰ For both systems limited to the 500kV level, the dispersed site scenario is about 10% lower in cost. In other words, the benefit of allowing 765 kV is much greater in the NEC case than in the dispersed case; in the former case, the total saving is some 38 percent, or \$552m; in the latter, only 25 percent, or \$324m. Thus clustered siting tends to provide further economic impetus toward a shift upwards to 765kV transmission.

Because of the significantly greater detail encompassed in the Cornell load-flow study, differences from the GE analysis should not be unexpected. The major discrepancy is the land use estimate for systems limited to 500kV, in which the Cornell analysis shows a significantly higher impact for the NEC. In terms of costs, however, both analyses are in rough agreement,

indicating that transmission requirements with clustered siting would range between 10 percent less and 10 percent greater than the dispersed case cost, depending on assumptions.

NOTES TO CHAPTER XII

1. NRC-NECSS, Vol. III, Section 4.
2. S.L. Linke and D. Chu, "Transmission Studies of Dispersed v. Clustered Generation Facilities", BNL 50565, Brookhaven National Laboratory, Regional Energy Studies Program.
3. The ability of a given network to perform under stress can be simulated by deletion of particular links in a network. In linear programming terms, one need merely delete an element in the node-adjacency matrix, and rerun the optimization to see if a feasible solution results for the network with given lines on outage.
4. L.L. Garver, "Transmission Network Estimation Using Linear Programming", IEEE Transactions, Vol. PAS 89, p. 1688-1697, 1970.
5. Linke and Chu, op.cit.
6. Details of the technical methodology, and full presentation of numerical input and output, are to be found in L.L. Garver et al., "Transmission Expansions as Affected by Energy Centers", Report by the Electric Utility Systems Engineering Department, General Electric Company, Schenectady, N.Y., to the NRC, November 1975.
7. MAAC Systems Plans, April 1, 1975.
8. For full details, see Linke and Chu, Note 4, supra.
9. var = volt amperes reactive. A var loss is a loss due to the reactive component of an AC current flow not in phase with the alternating voltage.
10. A transmission "line" consists of one or more "circuits," each circuit requiring three wires for 3 phase A.C. (or two wires for Direct Current). At high voltages, 345kV and above, most current designs call for one circuit per set of transmission towers.

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CHAPTER XIII*

SOCIOECONOMIC ISSUES

13.1 Methodology

Our analysis has been carried out for two general purposes. First, we have attempted to assess certain likely socio-economic impacts -- particularly employment and income -- which would result from construction and operation of a 24,000 Mw NEC at each of our three hypothetical sites in Ocean County. Second, we have considered how these impacts might differ should the same generating capacity be provided instead by the dispersed siting scenario described in Chapter III.

In making projections, we have assumed that several ceteris paribus conditions hold: (1) that the structure of the economy and basic national economic trends will not fundamentally change, and specifically will not be affected by construction of such a project; (2) that demographic factors of which we are presently aware will continue to hold; (3) that the technology needed to construct the NEC will indeed be on hand, and that present estimates of work force and other inputs necessary to initiate, construct, and operate such a project are more or less realistic; and (4) that there will indeed be demand for power generated by reactors of 24,000 Mw, whether in the NEC or the dispersed siting mode.

13.2 Socioeconomic Impacts of an NEC in New Jersey

The New York and Philadelphia metropolitan areas exert a strong influence on activities in Ocean County. In fact, the New Jersey Division of State and Regional Planning, Department of Community Affairs, has designated both New York and Philadelphia as Class I Centers--Metropolitan Centers of Extensive Influence.¹ The extent of the region--the area over which the

* This chapter was prepared initially by W. Isard, R. Van Zele and T. Reiner of the Regional Science Department, University of Pennsylvania. It represents a shortened version of a more detailed technical report to be published by the BNL Regional Energy Studies Program, "Regional Economic Impacts of Nuclear Power Plants."

NEC's socio-economic impacts will be distributed--is assumed to have a radius of approximately 70 miles. This corresponds to the distance within which virtually all of those employed at the site would live and commute. Some workers would, of course, live in this region only temporarily while engaged in particular construction activities.²

Our analysis further assumes that any nuclear energy cluster in Ocean County would have both an exclusionary zone -- the NEC site itself, "within the fence" -- and a buffer zone of low population density surrounding the cluster for some distance. Exclusionary zones of approximately 40 square miles each have been assumed for both the Inland Site and the Ft. Dix Site, based primarily on the as-yet undetermined limits of heat dissipation intensity.³ Because of the once-through cooling assumed for the Bay Site, a smaller exclusionary area of approximately 6 square miles has been assumed.⁴ Chapter V contains further details on these three sites.

A low population buffer zone ten miles in width from the outer edge of the NEC (its exclusionary zone) has been assumed for each of the three hypothetical sites, in accordance with the buffer zone concept discussed in detail in Chapter XIX.

Differences between the three sites with respect to location and cooling-water technologies have been noted in other sections of this report. These and certain other site-specific factors, described in Chapter V and summarized in Table 13-1, may have an affect on construction and O & M labor requirements. Accordingly, we have developed separate labor force estimates for each of the three hypothetical NEC sites. Tables 13-2, 13-3 and 13-4 present estimates of the required labor force directly involved in the NEC at each of the three locations. This labor force includes those employed to construct the following:

1. the power plants;
2. the cooling water tunnels;
3. the housing for those households displaced from the construction site; and

TABLE 13-1

OCEAN COUNTY NEC HYPOTHETICAL SITES - SUMMARY OF GENERAL CHARACTERISTICS

	<u>INLAND SITE</u>	<u>FORT DIX SITE</u>	<u>BAY SITE</u>
Township	Lacey	Plumstead	Eagleswood
Area of Exclusionary Zone, sq. mi.	40	40	6 ^a
Approximate land area of Buffer Zone, sq. mi.	450	550	300
Approximate land values, \$/acre ^b	924	924 ^c	924
Type of land in exclusionary zone	agricultural, forest	government military reservation	coastal wetlands
Approximate road distances to urban centers:			
Philadelphia	60	50	75
New York	75	70	90
Trenton	60	30	70
Atlantic City	40	55	30
Cooling water technology ^d	mechanical draft evaporative towers	natural draft evaporative towers	once-through
Approximate cooling water conveyance distance, miles	15	25	10
Other replacement and construction requirements ^e			
Housing	moderate	moderate	small
Roads	small	small	moderate
Bridges	several	none	several
Extent to which transient population groups a factor: ^f			
Seasonal residents	large (summer)	small	large (summer)
Day visitors	large (summer)	small	large (summer)
Motorists passing through	large	moderate	large
Military	episodic, medium intensity	episodic, high intensity	negligible

Footnotes:

- a. See text regarding tentative nature of this assumption and relationship of this area to use of once-through cooling water.
- b. County-wide average for Ocean County agricultural land (including buildings).
- c. Depending on the institutional arrangement, acquisition of land for a Fort Dix NEC might involve only a transfer of title between Federal agencies. The cost of land in the area might still be relevant as a measure of the opportunity cost of such a transaction.
- d. See Chapter VI.
- e. See Tables 13-2, 13-3, and 13-4, and Chapter VIII.
- f. That is, within the 10-mile LPZ being assumed here, to what extent are the transient groups indicated a factor in a physical and/or in an economic sense.

TABLE 13-2
LABOR FORCE FOR AN NEC IN OCEAN COUNTY

INLAND SITE					
Year	Power Plants ^a		Cooling- Water Tunnel ^a	Replacement Housing	Infrastructure ^b
	Const.	O&M			
1	0		300	330	100
2	530		300	330	
3	1260		300		
4	1780		300		
5	2720	125	300		
6	3450	350	300		
7	3500	600	300		
8	3550	750			
9	3600	900			
10	3600	1050			
11	3600	1200	300		
12	3600	1350	300		
13	3600	1500	300		
14	3600	1650	300		
15	3600	1800	300		
16	3600	1950	300		
17	3600	2100	300		
18	3600	2100			
19	3600	2100			
20	3600	2100			
21	3600	2100			
22	3600	2100			
23	3600	2100			
24	3300	2100			
25	2450	2100			
26	1200	2100			
27	400	2100			

Footnotes:

- a. See Appendix for background information on power plant labor force estimates.
- b. Includes the following:
 - a. Replacement of infrastructure lost to the exclusionary zone.
 - b. Bridges and similar facilities in the buffer zone.
 - c. Infrastructure required by NEC-related population growth.

TABLE 13-3
LABOR FORCE FOR NEC IN OCEAN COUNTY

PORT DIX SITE					
Year	Power Plants ^a		Cooling- Water Tunnel ^a	Replacement Housing	Infrastructure ^b
	Const.	O&M			
1	0		450	100	100
2	530		450	100	
3	1260		450		
4	1780		450		
5	2720	125	450		
6	3450	350	450		
7	3500	600	450		
8	3550	750			
9	3600	900			
10	3600	1050			
11	3600	1200	450		
12	3600	1350	450		
13	3600	1500	450		
14	3600	1650	450		
15	3600	1800	450		
16	3600	1950	450		
17	3600	2100	450		
18	3600	2100			
19	3600	2100			
20	3600	2100			
21	3600	2100			
22	3600	2100			
23	3500	2100			
24	3300	2100			
25	2450	2100			
26	1200	2100			
27	400	2100			

Footnotes: See Table 13-2.

TABLE 13-4

LABOR FORCE FOR AN NEC IN OCEAN COUNTY

RAY SITE

Year	Power Plants ^a		Cooling- Water Tunnel ^a	Replacement Housing	Infrastructure ^b
	Const.	O&M			
1	0		300	100	300
2	530		300	100	300
3	1260		300		
4	1780		300		
5	2720	125	300		
6	3450	350	300		
7	3500	600	300		
8	3550	750			
9	3600	900			
10	3600	1050			
11	3600	1200	300		
12	3600	1350	300		
13	3600	1500	300		
14	3600	1650	300		
15	3600	1800	300		
16	3600	1950	300		
17	3600	2100	300		
18	3600	2100			
19	3600	2100			
20	3600	2100			
21	3600	2100			
22	3600	2100			
23	3600	2100			
24	3300	2100			
25	2450	2100			
26	1200	2100			
27	400	2100			

Footnotes: See Table 13-2.

4. the infrastructure to replace that removed from the exclusionary zone, and such other related construction (e.g., bridges) as may be needed.

These tables also include the operation and maintenance (O&M) force required for the nuclear cluster, once constructed. Identical estimates are used for the power plant construction force at each site (item 1, above). Site-specific differences arise from variations in the labor estimates for items 2, 3 and 4, above. The bases for all of these estimates are detailed in the Appendix to this chapter.

The lower estimates for replacement of housing at the Bay and Fort Dix sites reflect the fact that these sites include much land not currently containing much housing stock, coastal wetlands in the former and a military base in the latter. A more significant difference between the Bay Site and the others involves infrastructure construction. We have allowed for a nominal 100 worker-years for replacement or relocation of secondary roads, utility networks and so forth at all three sites. Beyond this, we have included in the estimate for the Bay Site another 100 worker-years for relocation of US Route #9, a primary roadway currently is located within the assumed exclusionary zone. The most significant item within the infrastructure category, however, involves the need for adequate evacuation routes in the event that the Bay Site were selected. Whereas the transport networks around the other two sites might be adequate (both because of greater capacity and lower numbers of potential evacuees), the one bridge linking the barrier island, a popular resort area, to the mainland is clearly insufficient. In order to deal with the evacuation issue, we have included 500 worker-years for construction of additional bridges (a rough "order-of-magnitude" estimate at best). Clearly, any further consideration of the Bay Site as a potential NEC location must deal at considerably greater length and precision with the issue of capital investment required for evacuation facilities. Such would appear to be necessary given the relative locations of the NEC site and the shore population.

As a relevant aside, it should be noted that the construction of bridges would, as can be reasonably argued, further raise the attractiveness of the islands for resort and related purposes. On the one hand, land rents would

increase and pressure for more intensive development -- the result of improved access -- could almost certainly be anticipated. On the other hand, such more intensive use and potential congestion (whether or not disturbing to present residents or accruing to the economic advantage of today's landowners) would counter the very purpose of the bridge construction: to ease flight in the event evacuation were necessary. We therefore not only suggest that new bridges be part of the plan, especially if the Bay Site were to be more seriously considered, but also that measures of an institutional and legal order be put into effect to limit intense use of the islands and curb further shore development. Effectively, the resort barrier islands must become part of the buffer zone.

These comments are written in the assumption that utility and government institutions succeed in demonstrating the benign nature of NEC installations. There may be ample reason to doubt the effectiveness of such efforts, in which case pressure for further development on the islands would cease.

We have assumed that a considerable portion of the construction labor force (upwards of 75%) already lives within the defined region and has experience or appropriate skills in construction of nuclear power facilities. This would mean that a large percentage of the construction labor force for the NEC would commute from within the Greater Philadelphia Area; i.e., from a distance of up to seventy miles. There would be some differences in the source of labor, of course, across the three alternative sites, and thus in the distribution of impacts. Construction at the Bay Site, for example, located closer to Atlantic City, would have a greater impact on this old resort city than would selection of sites further to the north (although the impacts of these sites on Atlantic City would be non-negligible). This would be so particularly insofar as there is a fairly large pool of unemployed persons in the general trades. In contrast, a Fort Dix location would be likely to draw far less on Atlantic City labor. Instead, being closer to the fringes of the New York region and to the Trenton and Philadelphia SMSA's, it would likely generate an impact (considerably less, relatively speaking, than the impact of the southernmost site on Atlantic City) which would be felt in these large metropolitan areas. The Inland

Site would generate something of an intermediate impact in each of these various SMSA's.

Even though the construction phase of the project is expected to last for nearly thirty years, there might well be a considerable turnover in certain parts of the work force, especially in those job categories with high skill requirements. This has been the pattern in other large-scale construction operations such as resource reclamation and energy projects in the West.⁶ In the Salem Nuclear Generating Station's construction, for example, the number of welders hired in the course of construction has been approximately twice the number one would hire given the requirements of the job.⁷ That is, unplanned turnover is roughly equal in magnitude to the total number of welders one would expect to see on the project given no unplanned turnover. The reason for this high turnover rate appears to be more a function of competition for welders among projects of this type and the high degree of mobility of the people engaged in the work than of the short-run nature of the construction project per se. While an NEC might attract more stable workers into the welding field, and thus build a more stable long-term work force, to the extent that it did not and simultaneous construction of other nuclear plants elsewhere will be underway, competitive pressures will continue to result in the high rates of turnover. It is the feeling of this study group, therefore, that one oft-cited advantage of an NEC, i.e., the stability of the labor force, may not be as significant as frequently suggested. At the same time, as is discussed in Section 13.5, the disruptive effects on the local community of these high turnovers in certain crafts for dispersed nuclear siting projects may be of a much smaller magnitude than commonly thought. In the context of New Jersey and other predominantly urban regions, then, one may conclude that the relative advantage of an NEC vis-a-vis dispersed siting regarding labor force stability may not be all that significant.

With respect to the operation and maintenance force, it is expected that a large majority (80%) will be recruited from within this region and that there will be more of a tendency for these people to move to Ocean County and nearby counties. Judging from experience at existing plants, skilled

O & M personnel and plant administrators typically come from within the utility company. Thus these people would be drawn from other locations served by the utility companies involved in the NEC, i.e., the region under consideration. Unskilled personnel would be recruited locally. The small numbers involved as annual increments -- small relative to the labor pool of this region on the fringes of several large SMSA's -- makes such an assumption reasonable. Even so, one would note only a minor dent in the persistent high unemployment rate.

The income multiplier effects of labor on the NEC project are given in Tables 13-5, 13-6, and 13-7.⁸ Though the magnitudes may appear large from a local point of view, they are small from the regional standpoint. For example, the peak income effect of \$162 million (1975 dollars) in years 17 through 23 would amount to only a fraction of a percent of today's gross regional product (GRP) for the Philadelphia area. This already small fraction is reduced significantly, of course, when this income effect is compared to the GRP one might reasonably expect to see for the years of NEC construction into the 21st century. It is reduced still further when construction is completed and the NEC-related employment impacts reduce to those associated with a constant level of O & M employment, which is about one-third of the combined peak construction and O & M level. There would definitely be a measurable impact in the larger communities of Ocean County, however, and businesses would surely have to expand to meet the increased demands. (Although controls on new construction and business activity, more strict than those presently in force near single reactors, would be essential if the buffer zone concept were to be implemented.) In this respect, the consistency of the impacts from year to year implies a substantial effect and one that will require investment in the locality, transfers and readjustment.

The employment multiplier effects of labor on the NEC project are given in Tables 13-8, 13-9, 13-10. Within the first five years, the impacts of cooling water transmission construction and of residential housing and infrastructure replacement and new construction also are considered. Since the wages and leakages of the cooling water transmission construction force

TABLE 13-5

REGIONAL INCOME MULTIPLIER EFFECTS
OF EMPLOYMENT IN AN NEC
IN OCEAN COUNTY

Inland Site

Year	Labor Force ^a		Income Effects (Thousands of Dollars) ^b		
	Const.	O&M	Construction ^c	O&M ^d	TOTAL
1	730	0	16,069	0	16,069
2	1160	0	28,016	0	28,016
3	1560	0	40,794	0	40,794
4	2080	0	54,392	0	54,392
5	3020	125	78,973	4,025	82,998
6	3750	350	98,063	11,270	109,333
7	3800	600	99,370	19,320	118,690
8	3550	750	92,833	24,150	116,983
9	3600	900	94,140	28,980	123,120
10	3600	1050	94,140	33,810	127,950
11	3900	1200	101,985	38,640	140,625
12	3900	1350	101,985	43,470	145,455
13	3900	1500	101,985	48,300	150,285
14	3900	1650	101,985	53,130	155,115
15	3900	1800	101,985	57,960	159,945
16	3900	1950	101,985	62,790	164,775
17	3900	2100	101,985	67,620	169,605
18	3600	2100	94,140	67,620	161,760
19	3600	2100	94,140	67,620	161,760
20	3600	2100	94,140	67,620	161,760
21	3600	2100	94,140	67,620	161,760
22	3600	2100	94,140	67,620	161,760
23	3600	2100	94,140	67,620	161,760
24	3300	2100	86,295	67,620	153,915
25	2450	2100	64,068	67,620	131,688
26	1200	2100	31,380	67,620	99,000
27	400	2100	10,460	67,620	78,080
28	0	0	0	67,620	67,620
.	.	.	.	.	.

^a The construction labor forces for the NEC, the cooling-water tunnel, replacement of housing and of infrastructure have been aggregated. The income effects of tunnel construction labor are assumed to be the same as those of NEC construction labor. The income impact of residential and infrastructure replacement housing has been computed as follows:

$$Y_i = (10,625 + (.8 \times 10,625)) \times E_i$$

where Y_i is income generated by direct employment E_i in job type i . Note that income given is not of Federal taxes.

b Based on:
Average income before taxes:

1. Construction = \$25,000
2. O&M = \$20,000
3. Multiplier Jobs = \$12,500

And a Federal tax rate:

1. Construction = 20%
2. O&M = 20%
3. Multiplier Jobs = 15%

These figures are rounded estimates based on information provided by utilities, publications of consultants to local governments (e.g., Harbridge House), and other sources, as well as familiarity with wages and commuting pattern on large construction projects (e.g., Mountain West Research).

c This is the total income effect generated by wages paid to the construction labor force.

d This is the total income effect generated by wages paid to the O&M labor force.

TABLE 13-6
REGIONAL INCOME MULTIPLIER EFFECTS
OF EMPLOYMENT IN AN NEC
IN OCEAN COUNTY

Fort Dix Site

Year	Labor Force ^a		Income Effects (Thousands of Dollars) ^b		
	Const.	O&M	Construction ^c	O&M ^d	TOTAL
1	650	0	15,593	0	15,593
2	1080	0	27,540	0	27,540
3	1710	0	44,717	0	44,717
4	2230	0	58,315	0	58,315
5	3170	125	82,896	4,025	86,921
6	3900	350	101,985	11,270	113,255
7	3950	600	103,293	19,320	122,613
8	3550	750	92,833	24,150	116,983
9	3600	900	94,140	28,980	123,120
10	3600	1050	94,140	33,810	127,950
11	4050	1200	105,908	38,640	144,548
12	4050	1350	105,908	43,470	149,378
13	4050	1500	105,908	48,300	154,208
14	4050	1650	105,908	53,130	159,038
15	4050	1800	105,908	57,960	163,868
16	4050	1950	105,908	62,790	168,698
17	4050	2100	105,908	67,620	173,528
18					
19					
20					
21					

IDENTICAL TO INLAND SITE
See Table 13-5

Footnotes: See Table 13-5

TABLE 13-7
REGIONAL INCOME MULTIPLIER EFFECTS
OF EMPLOYMENT IN AN NEC
IN OCEAN COUNTY

Day Site

Year	Labor Force ^a		Income Effects (Thousands of Dollars) ^b		
	Const.	O&M	Construction ^c	O&M ^d	TOTAL
1	700	0	15,495	0	15,495
2	1230	0	29,355	0	29,355
3	1560	0	40,794	0	40,794
4	2080	0	54,392	0	54,392
5	3020	125	78,973	4,205	82,998
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					

IDENTICAL TO INLAND SITE
See Table 13-5

Footnotes: See Table 13-5.

TABLE 13-8

EMPLOYMENT MULTIPLIER EFFECTS OF THE
CONSTRUCTION AND OPERATING AND MAINTENANCE LABOR FORCES
FOR AN NEC IN OCEAN COUNTY

Year	Inland Site						
	(1) Const. Empl.	(2) Mult. Jobs (x 1.2)	(3) Total (1) + (2)	(4) O&M	(5) Mult. Jobs (x 1.6)	(6) Total (4) + (5)	(8) Total Employment Effect (3)+(6)
1	730	876*	1606*	0	0	0	730
2	1260	1512*	2772*	0	0	0	1260
3	1560	1872	3432	0	0	0	1560
4	2030	2496	4526	0	0	0	2080
5	3020	3264	6644	125	200	325	3145
6	3750	4500	8250	350	560	910	4660
7	3800	4560	8360	600	960	1560	5360
8	3550	4260	7810	750	1200	1950	4300
9	3600	4320	7920	900	1440	2340	4500
10	3600	4320	7920	1050	1680	2730	4650
11	3900	4680	8580	1200	1920	3120	5100
12	3900	4680	8580	1350	2160	3510	5250
13	3900	4680	8580	1500	2400	3900	5400
14	3900	4680	8580	1650	2640	4290	5550
15	3900	4680	8580	1800	2880	4680	5700
16	3900	4680	8580	1950	3120	5070	5850
17	3900	4680	8580	2100	3360	5460	6000
18	3600	4320	7920	2100	3360	5460	5700
19	3600	4320	7920	2100	3360	5460	5700
20	3600	4320	7920	2100	3360	5460	5700
21	3600	4320	7920	2100	3360	5460	5700
22	3600	4320	7920	2100	3360	5460	5700
23	3600	4320	7920	2100	3360	5460	5700
24	3300	3960	7260	2100	3360	5460	5400
25	2450	2940	5390	2100	3360	5460	4550
26	1200	1440	2640	2100	3360	5460	3300
27	400	480	880	2100	3360	5460	2500

* In each of the first two years, 330 workers are employed in residential replacement housing. Also, 100 laborers have been included in year 1 for infrastructure replacement. We have assumed an employment multiplier of .8 for those jobs and a multiplier of 1.2 for the remaining NEC and tunnel construction forces.

TABLE 13-9

EMPLOYMENT MULTIPLIER EFFECTS OF THE
CONSTRUCTION AND OPERATING AND MAINTENANCE LABOR FORCES
FOR AN NEC IN OCEAN COUNTY

Year	Fort Dix Site						
	(1) Const. Empl.	(2) Mult. Jobs (x 1.2)	(3) Total (1)+(2)	(4) O&M	(5) Mult. Jobs (x 1.6)	(6) Total (4)+(5)	(8) Total Employment Effect (3)+(5)
1	650	780*	1430*	0	0	0	650
2	1080	1296*	2376*	0	0	0	1080
3	1710	2052	3762	0	0	0	1710
4	2230	2676	4906	0	0	0	2230
5	3170	3804	6974	125	200	325	3295
6	3900	4680	8580	350	560	910	4250
7	3950	4740	8690	600	960	1560	4550
8	3550	4260	7810	750	1200	1950	4250
9	3600	4320	7920	900	1440	2340	4500
10	3600	4320	7920	1050	1680	2730	4650
11	4050	4860	8910	1200	1920	3120	5250
12	4050	4860	8910	1350	2160	3510	5400
13	4050	4860	8910	1500	2400	3900	5550
14	4050	4860	8910	1650	2640	4290	5700
15	4050	4860	8910	1800	2880	4680	5850
16	4050	4860	8910	1950	3120	5070	6000
17	4050	4860	8910	2100	3360	5460	6150
18	.	.	.	.	.	.	.
19	.	.	.	.	.	.	.
20	.	.	.	.	.	.	.
21	.	.	.	.	.	.	.
22	.	.	.	.	.	.	.
23	.	.	.	.	.	.	.
24	.	.	.	.	.	.	.
25	.	.	.	.	.	.	.
26	.	.	.	.	.	.	.
27	.	.	.	.	.	.	.

IDENTICAL TO INLAND SITE
See Table 13-8

* In each of the first two years, 100 workers are employed in residential replacement housing. Also, 100 workers have been included in year 1 for infrastructure replacement. We have assumed an employment multiplier of .8 for these jobs and a multiplier of 1.2 for the remaining NEC and tunnel construction forces.

TABLE 13-10

EMPLOYMENT MULTIPLIER EFFECTS OF THE
CONSTRUCTION AND OPERATING AND MAINTENANCE LABOR FORCES
FOR AN NEC IN OCEAN COUNTY

<u>Bay Site</u>								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<u>Year</u>	<u>Const. Empl.</u>	<u>Mult. Jobs (x 1.2)</u>	<u>Total (1)+(2)</u>	<u>O&M</u>	<u>Mult. Jobs (x 1.6)</u>	<u>Total (4)+(5)</u>	<u>Total Labor Force (1)+(4)</u>	<u>Total (3)+(6)</u>
1	700	840	1540	0	0	0	700	1,540
2	1230	1476	1706	0	0	0	1230	1,706
3	1560	1872	3432	0	0	0	1560	3,432
4	2080	2496	4576	0	0	0	2080	4,576
5	3020	3624	6644	125	200	325	3145	6,969
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
.								
.								
.								
27								

IDENTICAL TO INLAND SITE

See Table 13-8

* In each of the first two years, 100 workers are employed in residential replacement housing and 300 in infrastructure construction. We have assumed an employment multiplier of .8 for these jobs and a multiplier of 1.2 for the remaining NEC and tunnel construction forces.

are assumed to be the same as those for the power plant construction force (specialized and skilled workers, highly paid, drawn from some distance away), they have been included in the estimates of Column 1 and subsequent columns. Labor for housing and infrastructure also has been included in Column 1. One might reasonably expect a small multiplier to obtain for these jobs (local workers in the main would be hired). Thus the total multiplier jobs have been calculated as per the footnotes to these tables.

Both income and employment multiplier effects must be viewed, of course, in the context of demographic projections for the area, particularly since Ocean County has been growing so rapidly over the past fifteen years or so.

Certain questions must be posed, then, when considering the impacts of NEC construction and operation together with the currently projected growth rates. For example, are current demographic projections and those associated with the NEC necessarily additive? Are the reasons for the growth trends currently projected (i.e., exclusive of any NEC) likely to remain valid given construction of an NEC in Ocean County? If so, and if current growth projections and anticipated NEC-related impacts were consistent and additive, perhaps even exhibiting synergistic effects, then the possibility of a local disruptive effect in infrastructure seems quite large. Comparing our estimates of the labor force impacts with estimates of the growth of the labor force in Ocean County (as presented in Appendix E of BNL 50465), the relatively significant size of the NEC-related employment (that part of the direct, indirect and induced impact felt near the NEC site)^{4c} means that the combined impacts may not be absorbed with ease.

If, on the other hand, expected growth patterns in Ocean County are determined to be inconsistent with the existence of an NEC in that area, the question arises as to what revised expectations seem reasonable. It may be the case that because the area is geared up to accept a large growth from other causes, the effect of an NEC would be minor and relatively invisible, particularly if the non-NEC related growth would fail to occur due to its incompatibility with an NEC. Public policy decisions with respect to creation and enforcement of an effective buffer zone around the NEC would be critical in this regard; this issue is examined in depth in Chapter XIX.

13.3 Socio-Economic Impact of the Dispersed Nuclear Siting Scenario

The dispersed siting scenario set forth in Chapter III has been used as an alternative to construction of the Ocean County NEC, and the employment and income effects of constructing these 20 reactors has been examined as the basis for comparison with the NEC's impacts.

The characteristics of the six dispersed site locations presented in Chapter III are such that socio-economic impacts of construction and later of the operation of nuclear plants are likely to vary significantly from site to site. Accordingly, we have not focused our analysis on one prototype site, but instead, have attempted to introduce site-specific considerations to a limited degree by pairing the sites into three categories within which one may reasonably expect to see similar impacts. These categories include: (1) the two twin-reactor expansion sites, Limerick and Susquehanna; (2) the two quad-reactor sites on Delaware and Chesapeake Bays; and (3) the two quad-reactor offshore sites.

Estimates of the construction and O & M labor forces for each of these three site categories are shown in Table 13-11. Generally, estimates for the expansion and bay categories are based on experience at existing nuclear plants. Estimates for the labor forces within the study region required for the offshore plants are based on early order-of-magnitude projections by the New Jersey utility company currently studying the possibility of an offshore nuclear facility. These labor forces are smaller than those for comparable onshore plants because the reactors themselves would be constructed in a facility in Jacksonville, Florida; only the breakwater and some small on-shore support facilities would be constructed within the region. The fact that eight of the twenty nuclear units under consideration in the dispersed scenario would be so constructed obviously will have significance in the comparison of regional socio-economic impacts of the dispersed and NEC alternatives, since in the NEC case all twenty units would be constructed within the region.

We have not attempted to do a comprehensive and complete study of the socio-economic impacts of existing nuclear power plants. Such a study would constitute an incremental research effort not permitted by time and resource

TABLE 13-11

LABOR FORCE REQUIREMENTS, DISPERSED SITING SCENARIO

Expansion Sites^a

<u>Year^b</u>		<u>Labor for Power Plants</u>		<u>Labor for Construction of Upstream Storage^d</u>
<u>Limerick</u>	<u>Susquehanna</u>	<u>Const.^c</u>	<u>O&M^c</u>	
16	6	100		150
17	7	1100		150
18	8	2500		
19	9	2500		
20	10	1900	50	
21	11	600	150	
22	12	200	250	

Bay Sites^e

<u>Year^b</u>		<u>Labor for Power Plants</u>	
<u>Lower Delaware Bay</u>	<u>Lower Chesapeake Bay</u>	<u>Const.^c</u>	<u>O & M^c</u>
1	10	200	
2	11	1100	
3	12	2500	
4	13	3000	
5	14	3000	50
6	15	3000	150
7	16	2500	250
8	17	1800	400
9	18	700	460
10	19	200	460

Offshore Sites^f

<u>Year^b</u>		<u>Labor for Casting Yard</u>		<u>Labor for Onshore Sub-breakwater Floating station & Plant</u>		<u>Total Labor</u>	
<u>Atlantic B</u>	<u>Atlantic C</u>	<u>Caissons</u>	<u>Dolosse</u>	<u>Const.</u>	<u>Plant</u>	<u>Const.</u>	<u>O&M</u>
10	20	200				200	
11	21	200	200	300		700	
12	22	200	600	300	100	1200	50
13	23	200	600	600	100	1500	200
14	24		200	300	200	700	350
15	25			300	100	400	460
20	26				100	100	460

TABLE 13-11

Footnotes:

- ^a Expansion of existing two-reactor plants (approximately 2100 MW each) at Limerick and Susquehanna, Pennsylvania to four-reactor sites (4500 MW).
- ^b Refers to scheduling as shown in Chapter III.
- ^c See Appendix A of "Regional Economic Impacts of Nuclear Power Plants", op. cit., for the basis of labor force estimates.
- ^d 24,000 acre/feet required; see Ibid.
- ^e A four-reactor (4800 MW) complex on the lower Delaware Bay and another on the lower Chesapeake Bay.
- ^f These figures are representative for each of two four-reactor clusters presumed to be located approximately three miles off the New Jersey coast somewhere between Long Branch and Atlantic City, N.J. Data are based on informal discussions with PSE&G personnel and on their order-of-magnitude estimates for a two-reactor floating plant. Our figures are based on two 2-reactor plants located close to each other and constructed two years apart.

constraints on this research. Instead, we have used moderate interviewing efforts in connection with several nuclear plants in the Northeast, including Salem/Hope Creek (N.J.), Pilgrim I (Plymouth, Mass.), and Millstone (Waterford, Conn.), and have relied on the available literature to form a picture of some of the most significant impacts of nuclear power plants, both in an absolute sense and vis-a-vis the NEC alternative.

In Tables 13-12 and 13-13 the construction and the O & M labor, respectively, are aggregated for the six dispersed sites to determine the overall MAAC area labor requirements for the dispersed scenario. These totals have then been used in Tables 13-14 and 13-15 to establish total regional income and employment multiplier affects ("regional" here being loosely defined as the MAAC area).

13.4 Comparison of Dispersed and NEC Scenarios

Comparisons of the dispersed and NEC scenarios with regard to socioeconomic impacts have been grouped into the following topic areas:

1. Construction and O&M labor forces
2. Income and employment multiplier effects
3. Taxes
4. Colocation
5. Population
6. Miscellaneous

In the first two areas, some quantitative comparisons are established. The effects of the six dispersed sites have been aggregated into one set of figures, comparable to the effects of the NEC. Elsewhere in the comparative analysis below we speak both of aggregate regional comparisons and, insofar as appropriate, comparisons of the NEC impacts to those of dispersed sites.

1. Construction and O&M Labor Forces

Labor force levels corresponding to the assumed construction schedules have been shown in some detail in the tables of Sections 13.2 and 13.3. By way of comparison, these labor force levels for construction and for O&M have been represented as profiles over time in Figures 13-1 and 13-2 respectively.

TABLE 13-12

TOTAL CONSTRUCTION EMPLOYMENT WITHIN MAAC AREA
FOR DISPERSED-SITING SCENARIO

Year	Expansion Sites		Bay Sites		Offshore Sites		TOTAL
	Limerick	Susquehanna	Lower Delaware Bay	Lower Chesapeake Bay	Atlantic B	Atlantic C	
1			200				200
2			1100				1100
3			2500				2500
4			3000				3000
5			3000				3000
6		250	3000				3250
7		1250	2500				3750
8		2500	1800				4300
9		2500	700				3200
10		1900	200	200	200		2500
11		600		1100	700		2400
12		200		2500	1200		3900
13				3000	1500		4500
14				3000	700		3700
15				3000	400		3400
16	250			2500			2750
17	1250			1800			3050
18	2500			700			3200
19	2500			200			2700
20	1900				100	200	2200
21	600					700	1300
22	200					1200	1400
23						1500	1500
24						700	700
25						400	400
26						100	100

TABLE 13-13

TOTAL O&M EMPLOYMENT WITHIN MAAC AREA
FOR DISPERSED-SITING SCENARIO

Year	Expansion Sites		Bay Sites		Offshore Sites		TOTAL
	Limerick ^a	Susquehanna ^a	Lower Delaware Bay	Lower Chesapeake Bay	Atlantic B	Atlantic C	
1							
2							
3							
4							
5			50				50
6			150				150
7			250				250
8			400				400
9			460				460
10		50	460				510
11		150	460				610
12		250	460		50		760
13		250	460		200		910
14		250	460	50	350		1110
15		250	460	150	400		1260
16		250	460	250	400		1360
17		250	460	400	400		1510
18		250	460	460	400		1570
19		250	460	460	400		1570
20	50	250	460	460	460		1680
21	150	250	460	460	460		1780
22	250	250	460	460	460	50	1930
23	250	250	460	460	460	200	2080
24	250	250	460	460	460	350	2230
25	250	250	460	460	460	460	2340
26	250	250	460	460	460	460	2340

^a Precisely because Limerick and Susquehanna are "expansion sites", some workers on site are not included in these incremental calculations.

TABLE 13-14

TOTAL REGIONAL INCOME MULTIPLIER EFFECTS
FOR DISPERSED-SITING SCENARIO

Year	Labor Force		Income Effects (Thousands of Dollars) ^a		
	Const.	O & M	Const. ^b	O & M ^c	TOTAL
1	200		5,230		5,230
2	1100		28,765		28,765
3	2500		65,375		65,375
4	3000		78,450		78,450
5	3000	50	78,450	1,610	80,060
6	3250	150	84,988	4,830	89,818
7	3750	250	98,063	8,050	106,113
8	4300	400	112,445	12,880	125,325
9	3200	460	83,680	14,812	98,492
10	2500	510	65,375	16,422	81,797
11	2400	610	62,760	19,642	82,402
12	3900	760	101,985	24,472	126,457
13	4500	910	117,675	29,302	146,977
14	3700	1110	96,755	35,742	132,497
15	3400	1260	88,910	40,572	129,482
16	2750	1360	71,913	43,792	115,705
17	3050	1510	79,758	48,622	128,380
18	3200	1570	83,680	50,554	134,234
19	2700	1570	70,605	50,554	121,159
20	2200	1680	57,530	54,096	111,626
21	1300	1780	33,995	57,316	91,311
22	1400	1930	36,610	62,146	98,756
23	1500	2080	39,225	66,976	106,201
24	700	2230	18,305	71,806	90,111
25	400	2340	10,460	75,348	85,808
26	100	2340	2,615	75,348	77,963
27	0	2340	0	75,348	75,348
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Footnotes:

^a Based on:

Average income before taxes:

1. Construction = \$25,000
2. O & M = 20,000
3. Multiplier Jobs = 12,500

Federal tax rate:

1. Construction = 20%
2. O & M = 20%
3. Multiplier Jobs = 15%

^b This is the total income effect generated by wages paid to the construction labor force.^c This is the total income effect generated by wages paid to the O&M labor force.

TABLE 13-15

TOTAL REGIONAL/EMPLOYMENT EFFECTS FOR THE
CONSTRUCTION AND OPERATING & MAINTENANCE LABOR FORCES
FOR THE DISPERSED-SITING SCENARIO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year	Const. Empl.	Mult. Jobs (x 1.2)	Total (1)+(2)	O&M	Mult. Jobs (x 1.6)	Total (4)+(5)	Total Labor Force (1)+(4)	Total (3)+(6)
1	200	240	440	0	0	0	200	440
2	1100	1320	2420	0	0	0	1100	2420
3	2500	3000	5500	0	0	0	2500	5500
4	3000	3600	6600	0	0	0	3000	6600
5	3000	3600	6600	50	80	130	3050	6730
6	3250	3900	7150	150	240	390	3400	7540
7	3750	4500	8250	250	400	650	4000	8900
8	4300	5160	9460	400	640	1040	4700	10500
9	3200	3840	7040	460	736	1196	3660	8236
10	2500	3000	5500	510	816	1326	3010	6826
11	2400	2880	5280	610	976	1586	3010	6826
12	3900	4680	8580	760	1216	1976	4660	10556
13	4500	5400	9900	910	1456	2366	5410	12266
14	3700	4440	8140	1110	1776	2886	4810	11026
15	3400	4080	7480	1260	2016	3276	4660	10756
16	2750	3300	6050	1360	2176	3536	4110	9586
17	3050	3660	6710	1510	2416	3926	4560	10636
18	3200	3840	7040	1570	2512	4082	4770	11122
19	2700	3240	5940	1570	2512	4082	4270	10022
20	2200	2640	4840	1680	2688	4368	3080	9208
21	1300	1560	2860	1780	2848	4628	3080	7488
22	1400	1680	3080	1930	3088	5018	3330	8098
23	1500	1800	3300	2080	3328	5418	3580	8718
24	700	840	1540	2230	3568	5798	2930	7338
25	400	480	880	2340	3744	6084	2740	6964
26	100	120	220	2340	3744	6084	2440	6304
27	0	0	0	2340	3744	6084	2340	6084
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.

Figure 13-1. Total construction labor force profile (24,000 KW in MAAC region).

Figure 13-2. Total O & M labor force profile (24,000 KW in MAAC region).

Two points are immediately evident from the curves for construction labor. First, while the loading curve for the NEC rises, levels off for nearly twenty years and then declines, the curve for the aggregate dispersed construction forces is uneven and jagged, exhibiting several peaks and valleys which indicate a much more erratic employment picture. Obviously, the centralized planning for the nuclear cluster has the potential to smooth out such fluctuations. However, some smoothing of these peaks and valleys might be desirable and could be effected even with a dispersed siting alternative through implementation of an effective regional planning effort with regards to nuclear power plant construction (including, of course, other nuclear and fossil units being built in the region). The employment picture in any given locality certainly would be even more erratic, since the region over which the dispersed plants are built and operated is actually quite large.

The second point with respect to construction labor is that the area under the dispersed loading curve clearly is less than that under the NEC curve. This result seems to run counter to the expectation of economies of scale to be achieved in NEC construction. Some modest economies of scale have indeed been reflected in our estimate of NEC labor requirements. The result noted in Figure 13-1, however, obtains because in the dispersed case construction of significant portions of eight of the twenty units would take place outside the region (in Florida). This basic difference in construction employment is reflected throughout comparisons of the two scenarios. One important consequence is that the proportion of the labor force with heavy construction skills would be greater in the dispersed case, again a result of the structural requirements of the eight offshore units.

The O & M labor force is higher in the NEC scenario until year 23, when dispersed siting evidences greater O & M requirements.

2. Income and Employment Multiplier Effects

Profiles of the income and employment multiplier effects, respectively, within the region attributable to the combined construction and O & M labor forces are presented in Figures 13-3 and 13-4. These curves reflect the incomes and employment levels (direct, indirect, and induced) derived in

Figure 13-3. Regional employment effects of construction and O & M (24,000 KW in MAAC region).

Figure 13-4. Regional income effects of construction and O & M labor (24,000 KW in MAAC region).

Sections 13.2 and 13.3 for the NEC and the dispersed scenarios. Since we have used the same employment multiplier and "leakage" rates throughout (for reasons explained in Section 13.3), the differences between the NEC and the dispersed curves are due primarily to the same factors discussed above to explain the differences in the construction labor force profiles.

Note once again that the spatial incidence of an NEC would be much more concentrated in its impacts on local land values, taxes, and some employment and consumption effects. So far as the last items are concerned, on the one hand we would anticipate (since an NEC remains a hypothetical proposal--no evidence is on hand) a labor market somewhat more extensive spatially. On the other hand, we would anticipate nearby some commercial and residential development. How close would depend on the degree of enforcement of buffer zone regulations. The effect certainly would be to concentrate more than in the dispersed case the induced and indirect effects of the construction and the O & M workers' incomes.

3. Taxes

Our overall discussion of the impact of a clustered nuclear energy center on taxes, and a comparison with the impact of dispersed nuclear siting, is presented in Chapter XIV of this report.

4. Colocation

Mixed motives and expectations rule insofar as a nuclear power plant draws other activities to it. One of the features which makes such plants attractive to local interests is the belief held by many that industry will "colocate" nearby. A heightened pace of economic activity would, in the eyes of some experts, bring commercial activity as well. The gains would be reflected in new local employment opportunities and an increased base for local tax collection. Are such expectations realistic? Have such effects been noted following the construction of "dispersed" plants? Can one expect, though on a larger scale, some similar impacts where NEC's are built?

The state of the art of heat transfer at the present stage of technology appears to offer little advantage to any enterprise to locate near a nuclear power plant. While agricultural technology and, possibly, shortages of food and higher prices might eventually make a system of ground heating economically feasible, such is at best a thin reed on

which to lean in expecting or justifying colocation. Again and again we encountered the observation of informed persons, confirmed by analysis of industrial location factors,⁹ that large quantities of low-level heat are at best of marginal importance and then only to a few industrial activities. In any event, these would use only at best a fraction of the waste heat generated by a single reactor.

So far as the location choice of heavy power-consuming activities are concerned, the availability of power and the factor of assured supply are important variables. Given the power network characteristics and the pricing policies of utilities, however, there is no advantage to seek out a site directly proximate to a power plant (oil-fueled, coal-fueled, or nuclear).¹⁰

However, this is not to say that certain categories of enterprises would not be attracted to locate near a power plant. Two other factors should be taken into account. First, given the present practice in New Jersey of allocating tax revenues to small political units such as townships, there is a distinct advantage in siting an industrial plant within the boundaries of a jurisdiction already containing a nuclear plant. This may possibly hold over the long-term, too, given the glacial movement of social and economic innovations, particularly taxation systems. This advantage may initially appear in the form of low tax levels on the new industrial enterprise. In the longer run, however, such a tax break may be more than balanced by the higher land costs which we observed often are associated with location of a power plant, and the consequent decline in others' property taxes as the large revenues start to pour in. More important, perhaps, is a qualitative factor; i.e., knowledge that within the jurisdiction there will be a steady and guaranteed public revenue flow from the power plant, producing a "flywheel" effect in the local economy. The presence of a power plant with its assumed long life and its large assessment represents a guarantee to potential colocators that there will be no tax surprises with deleterious effects on the industrial taxpayers, employees, etc.¹¹

A second factor, more elusive, is that the very circumstances which brought the power plant to a given location might also provide an attraction to industrial plants, warehouses, truck terminals, and so forth.¹² Thus, waterside locations on a flat site, availability of large quantities of

water for cooling or production, and a political and environmental climate conducive to industries also appeal to other enterprises. The low population --one of the so-called "screening" criteria¹³-- may well be a reflection of economic conditions resulting in high unemployment or underemployment, and an antiquated economic structure. This is a recipe for accepting nuclear power with open arms. For similar reasons, other industrial activities would appeal to the locality and perhaps vice versa. Further, the decision to accept a nuclear reactor may result in better roads and other infrastructure improvements. Together, such make for an environment compatible with and attractive to industrial and other activities along a rather broad spectrum. Thus in Plymouth, Mass., for example, small factories have indeed come to the township along with the nuclear generating station.¹⁴

It does not seem unreasonable to suggest, therefore, that colocation is a plausible prospect for certain sites in the dispersed scenario. The Lower Delaware Bay sites, for example, in Cumberland County, N.J., had the highest unemployment rate in the state as of early 1976 (15.6 percent).¹⁵ Of course, this conclusion would be less relevant to the offshore sites where very little onshore development takes place (and allocation of the tax revenues from the offshore plants themselves remains to be determined).

The question remains, of course, as to whether or not colocation is desirable. The series of what might be called indirect colocation moves must be considered critically. The equity factor cannot be ignored. Small jurisdictions are recipients of vast gains in tax revenues, in part from such colocation ratables, while other nearby jurisdictions are simply left with greater demands on their services. Surely this is a matter for higher level, i.e., state or even national, policy and allocation decision.

More important, an entrepreneurial and local government decision frame so heavily weighted to respond to the tax question (which seems the most salient factor raised in discussions with planners, real estate, and government sources) might in the long run prove to be dysfunctional. That is, it would likely do ill service to the larger community and to the interests of a broader constituency. Steps to bring industrial enterprises and other activities to the vicinity of a power plant would run counter to the national policy of placing nuclear generating stations in areas of low density settlement

and activity.¹⁶ Any colocation in the neighborhood of an NEC would clearly vitiate the premises underlying the rationale of such a nuclear cluster. A strong hand, laid down from both state as well as federal agencies, would appear to be necessary in maintaining an effective buffer zone around clusters or NEC's. In the absence of such measures, and given the force of the real property tax impact, there do indeed exist indirect colocation pressures.

Such pressures are not restricted to the industrial sector. Commercial enterprises, recreation and tourism are drawn to the site. Residential developments are found within half a mile of some nuclear plants. Activity intensity is, at this point, a question which is left in the hands of local governments, developers and landowners. This question has security and environmental management aspects as well as economic considerations, and is loaded with the presence of major externalities. It is too sensitive and important to be left to decentralized decision-making units, often working at cross purposes. Further analysis of the buffer zone issue therefore must be made, steps must be taken to play down the colocation prospects, and innovative measures must be explored and implemented on an experimental basis to reduce activity levels in the vicinity of reactors.¹⁷

This discussion of colocation would not be complete without noting that there is a distinct tendency for reactors themselves to be "colocators."¹⁸ That is, a reactor in place is a signal for the utility to consider placement of a second reactor or even more installed capacity in the vicinity. The rationale is not hard to follow; acquired land, familiarity with terrain, possibility of shared facilities (e.g., access road) all support aggregation of units. Further, the political and power relations which make a locality attractive to a utility--leading for example to a sympathetic adaptation of local zoning codes--is expected to hold in the case of subsequent reactor proposals. Impact statements and other steps necessary for the construction process are facilitated where the pattern has been set and local precedents exist.

Local resistance to plant expansions, even in communities receiving the associated tax windfalls, probably will increase rapidly as new units are proposed, perhaps even as early as the third and fourth reactors at a site are being considered.¹⁹ The "fallout" effect seems to be felt at some distance from the initial power plant.²⁰

5. Population

As in the earlier report, it is possible to translate employment (direct and multiplier) effects into increased population. Population increase refers to those who would not be in the region were it not for construction and operation and maintenance of the power plants. We consider electricity production to be an export activity, though some of it is consumed regionally. Also, it may well be that individuals presently living in the area would find employment on the project or as the result of induced activity. If this is the case, new residents would fill previously held jobs, thus increasing population in the region. Obviously, too, some unemployed would be absorbed by this activity, thus reducing the number who would enlarge the labor force; no judgement can be made on such job or population shifts.

In order to provide some sense of the order of magnitude involved, it was estimated that 80% of the reactor labor force already lived within the expanded Philadelphia SMSA.²¹ Of the 20% or so of the construction workers who, in the case of the Salem County reactor, live outside the expanded Philadelphia SMSA, many make their home just beyond but still within commuting distance, i.e., in northern New Jersey or in the Wilmington, Delaware SMSA. Also, a good number of these workers, living (say) in the Newark area, spend the working week boarding in Salem or nearby towns. Our assessment is that relatively few workers are truly itinerant (unlike the situation encountered in low population density areas far removed from SMSA's, such as in the Rockies).²²

Many of the workers who are itinerant belong to highly paid crafts. Their skills make them mobile. This mobility, a source of some concern to the contractor, would appear to be as much a potential factor in building an NEC as in constructing a single reactor.

It is further assumed that all of the workers employed to satisfy the indirect and induced demand already live in the area. This is reasonable because sites selected for nuclear power plants tend to have high unemployment rates, in part a reflection of the siting factor noted above in the discussion of colocation. Also their locations are somewhat peripheral to the center of economic activity, i.e., in marginal agricultural zones. In the nearby larger metropolitan area, even relatively low unemployment rates (low by

today's standards, though hardly in an absolute sense) are associated with an underutilized labor pool large enough to satisfy the order of expansion considered here.²³ Thus the available labor force is greater than the present production requirement. Further, increments in most new activities can easily be staffed.

Assuming 2.5 persons per job holder, the population dependent on the nuclear power activity can be calculated.²⁴ Using year 9 as an illustration, the NEC dispersed population impacts are compared in Table 13-16. The total regional population dependent on construction and O & M activities is 48,650 in the NEC scenario and 43,600 in the dispersed pattern.

All this population (except that which can be attributed to the small, but growing, O & M employment) is in a sense temporary, though the time span (more than 20 years for the dispersed and NEC scenarios' is large enough to affect career, location and life style decisions, and brings with it a degree of locational permanence. Yet, the population related to these construction activities (42,800 in this NEC example) would be subsumed within far larger population movements and growth within metropolitan regions. The condition at remote NEC's would differ from coastal New Jersey, of course. There the NEC labor force and population would represent a more significant impact on the local social structure, employment, etc. However, for the larger Philadelphia region a decision to build an NEC in Ocean County, New Jersey, or to follow a "dispersed" scenario in the MAAC area, would represent only a marginal development decision.

Second, within the greater region, the study area, one would expect some population movement. Such shifts would not represent an increment to population, but would reflect mobility brought about by the project. Even those workers and their families who appear to be well established in their communities might choose to move closer to the job if their work at the nuclear plant involved long commutes. Others viewing the opportunities afforded by higher incomes associated with employment on a nuclear project might see the vicinity of the plant as a place to purchase a suburban home. Still others apparently respond to perceived tax advantages. Some 200 of the workers on the Pilgrim (Mass.) plant, for example, moved to Plymouth during or

TABLE 13-16

REGIONAL POPULATION DEPENDENT ON NUCLEAR POWER PLANTS
(ILLUSTRATION FOR YEAR 9)^a

	NEC Scenario	Dispersed Scenario
<u>Construction</u>		
Plant Labor-related ^b		
Direct labor force at plant	3600	3200
Indirect and induced employment	4320	3840
Plant Material-related (direct, in- direct, and induced employment) ^c	9200	9200
Employment Subtotal	17120	16240
Population Factor	X 2.5	X 2.5
Construction Dependent Population ^d	42800	40600
<u>O & M</u>		
Plant Labor-related ^b		
Direct labor force at plant	900	460
Indirect and induced employment	1440	740
Plant Material-related	negligible	negligible
Employment Subtotal	2340	1200
Population Factor	X 2.5	X 2.5
O & M Dependent Population ^d	5850	3000
<u>Total Regional Dependent Population^d</u>	48650	43600

^a See Tables 13-8 and 13-15.

^b Per Tables 13-8 (NEC) and 13-15 (dispersed).

^c Based on proration over time of aggregate results discussed in Section 13.5. We have assumed here that up to year 9, the NEC and dispersed scenarios each involve the same purchase of materials from within the region. Later, as offshore construction begins in the dispersed scenario, the assumption would have to be modified to reflect the different regional demand for plant materials for offshore plants.

^d Inclusive of workers.

after its construction. This accounted for a small but perceptible part of the town's population increase, part of Boston's southward expansion. A much smaller scale movement seems to be taking place in the case of the relatively more remote Salem reactor on the periphery of the Philadelphia SMSA.

A fair number of workers do tend to seek residences (if they are from outside the region) close to the construction site of the single reactors or small clusters of reactors. Apparently, though, they are not likely to invest in housing, preferring instead to rent or board locally.

Often workers who live, say, within 300 miles but further than about 70 miles from the site, will return to their homes for the weekend. As do those workers from more distant places, such as those from the South, these constitute part of a larger housing market. Expedients such as boarding out with families, use of motels, and rentals of vacated, possibly abandoned farms have been noted. In some areas, summer homes have been insulated and motels expanded. A fair amount of capitalization, often of an informal sort, takes place without notice in town records (e.g., "winterizing" of shore houses).²⁵ This will represent a major addition to regional wealth even after the income stream ceases. It does, however, run counter to the premise of a buffer zone around an NEC, a policy issue examined in depth in Chapter XIX.²⁶

6. Miscellaneous

- A. Though we are forced to make estimates without specific standards, the aggregate land requirements for a dispersed scenario would be less than for an NEC. Single units or small groupings are being built with reserved land around the plant measured in the low hundreds of acres. In addition, very little onshore land is required for the eight offshore units. A twenty unit NEC, on the other hand, has an exclusionary zone of about 40 square miles, plus a very large buffer zone.

Public access and low density use patterns seem to have been established and accepted in the case of single units or clusters. Housing and recreation areas are found practically within a stone's

throw of such power plants. Whether this pattern is permanent one cannot be sure; it probably is contingent on continued absence of effective sabotage, relative domestic tranquility, and a 100% internal safety record. An NEC, on the other hand (scaled to 24,000 MW), would appear to require the acquisition of perhaps three to six times the land and the development of a new and possibly elaborate system of controls in an extensive buffer zone in the surrounding ring.

The order of magnitude costs of agricultural land have been reflected. Compared to the dispersed scenario, an NEC would cost some \$20,000,000 more for land acquisition costs. Housing and infrastructure replacement appear to be negligible in the case of single or clustered reactors, and is calculable at sum on the order of magnitude of \$20,000,000 in the case of an NEC. An NEC, thus, accounts for some \$40,000,000 greater cost than would a dispersed pattern. Most of this would be circulated in the regional economy during the early years of the project.

B. The size and incidence of impact is very much the result of siting and scale choices by the utilities in collaboration with and constrained by public agencies at the Federal and state levels. Their screening methods identify plausible sites and build up commitments to the selection of one or more. The agendas of other institutions and organizations also must be taken into account, however, including:

1. Local governments. On the whole, local governments and commercial interests (inclusive of the real estate sector) seem to support wholeheartedly the advent of power plants--at least the initial ones in a locality. Their perspective does not extend beyond a horizon of three or so; perhaps they might view the prospect with less equanimity or enthusiasm if they calculated on the basis of more units*.
2. Regulatory agencies. One of their effects, perhaps unintended, is to reduce the number of enterprises producing nuclear power plant components. With each year, NRC and other requirements

* See Chapter XVIII.

(for reasons of safety, uniformity of product, etc.) restrict the number of potential suppliers. Not only does this contribute to monopolistic or oligopolistic practice with concomitant increase in cost, it also reduces the likelihood that a given proportion of the material for construction of a power plant will be met from regional suppliers. The regional "benefit" or impact thus decreases. With a dispersed scenario, some alternative designs are built in; the NEC might add to monopolistic pressures.

3. Unions. These are the main instrument for the organization and channeling of the labor supply. (Perhaps a dozen or more unions, representing different crafts, manage the hiring.) Thus, the location of union halls, the domain over which the unions draw their members for a given site, and the degree to which a local union would open its membership, all contribute to the regional impact of the nuclear power plant. Unions' constituencies are much larger than the locality where the plant is located. Thus, even though high unemployment may exist near the site of the proposed plant, particularly among non-union members, the unskilled, or among other categories of potential workers, outsiders often are brought in.

- D. Contractors. Contractors for the construction projects do parcel out certain tasks to subcontractors. Although these in some cases are from the locality, the pattern by which a decision to parcel out work is still unclear. In any event, such subcontractors seem to be ready to hire locally -- to the extent where apparently at one site, shortages of workers in certain crafts have occurred, disrupting local commerce and non-project construction.

Evidence indicates that some new businesses in the locality have been generated by the project (e.g., hauling, small contracts on road rebuilding, and services such as printing). Similarly, some commercial activity has sprung up or expanded locally to cater to workers' needs (e.g., taverns, insurance). But the pattern is hard to define. Thus, food catering would appear to have been a logical candidate for local entrepreneurial growth, but there has been only half-hearted involvement of distant center-city enterprises.

It would seem a fair guess that the more organized and presumably regulated development of a large NEC, with the prospects of long-run contractual commitments, would further reduce local economic participation. Large as is the scale of the construction of a single reactor, it still seems to allow for some local participation, both at the level of workers and enterprises. Less can be expected from the NEC.

- E. Placing a power station in a small community without doubt brings about social change. Three examples can be cited; these effects would be far more intense if an NEC were built and even small-scale residential relocations were involved.
1. A far greater measure of racial interaction than is the practice in the locality has been observed on one construction project, with local traditions bending under the pressure. For example, the taverns near one site were segregated prior to the influx of workers at the site; they no longer are.
 2. Choices as to the direction the locality should take have become part of the effective political agenda (Lower Alloways Creek Township, Plymouth). There is, as one informant said a more "intense" political life. Alternative agendas are meaningful and possible given a fatter public purse.
 3. Early stages of land speculation result in transfer of real property. "Outsiders" acquire fairly large blocks as old farms change hands.

13.5 Concluding Remarks

Despite some efforts to specify certain impacts in a precise quantitative fashion, any conclusions one might attempt to draw regarding the most likely local and regional socio-economic effects of an NEC in Ocean County, N.J., require speculation. The comments offered in this report are largely drawn from experience in construction and operation and maintenance of much smaller nuclear facilities, ranging in size from one to four reactors per site, and from other construction projects, large by today's standards but relatively small in comparison with an NEC. Extension of such information

to a regional energy development picture, much less an NEC, requires much caution. Throughout, assumptions have been as explicit as possible so that the readers can, at their discretion, make necessary and appropriate adaptations.

With these qualifications in mind, several major points deserve reiteration. First, in highly urbanized regions such as coastal New Jersey and elsewhere in the northeastern U.S., some modest regional economic gains would be realized from construction of an NEC. These gains, however, would tend to be diffused over the region and would be small in comparison to gross regional product (a small fraction of a percent for an NEC in coastal New Jersey). This applies to construction, operation and maintenance, and indirect and induced effects, as well as the direct impacts. Employment, income, and population effects which could be attributed to an NEC would be virtually invisible when considered in the context of a large metropolitan area.

Looking at NEC-related impacts on a smaller geographic scale, call it the local level, the general conclusion is that the magnitudes and distribution of impacts will be very much a function of two important variables (in addition to the all important "degree of urbanization" variable): land use controls and the tax structure. To a lesser extent, but still not insignificantly, other variables will shape local, and perhaps even regional impacts. These include the influence and character of the relevant labor unions through which the work force is channeled to the construction project, local geographic features, and ease of access to large metropolitan labor pools. Very little colocation of industry is anticipated either in the sense of technological linkages or due to other localization economies. Some small amount of colocation has been noted near existing power plants but the critical element seems to be the tax advantage. This would likely disappear with construction of an NEC.

Site-specific considerations also do much to influence any comparison between alternative siting modes. Perhaps the most significant factor affecting our NEC vs. dispersed comparison is the inclusion of eight offshore reactors in the dispersed scenario. This has resulted in the reduction of expected local and regional impacts in the dispersed case due to the assumed

construction of these plants outside the region (but with consequent increases of impacts in other regions, such as Jacksonville, Florida). The NEC is seen, therefore, to cause greater total effects on the region than the dispersed scenario. This factor may be peculiar to the MAAC area, however, thus limiting the degree to which the comparison might be generalized.

One of the perceived advantages ascribed to an NEC discussed early in its conceptualization was that it would be built, operated, and maintained by a stable labor force, one which was locally resident, socially adaptive, and nondisruptive. By the same token, it has been suggested that a relatively short-term, large construction project as is implied for several localities involved in a dispersed scenario brings with it a high degree of social turmoil. Both seem overstatements. The local impacts would not be all that different for clustered and dispersed nuclear siting in the New Jersey and MAAC study areas.

APPENDIX TO CHAPTER XIII

DERIVATION OF LABOR FORCE ESTIMATES

Basic to the assessment of certain socio-economic impacts of nuclear power plants are the estimates of the required construction and operation and maintenance (O&M) labor forces. One critical step in the work, therefore, involved collection of work force estimates and data from planned, ongoing and completed projects. These figures have been collected from certain utility and construction companies which are or have been involved in these projects as well as from secondary sources, such as other reports of this type.

What is seen when these collected labor force schedules are viewed with an eye towards consistency is a remarkable degree of variation. These differences may, of course, be reconcilable. Different plant designs, differences in technology, site specific characteristics, strikes and other labor-related issues, and other factors which exert differential influences on power plant projects may, if investigated, provide reasonable explanations for the differences observed. Such an investigation is well outside the scope of this small project, however, and has not been attempted. Instead, available data have been used to make the best estimates for the purposes of this study only.

The purpose of this appendix then is two-fold. First, the reasoning is presented which has gone into the labor force estimates upon which the work had been based. Since time and resource constraints have not permitted needed reconciliation between the varied data on labor forces, certain assumptions had to be made in order to arrive at labor force estimates. These assumptions are made clear here for the reader's information. Should other underlying assumptions eventually may be considered more reasonable, one could then, up to certain limits, modify the results accordingly.

A second reason for inclusion of this appendix is that the data collected on labor force magnitudes and on their levels over time may prove to be very useful to others interested in labor-related issues, even in its raw form and without the needed reconciliation. At the very least, it provides some useful notions of the ranges of labor forces and thus of potential impacts due to the construction, operation and maintenance of nuclear plants. Accordingly, it has been reproduced here to some extent and useful sources have been enumerated.

Certain raw data for construction forces for 2-unit and 20-unit plants are presented in Tables 13-17 and 13-18. Similar presentations for total O & M forces for 2, 4 and 20-unit plants are made in Table 13-19. The footnotes

TABLE 13-17
TWO-REACTOR PLANT CONSTRUCTION "ORCS"^a

MW per Reactor	1065	1150	1250	1300	1400	1500	1600	1700	1800	1900
Year	Limerick	Susquehanna	Zion ^b	Montague ^b	Hope Creek	Salem ^b	GE	Wash-1334	NECES	
1	100	300	141	610	376	565				
2	1100	1800	162	1650	2033	1797				
3	2460	2300	178	2300	2525	2257				
4	2500	2500	176	2390	3578	2742				
5	1900	2000	136	1920	3599	3662				
6	600	1500	82	1450	2880	2861				
7	150	800	33	460	1625	2200				
8	----	250	----	----	505	1500				
9	----	100	----	----	----	1200				
10	----	----	----	----	----	700				
11	----	----	----	----	----	300				
Total Supervisory Worker-Years (where ex- plicitly omitted above)	---	---	1274	---	---	---	---	---	---	---
Total (Worker- Years)	8810	11550	6442	10800	7822	19784	10700	9000	12300	
Adjusted Total ^c (1200 MW)	9900	13200	7400	11300	9000	21800	9900	10800	12300	

Notes to Table 13-17:

^a The data presented here are, except as noted otherwise, in the raw form as received by this study group. Source materials and relevant information are presented below for each.

Limerick. Based on an environmental impact statement for the original Limerick two-reactor plant. Per this EIS, these figures represent the anticipated average number of workers at the site.

Susquehanna. Source: Berkshire County Regional Commission. 1974. Evaluation of Power Facilities: A Reviewers Handbook, p. 172. Pittsfield, MA.

Zion. Source: Alice W. Shurcliff. November 1975. "Local Economic Impact of Nuclear Power Plants" (forthcoming in Technology Review). Based on unpublished data provided by Commonwealth Edison for the construction of their two-unit plant in Zion, Illinois (1968-1974). Figures represent average of numbers of workers at beginning and end of year. (Craft breakdown also available). Supervision added at 20%.

Montague. Source: Harbridge House, The Social and Economic Impact of a Nuclear Power Plant Upon Montague, Massachusetts and the Surrounding Area, November 1974, p. V-23. Based on estimates by Northeast Utilities. (Partial craft breakdown included).

NECES. Source: U.S. Nuclear Regulatory. Nuclear Energy Center Site Survey--1975 (NUREG-001). January 1976, p. III-5-26. Total above based on NRC estimate of 10.25 worker-hours per kw and 2000 working hours per year.

Hope Creek. Based on unpublished manpower forecast of Public Service Electric and Gas Company, Construction Department, 1975, for their plant in southern New Jersey.

Salem. Based on unpublished data for construction forces, 1969-1975, and on current projections, 1976-1979, from Public Service Electric and Gas Company for their plant at Salem, New Jersey. (Partial craft breakdown also available).

GE. Source: General Electric Company. May 30, 1975. Assessment of Energy Plants vs. Dispersed Electric Power Generating Facilities, p. E5-5. Based on 2.4×10^6 total worker-hours at 2000 hours/year.

WASH-1334. Based on estimate for 1000 MW one-unit plant of 4205 worker-years per WASH-1334. Projections of Labor Requirements for Electrical Power Plant Construction 1974-2000. August 1974. Allows that second plant built with 20% less labor and includes 20% supervision overall.

^b Full or partial craft breakdown available.

^c Totals adjusted linearly to 1200 MW.

TABLE 13-18
 TWENTY-REACTOR PLANT (NEC) CONSTRUCTION FORCES

Source	NECSS ^a	NECSS ^b	GE ^c	Batelle ^d
Reactor Starts per Year:	1	1	1	1
Total Number of Worker-Years	146,000	97,800	76,500	153,000
Peak Level of Labor Force	7,100	4,500	3,500	9,500

^a Source: U.S. Nuclear Regulatory Commission. Nuclear Energy Center Site Survey--1975 (NUREG-0001). Volume IV, p. 5-16. Total worker-years computed by integration of 20-unit loading curve excluding O&M. Peak loading also taken from that curve.

^b Source: Ibid, Volume III, p. 5-27 and 5-41. Total worker-years calculated per tables on p. 5-27 (i.e., at 8.15 years/KW). Peak loading taken from curve on p. 5-41 and excludes supervision. (Also from Vol. IV, p. 3-102).

^c Source: General Electric Company. Assessment of Energy Parks vs. Dispersed Electric Power Generating Facilities, May 30, 1975. Total worker-years computed as 153×10^5 hours, p. ES-5 divided by 2000 hours/year. Peak loading from Table 6-3, p. 6-133.

^d Source: Pacific Northwest Laboratories, Batelle Memorial Institute. "Economic and Social Impacts of Nuclear Energy Centers: A Preliminary Analysis" (draft copy) June 1975. Total worker-years calculated by integrating of curve for 10-unit (p. 4) and allowing that 10% labor savings seen on additional 10 units. Peak loading for 20-units implied by Table 1, p. 3, in that peaks for 10-unit and 40-unit are both 9500.

TABLE 13-19
 NUCLEAR POWER PLANT O & M LABOR FORCES

Source	Plant Size (MW)	Plant Staff
<u>2-Unit Plant^a</u>	AEC	2000
	GE	2600
	PSE&G	2200
	Harbridge House	2300
<u>4-Unit Plant^b</u>	Batelle	4800
	NECSS	4800
<u>20-Unit Plant^c</u>	Batelle	24000
	GE	26000
	U of P	24000
	NECSS	24000

^a Sources:

U.S.A.E.C. Utility Staffing and Training for Nuclear Power (WASH-1130), June 1973, p. 15.
 General Electric Company. Assessment of Energy Parks vs. Dispersed Electric Power Generating Facilities, May 30, 1975, p. ES-5.
 Public Service Gas & Electric Company. Projected operating force for Salem (N.J.) Generating Station.
 Harbridge House. The Social and Economic Impact of a Nuclear Power Plant Upon Montague, Massachusetts and the Surrounding Area, November 1974.

^b Sources:

Pacific Northwest Laboratories, Batelle Memorial Institute. "Economic and Social Impacts of Nuclear Energy Centers: A Preliminary Assessment" (draft), June 1975, p. 3.
 U.S. Nuclear Regulatory Commission. Nuclear Energy Center Site Survey--1975 (NUREG-0001), January 1976, Vol. III, p. 5-56.

^c Sources:

Pacific Northwest Laboratories, op. cit., p. 3.
 General Electric Company, op. cit., p. ES-5.
 Regional Science Department, University of Pennsylvania. Regional Economic Impacts of Nuclear Energy Centers, September 30, 1975, p. 49.
 U.S. Nuclear Regulatory Commission, op. cit. Vol. IV, p. 4-49.

^d Craft breakdown presented in source material.

to these tables present the sources and other relevant information for each estimate or data set. A short explanation of why the labor estimates seen in the body of this report were selected is presented below.

CONSTRUCTION LABOR FORCE

2-Unit Plants (i.e. Expansion sites)

Total worker-years for construction of a two-unit plant ranged from 6400 to 19,800, as seen in Table 13-17. The Limerick estimate has been used for several reasons. First, one would expect certain savings in labor in an expansion site over the original construction, and the lower end of the range best reflected these economies. Second, since the expansion sites being considered are Limerick and Susquehanna, it seems reasonable to use one of these two in order to capture certain site-specific factors. Limerick was chosen over Susquehanna for the first reason stated above. Finally, the Limerick estimate is consistent with the 20-reactor labor forces used in this and earlier work.

4-Unit Plants

Bay Sites--A labor schedule was developed for the 4-unit bay sites primarily on the basis of consistency with estimates for the 2-unit and 20-unit sites. If one were starting from scratch and looking only at new 4-unit plants, it most likely would seem more reasonable to use the actual data from the Salem project discounted by some margin to allow for labor difficulties there. This would result in higher figures than those used here. These figures would be inconsistent with our other estimates, and for that reason have not been used. If a reconciliation of the estimates of Table 13-20 should ever show these higher figures to be appropriate, our assessment of potential local and regional impacts should be adjusted accordingly.

Offshore Sites-- Our estimate of labor forces within the region has been developed with the help of PSE&G as shown in Table 13-11. These figures reflect only the labor involved in casting of the caissons and dolosse, construction of the breakwater, construction of a modest amount of onshore support facilities (a substation, warehouse facilities, boat ramp, parking lot, etc.), and the work involved in securing and operationalizing the floating plant. Construction of the floating nuclear plants themselves would be carried out by Offshore Power Systems, Inc., in Jacksonville, Florida, with the completed plants towed into place.

20-Unit Plant (NEC)

For the main plant construction, the estimates used previously have been retained (see September 1975 report). These figures were taken in the main from a preliminary version of the GE report referenced in Table 13-18. The later edition of the GE report represented in Table 13-18 does not show any major changes.

The GE (and our) figures are about 20-25% below one set of estimates presented in NRC-NECSS (column 2 in Tables 5-18). As such, they are sufficiently consistent not to cause alarm. If one would like to use our multipliers to duplicate our assessment of income and employment effects, for these higher labor estimates, these differences are not so great as to exceed reasonable bounds for extrapolation. The other estimates from NRC-NECSS (column 1) and the Batelle estimates are significantly higher, however, and such an extrapolation probably cannot be justified.

Labor requirements for infrastructure replacement and new construction for an NEC at the Bay Site has been estimated as follows:

Relocation of six miles of Route 9	100 worker-years
Construction of bridges necessary to permit evacuation of the barrier islands in the event of an untoward episode	500 worker-years
Miscellaneous secondary roads, etc.	100 worker-years

The Inland and Fort Dix sites would not require expenditures for the first two items above, and thus only a minimal requirement of 100 worker-years has been used for each of these sites for infrastructure replacement. We have assumed that all tunnel construction for an NEC will be completed in time for completion of the first reactor, reasoning that significant economies of scale in construction will more than offset the preinvestment of capital required (see discussion of Section 8.3).

O&M LABOR FORCE

For the 20-unit plant (i.e., NEC), as in the case of the construction labor, the estimate of labor requirements used in earlier work²⁷ has been retained. This will allow comparisons from one report to the other for several sites (i.e., Ocean and Salem Counties, N.J., and upstate New York). Our assumed O&M force of 2100 workers at full strength is not inconsistent with the NECSS figure of 2500. As with construction labor, this difference is sufficiently small so that the interested reader could extrapolate our income and employment multiplier analysis to this higher level without straining the limits of accuracy.

Our estimate for the 20-unit plant likewise is not inconsistent with the NECSS estimate for a 4-unit plant, given the assumption that few economies of scale will be realized in O&M staffing in going from four to twenty units. This assumption seems reasonable in light of our depiction of a 20-unit NEC as comprised of five separate "quads". Accordingly, the NECSS estimate of 460 O&M personnel has been used (an estimate built up by job classification in NRC-NECSS).

NOTES TO CHAPTER XIII

1. Ocean County Master Plan, p. 10.
2. Limerick, Salem, Oyster Creek and Peach Bottom all drew major portions of their work forces from areas within commuting distance. (This assertion is drawn from the Environmental Impact Statement for the Philadelphia Electric Company's Fulton 1 and 2 plants.) The assumption of a high proportion of the labor force coming from within the greater metropolitan region is substantiated further by the work of A. Shurcliff (in "Local Economic Impact of Nuclear Power Plants", Technology Review, forthcoming), F. Shoemaker (in "The Impact of Salem Nuclear Generating Station on Lower Alloways Creek Township, Salem, N.J.", unpublished Master's Thesis, Glassboro State College, 1975), and our own investigations of the Salem N.J. and Pilgrim 1 (Plymouth, Mass.) power station construction projects.
3. For a justification of this assumption, see Regional Science Department, "Regional Economic Impacts of Nuclear Energy Centers", September 30, 1975. University of Pennsylvania, Philadelphia, Pa. It has been assumed that, even though the mechanical and the natural draft towers differ significantly in size relative to each other, the overall effect of the cooling tower on the size of the exclusionary zone is negligible given that evaporative towers are used and heat dissipation intensity is the critical criterion determining size.
4. This assumption is based on the fact that the average land requirements of existing U.S. nuclear units with once-through cooling is 108 acres, or approximately 70% of the 156 acre average for units with cooling towers. See Nuclear Power Facility Performance Characteristics for Making Environmental Impact Statements (WASH-1335), U.S. AEC, Directorate of Regulatory Standards, December 1974.
5. Because of the proximity of the Inland Site and the Bay Site to the Atlantic coast, the actual land area of the buffer is less than that considered in the September 1975 report (*supra* Note 3) for the Salem County, New Jersey, and upstate New York sites. Obviously, this must be taken into account in our discussion of impacts on the area's infrastructure.
6. Some aspects of labor force movements as discussed in "Construction Worker Profile: Summary Report" (Final Draft Manuscript), Mountain West Research, Inc., Tempe, Arizona (1975).

7. Per PSE&G calculations.
8. For reasons explained in Section 13.1, the methodology and parameters used to compute income and employment effects are the same as those used for the Salem County hypothetical site in the September 1975 report (supra note 3). For a complete explanation of how these figures have been arrived at, see Sections II and III of that report.
9. See B. H. Stevens, "Investigation of Location Factors Influencing the Economy of the Philadelphia Region", Discussion Paper 12, Regional Science Research Institute, Philadelphia, 1967, and Shurcliff (1975).
10. There appear to be conflicting positions taken on whether power source locations at considerable distance from demand significantly add to overall costs. But these increments in any event would appear to be distributed over all network areas under present pricing policies.
11. This argument was presented with little variation by many of our informants.
12. See Thomas A. Reiner, "Community Response to Trucking Terminal Impact: Case Studies in the Philadelphia Region", Discussion Paper 86, Regional Science Research Institute, Philadelphia, 1975.
13. Safety and land availability as well as expectation of less potential opposition seem to underlie this criterion.
14. An industrial park on the outskirts was established roughly at the same time as the reactor was built and an old in-town factory building has recently been converted to house small enterprise.
15. Philadelphia Inquirer, "The Gloom, Tedium of Being Jobless", February 11, 1976, p. 1.
16. Once more we wish to call attention to the need to make specific LPZ criteria, and set forth performance standards for effectiveness of sanctions. In particular, we stress the need to apply LPZ limitations to activity levels as well as to residential population density.
17. Regional Science Department, note 3, supra.

18. As we observed in upstate New York (Nine-Mile Point), the colocation may involve a mix of fossil fuel and nuclear plants.
19. See the discussion of taxes above for one possible local economic reason for this.
20. The reaction to the proposal for a nuclear plant at Seabrook, New Hampshire, is not unrelated to that of the nearby Plymouth, Mass., Pilgrim plant.
21. We have included Salem and Burlington Counties as part of an expanded SMSA--this makes but little difference in any calculation since these counties barely account for 5% of the population and less than that in communications.
22. See "Construction Worker Profile: Summary Report" (Final Draft Manuscript), Mountain West Research, Inc., Tempe, Arizona, 1975.
23. In making this assumption, we highlight the need to distinguish the addition to the population (estimated in these paragraphs) from the population associated with this activity. The latter, for reasons cited in the text, would be considerably larger than the actual growth of the population.
24. This estimate may be high given present labor force participation rates of about 40% but an expected increase as the working age group proportionately increases, greater female participation, etc. This figure can be associated with a household size of about 4 persons.
25. Our observations are based in particular on developments near the Pilgrim reactor site and in the vicinity of the Salem County cluster.
26. Regulation of such non-capital expenditures in an LPZ would seem to be more difficult than control of new construction.
27. Regional Science Department, note 3, supra.

CHAPTER XIV*

TAXATION IN NEW JERSEY AND AN NEC

14.1 Introduction

Taxation is a major issue affecting the overall impact of an NEC in New Jersey. A Nuclear Energy Center of some 24,000 MW(e) of generating capacity would be a fantastic tax ratable. Under New Jersey's present gross receipts and franchise tax laws, it would produce a huge increment in tax revenues for the locality in which it happened to be located (transmission lines would produce further tax increments). Given today's tax rates and allocation procedures, essentially all of this revenue--perhaps in excess of \$50 million per year from a 20-reactor NEC--would be allocated to the township(s) in which the generating facilities were located.

Lower Alloways Creek Township in Salem County, for example, receives all the tax accruals associated with the 2-reactor Salem Nuclear Generating Station (and from the proposed 2-reactor Hope Creek facility as well). In 1975, Lower Alloways Creek Township received more than \$3 million in these taxes.¹ When all four reactors are operational in the early 1980's, this single township (1972 population: 1,410) will be receiving approximately \$10 million every year. Lacey Township in Ocean County gains similar financial benefits from the single-reactor Oyster Creek plant (and from the proposed 1-reactor Forked River station), receiving \$3 million in state taxes plus \$151,000 in local property taxes from the Oyster Creek facility in 1975.² A small township like Lower Alloways Creek cannot effectively utilize the massive tax revenues associated with even a single two-

* Prepared with the assistance of Fred Wright, Center for Environmental Studies, Princeton University.

Two unit nuclear station, let alone the taxes from 10, 15, or 20 reactors.

At the same time, an NEC is so large that its very presence could easily subsume the existence of one or two townships. Lower Alloways Creek Township, for example, is only 48 square miles, compared to 40 or 50 square miles needed for a 20-reactor NEC. If the entire township were consumed by the NEC, to what institution(s) of government would the immense revenues from the gross receipts and franchise tax be provided? An NEC seriously contemplated for New Jersey, in other words, would render tax sharing between municipalities an absolute imperative; the implication of this for state politics are explored later in this report.

The following information surveys New Jersey's taxation statutes as of 1975-76, and provides data covering the previous ten years to demonstrate the fiscal impact of a nuclear generating station-- Oyster Creek --upon a small township (Lacey) in Ocean County. This township is involved in one of three hypothetical sites studied for an NEC in Ocean County (Inland Site). While the emphasis is on Lacey, tax data are presented for Union and Ocean Townships which are also involved in the Inland Site area.

An additional hypothetical NEC site is in Eagleswood Township; and the third site studied straddles the township borders of Manchester, Plumsted and Jackson. Data concerning the tax situation during the last ten years in each of these Ocean County municipalities are included.

This study presents projections as to what could possibly result if an NEC were to become a reality without the changes in state tax legislation (tax sharing) which we believe to be imperative. Such data are presented regarding the amount of taxes an NEC might pay, and to whom. This analysis was approached from the perspective of having the potential tax liability associated with an NEC owned and operated by investor-owned utility companies;

14.2 How Would the NEC's Taxes Be Calculated?

In New Jersey, public utilities pay three types of taxes, all of which produce revenues which eventually accrue to the state's municipalities:

- Gross Receipts Tax
- Franchise Tax
- Property Tax

Unless state laws were changed, these three taxes would apply to an NEC just as they do to other electric generating facilities.

Gross Receipts Tax: This is the principal source of tax revenues obtained from utility companies in New Jersey. Gross receipts taxes are determined as a fraction of the company's revenues for a given year. Each utility company pays as tax 7.5% of its total gross revenues; this constitutes its gross receipts tax for that year.

In order to allocate these revenues to the municipalities, the state's Division of Taxation evaluates each electric generating station or transmission facility, and assigns it a specific dollar value.³ Each municipality's proportional share of the total statewide value of all utility company property is then calculated. This figure represents the municipality's proportion of the total state gross receipts tax for that year.

Franchise Tax: Utility companies pay this tax directly to municipalities in their service areas, based upon the value of their wires, poles and transformers. The total franchise tax paid by each company amounts to an additional 5% of its total gross receipts tax for that year. Each municipality receives its proportional share of this 5%, based on the value of the wires, poles, transformers, and so on, located there as compared to the total value of similar equipment within the entire company system.

Property Tax: This tax is assessed by municipalities on the land and ancillary buildings owned by utility companies. Amounts are small compared to the revenues associated with the gross receipts and franchise taxes. The different County Boards of Taxation assess the property to set appropriate levels of taxable value.⁴ Real property tax applies only to land and the buildings on that land. Property tax initially is assessed when construction begins and imposition of the tax continues through to completion and operation of the facility. Utility companies are taxed according to their initial investment, and rates are adjusted in order to allow for depreciation.

14.3 Collection of These Taxes

Utility companies pay these various taxes in the following different ways:

Gross Receipts Tax: The state notifies companies annually of their assessments and the dates on which payments are due. These taxes are payable directly to the local tax collector, based on a schedule provided by the state. These revenues remain in the municipalities.⁵

Franchise Tax: The franchise tax is paid directly by the companies to municipalities after state certification of the proportion of the franchise tax pool due to each municipality in the service area of the utility company.

Property Tax: Once the state Division of Taxation has certified the county Boards' assessment of property, the collectors of the taxing districts are authorized to send bills to utility company taxpayers. State statutes specify deadlines for payment of taxes in installments, and provide for discounts and penalties when tax payments are respectively prepaid or delinquent. The property tax is payable directly by the utility company to the individual municipalities.⁶

Realizing the importance of the tax revenues associated with nuclear generating facilities, a suit was filed which "aims at overturning the distribution formula for the state's 'gross receipts' tax in electrical utilities."⁷ In addition, the state's courts will face a related controversy when they are asked to decide who will receive the tax receipts from the proposed floating nuclear facility proposed for a location some 2.8 miles off the shore of Atlantic County.

"The problem, which will involve at least \$6 million taxes yearly when the billion-dollar plant begin operations in mid-1980's, stems from the state's utility taxation system. Because it's to be located offshore, out of the jurisdiction of any municipality, the millions in taxes it will pay become snarled in legalities."⁸

14.4 Ocean County Municipalities and Utility Company Taxes Over the Past Decade

Under these taxation statutes, Ocean County and Lacey Township have experienced tremendous increases in revenues during the last ten years. This development is due partly to the location of the Oyster Creek nuclear generating station in this area. While the taxes produced by the Oyster Creek plant

are impressive in themselves, the potential tax revenues from an NEC would be staggering, especially if these payments were to be made only to the above-mentioned township(s).

Tables 14-1 and 14-2 present data demonstrating the rapid rise in total tax revenues received from 1965 to 1974 by Ocean County's municipalities, including Lacey Township. Table 14-1 shows a jump in Ocean's County total revenues from just over \$8 million in 1965 to more than \$ 139 million in 1974, a more than 17-fold increase. However, since this county has been the state's fastest growing area and thus has had many other new sources of revenue, the effect of tax payments from the Oyster Creek Nuclear Generating Station is not readily discernable at the county level.

Table 14-2 shows the rapid rise in revenues for Lacey Township. In 1965, Lacey showed total revenues of less than \$850,000; the 1974 figures are very nearly \$6 million, a 7-fold increase. As an example of the rapid growth in ratables elsewhere in the county, Lacey's share of total taxes in Ocean County, even with its power plant, declined from 10.5% in 1965 to 4.3% in 1974. The big decline, as shown, took place in 1968 when the county's total tax receipts increased more than 5-fold in a single year.

Table 14-1

Total Taxes Received By All Ocean County Municipalities, 1965-74

1965	\$ 8,056,783.58
1966	9,230,111.31
1967	11,131,338.25
1968	57,453,586.79
1969	66,701,108.86
1970	79,124,718.58
1971	94,392,484.97
1972	109,545,798.28
1973	127,631,029.15
1974	139,972,269.30

Table 14-2

Total Tax Revenues Received by Lacey Township, Ocean County, 1965-74

	<u>Dollars</u>	<u>Percentage of Total County Tax Revenues</u>
1965	\$ 849,050.94	11%
1966	939,577.33	10%
1967	1,193,069.75	11%
1968	2,135,868.70	4%
1969	2,544,858.65	4%
1970	3,376,043.21	4%
1971	4,258,880.37	5%
1972	4,371,459.27	4%
1973	5,499,780.47	4%
1974	5,975,374.37	4%

Without a doubt, the primary source of this rise in Lacey Township's tax revenues has been the gross receipts and franchise taxes received from electric utility companies associated with the Oyster Creek plant. Table 14-3 gives data, by year (1965-1975), on the amounts of gross receipts and franchise taxes paid by utility companies to municipalities in Ocean County, including the amounts going to Lacey Township. Obviously the Oyster Creek Station has been a great tax boon to the area. As mentioned previously, Ocean County as a whole enjoys a varied tax base. As a result, while receiving some \$7.9 million from utility companies' gross receipts and franchise taxes in 1973 and \$9.2 million in 1974, these taxes amounted to only 6.1% and 6.5% respectively of the county's total revenues. In contrast, from 1965 to 1967 utility company payments of \$2.5 to \$3 million per year represented some 30% of total tax revenue.

The figures for Lacey Township alone are more indicative of the specific taxation implications of a nuclear generating station (See Table 14-4). In 1974, gross receipts and franchise tax payments by utility companies to Lacey accounted for almost 40% of the township's total revenues. The impact of construction of the Oyster Creek plant is shown in the jump in gross receipts payments alone to Lacey from 1967 (\$36,000) to 1968 (\$935,000), a 26-fold

Table 14-3

Taxes Paid by Utility Companies to All Ocean County Municipalities, 1965-1975

	<u>Gross Receipts Tax</u>	<u>Franchise tax</u>	<u>Total</u>	<u>Percentage of county revenues attributable to utility companies' tax payments</u>
1965	\$1,037,373.76	\$1,480,214.12	\$2,517,587.88	31.2%
1966	1,193,871.83	1,615,540.19	2,809,412.02	30.4%
1967	1,362,414.91	1,793,337.38	3,155,752.29	28.3%
1968	2,347,114.99	1,964,587.13	4,311,702.12	7.5%
1969	2,755,943.44	2,116,992.12	4,872,935.56	7.3%
1970	3,181,415.87	2,336,573.54	5,517,989.41	6.9%
1971	3,476,066.00	2,572,803.00	6,048,869.00	6.4%
1972	3,890,601.00	2,844,606.00	6,735,207.00	6.1%
1973	4,558,633.00	3,322,029.00	7,880,662.00	6.1%
1974	5,493,337.00	3,661,708.00	9,155,045.00	6.5%
1975	6,941,822.00	4,514,995.00	11,456,817.00	NA

Table 14-4

Taxes Paid by Utility Companies to Lacey Township, Ocean County, 1965-75

	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>Percentage of township revenues attributable to utility companies' tax payments</u>
1965	\$27,012.56	\$48,930.00	\$ 75,943.49	8.9%
1966	31,339.57	52,592.46	83,932.03	8.9%
1967	36,162.77	62,827.95	98,990.72	8.2%
1968	935,421.48	76,512.10	1,011,933.58	47.3%
1969	1,176,249.61	88,556.71	1,264,806.32	49.7%
1970	1,397,019.42	98,202.19	1,495,221.61	44.2%
1971	1,465,727.38	105,320.26	1,571,047.64	36.8%
1972	1,633,264.00	122,434.10	1,755,698.10	40.1%
1973	1,753,550.06	146,370.87	1,899,925.93	34.5%
1974	2,202,552.63	170,402.00	2,372,954.63	39.7%
1975	2,933,255.00	212,143.00	3,145,398.00	NA

Table 14-5

Total Tax Revenues and Taxes Paid by Utility Companies, Union Township, Ocean County, 1965-75

	<u>Total Tax Revenue</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>%</u>
1965	321,473.12	8,760.47	22,684.76	31,445.23	9.7
1966	320,924.00	9,154.94	23,730.13	32,885.07	10.2
1967	399,161.01	10,326.50	24,694.49	35,020.99	8.7
1968	396,482.00	10,587.34	26,712.81	37,300.15	9.4
1969	464,342.22	13,071.36	29,556.85	42,628.21	9.1
1970	526,284.13	14,076.05	34,220.42	48,296.47	9.1
1971	558,928.34	16,599.75	37,259.97	53,859.72	9.6
1972	918,466.96	18,700.91	39,734.42	58,425.33	6.3
1973	1,459,336.71	20,057.23	44,292.49	64,349.72	4.4
1974	2,500,014.95	26,018.63	57,699.82	83,718.45	3.3
1975	N.A.	35,189.58	79,865.41	115,054.99	N.A.

Table 14-6

Total Tax Revenues and Taxes Paid by Utility Companies, Ocean Township, Ocean County, 1965-75

	<u>Total Tax Revenues</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>%</u>
1965	382,728.26	16,656.98	27,290.88	43,947.86	11.4
1966	448,979.30	17,927.77	28,918.55	46,846.32	10.4
1967	528,910.90	19,984.81	31,556.93	51,541.74	9.7
1968	559,899.06	22,524.03	35,524.05	58,048.08	10.3
1969	609,118.50	26,410.54	38,934.47	65,345.01	10.7
1970	704,058.68	29,844.57	42,275.00	72,119.57	10.2
1971	849,857.62	32,599.23	45,299.01	77,898.24	9.1
1972	1,091,301.20	38,472.61	48,839.33	87,311.94	8.0
1973	1,597,480.95	40,226.45	54,427.44	94,653.89	5.9
1974	1,720,855.78	44,613.57	59,862.06	104,475.63	6.0
1975	N.A.	69,950.67	72,090.31	142,040.98	N.A.

Figure 14-1. Tax receipts.

In 1965, gross receipts and franchise taxes paid by electric utility companies to New Jersey municipalities amounted to just over \$75 million. By 1970, this figure had risen to nearly \$105 million and the figure for 1976 is more than \$250 million. Thus, income going to municipalities statewide from this source has more than tripled during the last ten years. Increases have been particularly rapid in recent years because of high fuel prices, reflected in consumers' bill through a fuel adjustment allowance and therefore seen in the companies' gross receipts.

As these figures illustrate, the state of New Jersey--that is, its local governments--exact an enormous amount in taxes from utility companies. Almost all of these revenues remain in the local municipalities. The result is the creation of certain wealthy townships and boroughs, almost overnight; meanwhile the state, being handicapped by current tax legislation, is powerless to activate a system of intra-state tax sharing or tax apportionment.

More specifically, if one looks at the townships being studied as hypothetical NEC sites, the possible fiscal impact of an NEC can be identified. Take the Inland Site first. The total tax revenues paid to Union and Ocean Townships from 1965 through 1974 are shown in Tables 14-5 and 14-6 along with the amounts paid in each township as Gross Receipts and Franchise Tax. Similar data for Lacey Township were given in Tables 14-2 and 14-4. These same tables also present figures representative of that percentage of the respective townships' total revenues attributable to the utility companies' tax payments. This provides another opportunity to view the fiscal impact of a nuclear generating station. Utility company tax payments to Union and Ocean Townships in 1974 accounted for 3.3% and 6.0%, respectively, of the total revenues received by these two municipalities; for Lacey Township--site of the Oyster Creek plant--utility company tax payments in 1974 amounted to more than 39% of its total revenues.

At the hypothetical Bay Site, an NEC would be an enormous tax boon. Of all the Ocean County townships studied, Eagleswood Township is the one whose revenues presently are the lowest. Table 14-7 gives similar data, by year, for this municipality. From a total figure of \$164,000 in 1965, this township's revenues had risen to \$411,000 a decade later. Eagleswood's smaller

Table 14-7

Total Tax Revenues and Tax Paid by Utility Companies, Eagleswood Township, Ocean County, 1965-75

	<u>Total Tax Revenues</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>X</u>
1965	164,250.03	9,170.00	14,780.00	23,950.00	14.5
1966	173,680.25	10,420.00	15,652.00	26,072.00	15.0
1967	204,641.15	12,221.00	16,740.00	28,961.00	14.1
1968	200,065.68	12,541.00	16,981.00	29,522.00	14.7
1969	251,910.86	13,180.00	17,690.00	30,870.00	12.2
1970	253,907.63	14,788.00	19,465.00	34,253.00	13.4
1971	281,150.35	15,574.00	20,935.00	36,509.00	14.3
1972	336,572.09	16,243.00	23,747.00	39,990.00	14.2
1973	382,540.02	18,699.00	26,721.00	45,420.00	11.8
1974	411,217.63	26,082.00	29,088.00	55,170.00	13.4
1975	NA	21,876.00	25,291.00	47,167.00	NA

Table 14-8

Total Tax Revenues and Taxes Paid by Utility Companies, Jackson Township, Ocean County, 1965-75

	<u>Total Tax Revenues</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>X</u>
1965	2,611,566.07	75,824.00	97,557.00	173,381.00	6.6
1966	2,458,599.89	66,175.00	98,661.00	164,836.00	6.7
1967	3,019,097.53	75,740.00	110,199.00	185,947.00	6.1
1968	3,559,651.56	79,475.00	174,501.00	203,974.00	5.7
1969	4,732,220.99	84,791.00	133,009.00	217,800.00	4.6
1970	5,536,955.87	94,264.00	145,416.00	239,680.00	4.3
1971	6,844,026.79	120,508.00	161,662.00	282,170.00	4.1
1972	8,096,922.98	135,228.00	178,789.00	314,015.00	3.8
1973	9,757,874.88	164,572.00	218,448.00	303,020.00	3.9
1974	10,510,668.62	190,625.00	236,432.00	427,057.00	4.0
1975	NA	230,368.00	290,144.00	520,512.00	NA

Table 14-9

Total Tax Revenues and Taxes Paid by Utility Companies, Manchester Township, Ocean County, 1965-75

	<u>Total Tax Revenues</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>X</u>
1965	554,538.23	24,172.00	31,062.00	55,234.00	9.9
1966	609,496.25	23,717.00	35,917.00	59,649.00	9.7
1967	795,054.16	28,382.00	48,115.00	76,497.00	9.6
1968	946,448.04	27,705.00	50,548.00	78,253.00	8.2
1969	1,096,779.62	29,191.00	53,406.00	82,597.00	7.5
1970	1,488,136.10	33,251.00	63,872.00	97,123.00	6.5
1971	1,927,201.71	36,535.00	74,055.00	111,390.00	5.7
1972	2,543,108.47	50,538.00	89,543.00	148,081.00	5.8
1973	3,445,712.82	66,394.00	110,743.00	177,137.00	5.1
1974	4,050,763.53	122,440.00	146,269.00	268,709.00	6.6
1975	NA	171,909.00	191,819.00	363,728.00	NA

Table 14-10

Total Tax Revenues and Taxes Paid by Utility Companies, Plumsted Township, Ocean County, 1965-75

	<u>Total Tax Revenues</u>	<u>Gross Receipts Tax</u>	<u>Franchise Tax</u>	<u>Total</u>	<u>X</u>
1965	457,938.87	11,576.00	21,894.00	32,474.00	7.3
1966	411,705.96	11,847.00	23,255.00	35,102.00	8.5
1967	367,309.11	14,991.00	27,964.00	42,955.00	11.6
1968	509,432.60	14,288.00	31,100.00	45,388.00	8.9
1969	397,624.02	14,130.00	32,796.00	46,926.00	7.8
1970	732,346.23	14,048.00	34,084.00	48,132.00	6.5
1971	756,644.63	20,918.00	35,843.00	56,761.00	7.5
1972	845,362.60	22,404.00	38,890.00	61,294.00	7.2
1973	850,897.78	23,301.00	45,120.00	68,421.00	8.0
1974	929,302.13	16,815.00	19,303.00	36,117.00	3.8
1975	NA	38,051.00	58,616.00	96,667.00	NA

tax base is easily demonstrated in another fashion. While the other townships in 1974, except those having nuclear generating stations, received about 6% or less of their yearly revenue from tax payments made by utility companies, Eagleswood Township, even without a nuclear generating facility, received some 13% of its annual revenue from such payments.

The three townships which make up the Fort Dix hypothetical NEC site are Jackson, Manchester and Plumsted. Tax data for these areas are presented in Table 14-8 through Table 14-10. Their total revenues in 1974 ranged from \$1 to \$10 million. Their reliance on tax payments made by utility companies is not as dramatic as Eagleswood or Lacey, although construction of an NEC would change this overnight.

For a clearer picture of what might happen, we calculated how much each of these townships might receive in the way of utility tax payments under the present tax structure if a 20-reactor coastal New Jersey NEC were to become a reality.

14.5 Tax Payments From an NEC

When the two units of the Hope Creek Nuclear Generating Station are completed, the station will pay approximately \$50,000 in property taxes and \$5,600,000 in gross receipts and franchise tax.⁹ It should be kept in mind that a company would pay varying amounts of property tax during construction of the facility. It is also to be expected that once part or all of the station is completed, its assessment might be reduced gradually because of asset depreciation.

Out-of-state companies presently do not pay a gross receipts and franchise tax to New Jersey municipalities on their portion of the utility plant. Out-of-state corporations doing business in New Jersey are taxed by the state, and revenue received from such a tax goes to the state.¹⁰ However, the revenue paid to the state amounts to substantially less than would otherwise be paid by the out-of-state corporations to municipalities as compared to New Jersey corporations.

For the Hope Creek station, this means that a single municipality-- Lower Alloways Creek--can expect to receive \$5,650,000 in gross receipts, franchise, and property taxes from a station consisting of only two nuclear units. Although projections of tax revenues associated with a 20-unit station are difficult since an increase from 2 to 20 units does not automatically mean an equivalent increase in tax revenues, for planning purposes a linear projection of the Hope Creek facility's taxes to a 20-unit NEC suggests a tax contribution of some \$56 million per year, all to the local municipality(ies). This figure has been used in subsequent comparisons.

Table 14-11 summarizes 1974 tax revenues for the seven Ocean County townships being examined as hypothetical locations for part or all of an NEC in coastal New Jersey. The table also illustrates the probable impact of an NEC's tax payments as compared to 1974 local revenues, and on a per capita basis. As explained in a footnote to Table 14-11, calculations were made for only five of these seven municipalities.

The Bay Site, located totally within sparsely-populated Eagleswood Township with its very limited base, would have an enormous fiscal impact. An NEC's annual taxes would be equivalent to 137 years of tax payments from all existing sources. The per capita figure is equally striking: nearly \$65,700 for each man, woman and child now resident in this municipality. If an NEC were to be built at the hypothetical Bay Site, Eagleswood Township would shift from being one of the state's poorest municipalities to its very richest, at least in terms of per capita tax accruals.

Because of the larger number of tax ratables already existing in Lacey Township, the fiscal impact of an NEC at the Inland Site would be somewhat less phenomenal. Nevertheless, the NEC's taxes alone would be some 10 times the total taxes collected in the entire township in 1974. On a per capita basis, the NEC's tax contribution would be about \$7,500 per Lacey resident.

Table 14--11

Impact of an NEC on Local Tax Revenues

<u>Bay Site</u>	<u>1974 Tax (1) Revenues</u>	<u>Tax Revenue From a 20-unit NEC</u>	<u>Equivalent Years of Total Municipal Taxes</u>	<u>Per Capita Annual Tax Contribution of of an NEC (1) (2)</u>
Eagleswood Twp.	\$ 411,000	\$56,500,000	137 years	\$ 65,698
<u>Inland Site</u>				
Lacey Township	5,975,000	56,500,000	9.5 years	7,474
Ocean Township	1,721,000	(3)	(3)	-----
Union Township	2,500,000	(3)	(3)	-----
<u>Ft. Dix Site</u>				
Jackson Township	10,511,000	22,600,000 (4)	2.2 years	1,076
Manchester Township	4,051,000	11,300,000 (5)	2.8 years	880
Plumsted Township	929,000	22,600,000 (4)	24 years	4,994

Notes

- (1) Rounded to the nearest \$1,000.
- (2) Based on 1974 population.
- (3) Only Lacey Township has been included in these tax calculations, since the vast majority of an NEC at this location would fall within this municipality's boundaries. As a result, Union and Ocean Townships would be less likely to receive large amounts of tax revenue from this facility. Their 1974 tax revenues are included in the Table for comparative purposes. Obviously the actual placement of an NEC could be adjusted somewhat to attain greater or lesser compatibility with existing municipal boundaries, should this be desired for tax reasons or other public policy purposes.
- (4) This figure is equivalent to 8 of the NEC's 20 reactors, or 40% of its taxes.
- (5) This figure is equivalent to 4 of the NEC's 20 reactors, or 20% of its taxes.

The Fort Dix Site demonstrates a very different fiscal impact in Plumsted Township than in the other two localities involved at this location. As shown in Table 14-11, based on the overall geography of this site we have assumed that 8 of the 20 reactors would be located in Jackson and Plumsted each, with the remaining 4 in Manchester. As a result of the sizeable tax base already existing in Jackson and Manchester, an NEC's revenues would be striking, but not at anywhere near the same magnitude as in the other Ocean County locations. The fiscal impact would be equivalent to 2.2 to 2.8 years of 1974 taxes, or to \$880 to \$1,076 per person. In Plumsted, however, even the assumed 40% of an NEC would produce revenues equal to 24 years of total taxes in 1974, or some \$5,000 for each present resident.

Clearly, the potential tax contribution of a 20-unit NEC is staggering. What is cause for more concern is the way these taxes would be allocated. Under existing state laws, very small or sparsely populated townships would be the recipients of great amounts of revenues overnight, while the fiscal needs of the state in general would receive no benefit from this new source of available tax revenues.

14.6 Tax Liability and the Complete NEC

Comparison With State Tax Revenues: For the fiscal year ending June 30, 1974, the revenue received by the state of New Jersey totalled \$2,042,138,140. Although this amount does not include the state costs of financing New Jersey's public schools, which are operated at the local level, it does include all but some minor tax revenues such as those received from the purchase of fishing licenses, etc.¹¹

Not accounting for real property tax paid during construction stages or reduced assessments due to depreciation, a complete Nuclear Energy Center's tax liability could conceivably amount to about 2.5 percent of the state's 1974 revenue, a not insignificant amount from a statewide perspective.

A NEC and School Costs: Like other states, New Jersey is constantly faced with the problem of financing quality public school education for its citizens. As a possible positive compensation for agreeing to locate an NEC in the state, it is interesting to speculate about the increase which would be required in current gross receipts and franchise tax rates to ensure

that the Nuclear Energy Center paid a substantial share of school financing in New Jersey.

The costs of operating the public schools in New Jersey for the school year of 1973-74 were \$2,369,433,708 (total expenditures). Thus, present utility tax rates would have to be raised about 5 fold from the level of the NEC's taxes of \$56,500,000 and the other gross receipts and franchise tax of \$164 million (in 1974) to cover half of current bills for New Jersey school costs.

Obviously, the implications under the existing tax system mean that small municipalities would have extremely large amounts of revenue at their disposal. Because of the state's financial woes (school costs, for instance), it seems imperative that New Jersey alter its existing statutes so that these high amounts of revenue become available on a county-wide if not state-wide basis, in order to achieve a more equitable scheme of tax-sharing for all of New Jersey if construction of a massive energy facility like an NEC were to be commenced.

14.7 NEC Ownership and Tax Liability

If the NEC were to have varied owners (federal government, private utilities, etc.), the potential tax benefits of the center to the municipalities and possibly to the state could be expected to decrease in relation to the portion of the NEC owned by the federal government.

14.8 Clustered vs. Dispersed Siting and Taxation Payments

The concentration of impacts into a single geographic location associated with so many aspects of an NEC--environmental, economic, social--is epitomized by the taxation phenomenon. Each quad-site in a New Jersey NEC could pay some \$11,300,000 per year to the local municipality; the 20-reactor NEC would pay 5 times this amount, or \$56,500,000. If the NEC alternative were selected, other localities--such as those in Cumberland County where the lower Delaware Bay Site would be built--would miss their tax bonanza while the site selected for the NEC would be overwhelmed with tax dollars. As shown earlier in this chapter, the Bay Site would provide Eagleswood Township annually with the equivalent of 137 years of taxes at today's level, amounting to some \$70,000 annually for every man, woman and child now residing in Eagleswood.

Even though this might be regarded as totally unrealistic, one should bear in mind that the \$11,300,000 in annual tax payments now actually destined for Salem County's Lower Alloways Creek Township in the early 1980's from the nuclear quad site at Artificial Island amounts to about \$8,000 each year per resident, not as income--which they would love--but as tax payments to the municipality, which they really can't use. As these large, capital-intensive nuclear generating stations are built in New Jersey, the present taxation system will have to be modified to make most of these revenues available at the state rather than local level. The decision to construct an NEC would simply exacerbate this problem and force a modification sooner rather than later.

The presence of a nuclear unit, given present local and state fiscal practices, thus surely is a distinct asset from the narrow perspective of funding sources of public revenue. Each nuclear power plant represents a taxable asset which would be a major share of the wealth of a small jurisdiction. This figure would be much larger for a cluster of reactors in an NEC, of course. As has been noted in numerous reports,¹² the favorable position taken by many local interests and governments hinges in good measure on the expectation of a steady and large revenue flow from such real property and from the plant's gross receipts.

The taxation system existing in many states, including New Jersey, guarantees that the bulk of revenues will accrue to the jurisdiction in which the plant(s) is (are) sited.¹³ In many cases, the assessed value of the plant may equal or exceed the sum of existing ratables in the jurisdiction.¹⁴ Even allowing for meeting expanded service needs,¹⁵ a sizeable surplus of revenues would remain in the localities' hands. Revenues from just one power plant can be sufficient to meet building, staffing and other operating demand even where a backlog of unmet needs exists. In these days of local fiscal stringencies, it is a bit surprising to learn of ample surpluses invested in federal Treasury notes.¹⁶

Equity and efficiency issues come to the fore immediately. Neighboring towns are left with insufficient revenues to respond to power plant-induced impacts (e.g., congestion, school enrollment increases), while at the same time the "fortunate" community can afford to finance necessary projects

and, possibly, luxuries.¹⁷ Indirectly, and in the longer run, such equity issues arise as projects and needs elsewhere remain unmet: such as those in older metropolitan centers (where, incidentally, much of the electricity is destined). Such pressing priorities are left unanswered while the "fortunate" jurisdiction with a power plant banks the tax collected from the utility. It is our sense that such will contribute to amended tax revenue producing and distributing practices, particularly to a turn away from locally collected real property taxes as the main source of revenues.¹⁸

One rather paradoxical aspect of the tax and revenue question should be noted. A nuclear unit (as would any costly taxable facility) initially brings with it the promise, and soon the reality, of lowered taxes for other property owners. The jurisdiction gets the reputation of something of a tax haven--not incorrectly. But as this is so, pressures also build up, for its attractiveness becomes quickly known. Three undesirable effects come to the fore:

1. Speculation in land (high expectations of earnings from resale, sometimes coupled with the unreal hope that heavy industrialization as well as residential settlement can be attracted).
2. Residential development enticed by the promise of low real estate taxes and quality public services made possible by the bonanza revenues from the power facility.
 - a. This may be undesirable for many seeking to maintain traditional patterns, say of a historical township.
 - b. It is sure to generate an increased load on public services (roads, sewers, schools) which are costly to provide--and thus soon erases the tax advantage which stimulated the development in the first instance.
3. As development is brought close to the power plant on the heels of the promise and reality of low taxes, density in the vicinity of the reactor or reactors rises. This vitiates the initial premises (reflected in site-screening criteria) that such facilities be placed in low density areas for safety and security reasons. Perhaps less explicitly, low density in the neighborhood of a reactor is desired to allow for expansion through the addition of other reactors in the immediate vicinity.¹⁹ At this point, local jurisdictions do not seem to be exercising direct controls over construction and settlement close to the plants, although indirectly some density control practices may be found.²⁰

In sum, the regional impact of present tax policies appears to serve as a stimulus to growth, mainly in the immediate vicinity of a nuclear power plant.²¹ But this is growth that does not, other than marginally, represent a real increase in activity in the larger region. Mainly it would seem to involve selective advantages of the jurisdictions where power plants are located. Conceivably an enterprise (a household) might be so sensitive to the relatively minor tax differential as to move to the region from outside but such a case (given industrial location practices) would be the exception. Rather, settlement near nuclear power plants represents choices not to build in other communities within the region.

As has been noted elsewhere, when the reactor project reaches the scale of an NEC, the impact may take a qualitative turn. Rather than providing a fiscal stimulus to a township, the project would require the absorption of one or more jurisdictions into an exclusionary zone. Other considerations aside, such a step would impress on the state legislators and other parties the need to sever taxation revenues and service provision from a jurisdiction base more suited to simpler days when projects or facilities were built at a smaller scale. Indeed, the current residents of the jurisdictions benefiting from "windfall" tax revenues understand this point very well. In several locations, such residents welcomed the first unit and tolerated the second, in one case in exchange for additional concessions to the local community not demanded for the first. Beyond two units, the residents foresee an "embarrassment of riches," i.e., the windfall and associated inequities will be so great as to induce restructuring of the tax system with consequent loss to them of the advantages which come with one or possibly two units.

A few other differences in taxation between clustered and dispersed siting are of some interest. First, if an NEC were so large as to swallow up an entire municipality within its borders,* to whom would taxes be paid under present structural arrangements? This issue also arises when comparing an NEC with the stipulated dispersed siting pattern, which includes eight floating nuclear power plants. Although the site is state-owned, and riparian rights are granted to the applicant by the State, it is

*The NEC also might leave such a small municipality that it would no longer be viable, and would have to be annexed to another one.

by no means certain that the existing situation, whereby communities facing any on-shore impact would not be direct beneficiaries of tax revenues, will not be changed. In view of the fact that off-shore facilities were not considered when the Gross Receipts and Franchise Tax legislation was drafted, it may well be that affected townships and counties will press for legislative amendments in their favor. Third, it is conceivable that an NEC would pay more total taxes than would the equivalent number of dispersed nuclear plants; and its pay-out curve certainly would be higher in the earlier years. This is a function of the larger amounts of front-end money needed for an NEC, and of its overall higher capital intensiveness. It would certainly pay far more taxes in New Jersey than would be associated with the dispersed siting pattern, which includes reactors in Pennsylvania and Maryland as well as in (and off the shores of) New Jersey. Fourth, if the Fort Dix Site were to be used as an NEC and retained in federal ownership, it would of course pay no taxes to the state or local municipalities.

The major distinction, however, is between dispersed nuclear sites paying huge tax revenues to local municipalities, as compared to a nuclear cluster which would completely overwhelm the local government(s) with its tax payments.

Notes to Chapter XIV

1. Jim Gallagher, "City to Sue for Utility Tax Share," Trenton Times, February 19, 1976.
2. Zone Binder, "Who Will Get the Nuclear Plants' Huge Tax Bonanza?" Atlantic City Press, March 4, 1976.
3. NJSA 54:30A-58, Scheduled property and unit value as basis for apportionment.
4. NJSA 54:402.26.
5. NJSA 54:30A-49.
6. NJSA 54:4-64; 54:4-66; 54:4-67.
7. Gallagher, op.cit.
8. Binder, op.cit.
9. Draft CAFRA Permit, Hope Creek Nuclear Generating Station, Para. 99a.
10. NJSA 54:15 and NJSA 54:15 15.
11. Information given by Mr. Glazer, Director of N.J. State Division of Taxation, June 10, 1975.
12. See Berkshire County Regional Planning Commission "Evaluation of Power Facilities: A Reviewers Handbook", Pittsfield, Mass., April 1974; Harbridge House "The Social and Economic Impact of a Nuclear Power Station upon Montague, Mass., and the Surrounding Area", Nov. 1974; D. Myhra, "One Nuke Gets a Warm Welcome", Planning Magazine, Sept. 14, 1975; B. Shoemaker, "The Impact of Salem Nuclear Generating Station on Lower

Alloways Creek Township, Salem, N.J." Unpublished Thesis, Glassboro State College, May 1975.

13. Harbridge House and Shoemaker, Ibid.
14. See D. J. Bjornstadt, "State and Local Fiscal Impacts Associated with Nuclear Energy Centers", Oak Ridge National Laboratory, 1975 and Harbridge House, note 12, supra.
15. See Harbridge House, note 12, supra, p. IV-8 to 10 and pass.im. and Shoemaker, note 12, supra, Chapter V. Also based on interviews on local informants in New Jersey and Massachusetts.
16. See Shoemaker, note 12, supra, p. 98. Also as a possible (if unenthusiastic) recommendation for a stabilization fund, see Harbridge House, note 12, supra.
17. See Harbridge House, Ibid., and Shoemaker, note 12, supra.
18. But, as noted by Harbridge House, note 12, supra, p. 1-29/30, such a shift is likely to come slowly, if at all.
19. Something of a similar sequence was found to take place in the vicinity of the Pilgrim plant; informants confirmed the report of Harbridge House, note 12, supra.
20. For example, a decision to hold population down by not providing a sewage system on the part of Lower Alloways Creek Township.
21. The reactor complex--say at an NEC scale--represents an asset of some \$20 billion. The most generous calculation of housing induced by the project, as well as other commercial taxables, would be on the order \$20,000,000 - \$40,000,000 in the neighboring town. This sum, though not negligible, falls within the range of cost overruns or minor variants of design for a single power plant. The revenue effect of such housing then would be at best a slight compensatory factor for the taxpayer in the jurisdiction not "advantaged" by the power plant.

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CHAPTER XV*

ORGANIZATIONAL ISSUES

15.1 Utility Companies in the PJM/MAAC Study Region

In order to assess the potential for individual utility companies or a consortia of utilities to plan, build, and operate a Nuclear Energy Center in New Jersey, it is necessary to review the relative size and strengths of the region's utilities and their existing planning organizations. Eleven utility companies comprise the Pennsylvania-New-Jersey-Maryland Interconnection (PJM), and might become involved in one aspect or another of a New Jersey NEC. Table 15-1 and Figure 15-1 summarize information for each of these utilities on service areas, operational boundaries, population served, and available and planned generation facilities. Figure 15-2 shows the location of operating and currently planned major generating facilities.¹

Public Service Electric & Gas Company. Organized under the laws of New Jersey in 1924, Public Service Electric and Gas Company (PSE&G) is the largest utility company in the state and the eighth largest in the nation. It serves an estimated 3.5 million people in its 1400 square mile electric service area which stretches from Bergen County in the northeast corner of the state (in the New York City SMSA) down to Camden County in west south-central New Jersey (in the Philadelphia SMSA). Principal cities served include Bayonne, Camden, Elizabeth, Hackensack, Hoboken, Jersey City, Newark, Passaic, Paterson, and Trenton.

At the end of 1974, PSE&G's total installed electric generating capacity amounted to 8,892 Mw. Most of this capacity comes from eight fossil-fueled steam generating plants scattered throughout the company's service area, all of which also contain gas-turbine units for peak-load generation. PSE&G is also half-owner of the Yards Creek Pumped Storage

* Prepared with the assistance of Harlan Fuglesten, Center for Environmental Studies, Princeton University.

TABLE 15-1

SIZE, POPULATION AND NUMBER OF ELECTRIC CUSTOMERS SERVED BY EACH UTILITY

<u>Company</u>	<u>Electric Service Area (sq. mi.)</u>	<u>Population of Service Area</u>	<u>Total Electric Customers (1973 Est.)</u>
Public Service Elec. & Gas Company	1400	3,450,000	1,622,000
Jersey Central Power & Light Company	3256	1,700,000	608,000
Atlantic Electric Company	2700	865,000	301,000
Philadelphia Electric Company	2475	3,800,000	1,229,000
Pennsylvania Power & Light Company	10,075	2,300,000	875,000
Pennsylvania Electric Company	17,615	1,500,000	469,000
Metropolitan Edison Company	3274	812,000	319,000
UGI Corporation	476	140,000	53,000
Delmarva Power & Light Company	5702	N.A.	236,000
Baltimore Gas & Electric Company	2298	2,265,000	733,000
Potomac Electric Power Company	643	1,850,000	446,000

Figure 15-1. Electric service territories of PJM companies.

Figure 15-2. Location of selected generating facilities.

Generating station near Blairstown, N.J., which provides the company with 165 Mw of net installed capacity. In addition, the company owns a portion of three major facilities located in Pennsylvania: it has approximately 23% ownership of the Keystone and Conemaugh mine-mouth generating stations, and 42% ownership of the two-unit Peach Bottom Nuclear Generating Station.

PSE&G is currently constructing two nuclear units at the Salem Nuclear Generating Station located in Lower Alloways Creek Township, Salem County. As at Peach Bottom, PSE&G owns approximately 42% of this installation. The first 1100 Mw reactor at Salem is expected to go on line during 1976. Future construction plans include two additional nuclear reactors at Hope Creek adjacent to the Salem facilities, a two-unit floating nuclear station approximately 12 miles north of Atlantic City, N.J., some 2.8 miles offshore, and another 2-unit floating station at an undesignated location.

Jersey Central Power & Light Company. Jersey Central Power & Light Company (JCP&L) is a wholly-owned subsidiary of General Public Utilities Corporation (GPU), a Pennsylvania holding company which also owns Metropolitan Edison Company and Pennsylvania Electric Company. In 1973, New Jersey Power & Light Company merged with JCP&L. The 3256 square mile electric service area of JCP&L, about 43% of the total land area of New Jersey, encompasses northwest, north central and east central New Jersey and thereby covers both sides of the PSE&G service corridor. A large part of Ocean County lies within JCP&L's service area, the total population of which is about 1.7 million.

To meet electricity demands in its service area, JCP&L owns and operates three steam generation plants and 21 combustion turbine installations. In addition, the company has a 640 Mw nuclear plant at Oyster Creek in Lacey Township, Ocean County, N.J. JCP&L is also half-owner (with PSE&G) and operator of the Yards Creek Pumped Storage Station, owns 16 2/3% of the Keystone Generating Station, and is part-owner of two nuclear units at Three Mile Island ten miles southeast of Harrisburg, Pennsylvania. Future generating plans include construction of an additional 1100Mw nuclear unit in Ocean County (the Forked River Plant), a 1000Mw underground pumped storage station near Dover, N.J., and installation of

a new pumped storage project adjacent to Yards Creek jointly with PSE&G. JCP&L's generation and transmission facilities are operated as an integrated system with other GPU subsidiaries.

Atlantic Electric Company.* Atlantic Electric Company (AE) provides electric service to an estimated 865,000 people in a 2700 square mile area covering the southern third of New Jersey. Within its service area, AE owns and operates several steam generating stations and combustion turbine units. The company has about 3% ownership in the Keystone and Conemaugh Generating Stations and about 7.5% ownership in the nuclear units at Peach Bottom and Salem. AE does not now plan to own and operate any nuclear generating facilities of its own. However, its future generation plans include a 10% ownership of PSE&G's proposed floating Atlantic Generating Station and the Hope Creek nuclear units, and of JCP&L's proposed Forked River plant.

Philadelphia Electric Company. Philadelphia Electric Company (PE) provides electricity to the city of Philadelphia and portions of five surrounding counties in southeastern Pennsylvania. Through subsidiaries, PE also serves parts of Cecil and Hartford Counties in Maryland. The total population in PE's service area of 2475 square miles is about 3.8 million.

PE's electric generation is currently being provided by nine steam generating stations, one hydro-electric generating plant, one pumped storage generating station, a number of combustion turbine units and one small nuclear reactor, all of which are owned and operated by PE and its subsidiaries. In addition, PE owns about 20% of the Keystone and Conemaugh Generating Stations, and 42% of two large nuclear units at Peach Bottom and of the two reactors now under construction at the Salem Nuclear Generating Station. PE is also constructing two nuclear reactors at the Limerick Generating Station on the Schuylkill River near Pottstown, PA., and planning for a two-unit nuclear station at Fulton, PA.

Pennsylvania Power & Light Company. Covering an area of some 10,000 square miles in 29 counties of east-central Pennsylvania, Pennsylvania Power & Light Company (PP&L) provides electric service to a total population of about 2.3 million. Major communities served include Allentown, Harrisburg, Scranton, and Williamsport.

* Formerly known as the Atlantic City Electric Company, its name was modified in 1976.

Most of PP&L's electric generating capacity comes from five company-owned coal-fired generating stations. Brunner Island Station and Montour Station each provide approximately 1500Mw capacity. PP&L also owns about 12% of the Keystone and Conemaugh Generating Stations. Currently, PP&L is constructing two 1050Mw nuclear units at the Susquehanna Generating Station in Luzerne County, PA, which are scheduled for completion in 1980 and 1982.

Pennsylvania Electric Company. A subsidiary of GPU Corporation, Pennsylvania Electric Company (PENELEC) has an electric service territory of over 17,000 square miles covering the western, northern, and south-central areas of Pennsylvania and stretching to both the Maryland and New York borders. The total population of this service area is about 1.5 million.

To meet its electric demand, PENELEC owns wholly or in part seven steam generating stations, four hydro-electric facilities, one pumped storage station, and several combustion turbine units. Its major generation installations include the 600Mw Shawville Generating Station in Shawville, PA, and the 1200Mw Homer City Minemouth Generating Station in western Pennsylvania in which PENELEC owns half-interest. Penelec also owns a quarter interest in the Three Mile Island Nuclear Station near Harrisburg, PA. PENELEC operates the Keystone and Conemaugh Generating Stations, although it has no ownership interest in either. Its generation and transmission facilities are operated in an integrated and coordinated system with other GPU subsidiaries and with the PJM Interconnection.

Metropolitan Edison Company. Metropolitan Edison Company (ME), another GPU subsidiary, provides electric service to about 810,000 people in a 3300 square mile area of eastern Pennsylvania. Major municipalities served include Reading, Easton, Lebanon and York.

The company's electric generation capacity is comprised of four steam generating stations, one hydro-electric station and 14 combustion turbines. In addition, ME owns half-interest in the Three Mile Island Nuclear Generating Station. ME's generation and transmission facilities also are operated in an integrated and coordinated system with other GPU subsidiaries.

UGI Corporation. The UGI Corporation is engaged in the production, purchase, distribution, and sale of gas and electricity in parts of eastern Pennsylvania. UGI's Luzerne Electric Division supplies electricity to portions of Wyoming and Luzerne Counties, comprising an area of only 476 square miles.

UGI's electric capacity is provided by a 91Mw steam generation station in Luzerne County and a 1.1% ownership of the Conemaugh Generating Station.

Delmarva Power & Light Company. Delmarva Power & Light Company (DPL) and its subsidiaries supply electric power to a 1450 square mile area including the entire state of Delaware, nine counties in Maryland on the east side of Chesapeake Bay and two counties in eastern Virginia. Wilmington, Delaware, with over 600,000 people, is the largest city in DPL's service area.

DPL's present electric generating capacity comes primarily from several fossil-fueled steam electric generating stations, the largest of which is the Edge Moor Station (836 Mw) at Wilmington. The company also owns a number of internal combustion and gas turbine units. In addition, DPL owns approximately 7.5% interest in the Peach Bottom and Salem Nuclear Generating Stations. Future plans include building two 770 Mw nuclear reactors at the Summit Generating Station in Newcastle County, Delaware, in conjunction with Philadelphia Electric Company.

Baltimore Gas and Electric Company. Baltimore Gas and Electric Company (BGE) serves a 2300 square mile electric service area in central Maryland, including the city of Baltimore and all or parts of nine counties. The total population of its service area is estimated at 2,265,000 people.

To meet its electric demand, BGE owns and operates five oil-fired steam-generating stations in or near Baltimore and has approximately 21% and 10.5% interest, respectively, in the Keystone and Conemaugh Generating Stations. The company also has a number of combustion turbine units. BGE owns the two-unit Calvert Cliffs Nuclear Generating Station in Calvert County, MD, the total capacity of which will be about 1700Mw. The first unit was completed in 1975 and the second unit is scheduled for service in 1977. The company is also constructing a 1200 Mw oil-fired generating station at Brandon Shores, Anne Arundel, MD.

Potomac Electric Power Company. Potomac Electric Power Company (PEPCO) provides electric service to approximately 1,850,000 people in its 643 square mile area, including the District of Columbia and contiguous territory in Maryland and a small part of Virginia.

The company's electric demand is currently being met by six steam generating stations which it owns within its service territory. It also has capacity available from its 10% ownership of the Conemaugh Generating Station. In addition, PEPCO operates a number of combustion turbine units. Future plans include construction of additional oil and coal-fired steam generating units and the building of the two-unit 2200 Mw Douglas Point Nuclear Generating Station in Charles County, MD, about 30 miles south of Washington, DC.

15.2 Regional Organizations and Utility-Company Coordination²

A number of regional organizations and inter-utility coordination arrangements exist in the study region. The PJM Interconnection's 11 companies provide electric service to 21 million people. Their transmission network links over 100 generating units through more than 50 inter-company connections.³

The PJM Interconnection operates on a one-system concept in which the least costly available units meet the instantaneous load requirements of the pool. Thus, there is continuous exchange of power between member utilities, metered constantly, with accounting and transfer payments made after the fact.⁴ The principal advantages of such power pooling arrangements are well known,⁵ and include greater operating efficiency, improved reliability, lower reserve requirements for each utility, coordinated scheduling of maintenance shutdowns, and exploitation of scale economies by the ability to build larger units serving the pool as a whole rather than the much smaller requirement of a single utility. The PJM companies also belong to the Mid-Atlantic Area Council, a service reliability group.

Coordination Within the PJM Interconnection

As the world's first integrated power pool, the PJM Interconnection was created in 1927 through agreement between PSE&G, PE and PP&M to construct a 230,000-volt transmission ring. At that time, this cooperating unit was called the Pennsylvania-New Jersey Interconnection. It became known as the

PJM Interconnection in 1956 with the inclusion of BGE and the several subsidiaries of the GPU Corporation. In 1956, PEPCO joined the interconnection. AC, DPL, and UGI participate in PJM through agreement with signatory members.

The PJM headquarters and control center near Valley Forge, Pennsylvania, has a staff of about 80 persons who operate the system. The PJM Management Committee, composed of representatives from member utilities, is the decision-making body with overall responsibility for PJM's direction and operation. The Management Committee meets at least monthly. All decisions made or directions given must be unanimous; they are binding on all parties.

Several other committees have important responsibilities within PJM. The Operating Committee establishes operating and accounting procedures for the Interconnection and studies overall bulk power supply system reliability. Coordination of planned maintenance shutdowns of generating units within PJM is the responsibility of the Maintenance Committee.

The PJM Planning and Engineering Committee reviews, evaluates and coordinates generation and transmission plans of the individual utilities. Under provisions of the PJM Agreement, each utility must submit its plans for additions, changes, or removal of generating units and transmission facilities to the Planning and Engineering Committee. If after a review the Committee believes such plans are detrimental to the Interconnection or not in accord with the planning principles and practices of PJM, it may request that the plans be modified. Although the terms of the PJM Agreement do not require member utilities to obtain approval for their generation and transmission plans from other Interconnection members, the PJM committees can exert strong influence on these decisions.

Periodically, the Planning and Engineering Committee recommends to the Management Committee the forecast requirements for generating capacity of PJM and an equitable allocation of the requirements to each utility. PJM has no separate planning staff. Planning and coordination of new transmission and generating facilities to meet future load requirements are the responsibility of the individual utilities working through the appropriate PJM committees.

TABLE 15-2

JOINT OWNERSHIP OF GENERATION FACILITIES

Generating Stations	PSEG	JCP&L	ACE	PE	PP&L	PENELEC	ME	UGI	DPL	BGE	PEPCO
<u>Operating</u>											
Conemaugh (1700 Mw--coal-fired) W. Wheatfield Twp. PA	22.5		3.8	20.0	11.4	x-o	17.2	1.1	3.7	10.6	9.7
Homer City ^a (1200 Mw--coal-fired) Homer City, PA						50.0 x-o					
Keystone (1640 Mw--coal-fired) Plum Creek Twp. PA	22.8	16.7	2.5	21.0	12.3	x-o			3.7	21.0	
Peach Bottom (2200 Mw--nuclear) Peach Bottom, PA	42.5		7.5	42.5					7.5		
Roseton ^b (1200 Mw--oil-fired) Roseton, NY											
Three Mile Island (1700 Mw-nuclear) Londonderry Twp., PA		50.0				25.0	25.0 x-o				
Yards Creek (330 Mw--pumped-hydro) Blairstown, NJ	50.0	50.0 x-o									
<u>Under Construction</u>											
Forked River ^c (1100 Mw-nuclear) Lacey Township, NY		88.0 x-o	10.0								
Salem (220 Mw--nuclear) Lower Alloways Creek Twp., NJ	42.6 o		7.4 x	42.6					7.4		
<u>Planned</u>											
Atlantic (2300 Mw--nuclear) Little Egg Inlet, NJ	80.0 o	10.0	10.0 x								
Hope Creek (2200 Mw--nuclear) Lower Alloways Creek Twp., NJ	90.0 o		10.0 x								
Summit (1540 Mw--nuclear) New Castle, DE				15.0					85.0 x-o		

x - denotes generating station is within company's service territory.

o - denotes company responsible for construction and/or operation of generating station.

^aNew York State Electric and Gas Corporation owns half interest.

^bNiagra Mohawk Power Corporation owns 40%, Central Hudson Gas & Electric Corporation owns 20%; facility operated by Central Hudson and located within its service territory.

^cAnticipated 2% ownership by Allegheny Power Cooperative, Inc.

To further enhance the reliability of the PJM's bulk electric supply system and to foster a higher degree of coordinated planning, members of the Interconnection entered into an additional agreement in 1967 creating the Mid-Atlantic Area Council (MAAC). MAAC's governing body is its Executive Board, composed of a representative of each member utility (except the three subsidiaries of GPU which together have a single representative). Decisions of the Executive Board require approval of representatives of signatories whose total peak load comprises at least 95% of the peak load of all signatories. The Area Coordination Committee has responsibilities for MAAC similar to those of the PJM Planning and Engineering Committee.

MAAC has entered into reliability coordination agreements with neighboring utility groups including the Northeast Power Coordinating Council, the Virginia-Carolina Area Reliability Council and the East Central Area Reliability Council. In addition, MAAC is a member of the National Electric Reliability Council whose member groups include almost all the bulk power systems in the United States and major portions of Canada.

15.3 Jointly-Owned Generation Projects

As the size and costs of electric generating units have increased, utilities have placed greater emphasis on joint planning and ownership arrangements, especially for nuclear facilities. This is generally true throughout the Northeastern U.S.; almost no major nuclear facility is owned by a single utility in this region, for example. Table 15-2 lists major joint generating projects in the PJM region, along with data on the ownership interests of participating utilities.

Ideas for jointly-owned generation units normally originate within an individual utility company and are subsequently brought to the attention of other utilities who may wish to participate in the project. Once ownership arrangements are settled, decisions on planning, design and construction may either be made by committee or by the lead utility selected to be responsible for operation of the facility. Front-end costs are typically pro-rated among the utilities in proportion to their ownership interest. Jointly-owned generating units need not be located in the service territory of one of the participating utilities, and the facilities may even be

operated by a utility with no ownership interest (as is the case with Penelec's operation of the Keystone and Conemaugh Generating Stations).

Most joint ownership arrangements in this region have been made by companies within the same power pool. However, there are no restrictions on projects involving utilities belonging to two or more power pools. The Homer City Generating Station, in fact, is an example of a project involving joint ownership by a PJM utility and a company in the adjacent New York Power Pool.

The number of utilities which participate in jointly-owned generating facilities varies greatly, from two-company projects such as the Yards Creek Pumped Storage Station to the nine-company Conemaugh Generating Station. Since many utilities might be involved in joint ownership of a New Jersey Nuclear Energy Center, the fact that there appear to be no restrictions on the number of utilities which may be partners in an electric generating venture may be significant.

15.4 Alternative Institutional Arrangements for Implementation of the NEC Concept in New Jersey

Various functions required for implementation of an NEC in New Jersey might be undertaken privately by one or a number of utilities; publicly through federal, state, or regional authorities; or through a joint public-private effort. The respective roles of public and private institutions may be considered in relation to five specific functions involved in implementing the NEC concept: planning, site acquisition, construction, ownership, and operation.

Private Role

It would seem unlikely that any single utility company in the study region could provide the financing or maintain an electric demand in its own service area sufficient to make sole ownership and operation of a New Jersey NEC feasible. Similarly, it seems unlikely that any single utility's resources would be adequate to absorb the large front-end costs associated with planning, site acquisition and construction of an NEC. Indeed, precedents in the region suggest that a joint ownership arrangement be the most likely.

Under a joint utility ownership arrangement, the problems of financing would be less severe, but problems of coordination might still arise. Although several utility companies in the region have a long history of cooperation and have engaged in numerous multi-company joint ventures, the sheer size of an NEC raises questions concerning whether current arrangements between utilities would be adequately suited to planning, building, and operating a facility of the scope of a NEC.

Under most current jointly-owned generation project arrangements, all participating companies are involved in the joint planning, with a single utility then given overall responsibility for site acquisition, construction and operation of the generating facilities. Participating companies share the expense. This seems to work well since a single management retains responsibility for the project from beginning to end. For example, PE had the lead on the Peach Bottom Station, PSE&G the lead for the Salem Generating Station; both facilities are being financed jointly. With an NEC project, however, even a relatively small percentage ownership share might require a utility to invest a billion dollars or more. Clearly, with such a large financial stake in the project, each utility company would be more inclined to want an active role in decisions to be made. However, one utility official noted, this type of shared decision-making is likely to produce "a camel instead of a horse".

Even if the several utilities participating in an NEC project agreed to turn over sole management authority to a single company, it is questionable whether one company would want to assume such massive responsibility. That company would clearly have to be of significant size and contain an initial core of highly-trained personnel.

Whatever the difficulties of an NEC project may be, it seems apparent that investor-owned utilities would much prefer private to public ownership. Another possible approach to maintain private ownership would be the establishment of a generation company specifically to build and operate the NEC. Such a company would be wholly owned by the existing utility companies. If it could overcome regulatory and anti-trust obstacles, this company could facilitate financing and coordinated management for an NEC project. The

New York Power Pool companies, in fact, have already formed such a generation company, called Empire State Power Resources, Inc. (ESPRI). No similar organization yet exists in the PJM region.

Public Role

Management and ownership by federal, state, or regional authorities would be another possible approach to the NEC project. The federal government could play a decisive role in implementation of an NEC in New Jersey. One alternative would be for the federal government to construct, own, and operate the NEC -- possibly located on federal land like Ft. Dix -- and then sell the electric power wholesale to the utilities for transmission and distribution to their customers.

If the federal government were to undertake the NEC project, this could expedite the regulatory and permitting process, although the NEC might also easily become an even more highly politicized issue at state and local levels. The military installation being studied in this analysis (Ft. Dix) would be one potential site on Federal land. Federal ownership and management of an NEC could have a major impact on existing utilities. Since, at least under one set of assumptions, the NEC would provide the nuclear generating capability for utilities in a several-state region, these utilities would have to buy power from the Federal government and forego a major part of their individual plans for additional base-load generating stations.

Short of public ownership and operation, the Federal government could still play an important role in implementation of a New Jersey NEC. One alternative would be Federal financial aid to private utilities in the form of long term, low-interest loans similar to those granted by the Rural Electrification Administration to Rural Electric Cooperatives. This could substantially reduce the problem of raising large amounts of front-end capital. In addition, the Federal government could possibly assist private utilities through planning grants and simplification of the permitting process.

State ownership of a New Jersey NEC raises certain institutional and political problems, since power might be supplied to surrounding states as well. Even if the NEC were intended primarily to serve consumers

in New Jersey, the NEC would necessarily feed into the PJM grid, encompassing several states and non-New Jersey utilities. In addition, the state of New Jersey has had no reason to acquire the expertise to undertake such a massive project. The state, however, would become involved with many important aspects of the NEC project and should be directly involved in its planning. Acquisition of the necessary land could be primarily a state responsibility.

Another alternative for implementing an NEC in New Jersey would be the formation of a public regional organization, such as the Delaware River Basin Commission, with total responsibility for the project. The Tennessee Valley Authority(TVA) provides one model of such an agency.

15.5 Conclusion

It appears that the most promising institutional arrangement for implementation of a New Jersey NEC would involve construction, ownership and operation by some consortia of utilities, either acting jointly or through a generation company, with Federal and state planning assistance. In addition, Federal financial support might be needed to help spread out the large front-end costs of the project, and state assistance could be most critical in terms of site acquisition.

NOTES TO CHAPTER XV

1. Information for this section was obtained from the MAAC Systems Plan, April 1, 1975; Data on Coordinated Regional Bulk Power Supply Programs, Northeast Power Coordinating Council, April 1, 1975; Moody's Public Utilities Manual, 1974; and annual reports of several of the utilities discussed.
2. Information for this section was obtained from the PJM offices and from interviews with utility officials.
3. "MAAC Systems Plans, December 31, 1974", MAAC, April 1975..
4. For more detail on such pool-wide operation, see, R. Turvey, Optional Pricing and Investment in Electric Supply, MIT Press, Cambridge, Massachusetts, 1968 or L.K. Kirchmeyer, Economic Operation of Power Systems, Wiley, N.Y., 1958.
5. See, e.g., R. Billington, Power System Reliability Evaluation, Gordon and Breach, New York, 1970.

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CHAPTER XVI

THE FEDERAL GOVERNMENT AND A NEW JERSEY NEC

16.1 Introduction

The complex relationships among the various investor-owned electric utility companies in the PJM area described in the preceding chapter comprise only one element in a larger set of institutional issues that would have to be examined were construction of a Nuclear Energy Center in New Jersey seriously contemplated. An entire panoply of public sector institutions would have to be orchestrated to turn this idea into a reality. The purpose of this chapter is to identify the most critical institutions, statutes and regulations which would be involved in governmental regulation of a New Jersey NEC from the federal perspective; the chapter which follows presents the state and local perspective. In this chapter special emphasis is placed on the issue of federal preemption and on the federal role with respect to military land (the Ft. Dix Site) and a national wildlife refuge (the Bay Site).

The perspective of our analysis of the federal preemption issue perhaps needs careful introduction. On the one hand, the NRC-NECSS finds that there is no "...great or unequivocal advantage (to the energy center), or compelling need for such centers",¹ and, therefore, from this viewpoint any discussion of positive federal incentives, policy or authority to achieve energy center siting, especially over the objections of state and/or local levels of government, may be somewhat academic. On the other hand, there is no question that one of the key public issues generated by our analysis of the New Jersey surrogate site was the fear that the Federal government could indeed impose an energy center siting policy against the objections of State and local agencies. Moreover, even though there may be no compelling present need for energy centers, continuing controversy over nuclear energy, and particularly over fuel cycle management questions, may well reopen the question of the desirability of energy centers. If future national energy policy does indeed identify clustered

siting as a necessary or desirable element, from an overall national perspective, then analysis of positive measures available at the federal level to implement such a policy clearly becomes imperative. Furthermore, our analysis of the New Jersey surrogate site suggests strongly that the only way an energy center in Ocean County would ever be implemented would be by strong federal action, as the initiative would certainly not come from the local or regional level. Consequently, regardless of current generic NRC-NECSS conclusions, the issue of federal preemption is of primary importance to the practicality of clustered relative to dispersed siting in New Jersey.

16.2 Federal Preemption and Nuclear Power Plant Siting

The judicial doctrine of preemption rests on the supremacy clause of the federal Constitution which provides that the Constitution and the laws of the United States shall be the supreme law of the land.² In its classic formulation the rule of decision established by this doctrine is that where a state law stands as "an obstacle to the accomplishment and execution of the full purposes and objectives of an Act of Congress", the federal statute prevails and the state law is invalidated.³ The various federal statutes on regulation of nuclear power, especially the Atomic Energy Acts of 1946 and 1954, the Price-Anderson Act of 1954, the statute enacted in 1959 as section 274 of the Atomic Energy Act, and, finally, the Energy Reorganization Act of 1974, evidence the determination of Congress to maintain authority over nuclear power plants at the federal level, particularly as regards protection of public health and safety from any radiation hazards.

Over the years there have been many attempts by states to enter the regulation of nuclear power plants, most recently in the proposed nuclear "moratorium" legislation under consideration by a number of states. However, it seems likely that any attempt by a state to regulate nuclear power plants on grounds of safety and radiation hazards under existing federal statutes would be struck down under the preemption doctrine. This is expressed most vividly by Northern States Power Company vs. State of Minnesota, which dealt explicitly with the state's authority to set and enforce radiation standards more stringent than those established by the federal Atomic Energy Commission. The courts finally ruled that the federal government had effectively preempted this subject area.⁴

This issue of the basis of state regulation of nuclear power plants is important because the same congressional mandate that regulation of hazards from nuclear power plants remain the exclusive preserve of federal government also declares that State and Local agencies can regulate AEC (now NRC) licensed activities for "purposes other than protection against radiation hazards".⁵ Thus, for example, state or local zoning ordinances which exclude all power plants (not just nuclear plants) from areas not zoned for industrial use would, in the judgment of some observers, meet such a test.⁶ However, the issue remains ambiguous because other sections of the Atomic Energy Act(s) also make explicit that state and local regulation is permitted only in regard to the rates and services of electric power produced in nuclear plants.⁷ Thus it is not entirely clear whether a state attempt to frustrate a Nuclear Energy Center by means of withholding permits, say, for transmission line construction would be successful, especially in view of the fact that electric transmission has been held to constitute interstate commerce⁸ (as it would certainly be in the case of the New Jersey energy center, since it would necessarily be connected to the multi-state PJM transmission grid). Moreover, several recent decisions affecting New Jersey point to the emerging federal dominance not just in matters of nuclear regulation, but in the energy area generally. The New Jersey Supreme Court in 1976 ruled in favor of Jersey Central Power and Light Company and against the State of New Jersey on liability for the Oyster Creek fish kills, on the grounds that federal standards prevailed;⁹ and the Federal Power Commission was ruled correct in its decision to allow large natural gas storage tanks in an area of New Jersey's Hackensack Meadowlands zoned as residential by the state's Development Commission.¹⁰

As a practical matter, each state--and New Jersey in this particular assessment--clearly cannot afford to expand the technical and financial resources which would be required to amass the necessary expertise to mount an exhaustive, independent and in-depth technical review of all features related to nuclear safety and environmental impact that accompany each unique reactor design proposed for a specific location within or near that state's boundaries. Nevertheless, states like New Jersey continue to address a variety of safety-related nuclear siting questions in their own review of proposed nuclear generating stations, under state environmental

and coastal zone legislation. The import of this state regulatory posture for a potential Nuclear Energy Center in New Jersey is addressed below.

In fact, the State of New Jersey had a significant influence on two previous nuclear siting cases, in the process affecting the location finally approved by the AEC for these facilities.¹¹ The state opposed a site in Burlington County ("Burlington") proposed in 1966 by PSE&G for a 2,100 MWe pressurized water, twin-reactor facility. This nuclear station was subsequently approved with state consent for location on Artificial Island in Salem County (becoming the Salem Nuclear Generating Station). Similarly, in 1972 and 1973 the state opposed another site in Burlington County (the "Newbold Island" site, in Bordentown Township) proposed by PSE&G for a twin 2,200 MWe boiling water station. With the subsequent concurrence of the state, the AEC approved construction of this facility ("Hope Creek Generating Station") at the Salem Artificial Island site. Thus New Jersey has demonstrated an ability in recent years to influence directly and forcibly siting decisions by the federal government on nuclear power plants within its borders.

The issue of federal preemption in the NEC area is, of course, very difficult to address in the absence of a specific scenario of NEC implementation. As noted in the previous chapter, the most likely scenario would be for a consortium of utilities to apply for an NRC license (assuming either that the utilities themselves considered energy center siting to be desirable,¹² or that NRC promulgated a policy whereby licences would be granted only to reactors sited in energy centers). Since the utility consortium would be dependent on state cooperation in many other ways, however, is it likely that the utilities would proceed if the state was in categorical opposition? Indeed, there are also precedents suggesting that federal preemption notwithstanding, a utility may submit itself voluntarily to state regulation over a proposed nuclear facility in the interest of some other utility objective. While the Northern State Power litigation was pending, for example, the Vermont Yankee Nuclear Power Corporation signed an agreement with the State of Vermont and several conservation groups wherein it agreed to submit to rules and regulations in regard to radioactive emissions notwithstanding federal preemption, and to use its best efforts to secure AEC approval of the installation of any device that would reduce emissions.¹³ The utility's motivation for this

agreement is not altogether clear; however, the fact that the Vermont Yankee Corporation simultaneously was seeking approval from the Vermont Public Service Board for a bond issue strongly suggests that the concession was made in the interests of maintaining a good business environment with the state.¹⁴ It would thus seem likely that in New Jersey the most probable scenario of implementation in which conflicts between state and federal jurisdiction might assume serious proportions would be one in which the federal government itself (or a quasi-federal agency such as TVA) entered the area of nuclear power generation, using, say, federally-owned land at Ft. Dix. But such a scenario would presuppose a fundamental realignment of the balance between private and public sector involvement in electric energy generation in the state, which in New Jersey has historically rested exclusively with the former.

In conclusion, it appears that because of the sheer size of a Nuclear Energy Center, state decision-makers would be expected to become deeply involved in the site approval process, even though the NEC concept implies a larger federal role in many aspects of its planning and implementation. Thus, ironically, what one can expect is a greater federal and state role for an NEC as compared to dispersed siting and indeed the ability to implement an NEC may be crucially dependent on the ability of federal and state authorities to join in a cooperative planning venture. Certainly we regard a policy of NEC implementation based on the federal preemption doctrine as being quite unlikely.

16.3 Federal Review of a New Jersey NEC

One would expect a number of significant differences to appear in federal review and licensing procedures when the facility being considered is a Nuclear Energy Center rather than a single dispersed site.¹⁵ As noted in Chapter XV, the initiative to propose development of an NEC at a specific site--in coastal New Jersey, for example--might emanate to a large extent from the federal government rather than from a single utility or a consortium of utilities as is typical for dispersed sites. Changing the locus of initiative could not help but alter the nature of regulatory activities, particularly in the early stages of the process (that is, the series of contacts that take place prior to utility company filing of a formal application for a construction permit and related licenses).

Whether the NEC was to be constructed by a consortium of utility companies, by a wholly-owned private subsidiary corporation, or by a governmental entity, presumably a formal application for a construction permit would have to be filed with the NRC under procedures similar to those existant today. This would undoubtedly lead to review by the Advisory Committee on Reactor Safety and, eventually, hearings by the Atomic Safety Licensing Board (or its equivalent). However, here too one would anticipate some major differences for a large Nuclear Energy Center as compared to a typical dispersed site. First, the proposal would be expected to garner far more attention than is the case for most dispersed nuclear sites. Because of its sheer size, publicity would appear certain to produce a greater amount and diversity of intervention. Some local citizens might be irate at the need for relocation, or feel that their area was being "exploited". Citizen groups from across the state might well notice and be concerned about an NEC, whereas they would remain tolerant of dispersed sites in the state "as long as they aren't in my own backyard." Political leaders--Governors, Senators, Representatives, members of state legislatures, Mayors--might be impelled to take a stand for or against a Nuclear Energy Center in their local area, constituency or state, in contrast to their near-total absence from present controversy over individual dispersed sites. Again because of the NEC's sheer size, this publicity and concern over the proposed facility would begin to emerge much earlier than has been true for dispersed sites, well in advance of formal public hearings on the construction permit application. One would expect to see a series of preliminary hearings, not just in Toms River but across the state, and dealing not only with the proposed facility on a technical basis, but on the entire situation with respect to electricity demand, nuclear power in general, energy conservation strategies as an alternative. These hearings would thus differ greatly from the sessions now carried out by the NRC. A balanced public "debate" of some kind would probably have to run its time-consuming course prior to any formal decision to begin construction of an NEC in the state; without it, the political backlash could well be enormous. In fact, one panel at the NRC-sponsored workshop on Nuclear Energy Centers concluded that:

...framing the issue in terms of parks vs. dispersed siting, would have the tendency of sharpening the issue and perhaps result

in a high-level debate engaged in by the public and Congress to the end that we could dispell some doubts one way or another and be on with our business, whether nuclear or not.¹⁶

The federal licensing process would have to adopt a new approach for review and approval of a proposed NEC if the standarization and economies of scale noted by the center's proponents are to be realized. For example, how many reactors are to be considered in the first formal hearings? How is all of this to be licensed? In many ways, there is an appropriate analogy with the changes in review and licensing procedures brought about by the proposal for floating nuclear power plants. In this case, the NRC (or AEC at that time) agreed to bifurcate licensing approvals, with a generic license for the barge-mounted reactors and site-specific review of proposed locations. For a large Nuclear Energy Center, one might envision the exact reverse of this. Federal (NRC) review of the site's overall characteristics would come first, a generic review of the area's suitability for a large nuclear energy facility. The state undoubtedly would play a major role at this stage, as would local governments. Later the individual reactors (or 2 to 4 reactor combinations) would undergo individual technical review to ensure their specific suitability and applicability for construction on the previously approved large site. Were this split review -- area/generic, facility/specific -- to be instituted, one would expect the public's role to be paramount in the first issue, with respect to the site and its overall suitability as a future Nuclear Energy Center. The subsequent facility-specific hearings would primarily cover more technical issues. The possible usefulness of this approach was indeed recognized by the Atomic Energy Commission in WASH-1355:

In the past, licenses to operate nuclear plants have been granted for specific plants located on specific sites. The licensing process has involved the concurrent review of all safety and environmental issues associated with plant siting, design, construction, and operation.

Separation of the site review process from the plant review process would save substantial time and effort. It would be possible to resolve all safety and environmental issues related to site selection well in advance of a decision to locate a nuclear power station at the site. If such issues were settled for a number of potential

sites, the result would be the creation of an inventory of approved or designated sites that would be available for future nuclear plants. Then, when an applicant filed for a permit to construct a nuclear plant at one of the designated sites, site preparation and limited construction activity could begin immediately.¹⁷

16.4 Land Acquisition for the Fort Dix Site*

The federal role would be particularly strong for the Ft. Dix site, already federally-owned land which would have to be transferred from the military's hands to the generating authority, whether public or private.

We have assumed that all of the military's land within Ocean County would be available for use as an NEC, but that the center would not include any of the military's territory in Burlington County to the west. The military reservation includes portions of three townships within Ocean County: Plumsted, Jackson and Manchester. Table 16-1 gives figures for the two military installations within Ocean County, Ft. Dix and Lakehurst Naval Air Station.

Table 16-1

ACREAGE FOR FORT DIX AND LAKEHURST NAVAL AIR STATION WITHIN OCEAN COUNTY

<u>Installation</u>	<u>Township</u>	<u>Acreage</u>	<u>Square Miles</u>
Fort Dix	Plumsted	11,939.9	18.7
	Manchester	4,030.6	6.3
Lakehurst	Jackson	6,288.0	9.8
	Manchester	1,125.0	1.8
Total		23,383.5	36.6

Source: Department of the Army, Corps of Engineers, and Engineering Command, Naval Facilities, Department of the Navy.

The area included in the site was acquired by the federal government through direct purchase and condemnation between 1919 and 1944, and is presently under complete federal jurisdiction. Disposition of this land for use such as an NEC would be the responsibility of the General Services Administration (GSA).

*Prepared with the assistance of Gail Peek, Center for Environmental Studies, Princeton University.

The site has several distinct advantages, including: (1) a preassembled land area, large enough for an NEC; (2) apparent Army willingness to discontinue use of Ft. Dix as a Basic Training Center; and -- especially -- (3) land already held by the federal government, and therefore possibly usable for a preemptive "federal" NEC if state and local officials were to be adamant in rejecting a New Jersey location for an NEC under private auspices.

It is also possible, of course, that this land could be provided by the U.S. government to a consortium of utility companies for an NEC. In order for the government to divest itself of Fort Dix or of any other military installation, the real property would have to be declared "excess" or "surplus" property. This involves the following definition:

"Excess property is any property under the control of any Federal agency which the head of the agency determines is not required for the needs and the discharge of the responsibilities of the agency... surplus property means any excess property which the administrator of General Services determines is not required for the needs and the discharge of the responsibilities of all Federal agencies."18

The standard procedure for declaring property "surplus" is for the appropriate GSA regional office to receive a report of excess property (including descriptive data) from a specific agency (in this case, the U.S. Army and Navy). GSA follows a sequence of steps in notifying different agencies of the availability of the property: federal agencies first, then state and local governments, and finally the public at large. Were an NEC to be planned for this location, the land presumably could be obtained at any of several levels -- federal, FEA or ERDA; state, PUC or a special public corporation; or a public utility company.

The first step is for GSA to notify other federal executive branch agencies, whose functions require the use of real property, of the existence of this excess property. These agencies have 30 days within which to notify GSA of their interest in the particular property being declared excess. NRC certainly could be one of the agencies to be notified.

Unless Congress were to pass an act specifically altering this process for development of an NEC, the standard sequential procedure for disposal of surplus land by federal agencies would apply to Fort Dix/Lakehurst NAS. First,

notice of the availability of excess property would be sent to other Federal agencies; then to state and local agencies; and finally to the general public. As a standard practice, the Federal Energy Administration, upon receiving notice of surplus property, already identifies land suitable for energy purposes and notifies appropriate agencies. Since September, 1975, FEA has been supporting legislation which would grant public utility companies higher priority access to surplus federal property. At present, utilities may purchase land only when it has been opened for sale to the general public.

Should the State of New Jersey wish to acquire federal real property such as Ft. Dix or Lakehurst NAS for an NEC (or any other purpose), it has merely to follow the standard procedures. The Chief of Staff (head of the State's Department of Defense, which includes the State Bureau of Surplus Property) would handle the transaction under the following provisions of New Jersey law:

"The Chief of Staff is authorized to lease or acquire by gift, grant, purchase exchange, eminent domain or in any other lawful manner, in the name of and for the use of the State of New Jersey such real property as shall be necessary for the property leased by the State of New Jersey for armory or other facilities shall be subject to condemnation proceedings without prior approval of the Governor.¹⁹

Accordingly, the Chief of Staff may "lease, rent or permit the use of any armory or other military facility, or any part thereof for non-military purposes under such restriction and for such compensation, if any, as he may be regulations prescribe."²⁰ Given a federal attitude favorable to development of NEC's, it would be quite plausible for the federal government to give the state access to a facility like Ft. Dix (should it decide to close the facility) for use as an NEC. After receiving full title to this property, the state could then decide to lease or sell it to one or several utility companies for private development of the NEC.

Assuming a favorable state (as well as federal) attitude toward development of an NEC, the only foreseeable impediments to such events would be exercise of public pressure by regional agencies, local governments or private citizens opposed to an NEC at this New Jersey site. However, such tactics would have to be applied prior to GSA's disposal of the land, with arguments concentrating on issues of environmental quality or regional land use. To be effective, such opposition would have to occur before the state leased or sold the property to the utility company.

The state could also decide to dispose of the land to municipal agencies. New Jersey law provides that under such circumstances:

"The board of chosen freeholders of any county or governing body of any municipality may purchase any building and real property -- at a price and upon the terms and conditions so fixed."²¹

The municipalities might then decide to give public utilities access to the land in return for tax revenues. The amount of coordination between municipalities might be the greatest obstacle to overcome if this option were selected. If the purchase were a joint effort by several municipalities, such issues as revenues, shares from the sale and actual placement of reactors would have to be resolved. This alternative would seem to create more points where public pressure could be applied to weaken the unity of the purchasing group. Divisions among the several municipalities could be played upon by interest groups.

One precedent exists in New Jersey of federal transfer of title to land to a public utility company for construction of a nuclear generating station: Artificial Island on Delaware Bay in Salem County. This "island", actually a peninsula, was created by the U.S. Army Corps of Engineers from dredge spoils unearthed in clearing the deepwater channel through Delaware Bay and the Delaware River. When the Public Service Electric and Gas Company identified this site for construction of its Salem Nuclear Generating Station, the Army agreed to transfer title to PSE&G in exchange for land owned by the utility company further upriver on the Delaware.

On the assumption that a large Nuclear Energy Center would be deemed to be in the national interest but would be resisted by state and local governments in response to clamor from concerned citizens, the Ft. Dix site assumes special significance. Since this land already is owned by the federal government, exercise of federal pre-emptive authority would be simplified. Although some approvals still would be required from the state (riparian grants for construction of the water tunnels, for example), federal pre-emptive leverage would be decidedly greater at the Ft. Dix Site than at the Bay or Inland Sites.

16.5 Federal Ownership of the Bay Site

Because the hypothetical Bay Site falls within a national wildlife refuge, the Department of the Interior would be expected to play a special role in any licensing activities associated with an NEC at this location. Procedures similar to those described for the Ft. Dix Site could be followed in transferring this site from ownership by Department of Interior to the operator of an NEC. One caveat, though, is that the deed from the Nature Conservancy to Interior probably contains a reverter clause.

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Notes to Chapter XVI

1. NRC-NECSS, Executive Summary, p.2.
2. U.S. Constitution, Art VI, cl.2.
3. Hines v. Davidowitz, 312 U.S. 52, 67-68 (1941). The Burger Court has recently stated its approval of this formulation in Goldstein v. California, 412 US 546, 561 (1973).
4. 447 F. 2d 1143 (8th Cr. 1971), affirmed 405 U.S. 1035 (1972).
5. 42 USC 8 2021 (k), 1970.
6. See especially A. W. Murphy and D. B. LaPierre "Nuclear Moratorium Legislation in the State and the Supremacy Clause: A Case of Express Preemption" Columbia Law Review, 76, No. 3 (Apr. 76), p. 392.
7. Section 271 of the 1965 Amendment to the 1954 Atomic Energy Act.
8. See especially Chemehuevi Tribe of Indians v. FPC, 420 U.S. 395, 400 (1975).
9. State Dept. of Environmental Protection v. Jersey Central Power and Light Company. 133 N.J. Super 375; 336A. 2d, 750 (App. Div. 1975), reversed 351 A 2d 337 (N.J. Sup. ct, Jan. 22, 1976).
10. Transcontinental Gas v. Development Commission (No. 71-2034) - See Chapter XVII, below, for further discussion of this case.
11. The state's role in these two cases was a de facto intervention, although it might not be so-termed from a de jure perspective; that is, the state did intervene in public hearings during the licensing process, but without taking sides as an intervenor is supposed to do, until all testimony was presented.
12. As is the case, for example, in Florida, where the Florida Power and Light Company is reported as seriously studying the Energy Center concept - see e.g. Power Engineering, Jan. 1976, p. 36.

13. See in re Vermont Nuclear Power Cor., 91 P.U.R. 3d1 (Vt. Public Service Board, 1971).
14. Murphy and LaPierre, Note 6, supra at 420.
15. For an outline of the typical federal regulation process, see Appendix D of BNL 50465.
16. Summary of Recommendations of the Panel on Social, Political and Economic Impact, Nuclear Energy Center Workshop, sponsored by the Nuclear Regulatory Commission and convened by the Mitre Corporation, Portsmouth, N.H., May 1975, page 7.
17. Atomic Energy Commission, Nuclear Power Facility Performance Characteristics For Making Environmental Impact Assessments, WASH-1355, December 1974, p. I-1.
18. Disposal of Surplus Real Property, General Services Administration, Washington, D.C., p. 2.
19. N.J.S.A., 38A:12-1.
20. N.J.S.A., 38A:12-15.
21. N.J.S.A., 38A:12-8.

CHAPTER XVII *

STATE AND LOCAL GOVERNMENTS AND A NEW JERSEY NEC

17.1 Introduction

Several unique aspects of law and regulation in New Jersey relate to nuclear energy. In this chapter the roles of various agencies and the impact of different state statutes are weighed to provide insights into: (1) the overall process of state regulation of nuclear power; and (2) specific differences which would be evident in New Jersey between review of dispersed nuclear generating stations and an NEC. Particular attention has been given to the probable impact of New Jersey's Coastal Area Facilities Review Act (CAFRA), its wetlands and riparian lands statutes, and special legislation affecting the unique ecological area commonly known as the Pinelands -- the only large tract of open land in the Ocean County area. There is also a brief review of potential state regulatory authority over a possible Nuclear Energy Center located on federal territory, such as the hypothetical Fort Dix site.

Moving below the state (or inter-state) level, one encounters further layers of government which would be involved in one aspect of another of a New Jersey NEC: regional planning agencies, counties, sanitary and other special-purpose districts, and -- traditionally of greatest importance to all land use decisions in this strong home rule state -- the 567 municipalities. No area of New Jersey is unincorporated, a difference from most other states which must be taken into account when contemplating construction of a massive energy facility like an NEC. Because municipalities are so strong, counties tend to be relegated to a lesser position, providing selected public services and conducting countywide planning but making few critical land use decisions and collecting little in the way of taxes.

* Prepared with the assistance of Gail Peek, Center for Environmental Studies, Princeton University.

These vital functions of local government are performed in New Jersey by a township, borough, city, or other municipality. Ocean County, for example, is composed of 14 townships and 19 boroughs.

17.2 Overall State Authority: Laws, Regulations, Agencies and Political Action

Although federal preemption is indeed great in issues related to nuclear energy, the State of New Jersey obviously would express deep concern regarding a facility of such magnitude, importance and potential impact as a Nuclear Energy Center. A variety of existing state statutes and regulations -- particularly those associated with the Department of Environmental Protection and the Public Utility Commission -- would be reviewed carefully for their potential applicability to the NEC. Given the reaction to date in the state to large energy developments in general,¹ and to new nuclear energy facilities in particular,² new legislation would likely be introduced in the state legislature in an attempt to enhance the state's legal authority over proposed energy facilities like an NEC. one can contemplate circumstances in which strong legislation opposed to an NEC could pass the legislature and be signed into law by the Governor, setting the stage for intense -- and undoubtedly prolonged -- legal conflict between the state and the federal government over the NEC proposal.

Above and beyond such vital legal battles over jurisdiction and authority-- a constitutional conflict involving the fundamental features of both states' rights and the national interest-- lie the basic political realities of the situation. Whatever its statutory power, if a state's Governor, legislature, entire delegation to the U.S. Congress, and a vocal segment of its citizenry were to protest aggressively against "energy exploitation" of its coastal or estuarine environment in the interest of the residents of other states and the federal government, it is difficult if not impossible to envision construction of the NEC as proposed. In fact, a federal/state political confrontation of this magnitude would seem quite likely were an NEC to be proposed seriously for New Jersey, based on recent energy-related events and on our assessment of present attitudes with the state. However, it seems far more

likely that the NEC would simply be built elsewhere, outside New Jersey (assuming, of course, that other states would oppose it less vigorously, at least for their remote areas).

Within the confines of this potential federal - state tension, the fabric of state regulatory authority and the roles of varying state institutions can be examined.

17.3 Roles of the Governor and State Legislature

The Governor as the state's chief executive officer, along with the state legislature, comprise the state's two principal policy-making institutions. It is the Governor who proposes agencies necessary for him to fulfill his duties (e.g., creation and revamping of various state agencies). The Governor must approve and sign leases or grants of riparian and other state-owned land.³ This gives him final control over land usage in areas still covered under the state's riparian rights powers (though not elsewhere, where state land use authority has been delegated to local governments). The Governor has the ability to "go to the public" via the mass media, thereby arousing support for his position.

As with any executive office, the role of the Governor is dependent upon his approach to the office. In the case of New Jersey, Governor Brendan T. Byrne has been a strong advocate of tight environmental review of the costs as well as the benefits of any major project proposed in the state -- a Nuclear Energy Center certainly would receive extremely close scrutiny. The Governor's budget can directly affect the ability of various agencies to operate (e.g., the Department of Environmental Protection depends on funds to investigate projects before issuing licenses and, therefore, needs a fairly large staff). The Governor has at his disposal a varied set of agencies that can provide him with desired information (e.g., the Office of the Governor's Counsel).

The legislature has the capacity to place laws on the books and to review (and revise) existing laws. However, unlike the Governor, whose

constituency is the state, members of the legislature may be subjected to pressure by the "few" citizens who are their constituents in their own electoral districts. Areas directly affected by the location of the proposed NEC might exert influence upon their representatives to oppose (or support) this particular location. Yet, just like the Governor, because of the magnitude of the project these representatives may be pressured by many elements exterior to their "home" district alone. One of the roles of the state legislature would be its ability to influence, through hearings and authority over appropriations, regulations and standards that might govern operation of the NEC, or even to influence the locational decision. Thus, for example, in March 1976 the State Senate's Committee on Energy and Environment opened a series of public hearings on nuclear power in New Jersey, including the NEC concept. These hearings served to widen the scope of continuing debate over the state's increasing reliance on nuclear energy and on possible alternatives.

17.4 Special State Legislation: CAFRA, Wetlands, Pinelands, and Other Areas

Since 1970, New Jersey has instituted several items of special legislation designed to regulate usage of its natural resources and protect its areas of critical environmental concern. Almost all of this legislation has placed enforcement power in the Department of Environmental Protection (DEP), along with its continuing responsibility for enforcement of actions related to air and water quality. These acts, and the power which they establish to issue or deny permits, could pose the greatest potential obstruction (or provide the greatest point of positive leverage) at the state level regarding construction of a Nuclear Energy Center in New Jersey.

Coastal Area Facilities Review Act (CAFRA): This 1973 statute seeks to preserve New Jersey's coastal areas for those land uses which promote the public health, safety and welfare, protect public and private property, and are reasonably consistent and compatible with the natural laws governing the physical, chemical, and biological environment of the coastal area.⁴ A coastal zone of 1377 square miles (about one-seventh of the state) was established, with boundaries as shown in Figure 17-1. A large part of Ocean County - including the entire coastline - is encompassed by CAFRA.

However, if the NEC were set back 5-10 miles from the shore (or the bay), the nuclear facility itself would be outside the CAFRA jurisdictional area-- although the cooling water tunnels and other support facilities crossing on, or under, the defined coastal areas would require CAFRA review and permit issuance. As shown in Figure 17-1, our hypothetical Fort Dix lies wholly, and the Inland Site partially, outside the CAFRA regulatory area.

The act requires that a permit be issued by the Commissioner of the Department of Environmental Protection prior to construction of any major facility in the designated coastal zone. Facilities encompassed in this definition include electric power generation, incineration of wastes, housing and public facilities, heavy industry and storage. Also subject to DEP coastal zone regulations are roads, sanitary landfills, waste treatment plants, and specified uses involving food processing, paper production, chemical processing, metallurgical processing, and certain additional specified uses. The Act explicitly requires approval by the DEP Commissioner of any application for construction and operation of a nuclear electricity generating facility within the defined coastal area. An environmental impact statement must be filed with DEP as part of each application for preconstruction review and permit issuance.

To guide the use of its permit authority under CAFRA, DEP is preparing an "environmental design" which is to establish guidelines and possibly territorial boundaries for various kinds (and densities) of coastal development. An "Interim Guidelines" document was issued in June 1976.

To date, DEP has displayed flexibility in administering CAFRA permits. For example, although it denied a permit to a high rise condominium in Toms River (the Ocean County seat), the DEP opinion described specific project modifications which might lead to subsequent issuance of a permit. These conditions included installation of a jitney service by the condominium to both downtown Toms River and an outlying area in order to ameliorate traffic congestion and lessen carbon monoxide air pollution. Conditions also were attached to the permit approved for a large subdivision in Dover Township (also in Ocean County) requiring the developer to provide more open space on the project site, as well as requiring the local water company's

Figure 17-1. Area coverage under the Coastal Area Facilities Review Act (CAFRA).

certification that certain water storage capacity and anti-contamination requirements were satisfied.

In January 1976, the department completed action on its first permit review for a major industrial facility in the coastal zone: PSEG's Hope Creek Nuclear Generating Station in Salem County. Following extensive review of this application, and several public hearings, a permit was issued * subjecting the facility to 14 specific conditions (none of which appear to be particularly onerous nor unexpected):

- (1) Acquiring all other state-required permits for construction of the facility.
- (2) Continuing a monitoring program to define the effects on aquatic life attributable to use of chemicals and biocides in the plant's operations.
- (3) Studying use of alternative chlorination methods to assure use of those methods acceptable by the Department which will result in acceptable chlorine residuals under full plant operating conditions.
- (4) Limiting dredging operations to the months of September, December, January, and February.
- (5) Monitoring discharge of copper and other heavy metals from the cooling system.
- (6) Monitoring to assess the effects of entrapment and alteration of productivity within the thermal plume in Delaware Bay.
- (7) Demonstrating acceptable methods of disposal of sewage effluent on the site.
- (8) Analysing possibilities for later retrofit of technology to reduce the emissions of radioactive materials into both air and water, including where required full cost/benefit analysis of installing such improved control technology as may be developed during the estimated 40-year lifetime of the plant.
- (9) Continuing the radioactivity monitoring program initiated with construction of the Salem Nuclear Generating Station next to the Hope Creek site.
- (10) Notifying DEP's Bureau of Radiation Protection at least one week prior to shipments of radioactive material.
- (11) Determining bird mortality caused by the cooling towers.

* This permit was appealed by the New Jersey Public Interest Research Group, and litigation is still underway.

- (12) Adhering to prior commitments with regard to transmission corridors, excavation and construction.
- (13) Rescheduling deliveries and staggering work shifts if increased traffic contravenes carbon monoxide or hydrocarbon air quality standards.
- (14) Sending copies of reports to the Department on all preoperational and operational monitoring programs, and taking immediate action to remedy any problems as warranted by DEP.⁵

All hearings under CAFRA are public. The Coastal Areas Review Board hears disagreements with the Commissioner's application of the act. In cases where the agency may determine not to give permission for construction work, dredging, waste disposal, access roads or water diversion, appeals may be taken to the state courts.

In March 1976, New Jersey became the first state in the country to exercise positive state land use regulatory authority in the area immediately surrounding nuclear generating stations: a radius of four miles around the Oyster Creek plant (Ocean County) and six miles surrounding the larger Salem/ Hope Creek facility (Salem County). Using the regulatory powers of CAFRA, the DEP Commissioner formed a special study commission chaired by DEP's Assistant Commissioner for Science to develop formal regulations. In the interim, a moratorium was placed on any new CAFRA permits for residential construction* in these two protective zones.

CAFRA is clearly one of the strongest pieces of land use regulatory legislation in New Jersey's arsenal, and it would play a major role in any determinations on an NEC in Ocean County. Whether the NEC--including associated secondary growth impact--could be approved under CAFRA's guidelines and purposes for protection and preservation of the coastal zone remains open to gross speculation. If the 14 conditions imposed on the Hope Creek facility were the only end result of CAFRA review of an entire NEC, that would be a

* At present, CAFRA review is required only for residential sub-divisions of 25 or more dwelling units.

modest imposition of state authority indeed.. One thing is certain: the review process for an NEC under CAFRA, surely including more than one public hearing, would consume many months--independent of any federal NRC hearings and review procedures--and could be the focus of extreme contention and controversy.

Wetlands Act. This act, passed in 1970, provides for designation by the DEP Commissioner of certain coastal wetlands, followed by their environmental mapping.⁶ The intent of the legislation is to protect wildlife and water cycles, to preserve the ecological balance of such areas, and to prevent their further deterioration and destruction by regulating the "dredging, filling, removing or otherwise altering or polluting coastal wetlands."⁷ Development activity in wetlands areas is regulated by a DEP permit system, with fines for non-compliance.

There are two types of permits. Type A permits are required for the "cultivation and harvesting of naturally occurring agricultural or horticultural products..., excavation of a small boat mooring slip..., maintenance or repair of bridges, roads, highways, railroad beds, etc..."⁸ Type B permits are required for:

"installation of utilities, excavation for boat channels and mooring basins, construction of impoundments, construction of sea walls, diversion or appropriative use of water, use of pesticides except those applied... to the skin..., driving or causing to pass over or upon Wetlands any mechanical conveyance which may alter or impair the natural contour of the Wetlands..., the construction of any structure, filling or excavation except as otherwise provided in this Order."⁹

Figure 17-2 shows the areas of Ocean County covered by the Wetlands statute. Wetlands and CAFRA jurisdiction overlap; as with CAFRA, location of an NEC further inland would effectively preclude either of the acts having impact except for access to the water. Both the Fort Dix Site and the Inland Site would be exempt from the Wetlands Act by their location, although tunnels and other support facilities might have to receive Wetlands Act permits.

Flood Plain Legislation. The Act delineating the Flood Hazard Areas of the state, passed in 1972, authorizes DEP to adopt land use regulations for

floodways--defined as the channel of a natural stream and portions of the flood plain adjoining the channel which are reasonably required to carry and discharge the flood water or flood flow of any natural stream--and to coordinate effectively the development, dissemination and use of information on floods and flood damages that may be available.¹⁰ The Department is authorized to adopt, amend and repeal rules and regulations concerning development and use of land in any designated floodway. Such regulations are designed to preserve its flood carrying capacity and to minimize the threat of flooding to public safety, health and general welfare.

In flood fringe areas--the part of the flood hazard area not included within the floodway--the Act requires affected municipalities to adopt rules and regulations concerning development and use of land which are at least as stringent as rules established by the Department of Environmental Protection. If they fail to do so, DEP is to adopt such rules for them. Localities have the option of making their rules more stringent than those of the state. Again, there are fines for non-compliance.

This legislation applies to designated flood hazard areas in Ocean County and might, therefore, influence construction of an NEC or its necessary support facilities.

Riparian Lands. The issue of riparian land ownership and usage is crucial to approval and operation of an NEC in New Jersey, specifically because the proposed nuclear facility would need water for cooling purposes.* Access to water implies some type of construction on, under or over riparian lands, defined as "those lands now, formerly or hereafter flowed by mean high tide, except where such tidal flow is caused by artificially-produced changes in land or water elevation."¹¹ As stated by Deputy Attorney-General Lewis Goldshore, the State of New Jersey "as trustee for the public" owns all of this land (except that which has been subject to a prior conveyance).¹²

* Possible state opposition to the world's first floating nuclear power plant proposed for a site off the coast of New Jersey would be likely to utilize riparian statutes; the state actually owns the land where the FNP would be moored.

State jurisdiction extends a distance of three miles seaward from the mean high water line. It would be imperative, therefore, for utilities (or any party who wished to build an NEC) to obtain rights to use this riparian land.

The Wetlands Act of 1970 was geared toward regulating private owners (including municipalities) in their use of wetlands. The riparian statutes¹³ are aimed at the state's ability to grant out these lands, while also influencing private usage of the same regions.

One key point of debate involves the precise meaning of state "ownership" of riparian lands. According to Mr. Goldshore, historically the state "has disposed of substantial acreages of its submerged lands to private persons, primarily for purposes of furthering commerce and development (e.g., construction of wharves and docks)." Issuance of such grants was based on the fact that riparian lands were considered to be held in trust by the state on behalf of the people of New Jersey. One must not confuse "ownership" with "held in trust," although the distinction may be a fine one in this case. It appears that a trustee has special rights and duties concerning the object of the trust (the land) which an owner may not have.

Understanding the public trust doctrine is essential if one is to comprehend the controversiality of grants of riparian lands. Arnold v. Mundy in 1821 was the first case in which public trust and New Jersey state ownership were at issue. From this case came the ruling that riparian lands are placed in the "hands of the sovereign power (the State of New Jersey as successor to the crown), to be held, protected and regulated for the common use and benefit."¹⁴ Often the interpretation of the legislature has determined who would receive rights to riparian lands (for the legislature had the power to decide what was in the public interest). "In the 19th and 20th centuries the intensive type of water-front development was considered to be the highest and best use of the state's littoral zone."¹⁵

The wave of environmentalism has not bypassed the courts. As Mr. Goldshore notes, "the state's courts have had some second thoughts about this dedication of the unique tidal resources." That is to say, recent

court decisions have impeded continued development of riparian lands. For example, in New Jersey Sports and Exposition Authority v. McCrane, a 1971 case heard by the Supreme Court of New Jersey, former Justice Hall delivered a decision that was particularly interesting because of the recognition afforded environmental concerns. The crux of the case was the constitutionality of creating a New Jersey Sports and Exposition Authority and its jurisdiction over a 750-acre site in the Hackensack Meadowlands (an area under the prior jurisdiction of the state's Hackensack Meadowlands Development Commission). According to Justice Hall (in partial dissent from the majority), development of the meadows (including state-owned tidelands and privately-owned lands) should proceed in such a manner that construction for human purposes did not mean destruction of the "delicate balance of nature" in the region. "I should think the latter ought to have primary consideration," Justice Hall wrote in his opinion. In the 1972 case of Borough of Neptune v. the Borough of Avon-by-the-Sea, Justice Hall, writing for the court, ruled that "a municipality that owns uplands and, being a creature of the state and dedicated to public beach purposes," may not deny a citizen equal access to beach areas. This decision meant that the public trust did not end with actual transfer of property. The state had a duty to preserve the common benefits that should accrue to all. Thus, in this particular case, non-residents of Avon-by-the-Sea could not be prohibited from using beach facilities accessible to any resident of the borough.

There are limitations to the exercise of state power over riparian lands. The Genesee Chief decision in 1851 extended Federal admiralty and maritime jurisdiction from only tidal waters to all navigable waters. In 1870, the Federal commerce power was extended to all navigable waters which could connect one state to another.¹⁶ Therefore, the Federal Government could intervene in instances where the state sought to impede construction on its navigable (or tidal) waterways through the public trust doctrine. "A full evaluation of the Federal prerogatives pursuant to the supremacy and commerce (and navigation) powers is necessary to resolve potential federal/state confrontations."¹⁷ Mr. Goldshore notes that the state's prerogatives may be further limited as a result of the Federal government's

reliance on provisions of the Atomic Energy Act or other Federal statutes, including the Federal Water Pollution Control Act, the Clean Air Act, and the Coastal Zone Management Act. Disputes over the relative extent of federal v. state authority ultimately will have to be decided in the Federal Courts.

Pinelands Act. New Jersey's Pinelands are a unique environmental phenomenon, providing not only visual beauty but one of the most valuable remaining natural water recharge systems along the entire east coast. An act passed in 1972 established the Pinelands Environmental Council (PEC) to engage in comprehensive planning for these 320,248 acres of predominantly undeveloped pine land in Ocean and Burlington Counties.¹⁸ Figure 17-3 shows the PEC's area of jurisdiction. Much of this land is in the state-owned Wharton Tract (state forest); however, as shown in Table 17-1, 167,718 acres remain as vacant land in private hands. Thus, there exists nearly 80,000 acres of vacant privately-owned land in Ocean County (plus another 88,000 acres in Burlington County), potentially developable--but at a high environmental cost.

In addition to its value as a natural aquifer, the Pinelands has another vital geological value: it is a major barrier against salt water intrusion for Ocean County, and the areas that surround it. According to the Executive Director of the Pinelands Environmental Council, unconstrained major development in the Pinelands could deplete the supply of natural groundwater to a level where salt water from the Atlantic Ocean could begin to enter the area's water supply.

A planning and advisory body rather than a regulatory agency, the PEC is charged with protection of the "water resources and other natural assets" of the area. To achieve its planning objective, the Council is directed to "encourage compliance with the plan by all public and private agencies and persons." The Council seeks to protect the area by restricting its use to limited recreational purposes, or to highly specialized types of farming which do not disturb the delicate ecosystem--cranberry bogs, for example. Although denied direct enforcement authority, the Council can review and comment on each project which presents a substantial risk to

Figure 17-3. Area of jurisdiction of the Pinelands Environmental Council.

TABLE 17-1

EXISTING LAND USE PATTERNS ON THE PINELANDS
(in acres)

	Total Uses, Both Counties		Ocean County Municipalities							
			Burlington	Ocean	Eagleswood	Lacey	Little Egg Harbor	Manchester	Ocean	Stafford Union
<u>State-Owned Lands</u>	(131,535)	(105,558)	(25,977)	(590)	(7,989)	(2,754)	(12,429)	(0)	(190)	(2,025)
Parks	1,055	0	1,055	0	1,055	0	0	0	0	0
Forests	112,665	102,694	9,971	0	0	662	9,309	0	0	0
Fish & Wildlife Mgt Areas	15,339	818	14,521	590	6,934	1,852	3,120	0	0	2,025
Institutions	1,854	1,854	0	0	0	0	0	0	0	0
Recreational Areas	622	192	430	0	0	240	0	0	190	0
Non-State Held Land <u>Being Utilized</u>	(20,995)	(11,717)	(9,278)	(54)	(2,647)	(1,836)	(1,637)	(1,401)	(795)	(908)
Federal Land ^a	3,968	2,534	1,434	0	0	1,367	0	0	67	0
County Land	400	0	400	0	358	0	0	31	11	0
Municipal Land	1,704	36	1,668	0	370	83	33	775	336	71
Rights-of-Way ^b	4,889	3,157	1,732	23	503	147	381	103	215	360
Agricultural Land ^c	4,001	3,322	689	0	120	30	279	0	79	191
Industrial Land ^d	3,268	1,548	1,720	30	1,214	170	79	72	0	155
Residential Land	2,001	883	1,118	1	59	31	842	24	55	106
Other Private Used Lands ^e	754	237	517	0	23	8	23	396	32	35
Privately Held <u>Vacant Land</u>	(167,718)	(87,965)	(79,753)	(1,708)	(32,799)	(6,236)	(7,843)	(6,626)	(13,027)	(11,514)
<u>Total Land Within PEC Boundaries</u>	<u>320,248</u>	<u>205,240</u>	<u>115,008</u>	<u>2,352</u>	<u>43,435</u>	<u>10,826</u>	<u>21,909</u>	<u>8,027</u>	<u>14,012</u>	<u>14,447</u>

Source: Pinelands Environmental Council, Supplement to Plan for the Pinelands, 1975, pp. 39 and 41.

Notes:

- a Divided into military installations (3,547 acres) and communications facilities (421 acres).
- b Divided between state, county and municipal roads, railroads, and transmission lines -- 145 acres, all in Lacey Township, Ocean County.
- c Craberry bogs account for 76 percent (3,024 acres) of this agricultural land.
- d Almost entirely used for open mining.
- e Divided between commercial operations, recreational facilities, private institutions and utility ownership -- 82 acres, in several different townships.

the pinelands environment--unless the project were immediately needed as an emergency action to protect life or property. With these review powers, the PEC can delay commencement of a project by up to 90 days, holding a public hearing and disseminating widely any negative findings in an effort to block undesired projects. After 90 days, however, the project may proceed.

A further constraint upon the effectiveness of the Council ensues from the fact that the Pinelands sprawl across two counties, Ocean and Burlington; they encompass part or all of some 14 municipalities in those two counties. Even in dealing with such a legendary natural resource, consensus is hard to come by.

After the review and hearing process of 90 days, the recommendations of the Council can be refuted by municipal override. At present, the best the Pinelands Environmental Council can do is to hold a proposal at bay for 90 days, and hope that the communities and the developers can come to more reasonable considerations of the area in their development proposals.

If a decision were made to proceed with detailed site selection for an NEC in the Ocean County area, because of the existing and planned population in the immediate vicinity of Toms River and the coastal communities, the Pinelands appears to be the only place where 40 square miles of territory could be found. The Inland Site lies completely within the PEC's area of jurisdiction; the Bay and Fort Dix sites do not. The Pineland's ecological importance, and the limited powers granted to date to the Pinelands Environmental Council, would immediately become focal points for discussion in debate over the NEC. As of the moment, since the Council is primarily an advisory body, the 1972 Act may not be as protective of the Pineland's area as it could--or perhaps should--be.

Comment: The Hackensack Meadowlands Development Commission. Except for the Pinelands, the statutes described above relate to broad geographical jurisdictions and functionally-specific authority. A very different type of state agency, the Hackensack Meadowlands Development Commission, was created in 1968 to give special attention to the "ecological factors, air and water pollution, waste disposal and the protection of the balance of nature that could be adversely affected by artificially imposed development

in one defined area." The Commission itself transcends municipal boundaries, covering all or part of 14 separate municipalities. A committee representing municipal interests "acts in concert" with the Commission to "plan, develop and redevelop the Hackensack meadowland." HMDC is formally administered within the Department of Community Affairs.¹⁹ Although its geographic area does not cover an Ocean County NEC, several conceptual aspects of the HMDC relate to this analysis.

The uniqueness of HMDC is that it is a state-initiated regional planning body endowed with sweeping authority in its area. It has been given all powers of zoning in the area normally granted only to municipalities, and at the same time it performs the functions of several state agencies (e.g., DEP and the Department of Health). Innovative tax-sharing measures apply to all new ratables. Of particular interest is the Commission's power to:

"Acquire land and...set forth (1) description of tract; (2) reason for acquiring it; and (3) estimated cost of compensation. If for any of its authorized purposes... the Commission shall find it necessary or convenient to acquire any real property within its jurisdiction... whether for immediate or future use, the Commission may deem that such property is required for public use... the said determination shall not be affected by the fact that such property has heretofore been taken for, or is then devoted to a public use of any municipality, county, school district, or other local or regional district, authority or agency, but the public use in the hands or under the control of the Commission shall be deemed superior."²⁰

The powers of the HMDC were tested in 1972, in a case bearing directly on the federal preemption issues likely to arise if an NEC were seriously contemplated in New Jersey. In this case, Transcontinental Gas v. Development Commission (No. 71-2034), in March 1970 the utility company had received a certificate from the Federal Power Commission approving construction of a privately-owned Liquefied Natural Gas (LNG) storage facility in an area of the Meadowlands zoned by the HMDC for residential use only. Despite federal approval, the HMDC refused to approve a zoning variance and issue Transco the necessary building permit. The Development Commission concluded that construction of the large storage tanks "would seriously restrict the range of possible

uses in the surrounding areas," and would "fail to meet applicable planning and safety regulations." Transco appealed the HMDC decision, and the court found that while the Commission was exercising its authority to "enact zoning ordinances under the state's police power," such state authority could not be exercised so as to place "a substantial burden on interstate commerce" (Transco supplies New Jersey and New York with natural gas shipped from the Gulf Coast). The court found the HMDC's actions to constitute an "arbitrary" use of state's police powers. While admitting that sound community and regional planning are beneficial, the court argued that due consideration also must be given to the needs of the New York-New Jersey metropolitan area for an adequate and efficient supply and delivery of natural gas. Also, the Commission had no set of "regulations, standards or criteria" applicable to proposed construction. Therefore, denial of the variance requested by Transco based on the lack of conformity with "applicable planning regulations and safety considerations" was unfair. The utility did, in fact, "conform to current building and safety standards" for comparable LNG storage facilities elsewhere.

Several points relevant to an NEC emerge from the above case. The HMDC's exercise of state land use controls (under the police power) was superceded by the authority of the FPC, a clear-cut example of federal preemption in the energy field, albeit natural gas rather than nuclear. Provision of services by the utility company to its consumers carried great weight in the court's final decision. It was deemed important that the utilities not suffer any undue burdens that might prove detrimental to their provision of these energy services to the public.²¹ In addition, if public safety is to be a plausible criterion for impeding construction of certain facilities, it will be necessary to have explicit standards of safety promulgated in advance. HMDC had not done so, and suffered as a result in the court decision. Perhaps more important is the need to decide in advance whose rules are to prevail, the federal government's or the state's, especially in cases where the state's standards are more stringent than the federal guidelines. Usually, such issues are resolved in the federal courts. Any discrepancies within levels (e.g., various safety codes affecting buildings) must be clarified.

Based on the court's ruling in the Transcontinental Gas case, it would appear that local and even state zoning ordinances may be overruled when they interfere with interstate commerce (a function controlled by the federal government). It is difficult in this context to imagine a 20-reactor NEC being seen as not involved in interstate commerce, should this issue be raised in a court challenge.

Comment: CAFRA and the National Interest. It is explicitly stated in CAFRA that:

"Construction and operation of a nuclear electricity generating facility shall not be approved by the commissioner unless he shall find that the proposed method for disposal of radioactive waste material to be produced or generated by such facility will be safe, conforms to standards established by the Atomic Energy Commission (AEC), and will effectively remove danger of life and the environment from such waste material."²²

This section would appear to give the DEP added jurisdiction over the operations of an NEC, at least one located within the CAFRA zone (the Bay Site, for example).

However, CAFRA's effectiveness in coping with a Nuclear Center could easily fall victim to the same legal and constitutional pressures which produced explicit federal preemption with respect to Minnesota's radiation standards (Northern States Power Co. case) and with respect to Transco's LNG storage tank in a residential area of the Hackensack Meadowlands of New Jersey. That is, what is the legal definition of "safe" with respect to a Nuclear Energy Center of some 20 reactors and associated fuel cycle facilities? It seems reasonable, based on the record to date, to predict that the utilities and the nuclear energy advocates within the federal government could rely on their conformance with applicable federal standards for radiation, siting, containments, emergency core cooling systems, and so on as justification for their contention that each facility -- and therefore the entire NEC -- was "safe". If this stance were upheld in the courts, not an unreasonable prediction, the NEC could thereby circumvent possibly more stringent standards of state review under CAFRA.

At the present time, if a federal/state dispute of this kind were taken to court, it appears unlikely that DEP opposition would be upheld.

Radioactive wastes, with half-lives into the thousands of years, pose a continuous threat to any environment. Today we assume that the storage facilities will not deteriorate or be destroyed by natural disaster. So long as this is true, the environment may be considered "safe" from radioactivity. We cannot predict long-term future effects. Therefore, our interpretation of "safe" is time bound. Any court decision must adhere to these criteria. Therefore, it seems improbable that vague definitions of long-range risk would carry much weight in court. The state might well lose even its land use regulatory authority for a facility like an NEC.

In addition, the state's exercise of the police power under CAFRA to deny a necessary permit to an NEC-related facility for construction, dredging, waste disposal, access roads or water diversion could be challenged by the federal government specifically because the proposed NEC would be engaged in interstate commerce (supplying energy to some consumers outside New Jersey).²³ In such a case, it seems questionable whether the state's jurisdiction would be upheld. In effect, any state regulation applying to an NEC might be overruled in federal court as an unfair burden on interstate commerce.

Comment: The State and Federal Lands. The federal government has control over disposition and use of its property (e.g., Fort Dix). Any government agency authorized to engage in the "production, marketing or distribution of electric energy" may obtain a license, if qualified, for construction and operation of production or utilization facilities for the purpose of producing electric energy for public consumption.²⁴ State involvement would occur if any construction were necessary beyond the federal lands: for example, the laying of tunnels to pump water to the facility, any access roads, and control of environmental quality of state lands (air, water, land and wild and marine life). Again, the interstate commerce clause might become a particularly powerful bargaining tool for advocates of the nuclear energy facility.

17.5 The Cabinet Energy Committee and the Nuclear Energy Council: Coordinative Mechanisms.

On October 26, 1971, a Cabinet-level Nuclear Energy Council was established by Governor William Cahill to give guidance to the state's decision-makers on

issues involving nuclear energy. The expanding number and complexity of proposals for nuclear generating facilities in the state, along with growing concern over the environmental impacts and inherent safety of such facilities, suggested need for such a coordinating body. Essentially a Cabinet subcommittee, New Jersey's Nuclear Energy Council is chaired by the Commissioner of the Department of Environmental Protection and includes the President of the Board of the Public Utility Commission, the Attorney General, the Commissioner of Health, and others as the Governor may designate. The group met on an as-necessary basis to discuss nuclear energy policy and review proposals for specific nuclear facilities in the state. The Council's major action as a group involved the decision in 1973 to oppose the generating station proposed by PSE&G for Newbold Island, near Trenton, supporting as an alternative the Artificial Island site in Salem County.

With the advent of the Arab oil boycott and the petroleum crisis, it became apparent that a coordinating body whose concerns were restricted to matters of nuclear energy was no longer adequate. Therefore, in early 1974 Governor Brendan Byrne created a Cabinet Energy Committee by executive order. This Cabinet-level committee is an intermediate body for formulation of energy policy. It includes the three PUC Commissioners, the Commissioners of the Departments of Environmental Protection, Labor and Industry, Community Affairs and Transportation, a representative of the Office of the Governor's Counsel and of the State Treasurer. It provides a forum whereby senior officials of various state agencies can discuss and hopefully resolve conflicts with respect to policies, programs and regulatory decisions in the energy area. The primary aim is to present a "unified state position." Ultimate decisions concerning policy, of course, continue to be made by the Governor and/or the legislature. Nevertheless, the Cabinet Energy Committee's discussions can be quite influential, and it is significant that such an agency does exist at all in New Jersey, since coordination of the positions of various state agencies would enhance the authority of the state in questions of energy generation. One would expect New Jersey's Cabinet Energy Committee to play a major role in formulating state policy with respect to an NEC.

For sometime, a proposal to merge the Nuclear Energy Council into the Cabinet Energy Committee has been receiving serious consideration. The former no longer seems necessary since nuclear power issues as well as other energy policy issues can and are being discussed within the Cabinet Energy Committee.

17.6 Department of Environmental Protection: Regulation of Air and Water Quality

The Department of Environmental Protection (DEP) is undoubtedly the state agency in New Jersey that would have the single greatest role to play in decisions on construction and operation of an NEC within the state. Created under an act reorganizing the Department of Conservation and Economic Development, in its loosest sense the DEP is empowered to "protect the state's environment."²⁵ In essence, the agency is responsible for developing policies and administering programs for conservation and protection of the state's natural resources. Major programs are in the areas of water resource management, environmental quality control, open space and recreation, and a variety of other environmental quality control, open space and recreation, and other environmentally-related programs. DEP is also empowered to prepare, administer and supervise statewide, regional and local programs of conservation and environmental protection. These powers provide the agency with a key position concerning questions on the use of land in New Jersey, particularly facilities with potentially damaging environmental effects. The agency's approval is required for construction in all coastal wetlands except the Hackensack Meadowlands; in flood plains; in coastal areas; and on riparian lands. The Department's approval is also needed for disposal of solid wastes. Through its various divisions, DEP grants permits to dredge and repair dock facilities; construct breakwaters; construct submarine cables; construct buried cables; and construct facilities and breakwaters on riparian lands. Any offshore meteorological towers must be licensed. Any construction of transmission lines on state lands requires DEP approval.

With respect to nuclear generating stations, the DEP's Division of Environmental Quality, Bureau of Radiation Protection must also issue permits for the possession of radioactive materials on the site, and for discharge of materials into a waterway (a present area of conflict between New Jersey's DEP and the NRC).

New Jersey's Water Resources Legislation and an NEC. DEP has established water quality criteria according to two categories. Primary contact recreation refers to waters used for body contact; secondary contact recreation refers to non-body contact sports such as fishing. Waters are further classified by the state as fresh water, tidal water, coastal water, trout maintenance and trout production. Water quality criteria are set according to the usage of the water. The standards include criteria for floating solids, settleable solids, oil, grease, color, turbidity, toxic substance, PH, dissolved oxygen, temperature, bacterial quality and radioactivity.

To enforce standards for surface waters, DEP's Bureau of Water Pollution Control issues permits and regulates activity relating to sewage systems, wastewater treatment plants, construction of sewerage facilities, new factory locations in certain watersheds, sealing of abandoned wells, and installation and supervision of sewage facilities in areas of critical water quality.

Requirements of the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA) have expanded DEP's activities in the areas of planning, waste water treatment facility construction, and permits for the discharge of effluents into surface waters. The state's Continuous Planning Process under Section 303 (e) of the FWPCAA is a management process to organize and coordinate state decisions, develop overall water quality management strategies, and develop a comprehensive data base to use in issuing discharge permits.

Land use implications in the FWPCAA as applied through NJDEP might affect an NEC and its associated secondary development. Even if they can meet applicable standards, new pollution sources will not be allowed if they interfere with applicable water quality standards. Since in some areas of the state waters do not now meet existing standards, any further development may be limited. Where waters of the state are designated to be free from an effluent discharge, or where existing water quality is high, both point sources and non-point sources of discharge may be limited to prevent water quality degradation.

Although techniques for control of non-point sources of pollution are not yet well developed, it is realistic to assume that in the case of salt-

water dispersion through cooling tower evaporation, it would be necessary to protect effectively against saline pollution of surface and ground waters in a rather large area around the NEC. This would require new regulatory programs by the Federal EPA and NJDEP. Similarly, no effective methods exist at present to prevent salt intrusion into aquifers. Although the FWPCA specifies high-quality ground water as a policy objective of pollution control, there are great difficulties in regulating such pollution and in guarding against such contamination.

The Bureau of Water Control in DEP's Division of Water Resources has authority to review water supply applications, issue permits for water diversion and dam construction, and report on water diversions. The Water Policy and Supply Council has the legislative authority to review and approve all water supply projects. The Bureau of Water Control acts as staff to this quasi-legislative body. The Council, whose nine members are appointed by the Governor, meets weekly and has jurisdiction over all potable water sources and public water supplies including surface, sub-surface and percolating water. In particular, the Council has responsibility for undeveloped water resources and for approval of any water diversions. Contracts for water supplies for municipalities are submitted to the Council for its review and approval. The right of eminent domain may be exercised by holders of permits for diversion of potable water only with approval of the Council. The Council at public hearings requires applicants for public water supply diversions to show that diversion will not interfere with supplies in existence, exhaust natural replenishment, or render such waters unfit. For private water subsurface supply, the proceedings are similar, but diversion must be shown not to exceed natural replenishment rates or render such waters unfit for use by intrusion of salt water.

Diversion of the enormous quantities of water required for cooling purposes at an NEC would seem to raise other issues, even though ocean water is plentiful. It is not clear that the Water Policy and Supply Council, as presently constituted, would have jurisdiction regarding salt water diversion for cooling purposes at an Ocean County NEC. New state legislation might well be required to cope with approximately 800 mgd in

ocean water evaporated through the cooling towers of a 20-reactor NEC. And it seems clear that no fresh water sources could possibly offer the quantities of water required for diversion. New Jersey is already under pressure to expand existing water supplies and to develop new sources to meet expected future demands. A rough estimate of consumptive water use in the state is 2,000 mgd -- 1,000 municipal, 750 industrial and 250 agricultural. Even the renowned Pinelands aquifer could produce only about 100 mgd without replenishment, if salt water intrusion is to be avoided.

New Jersey's Air Quality Regulation and an NEC. The New Jersey Air Pollution Control Act of 1954 is also administered by DEP, operating within the constraints of the Federal Clean Air Act Amendments of 1970. Under this Act, the department has authority to formulate and promulgate codes and establish rules, regulations and standards to control air pollution.²⁶ Through the Bureau of Air Pollution, regulations have been issued covering the following activities: control and prohibition of open burning, smoke from fuel combustion, solid particles from fuel combustion, particles from manufacturing processes, sulfur, sulfur in fuels, sulfur in coal, and incinerators. The Bureau of Air Pollution also prepares for air pollution emergencies, sets state ambient air standards, regulates diesel smoke and controls and prohibits air pollution from light duty gasoline fueled motor vehicles. Parts of the New Jersey implementation plan remain incomplete. The emissions inventory, the transportation control plan, secondary standards for sulfur dioxide and particulates, and the air quality maintenance plans and prevention of significant deterioration are all pieces for which EPA approval is still pending.

The present New Jersey Air Pollution Code contains no provisions for control of the steam and water vapor emissions which might result from the large number of wet evaporative cooling towers associated with an NEC. Twenty reactors are estimated to evaporate 270,000 gpm into the air via plumes of vapor from the towers. This much water vapor could have significant environmental effects, particularly if salt water were used in the cooling process (as noted above, adequate amounts of fresh water do not appear to be available in coastal New Jersey). To protect the soil and the residents of

areas near the NEC -- and up to 30/40 miles downwind - new standards might have to be established for salinity in evaporative water. Enforcement of stringent salt emissions standards might, in fact, constrain implementation of the entire NEC concept in any coastal area. This would seem to be an important issue for further research. The potential economic effects of extensive vapor plumes or cloud cover on shore resort areas, and the political implications of the aesthetic impact of these plumes, are discussed elsewhere in this report.

Some particulate pollution would emerge from a construction effort of the magnitude of an NEC: special steps might have to be taken to ensure against violations of federal/state ambient air quality standards for Total Suspended Particulates (TSP). Development of an Air Quality Maintenance Plan for the area would seem an essential concomitant of a decision to proceed with the NEC.

Except for salt depositions (mentioned above) and low-level discharge of radiation (an issue preempted by the Federal government following the Minnesota/Northern States Power case), all the other major air pollution concerns will result from secondary regional development stimulated by the NEC. This development will involve construction activity, new indirect, moving and stationary sources of air pollution, and in general will necessitate large-scale planning by counties, regional planning agencies, DEP and other state agencies to assure that ambient air quality can be maintained and enforced through appropriate control strategies. Since many of the EPA-directed air pollution control strategies involve land use considerations, air quality maintenance and implementation will affect site planning both for the NEC and for the expected secondary development around the NEC site.

17.7 The Public Utility Commission and an NEC

The Public Utility Commission (PUC) is comprised of three Commissioners appointed by the Governor with the approval of the legislature. The Commission is required to ensure that no public utility "provides or maintains any service that is unsafe, improper or inadequate, or withholds or refuses any service which can reasonably be demanded or furnished when

ordered by the Board."²⁷ In its loosest interpretation, the Commission is thus responsible for the public's safety. This mandate to assure "safe, adequate and proper" service by utilities would make the PUC one of the key agencies with respect to construction and -- particularly--operation of a Nuclear Energy Center in New Jersey.

Several statutes are of prime significance in terms of the connections between the PUC and a potential NEC. For instance, the legislature has given the PUC authority to override local zoning ordinances. With approval of the Commissioners, a public utility can acquire property by eminent domain for transmission line rights of way. However, under existing legislation neither the PUC nor the public utilities may condemn land for generating stations, substations or support facilities.²⁸ In addition, local zoning ordinances or regulations applied to the property of the public utility companies can be thrust aside. If the Commissioners decide (after a hearing) that the present or proposed situation of the structure or building is "reasonably necessary for the service, convenience or welfare of the public, they can exempt the utility from the local building permit and site approval requirements."²⁹

The PUC's power to override local zoning is of particular importance to the proposed NEC because any disputes over zoning between a municipality and a utility would be resolved by the PUC following a public hearing at which all "parties in interest" may attend and be heard.³⁰ The hearing examiner would submit a recommendation to the Board of Commissioners. After two weeks, during which time both sides might contact the Commission with respect to the findings of the hearing examiner, the Board would render a final decision.

The Public Utility Commission must approve rates to be charged to consumers of electricity; and it may or may not condone a utility's sales of assets. The latter circumstance would enable a utility to acquire greater capital, which may be necessary for continued construction of the NEC's facilities. Such financial actions are termed technically "earnings on construction work in progress (ECWIP)." The necessity for such earnings must be proven to the satisfaction of the PUC as a condition of its approval. Denial of such sales could impede construction of the proposed facility due

to constraints on availability of capital.

Thus there appear to be three areas that could involve the PUC in aspects of the construction and operation of an NEC: (1) the mandate to assure safe, proper and adequate service; (2) the power to override municipal zoning ordinances; and (3) decisions on ECWIP. Disputes in any or all of these areas would require separate hearings by the PUC held in either Newark or Trenton to afford easy statewide access. Such hearings might attract a high degree of public participation on an NEC-related issue. It is perhaps significant that any resident of New Jersey could be considered a "party in interest" to such an NEC hearing before the PUC, not just residents of areas near the proposed NEC location. Individuals and agencies may be included within this definition. For example, the Department of Community Affairs (DCA), the Department of Labor and Industry (DLI), and the Department of Environmental Protection (DEP) might participate actively in such hearings; surely the New Jersey Public Advocate would also be involved.*

One can only speculate as to the effect of such participation by state agencies. Because of press coverage, one likely result would be greater public interest in the proposed NEC project, at an earlier date. The usual course of public mobilization is a slow process of building up public interest to a crescendo and then a slackening. The activities of the above-mentioned agencies might in fact both speed up and prolong that mobilization. It should not be expected that these agencies would follow the same side via the NEC. DLI might favor the NEC because of its employment potential and subsequent secondary effects (a potential economic boom around the center); DEP, on the other hand, might consider the environmental costs too extreme and, therefore, choose to oppose the NEC.

The PUC must approve all local government franchising decisions as well as the acquisition of any property by a public utility.³¹ Thus, the commission has some influence over the location of a facility, as well as its operation within a community.

In recent years, the jurisdictional scope of the New Jersey PUC has expanded considerably. From a narrower focus on rate-making and rate-structure alone, the commission has been called upon increasingly for policy

* The Public Advocate has intervened in PVD hearings on electricity rates and in NRC licensing proceedings on the proposed offshore nuclear plant.

inputs across the spectrum of energy interests, including nuclear energy. The PUC's expanding role in energy policy was formalized in early 1975 when the State Energy Office, established in the Governor's office in Trenton as an ad hoc institutional response to the Arab oil embargo and the chaos of fuel allocation, was formally shifted to the purview of the PUC in Newark.³² Thus, it seems safe to conclude that the PUC and its staff, including the Energy Office, would participate actively in devising state policies towards an NEC.

One major regulatory and jurisdictional issue which would have to be resolved before an NEC could be built in New Jersey -- or elsewhere -- involves the role of the state Public Utility Commission with respect to out-of-state consumers of electricity produced in New Jersey. In the event that a full NEC produced more power than needed for New Jersey's own consumers, the state would become a net exporter of electricity to New York, Pennsylvania and elsewhere, at least some of the time. This raises the following questions for further study:

- . . . would the advent of an NEC bring about increased incentives for coordination of state utility commissions?
- . . . would the advent of an NEC accelerate the formation of regional institutions?
- . . . what additional difficulties would be imposed by an NEC in matters of rate regulation?

While there is no "rule of thumb" as to the decisions of the PUC regarding a Nuclear Energy Center in New Jersey, one cannot over-emphasize the importance of the key role of that agency: "to assure safe, proper and adequate service." The utilities have a powerful argument on their side once they can show the necessity of an NEC to continued service to consumers. There probably are enough federal regulations and licensing procedures to satisfy the "safety" mandate of the PUC. Compliance with such criteria should be advantageous in the event of any disputes between utility companies and the state's municipalities.

17.8 Other Executive Agencies and an NEC

The Department of Labor and Industry (DLI) also would play a part in review and regulation of an NEC. This agency must grant building permits for construction of the plant and shore support facilities. DLI's Bureau of Engineering and Safety approves plans for construction of new buildings and alterations of existing ones, and establishes and enforces standards. Its Division of Labor Relations and Work Place Standards establishes and enforces standards to guard "workers" safety, health, efficiency and general well-being."

The Division of State and Regional Planning of the Department of Community Affairs engages in statewide planning. In so doing, it has some impact upon land use schemes. Projects requiring major federal funding may not receive the necessary approval if a regional planning body issues a negative A-95 review (authorized by the Federal Office of Management and Budget Circular A-95). The Division promotes "the orderly development of the State's physical asserts" by assembling facts; preparing comprehensive guidance plans for long-term development; fostering coordination of development activities between several state departments; and informing and coordinating "local, county and regional planning activities." The Rural Advisory Council in the Department of Agriculture studies and makes recommendations with respect to rural land use affecting social and economic conditions.

The Department of Transportation exercises some authority in regulation of land use in property along an acquired right-of-way. Connection of the NEC to pre-existing thoroughfares would, therefore, require approval from this Department. Construction and operation of heliports would also fall under DOT's jurisdiction.

17.9 State Courts and an NEC

The state courts would decide upon any litigation resulting from application of state regulations to the installation, construction or operation of an NEC with New Jersey. If the state agencies mentioned earlier decided to intervene in the facility's construction application or in a single intervention by the State through the Cabinet Energy Committee, court proceedings could conceivably delay construction for a considerable time.

Clearly, that is an extreme case. Still, depending upon the extent to which each side were to remain adamant, some issues eventually could be taken to the U.S. Supreme Court (average cases take about two years to be heard at that level). Such delays add to the expenditures of the utility companies, and of their electricity consumers.

Most states have a set of codes entitled "nuisance laws." New Jersey defines a nuisance as "the use of property or rights and personal conduct causing material annoyance, inconvenience, or injury to others, in respect of health, safety and comfort..." The question to pursue is whether citizens can use nuisance laws against a proposed NEC. Then, would federal licensing preclude a finding of public (or private) nuisance?

Are New Jersey's nuisance laws applicable to nuclear energy? Most statutes and regulation enacted prior to 1940 are expressly concerned with noise, water, odor (noxious vapors) and vibrations (that is, activities involving shaking of the earth). Since nuclear reactors emit no air pollutants, the applicability of these laws appears poor. Yet, can one consider as pollution the large quantities of salt and/or steam released into the atmosphere by the NEC's cooling towers? Unsightliness alone, however, has not been held to constitute a nuisance. Therefore, the aesthetic aspect of the NEC could not fall under legal attack (Francisco vs. Dept. of Institutions and Agencies, 1935). An injunction may be issued where manufacturing discharges into a reservoir (and subsequently into a small natural stream) are hazardous to the public health (Butterfoos vs. Board of Health, 1885). Diversion of the water of a stream so that -- when returned -- it was polluted and its quality appreciably impaired to the injury of others has been held to constitute a public nuisance and not a reasonable use of riparian land (Auger and Simon Silk Dyeing Co. vs E. Jersey Water Co., 1915). Would the elevation of water temperature and its potentially damaging effects to existing ecosystems and secondary effects on citizens constitute such a nuisance?

In the past, interruption of sleep has been deemed a nuisance. Could the interference with pleasure derived from "natural endowments" of areas, including its marine life or the sunshine absent from Long Beach Island's

resorts because of plumes of vapor from the NEC's cooling towers be deemed a nuisance?

The facility might be protected by a ruling exempting persons and/or agencies from nuisance laws if they were so authorized by statute (State vs Erie R. Col., 1913). However, this decision would then throw the dispute back to the state agencies, who would then have to decide whether an NEC were authorized by an existing New Jersey statute, or to the state legislature which would have to pass such an act were it deemed not to exist.

17.10 Regional Agencies and an NEC

Regional agencies frequently fall into an anomalous position with respect to governmental regulation; this fact applies with equal validity to agencies in interstate regions and substate regions, both of which lack the power to make authoritative decisions. Nevertheless, such agencies can play important roles in planning for a massive project like an NEC.

The Atlantic County Planning Board (ACPB) is the only regional planning agency whose jurisdiction directly reaches to the three hypothetical NEC sites in Ocean County. The Board has A-95 review and comment authority in Ocean County. It also does regional planning for the Atlantic City Standard Metropolitan Statistical Area, and within that area the Board can grant special preference in community development entitlements. While the agency cannot alter zoning ordinances (and serves solely in an advisory capacity in this regard), it does provide a master plan for the area. Thus through its A-95 power the Board can exercise some control over land use.

ACPB occasionally coordinates its activities with other regional agencies outside the area, particularly with respect to transportation planning. These agencies which might become involved in planning for an Ocean County NEC include:

- The Delaware River Basin Commission (DRBC)
- The Delaware Valley Regional Planning Commission (DVRPC)
- Wilmington Metropolitan Area Planning Coordinating Council
(WILMAPCO)
- Delaware River Port Authority (DRPA)

An area wide-water quality management program is underway in Ocean County, under the aegis of Section 208 of the Federal Water Pollution Control Act. The Board of Chosen Freeholders of Ocean County has been designated as the formal 208 agency, responsible for the entire county (and for a small portion of Monmouth County, encompassing the Metedeconk River Basin). As of April 1976, Ocean County's 208 planning staff consisted of six people (five full-time); expansion to a total of nine was anticipated. The planning effort is being supported by activities of the Ocean County Sewage Authority and the county's Departments of Health, Engineering and Planning. In addition to the 208 planning group, two committees have been appointed to participate on the 208 process. The Policy and Technical Advisory Committee consists of the County Administrator; County Planner; County Engineer; Director, County Health Department; Executive Director, Ocean County Sewage Authority; and representatives of the County Soil Conservation Service, County Mosquito Commission, USEPA, NJDEP, USGS and the US Department of Interior. This group meets formally on a quarterly basis. The Citizens Advisory Committee meets monthly. While there is no formal air quality maintenance planning at this time, the county has met with DEP and EPA in order to enable it to integrate such a program into its own planning process. There will be an interface between 208 and AQMP, and coordination is moving forward. All Federal environmental impact statements on sewage treatment or water quality include sections on air quality.

A tri-county organization linking Ocean County more formally with leaders of Atlantic and Cape May Counties on issues of common concern evolved from initial meetings held between Atlantic and Ocean Counties in 1975 regarding the proposed floating nuclear plant (FNP), and the subsequent intervention by the counties in the licensing proceedings. In the latter part of 1975 Cape May County joined the group, and is now an active participant. Although first concerned solely with FNP, activities soon expanded to include OCS drilling and sludge dumping. The group foresees proposals for a deep-water port as another issue in which they will be involved in the future. Before each of the three Freeholder Boards in April 1976 was a resolution for the alliance to become a truly formal entity under the name of : "Tri-County Committee to Control Industrialization of

the Ocean". Each county has budgeted \$18,000 for technical and professional services, primarily associated with their intervention against the FNP. This does not include legal fees, which are to be allocated separately.

Atlantic County Freeholder Darryl Todd is Chairman of the directing group, which includes two Freeholders and the County Planning Director from each of the three counties. Other county officials often attend these meetings. For example, in April 1976 Ocean County was normally represented at meetings of the tri-county organization by the following individuals:

- Ernest Buhr, Freeholder Director
- Joseph Flynn, Freeholder
- Charles Pike, County Administrator
- Thomas Thomas, County Planner
- Jack Lamping, County Information Officer
- Franklin Berry, Attorney (and former N.J. State Legislator).

In addition, there has been an active participation from the staff of Congressman William J. Hughes, whose congressional district includes these three counties.

There is a growing concern in the three counties that the oil companies and the U.S. Department of Interior are moving too quickly on OCS leasing, before its full impacts on the shore communities are really understood. The tri-county group met in April 1976 with representatives of the two Long Island (N.Y.) counties -- Nassau and Suffolk-- to consider a joint law suit on the OCS issue. These five counties have many problems in common, including possible impacts of OCS on tourism and the fact that an oil spill in New Jersey would also affect Long Island's beaches. The major result of this alliance is the realization that OCS activities are regional in nature, and that their impacts are more dramatic than has been stated by those advocating early leasing. Specific topics discussed at the five-county meeting included the possibility of a blow-out at an oil rig in the spring, which would render beaches unfit for use during that summer season; and a pipeline break on or near shore.

The Monmouth-Ocean Development Council (MODC) is a bi-county organization in which Ocean County is a member, much as it is a member of the

larger Southern New Jersey Development Council. MODC basically is a business organization similar to a Chamber of Commerce, except that its prespective is much broader and more regional in nature. Over the past two years, MODC has increased its membership from 25 to at least 185. Its purposes include exchange of information; application of pressure for a favorable business development climate (including tourism); and serving as a social setting where a cross-section of people can meet. Its members include many community leaders, e.g. the President of Ocean County College, Mayors, Freeholders and business people. Presently MODC has no real full-time staff, although this may emerge in the near future.

17.11 Local Governments and a New Jersey Nuclear Energy Center

This section describes briefly the nature and scope of land use authority available to local governments in New Jersey. The State's 567 municipalities, although without any inherent authority of their own, have been delegated by the state legislature almost all of the power to make land use decisions: zoning, approval of requests for variances, sub-division approval, building permit issuance, and the other related actions in the arena of land use regulation. These municipalities are of the following kinds, by total frequency across the State:

Borough:	257
Township:	234
City:	53
Town:	21
Village:	<u>2</u>
	567

Ocean County is composed of 19 boroughs and 14 townships.

New Jersey's 21 counties have very limited land use regulatory powers; municipalities zone and regulate development across the state. There are no unincorporated areas in which, in other states, county governments exercise sole land use authority. The home-rule tradition continues to be practiced widely, justified by the argument that the local welfare can best be advanced by a local governing body. Counties -- located between the state and municipal governments -- have not been granted by the legislature any powers comparable to those of the municipalities. "From a

purely legal view," says the New Jersey County and Municipal Government Study Commission, county government "does not even have a power to tax its residents, much less to legislate on their behalf, to provide vital services on its own initiative, to reorganize its structure, and do all of the other things which municipal governments can do for themselves and their inhabitants."³³

In the sphere of local planning as well as zoning regulation, again primary activities are carried out at the municipal level.³⁴ This trend is further affirmed by the repeal of an earlier provision requiring every municipality to file its master plan with the county planning board within a certain period of time.³⁵ Maximum co-ordination between municipal and county plans is expected to be achieved primarily by voluntary action on the part of municipal planning boards.³⁶

In essence, municipal powers rest on the local government's responsibilities to promote the general welfare of its citizens. However, the same idea of promoting the general welfare provides certain limits over the land use powers of New Jersey's municipalities. First, the zoning power of a municipality is limited solely to the land within its territory.³⁷ More important still, the regulatory power of the municipality is seriously limited where other authority -- such as the Public Utility Commission -- is deemed to be in a better position to promote the public welfare. Thus, a zoning regulation may not be enforced against property used by a public utility in furnishing service if the Board of Public Utility Commissioners determines, on petition of the utility and after a hearing, that the use is reasonably necessary for the convenience or welfare of the public.³⁸ Thus the state's home-rule tradition, at least with respect to electrical generating stations, is not as strong as it might seem.

Promotion of the general welfare is also the basis on which the right of eminent domain is exercised by various authorities. The right of eminent domain involves acquisition of real property so that private property is not taken for public use without just compensation to the owners (the "taking clause"),³⁹

In an effort to discover the main weaknesses in county government across the state, and to develop methods of adding to the administrative and functional effectiveness of county government, the State of New Jersey County and Municipal Government Study Commission made an extensive study of county government. In its report, County Government: Challenge and Change, the Commission set out four main areas of inadequacy which would have to be rectified if the county were to become a viable partner in the exchange between large-scale and small-scale governmental operations:

- a. Legal inadequacy
- b. Fiscal inadequacy
- c. Structural and administrative inadequacy
- d. Political inadequacy

Recognizing that all counties suffered, in varying degrees, from these weaknesses, the Commission recommended that counties be given general powers to undertake the following:

- a. Reorganize themselves as they see fit.
- b. Initiate area-wide and inter-local services.
- c. Provide for a legislative and policy-making role for the Board of Freeholders.

These recommended options have recently been incorporated into the Optional County Charter Law, which gives the residents of each county the right to vote by referendum at election time for a Charter Study Commission so that individualized county needs can be incorporated should the voters later opt for charter change.

The limited statutory authority of local governments in New Jersey to influence siting decisions regarding any energy facility under the preview of the Public Utility Commission would be weakened further in the case of a Nuclear Energy Center. This facility's sheer size would mean, in all probability, that at least one and possibly two or three existing townships would have to cede much if not all of their territory to the owner/operator of the NEC. Once most of Lacey Township were swallowed up by the Inland Site, for example, it certainly would be in no position to scrutinize

requests for building permits for facilities within the NEC. This very fact of their jurisdictional demise, however, suggests that these local governments, and their citizens, might resist the NEC even more vociferously on the political front.

The concept of Nuclear Energy Centers could certainly have an effect upon the county's role in land use planning, as well as serving to promote inter-county cooperation in seeking solutions to the larger than countywide implications of secondary service needs and impacts created by construction and continuing operation of such facilities. As the size and scope of federal and state participation in local affairs enlarges, and as the problems of municipalities become increasingly complex-- extending, perhaps, beyond municipal boundaries -- it becomes increasingly evident that an effective "middle level" of government is needed which can act as a bridge between the large and small scales. Counties could possibly be that bridge in New Jersey. For one thing, counties already exist as jurisdictional entities; for another, they have internal administrative hierarchies which could be put to broader use, given the proper mandate.

NOTES FOR CHAPTER XVII

1. E.g., Governor Brendan Byrne's leadership of several mid-Atlantic and New England states against the procedures being employed by the Department of the Interior for leasing oil exploration and development rights on the Outer Continental Shelf.
2. E.g., opposition to the proposed floating power plants -- PSEG's Atlantic Generating Station -- by residents in Atlantic and Ocean Counties, and opposition within state government to the proposed Newbold Island's facility.
3. NJSA 13:1A-29
4. NJSA 13:19-1.
5. Draft Permit for Hope Creek Nuclear Generating Station, NJDEP.
6. NJSA 13:9A-1.
7. NJSA 13:9A-2.
8. "Basis and Background of N.J. Wetlands Order", NJDEP Regulated Activities, Type A, page 2.
9. Ibid., Regulated Activities, Type B, page 3.
10. NJSA 58:16A-55.
11. NJSA 13:17-3.
12. We gratefully acknowledge Mr. Lewis Goldshore's aid and would only add that his statement as reported in this document do not necessarily reflect formal or legal positions of the State of New Jersey.
13. NJSA 12:13-1 et. seq.
14. 6NJL1
15. As noted by Mr. Lewis Goldshore.
16. Rutgers Law Review, Volume 25, No. 4, Summary 1971, p. 646.
17. Note from Mr. Goldshore.
18. NJSA 13:18-1 et. seq.

19. NJSA 13:17.
20. NJSA 13:17-34 entitled acquisition; eminent domain.
21. Similar reasoning was expressed in Suburban Transit Company et al v. Borough of S. Plainfield, a case heard by PUC in April, 1974.
22. NJSA 13:19-11.
23. Note that the Salem Nuclear Generating Station, and the other joint facilities described in Chapter XV, already provide power to an interstate (PJM) area.
24. 42USC 2020.
25. NJSA 13;;D-9 (e), (f), and (g).
26. NJSA 26:2C-1.
27. NJSA 48:3-3.
28. NJSA 48:3-17.6 and 48:7-3.1.
29. NJSA 40:55-50.
30. NJSA 40:55-1.19.
31. NJSA 48:2-14 and 7-10.
32. Some consideration has been given to relocating the State Energy Office under the Attorney General in Trenton.
33. New Jersey County and Municipal Government Study Commission, County Government: Challenge and Change, 1969, p.11.
34. NJSA 40:55-1.3.
35. NJSA 40:55-4.
36. See the Municipal Planning Unit Development Act of 1967 and NJSA 40:27-47.
37. NJSA 40:55-31.
38. NJSA 40:55-50.
39. Constitution, Article 1, Para 20: and NJSA 20:1-1.
40. Note 55 Cornell Law Review 846-1970.

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CHAPTER XVIII*

PUBLIC ATTITUDES TOWARD AN NEC IN NEW JERSEY

18.1 Introduction

Coastal New Jersey has been the scene of many environmental and energy controversies in recent years. Second home developments, oil refineries, chemical complexes, offshore drilling, superports, a liquified natural gas (LNG) depot, sludge dumping and nuclear power plants--on land, and floating--all have been the focus of bitter disputes. Many of these disputes have spawned new citizens' groups, and although the groups themselves often have been short-lived, they have usually left an additional residue of newly aroused and active people.

On the Atlantic coast, two specific controversies have arisen over nuclear power plants--one revolving about the existing Oyster Creek plant, the other about the floating nuclear power plant proposed to be installed 2.8 miles offshore northeast of Atlantic City. The effect of these controversies has been to sensitize residents up and down the shore to nuclear issues and to stimulate the emergence of groups opposed to nuclear energy in general, and to plants, in New Jersey's coastal areas in particular.

There has also been some controversy about nuclear power plant siting on the other side of New Jersey, along the Delaware River. The Delaware disputes have focused primarily on two issues: (1) population density around proposed sites; and (2) consumption of fresh water from the river for cooling. To date these two issues have been resolved by siting the proposed plants on the shores of Delaware Bay, in Salem County, where they are more remote from population centers and where they can use saline rather than fresh water for cooling. Under pressure from state officials, environmental groups and the Delaware River Basin Commission, the utilities actually shifted their prospective Delaware River nuclear projects downstream to the Bay. In fact, utility officials already are talking about an eventual small nuclear center (perhaps

* Prepared with the assistance of Grace Singer and Laura Lewis, Center for Environmental Studies, Princeton University.

eight plants) on Artificial Island in Salem County, where two plants already are nearing completion of construction and two more are in the final stages of pre-construction review. Most residents of Salem County appear to be in favor of the plants now being built there, and there is no sign that they would oppose further plants. The citizens' groups who challenged the upstream sites were largely from Philadelphia and Northern New Jersey. In addition to concern over population proximity, their attention was focused on the Tocks Island Dam; they were concerned that the nuclear plants would deplete the river's fresh water, thereby creating an apparent need for the Tocks Dam.

Sites on Delaware Bay, however, did not go entirely unchallenged. The facility originally planned for Burlington, New Jersey (on fresh water, near densely populated areas) was subsequently proposed for a site far down the Bay in Cumberland County, near the mouth of the Cohansey River. After protests from biologists concerned about the oysters (they testified that a more sensitive spot could not have been picked), a third site was suggested, this time on Artificial Island where the facility is now being built as the Salem Nuclear Generating Station.

This analysis of citizen groups and nuclear power in New Jersey is based on insights from a variety of sources and research approaches. Section 18.2 is an account of in-depth interviews with 22 opinion leaders in Ocean County, to obtain their insights on the NEC concept and a variety of related public policy issues. Section 18.3 describes the views of various participants at a statewide meeting on the NEC concept held at Princeton in 1975, while Section 18.4 presents a brief discussion of the role of the press in reporting the nuclear debate in New Jersey. Finally, the chapter concludes (18.5) with an overview of the probable reaction in Ocean County which might be anticipated were a Nuclear Energy Center really proposed for construction in that location.

18.2 Attitudes Toward an Ocean County NEC

As a means of obtaining the views of community leaders and other key "interested individuals" in Ocean County, an in-depth, non-random study of attitudes toward a large (20 reactor) NEC in the county was conducted in late March, 1976. Twenty-two interviews were conducted, 20 in person and 2 on the telephone. These interviews lasted from one to one-and-a-half hours,

each following a standard format, although different issues were pursued in depth from one respondent to another depending on the individual's specific interests.

Participants in this survey were as follows (listed in order of interviews):

Ocean County Officials

Charles M. Pike, County Administrator
Ernest A. Buhr, Director, Board of Freeholders
Robert A. Gasser, Freeholder
Gregory Neilsen, Director, Energy Conservation
Charles Kauffman, Director, Health Department
A. Morton Cooper, Chairman, Environmental Agency
Thomas A. Thomas, Planning Director
George Glehan, Chairman, Economic Development Agency
William K. Hayes, Coordinator, Civil Defense Disaster Control
(interviewed with Eugene A. Keller, Deputy Coordinator)

Ocean County Community Leaders

Ralph H. Reynolds, President, New Jersey Travel and Resort Association, and owner of restaurant in Manahawkin (formerly an electrical engineer with a utility company).

Lydia Arden, Chairman, Environmental Quality Committee of Ocean County League of Women Voters; Vice President, Citizens Conservation Council of Ocean County; (B.A. in Zoology, 7 years in Public Health at Johns Hopkins School of Public Health).

Shepard Bartonoff, President, Jersey Central Power and Light Co. which operates the Oyster Creek nuclear generation plant in Ocean County, the only nuclear plant currently in operation in New Jersey.

Harold Kendler, United Transportation Union (Local 1370), Legislative Representative; member of Monmouth-Ocean Development Council (Co-Chairman of Transportation Committee). As a union official, Mr. Kendler represents Passenger Conductors and Trainmen on the Penn-Central Railroad (now ConRail).

Blair Rogers, Executive Vice President, Toms River National Bank.

Fred Lesser, President, Citizens Conservation Council of Ocean County and head of Ocean County Mosquito Commission.

Dean Haines, Mayor of Union Township since January, 1976, and Deputy Clerk of Ocean County. Part of Union Township is in a hypothetical site of the NEC under study. At 23, Mr. Haines is reported to be the youngest mayor in New Jersey.

Eleanor Angott, Newspaper Reporter, Manchester Nickel News and Ocean County Review, both weekly publications.

Dr. Andrew G. Moreland, President, Ocean County College.

N.J. Senator John F. Russo, Attorney; Chairman of N.J. Senate Committee on Energy and Environment. Senator Russo's Committee is in the midst of public hearings on nuclear energy, and while he would not comment directly on the NEC proposal, he did contribute some interesting insights.

Thomas F. Butz, Attorney: Haines, Shuman and Butz. Mr. Butz has been an attorney for municipalities and municipal Planning and Zoning Boards as well as Boards of Education.

Dr. Robert Curry, President, Toms River Chemical Company. This is the largest industrial entity in Ocean County, with 1265 employees in a multi-building complex spread on approximately 100 acres. A subsidiary of Ciba-Geigy Pharmaceuticals of Switzerland, this is the only heavy industrial facility in the county.

These interviews took place during a time when much attention was being given to two other very large, precedent-setting energy siting proposals affecting the New Jersey coast: off-shore oil exploration in the Baltimore Canyon, and the proposed floating nuclear power plant. Combined with the publicity given the preliminary version of this NEC study, and the fact that Ocean County is the site of New Jersey's only operating nuclear power plant, this ensured a generally high level of interest and knowledge on the part of respondents regarding energy issues, especially nuclear energy.

Clustered vs. Dispersed Nuclear Siting in Ocean County

None of the people interviewed advocated locating an NEC in Ocean County. Twenty of the 21 interviewees explicitly opposed the idea. As noted on the list of participants, one state official would not comment specifically on NEC's because his legislative committee has been holding public hearings on the subject. Comments ranged from "vehemently opposed", "absolutely insane", "environmental disaster" and many "opposed to concept", to one person's benign statement: "would not prefer or like it, but Ocean County has more space than northern New Jersey." A leading member of the business community

indicated his displeasure of the cluster concept by stating that he might even join in a street demonstration if such a proposal were to become serious. Several people stated that they would move from the area if an NEC were built in Ocean County, although they had been raised there.

The Pinelands were selected for special attention by many respondents. Most objected to any large-scale development in the Pinelands, and were very much aware of its "unique and fragile nature". A county official pointed out that the "Cohansey" aquifer beneath the Pinelands is one of the largest and best in the eastern United States. Details were cited on the sensitive plant life and porous soil of the Pinelands. It was noted that this is the only area in the United States where Southern and Northern habitat plants and animals meet; that this phenomenon is not found again until the reaches of Nova Scotia; that the Pinelands have many Arctic tundra plants; and that one of its watersheds, Cedar Creek, has some 20 native varieties of orchids. Even the community leader who said "Ocean County has more space than northern New Jersey", qualified his responses by stating that if the NEC adversely affected weather and the Pinelands' aquifer, he too would be opposed to it.

The utility company official's reaction was "less than favorable"; he felt Ocean County was not a good choice for an NEC. This individual doubted if there were "a single site in Ocean County which can environmentally support the magnitude of a large NEC". He cited the fact that the county has been the "fastest growing anywhere", and felt that an NEC would stimulate secondary growth impacts any place it were located. This official also has serious reservations about an NEC on a technical level. He felt that heat dissipation would be a problem, as would transmission of electricity from the cluster to the load centers. Solution to all these issues would be "easier in less densely populated areas than in Ocean County and New Jersey."

An industry leader who is opposed to the concept of NECs pointed to the highly visible towers and the aesthetic impact of the facility as its biggest problem. A few interviewees expressed concern over New Jersey's high cancer mortality rate, citing the fact that New Jersey already is dubbed "cancer alley". This was mentioned in connection with nuclear radiation.

In an effort to find out if the objection to NECs was a "not in my backyard" attitude or a more fundamental rejection of the concept, a question

was asked about locating an NEC anywhere in New Jersey, or in the United States as a whole. The overwhelming majority of respondents were opposed to the concept of a large NEC in general because of its tremendous environmental and social impact on any particular area. Population density was the main reason cited for rejecting the idea for Ocean County and New Jersey;

..."Ocean County is the fastest growing in the United States";

..."New Jersey is the most densely populated state in the nation."

The utility official felt that no location in New Jersey could support generation of more than 6,000 MW(e).

Other specific comments on the concept included:

..."dissipation of heat and huge amounts of water use would be problematico anywhere";

..."vulnerability to sabotage of a large facility likened to a community of ants or bees which could be demolished in one swat";

..."against concept in New Jersey if energy is for export to other states;

..."if absolutely necessary, locate NECs only in unpopulated areas of United States not likely ever to become populated";

..."might possibly accept no more than six reactors in one area of New Jersey, depending on location (but definitely not in Ocean County)";

..."clusters in New Jersey should be no larger than two reactors (and no more than two reactors in Ocean County)".

The one respondent who did not explicitly and irrevocably reject an Ocean County location for an NEC proffered a comparative argument:

..."the northern part of New Jersey is not acceptable because of density of people and industry; by contrast, the southern part of the state is more suitable, even for a large NEC."

Three or four participants in particular felt that although they would want to know more about the specifics of NEC, they opposed the idea because of their present understanding of the huge impacts which those large clusters would have. They noted that the Ocean County Planning Board and the Freeholder Board both have passed resolutions against locating an NEC in Ocean County.

Clustered vs. Dispersed Nuclear Siting in General

When asked specifically if they felt clustered siting could have some advantages over the dispersed pattern, a few respondents chose to question

the use of nuclear power in general. However, even with such reservations, a minority could see some advantages to clusters given only this "either-or" choice. Some of their comments are illustrative of opinions in this regard:

..."I can see the value of a cluster from the point of view of security, economies of scale, very sophisticated technology; but with all this sophistication, then they do something like transporting nuclear wastes by truck";

..."a cluster would facilitate permit procedures";

..."perhaps a cluster would be possible in large, open, unpopulated areas of the West";

..."it's probably more economical to cluster, perhaps meaning lower costs of energy to the consumer";

..."the amount of power generated is the real question, not the number of reactors".

..."In balancing and trade-offs, we may want large clusters, but this would depend on location and other factors."

However, the great majority of respondents remained unalterably opposed not only to an Ocean County NEC, but to the overall cluster concept as well. They made the following comments, among others, on this issue:

..."While the large clusters may make sense, I question the damage they would do with regard to huge amounts of water required, tunnels, towers, etc. Who would accept this?"

..."If one unit had a melt-down, it might contaminate other units."

..."Clustering is only a political expedient. Criticism of government today is that it is high-handed. Public inputs must not be circumvented."

..."We can consider the heavy concentration of industry in northern New Jersey a cluster, and look what it's done there";

..."We might need a national security police force to protect such large facilities. This would be dangerous to a democracy";

..."A cluster would deteriorate any area in which it were located."

When pressed on a choice, two people would agree to a "cluster", but of no more than two reactors; another said vaguely that if we are to have nuclear energy at all, perhaps smaller-sized clusters might be more acceptable than

dispersed sites; and two others, framing their response in the same context, said a maximum of six reactors might be acceptable as a cluster (though definitely not for a New Jersey location). One community leader likened massive energy facilities to welfare, in that both make people dependent and commit them to a certain way of life.

Basically, about 15 of the 21 respondents remained adamantly opposed to the clustering concept, and would prefer dispersed nuclear siting. They associated the following advantages with a dispersed siting pattern:

..."for the least impact on the environment, we should have the smallest possible entites";

..."scattered siting is better, just as concentration of sawago or other pollution causes the greatest problems."

An educator felt that decentralization was beter, having less environmental impact. He also felt that dispersed siting would be preferable from an economic standpoint by spreading the wealth to various areas instead of concentrating it in one place.

Additional Individual Nuclear Power Plants in Ocean County

All but five respondents expressed the attitude that "Ocean County has done its part and has enough nuclear facilities. The county is becoming an energy exporter." Among the five who felt differently was a municipal official who said that, under the present tax structure, he could accept one reactor in his municipality. He noted however, that this might cause growth which would be economically counter-productive for his area. Three other respondents felt that if the electricity were needed in Ocean County, and if the plants were properly located, they would be willing to accept more nuclear facilities. The one community leader who did not oppose an NEC felt that even if he were not particularly happy about more nuclear plants, Ocean County was in a better position to handle them than, for example, Newark. In his opinion, the county should not be provincial in its attitude, even if the energy was being produced for export to other regions and states.

The utility official was not sure about all of Ocean County, but stated that his company's studies of the Oyster Creek site indicated it could support two more plants in addition to the proposed Forked River facility, for a

total of four plants in the area. If the three new plants were about 1,000 MW(e) each, this would be a total of nearly 4,000 MW (e) at the Oyster Creek site. He emphasized that there were no current plans to build these two additional plants.

Public Opinion in Ocean County Toward More Nuclear Facilities

When asked their perceptions about community sentiment on additional nuclear facilities in the county, almost all respondents felt public opinion was becoming increasingly opposed. This was attributed primarily to publicity concerning the June 1976 California nuclear moratorium referendum, resignations of nuclear industry engineers, and other accounts of nuclear power plant accidents. A county official stated that the county had written to all 33 municipal governing bodies; all but Lacey Township, which already has a nuclear facility, indicated they would react unfavorably to any proposal to locate a nuclear installation within their jurisdiction.

Several respondents felt that, because of unfavorable public opinion in Ocean County towards nuclear energy, any nuclear facility proposed for construction in the county--an NEC, or a single reactor--would face great difficulty in obtaining approval at this time. Beyond the reasons given above, additional causes were set forth in the interviews. Public awareness of problems caused by the Oyster Creek plant was one of the most prominent. People in the country are quite familiar with the fish kills, shipworm infestation and effects on water quality in Barnegat Bay. Public concerns were raised in connection with the Oyster Creek plant, where a valve failure released over 100,000 gallons of water into the containment. Although there was apparently no release of radiation to the environment, many people did believe this to have taken place, increasing their concerns about the Oyster Creek plant. In addition, several respondents reported that the plant, which went into operation in 1970, has had to be shut down frequently for maintenance due to structural and safety problems. Another county official said that some people who had served on the Planning Board--and opposed nuclear facilities--in the late 1950's and early 1960's are now very sorry that they had not prevailed at that time.

A community leader who felt that public opinion was overwhelmingly opposed to any more nuclear power plants in Ocean County pointed out that Little Egg Harbor Township's residents favor the off-shore floating nuclear plant only because the facility's transmission lines are to come ashore in that municipality,

benefiting their tax base.* It was pointed out that Little Egg Harbor had many retirees who are very concerned about rising taxes, and are thus quite susceptible to tax ratable incentives. Although Lacey Township might approve a plant today, it has been undergoing rapid growth--partly at least because of its low residential tax rate induced by presence of the nuclear power plant. Since Lacey soon must provide services for its new residents, it is problematical whether the township ultimately will come out ahead financially.

The utility official felt there were three segments of opinion in Ocean County with respect to nuclear energy: (1) a large segment which cares only that the lights go on; (2) another segment which doesn't disapprove of nuclear energy, but has some concerns; (3) a small but vociferous group which is opposed to nuclear power and is having an impact out of proportion to its numbers. He added that there would be increasing opposition to the concentration of any one type of facility in any one locality, not just in Ocean County.

Finally, several respondents expressed the opinion that many people were confused about all the conflicting arguments about nuclear energy, and really didn't know what to think.

Respondents' Personal Attitudes Toward Nuclear Power in General

Of the 20 people who answered this question directly, 12 were not opposed to nuclear power per se; most, however, included qualifying remarks such as:

1. If needed, put it in very remote areas of the western United States.
2. Concerned about plutonium and the fast breeder reactor. If even one life is threatened, nuclear plants should be closed.
3. Must approach this issue with extreme care, observing all cautions expressed by concerned scientists.
4. Nuclear power is an intermediate step; we need to know more.
5. Concerned about the chances and consequences of human error.
6. In United States we now have only two domestic sources of fuel, uranium and coal; we should use both.
7. Disposal of radioactive wastes is a serious problem.
8. Nuclear energy is a step between fossil fuels and fusion and solar energy.

* Actually, allocation of tax revenues from the proposed floating nuclear power plant remains an open question.

9. It is a necessary source of power if we are to continue to enjoy our high standard of living.
10. Can we survive without nuclear energy?
11. Nuclear plants should be put underground, for safety reasons.

Those eight respondents who were opposed to nuclear power offered these comments:

1. Prediction of a radiation cloud once every 200 years is likened to flood predictions. It does not necessarily follow that they occur as infrequently as is predicted.
2. Concerned about the danger of catastrophic accidents and about radioactive waste disposal.
3. Would like all nuclear plants to be phased out. Concerned about human error, e.g., the engineer with a candle causing the Browns Ferry, Alabama, nuclear accident. In the past two years his opinion has turned 180° on nuclear power.
4. Incredibly long half-life of radiation in nuclear wastes is a serious problem; containers used to hold these wastes are not made to last as long as necessary.
5. Resents that they were told nuclear energy would be cheaper. Now it turns out it isn't cheaper.

Comparison With Other Kinds of Energy Facilities

In an effort to fathom the relative acceptance or rejection of other large energy facilities for Ocean County in comparison to an NEC, attitudes toward the following were probed:

(1) A solar energy research center (Ocean County, along with a multitude of states, counties and municipalities across the United States, is vying to have such an ERDA center located in its area. The proposed site in Ocean County would be at the present Lakehurst Naval Air Station.)

(2) A large energy center burning coal.

(3) Off-shore oil drilling, with pipelines coming into Ocean County.

There was enthusiasm and near unanimity of opinion in favor of locating a solar energy research center in Ocean County. Only one community leader felt that such a facility would be better located in an area like Arizona. He did not want the secondary growth impacts which such a center would bring.

Most respondents felt that much more should be done in the U.S. to develop solar and other alternate sources of energy; e.g., "If we can put a man on the moon, we can develop solar energy."

Most interviewees would prefer that neither a coal-burning energy center nor off-shore oil drilling and pipelines come into Ocean County. Most could accept a coal facility, however, if they were assured that available technology would be used to render it non-polluting. They expressed reservations and great concern about air pollution from coal, and saw a large coal facility as incompatible with the county's tourist environment.

Overall, fears were expressed about allowing the shore area to become any sort of industrial complex, with references made to the proposed floating nuclear plant in addition to other energy proposals. Some who were pressed for a preference between off-shore oil drilling or an NEC said that they could not select either one. They claimed to be ready to move if either become a reality. Strong opposition was expressed against on-shore storage tank farms. One respondent had been in Santa Barbara after the 1969 oil spill, and feels that such a spill could ruin tourism completely in Ocean County. Another individual expressed concern about energy facilities in the ocean because he had great respect for the power of the sea; he noted that the Atlantic was not like the Gulf of Mexico. One county leader pointed to the emergence of a tri-county organization consisting of Ocean, Atlantic and Cape May Counties organized against off-shore energy facilities which they feel would be detrimental to tourism.

If really pressed on the choice of an NEC or off-shore oil drilling, the majority of our 22 respondents would choose off-shore oil. Having stated this, a planning official said he was sure "no one in his right mind would locate oil refineries in the coastal areas or in the Pinelands." One industry leader who has lived in Louisiana noted that while the cities of that state are highly industrialized due to the oil industry, they have nothing as noxious as the oil refinery area of northern New Jersey; he did not wish to see the Jersey shore go the same route as has the northern part of the state.

The utility representative felt that much more should be done to develop solar energy, seeing solar and fusion energy as the answer for the future.

He pointed out that any large energy facility would have the same problems as an NEC in transmitting huge amounts of energy, and that "half the county would have to be covered with transmission lines to accommodate such enormous facilities." He, too, "would choose oil development over an NEC located anywhere in New Jersey."

Based on attitudes of respondents, the following grading could be given to the various energy facility choices for Ocean County:

solar research center--great enthusiasm.

off-shore oil--great concern about oil spills; rejection of refineries, but grudging acceptance of drilling if the only choice were between oil and an NEC.

large coal facility--deep reservations and concerns about air pollution, and about any large energy facility; but if rendered non-polluting, coal is considered more acceptable than nuclear as the fuel for a large energy center.

NEC-- resounding rejection.

Social Effects of an NEC

None of the respondents felt that presence of an NEC would enhance the area. Most felt the effects on the community's social fabric would be profound, far-reaching and detrimental. Several mentioned the psychological effects of fear and anxiety resulting in an exodus of tourists and residents rather than the influx experienced in recent years.

It was felt that the area's overall tenor would change from tourism/rural to industrial/energy. This, respondents felt, would spawn the pollution problems of northern New Jersey and diminish the unique quality of life people had come to Ocean County to enjoy. There was resentment that a fine coastal area would be considered for such a large energy project. A county leader summed it up by saying that people were not moving to Ocean County for jobs, but were fleeing from bad physical and social environments elsewhere. He felt the change caused by an NEC would negate the dream of many who had come to Ocean County for a better life style.

An NEC's Effects on Tourism at the Jersey Shore

All respondents felt that tourism would be affected adversely by an NEC in Ocean County. It was pointed out that tourism--and its related services--constitutes the largest industry in the county. There are about 30,000 seasonal homes and businesses in the county, and one-quarter of Ocean's tax ratables consist exclusively of tourist property. These properties do not generate children who require school facilities; thus, they represent a net plus to the economy. Tourist ratables generate over a billion dollars annually, out of a total income of \$4.4 billion (1974 figures). Land values in the county have soared in recent years.

The following quotes capture the tone of this section of each interview:

- ..."the psychological effect of towers, plumes, tunnels will be great; tourists will be apprehensive";
- ..."problems would be created by adverse weather, salt spray, heat and possible long-term radiation";
- ..."tourists are fickle and skittish; they will go elsewhere";
- ..."an NEC would destroy the main reason people move to and vacation in Ocean County, e.g., clean air, water and lack of industrialization";
- ..."tourism is the most sensitive segment of the economy; an NEC would be severely injurious";
- ..."current thermal pollution from the Oyster Creek plant is causing the shipworm population to expand, and ruining the marina business."

Two people felt that if the weather were not adversely affected and if an NEC were far enough from the county's shore area, it would probably not affect tourism.

The utility official felt that four or six nuclear plants in the county would not have any effect on tourism. As far as he could tell, the Oyster Creek plant operated by his company had not caused any diminution of tourism. However, he felt that 20 reactors would cause a reduction in tourism through people's fear which exists. He thought the construction period could be very messy, but was not aware that the construction time for a large NEC could well be as long as 20 years. He stated that "eventually people might come to feel that the towers are beautiful and this may increase tourism in

the area." He acknowledged that nuclear fuel transported through the community creates problems; however, he thought a 20-unit NEC could have its fuel transported by railroad rather than on the highways.

Growth Resulting From an NEC

Responses to the question of whether an NEC would enhance desirable growth and development in Ocean County were varied. Eleven of the twenty respondents who answered this question directly felt an NEC would retard growth, particularly in the tourist industry. Two respondents felt that growth depended upon where an NEC was actually located. The other seven interviewees felt an NEC would foster undesirably rapid growth and/or too much industrialization, adding to demands for already strained county and municipal services. This strain is a result of the very rapid development which Ocean County has experienced in the last several years, during which time it has been one of the fastest growing counties in the nation.

A labor leader likened an NEC experience to that of major airports in New York. "Originally they were open marsh areas. After the development of Kennedy and LaGuardia Airports, industry, jobs and residential growth followed, creating social problems of noise and pollution. All new technology presents social change and some problems. The enormity of an NEC might be self-defeating anywhere in the United States." A planner felt that "an NEC would destroy the very reasons people came to Ocean County. If electricity rates become cheaper, industry would move in at a greater rate, including the petrochemical and smelting industries." An industrial leader thought "that although an NEC would generate very few jobs after the initial construction period, it could lead to very rapid development and population density, creating further problems." A banker felt growth would be restricted, and used as one example the four-mile buffer zone called for by NJDEP in early 1976 around the Oyster Creek plant. He felt that a 75 square mile NEC might require a 300 square mile buffer area. An environmental leader felt Ocean County's growth was due to its unique position as an open area on the periphery of large urban centers, and that this would be changed by an NEC. The original dissenting community leader (regarding overall attitude toward NEC's) suggested that although an NEC might retard growth, this could be a plus in keeping down a

spiraling population. In addition, he felt, buildings have less effect on the quality of life than do people.

Perhaps the most interesting analogy came separately from two respondents who likened the growth an NEC might create to the "boom and bust" circumstances of the Cape Kennedy area in Florida. One of these respondents was in Florida when Cape Kennedy was built. The area grew dramatically when the space program was at its height, and many homes were built. However, due to cut-backs in space exploration, homes are now difficult to sell and the economy at Cape Kennedy has been drastically altered.

In sum, the growth factor was seen largely as a negative impact by those on one hand who felt it would retard the tourist industry, and on the other hand by those who felt growth would be too rapid or of the wrong kind for the overall quality of life in the area.

Adequacy of Infrastructure for Growth

The question of the adequacy of existing county and municipal infrastructure to accomodate growth ensuing from an NEC was answered in the negative by 15 respondents. Several pointed to schools, roads, and health care as the most important problems. Rapid growth in the early 1970's has both diminished and enhanced infrastructure. Schools are still straining from growth, while budget rejections are attributed mainly to elderly residents who have become a potent political force in several Ocean County communities. (According to the County Planner, 50% of development in the past five years has been in retirement communities). One high school may lose its accreditation due to overcrowding.

A county health official related that DEP has prevailed in having developers in Manchester Township ("Crestwood", a 2500 unit retirement community) and Brick Township ("Greenbrier" retirement community) incorporate in their sales contracts statements which raise questions about the adequacy of health facilities in the area. Apparently, New Jersey Health Department criteria have prevented expansion of hospitals since they do not take into account the tourist population and high percentage of older people. In addition, New Jersey is using a population figure for Ocean County which is 30,000 lower than figures used by the federal government for revenue sharing (255,000 vs 285,000).

One county official was concerned about the large network of roads which would have to be upgraded. The county's infrastructure is being enhanced by a large regional sewage system scheduled for completion in 1978.

Land Values

Responses to a question on the effects of an NEC on land values in Ocean County were again varied. Most participants felt land values would be depressed for residential and tourist uses, due to environmental degradation. Some felt this would be limited to the area of the NEC itself; others felt land values would be affected in all of Ocean County, and one person projected these effects into Burlington and Monmouth Counties as well. Others felt that while residential and tourist values would be depressed, industrial values would be increased, hastening a change in the overall character of the shore area.

Four people felt the tax structure was instrumental in determining land values; if the current windfall tax structure still existed for an NEC, values could rise. A community leader who felt land values would be depressed theorized that the cheaper land around an NEC might be used to house people in the lower socio-economic groups, resulting in social unrest.

The utility official, while feeling that tax structure is paramount in determining land values, also thought that the effect of transmission lines would be a depressing factor. A community leader referred to the "boom and bust" economy of an NEC which would initially raise values only to see them plunge ultimately.

Tax Incentives and Energy Facility Siting

When asked if a larger tax benefit to the local government could persuade them to view an NEC more positively, all respondents said "No". They still felt that the NEC would induce more economic loss, in tourism and tax ratables. Some key comments on this issue were as follows:

..."If people in Lacey Township were given the choice today, they would reject the Oyster Creek plant";

..."Lacey Township now needs more roads and other services as a result of its nuclear plant";

..."Sooner or later, these tax benefits will be spread out all over the state";

..."Economic problems can be overcome, but if we ruin our environment, we're finished. Environmental limits must control economic actions."

An official involved in attracting business to Ocean County noted that businesses are coming in because their executives and employees want a pleasant environment in which to relax. He felt that all this would be lost if an NEC were to locate in the area. The utility official felt that while areas with nuclear facilities should reap some benefits because of losses which ensue in other tax ratables, the present tax structure provides excessive amounts of money to a few municipalities. In his opinion, these tax benefits should be spread more evenly throughout the state. He admitted that tax windfalls lessen local opposition to electric generating facilities, but still felt that the laws needed to be changed.

(It is interesting to note that the March 28, 1976 New York Times and March 30, 1976 Trenton Times carried stories of legislation sponsored by N.J. Senator Russo of Ocean County that would allow Jackson Township in Ocean County to charge a one percent amusement tax on ticket sales at "Great Adventure", the huge amusement park located in Jackson Township. The reason given for the tax was that extra revenue is needed by Jackson Township to cover the costs of providing services to "Great Adventure", even though the amusement park pays a great deal already to Jackson in property tax. It may be that citizens are beginning to question whether certain ratables are indeed a net boon to the local government's budget.)

Attitudes Toward Nuclear Safety

It would be safe to say that almost all respondents would not want to live in close (or even not-so-close) proximity to an NEC. This is due primarily to their concern for nuclear safety, although the original dissenter who did not oppose the NEC cited aesthetics as his reason for not wanting to

live nearby. The one exception to this view was the utility official, who said he would have no compunction about living next to the fence of an NEC from a safety point of view. Although his office is located in Morristown in northern New Jersey, he felt that most knowledgeable people working at nuclear plants do live near them.

Respondents now live or work within a 10 to 12 mile radius of the Oyster Creek nuclear plant, and had varying feelings about it. One county official told of his recent visit to the plant, where he had to wear a device which measured radiation. During his 1 1/2 hour visit the indicator moved from 8 to 9 on a scale of 1 to 20, giving him pause for thought.

Lack of confidence was expressed in federal and state safeguards, e.g., allowing trucks to carry nuclear wastes on local roads where they are subject to accidents. The utility official stated that spent nuclear fuel from the Oyster Creek plant is transported by truck to a reprocessing company--Nuclear Fuel Services Facilities--in western New York state. He explained that shipments are made by special trucks equipped with casks built to withstand accidents. By removing spent fuel, the company clears space to unload the reactor if necessary. The company's policy is that the fuel storage pit should have sufficient capacity to be able to remove all the fuel from the reactor if necessary. Thus, if repairs are necessary to correct vibrations, for example, there is room to do so because the pit is not filled with spent fuel.

Several respondents related the safety issue to the question of population proximity and "remote siting". Nuclear plants in the United States are built in less densely populated areas for safety reasons. However, if the government considers them safe, perhaps they should be built in cities as is the case in Europe. Many respondents expressed their deep resentment at Ocean County being considered "expendable" because it is an area of lower population density. Also mentioned were the Browns Ferry, Alabama, nuclear accident and the concerns about safety raised by former nuclear engineers (the GE and NRC engineers). A labor leader was concerned that a large NEC

would constitute a constant source of anxiety to the general public and would create an atmosphere where any rumors would add to public hysteria and irrational behavior. Four respondents were not really concerned about safety vis-a-vis close proximity to the Oyster Creek facility, and the dissenting (on NEC's) community leader said he could not believe the government and utility companies would ever build reactors without incorporating adequate safety factors into their designs.

Evacuation Plans

Respondents indicated no knowledge of any public evacuation plans in connection with the facility at Oyster Creek (the only nuclear plant now in operation in the state), nor of any future nuclear facilities, NEC or otherwise.

A county official who had written to all 33 municipal Chiefs of Police in the county found no awareness of any evacuation plans in relation to a nuclear accident. The sole possible exception was Lacey Township, where the Oyster Creek plant is located. In a letter to the Nuclear Regulatory Commission, the county official noted that while Ocean County had an "active, alert and fully funded Civil Defense program", the state had no plan for evacuation after an accident at the Oyster Creek facility. In addition, he stated that county officials had not been alerted or briefed on plans for traffic and internal safety apparently held by NRC.* A county health official said he knew of no evacuation plan for nuclear accidents, although he is part of the county's Civil Defense program. He does not know of any local health care facilities which could handle radiation cases. Officials of the Jersey Central Power and Light Company had assured him there was no problem with radiation.

The County Civil Defense official stated that the NRC does not require general population evacuation plans, although the county is now in the process of completing a plan on its own. He noted, however, that road movement capabilities are not adequate for evacuation, and that special problems exist for the beach area. He stated that 21 of 33 municipalities have Emergency

* At the March 10, 1976, public hearing, the utility official respondent had indicated to the New Jersey Senate Committee on Energy and Environment that his company had an evacuation procedure for their own employees only, not for general public; he emphasized that the company has no authority to take any actions with respect to evacuation of the public at large.

Operation plans, although these certainly are not evacuation plans. Several other respondents, including a county planning official, also were concerned about the limited road network for evacuation, particularly in the summer when beach traffic can be backed up 10 miles on the Garden State Parkway. It was felt that evacuation on the island beaches would be "disastrous". Long Beach Island alone has 125,000 to 150,000 visitors in the summer, connected to the mainland by only a single bridge.

Land Use Controls

On March 10, 1976, David J. Bardin, Commissioner of New Jersey's Department of Environmental Protection, announced a moratorium on construction in a four mile area around the Oyster Creek plant pending studies of safe land uses near nuclear facilities. Thus, when interviewees were asked if land use controls were necessary to prevent development from creeping up to the fence of a nuclear facility, most of their responses contained references to this recent action by DEP.

More than half the respondents felt land use controls around nuclear facilities were necessary and agreed with the DEP action at Oyster Creek. They felt, however, that compensation must be paid by either the federal or state government or utility company to those who owned land in the buffer zone. Some also felt the buffer zone should have been effectuated when the plant was built, not a decade later. Some, while agreeing with the concept, felt the four mile buffer was an arbitrary limit. Others felt it could be helpful as protection against low levels of daily radiation, but would be basically meaningless in the event of a serious accident.

A planning official, who applauded the action, was concerned that while the U.S. Nuclear Regulatory Commission's criteria for nuclear facility siting include population density considerations, once a plant is built there are no restrictions on population growth in the area. He felt that a buffer zone "is necessary since the half life of radiation dissipates with distance and time". He further felt that utility companies should be required to offer to move residents out of the buffer area at their expense. One community leader, who also felt that land use controls were necessary, expressed cynicism and a lack of confidence in government in implementing meaningful controls because of economic pressures which are brought to bear.

Those four respondents who felt land controls were not necessary around nuclear facilities included the utility official who thought that the recent DEP decision could be challenged in court. He was concerned that this decision added to the fear people already have of nuclear energy. His idea of the ideal land use arrangement around nuclear plants would be to have them surrounded in concentric circles: first by heavy industry, then by commercial and light industrial uses and, in the outer ring, by residential uses. This plan, he thought, could make good use of waste heat from the nuclear plant.

The other three respondents who did not want land controls included the Mayor of a township which is affected by the DEP decision. He said realtors have been "oerreaming" over this action, and that it was a premature response to public hysteria about nuclear safety. The Mayor stated that in his 38 square mile township, a four mile buffer translates into 17 square miles. A business leader felt no controls were necessary and that people could make up their own minds as to where to live. He is generally concerned about "too much government regulation". This point was raised throughout the interviews by four or five people, who seemed to be particularly sensitized by the far-reaching land use regulations of the state's Coastal Area Facilities Review Act (CAFRA) and Wetlands Act, which already affect a large segment of Ocean County.

Some respondents had mixed feelings about land use controls around nuclear power plants. One felt they should be enforced at the municipal rather than state level. Perhaps the most succinct comment came from a state official who felt that if nuclear plants were safe, we should be able to build homes right up to the fence. However, if they are unsafe, we should not be building them at all. He wondered if residences within four miles are considered unsafe, are they then safe at a distance of five miles?

Energy Conservation

All respondents considered energy conservation to be a very important policy. Several offered some interesting thoughts:

1. No real energy conservation efforts are being made by the utility companies. To the contrary, the companies oppose legislation which encourages conservation. In other countries, e.g. Germany, converters are used in gas and oil furnaces in order to decrease heat dissipation through chimneys. We

could have light bulbs now which require a fraction of current energy use.

2. We're being "conned" into believing we need so many new energy facilities. We should spend as much money fostering true energy conservation.

3. People will conserve if they knew that everyone else was also sacrificing. Many feel that technology can solve all our problems. We must have coordinated plans which can include energy from sewage. In the future, each building will have its own complete, closed waste disposal/energy system, but the current economic structure won't allow this to happen soon.

4. We've lost our perspective and feel money can buy anything. We have no real concept of finite resources. True recycling and resource recovery can generate large amounts of energy.

5. We must educate the public on the true facts about energy use and misuse.

6. Mass transit is essential to energy conservation.

7. If our position in the world is threatened by dependence on oil from the Middle East, we must have conservation.

Another interesting perspective came from the utility official, who also felt that energy conservation is very important, but believes that it is limited in what it can accomplish. He feels that even if we were to decrease per capita energy use by 10 to 15% and had zero population growth, we will still have a population increase because a large segment of our population is in the child bearing age. This factor, and the need to replace obsolete electric generating plants, will create the need for additional energy facilities for several more decades at least. His suggestion for conservation is redistribution of usage patterns by reducing peak demand and filling in times of low usage primarily on a daily, not annual basis. He added that if the utilities can work with "base load" they can use their most efficient units.

Public Hearings as a Process for Citizen Input into Energy Decisions

When asked if they considered the public hearing process to be an adequate means of obtaining public input on siting of large energy facilities like an NEC, all respondents but one favored the process. Again they exhibited individualism in their qualifying remarks:

1. Although not many people's minds are changed, hearings do educate the public and indicate to decision makers the extent of opposition to the project.

2. Do officials really listen? After a while they cannot absorb all the data being presented.

3. Federal hearings are a charade, and serve only as a safety valve. State hearings are more valuable because decision makers are closer to the people.

4. Average people do not offer inputs because they don't believe they really can affect the government's decisions.

5. Insufficient notice is given in advance of the hearing, and there is not enough publicity to allow full input.

6. Hearings should be televised.

7. Opinions presented are generally biased. There is a great need for more objective witnesses, who now appear only by invitation.

8. It is difficult for the average person to prepare testimony.

9. Some project proposals have been reversed by public hearings, e.g. in Florida, the jet port and cross-state barge canal proposals were both defeated.

10. In addition to hearings, questionnaires should be sent to residents in areas to be affected by the project.

11. One has to be an expert to evaluate technical statements made in the hearings.

One industrial leader disagreed with the majority; he felt that public hearings are largely a waste of time because ill-informed pressure groups can show up in large numbers to dominate the proceeding. He does not know how a democratic society can best structure itself to make technical decisions.

Perhaps the most revealing comments came from a county official who related Ocean County's experience in public hearings on the off-shore floating nuclear plant and off-shore oil leases. He stated that, if the county had not asked for early access to copies of impact reports on the floating plant proposal, they would have been confronted with 22 volumes, each 3" thick, with only 30 days to respond. Public Service Electric and Gas Company did accede to the county's request, although according to NRC rules this was not

mandatory. This official noted that NRC hearing procedures were different from those of any other agency, in that the NRC requires all documentation to be completed prior to intervention. Given the rules, this is not always possible because one is dealing with voluminous, highly technical data. The utility company has repeatedly tried to have intervenors dismissed because they did not have all their data completed within 30 days. In the off-shore oil drilling case, when information from the companies was not forthcoming, the county threatened to go to court. When it joined with Atlantic and Cape May Counties in pressing these demands, however, the necessary data were made available. This official noted that the internal conflicts between NRC staff members and between scientists on the issues added a confusing element to the public hearing process.

Who Should Have the Power to Decide on Massive Energy Facilities--Who, if Anyone, Should Have Veto Power?

This issue was the most difficult in the interview for respondents to contemplate; again, their answers reflect the leaders' individuality. In spite of this, they managed to register their opinions. Several respondents noted that the question presupposes the acceptance of large energy facilities such as NECs, and reiterated their rejection of that concept. Beyond that, most registered their attitudes toward the institutional structure of government and its interplay.

Most respondents felt it was important that there be a meshing of inputs from all levels of government, although it was generally agreed that the federal level would "carry the ball" because of its greater financial and technical resources. Some felt that while they would want to have veto power available at state, or county, or local levels, they recognized that in certain instances only a national perspective would suffice. Some suggested the need for legislation which would define criteria for a national emergency, at which time the federal level would be able to over-ride veto power at the lower levels. This idea and other similar references to national emergencies or crises indicated a recognition from these local officials and community leaders that local opposition stems from a more limited, often parochial perspective. While opinions on veto power were fragmented across the various jurisdictional levels, only four people clearly wanted no veto power of any kind below the federal level. The remaining 12 who registered opinions were

reluctant to give up state, regional, county or local prerogatives to reject such high impact facilities for good cause.

One community leader, who wanted municipalities to have veto power, said that if no one would accept the very large facilities, perhaps this would be an indication that the country should be working harder on alternatives. An industrial leader felt that if Ocean County itself does not need additional energy, a large facility should not be located there. However, if the county was in need of energy, it should make the decision as to facility location. He felt that the federal government does not have all the answers, as indicated by the fact that it cannot even agree on basic energy legislation. Another community leader felt that basic decision-making powers should be at the regional (several counties) level.

Again, some insights come from the utility official who felt that an NEC (about which he has strong reservations) might require a special federal-level entity which would have sole veto power, with legislative and/or judicial review. This new group would be composed of qualified people from various segments of society so that energy needs, environmental, social and economic consequences could be assessed. The group would seek wide input and study the broadest possible short and long-term aspects of the problem. The idea expressed in the interview reinforced the call by the utility official at the March 10, 1976, public hearing for a one-stop decision-making agency on energy facility siting. This type of efficient process runs head-on into the fears expressed by many respondents about the need for checks and balances in our decision-making mechanisms.

Conclusions

Although all respondents in these interviews recognized the broader problems and responsibilities all citizens share in meeting national and regional energy needs, there was an overwhelming rejection and fear of the prospect of an NEC in Ocean County. Facts on population, environmental fragility and adverse effects on the key tourist industry were cited to give substance to these fears. The following quote from testimony given at the March 10, 1976, public hearing by the Ocean County Freeholder Director is illustrative of this position:

"One of the Biblical punishments was to cover an enemy's field with salt. This technique brought immediate results by destroying the fertility of the soil. The use of salt water cooling towers, which encourage the evaporation of the cooling water and deposition of salt residue, to cool the nuclear reactor core is likely to result in the conversion of the Pine Barrens to the Salt Barrnes of Ocean County. What did we do to incur this twentieth century wrath, and to whom do we complain?"

Similarly, from a resolution passed by the Ocean County Board of Freeholders when the NEC idea was first proposed:

"It is submitted that the attempted solution to one problem, by the creation of more and deeper problems, represents a giant step backward in the process of human achievement."

Beyond these local considerations, however, most respondents rejected the concept of a large (20 reactor) NEC not only for Ocean County and New Jersey, but anywhere. They concluded that dispersed siting would have lower environmental, social, radiation and accident impacts. A minority of respondents could accept the concept of a much smaller cluster in the right location and circumstances, though not in Ocean County. The majority of respondents felt that Ocean County has done its part as a location for nuclear facilities, and do not wish to have any additional nuclear plants located in the area. This is particularly true if the power is to be generated for export to consumers outside Ocean County.

Although many questions and doubts were expressed about the efficacy and safety of nuclear power in general, about half of the respondents did not object to it per se. Some seem to be unsure of what the true facts are, because of conflicting information and opinions of various experts.

Most respondents assume that federal initiative and follow-through are essential because of the scale of any very large energy facility; only the federal level is believed to have sufficient resources to carry out such a program. However, the majority was unwilling to abrogate the veto prerogatives of lower jurisdictional levels. One community leader said he "lacked confidence in government agencies and in big industry when millions of dollars are involved", because of the impact of pursuit of private profit.

It must be emphasized that the prevailing atmosphere at the time of these interviews was one of great intensity--as it has been for the past year or so--with regard to energy facility siting in the Atlantic coastal area.

In addition to the NEC proposal, plans for a floating nuclear plant and for off-shore oil exploration have kept the energy issue at the forefront of people's attention, with emotions often running quite high. These New Jersey shore communities and their leaders see themselves under siege from many quarters, and feel seriously threatened. In addition, recent publicity about the resignations of nuclear industry engineers due to safety concerns; accounts of nuclear plant accidents; and the forthcoming California nuclear moratorium referendum have added to the atmosphere of fear and uncertainty.

Ocean County is the location of New Jersey's only operating nuclear power plant. It has seen first hand some of the detrimental effects of atomic energy: fish kills, shipworm infestations affecting marinas, and effects on water quality in Barnegat Bay. The entire nuclear safety question is not just an abstract issue for those who live in close proximity to an operating facility like Oyster Creek.

In any survey of community leaders, one might expect to hear expressed a great deal of individuality of opinion. In that respect there were no surprises in this sampling, as opinions were often most varied. The surprising element, perhaps, was that one could not always predict a set response because of the interviewee's professional position in industry or business. Stereotypes simply do not appear to fit very well on nuclear energy issues. For example, the strongest statement of opposition to an NEC (from the person who suggested getting involved in street demonstrations) came not from an environmental leader, but from a leading member of the county's business community.

Many sensitivities and deep concerns were encountered on the subject of where we, as a people and a nation, are heading in terms of energy, technology and public policy. The enormity of the NEC proposal and of the many other large energy facilities also proposed for these coastal areas seem to have evoked this deeper contemplation on the part of these community leaders. There is a fair amount of cynicism and questioning about our institutional and political ability to cope with the far-reaching social decisions involved in these technological areas. Clearly, all agree that there are no easy answers.

18.3 Various Views on a New Jersey NEC

As one means of obtaining the views of "interested persons" and "citizens' group leaders" from across the state on the NEC concept, meeting was

convened at Princeton in mid-1975. In attendance were about twenty especially well-informed individuals who represented a variety of viewpoints, but who do not have any potential financial or administrative interest in establishment of an NEC. Among these invited were county planners and officials, environmentalists, a biologist and representatives of business and labor groups. Telephone interviews supplemented this approach. The following paragraphs summarize some of what was said, along with some other information that was supplied subsequently.

A participant from Atlantic County said that the primary reason for the strong opposition to the floating nuclear power plant was fear of nuclear accidents. He commented further that this fear has two dimensions, personal and economic. People are afraid of injury to themselves and their families, and they are also afraid that tourists, upon whom Atlantic County's economy heavily depends, will be frightened away. The latter concern gains some substance from the obvious impossibility of rapidly evacuating the island on which Atlantic City is situated by means of the existing bridges. Tourism might be especially affected, he felt. The participant from Atlantic County said that opposition to the offshore plant was heightened by the feeling that the area was obtaining nothing in return for the risk it would be taking. Since the plants would be constructed in Florida, few local jobs would be created. Construction of the breakwater might provide some jobs for residents, but it is generally believed that most workers for this part of the project would be brought in from elsewhere. Further, the offshore site puts the plant outside normal taxing jurisdictions, and no arrangements have been made for providing the local area with the tax revenues they would expect from a land-based site. In response to a question, the participant from Atlantic County expressed doubt about the degree to which opposition to nuclear plants would diminish if large tax revenues were now promised from them. Significant opposition would remain at almost any tax level, he felt, partly because of recently enlarged distrust of big business and big government and partly because opposition to the plants has already emerged.

A resident from the west side of South Jersey questioned whether many tourists actually would be deflected by the accident hazard posed by the

offshore plant, or even by a large nuclear energy center. Our society, he said, tends to be polarized into two groups--a small sophisticated group on the one hand, who read up on public issues, and a large unsophisticated group on the other hand, who do not read and are largely oblivious to public issues. The latter group, he felt, would soon become accustomed to the presence of nuclear plants and pay no attention to them. A more serious effect on tourism would occur, this participant suggested, if the nuclear energy center significantly increased cloud cover over the shore. People might easily ignore an invisible hazard, but they would not ignore a visible absence of sunshine.

Participants from Ocean County agreed with the Atlantic County representative that citizens of shore communities would oppose a nuclear energy center. You would get a "solid wall of resistance," said one. A freeholder from Ocean County said that his board had been passing strong resolutions against nuclear power plants since 1972, and that "never once has a citizen ever told us that he favored any nuclear plants beyond the one we have." In Ocean County, attention has been focused on the Oyster Creek nuclear generating station. Any proposal to locate a nuclear energy center in Ocean County, a participant from that area noted, would contravene the whole concept of marine preservation expressed in both federal and state law. New Jersey's CAFRA, for example, is designed expressly to prevent "inappropriate" industrial development in the wetlands; "certainly nothing could be more inappropriate than a large nuclear energy park." Furthermore, it has been the explicit policy of the federal government to restrict development in Ocean County. The EPA intervened to restrict a sewage treatment plant in central Ocean County because it feared that development of the plant would violate the area's air quality standards. The capacity of the sewage plants now permitted will be reached in 1985 under normal growth.

A participant from Ocean County commented further on the difficulty of evacuating people from Long Beach Island. Thus, it appeared that the simple criterion of low population density as measured by NRC guidelines might not adequately capture the problem of population protection along the New Jersey shore.

An official of Salem County said there was very little public opposition to the Salem Nuclear Generating Station. The controlling consideration

in issues of this sort is the perceived need for development in the overall area. Unemployment in neighboring Cumberland County in 1975 was 18%. Even though the effects of an NEC would not be felt until the 1980's, a decision made in the near future would see unemployment dominating opinions in Salem and Cumberland Counties, and perhaps in Atlantic City as well. Any new development would be seen as beneficial even though many jobs might be filled from outside the region.

The Salem area has not developed any environmental groups or even much environmental awareness, this official continued. Therefore, if an NEC were to be placed in New Jersey, the Salem area might just get it because the people there are not prepared to fight it.

In a telephone conversation, an industrialist who serves on a Chamber of Commerce said that environmental fears were usually greatly exaggerated. He saw little point in consulting the public on such questions because the public does not understand them and will agree to reasonable development. Contrary to the assertions of some that electric demand projections are uncertain, he believes that new power plants are going to have to be built in large numbers. Very large nuclear centers, however, do pose the danger of federal ownership and in his opinion this is something to be avoided at any cost. In spite of the large capital investment involved, it should be possible to set up private holding companies that could do this job; admittedly, this would require crossing previously uncrossed political boundaries.

The Energy Council of the New Jersey Manufacturers Association, made up of high-ranking industrialist, has prepared a position paper on energy. The following excerpts present the basic focus of their argument:

New Jersey, the most heavily industrialized state in the nation, has serious environmental problems. The state government has pursued environmental improvement with a zeal unmatched in the country. Rules and regulations have been so strict as to be punitive and appear to be based on little regard for the value of energy relationships to employment and business economics...the loss of 110,000 manufacturing jobs since 1969 must be attributed, at least in part, to unrealistic environmental pressures. . .

Fifty-six operating nuclear plants are currently producing about 8% of the nation's electricity. However, the pace of development has slowed significantly in recent years due to licensing delays, opposition groups, labor and materials problems, and increasingly strigent environmental restrictions. . .

(The Salem and Hope Creek facilities) will produce electricity at approximately half the costs of comparable oil fired units, taking into consideration all capital and operating costs. The sooner they become operative the better. . . It is essential that licensing of all these nuclear plants be expedited so that they can be brought in on schedule. These plants will provide major advantages in terms of low environmental impact, reduced fuel costs, and decreased reliance on foreign imported oil. . .

In the long run, the use of nuclear energy to generate electricity could prolong oil resources for petrochemical and other uses for which oil is irreplaceable. Present fission plants should begin to be complemented by Breeder reactors by the late 1980's. . .

Although this paper does not examine nuclear centers as such, it does support enthusiastically the rapid development of nuclear power in New Jersey as an alternative to oil and natural gas. A member of the NJMA's Energy Council, while endorsing the general idea of nuclear centers if they could reduce licensing delays, raised a number of questions about them, including the following: (1) Is there a military hazard in putting so many eggs in one basket? (2) Will the standardization encouraged by NEC's tend to lock us into obsolete technology and slow innovation? (3) Would an NEC (and offshore drilling, superports, etc.) so change the character of New Jersey that people would no longer consider it a good place to live? Manufacturers cannot attract employees to a place in which nobody wants to live. Everyone in New Jersey must be environmentally aware. Our air and water are still too dirty.

Most business people expressed concern about the loss of businesses and jobs to other states. New Jersey has lost 150,000 manufacturing jobs since 1969, or 16% of its total. Many of these have gone to Pennsylvania, which offers tax incentives and low interest loans. Business people found it difficult to say whether an NEC would help or hurt that situation. While favoring development in general, many were wary of such a large project, because they feared it might disrupt existing patterns of commerce too drastically, though they were not sure just how. Most felt that the extent and nature of such disruption were too uncertain to speculate about.

18.4 The Press and a New Jersey NEC

In its role of disseminating information to the people, the press can have a decided impact on perceptions of an NEC. Not only the appearance of articles on the subject but the type of coverage can help activate the audience in one direction or another.

One has only to read about a particularly "touchy" subject in a local paper to appreciate the dictum "the closer an issue gets to home, the more heated the reporting." An example is press coverage of this very study of a hypothetical NEC. A Trenton Times reporter, upon being informed of the NEC study, gave an account of the intent of the study and the concern of the Ocean County Board of Freeholders. However, coverage of the same event by the Atlantic City Press was entitled "Freeholders React 40 N-Plants: It's Maniacal" (the Trenton Times article was entitled "A-Plant Plan Awes Ocean Freeholders"). The first four words of the Atlantic City Press article were "maniacal, suicidal and irresponsible." Overwhelming coverage was given to just how upset that Board of Freeholders was. The opposition of the Boards' members, as well as a candidate for the Board, were printed in detail.

It is interesting to note the opposing views the different actors in the nuclear controversy in New Jersey have towards the press. PSE&G is convinced that it being unfairly persecuted, that press coverage of nuclear issues is biased in overt sympathy to opponents of the technology. They give an example of the Sun People in their frightening "Sun Dresses" getting all the press (and TV) attention at the Toms River hearings on March 10, 1976, and the large amount of coverage given to the resignations of the NRC and GE engineers. The nuclear opponents complain, however, that not enough coverage is given to stories like the leak of radioactive wastes in South Carolina. Some claim that the press wasn't covering the opposing view of nuclear energy at all in Atlantic County until local opposition groups began to gain influence.

18.5 Ocean County Reaction to an NEC in Summary

The strong public reaction to the NEC proposal in Ocean County may be attributed to several factors. First of all, Ocean County has one operating nuclear power plant--Oyster Creek. Attention has been focused on that facility because of public concern over a number of apparent problems. Secondly, Ocean County

depends upon tourism. That industry might be affected if safety precautions required tourists to be informed routinely (by signs or otherwise) of actions they should take in case of emergency, since such information would make them conscious of the potential hazard nearby. Plumes from the cooling towers could be an even more serious problem for the tourist business. Thirdly, the outspokenness of local officials in Ocean County gives the newspapers something to write about. In the fourth place, the question of evacuation has stimulated strong reactions to an NEC on the Jersey shore. Existing bridges connecting island and mainland are inadequate for rapid evacuation of the islands in case of emergency. Finally, one must consider the possible tax revenues to a county and its municipalities. Although the prospect of added income from an NEC is not a significant factor in Ocean County's overall perceptions of an NEC, it would influence attitudes in a few of the specific townships. However, all see the amounts of money as being so large that they might end up in state rather than local hands.

New Jersey is such a compact--and densely-populated--state that a wide range of citizens can be expected to become involved in the nuclear controversy. Past controversies over single nuclear plants have generated participation from a large radius of the population, and proposals to site a 10 to 20 reactor NEC certainly would not be viewed as isolated events. As Mr. George W. Ligget of Mays Landing (in Salem County) pointed out during the May 1975 hearings on the Hope Creek Nuclear Generating Station, his community is located equidistant between the Oyster Creek and Salem nuclear power plants, about 35 miles from each. Without doubt, any proposal to actually construct a Nuclear Energy Center in coastal New Jersey would engender voiciferous, adverse public reaction.

CHAPTER XIX

POPULATION PROXIMITY AND NUCLEAR FACILITY SITING IN COASTAL NEW JERSEY

19.1 Introduction

As noted elsewhere in this report, a number of difficulties would be encountered in siting an NEC in Ocean County, and perhaps anywhere in coastal New Jersey. It must be remembered, however, that there would also be difficulties in siting twenty nuclear plants in dispersed locations around the state, or in locations off the Jersey shore, or in siting new fossil fuel generating capacity of that magnitude. The chapter thus concentrates on analysis of the constraints and impacts of dispersed versus clustered nuclear siting in New Jersey from the overall perspective of land use and population proximity, and suggests a role for public policy measures particularly land use planning, to keep the site "remote".

Two reasons are commonly given for deciding to locate nuclear reactors in areas with low population density:

- (1) To minimize the number of people actually exposed to radiation in case of an accident, and
- (2) To assure that protection of the public through evacuation would be possible if it were ever needed.

The first reason, while statistically reasonable, raises a serious question of equity, at least in the minds of those affected. One Ocean County Freeholder, in denouncing the suggestion that his area be considered as a site for nuclear power plants, expressed it this way: "They think we are expendable because there are so few of us."* In fact, the AEC's (now NRC's) Reactor Site Criteria do not mention Reason 1 explicitly, relying instead on Reason 2.¹ Among other things, these criteria specify a low population zone "such that there is a reasonable probability that appropriate protective measures could be taken in (residents') behalf in the event of a serious

*Reactions of the public and of government officials in Ocean County to the NEC concept were examined in Chapter XVIII.

accident...." Whether a specified number of people can be evacuated from a specific area on a timely basis, or instructed to take shelter, would depend on many factors: location, number and size of highways, scope and extent of advance planning, actual distribution of residents within the area, amount of time available, nature of the public announcement and response thereto. Low population density certainly is the most important general factor making for ease of evacuation. It is reasonable, therefore, that broad guidelines applicable to all nuclear sites should concentrate on this factor; but as the AEC criteria recognize, many special site-specific factors may be important as well.

19.2 Population Density in Coastal New Jersey

Coastal New Jersey was selected in the initial coarse screening process of the NRC study in large part because of its low overall population density, as well as its access to ocean water for cooling and its general proximity to electricity demand load centers.

The three hypothetical NEC sites were chosen for areas which were relatively distant from existing population centers in Ocean County. Actual distribution of population around these three hypothetical sites, including population outside Ocean County, must now be examined; and because an NEC's construction and operation would range far into the future, anticipated population distribution patterns must be estimated.

Basic features of land use and population distribution in Ocean County as a whole were described in Chapter IV; thus a brief summary here should be sufficient to provide the basis for our analysis of detailed population proximity data for the areas around each of the three cluster sites.

Because of its position equi-distant from two major metropolitan areas, Ocean County receives development pressures from both directions. The county's population is concentrated along the Atlantic Coast and on its two major offshore islands in a series of sprawling suburban-style communities. Recreational opportunities are the county's biggest attraction; the construction spawned by demand for second homes, retirement villages and inexpensive suburban housing made it the fastest growing county in New Jersey throughout the 1960's.

Based on the county's development plans described in Chapter IV, it would appear that intense development is not expected in or closely adjacent to the three hypothetical NEC sites in the near future, with the possible exception of development just east of portions of the Lakehurst Naval Air Station (Ft. Dix Site). It is possible that a new growth center might emerge in the area around the Inland Site, especially a self-supporting senior citizen village.

Tables 19-1 through 19-3 present data on the population residing within various distances from the borders of the three NEC sites in Ocean County as of 1970, and provide projections for 1985 and 2000.

Population densities as of 1970 are compared in Figure 19-1, a graph which shows population per square mile around the three sites along with comparable curves for two dispersed nuclear power plant sites in New Jersey: Newbold Island (proposed) and Oyster Creek (actual). These data have clear implications for nuclear siting policy, for risk, and for the efficacy of evacuation procedures. Even at current (1970) population levels, the area around the Ft. Dix Site contains 2 to 3 times more people than those around the Bay Site or Inland Site. Because of its location in the middle of the state, concentric circles around the Ft. Dix Site include population centers along the Delaware River, along the Atlantic Coast, and at longer distances even in the New York metropolitan area. Population centers included in the Ft. Dix ring not included for equal distances from the other two sites include: Elizabeth, N.J. (108,000), Irvington, N.J. (57,300); Linden, N.J.; Newark, N.J. (358,000); Plainfield, N.J. (46,000); Union N.J. (51,900); Haverford, Pa (66,000); and Staten Island, N.Y. (295,443). As shown in Figure 19-1, population around the Ft. Dix Site exceeds even that at the Newbold Island Site -- rejected in the licensing process because of excessive population proximity - at distances beyond about 37 miles.

In comparison with the other two hypothetical NEC sites, the Ft. Dix Site represents a classic dilemma of nuclear power plant siting. It is the least environmentally sensitive of the three sites. Significant

Figure 19-1: Comparative population densities within 50 miles of the three hypothetical sites and two sites actually proposed for dispersed plants.

TABLE 19-1

APPROXIMATE CUMULATIVE POPULATION AROUND BAY SITE
(Thousands of People)

	2.5 <u>miles</u>	5 <u>miles</u>	10 <u>miles</u>	20 <u>miles</u>	30 <u>miles</u>	40 <u>miles</u>	50 <u>miles</u>
1970	2.25	5.55	16.9	33.1	227	648	3,667
1985 ^b	a	a	a	41.4	297	901	4,724
2000 ^b	a	a	a	46.7	384	1,173	5,792

TABLE 19-2

APPROXIMATE CUMULATIVE POPULATION AROUND INLAND SITE
(Thousands of People)

	<u>2.5</u>	<u>5</u>	<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>
1970	0.5	1.45	25	104	314	1,367	5,243
1985 ^b	a	a	a	144	459	1,864	6,748
2000 ^b	a	a	a	201	620	2,296	8,172

^aProjections were not estimated for areas immediately adjacent to the hypothetical NEC site, since it is assumed that buffer zones or land use controls might be used to limit population growth within this area.

^bPopulation projections for New Jersey population centers for 1985 and 2000 were taken from 1973 estimates made by the Office of Business Economics, N.J. Department of Labor and Industry. These projections are higher than current projections, as are the independently-generated projection for population centers in Pennsylvania and New York contained in the cumulative figures.

TABLE 19-3

APPROXIMATE CUMULATIVE POPULATION AROUND FT. DIX SITE
(Thousands of People)

	<u>2.5</u>	<u>5</u>	<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>
1970	3.1 ^a	13.7	43	436	3,070	6,384	11,500
1985 ^d	b	b	50 ^c	588	3,960	8,400	14,200
2000 ^d	b	b	55 ^c	738	4,848	10,300	17,400

^aExcludes military personnel living on the base, at the western part of Fort Dix and McGuire Air Force Base.

^bProjections were not estimated for areas immediately adjacent to the hypothetical NEC site, since it is assumed that buffer zones or land use controls might be used to limit population growth within this area.

^cWe assumed implementation of only a 5-mile buffer zone around the Fort Dix Site.

^dPopulation projections for New Jersey population centers for 1985 and 2000 were taken from 1973 estimates made by the Office of Business Economics, N.J. Department of Labor and Industry. These projections are higher than current projections, as are the independently-generated projection for population centers in Pennsylvania and New York contained in the cumulative figures.

portions already have been altered, for instance by construction of military exercise areas and the Lakehurst Naval Air Station's landing strip. This site clearly does not have an environmental constituency concerned with its preservation, as do the Inland and Bay Sites. However, this site is closest to significant numbers of people, thus posing the classic tradeoff of trees versus people.

In fact, the Ft. Dix Site might require waiver of the NRC's population density criteria. Population density in the 30 mile circle around the site is about 1100 per square mile.* If it appears that population density may exceed 500 per square mile within a 30 mile radius of a proposed plant, the NRC requires careful consideration of alternative sites.

19.3 Seasonal Populations and Evacuation

All of these data refer to permanent residents in these areas. Closer examination of this coastal area reveals that all along the Atlantic Ocean, the presence of extremely heavy seasonal populations on the beaches and islands renders the area even less attractive in terms of population protection than the permanent population data would suggest.

Although average population density in Ocean County itself may be considered relatively modest, many thousands of residents, especially in the summer, occupy extremely dense settlements on the long, narrow barrier islands that lie just offshore across Barnegat Bay. Long Beach Island, 20 miles long and less than a mile wide, is connected to the mainland by a single 4-lane bridge at its center. Although the island's year-round population is only about 10,000, as many as 120,000 more stay overnight on the island during the summer; and the summer day-time peak population of this island and the island just to its north reaches an estimated 250,000. The summer population of the Atlantic County islands also reaches about another 250,000. In this case, three bridges join the islands with the mainland. Timely evacuation of these island communities across these few bridges appears to be virtually impossible (although, of course, more bridges could be built commensurate with a decision to proceed with the NEC). The possible presence of thousands of people who cannot be trained or organized ahead of time

*This is a circle with its center at the approximate center of the site. A set of circles drawn from the corners of the site would extend further, taking in even more people.

compounds the difficulties and substantially increases the likelihood of panic in the event of an emergency.

The annual wind rose for McGuire Air Force Base shows that the wind comes predominantly from the W-WNW, with a mean hourly speed of 6.6 knots. Table 19-4 gives monthly prevailing wind directions and the mean hourly speed in knots (1 knot = 1.151 MPH).

Table 19-4
WIND IN OCEAN COUNTY

	<u>Month</u>	<u>Direction</u>	<u>Speed (knots)</u>
	January	WNW	7.7
	February	WNW	8.1
	March	WNW	8.3
	April	W-WNW	7.9
	May	SW	6.5
Peak Season	June	S-SW	5.8
	July	SW	5.1
	August	SW	5.0
	September	S-SW	5.5
	October	W	6.0
	November	W-WNW	6.7
	December	W	7.2

During any one month, the wind varies considerably in direction. However, the probability is typically about 60% that it will come from the directions indicated above, or from one of the three sectors to either side of it (with about 15% chance of calm). This leaves something on the order of a 25% chance that if the wind is blowing, it is not coming from the predominant direction. Spring and fall months are more evenly distributed; i.e., there are not such great variations in wind direction probabilities. Winter and summer months show the greatest differentiation.

Ocean County's major population centers are along the coast, in and around Toms River and Long Beach Island (especially during the summer). These areas are generally to the east of all three NEC sites. Although wind direction cannot be specified, the wind will most likely be blowing somewhere from the west, and hence towards the main populated areas of the county.

Depending on the circumstances of a nuclear accident, there might be warning times for the various communities. Table 19-5 shows the approximate time

that it would take airborne fallout to travel to Long Beach Island and Toms River from each of the three sites if the wind were blowing in the appropriate direction at an average speed of 6.6 knots (7.6 mph). Combining the information in Tables 19-4 and 19-5, one may conclude that, in general, the Long Beach Island area would be in the least danger during the summer months when it is most populated; the Toms River area would be most endangered by the Bay and Inland Sites during the summer, and by the Ft. Dix Site during the winter or spring months.

TABLE 19-5

PROBABLE EVACUATION WARNING TIMES

<u>NEC Site</u>	<u>Toms River Area</u>		<u>Long Beach Island Area</u>	
	<u>Wind Direction</u>	Approx. Warning Time (minutes)	<u>Wind Direction</u>	Approx. Warning time (minutes)
Bay Site	SSW	90	WSW-N	20
Inland Site	SW	60	NNW	60
Ft. Dix Site	WNW	132	NNW	240

Main evacuation routes would be the Garden State Parkway and Route 9 (N-S), and various other routes to the west. In approaching these roads, which lie to the west of the county's most populated areas, evacuees would be forced to travel towards the NEC site for a time before they could head away from it.

Long Beach Island has only one bridge connecting it with the mainland (Route 72), and any orderly evacuation would prove unmanageable if not impossible. To make matters worse, Route 72 passes very near both the Bay Site and the Inland Site. Ocean Beach Island is not in a much better situation, as it has just two bridges connecting it and the coast, and another two bridges served by the same road at its northern end.

During the summer months, the population of these islands (20,000 permanent residents) swells to nearly 250,000 people. For the purposes of this discussion, it is assumed that 150,000 people would be on the northern island on a peak summer day, and 100,000 on the southern island. This difference is due to the northern island's greater size, development, and proximity to New York City and populated northern New Jersey. It is assumed that there would be an average of 3.5 people in a car, which means that there would be about 42,860 cars on the northern island and 28,570 cars on the southern island.

The bridge from Long Beach Island has four lanes, all of which can be converted to flow in one direction in the case of an emergency. Due to the bottleneck problem and the fact that lead-in roads are only two lanes, we can assume that there will be only two effective traffic lanes. Further, if we assume that each lane can carry 2000 vehicles per hour, a reasonable number for minimum safe headways (1.8 second average) and moderate speeds (40-50 mph), we see that a forced evacuation of Long Beach Island would be slow indeed. It would take approximately 14.5 hours for the 28,570 cars to cross the bridge in a steady flow, if there were no accidents nor panic. If we assume that equal numbers of people use each of the two southern bridges of the northern (Ocean Beach) island and the two bridges in the north, it would take over seven hours to evacuate that island. These assumptions again use the optimum case. Most likely, the distribution of cars would not be so even, and one bridge would prove more popular than the other two, with evacuation time proportionately increased. Also, any stoppages in traffic due to boiled-over radiators or other causes would likewise extend evacuation time. The few buses available, or forced packing of cars, would not alter this situation significantly.

The problem of these resort islands may effectively cancel out the advantage of low average population density that a coastal New Jersey site for a NEC would otherwise have. And since barrier islands and their heavy resort populations extend along the Atlantic Shoreline from Long Island to Virginia Beach, or even further, their presence may inhibit any coastal siting of an NEC in the East.

19.4 Remoteness vs. Growth: The Siting Dilemma for Nuclear Energy Centers in General, and an Ocean County NEC in Particular

Much of the discussion of the Nuclear Energy Center concept, and several of the principal documents produced to date, contain an inherent contradiction in terms of siting for such a facility. On the one hand, these large facilities clearly are supposed to be located in "remote" areas, primarily on grounds of safety and ability to evacuate the population at risk in the event of an accident and release of radiation. Remote sites are desired for dispersed nuclear plants as well, of course; witness the AEC's decisions with respect to nuclear power plants proposed for densely-populated areas like Ravenswood, New York; Burlington, New Jersey; and Newbold Island, New Jersey. In addition to the usual NRC guideline of 400 or 500 persons per square mile average population density, the operating assumption for siting of an NEC in the initial course screening for this study, was that the facility also should be no closer than 20 miles from the boundary of any population center over 25,000 people--thereby providing a buffer of at least relatively low density.

One of the inherent problems troubling public policy analysis in this regard involves the definition of a "population center". Is it to be:

- (1) any municipality, any incorporated political jurisdiction; or
- (2) certain kinds of municipalities, like a city or borough, but not a less densely-populated township or village;
- (3) an agglomeration of persons measured physically through average or peak density criteria?

The Portage, Indiana (Bailly) case decided by the U.S. Supreme Court in 1975 ruled that--for the present--number 3, above, is to be used. This distinction is relevant to this Ocean County analysis because, by 1974, three municipalities in the county already exceeded 25,000 people:

Dover Township--50,185

Brick Township--44,795

Lakewood Township--32,550

All three townships lie immediately to the east of the hypothetical Ft. Dix NEC site, and in reasonably close proximity to the Inland Site centrally located in the county. Moreover, all three municipalities are characterized by relatively low-density suburban sprawl, although formally incorporated as a "population center" under the court's Bailly case formula. Nevertheless, average population densities in these three municipalities far exceed 500 persons per square mile:

Dover Township--1,206

Brick Township--1,697

Lakewood Township--1,334

In addition, all such calculations ignore the problem of peak populations on the resort islands. At these times, population within reasonable proximity of an Ocean County NEC would be very large.

Furthermore, the meaning of population criteria for siting is called into question by the difficulty of making accurate population projections years into the future. This is difficult enough for a dispersed nuclear site, with its 30-year operating life. For an NEC which would not even begin to construct its 20th reactor until well into the 21st century, one person's guess is as good as another's; but all clearly are only guesses.

To exemplify this difficulty, examine actual population growth rates in recent years for the seven Ocean County municipalities in which a hypothetical NEC is being studied and in the eight municipalities immediately adjacent. These data are presented in Table 19-6. If growth rates anything like those experienced in most of these 15 municipalities in the 1960's and early 1970's were to continue, none of these NEC sites could be considered "remote" by any but the most obscure definitions.

In direct contradiction to the supposed requirement that nuclear facilities be located only in "remote" sites, some arguments in favor of an NEC suggest that the facility itself could be viewed as an important stimulus to growth in the area. This stimulus would be not only in terms of construction employment, but also as an inducement of new industry to move into the area (for process heat, cheaper electricity, a conducive technological/industrial environment, and so on). Some analyses perceive a Nuclear Energy Center becoming a "growth

pole" around which an entire new community of 50,000 or even 100,000 people is to emerge particularly in the "inter-metropolitan fringe".²

Both remoteness and growth, then, would appear to be legitimate goals relative to the employment of an NEC. Unfortunately, they would also appear to be contradictory. It would seem that public policy toward NEC's must choose between remoteness or growth. Our analysis of the New Jersey situation suggests a means of bridging that policy gap by the use of a buffer zone around the nuclear center.

19.5 The Buffer Zone Concept

One answer to this dilemma, probably the only acceptable one, is to locate Nuclear Energy Centers in relatively remote areas, and then implement specific public policies to keep them remote, avoiding new residential development which has grown up around the Oyster Creek nuclear site, for example. The township in which this facility (approved in 1965) is located grew by 138% during the 1960's and by another 64% in the first four years of the 1970's.

Although we recognize that this concept of using a sizeable buffer zone to keep a nuclear facility--clustered or dispersed--relatively remote from the surrounding population is not the current policy of the Nuclear Regulatory Commission, we consider it imperative that serious research focus on this concept.

Not only will the specifics of any research on impacts be determined by standards for such a buffer zone, but also regulations to be enforced in such a zone could greatly affect our estimates of the spatial distribution of future income and employment impacts of an NEC. Buffer zone policy could also very well affect the demographic trends projected for the area. For example, depending upon the extent of the buffer zone, large areas of the New Jersey coastal resort belt might or might not be included under such land use restrictions as might be developed. Only after a buffer zone policy has been established can realistic estimates and forecasts be made of the effects of an NEC; and only then can the costs to be borne by local, state and federal governments be estimated.

TABLE 19-6

RECENT POPULATION GROWTH RATES IN OCEAN COUNTY MUNICIPALITIES
IN OR NEAR HYPOTHETICAL NEC'S
(percentage growth)

NEC Sites: Seven Municipalities

	<u>1960-70</u>	<u>1970-74</u>
Eagleswood Township	7%	5%
Jackson Township	308%	15%
Lacey Township	138%	64%
Manchester Township	100%	70%
Ocean Township	141%	20%
Plumsted Township	25%	10%
Union Township	21%	172%

Nearby to the NEC: Eight Municipalities

	<u>1960-70</u>	<u>1970-74</u>
Berkeley Township	85%	55%
Dover Township	151%	15%
Lakehurst Borough	-5%	11%
Lakewood Township	57%	29%
Little Egg Harbor Township	251%	57%
South Toms River Borough	148%	7%
Stafford Township	91%	25%
Tuckerton Borough	25%	18%

(See Chapter IV, Table 4.2 for details)

One must first arrive at a reasonable definition of "remote", and then select sites which indeed meet these criteria. An ideal location might probably be "fifty miles from nowhere": this is obviously impossible in a state like New Jersey, the nation's most densely populated. One possibility is to establish the criterion that, to be adequately "remote", a Nuclear Energy Center's boundaries ("the fence") not be closer than 10 miles from an urbanized area, including any "population center" over 10,000; plus at the same time, meeting the overall 400 or 500 persons-per-square-mile criterion (at 30 miles, for example).

We have examined Ocean County using these rough criteria, and have discovered that an NEC of about 40 square miles **conceivably** could be located there (this ignores the issue of proximity to high summer transient population). Part of the NEC itself (and its buffer zone) clearly would have to lap over into Burlington County. An Ocean County site on these population proximity and density grounds is, at best, an extremely tenuous fit. The county's average density in 1975 was 423 per square mile. The areas east of the Garden State Parkway, all along the shore, around Toms River, and in the northern sections of the county already are rather heavily populated, and continue under very heavy residential growth pressures. The western fringe of the county is really the only conceivably "remote" location; here lie the Pinelands, a fragile ecological area. If a decision were made to locate an NEC in Ocean County, surely much if not all of it would have to be located in the Pinelands--a decision which might be difficult to justify unless associated with a policy to prevent development of those portions of this open space now in private hands. If properly accomplished, such a decision could be used, in fact, to preserve the Pinelands from private exploitation.

Equally if not even more important, once an appropriately remote site were selected a set of public policies would have to be formulated and then implemented to keep it remote. A buffer zone of perhaps five or even ten miles in width seems appropriate around the boundary of the NEC itself (for a circular 40 square mile NEC, the total including a five-mile buffer zone would then be some 231 square miles).^{*} This buffer zone would ensure that new housing, industry, strip-commercial development and other land uses incompatible with a nuclear facility sited for its remoteness were indeed precluded from locating on the fringe of the NEC, just outside the fence. Preventive land use measures in this five-mile buffer zone would provide an extra margin of safety for evacuation in the event of a nuclear accident, would minimize the aesthetic insult of 400-foot cooling towers, and would isolate the center's noise, radiation and particulate air pollution at least a little from the rest of the society which it is serving.

The buffer zone could be protected from incompatible land uses by a variety of regulations. To avoid litigation over the "takings clause" of the U.S. Constitution, compensable regulations rather than police-power zoning seem to be the appropriate methods to employ. For a \$20 billion center, a modest amount of front-end money could purchase conservation easements, development rights, or other covenants throughout this vital buffer area. Some limited land uses could, of course, continue to take place within this protective green space: farming, forestry, light mining, low-density residential dwellings which pre-date initiation of the preventive land use measures, and so on. Energy intensive industry tends not to be labor intensive. The buffer zone would thus be an appropriate region for the location of industry with larger needs for electricity or process heat (to be supplied by the NEC's waste heat).

^{*} On March 10, 1976, partly as a result of considering the implications of a preliminary version of this report, the Commissioner of New Jersey's Department of Environmental Protection announced a new state policy of controlling residential growth in the vicinity of nuclear reactors, including the Oyster Creek plant in Ocean County. Pending detailed study of alternative policies and their impact, he announced a moratorium on approval of large-scale residential projects under the state's Coastal Area Facilities Review Act (CAFRA) for an area within four miles of Oyster Creek and six miles of the Salem/Hope Creek nuclear complex on Delaware Bay.

Were any particular landowner recalcitrant about selling his development rights to the state for this zone (it probably ought to be created by the state government rather than by utility companies or the federal government), eminent domain powers are available to ensure its purchase, in the interests of the public's welfare and safety.

It is important to note how the buffer concept brings the state government into an important role in implementation of an NEC. The specific land use controls to be selected must be part of the broader state policy toward overall land use planning and regulation.

We would anticipate that there would be de facto as well as de jure controls in the case of the large buffer zone associated with an NEC; and we would anticipate that the qualitatively greater impact of an NEC would more likely generate institutional change and new controls than would a dispersed pattern. This suggests that the labor force for an NEC is likely to be more dispersed than that involved in building a single or small number of nuclear power plants. Not only would there be few workers living close by, but the pattern of consumption also would be more dispersed, and so too the indirect impacts. In any event, building an NEC (compared with the construction of, say, two or four reactors) would preempt so much land as effectively to push the construction labor force some distance from the site--even were the workers to look for housing in the immediate vicinity. Also, with major associated projects involving skilled workers, e.g., tunnel building, a contractor would find lack of qualified local people to be an even more severe problem than it appears to be today with smaller projects. He would, therefore, tend to draw much of his labor force from a larger and more distant union headquarters. Given the density and extent of large urban metropolitan areas on the Eastern coast or along the Great Lakes, many existing nuclear power plants are within long range commuting distance of such metropolitan areas. It is in these areas that the institution (including unions) as well as the energy demand are found. The result is that the reactor site may emerge as a distant appendage of the metropolitan area. Effectively it is part of it for many existing nuclear plants, and the same would be true for an Ocean County NEC.

Because of this large commuting range for construction workers and NEC employees, transportation to and from the Site becomes another key policy requirement related to remoteness and growth. It seems imperative that the

Figure 19-2. Model of a mass transit system serving an NEC in Ocean County.

new growth associated with the NEC--housing, commercial establishments, and so on--not be channeled into a single new town, nor allowed immediately outside the fence of the NEC. Instead, most growth pressures should be directed into expansion of existing communities outside the five or ten-mile buffer. The buffer itself, as noted, might remain in the low-density uses which characterized it at the time the NEC was approved. To avoid large amounts of automobile traffic and associated air pollution from commuting workers, as well as to conserve petroleum and ensure the site's continuing remoteness, it seems important to utilize mass transit to move workers at frequent intervals from a set of park-and-ride facilities in surrounding communities to the NEC itself, along limited access highways through the buffer zone. Very limited parking would be provided at the NEC entrances to ensure that workers used the bus service (a more sophisticated alternative, employing the same concept, would be to substitute a monorail for the buses).

A conceptual model of this limited-access transit system to service a hypothetical NEC located in the Pinelands of Ocean County is shown in Figure 19-2. The model NEC is approximately 40 square miles in size, plus an additional preventive land use (buffer) area about 5 miles wide. The map is illustrative of the concept rather than exactly drawn to scale and detail. As shown, the NEC/buffer zone complex would be located primarily in Ocean County, but would include parts of Burlington County as well. The NEC is located mostly in the Pinelands to the south of Fort Dix, with its preventive buffer zone reaching almost to the Garden State Parkway. Limited access routes link the center with park-and-ride facilities at planned growth centers: Toms River, Atlantic City, and the points of intersection with I-195 to the north (in Jackson Township, Ocean County), the Philadelphia-Atlantic City Expressway to the south (in Atlantic County), and the Garden State Parkway to the east.

To ensure that growth in housing and service industries takes place where desired, a variety of positive public incentives could be employed along

* The location and shape of this NEC is purely hypothetical, and not indicative of any particular recommended configuration; it is not identical with any of the three specific sites examined in this report, although it is most similar to the Inland Site.

with preventive land use regulation in the buffer area. For example, no park-and-ride facilities would be provided in towns immediately adjacent to the buffer zone; growth would be encouraged by locating these parking lots and bus transit stops where the growth is desired, in towns like Toms River or Atlantic City, or at major expressways. Growth incentives at points where growth is desired could include mortgage insurance, subsidized interest rates, tax incentives and so on. Equally important, provision of necessary services--particularly sewage collection and treatment--could be used to induce growth in certain areas, and prevent it in others.

In these ways, well-planned Nuclear Energy Centers could be kept relatively remote while also serving as a growth stimulus throughout a wide regional area encompassing not only southern New Jersey but also Trenton and even Camden and Philadelphia. For this type of region, the concept of a buffer area would appear to be important in terms of maximizing the social benefit that would be associated with clustered siting.

NOTES FOR CHAPTER XIX

1. U.S. AEC, Rules and Regulations, Title 10, Part 100, Reactor Site Criteria, December 5, 1973.
2. Gerald Garvey, "Community Implications of Energy Parks: A Regional Development Perspective," paper prepared for the National Academy of Public Administration, 1975.

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CHAPTER XX*

SUMMARY AND CONCLUSIONS

20.1 The Major Findings

This study has identified a number of serious difficulties which would be encountered in siting a Nuclear Energy Center in a region that has the characteristics of Ocean County, New Jersey. Although our overall assessment of the Ocean County surrogate NEC site is undoubtedly negative, one must remember that selection of Ocean County was not predicted on grounds of its being a desirable site, but rather on the basis of its being representative of the issues and problems that any coastal nuclear energy center would bring. There may well be far better locations for an energy center in Southern New Jersey,** or elsewhere in the PJM/MAAC area, or somewhere else in the Northeast. One should therefore be careful not to interpret some of our specific, negative conclusions with respect to an NEC in Ocean County as categorical judgements on all energy centers, wherever located.

These caveats notwithstanding, we regard the problems of energy center siting in Ocean County as probably quite representative of much of the Northeastern Atlantic coastline. The concentration of population in the Northeastern corridor makes the nearby coastline a very valuable recreational resource. Those whose livelihood is dependent on this resource, and those who enjoy its benefits, are unlikely to view clusters of nuclear reactors in its proximity with any enthusiasm. Thus public opposition will likely be much broader than the environmentalist groups normally opposed to nuclear plants, translating into political initiatives at the state level that may be quite effective in blocking proposed nuclear power plant sites.

Even if public and political opposition prove to be the deciding factor, some technical factors make coastal energy center locations not as attractive as they might at first appear to be. Much of the Northeastern Atlantic coastline is endowed with barrier islands that enclose shallow bays of significant

* Prepared with the assistance of Dr. Philip F. Palmedo, National Center for Analysis of Energy Systems, Brookhaven National Laboratory.

**In our preliminary assessment, BNL 50465, which focused on Salem County as well as Ocean County, we noted that Salem County, on balance, was to be preferred over Ocean County as an NEC location (though serious problems would be encountered in Salem as well).

recreational value. Since the islands themselves are quite unsuited as energy center locations, and the mainland shoreline is also generally heavily developed, probable locations of energy centers must be some distance inland. This in turn means typically a 5 to 10 mile distance between the energy center and the ocean, since the bay waters themselves cannot be used for cooling purposes. It also seems clear that the environmental impact of constructing cooling water conduits across the bay and the beaches would be quite unacceptable, requiring construction of bored tunnels rather than surface conduits. Tunnels, especially those in unconsolidated coastal sediments, are substantially more expensive than cut and fill conduits, and in fact once-through cooling proves to be more expensive than evaporative systems in such situations. Yet evaporative systems, with their attendant problems of aesthetics (both plumes and structures), and of salt drift, pose other problems in the coastal areas. Moreover, inland construction in Ocean County would place the energy center in the Pinelands, an important ecological area.

An entire spectrum of unanswered questions arise in regard to population proximity. Even if population density in the immediate vicinity of an energy center were low (as it might well be if the nuclear cluster were located far enough inland in Ocean County), the enormous influx of visitors during much of the summer only some 5 to 10 miles distant raises serious questions as to whether the spirit of current siting guidelines could ever be met. In any case, in contrast to all of the other surrogate sites examined in the NECSS study, Ocean County, nor indeed any other Northeastern coastal location, can by no means be described as a remote site in view of the proximity of major metropolitan areas.

Finally, the overall impact of a nuclear energy center in a region such as Ocean County may depend significantly on the degree and kind of land use planning and management that is carried on outside of the fence of the center. Given appropriate modifications of current regulatory practice, a very small increase in the initial investment in a center located near the Pinelands could preserve the unaffected parts of this significant natural resource from private exploration. Similarly, if low population densities are to be maintained in the immediate vicinity of an NEC over its long expected life, there may have to be initiated a form of land use control not now exercised around smaller number of plants. With such planning, an NEC could act as a "growth pole" for regional

development and, at the same time, remain "remote" from the perspective of population density distributions. Thus, both in terms of taking advantage of the possible regional economic benefits of NEC's and avoiding their social costs, planning must not stop at the fence. Optimization of energy center benefits is crucially dependent on active state involvement in land use planning in the overall vicinity of an NEC.

20.2 Specific Conclusions

Turning first to the question of energy demands in the New Jersey region (Chapter II), we find that the demand for additional base load capacity within the state of New Jersey alone is consistent with our assumed growth rate for an NEC, which would benefit primarily the residents and economy of New Jersey. While we recognize that modern utility practice and power pool arrangements often cross state lines (and this is indeed the case in New Jersey), we regard it as highly unlikely that a New Jersey NEC planned to serve primarily the needs of another state, and particularly the needs of the New York City area, would be politically feasible. Consequently the conclusion of adequate load growth within the state is of some practical importance. However, conservation might change this conclusion somewhat, with the role of NEC reactor construction needing to be slowed if a "no export" policy were imposed. In fact, the magnitude of a Nuclear Energy Center needed only to serve New Jersey's own demands for electricity provides emphasis for more serious attention to aggressive programs of energy conservation in the state, as an alternative to a future dominated by nuclear reactors. But certainly under existing institutional arrangements, and even in the event of strong conservation, the MAAC area could accommodate at least one NEC of the timing and size considered in this report.

Water resource constraints (Chapter VI) prove to be a most important factor in terms of defining available cooling choices for the NEC as well as in the dispersed-clustered comparison. Because of the absence of freshwater sources for flow augmentation and salinity control, and the shallowness and environmental sensitivity of Barnegat Bay, the NEC must communicate with the ocean for both make-up and blowdown. And because of the close proximity of recreational activity, and the perceived fears of the recreational industry that plumes from evaporative towers might significantly impact the beaches (Chapter X), wet/dry plume control towers are the indicated choice for an evaporative system. Certainly cooling ponds, or spray cooling options, can be rejected.

The long distances between the NEC site and the water source pose severe problems for water conveyance systems. Bored tunnels appear to be the only feasible choice, but this makes once-through cooling, even at the Bay Site (purposely selected as being closest to the water source) more expensive than evaporative cooling at the Inland Site, some miles from the shoreline (at least in terms of construction costs). An analysis of the trade-off between water conveyance costs and transmission costs shows clearly that proximity to the water source is the dominant siting consideration; electrical transmission cost penalties are quite small in comparison to water conveyance costs (Chapter VII).

We examined two construction management issues that would be site-specific to the Ocean County NEC: access of heavy components to the site and problems associated with tunnel construction (Chapter VIII). Analysis of the former issue shows little difference between the NEC case and the dispersed scenario, and analysis of tunnel construction shows that impacts can be held to manageable levels, provided construction is begun at the earliest possible time.

Our analysis of electrical transmission issues (Chapter XII) indicates that there is only a small difference in transmission costs between the dispersed and clustered siting scenarios considered. Transmission costs for the energy center mode lie between 10 percent more and 10 percent less than the corresponding dispersed case, dependent on some of the technical assumptions utilized. Indeed, such differences likely lie within the accuracy of the cost functions used in the mathematical modelling. However, the energy center case may require significant amounts of 765 Kv transmission line, whereas the dispersed case could be limited to the existing 500 Kv maximum voltage without a severe economic or land-use penalty. This indifference to transmission costs should not be unexpected, since the Ocean County location is quite near the major load centers in comparison to the truly remote sites considered in other surrogate studies (Nevada, Upstate New York), where transmission penalties do indeed become quite significant.

Turning next to the socioeconomic issues (Chapter XIII), we note first that in highly urbanized regions, such as those of the northeastern U.S., some modest regional economic gains would be realized from the construction of an NEC. These gains, however, would tend to be diffused over the region

and would be very small in comparison to gross regional product (a small fraction of a percent in our case study). This applies to construction, operation and maintenance, and includes direct as well as indirect and induced effects. Employment, income, and population effects attributable to an NEC would be virtually invisible when considered in the context of a large metropolitan area.

Looking at NEC-related impacts on a smaller geographic scale, call it the local level, our general conclusion is that the magnitudes and distribution of impacts will be very much a function of two important variables (in addition to the all important "degree of urbanization" variable.) These are land-use controls and the tax structure. To a lesser extent but still not insignificantly, other variables will shape local impacts. These include the influence and character of the relevant labor unions through which the work force is channeled to the construction project, local geographic features, and ease of access to large metropolitan labor pools. We also expect that very little colocation of industry will be seen, either in the sense of technological linkages or due to other localization economies. Some small amount of colocation has been noted near existing power plants, but the critical element seems to be the tax advantage. This could well disappear with construction of an NEC.

Site-specific considerations also do much to influence any comparison between NEC and dispersed siting, especially inclusion of eight offshore reactors in the dispersed scenario. This has resulted in reduction of expected local and regional impacts in the dispersed case due to the hypothetical construction of plants outside the region (but with consequent increases of impacts in other regions). The NEC is seen, therefore, to cause greater total effects on the region than would the dispersed siting pattern. This factor is peculiar to the PJM/MAAC area, however, and limits the degree to which the comparison might be generalized.

One of the perceived advantages ascribed to an NEC discussed earlier in its conceptualization was that it would be built, operated, and maintained by a stable labor force, one which was locally resident and socially adaptive. By the same token, it has been suggested that a relatively short-

term, large construction project as is implied for several localities involved in a dispersed scenario brings with it a high degree of social impact. Both seem overstatements. Our research leads us to conclude that in aggregate, local impacts would not differ greatly between clustered and dispersed siting.

Our analysis of taxation issues in Chapter XIV makes it obvious that if an NEC were built in New Jersey, the state would need to modify its existing tax system. Since the tax revenues from an NEC are enormous, the potential use of this revenue is of state-wide importance. It seems clear that the state will need to replace the municipalities as the primary recipient of tax revenues. However, one should also note that even under the dispersed siting mode, concentrations of power facilities in single townships may make revision of the tax structure necessary even if the NEC concept is not pursued further.

As discussed in Chapter XV, we find that organizational problems are unlikely to present a significant obstacle to the NEC concept in New Jersey. Private utility companies in the state are already accustomed to joint ownership and consortium arrangements, and one is led to the conclusion that construction and operation of an NEC could be handled by a multi-utility consortium. The primary state role would probably be in land assembly and site planning, whereas federal assistance would be necessary primarily for financing the significantly larger front-end costs, and in initial technical planning efforts. Radical restructuring of the private utility sector in New Jersey or creation of a state-owned public power authority are not, in our judgment, a pre-condition for successful implementation of an NEC in the state.

Several major conclusions emerge from our analysis of institutional and political issues (Chapters XVI and XVII). First, it is quite clear that there will be significant differences in political response to an NEC at the local level, and that these differences will play an important part in the final choice of an NEC location within a state. For this reason, we conclude that an NEC location in Ocean County, or indeed in any Atlantic coastal county, is far less likely than in the less populated counties along

the Delaware Estuary and Bay. Second, we note that the state has substantial powers in the siting and environmental areas. This underscores the extreme importance of close cooperation between federal and state authorities in any further examinations of the NEC concept.

20. 3 Summary and Comparison of the Three Hypothetical NEC Sites

Each of the three sites poses difficult problems. Were the Bay Site to be used for an NEC, its natural values would be totally devastated by land fill and construction activities. The filling itself would adversely alter drainage patterns from the uplands and displace the flood water which cyclically inundates this area, an important wildlife refuge and wetlands preserve. The site is extremely close to the dense summer population of Ocean County's barrier beaches, from which evacuation would take 14 hours and by necessity force evacuees along a road running close to the site itself. The land is now held by the U.S. Department of Interior, and reverter clauses in the deed held by that Department may prevent any change in its use. However, no other suitable bay-side sites for an NEC appear to exist in Ocean County.

Of the two sites located further inland from the ocean, use of the Fort Dix Site for an NEC would clearly cause less adverse environmental impact than would use of the Inland Site. The latter is a rich and varied undeveloped area with significant natural ecological values. While mitigating measures could be used to reduce the primary impact of an NEC at the Inland Site, it is unlikely that benefits would outweigh environmental costs. It might be difficult to assemble land within the Inland Site because of title problems.

Although more environmentally suitable by virtue of the construction and military activities which have already taken place on Ft. Dix and the Lakehurst Naval Air Station, use of the Fort Dix Site would threaten more grave safety and social impacts than either of the other two sites. Some 5,600 people are now employed at the Lakehurst Naval Air Station, and it is not likely that permanent employment opportunities at an NEC would equal this number of jobs (and certainly not for the same people). Moreover, this site includes within the concentric circles around it far more population than either of the other two, and in fact exceeds the guideline used by the NRC

of 500 people per square mile at 30-mile radius. Use of natural draft cooling towers as suggested for the Ft. Dix Site would pose serious problems of visual and aesthetic impact.

In short, none of the hypothetical sites is entirely suitable for an NEC, and based on the constraints map used to select these three sites, no good site for such a nuclear cluster seems conceivable anywhere in Ocean County.

20.4 Recommendations for Further Research

The major recommendation in regard to follow-on work concerns geographic focus. Time and resource constraints have narrowed the focus of the present study primarily to Ocean County, New Jersey. This perspective has proven quite restrictive, and would need to be extended to all of the coastal and Delaware Bay counties in a more comprehensive investigation.

Indeed, if the concept of clustered nuclear siting is to be examined further, one must progress from the type of surrogate analysis exemplified in this report to an actual identification of potential sites, requiring a regional screening effort of some detail. This should encompass the entire Northeast. Such a regional site screening effort also should include the option of an offshore NEC. Our analysis shows that much of the Atlantic Coast south of Maine, as typified by Ocean County, may be unsuited as an NEC location for reasons of recreation and development pressures and unfavorable cooling water constraints. For a coastal state, therefore, the offshore option may be worthy of some attention.

20.6 Concluding Remarks

In order to assess the impact of a clustered siting policy on public acceptance of nuclear power plants, one must distinguish two categories of objection to nuclear power. The first is based on generic questions and argues that nuclear power per se should be delayed or not implemented at all. The second is based on objections to a particular plant at a particular location and generally argues that the plant should be built "elsewhere". In practice the distinction between these categories has not always been maintained; but the instigation of studies and hearings on

critical generic issues such as the use of plutonium and nuclear safeguards by the NEC should provide an adequate forum for discussion of this type of issue and move that discussion away from hearings on individual plants.

Given the insight gained from our studies in New Jersey, how would a policy of clustering affect public attitudes toward nuclear power, in terms of these two categories? An immediate difficulty is that from the perspective of Ocean County, a comparative analysis between clustered and dispersed siting has little relevance, since the alternative to the Ocean County NEC would be no nuclear plants at all in that county. (Even if one admits an additional unit at Forked River, and one or two offshore units, one would certainly not be considering 20 dispersed reactors in the county). Thus, from the Ocean County Perspective, the dominant issue in terms of public reaction is the impact of the NEC, rather than the differential impact between the NEC and dispersed sites elsewhere. Clearly, then, the locational issue involves basic questions of equity which would appear to be rendered more difficult of solution under a policy of clustering.

The basic equity problem in a power plant siting decision resides in the difference between the spatial distribution of social benefits and social costs. If we ignore the spatial problem, there will still be a range of opinion on the desirability of a new electric generating plant. But, conceptually at least, the majority rule of the American free enterprise-democratic political system provides a mechanism for resolving such issues. The difficulty arises when the group that is benefiting from the electric power from a given plant is (at least in part) different from the group that is bearing the social costs of the plant. The typical manifestation of this phenomenon is the expression, "sure we need nuclear power plants, but not in my backyard."

The traditional mechanism for resolving this problem is, in fact, to redistribute costs and benefits--usually through the tax system. Residents in the local area of the plant are given tax benefits to compensate them for the disbenefits of having the plant nearby. The consumers of the electricity, of course, pay that tax. This system is imperfect in a number of regards, one of which being that social costs do not distribute themselves conveniently

along political boundaries used for tax purposes. But with all its imperfections it seems to operate relatively well.

What happens to this scheme under a clustering policy? As is clear from the discussion of public attitudes above and the problems of taxation, an NEC would appear to exceed the bounds of successful operation of the taxation-compensation principle. Even for those who would be willing to have a single (or few) nuclear plant "in their backyard" if their taxes are reduced sufficiently, most would likely not see any benefit to having 20 there. This would appear to be the case judging by the expressions of the residents of Ocean County. Thus a policy of clustered siting would appear to make much more difficult the task of equitably distributing the costs and benefits of nuclear power plants. Nevertheless at this point it is difficult to judge whether the problems of siting a single 20 reactor NEC are greater or less than those of siting the same number of plants in a dispersed pattern.