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DELAWARE'S COASTAL ZONE MANAGEMENT PROGRAM

THE NATIONAL INTEREST IN RESOURCES AND FACILITIES OF THE DELAWARE COASTAL ZONE

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THE NATIONAL INTEREST IN RESOURCES AND FACILITIES OF THE DELAWARE COASTAL ZONE

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PREFACE

This is the seventh in a series of working papers which are issued to interested citizens and governmental officials so that they may actively and effectively participate in the development of Delaware's Coastal Management Program. Working papers have also been issued on the following subjects:

1. Program Overview and Public Review Guidelines
2. Coastal Zone Boundaries
3. Geographic Areas of Particular Concern
4. Program Goals and Objectives
5. Federal-State Interaction and the National Interest
6. Authorities and Organization

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INTRODUCTION

Subsection 306(c) of the Coastal Zone Management Act of 1972, as amended in 1976, provides, in part, as follows:

> "Prior to granting approval of a management program submitted by a coastal state, the Secretary (of Commerce) shall find that...(8) The management program provides for adequate consideration of the national interest involved in planning for, and in the siting of, facilities..."

One of the primary purposes of this paper is to furnish part of the basis for that finding.

Other sources which may assist the Secretary include a previous Coastal Management Program working paper, namely Working Paper No. 5, entitled Federal State Interaction And The National Interest; correspondence between the Delaware Office of Management, Budget and Planning (OMBP) and federal, State, and local agencies, as well as private organizations and individuals; various supporting materials submitted with the program document; and the program document itself.

The program document, developed in conjunction with the paper, supplements much of this discussion, and is particularly important with respect to the description of how the national interest in facility siting decisions will be considered during program implementation.

The paper describes national, regional, and State interests in resources and facilities which were considered during program development. It also indicates how competing interests have been weighed and how that weighing is reflected in the substance of the Coastal Management Program.

Describing and balancing the interests of nearly all the planet's resources and a great many facilities is an admittedly ambitious undertaking. It is for instance, very difficult to compare the value of 1000 acres of wetlands with the value of a coal-burning power plant located on that 1000 acre site. It is possible, however, to generally describe the impact of different land or water uses on the quality of human life. The decision to retain the natural condition of a given resource or to provide a new facility can then be made with a better understanding of what "trade-offs" are involved.

To present a clearer picture of those trade-offs, the paper considers the interrelationships between resources

and facilities twice. There is a section on each major resource, which in most cases discusses the interest in preserving the resource, the impact of different facilities on the resource, and the management of the resource in Delaware. Separate sections address the interest in each facility, the facility's impact on various resources, and the status of the facility in Delaware. The conclusion ties the sections together, and briefly summarizes why certain interests prevail over others. The paper suffers from repetition, but the methodology does impart a sense of what trade-offs are involved and how the Coastal Management Program resolves the conflicts.

Delaware's relative smallness makes the State's unique character and heritage sensitive to development. That development may be beneficial to the Nation as a whole, but undesirable from the State's perspective. In some cases, therefore, the national and State interests may not coincide. Neither this paper nor the program document claims that every Delaware Coastal Management Program decision maximizes the national value of the land or water use. However, they do consider the national interest, and the Coastal Management Program accommodates that interest whenever possible.

To avoid making a lengthy paper even lengthier, the rationale for similar decisions is not repeated in full. For example, the siting of either a deepwater oil terminal or a LNG facility may induce more development. The section on deepwater ports explains why a port may induce such development and its impact. It then explains that the policy on deepwater ports is based partially on the potential for that impact. The same reasoning would apply to LNG facilities, but is not repeated in the same detail. Further, numerous references are made to the program document in order to shorten the length of the paper. To obtain a good sense of the Delaware Coastal Management Program consideration of the national interest, both the paper and the document should be read in their entireties.

Another caveat involves the employment of the term "coastal strip." For purposes of the Coastal Management Program all of Delaware is included in the "coastal zone," as that term is used in the federal Coastal Zone Management Act. To avoid confusion with the "coastal zone" which is defined in the Delaware Coastal Zone Act and applies only to a portion of the State, the term "coastal strip" is used to identify the area defined in the State statute.

Finally, the sources of the information which appears in the paper bear some explanation. The paper was prepared by a consultant who from January, 1976 to the present, has worked on a full-time basis with the OMBP staff responsible for developing the Coastal Management Program. Among the most important sources of imput received during the development of the paper, were the countless informal discussions between members of the staff and the

author--not only in connection with the paper, but also with the program document.

Other valuable information was gleaned from the following sources: (1) several Coastal Zone Management Committee meetings at which federal agencies, State and local agencies, private industry, environmental action groups, and others were represented; (2) correspondence between OMBP and interested parties, particularly federal agencies; (3) dozens of conversations with federal, State, and local agencies, as well as private organizations; (4) federal statutes and other statements of legislative policy; (5) Executive Orders and other executive policy statements; and (6) a myriad of reports, studies, and plans.

The paper presents a great deal of data. The assumptions and methodologies underlying that data have not, in most cases, been examined. To enable the Secretary and others to evaluate the range and reliability of sources utilized, the paper makes liberal use of footnotes.

I. Water

A. The national interest

> "When the well's dry, we know the worth of water." -- Benjamin Franklin.

The U. S. Environmental Protection Agency, although not necessarily disagreeing with one of our wisest forefathers, has pointed out that:

> "Americans have come to realize that clean water is essential not only to our physical health and general well being, but to our national economic welfare. Clean water is necessary for drinking water supplies, agricultural and industrial use, commercial and residential development, recreational use, and for a healthier environment."[1]

The Army Corps of Engineers has added:

> "The Nation is concerned that all regions share in the national wealth; that individuals have an opportunity to enjoy the natural environment; that the quality of the environment will be protected and enhanced as the nation grows; and that the social consequences of contemplated water resource development actions are considered and taken into account during the planning process."[2]

Water resources affect a myriad of national interests, including: waste reception; flood control; soil erosion control; tourism; recreational activities, such as swimming, fishing, boating, and canoeing; commerical fisheries; wildlife; agriculture; navigation; industry; energy production; and defense.

Most of these receive detailed attention in later sections. There is, for an example, an entire section devoted to sewage treatment facilities and desalinization plants. This subsection focuses on withdrawal uses of water, water demand and supply, water quality, impact of water quality on health, and briefly, a few of the federal water management programs.

1. water uses, demand and supply

Only withdrawal uses of water are examined in this part. Instream uses, such as fishing and navigation, are discussed elsewhere. The cost of transporting water is prohibitive, thus most water uses require consideration on a regional, as well as national basis.[3]

On an average day in 1975, the Nation used roughly 359 billion gallons of water; 181 billion gallons for crop irrigation, 93 billion gallons for steam electric cooling, 51 billion gallons for manufacturing processes, 22 billion gallons for domestic purposes, 8 billion gallons for minerals production, and 4 billion gallons for miscellaneous uses.[4] The 1970 daily per capita withdrawal, excluding hydroelectric water uses, was 1,800 gallons.[5]

Nineteen seventy-five daily withdrawal in the Middle Atlantic water resource region equalled approximately 16 billion gallons; 327 million gallons for irrigation, 6.0 billion gallons for steam electric cooling, 5.3 billion gallons for manufacturing processes, 4.0 billion gallons for domestic purposes, 459 million gallons for minerals production, and 93 million gallons for miscellaneous uses.[6] The 1970 daily per capita withdrawal in Delaware, excluding hydroelectric water uses, was 2,200 gallons.[7]

The importance of water withdrawal for irrigation cannot be overstated. In the West, irrigation often is the difference between low production with uncertain income and high production with good farm income.[8] In the more humid East, irrigation can prevent crop failures, increase yields, improve product quality, provide frost protection, and mitigate the effects of high temperatures on specialty crops.[9]

Future water demand for irrigation is projected to drop to 167 billion gallons per day by the year 2000.[10] Total daily demand in the year 2000 is expected to decline by 56 billion gallons from the 359 billion gallons figure of 1975;[11] with another 70 billion gallons going for steam electric cooling, 19 billion gallons for manufacturing processes, 30 billion gallons for domestic purposes, 11 billion gallons for mineral production, and 5 billion gallons for miscellaneous uses.[12] The decline in manufacturing withdrawals reflect expected increased use of recycling facilities; projected reductions of water use for steam electric cooling anticipate the increased use of dry cooling towers to avoid thermal pollution; and increased domestic use is predicted due to population growth and greater per capita use.[13]

The daily water demands for the year 2000 in the Middle Atlantic region are projected at 596 million gallons for irrigation, 2.3 billion gallons for steam electric cooling, 2.1 billion gallons for manufacturing, 6.2 billion

gallons for domestic use, 699 million gallons for mineral processing, and 101 million gallons for miscellaneous purposes.[14]

These substantial requirements would be overwhelming were it not for the fact that nature pours an average of 4.2 trillion gallons of water on the 48 conterminous states per day.[15] The effective daily renewable water supply, that is what is left after evaporation or transpiration from vegetation, is equivalent to 1.2 trillion gallons.[16]

Groundwater reserves, many of which cannot be economically tapped, add another 30 years of water supply.[17] Groundwater aquifers presently supply more than 20 percent of the Nation's withdrawal use of water.[18] The Atlantic and the Gulf Coastal Plains contain the largest groundwater reserves in the Nation.[19] Present pumpage is only a small fraction of the supplies that could be developed, but salt-water encroachment along the coasts is a limiting factor in groundwater development.[20]

The Middle Atlantic region can expect an average daily water supply of 56.2 billion gallons in 95 out of 100 years, and no water quantity problems are anticipated, although severe shortages could occur in localized areas on a seasonal basis.[21] Water quality, however, poses a more serious problem.

2. water quality

Large quantities of water do not necessarily mean that the Nation's water demands will be met. Quality determines the usability of water and the suitability of a given water supply depends on the use for which it is needed. The familiar quotation--"Water, water everywhere, but not a drop to drink"--illustrates the importance of water quality. Men have perished in the middle of the ocean for the lack of drinking water. Fish cannot survive in waters with low levels of dissolved oxygen, and it is unhealthy for humans to swim in the presence of high quantities of coliform bacteria.

Water quality is a function of several characteristics, including light, temperature, circulation, turbidity, taste, odor, color, oxygen, metals, bacteria, nutrients, pesticides and oils. These characteristics can be altered by nature and man. The most important natural impurities are dissolved minerals and sediment.[22] Man-caused pollution consists primarily of waste discharges from industrial and domestic sources; salinity of irrigation return flows; sediment and other diffused wastes in runoff from urban, mined, industrial, and agricultural lands; and sediment from logging operations and roadway construction.[23] Water pollution sources and effects are critically important to the Nation and are discussed in several sections of this report.

The Council on Environmental Quality says that "there is growing evidence that some of our worst water quality problems have been diminishing."[24] Levels of nutrients, the primary cause of eutrophication, have increased, but significant improvements have occurred in terms of organic waste loads, coliform bacteria and additional pollutants that have been the subject of efforts to control point source pollution.[25]

Such efforts have been expensive. Federal funds obligated for water pollution control and abatement increased steadily from $677 million in 1970 to an estimated $5,492 million in 1976.[26] When water resource development programs are also accounted for, federal expenditures totaled $7.4 billion in fiscal year 1974, $9.1 billion in fiscal year 1975, and $10.2 billion (5 percent of the total budget) in fiscal year 1976.[27] State water quality control expenditures rose from $157.1 million in 1970 to $636.0 million in 1974, roughly 8 times the amount spent on air pollution control during the same period.[28] Total national expenditures for water quality control (excluding those made by agricultural business, real estate operators, private medical, legal, educational and cultural services, and nonprofit organizations) totaled $8,547 million in 1972.[29] Recent expenditures were undoubtedly higher and reflect the keen national interest in maintaining good water quality.

3. the impact of water quality on health

Germ-laden drinking water can cause salmonellosis, gastroenteritis, dysentery, typhoid, cholera, cancer, birth deformities, infectious hepatitis, and heart and blood disease.[30] At least 4,000 known cases of waterborne illnesses occur each year in this country.[31] The actual total may be 10 times greater.[32] Further, the long-term effects of low-level exposures to contaminated drinking water are undetermined.[33]

There are more than 50,000 community water supply systems in the Nation and more than 200,000 water supply systems serving locations such as restaurants and motels--many of which were not designed to cope with their present raw water quality.[34] A 1970 survey of nearly 1,000 public water supply systems disclosed that 56 percent had facility deficiencies relating to equipment design, construction or plant condition; 77 percent of the plant operators were inadequately trained in microbiology and 46 percent were deficient in the chemistry relating to their assignments; and 79 percent of the systems had not been inspected by State or county authorities during the preceding year.[35] In 1975, an U. S. Environmental Protection Agency survey of public water supplies in 80 cities revealed that all 80 cities' systems were contaminated with chemical compounds, some of which are believed to be carcinogenic.[36]

Recently, there has been evidence indicating that chlorinated hydrocarbons found in drinking water supplies, some of them possibly created in the process of "purifying" the water, may be cancer-causing.[37] The President, accordingly, has instructed the U. S. Environmental Protection Agency to develop standards to control such carcinogens as well as other toxic pollutants.[38] The next part discusses additional federal initiatives which reflect the national concern for water quality.

4. federal water management programs

A final measure of the national interest in water is the number and nature of federal programs dealing with the resource. Space does not permit a comprehensive listing or discussion of federal water quality-oriented provisions. Hundreds of individual water pollution bills were introduced during the 92nd Congress alone,[39] resulting in over 30 pieces of water resource-related legislation.[40]

One of those laws, of course, is the Coastal Zone Management Act. The statute declares that it is a national policy to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone."[41] The Act expresses a particular interest in water by extending the inland boundary of the coastal zone "only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters."[42]

The Costal Zone Management Act also requires that the Coastal Management Program incorporate requirements established by the Federal Water Pollution Control Act of 1972. The objective of this lengthy and complicated statute is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[43] In order to achieve this objective the act declares--

> "(1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985;
> (2) it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and progagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983;
> (3) it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited;
> (4) it is the national policy that Federal financial assistance be provided to construct publicly owned waste treatment works;
> (5) it is the national policy that areawide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each State; and

(6) it is the national policy that a major research and demonstration effort be made to develop technology necessary to eliminate the discharge of pollutants into the navigable waters, waters of the contiguous zone, and the oceans."[44]

The President has affirmed those Congressional goals, stating among other things that "we must enforce the Water Pollution Control Act, and reach our goal of making our lakes and streams suitable for swimming and fishing."[45]

The Act directs the United States Environmental Protection Agency to evaluate water quality criteria in terms of meeting the statutory objectives, and then to establish national effluent limitations and national performance standards for new sources of water pollution which guarantee that the desired levels of water quality will be attained. The law makes it illegal to discharge any pollutant into the Nation's waters without a permit, and permits are not issued unless compliance with the long-range effluent standards is assured. States have the option of administering the permit program, provided they set and enforce water quality standards at least as stringent as federal standards.

The Act also authorizes federal grants for planning, designing and building municipal sewage treatment facilities, and for assisting State governments plan for areawide waste treatment management. This latter program, so-called "208 planning," calls for the preparation of comprehensive plans for controlling water pollution from point and nonpoint sources. The Governors designate specific geographic areas as planning areas. Local or regional agencies then identify water quality problems in the planning area; identify pollution sources; recommend guidelines for locally developed management practices to curb pollution; recommend regulatory programs; and recommend State or local agencies needed to implement long-term water quality management programs. As of May 1977, 176 agencies had been designated to complete such plans, and State agencies are completing plans in areas where local agencies have not been designated.[46]

In his Environmental Message to the Congress, the President stressed the significance of expeditious completion and implementation of effective 208 plans and reemphasized the importance of the State and local planning efforts to the continued progress of the water pollution control program.[47] The next subsection discusses these efforts in Delaware.

B. Water resources in Delaware

In 1974, the average daily use of water in Delaware equalled 137.8 million gallons a day; 74.4 million gallons for municipal, institutional and military uses, 33.9 million gallons for industrial purposes, 13.9 million gallons for irrigation, 13.1 million gallons for rural utilization, and

2.5 million gallons for miscellaneous uses.[48] Nearly 59 percent of this total was provided by groundwater supplies.[49] Northern New Castle County's supply is the streams originating in the Pennsylvania piedmont--Brandywine River, White Clay Creek and Red Clay Creek--the rest of the State's supply is primarily from subsurface aquifers which are charged by rain falling directly on Delaware.[50] In 1974, groundwater supplied 98 percent of Sussex County's water needs.[51] Potential groundwater shortages exist in the Dover area in Kent County.[52]

The Delaware State Department of Health has established standards of drinking water quality which apply to all public water suppliers in the State.[53] Those standards set maximum recommended concentration levels for various substances, including nitrogen, chloride, iron, manganese, sulfate and total dissolved solids.[54] Potential danger exists especially where nitrate concentrations are excessive. Infant cyanosis ("blue baby" disease) has been connected with high nitrate levels in drinking water, which, in turn, often indicate contamination by sewage or other organic matter.[55] State Coastal Management Program efforts to eliminate this problem are described in another section.

The State Department of Natural Resources and Environmental Control (DNREC) has the primary responsibility for preventing high levels of water contamination in Delaware. It administers the permit system discussed above, pursuant to federal and State authorities. Much of the State authority appears in DNREC-adopted regulations, including rules related to: effluents standards for point sources of pollution; water quality standards for streams; solid waste disposal; and installation and operation of septic tank sewage systems.

DNREC also coordinates section 208 planning activities with 2 county agencies responsible for developing the plans. In addition, the Department itself is responsible for all the 208 planning in one area--Kent County and the western portion of Sussex. DNREC's entire water control program is incorporated into the Coastal Management Program.

DNREC reports that Delaware's streams are generally in very good condition and that the State will probably meet the national goals set by Congress.[56] Surface water quality problems are most serious in central Sussex and central New Castle Counties.[57] Most of the streams support the propagation of aquatic and other wildlife, the major exception being the Delaware River from its northern State reaches to the vicinity of the Chesapeake and Delaware Canal--a stretch dependent upon the upgrading of major industrial and municipal treatment facilities upstream in Pennsylvania and New Jersey.[58]

There are other areas of concern. Contamination of groundwater aquifers from landfill sites has been a problem. Pollution also results from the runoff of water, which carries nutrient bearing sediment into many bodies of State waters and causes eutrophication. DNREC and the U. S.

Environmental Protection Agency have studied this problem in selected ponds of the State.[59] Finally, urban development in the inland bays pose another major State water quality problem.

The State's current water quality control strategy is, inter alia, to abate pollution from existing point source discharges with the: (1) regionalization of waste water treatment; (2) upgrading of onsite wastewater treatment plants; and (3) elimination of discharges either by total recycling or land application.[60]

Nonpoint sources of pollution are being addressed through the section 208 planning process. Legislation has been drafted and introduced in the Delaware General Assembly, in large part through the efforts of the Coastal Management Program, which would authorize DNREC to expand its authority over sediment and erosion generating activities in the State--a major "contributor" to the nonpoint source problems.

Delaware seeks to resolve water resource problems not only in conjunction with the U. S. Environmental Protection Agency, but also through interstate coordination. Delaware shares its streams with Maryland, Pennsylvania and New Jersey. The quantity and quality of waters in commonly shared streams, therefore, are affected by actions of government, industry, agriculture and other interests.

Delaware coordinates directly with its neighbor states through their respective environmental protection agencies and indirectly via the Delaware River Basin Commission.[61] This Commission annually adopts a Water Resources Program which identifies Delaware River Basin water resource needs for the ensuing 6 years, and the projects and facilities scheduled to meet these needs.[62]

The Commission also reviews proposed projects or facilities to determine whether they will have a substantial effect on the water resources of the basin. The next subsection takes a brief look at some of those facilities which may be in the national interest.

C. Facilities which may be in the national interest and also impact water resources

This subsection generally describes facilities which may be in the national interest and which also impact water resources. The sections dealing with the facilities themselves provide more specific information on the facilities and their impacts.

Any facility which involves large-scale land development may impact water quality because of potential sediment and erosion problems. Surface water runoff carries sediment to water bodies and thereby increases turbidity,

reduces the photosynthetic activity of plant life, and, in some cases, smothers benthic animal life. In addition, large-scale development is typically accompanied by population influx which imposes greater demands on waste treatment facilities and on domestic water supplies.

Water supplies will also be affected if the facility itself requires substantial quantities of water. Heavy industrial, manufacturing and power plant operations are examples of such facilities. Those facilities also impact the quality of the water. In some instances, water discharges are contaminated with chemical waste, in other cases the water is thermally polluted. Power plants, in particular, present the latter problem. In either case, the water quality may be impaired, especially if the receiving waters are shallow and flush poorly.

Support facilities for outer continental shelf activities may also create water quality problems. In a statement to the Delaware Coastal Management Program, the U. S. Environmental Protection Agency warns that

> "The onshore effects of oil leases may very likely impact Lewes and vicinity. Increased development will then occur near Upper Rehoboth Bay, the portion most susceptible to eutrophication."[63]

Offshore oil activities may also increase the likelihood of oil spillage. The impact of oil well seepage depends on the quantity of oil lost and its proximity to shore. Catastrophic oil spills from transportation accidents and onshore storage or refinery mishaps severely threaten coastal water quality. Oils and petrochemicals are non-biodegradable and interfere markedly with water's ability to sustain fish and wildlife. Oily waters and beaches also discourage fishing, swimming, boating and other recreational pursuits.

Those pursuits can also be adversely affected by port-related activities. A serious secondary effect of marine transportation on coastal water quality is the intermittent disposal of spoil from channel and port dredging operations. Water turbidity and the smothering of benthic life are only part of the problem. Often the spoil is removed from a polluted area to a cleaner environment, thereby degrading the receiving waters. Moreover, by changing the topography of the water bottom, local states of equilibrium may be destroyed.[64] The dredging itself, of course, also causes temporary turbidity problems.

Boat emissions, be they discharges of human wastes or exhaust products from boats, also have negative effects, including noxious odors, unsightliness, sludge deposits, increase in concentration of pathogenic organisms, excessive oxygen depletion, toxicity to aquatic life, and stimulation of excessive algal growth.[65]

Submerged pipelines, unless they are very large or leak, do not affect water quality significantly. Turbidity will be temporarily increased during the construction period, but at tolerable levels.[66] Likewise, modest bulkhead or pier construction causes only short-term turbidity problems.[67]

Construction equipment and spills in maintenance yards can result in the passage of petroleum products into the water courses.[68] Also, highways will deliver large quantities of motor vehicle exhaust products--such as lead, hydrocarbons, oil from road washings, and asbestos from brakes linings--into neighboring streams.[69]

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II. Air

A. The national interest in clean air

> "Some segments of our population are interested in air pollution because it soils the paint on their homes and interferes with the proper growth of certain of their ornamental plants and shrubs. I welcome their support.
>
> "Other people ask for the abatement of air pollution primarily because they are tired of brushing soot off the sill every time they open a window for a breath of more-or-less fresh air.
>
> "There are yet others who seek an end to air pollution because their citrus groves will not flourish or their cattle will not grow properly in an atmosphere contaminated with certain types of pollutants.
>
> "Some seek an end to pollution because it interferes with the proper performance of their professions. These are represented by such diverse groups as city planners, airline pilots, farmers, and manufacturers--particularly those who need clean air to produce the products they market.
>
> "There are many who seek an end to air pollution because they don't like the smells that assail them where they live or work; and many who are chagrined because the mountains or the forest or the other aesthetic delights that they enjoyed as children are now obscured by a blanket of smog on too many days of the year.
>
> "All of these and others have good reasons for wanting to see the myriad sources of air pollution abated. But all of them I believe, would agree that the primary reason they favor control is that air pollution threatens human health. The threat to health, in my opinion, constitutes the primary impulse for the control of air pollution in the United States."[1] (Dr. William H. Stewart, Former Surgeon General, United States Public Health Service).

The President is more concise. He simply says, "Clean air is essential to the health and welfare of all Americans."[2]

The national interest in clean air may be classified into 4 broad categories: (1) protection of human health; (2) preservation of other fauna and vegetation; (3) conservation of materials; and (4) enhancement of aesthetic experiences.

1. protection of human health

The Congress, it seems, would agree with Dr. Stewart's assessment that the public health is "the primary impulse" for air pollution control. Under the Clean Air Act of 1970, national ambient air quality standards have been designated for major air pollutants, including total suspended particulates, sulfur dioxide, carbon monoxide, photochemical oxidants, nitrogen dioxide, and hydrocarbons. Those standards set different maximum levels which are permitted for the pollutants. The statute requires that "primary standards" be based on criteria allowing "an adequate margin of safety" and which "are requisite to protect the public health."[3] The Act also provides for "secondary standards" to protect the public welfare (that is, the public interest in clean air aside from health related benefits).[4] The Act emphasizes public health over welfare by allowing more time for the secondary standards to be met than the primary standards. In addition, the Clean Air Act requires special standards for particularly toxic pollutants which cause or contribute to "air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness."[5] Such pollutants include, for example, asbestos, beryllium, and mercury. That the Congress creates a special category for pollutants which may cause death or serious illness, reflects its concern not only over these effects of dirty air, but on less serious health effects as well.

Unfortunately, health damage depends not only on the concentration level of pollutants, but also on the physical conditions of individuals. There is no single threshold of pollutant concentration below which safe health will be assured.[6] At each level of pollutant concentration, someone will probably be adversely affected.

Some of these adverse effects exhibit themselves in the form of headache, dizziness, coughing, shortness of breath, sore throat, eye irritation, nasal discharge, nausea, vomiting, chest pains, skin ulcers, loss of appetite, and mental impairment.

The relationship between air pollutants and disease has been well documented. Respiratory diseases caused or aggravated by air pollution include emphysema--a progressive breakdown of air sacs in the lungs typically brought on by irritation of the bronchial tubes--chronic bronchitis, chronic constrictive ventilatory disease, bronchial asthma, lung cancer and the common cold. Cardiac diseases are often exacerbated by respiratory problems. Cancer outside the respiratory tract can also result, at least in part, from air pollutants. A National Cancer Institute report indicates that angiosarcoma, a form of liver cancer, is 3,000 times as likely to occur among workers exposed to vinyl chloride than among members of the general public.[7]

Sulfur dioxide and total suspended particulates are the major airborne pollutants responsible for most of the deleterious effects on human health.[8] Sulfur dioxide is very soluble in body fluids. The gas irritates the tissues lining the upper respiratory tract, resulting in bronchial constriction.[9] Prolonged exposure to sulfur dioxide may also affect ciliary activity and mucous flow.[10] Finally, sulfur dioxide sometimes combines with water, soot particles and other aerosols in the atmosphere to produce toxic acid aerosols and other contaminants far more dangerous than any of the individual ingredients.[11] According to the Council on Environmental Quality, "Suspended sulfate aerosols are believed among the air pollutants most damaging to human health...," contributing to chronic bronchitis, acute respiratory diseases in children, aggravation of asthma, heart and lung disease, and death.[12] Most airborne sulfur emissions originate from natural causes, but in the United States, manmade emissions--almost entirely in the form of sulfur dioxide--outweigh emissions from natural sources.[13] Combustion of fossil fuels, smelting of metal ores, and other industrial processes are the principal manmade sources of sulfur dioxide.[14]

Total suspended particulates originate from solid or liquid particles and are dispersed in the atmosphere as dust, ash, soot, and so on. They can aggravate asthma and other respiratory or cardiorespiratory problems, increase cough and chest discomfort, and increase mortality.[15] Principal sources of total suspended particulates include stationary combustion of solid fuels, construction activities, and industrial processes.[16]

Sulfur dioxide and total suspended particulates are not the only problem. Carbon monoxide, nitrogen oxides and photochemical oxidants also exert damaging effects.[17] Carbon monoxide interferes with the ability of blood cells to carry oxygen, a key requirement for efficient operation of nerve tissue. Low levels of carbon monoxide can induce headaches, as well as the slowing of physical and mental activity.[18] Exposure to low concentrations of nitrogen oxide which, like carbon monoxide, is present in automobile exhaust--can cause visual and olfactory abnormalities.[19] Exposure to photochemical oxidants, gaseous compounds produced from chemicals under the influence of sunlight, results in eye irritation and lung damage.[20]

Inhalation of asbestos fibers has been related to bronchogenic cancer, asbestosis, mesothelioma and other malignant diseases.[21] Beryllium, a metal commonly used in nuclear reactors, is thought to cause lung disease.[22] Mercury, used to manufacture paint, pulp, and paper, can affect the central nervous system and lead to insomnia, weight loss, tremors, and psychological disturbances.[23] High concentrations of lead in dust, vegetation and soil near roadways is also attributed to motor vehicles.[24] Excessive amounts of lead ingestion causes neurological impairment, including seizures, mental retardation and behavioral disorders.[25]

Death rates are influenced dramatically by air pollution. The National Institute for Occupational Safety and Health estimates that 100,000 American workers may die each year due to adverse working conditions.[26] The death rate from emphysema and lung cancer is twice as high in cities as in cleaner rural areas.[27] In 1952, deaths in London were 4,000 greater than normal during a 7 day period in which the city was enveloped by smog.[28] The death rate in Donora, a small industrial town in Pennsylvania, also jumped when a thick, stagnant fog blanketed the area for only 4 days. In addition, 6,000 of the 14,000 residents were struck with illness.[29]

Aside from insidious health hazards associated with air pollution, there are more drastic dangers. The Clean Air Act cites air pollution hazards to air and ground transportation as a "mounting danger to the public health and welfare."[30] For example, in Los Angeles, where smoggy days are commonplace, visibility often is less than the 3 mile minimum considered safe for the operation of airplanes.[31] The Senate Public Works Committee reported in 1963 that:

> "any smoke close to a modern highway can pose a serious threat to travelers. In at least two recent instances--one in Pennsylvania close to a smoldering culm pile, another in Los Angeles near a burning dump--the sudden application of brakes by a single motorist led to a chain reaction which involved the wrecking of a number of vehicles."[32]

Virtually all types of transportation can be affected. During the air pollution disaster in London, shipping was at a standstill in the Port of London with 60 ships fog-bound between Gravesend and the Nore.[33] All London bus service was halted, ambulances did not leave their garages, London Airport was closed for over 60 hours, and 2 trains crashed together in the fog.[34]

The cost of public health problems attributable to air pollution is in some respects incalculable. Nonetheless, the national cost of health damage resulting from air pollution has been estimated at over $8 billion annually.[35] Researchers commonly compute such costs as the present value of lost earnings plus the costs of medical treatment and prevention, absenteeism and burial.[36] Emphysema and chronic bronchitis, for example, are among the more significant causes of disability compensated by Social Security.[37]

But direct economic measures do not account for some of the most important costs of illness and death, the suffering of patients and the grief of bereft families.[38] As one commentator expresses it, "When someone suffers from a pollution-related chronic illness, the cost of pollution to him is almost infinite; the value of avoiding the pollution-induced discomfort is, for this person, immeasurably high.[39] The Environmental Protection Agency agrees:

"There is no way to ascertain absolutely the chronic effects of environmental pollution... But we must not suspend all judgment while we argue about proof. We know that environmental pollution has significant adverse effects on the physical and emotional health of Americans... As the costs of pollution control become more apparent, it is important to remember that the primary benefit--good health-- is priceless."[40]

2. preservation of other fauna and vegetation

Air pollution causes considerable damage to animals. Usually, however, cases are localized, sources are easily identified, and the economic consequences are not relatively serious.[41]

Poisoning of livestock from airborne metals, such as arsenic, lead, and molybdenum, is not uncommon.[42] In addition to the direct economic losses of animal mortality, significant losses may also result from the effects of decreased reproductivity and growth, as well as lower output of milk, eggs, wool, and so on.[43]

Damage to vegetation is more serious, at least economically. The U. S. Environmental Protection Agency estimated 1973 crop losses from high oxidant levels at almost $3 billion.[44] Damage to ornamental plants, flowers, lawns, and timber undoubtedly raises the figure substantially.

The air pollutants which cause the greatest harm to plant life are sulfur dioxide, hydrogen fluoride, photochemical smog and oxidants, ethylene, and herbicides and fungicides.[45] Generally, the plants most sensitive to sulfur pollution are those with succulent leaves having high physiological activity--plants such as alfalfa, squash, apple and the grains.[46] Fluoride--which is emitted during the industrial processing of fertilizers--aluminum, and steel, cause plant tissues to die at the edge and tip of the leaf.[47] Nitrogen dioxide sometimes restricts the growth of plants without exhibiting any other characteristic symptoms of injury.[48]

Air pollution places restrictions on the types of vegetation that may be raised in many areas. For example, in metropolitan areas, photochemical smog often makes it impossible to raise orchids.[49] In neighboring New Jersey--the Garden State--air pollution induced damage has been reported in every county and to at least 36 commercial crops.[50] The national interest in crops is discussed at greater length in the section on soils.

3. conservation of materials

Air pollution abrades, corrodes, tarnishes, soils, erodes, cracks, weakens, and discolors materials of many

varieties. Air pollutants devastate many materials, including rubber, textiles, paints, metals, electrical contacts, paper, leather, plastics, and stone.

In 1968, the national cost of air pollution damage to materials, excluding residential property damage which was estimated at $5.2 billion by itself, was $4.7 billion.[51] Air pollution induced corrosion of metal alone cost the country over $1.6 billion in 1973.[52] Steel corrodes 2 to 4 times faster in urban and industrial areas than in rural settings.[53] It has been estimated that one third of the replacement cost of steel rails in England is attributable to sulfur pollution.[54]

The burning of sulfur-bearing coal and oil has also forced electrical equipment manufacturers to use gold for electrical contacts, because other metals such as silver and palladium resist the passage of electrical current when corroded.[55] Nylon stockings can be ruined in a matter of minutes by sulfur pollution.[56] Sulfur accelerates the erosion of stone statuary and buildings. In many cities conservationists have moved art works indoors for preservation purposes. Cleopatra's needle reportedly has deteriorated more since its arrival in New York in 1881 than it did during the more than 3,000 years it spent in Egypt.[57]

Air pollution also accounts in large measure for the grime of life. It means we must wash our cars, paint our houses, and clean our buildings more frequently.[58]

4. enhancement of aesthetic experiences

The national interest in preventing grime, of course, cannot be defined merely in terms of the desire for shiny automobiles. Aesthetic damage caused by air pollution, though difficult to quantify, represents one of the most significant categories of economic loss suffered as a result of degraded air quality.[59] Aesthetic damages include assaults on the sense of smell, reduction in visibility, and destruction of art works or historical relics.

Odors can interfere with outdoor recreation, ruin sleep, produce discomfort, dull appetites, and disrupt normal social and family relations. Aesthetic damages caused by noxious odors have been documented by opinion surveys. A survey conducted in St. Louis showed that 926 of 1361 complaints received during a 4 year period by the local division of air pollution control pertained to odors.[60] Further, over 73 percent of the subjects interviewed defined the concept "air pollution" as offensive odors.[61] Ninety-one percent of the respondents in another survey made a similar identification of air pollution with odors.[62] A study in Cincinnati revealed the same connection, and over half the complaints received by air pollution control officials involved odors.[63]

Odors can be a regional problem. Public Health Service investigations of an interstate ordor problem along

the Vermont-New York boundary turned up evidence that a conjunction of stable atmospheric conditions and a wind speed of 5 miles per hour were enough to transport noxious hydrogen sulfide fumes from the International Paper Company mill in Ticonderoga, New York 31 miles downwind.[64] Similarly, an accident at a chemical plant in Carteret, New Jersey, released a cloud of smelly ethyl mercaptan gas that covered Manhattan from the Hudson to the East River, from City Hall to the vicinity of 90th Street.[65]

Decreased property values frequently reflect the costs associated with aesthetic problems of air pollution. Several studies have documented how property values have risen as a result of cleaner air. The estimated property value benefit of shifting to low sulfur fuels in St. Louis back in 1960 was $10-15 million.[66] Abatement of air pollution in 3 cities is believed to have enhanced property values from $300-700, per property.[67] Finally, the National Academy of Sciences in 1974 reported to the United States Senate that its study indicated that implementation of the Clean Air Act meant annual increases in real estate values of $1.5-5 billion per year for the entire United States.[68]

5. total economic national interest in clean air

The total national pollution damage resulting from air pollutants has been estimated as low as $6.0 billion for the year 1968 and as high as $35.4 billion for the year 1973.[69] Many economic analyses do not account for avoidance costs--money spent to avoid damages, for example, the cost of air filters, plastic bags, and so on.

Still another measure of the national interest in air is the amount of money the Nation spends in an attempt to keep it clean. In 1972 approximately $6.5 billion was spent on air pollution control programs, or about one-half percent of the GNP.[70] An estimated 356.5 million federal tax dollars will be spent to control and abate air pollution in 1977.[71]

Although only a small portion of this sum will be spent in Delaware, the foregoing discussion makes it obvious that the national interest, as well as the regional, State and local interests, in clean air in Delaware is enormous.

B. Air quality in Delaware

Pursuant to §107 of the Clean Air Act, air quality control regions have been designated as the basic geographic units in which the air control programs take place. The regional boundaries are based on considerations of climate, meterology, topography, urbanization, and other factors affecting air quality in each area.[72] The country has been divided into approximately 250 regions, 2 of which encompass Delaware.

Also pursuant to the Clean Air Act, Delaware has formulated an "implementation plan" to meet, maintain and enforce the primary and secondary national ambient air quality standards--discussed above--for pollutants in each of the 2 air quality control regions within the State's jurisdiction. The plan is adopted by the Coastal Management Program.

For the most part, the State air quality control program has been successful. Particularly encouraging has been the substantial reduction of sulfur dioxide emissions. In 1969 the total weight of sulfur oxide discharges in Delaware was 231,586 tons, compared to 140,153 tons in 1974.[73] Similar reductions were noted in carbon monoxide emissions.[74]

Most of the national primary and secondary ambient air quality standards are now being met in Delaware. Unfortunately, a few difficulties persist. New Castle County oxidant levels are violating the national primary standards.[75] The problem probably exists statewide, but had been documented only in New Castle as of October, 1977.[76] Oxidants are formed in the atmosphere, in part, from hydrocarbons. Inspection and maintenance programs for motor vehicles is one method for dealing with the problem which the State will probably consider if other approaches prove unsatisfactory.[77]

At least until very recently, the Port of Wilmington has not met the national primary or secondary standards for total suspended particulates, probably because of heavy traffic and other transport operations. The terminal is cooperating with State guidelines--for example, paving dirt roads--to correct the situation.[78]

Finally, the national secondary standards for total suspended particulates are not being met in downtown Wilmington due to short-term construction activity.[79]

Delaware's failure to attain and maintain all the national levels of air quality for each of the principle classes of pollutants is hardly surprising. As of Mid-1975, the standard levels had been fully achieved in only 91 of the Nation's 247 air quality regions.[80] The standards were exceeded for total suspended particulates in 118 of the 247 regions.[81]

Several obstacles confront efforts to reduce air pollution. Aside from the occasional lack of adequate scientific knowledge, as well as available technology and legal mechanisms for dealing with air pollution, the Nation's economic and energy problems have dictated compromise. Some facilities, for example, have been granted extensions or variances which permit the burning of fuels with high sulfur contents.[82] Earlier discussion has identified some of the facilities which sometimes "contribute" to high air pollution levels. The next subsection takes a closer look at those and other facilities.

C. Facilities which may be harmful to air quality

Any facility or combination of facilities which emits high concentrations of air pollutants into the atmosphere may be harmful to air quality. Manufacturing facilities, military bases and installations, aerospace facilities, petroleum refineries, gasification plants, oil and gas rigs and storage or transportation facilities, power plants, deepwater ports, LNG facilities, geothermal facilities, highways, railroads, airports, ports, sewage treatment plants, and desalinization plants all may be the site of air quality problems.

Combustion of fossil fuels at stationary sources accounts for most of the sulfur dioxide, nearly one-half the nitrogen oxides, and a large portion of the particulate matter emitted nationwide.[83] Airborne arsenic, beryllium, chromium lead, mercury and fluorides are also by-products of fossil fuel combustion. In Delaware, all categories of air pollution attributable to fuel combustion increased in each of the 3 counties from 1970-1974.[84] Nationally, no appreciable progress in the reduction of air pollutant emissions from fuel combustion was made over a similar period.[85]

Electric plants and industrial facilities are major utilizers of fossil fuels. Sixty percent of the total sulfur oxide, almost one-half the total nitrogen oxides and over one-third the total particulate matter emissions in Delaware resulted from power generation in 1974.[86] The nationwide geographic pattern of sulfate levels corresponds roughly with the geographic distribution of sulfur dioxide emissions and power plant sites.[87] Nuclear power generation, of course, presents the spectre of air contaminants in the form of radioactive substances, for example, Co-60, I-137, and Sr-90.

DNREC recently expressed concern that the siting in Delaware of new major sources of air pollution, particularly oil refineries, would interfere with maintenance of national ambient air quality levels.[88] Air pollution emissions in tons per year for a standard size oil refinery are 1,591 for particulates, 3,739 for sulfur oxides, 11,408 for hydrocarbons, 4,363 for nitrogen oxides, and 330 for carbon monoxide.[89] Gas processing plants typically emit 94 tons per year of particulates, 91 tons of sulfur oxides and 232 tons of hydrocarbons.[90] Standard size petrochemical complexes release 383 tons of particulates and 2,625 tons of hydrocarbons into the atmosphere annually.[91]

Deepwater ports may also cause substantial hydrocarbon loadings. Nearly half the Nation's hydrocarbon emissions result from solvent use and from the storage, shipping, and handling of gasoline and other petroleum derivatives.[92]

Even the construction of small structures, such as a gas or oil pipeline, has an adverse effect upon the air quality during the construction period. Emissions from heavy duty diesel-powered construction equipment, cars, and boats can cause severe temporary local problems. Ports, airports, and marinas may be subject to continuous air quality difficulties due to high density vehicular traffic in and out of such facilities.

Some facilities, of course, may emit air contaminants and still exert a net benefit on air quality. Power plants, for example, are more desirable from an air pollution perspecitive, than individual coal-burning stoves in each house. Likewise, waste treatment plants may add to air contaminant loadings, but at the same time eliminate noxious odorants which would otherwise result from inadequately treated sewage.

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III. Wetlands

> "The Nation's coastal and inland wetlands are vital natural resources of critical importance to the people of this country. Wetlands are areas of great natural productivity, hydrological utility, and environmental diversity, providing natural flood control, improved water quality, recharge of acquifers, flow stabilization of streams and rivers, and habitat for fish and wildlife resources. Wetlands contribute to the production of agricultural products and timber, and provide recreational, scientific, and aesthetic resources of national interest." (Statement by the President Accompanying Executive Order 11990. May 24, 1977).

The Congress, of course, also recognizes the national importance of wetlands. The Coastal Zone Management Act states "(t)here is a national interest in the... protection...of the coastal zone."[1] It also says that there is an "urgent need to protect and to give high priority to natural systems in the coastal zone."[2] Finally, the statute identifies wetlands as part of the coastal zone.[3]

The President's statement expresses in general terms the national interest in wetlands. The remainder of this section explains in greater detail why wetlands are important to the Nation. It also describes wetland resources in Delaware. Finally, it identifies facilities which may be in the national interest, but which may also be harmful to wetlands.

A. The national interest

1. wetlands as a source of food

> "As salt grass dies and falls into the water...the microscopic life (bacteria, fungi, etc.) convert the plant tissues into particles circulating in the rich sea waters, which are high in proteins, minerals, carbohydrates and vitamins. Picture this process as a marine food factory wherein the foods thus prepared are made available to the teeming populations of hungry creatures by way of the excellent distribution system performed by rhythmic tidal action of the water. The patrons of this manufacturing and distribution plant are varied indeed and in number: Clams, oysters, mussels and scallops, as well as all the smaller

> fishes, crustaceans and other marine animals which feed on the microscopic life and in turn are fed upon by larger fishes, birds, mammals and man, himself."[4]

The Environmental Defense Fund has referred to wetlands as "the most productive biological resources on the planet."[5] Wetlands are naturally fertile due to efficient nutrient exchange, flowing water, accessibility to light and year-around primary production.[6] Ten times as productive as ordinary agricultural lands,[7] an estuarine marsh can produce up to 242 pounds of foodstuffs per acre per day all year long without help from human labor.[8]

Human labor, of course, is needed to capture the food value of wetlands once it is converted into an useable form. A later section describes in detail the national interest in fisheries and other wildlife. For now, it is sufficient to note that most of the food we take from the ocean spends part or all of its life eating what wetlands produce.[9] In addition, around 90 percent of the species of commercial importance either pass their entire lives within the estuary or use it as a nursery ground during the critical early life history stages.[10] The U. S. Fish and Wildlife Service, for example, has pointed out that the larvae of shrimp spend 3 to 4 months in an estuary before migrating to the ocean; many oysters and crabs spend their entire lives in estuaries; and anadromous fish, such as salmon and shad, rest there during their migration from salt to fresh water.[11] The National Marine Fisheries Service has simply said that marine biota are "very dependent" on wetlands.[12] It is no surprise, then, that the Congress, in the Fish and Wildlife Coordination Act, has acknowledged the importance of protecting the habitat of the Nation's wildlife resources.[13]

2. <u>wetlands and the national interest in recreation</u>

> "Only those people that have directly experienced the wetlands that line the shores of our bay can appreciate their mystic qualities. The beauty of rising mists at dusk, the ebb and flow of the tides, the merging of fresh and salt waters, the turmoil of wind and weather--all unite to create an environment that man has only superficially explored."[14]

The national recreational interest in wetlands is difficult to quantify, although figures are presented in the Fish and Wildlife section of the paper on what people pay for sport fishing and waterfowl hunting.

Hunting and fishing, of course, are not the only recreations pursued in wetlands. As the U. S. Fish and Wildlife Service has put it, "those who have seen a...flock of waterfowl wheel...into a tidal marsh feel that they have

as real a stake in our wetlands as do the hunter and fisherman."[15] The Service has also reported, not surprisingly, that the hiker, photographer, birdwatcher, and naturalist spend far more hours enjoying scenic wetland areas than do the hunter and fisherman.[16]

Finally, the President, in his recent Environmental Message to the Congress, underscored the national recreational interest in wetlands by proposing a budget increase of $50 million over the next 5 years to purchase wetlands "to protect and sustain waterfowl for recreational enjoyment."[17]

3. wetlands' contribution to water quality

The national interest in high quality water has already been described. Both the U. S. Environmental Protection Agency and the U. S. Fish and Wildlife Service emphasize the important role that wetlands play as a pollutant filter.[18] When water, polluted by agricultural fertilizers and sewage runoff, enters the marsh, the nutrients are trapped by the tidal circulation pattern and absorbed by the vegetation and detritus. Those nutrients are then recycled in the aquatic food web.

In effect, wetlands act as a tertiary treatment plant for nutrients. Such treatment is very expensive if done by man in artificial systems. One study, for example, concludes that the income-capitalized value of wetlands for waste assimilation is approximately $50,000 per acre, 25 times greater than its value in by-product production, such as fisheries.[19] Delaware's wetlands act as a cleansing buffer zone between the Nation's waters and heavily fertilized agricultural lands, industrial waste treatment plants, and other potentially serious sources of water pollution.

4. wetlands and coastal stabilization

Wetlands prevent storm damage, provide erosion control, and contribute to harbor maintenance. They have a tremendous capacity for absorbing water and the energy from storm waves. For instance, wetlands can soak up to 18 times their volume in water.[20] The resiliency of the millions of stalks of wetlands cord grass serves to mitigate the shock of pounding waves before they reach manmade structures.[21] The net result is savings in human life, as well as reduction in the national cost of "disaster relief" and expensive bulkheading--priced at a minimum of $100 per foot of edge.[22]

By catching the silt in rain runoff, wetlands prevent harbors and channels from filling in.[23] The powerful flow of water in and out of tidal basins also tends to keep harbors and inlets "dredged."[24] An article published in 1883 describes how the early harbors on the southeastern coast of England were silted in when the marshes were diked and filled in; constant dredging and "a vast expenditure of national funds" then became necessary to keep the harbors operational.[25]

5. wetlands as an educational resource

The President's reference to the scientific value of wetlands should not be overlooked. Wetland areas serve as ideal natural laboratories for the study of many biological processes upon which elemental food chains are based. Moreover, their proximity to coastal population centers provides convenient access for millions of would-be students.

6. economic value of wetlands

All of the foregoing national benefits bestowed by wetlands have associated monetary values, regardless of how difficult their computation might be, and a few attempts have been made to determine the dollar value of wetlands. One author estimated water use values--including uses not discussed herein, such as livestock watering, irrigation, fire protection, and so forth; product values--for example, cattail crop; habitat values--waterfowl, gamebirds, and so on; recreational and educational values. He concluded that the capitalized value of one acre of wetlands to the community was at least $350.[26] This modest assessment admittedly overlooked many values, most of them major ones. It did not examine wetlands for their value in fisheries by-products, the potential for aquaculture development, waste assimilation, or total "life support" in terms of primary production.

Another study did quantify those values. The income-capitalization value of one acre of wetlands was appraised in 1973 at $2,000 for commercial and sports fisheries; $18,000 for an intensive oyster aquaculture; $5,600 for secondary waste treatment; $19,000 for phosphorous removal; $50,000 for tertiary waste treatment; and $83,000 for total life support.[27] Although those figures and the assumptions upon which they are based may be questioned, there is no doubt that wetlands are an extremely valuable national resource.

B. Wetlands in Delaware

There are some 106,000 acres of wetlands in Delaware, roughly 8 percent of the State's total area.[28] Wetlands in neighboring coastal states--New Jersey, Pennsylvania and Maryland--constitute a much smaller percentage of their respective land areas.[29]

Most of the Delaware wetlands are in close proximity to the Delaware Bay. Approximately 23,700 acres of the wetlands are in New Castle County, 52,300 acres are in Kent County, and the remaining 30,000 acres are in Sussex County.[30] The most valuable wetlands are concentrated in Kent County, primarily in the coastal saline type marshes from Woodland Beach to Little Creek, which have high waterfowl value.[31]

The next subsection and later sections of the paper, as well as the Coastal Management Program document itself, describe the fragility of the wetlands, and the State concern for them. Here it is sufficient to note that wetlands are designated as Geographic Areas of Particular Concern in which no substantial development is permitted.

C. Facilities harmful to wetlands

> "The unwise use and development of wetlands will destroy many of their special qualities and important natural functions. Recent estimates indicate that the United States has already lost over 40 percent of our 120 million acres of wetlands inventoried in the 1950's. This piecemeal alteration and destruction of wetlands through draining, dredging, filling, and other means has had an adverse cumulative impact on our natural resources and on the quality of human life." (Statement by the President Accompanying Executive Order 11990. May 24, 1977)

1. general activities

The wetlands discussion in the program document provides a detailed analysis of human actions--including dredging, spoil disposal, impounding, ditching, waste disposal, and certain agricultural practices--which have given rise to the President's concern. Any facility which significantly alters the natural balance of the wetlands ecosystem is likely to be harmful. Obviously any large-scale filling operation necessarily contributes to the national loss of the resource. Such loss still proceeds at the alarming rate of some 300,000 acres per year.[32]

From the developer's viewpoint, wetlands make an attractive investment. The land is often cheap, water transportation is just a canal away, and natural waste disposal systems come free of charge. Developers typically dredge the bay bottom and place the spoils on top of the salt marshes for building lots. Homes are erected using septic tanks for sewage disposal. That type of unregulated construction destroys the bay bottom, suffocates the marsh, and degrades the water quality. The exchange of plant energy between land and water, an exchange critical to the natural function of the marsh, halts.[33]

Unfortunately, the private wetlands owner cannot readily capture the value of his property in its natural state. He or she has a strong economic incentive to develop the marsh, but, as the President points out, the "(d)estruction of wetlands shifts economic and environmental costs to citizens...who have no voice in the decision to alter them."[34]

However ineffectual that voice may be, citizens are reluctant to spare it. A public opinion poll in Delaware revealed that over 66 percent of Delaware's residents favor preserving wetlands as a natural area; 19.5 percent support development for public recreation; only 2.2 percent recommend development for residential use; 5.2 percent endorse development for light industry; and a mere 2.1 percent countenance development for heavy industry.[35] The need for oil, steel and chemicals persuaded only 6.9 percent of those polled to support development of the wetlands by the industries associated with those products.[36] Surprisingly, the jobs which those industries generate justified development in the minds of just 5.5 percent of the people surveyed.[37]

Several groups in Delaware have voiced strong opposition to wetlands development. The program document refers to the Wetlands Action Committee, the State Preliminary Comprehensive Development Plan, the plans of New Castle and Kent Counties, and at least 8 smaller political subdivisions, all of which call for the preservation of wetland areas. In addition, a blue ribbon coastal zone study committee has advised the Governor and the General Assembly that "wetlands should be designated as Areas of Absolute Conservation."[38]

2. specific facilities

Any facility which requires the filling of wetlands is harmful. Thus, the siting of military bases and installations; defense manufacturing facilities; aerospace facilities; interstate highways; airports; sewage treatment and desalinization plants; energy storage facilities; power plants; LNG facilities; geothermal facilities; and so forth in wetlands themselves would be harmful to the resource.

Some of those facilities pose grave ecological threats when located near the wetlands. Large industrial plants such as oil refineries, chemical plants and cement plants, require extensive piping systems, placement of power lines, and installation of plant drainage systems, all of which may impact the surrounding area. Air and water waste discharges are frequently drastic. Petrochemical complexes threaten the value of the wetlands as a wildlife habitat with accidental oil spillage.[39] Tidal action aggravates the impact of such spillage. As the Governor's Task Force on Marine and Coastal Affairs has expressed it,

> "If a petrochemical industry, or a comparable industry, is established in the Liston Point or Big Stone Beach areas, there may be undesirable effects upon existing fish and wildlife within at least a 15-mile distance from these areas because of tidal action."[40]

Oil storage and transfer systems, of course, pose similar problems.

Pipelines, if they do not leak, may be laid in wetlands with relatively minor effects. Vegetation and other life forms are disturbed in narrow strips, but normally re-establish themselves after construction is completed, if the final height of the covered pipe is level with the original ground surface.[41]

Pier construction over a fringe marsh results in the loss of the wetland vegetation underneath the pier.[42] Piers over tidal flats impede algae growth, interfering with production and nutrient recycling in the area under the pier.[43] Grass beds are influenced by pier construction and by boat traffic. Increased turbidity, sedimentation, and decreased light penetration sometimes result in destruction of grass bed areas as fish breeding, nursery, and feeding areas.[44] Ironically, marinas tend to destroy the source of the primary attraction for boat owners--sport fishing.[45]

In sum, wetlands are vital and fragile resources in dwindling supply.

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IV. Fish And Wildlife

The Wetlands section identified propagation of fish and wildlife as one of the national interests in wetlands. This section describes the national interest in fish and wildlife itself. The first subsection discusses the importance of the fishery. The next subsection presents the interest in wildlife refuges and reserves. The third subsection describes the national interest in endangered wildlife, both animals and plants. The fourth subsection outlines Delaware's contribution to fish and wildlife resources. The concluding section identifies coastal facilities and uses which may conflict with wildlife resources. The section, taken as a whole, underscores not only the national importance of wildlife, but also the natural habitats which literally give fish and wildlife a place in our world.

A. The fishery

Section 2 of the Fishery Conservation and Management Act of 1976 says,

> "The Congress finds and declares the following: (1) The fish off the coasts of the United States, the highly migratory species of the high seas, the species which dwell on or in the Continental Shelf appertaining to the United States, and the anadromous species which spawn in United States rivers or estuaries, constitute valuable and renewable natural resources. These fishery resources contribute to the food supply, economy and health of the Nation and provide recreational opportunities."

This subsection discusses the fishery resource in terms of its contribution to food supply, recreational opportunities and the economy.

Fish and shellfish consumed directly by man provide about 14 percent of the world's supply of animal protein.[1] Indirectly, in the form of oil and meal fed to domestic animals, fish provide another 10 or 11 percent of the world's animal protein.[2] Some experts have estimated that the total sustainable annual harvest of all fishery species might be on the order of 300 to 650 billion pounds, a volume of animal protein sufficient to furnish a substantial share of the basic requirements of a future world population of 6 billion expected by the year 2000.[3] Almost one-fifth of those vast resources lie within 200 miles of the United States coasts--the area over which our Nation exerts fishery management controls.[4]

In 1973, the average person in the United States consumed directly 12.6 pounds of commercial edible fishery products.[5] When indirect consumption is added, that weight is 48.7 pounds.[6] Recreational catches add another 7.5

pounds, for a total of about 56 pounds per person.[7] In 1975, the United States consumed approximately 7 billion pounds of fish.[8] By 1985, consumption may rise as high as 8.7 billion pounds.[9]

The national recreational interest in the coastal fishery can also be documented. In 1970, 9.5 million fisherman spent 113 million days saltwater fishing.[10] Over half of those men and women spent over half those days on the Atlantic Coast.[11] One in every 3 American men and one in every 9 American women fished somewhere.[12] A total of nearly 2.6 billion miles was travelled to and from saltwater, "just to go fishing." A good deal of that mileage was not local.[13] Almost 3.2 million fishermen travelled out-of-state to reach saltwater fishing areas.[14]

The 1970 figures demonstrated a substantial increase over similar figures collected for 1955. That the trend has continued is supported by recent data. The number of recreational fishermen enjoying saltwater fishing had jumped from about 9.5 million in 1970 to over 16.3 million in 1975.[15] Moreover, the results of several recent marine recreational fishing surveys indicate that participation is much greater than previously believed.[16] Although such surveys yield estimates only, it is evident that the total number of saltwater recreational fishermen is tremendous and growing.[17]

Those fishermen impact the United States economy significantly. In 1970, over $1.2 billion was directly spent on saltwater fishing.[18] To that $1.2 billion could be added $1.5 billion in primary economic benefits, for a total of $2.7 billion.[19]

The Congress has recognized both the recreational and commercial benefits bestowed upon the economy by the fishery:

> "Commercial and recreational fishing constitutes a major source of employment and contributes significantly to the economy of the Nation. Many coastal areas are dependent upon fishing..."[20]

The 1973 United States fishery employed 243,000 people, utilized 90,000 crafts, and used 3,500 shore establishments.[21] The commercial dockside value of the catch in 1975 was $971 million.[22] It is estimated that the total impact of the fishery on the United States economy is in the neighborhood of $6.5 billion.[23]

The value of the fishery will probably increase. As the National Marine Fisheries Service explains, "In this... age of growing populations and growing demands for food--the sea remains both a frontier and a storehouse of living resources of immense value."[24]

In spite of the sizeable positive impact the national fishery makes on the economy, the national need for

fishery products may become an economic liability. United States consumption of fishery products has nearly doubled in the last 25 years, the increase being met by a fourfold step-up in imports.[25] The 1975 harvest accounted for slightly less than half of total United States consumption, the remainder being imported.[26] The total dockside value of imports was approximately $1.6 billion compared to only $305 million worth of exports.[27] If the projected national demand for fish is to be met by United States fishermen, the present national catch of edible fish must be doubled and the total catch, including industrial fish, must be increased by about 50 percent.[28]

Twenty years ago the United States was the world's second largest fishing nation.[29] By 1974 it was fifth, catching only 4 percent of the world's fish supply.[30] In 20 years the Nation's catch dropped 8 percent, while some foreign nations increased by as much as 250 percent.[31]

Much of the foreign catch has been within 200 miles of the United States coasts, and at the expense of certain finfish stocks which have been fished far beyond their maximum sustainable yields. The result, in some cases, is that United States fishermen must now expend more effort to catch fewer fish. The national interest in the fishery prompted the Congress to pass, and the President to sign, the Fishery Conservation and Management Act of 1976 to correct those abuses and promote the fishery. The next subsection discusses additional Congressional measures which protect wildlife habitat.

B. Wildlife refuges and reserves

> "It can be stated unequivocally that our Nation owes much of its strength and tradition to a bountiful fish and wildlife heritage. The future would be far more appealing were there some assurance it would be built in harmony with nature and tradition."[32]

The Congress has taken several steps to provide such assurance. Aside from the Fishery Conservation and Management Act, several statutes address the national interest in wildlife refuges and reserves. Among these are the Pittman-Robertson Act, the Dingell-Johnson Act, the Land and Water Conservation Fund Act, the Wild and Scenic Rivers Act, the Wilderness Act, the National Wildlife Refuge Administration Act, the Fish and Wildlife Coordination Act, the Migratory Bird Conservation Act, the Endangered Species Act, and the Federal Land Management Policy Act. Indeed, there are over 100 treaties, international agreements, federal statutes and executive orders which provide wildlife programs in this country.[33] As a result, the President has directed the Council on Environmental Quality to report to him with steps needed to simplify, coordinate, and codify the body of law on wildlife protection.[34]

One of the more important of these laws is the Wilderness Act of 1964. Upon passage, this statute immediately designated some 9.1 million acres of national wilderness as areas where roads were generally barred forever; where timbering, commerce and manmade structures were permanently banned; and where motor vehicles, with few exceptions, were not allowed. During the next 10 years, Congress added 71 new areas to the Wilderness Preservation System.[35] By 1975, Wilderness Areas amounted to 12.7 million acres, which is 2 percent of our public lands and .5 percent of all the land in the United States.[36] An additional 26.9 million acres has been proposed for preservation and another 35.5 million acres is being reviewed for possible addition to the system.[37] Fortunately, there is still time for preservation. Over 200 million acres is still suitable for wilderness designation.[38]

Another statute, the National Wildlife Refuge System Administration Act of 1966, is the law consolidating federal wildlife holdings into the national Wildlife Refuge System. The legislation gives the United States Fish and Wildlife Service broad discretion over what types of activities will be allowed in refuges, with management of each refuge tailored to the species and habitat being protected. The main purpose of the refuges is to protect and provide breeding grounds for wildlife, particularly migratory birds and endangered species, although almost all of the refuges are open to limited hunting.[39] As of June 30, 1974 there were 367 National Wildlife Refuges encompassing over 32 million acres in 49 states.[40] Despite the enormity of the total holdings, some of the refuges are small. For example, Pelican Island, Florida is only 6 acres.[41]

Wildlife reserves and refuges serve the national interest in several ways. One federal statute identifies one wildlife resource--wild and scenic rivers--as possessing "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, cultural, and other similar values."[42] Another, the Fish and Wildlife Coordination Act, recognizes "the vital contribution of our wildlife resources to the Nation (and) the increasing public interest and significance thereof due to expansion of our national economy and other factors..."[43] The Wilderness Act of 1964 says:

> "In order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American People of present and future generations the benefits of an enduring resource of wilderness. For this purpose there is hereby established a National Wilderness Preservation System to be composed of federally owned areas designated by Congress as "wilderness

areas", and these shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness..."[44]

Enjoyment is without question one of the more important national interests in wildlife areas. In 1970, 13.5 million American men--one in every 5--and 869,000 American women hunted.[45] Nearly 3 million waterfowl hunters spent $244 million, travelled 567 million miles, and spent 25 million recreational days hunting.[46] Over half a million hunters spent over 4 million days waterfowl hunting in the Atlantic flyway alone.[47] More money, $85 million, was spent hunting this flyway than any of the other 3 American flyways.[48]

There is every indication that wildlife areas are in greater demand than ever. The number of hunters in the United States jumped from 14.4 million in 1970 to 20.5 million in 1975.[49] There were 8.6 million migratory bird hunters in 1975, 2.5 million of which hunted geese and 4.8 million of which hunted ducks.[50] Those hunters spent a total of $949 million on hunting equipment, food and drinks, lodging, transportation, hunting fees and other bird hunting related costs. The 1976 waterfowl hunters spent 15.2 million days harvesting over 15 million ducks, 1.6 million geese, and 962,200 coots.[51]

A great deal of this and other hunting does not actually take place in designated wildlife refuges or reserves. In 1975, 67 percent of all United States hunting was on private lands, 9.5 percent on federal lands, 8.7 in state wildlife management areas, 9.3 percent in other public areas, and 5 percent on lands of unknown ownership.[52] Nonetheless, public wildlife refuges and reserves provide critical habitats for wildlife populations which eventually find their way to private lands.

Hunting, of course, is only one recreational activity accommodated in wildlife areas. In 1970, 6.8 million Americans spent 411 million days birdwatching, while 4.5 million bird and wildlife photographers enjoyed 37.8 million days in wildlife areas, and nearly 27 million United States citizens spent 337 million days nature walking.[53] Although there appears to be no data on the total benefits provided by all recreational activities in wildlife areas, one study estimates that the annual benefit to hunters, fishermen, photographers and nature watchers in one region--the Southeastern United States--is between $24 billion and $31 billion.[54]

It is even more difficult to quantify the national interest in the biological benefits of wildlife areas. They are, perhaps, priceless. The President has said that wildlife is "part of the biological system that sustains us."[55] Accordingly, he proposed a budget increase of $295 million for the rehabilitation, habitat improvement, and development of the wildlife refuge system.[56] Hopefully that money will

help guarantee that a balanced ecosystem is maintained. The next subsection discusses the national interest in preserving some of those species which contribute to such maintenance.

C. Endangered fauna and flora

> "(A)t the very best, the dying wildlife is symbolic--a reflection not only of our insensitivity to the environment but of an even more exacting insensitivity to each other. If you recall from your childhood literature the classic tale of "Snow White and the Seven Dwarfs," you will recall, as well, that it was the wicked witch who produced the magic mirror--for in all the land, there remained not one human soul to speak a gentle word in her presence. Years from now, we can ask if that was truly a tale of evil in the world around us--or whether it was simply a fantastic account of human isolation."[57]

As the passage implies, one of the national interests in the preservation of endangered species involves moral considerations. Perhaps such considerations underlie the U. S. Fish and Wildlife Service-National Marine Fisheries Service joint statement that "(t)here is a substantial National interest in living resources of the coastal zone as well as their associated social and economic values."[58]

The social and economic values of a diversified community in the natural world are derived, in part, from the extension of food chains, the restraint of potentially over abundant populations, and the limitation of disease and insect infestation to isolated areas.[59] As one Senate Report puts it,

> "Consideration of this need to protect endangered species goes beyond the aesthetic. In hearings before the Subcommittee on the Environment it was shown that many of these animals perform vital biological services to maintain a "balance of nature" within their environments. Also revealed was the need for biological diversity for scientific purposes."[60]

Whether the national interest in preserving endangered species be expressed in altruistic or selfish terms, it is apparent that the Nation is not yet committed to the deployment of magic mirrors. The national interest in endangered fauna and flora is reflected in several federal statutes. In the Endangered Species Act of 1973, the Congress "finds and declares" that species of fish, wildlife, and plants in danger of or threatened with extinction "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people."[61] In the Marine Mammal Protection Act of 1972, the Congress finds that

marine mammals in danger of extinction or depletion are "a significant functioning element in the ecosystem" and "affect the balance of marine ecosystems in a manner which is important to other animals and animal products which move in interstate commerce..."[62] The Congress also finds that "marine mammals have proven themselves to be resources of great international significance, esthetic and recreational as well economic..."[63] One endangered species has a special significance. In the enacting clause of the Bald and Golden Eagle Protection Act, the Congress declares that "the bald eagle is...a symbol of the American ideals of freedom."[64] In addition to wildlife conservation measures provided in the foregoing acts, the National Wildlife Refuge System Administration Act of 1966 provides for protection of fish and wildlife threatened with extinction.[65] Finally, the United States has pledged to the international community that it will conserve various species of fish or wildlife and plants facing extinction, pursuant to: migratory bird treaties with Canada and Mexico; the Migratory and Endangered Bird Treaty with Japan; the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere; the International Convention for the Northwest Atlantic Fisheries; the International Convention for High Seas Fisheries of the North Pacific Ocean; the Convention on International Trade in Endangered Species of Wild Fauna and Flora; and other international agreements.[66]

Former President Ford expressed his interest in endangered species, in part, through creation of the Endangered Species Scientific Authority and by prohibiting the federal use of a chemical dangerous to wildlife--sodium cyanide--in areas where endangered or threatened animal species might be adversely affected.[67] President Carter, recognizing as does the Endangered Species Act that habitat protection is the key element in preventing the extinction of valuable wildlife resources, has directed the heads of federal departments and agencies to provide information on critical habitat for endangered and threatened species on the lands under their control.[68] He has also directed the Secretary of Commerce to prohibit whaling within our 200-mile fishery zone and to take other specific steps to discourage international whaling.[69]

The national concern for endangered species extends to plant life. The Smithsonian Institution, in a report to the Congress, lists endangered, threatened--likely to become endangered--recently extinct, and exploited species, subspecies, and varieties of native plants.[70] Such plants comprise 10.4 percent of the flora in the Continental United States, with 100 of those species, subspecies, and varieties recently or possibly extinct, 761 endangered, and 1,238 threatened.[71]

Diverse plant species make man's environment more beautiful; contribute to food, fiber, shelter, and fuel; prevent wind and water erosion; develop fertile soil; store

water; stock different habitats and ecosystems necessary to maintain ecological stability; contribute to the gene pool; provide medicinals and insecticides; and even indicate the presence of needed minerals and metal ores.[72]

The development and extinction of a plant species is usually a long, slow process. Man, with his highly advanced technology, has sped up the extinction process by greatly modifying the earth's surface. As a result, many plant species recently have become extinct, and a large number are highly endangered and require special protection.[73]

There are many complex causes for the decline of wildlife population. However, it is perfectly obvious that no species can survive if man destroys its source of food and shelter. The President has identified habitat destruction and pollution as the major threats to wildlife today.[74] In his words, "Endangered species pose particular problems. Once they disappear we can never bring them back. We must deal with all of them, from the great whales to the most minute plant, wisely and reverently."[75]

D. Delaware's contribution

1. the fishery

The habitat of the Delaware River Basin marine fishery is comprised in large part of the lower reaches of the Delaware River, Delaware Bay, and the Atlantic Ocean within the 100-fathom contour between Chincoteague Inlet, Virginia, and Barnegat Inlet, New Jersey.[76] Inclusion of the stated portion of the ocean is a necessity because ecologically it is important for many species of the River and Bay.

That area, constituting the Delaware Bay Subbasin, supports coastal fisheries which are among the most productive in North America.[77] It is the geographic center for migratory fish stocks ranging between Cape Cod and Cape Hatteras. It is considered the southern range limit of northern marine species and the northern limit of southern species inhabiting the eastern coastal waters of the United States.[78] More than 200 finfish species alone are known to inhabit the subbasin.[79]

There are several reasons for the bay's high productivity. It is an area where fresh waters laden with nutrients from soils of the basin and from marsh productivity mingle with plankton-rich sea waters. The bay is shallow with broad expanses of bordering tidal marshes. Important and abundant nutrients from the shore marshes, guts, and inflowing streams are flushed by tides into the bay where they combine with those of the Delaware River and its tributaries.[80] Within the subbasin, the only area of less than very great fishery importance is the segment of the Delaware River between Chester, Pennsylvania and Artificial Island.[81] That is an area associated with petrochemical industry.[82]

Major commercial fishing ports are on the Leipsic River, Port Mahon, Little Creek, Bowers, Mispillion Light, and Lewes.[83] Smaller ports for incidental fishermen--rakers, gill netters, and tongers--occur along the entire Delaware coast.[84]

A significant number of fishes are brought to those ports. Delaware seafood landings in 1976 amounted to over 7.1 million pounds worth nearly $2 million.[85]

The blue crab, Delaware's most valuable fishery, accounted for about half of both these totals. Two methods, potting and dredging, are commonly employed in commercial crabbing. The largest concentration of pots in Delaware is found from Augustine Beach to Bowers Beach.[86] Commercial dredging for crabs takes place primarily in deepwater beds located between Bigstone Beach and Breakwater Harbor.[87]

Detailed information about individual species of fishes present in Delaware waters has been compiled in the Delaware Coastal Management Program's Technical Report No. 2- An Atlas of Delaware's Wetlands And Estuarine Resources.

In some respects Delaware's recreational fishery is more important than the commercial fishery. In fiscal year 1977, 80,000 Delaware fishermen spent over $20 million on more than 1.2 million days fishing.[88] Their catches exceeded 5.9 million fishes.[89]

The National Marine Fisheries Service has underscored the importance of State Fisheries management in a letter to the Delaware Coastal Management Program, which says, "approximately two-thirds of our commercial species are dependent upon esturine waters that are under State control."[90] Delaware's Division of Fish and Wildlife, within DNREC, has an active freshwater and saltwater fisheries management program. Water fertilization, fish stocking, mechanical and chemical control of aquatic vegetation, seed clam planting, surveying and research are among the fishery activities of the Division.[91] That fisheries and wildlife management program is incorporated in the Delaware Coastal Management Program.

2. wildlife refuges and reserves

The Division of Fish and Wildlife is also responsible for wildlife management and enforcement in the State, except on the 3 national Wildlife Refuges--Bombay Hook, Prime Hook and Killcohook--which comprise approximately 25,000 acres of wildlife habitat.[92] The Division operates 11 major State wildlife areas of about 26,000 acres.[93] DNREC's Annual Report states that "The State's wildlife areas provide needed open spaces where hunting and fishing, agriculture and other interests blen harmoniously."[94] Among Division of Fish and Wildlife management activities are the raising and reintroducing into the State of certain wildlife species; combating unlawful

deer and waterfowl hunting; conducting hunter safety training programs; and collecting wildlife data.[95]

Such data indicate the significance of Delaware wildlife resources. In fiscal year 1977, 30,000 Delaware hunters spent $5 million on 550,000 days of hunting in Delaware.[96] In fiscal year 1976, over 100,000 ducks and 76,000 geese were harvested in Delaware on nearly 170,000 hunter days.[97] In that same year, over 2 million ducks and 375,000 geese were harvested during over 2.8 million days of hunting the Atlantic flyway.[98]

Delaware is also important as a wintering ground. Winter survey counts show that far more mallard ducks spend the winter in Delaware than in any of the more northerly states, with nearly 3 times as many in Delaware as in New Jersey.[99] Indeed, only 4 states in the Atlantic flyway, which runs from Maine to Florida, sheltered more mallards during the winter.[100] Delaware also ranked 5th among 17 states in harboring geese through the 1976 winter.[101]

The Division of Fish and Wildlife has noted that the presence of those birds and their habitat is enjoyed by many more birdwatchers, photographers, and nature walkers than by hunters, with the latter group accounting for only a "small portion" of the total manhours of use of those resources.[102]

It is not surprising, then, that there is broad-based concern over natural areas in Delaware, especially wetlands. Delaware Wild Lands, a private non-profit organization, was established in 1961 and has acquired several outstanding natural areas for preservation, including select coastal wetlands and the great Cypress Swamp in southern Delaware.[103] The Delaware Nature Education Center, with the help of an advisory board of 25 experts and funding through the Coastal Management Program, has prepared a statewide inventory of natural areas.[104] The two-volume study identifies 101 select "natural areas" and 38 "natural vistas" worthy of preservation.[105]

There have been 2 major outgrowths of the study. One, the Coastal Management Program has developed and recommended specific policies for preserving critical natural areas in the State. Two, recent legislation establishes a State system of nature preserves; provides for their acquisition, control, use, management and protection; and otherwise implements the Coastal Management Program policies.

3. endangered fauna and flora

Federally listed endangered and threatened animal species, which are "resident"--as defined by the Endangered Species Act of 1973--in Delaware, include: the southern bald eagle; the brown pelican; the american peregrine falcon; the

artic peregrine falcon; the leatherback turtle; the Atlantic ridley turtle; the shortnose sturgeon; and several whales, inluding the blue, bowhead, finback, humpback, right, sei, and sperm.[106] Of these, only the bald eagle, which nests in the Bombay Hook National Wildlife Refuge, is sighted more than rarely.[107]

The following plants are on the national endangered and threatened list, and are found in the State of Delaware: Cyperaceae-Rhynchospora knieskernii (Family-species), endangered; Ranunculaceae-Trollius laxus, endangered; Apiaceae-Oxypolis canbyi, threatened; Betulaceae-Alnus maritima, threatened; Orchidaceae-Platanthera peromoena, threatened; Poaceae-Muhlenbergia torreyana, threatened; and Scrophulariacea Micranthemum micranthemoides, threatened.[108]

The State of Delaware, through its Division of Fish and Wildlife, has a cooperative agreement with the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior to protect endangered species. State legislation prohibits the importation, transportation, possession or sale of endangered species, including all species declared endangered pursuant to the federal Endangered Species Act of 1973.[109] State law also requires DNREC to protect, conserve, and propagate all forms of protected wildlife.[110] Finally, it authorizes studies to determine the needs of conservation programs and authorizes lands acquisition for the protection of fish and wildlife.[111]

The Delaware Division of Fish and Wildlife administers an Endangered Species Program and provides habitat preservation for certain endangered species through the system of State wildlife areas. General program objectives and activities include inventory of endangered species, enforcement patrol of areas where endangered species are thought to be present, acquisition of further land holdings, and an endangered species information and education program. The program also contains specific strategies for protecting certain species, including the bald eagle.

Both the State legislation and State Endangered Species Program are incorporated into the Coastal Management Program.

E. Coastal facilities and uses which may conflict with wildlife resources

Subsection 302(d) of the Coastal Zone Management Act recognizes that "The coastal zone, and the fish, shellfish, other living resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations..."

Many of those "alterations" have been discussed in earlier sections which identify the bay and associated

rivers and wetlands as some of the most important wildlife habitat in Delaware and the Nation. Those sections also describe some of the adverse effects of the activities which alter the face of the land or foul the water and air.

General classes of activities which may be harmful to wildlife include dredging and filling operations; spoil disposal; clearing of land; use of pesticides; disposal of radioactive waste products; and any operations which contaminate the water or air.

Between 1950 and 1969, 4 percent of the Nation's estuarine areas were lost through dredging and filling.[112] That low a percentage may not seem serious, but in absolute figures a great deal of wildlife habitat has been lost. Moreover, 20 years is a very short period of time, cumulative losses over longer periods could be drastic.

Spoil disposal and land clearing can be equally destructive. Benthic organisms--those animals living on beds of mud under water--are smothered by spoil disposal operations. Land clearing has the opposite effect, it exposes wildlife to a hostile environment devoid of shelter and food. A national survey revealed recently that 26 percent of our hunters feel the most serious hunting problem in the country today is loss of habitat.[113]

The habitat need not be destroyed altogether in order to render it unfit for wildlife. Slight changes in water quality can be critical. Water moves and with it moves dissolved, suspended and floating waste materials. Such materials use up oxygen either directly by oxidation or indirectly by causing "plant blooms," which then remove oxygen from the water. The quantity of dissolved oxygen in the water is extremely important to the economics of the commercial and sport fisheries.[114]

Declines in many species of both finfish and shellfish can be correlated with decreases in water quality.[115] In one 5-year period 6.4 percent of the Nation's shellfish harvesting areas were closed because of pollution.[116] Seventy years ago shad and sturgeon were major commercial fish in Delaware. Throughout the 19th century the annual shad catch weighed between 10 and 19 million pounds.[117] Today, only a few Delaware gill net fishermen seek the relatively rare shad or sturgeon for commercial purposes.[118] Their low population is attributed to the high pollution level in the lower Delaware River which contributes to mortality and curtails upriver migration for the purpose of spawning.[119]

Indeed, the effects of water pollution on productivity and general health of the fish stocks may be more significant than its direct impact on mortality. Fish mortality is, nonetheless, a serious problem. In 1974,

nearly 120 million fishes were reported killed by pollution.[120] Of these, over 104 million were killed in estuaries.[121]

Some of the specific land and water uses which can cause mortality or otherwise adversely impact fish and wildlife are power plants, outer continental shelf (OCS) development activities; industrial operations, including petrochemical complexes; sewage disposal systems; and certain recreational activities.

Power plants sometimes use areas as large as 2,000 acres and utilize tremendous amounts of water for cooling and other purposes.[122] When that water is discharged into the receiving waters, thermal pollution can reach intolerable levels. Fish and other aquatic organisms are also destroyed by the machinery used for cooling, which frequently pass the organisms, as well as the water, through the systems.[123] In addition, wildlife habitat can be drastically changed or eliminated as a result of the construction or operation of plants, transmission lines, and other land based facilities.[124]

OCS operations, aside from incidental dredging and waste disposal activities, pose serious threats to wildlife because of oil spill risks. Oil toxicity can directly kill animals, including fishes and birds. Further, reproductive functions and the hatchability of eggs can be impaired by oil contaminants.[125] The effects of oil pollution are discussed in greater detail in conjunction with deepwater ports.

Petrochemical complexes, of course, also present oil pollution hazards. One study, concluding that such complexes are simply incompatible with wildlife, says "... which shall it be? Heavy petrochemical industry or the benefit and use of Delaware's most valuable natural resource."[126]

Delaware's Coastal Zone Act, of course, precludes construction of heavy industries in the particularly fragile and valuable coastal areas. One 6,000 parcel in this area is owned by an oil company.[127] The property is situated between Smyrna River and Taylors Bridge, east of Route 9.[128] To its south is the 4,000 acre Woodland Beach State Wildlife Refuge.[129] To its north is roughly 3,000 acres of marshlands and uplands owned by Delaware Wild Lands.[130] Gross pollution is this area would severly impact wildlife resources.

Sewage disposal systems can also devastate wildlife. Of the nearly 120 million reported fish kills in 1974, almost 110 million were attributed to such systems.[131]

Finally, certain recreational activities can adversely impact wildlife. Hunting and fishing, of course, are strictly regulated to maximize the health of the animal populations. However, it is not feasible to regulate all pursuits in a manner which promotes wildlife conservation objectives. Thus,

for example, endangered Atlantic ridley turtles have been discovered dead on Delaware shores, the result of motorboat accidents.[132]

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V. Forests

A. The national interest

The Congress has recognized the "vital importance of America's renewable resources of the forest...to the Nation's social and economic well-being..."[1] The President has also acknowledged the national interest in forests with respect to their impact on national environmental goals, meeting the Nation's needs for wood, and improving and maintaining fish and wildlife habitats.[2]

The national interest in wildlife habitat has already been discussed. Forests also add beauty to the environment; help keep the air clean and cool; deaden sound; provide shade; offer outdoor recreational opportunities; and collect and regulate the flow of water needed for domestic and industrial uses.[3]

The Council on Environmental Quality points out that the environmental movement originated because of timbering:

> "The widespread cutting of our virgin forests for timber--resulting in stripped hills, muddy streams, loss of soil, and floods--aroused a strong public determination to manage the public lands so as to preserve both land and water and the long-term timber yield of the forest."[4]

Conservationists recognize that woodlands are the surest protection against accelerated soil erosion.[5] Annual soil loss in woodlands has been estimated at between .05 and .1 ton per acre, compared to 800 tons per acre for skid roads in woodland areas.[6] Due to the effectiveness of vegetation in stopping erosion, reducing sedimentation, and stabilizing stream flows, several million acres of forest and range land are in watershed protection areas.[7] On those areas--mostly watersheds used as a source of municipal water supplies--other uses, such as recreation or timber production, are carefully controlled or prohibited.[8]

Elsewhere, of course, timber production is an important national industry. Forests produce an amazingly versatile and useful material, wood. Wood has a tensile strength--resistance to forces trying to pull it apart--equal to that of steel.[9] A piece of wood 2 inches by 2 inches in cross section can sustain end-wise pressure of up to 40,000 pounds before falling.[10] Wood retains its strength whether wet or dry and under a wide range of temperatures, making it a favored material for cooling towers and other structures which must withstand rapid and severe climatic changes.[11]

Wood is also a good insulator. One inch of Douglas-fir in a wall resists the heat flow as well as 12 inches of concrete or stone.[12] The so-called inch board, which is only three-quarters of an inch thick, retains heat as well as 4 inches of common brick.[13]

Wood is light and easy to work with. Simple construction with wood is possible by millions of people who have none of the skills necessary for working with other materials. Moreover, wood is attractive to the eye and the touch.

Best of all, wood, unlike many other valuable resources, is renewable. It grows relatively quickly and can be harvested without great expense.

Wood can be readily transformed into other useful materials. Forest products include pulp and paper, pharmaceuticals, resins, oils, railroad ties, mine timbers and posts, telephone poles, pallets, packaging, wood and charcoal fuel, houses, furniture, plastics, textile fibers, maple syrup and sugar, nuts, fruits, tannins and dyes, and even Christmas trees.[14]

In 1975, the Nation consumed 11,205 million cubic feet of timber products.[15] The 1975 per capita consumption of timber products equalled 52.4 cubic feet.[16] In 1970, the total value of roundwood timber production at local points of delivery was $4.2 billion, making timber the Nation's second most important agricultural crop in terms of value, equal to approximately 17 percent of the value of all farm crops, and substantially more than such major crops as soybeans, wheat and cotton.[17] Roundwood composes nearly one-fifth of all industrial raw materials consumed in the economy.[18]

The Nation meets the demand for timber products with domestic production and imports. Roughly one-third of the 2.3 billion acres of land in the United States is forested.[19] About 500 million of these 754 million acres are classed as commercial timber land--land available and suitable for growing continuous crops of wood in excess of 20 cubic feet per year.[20] Less than one-fifth of this timberland is owned by the federal government.[21]

Fifty-nine percent of all private commercial forests lands are owned by over 4 million people, and produce 48 percent of our Nation's demand for roundwood and 40 percent of the demand for softwood timber.[22] Three-quarters of the commercial timberlands are in the East, with oak-hickory forests accounting for about 23 percent of all commercial timberlands in 1970.[24] The loblolly-shortleaf pine is the most prevalent type of softwood timber, constituting 10.7 percent of all commercial timberlands.[25]

Since the early 1900s, the United States has met a growing part of its timber demand with imports.[26] In 1973, the Nation imported 3.1 billion cubic feet of timber products, one-fifth the total supply of timber products in the United States.[27] Timber exports, on the other hand, amounted to only 1.5 billion cubic feet in 1973.[28] Those figures have obvious implications for the national balance of trade.

It is difficult to forecast the future timber demand, supply and balance of trade because new technologies, population trends, changing customs, shifts in income, and prices all introduce uncertainties. It appears, however, that the national demand for wood may double by the year 2020, increasing faster than the projected supply from our native forests.[29] Timber supplies from United States forests in the year 2000 are projected to be 19.0 billion cubic feet,[30] the rough equivalent of the combined production of all metals, cement, and plastics.[31] Under one set of assumptions, the forecasted demand for roundwood is 26.2 billion cubic feet in 2000, 32.0 billion cubic feet in 2010, and 37.3 billion cubic feet in 2020.[32]

World demand and supply, of course, will affect national consumption and production. Timber consumption has been growing-rapidly in all parts of the world, rising some 70 percent between 1950 and 1969.[33] The predicted worldwide market for wood is expected to double between 1977 and 2000.[34]

There are ample resources for meeting that demand. Forests cover an estimated 9.2 billion acres, about 28 percent of the world's land area.[35] Those forests contain an estimated 12.6 trillion cubic feet of timber.[36]

Actual harvests, of course, have been much less. In the late 1960s, the total harvest of industrial roundwood was about 42 billion cubic feet, most of it from North America, Russia, and Europe.[37] Latin America contains over half the world's total hardwood resources, but in the late 1960s accounted for less than 10 percent of world production of hardwood products.[38] Canada, the source of most of our imports, is likewise producing far below sustainable yields. In 1970, for example, the Canadian timber cut of about 4.3 billion cubic feet was well below the calculated sustainable cut of 10.7 billion cubic feet.[39]

However abundant would supplies may be, high levels of domestic production will be critical. The United States Forest Service points out that "the Nation must look to its domestic timber resources as the best means of attaining some stability in relative prices of timber products."[40] The next subsection discusses how the State of Delaware helps meet the national need for forest resources.

B. Delaware's forest resources

In 1969, Delaware's land was 30.8 percent forested, compared to 31.9 percent for the entire Nation.[41] There are approximately 400,000 acres of forest land in Delaware, of which 355,000 acres are privately owned, 25,000 acres State owned, and 20,000 acres federally owned.[42] About one-half of the total acreage consists of loblolly-shortleaf pine forest, with oak-hickory and oak-gum-cypress forests accounting for most of the remaining acreage.[43] Delaware has a much higher volume-per-acre net annual timber growth than most eastern states.[44]

The largest forest holdings are concentrated along the southern and western portions of the State where poor surface drainage enhances tree growth and discourages agricultural development.[45] The marsh soil which typifies the eastern side of the State does not generally support mature forest stands.

In 1970, 33 million board feet of sawtimber were removed from Delaware forests, compared to 62,770 million board feet for the entire Nation.[46] Growing stock removals in the State amounted to 12 million cubic feet, compared to 14,033 million cubic feet for the United States.[47] Principal timber products included lumber--13.1 million board feet; pulpwood--62,200 cords; and veneer logs and bolts, cooperage, piling, poles, and fuelwood--2.8 million cubic feet.[48]

The timber supply outlook in Delaware is mixed. Softwood timber removal is proceeding at a greater rate than annual net growth, indicating that future supplies may be less than present supplies.[49] Hardwood growth, on the other hand, is outpacing removal, indicating that future supplies will be greater.[50] Assuming a fairly constant growth rate, the available cut for all timber is projected to increase from 12.5 million cubic feet in 1971 to 19.5 million cubic feet in 2001.[51]

The future productivity of Delaware timber will depend, to some extent, on the continued efforts of the Delaware Forest Service. The Service, a Section within the Delaware Department of Agriculture, derives its authority from Title 7, Chapter 29 of the Delaware Code. The State forestry program carried out pursuant to the Act is incorporated into the Coastal Management Program.

The Delaware Forest Service has 4 branches. The State Forest Branch lets contracts and issues permits for harvesting timber; thins, prunes, plants and harvests State timber; patrols forest areas for fires; conducts research; and provides information to hunters and other members of the public.[52] The Cooperative Forest Management Branch imparts woodland management advice to forest landowners; cruises and marks timber stands; secures markets; assists with timber contracts; draws maps; distributes public

relations programs to schools and civic organizations; and administers a watershed reforestation program.[53] The Forest Fire Control Branch assists the 61 fire companies of Delaware to prevent and control forest fires.[54] It also cooperates and coordinates on a regional basis with four other Mid-Atlantic states pursuant to the Mid-Atlantic Interstate Forest Fire Compact. The State Tree Nursery Branch raises and sells tree seedlings.[55]

C. Facilities which may conflict with forest resources

Trees die from many causes, including disease, fire, insects, animals, flooding, soil compaction, building and road construction, chemicals, minerals removal, improper planting or pruning, and air pollution. Many of these causes appear in aggravated forms near urban centers--areas where trees are particularly important for esthetic reasons, cooling, shade, and protection from wind, dust and noise.

Unfortunately, air pollutants generated in urban or industrial areas also cause the decline of forests located far from the pollutants' points of origin. For example, air contaminant-induced tree mortality has been reported 80-100 miles from smog-congested Los Angeles.[56] In the East, air contaminants have injured plant species more than 70 miles from large metropolitan sources such as Philadelphia.[57]

Electric generation, transportation, and industry are the most significant sources of phytotoxic air pollutants in the United States.[58] Sulfur dioxide, a by-product of coal-burning electric plants, seems to be one of the most important pollutants affecting trees, perhaps finishing second only to ozone.[59] Tree injury usually results from exposure to low levels of sulfur dioxide poisoning over a long period of time.[60] Death is observed after short-term doses of high levels of sulfur dioxide pollution, or when the tree species is very sensitive.[61] Loblolly pine seedlings up to 6 feet are sensitive.[62]

Ozone is a by-product of hydrocarbons and oxides of nitrogen, which are emitted into the atmosphere by automobiles. Petroleum refineries are an additional source of oxides of nitrogen. Ozone is a leading "air crippler" of trees. Fluorides released in steel manufacturing operations are also harmful, particularly hydrogen fluoride and silicon tetrafluoride.[63] Ethylene, emitted during the processing of natural gas in petrochemical plants, in high doses acts as a herbicide, causing growth reduction, bud abscission, flower deformities, yellowing, and death. The particulates given off by certain industries may injure trees and other plants, if concentrations are exceedingly high. Cement dust, for example, contains high quantities of calcium oxide which is harmful to most forms of vegetation, including trees.[64]

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VI. Minerals

Although the national interest in mineral resources is great, this discussion is limited for 2 reasons. One, mineral resources in Delaware are generally less significant than other resources in the state; and two, facilities which may be in the national interest do not impinge upon mineral resources in Delaware to the extent that they may interfere with the use of other resources. Moreover, the national interest in some of the most important mineral resources is discussed in the energy facilities section.

The 1974 value of crude mineral production in the United States, including mineral fuels, was approximately $55.2 billion.[1] About $3.8 million of this total was produced in Delaware--almost all of it sand and gravel.[2] The 1974 value of sand and gravel production for the entire Nation was nearly $1.5 billion, with every state in the country contributing to the total.[3]

Clay and gem stones, the only other minerals produced in Delaware, accounted for just $10,000 in 1974.[4] Only 286 people out of a state workforce of 212,471--those covered by State Unemployment Insurance Laws--were employed by the Delaware mining industry that year.[5]

In 1974, the Nation exported over $12.7 billion worth of minerals while importing close to $40 billion worth of those resources.[6] The country exported about $11.7 million worth of sand and gravel and imported less than one million dollars worth of the minerals.[7] The largest consumer of sand and gravel in Delaware is the State Division of Highways.[8] Much sand and gravel is imported into Delaware from adjacent states.[9]

The national interest in minerals, as expressed to the Delaware Coastal Management Program by the U. S. Bureau of Mines, is to ensure that the Nation has an "adequate, dependable, and continuing supply of mineral commodities at reasonable cost."[10] The President has made it clear that environmental standards should be maintained while meeting the demand for minerals.[11]

Delaware's Coastal Management Program is consistent with those 2 objectives. The program encourages minerals development to the extent that State environmental laws are obeyed. Title 7, Section 4511 of the Delaware Code empowers the State Department of Natural Resources and Environmental Control to lease public lands for mining and mineral exploration. Title 7, Chapter 61 of the Code makes similar provision for offshore lands. That Chapter, because it provides a mechanism for allowing pipelines through State lands, is discussed elsewhere in the program document, as well as in the energy facilities section of this report.

The leasing of State lands for minerals development will become important only if there are economically feasible quantities of mineral resources. Preliminary surveys have not disclosed such deposits anywhere in the State with respect to several potential mineral resources, but industrial interest has been displayed at various times and geologic conditions do not preclude their occurrence.[12] Those potential mineral resources include: garnets for abrasives, kaolin for fine china, serpetinite and gabbro for building stone, feldspar for ceramics--all in the Piedmont; iron ore at Iron Hill, and bog iron ore in Sussex County; heavy minerals such as those containing titanium mostly in Sussex County; glass sands--mostly in Sussex County; and the possibility of phosphate deposits.[13]

The best potential areas for future sand and gravel extraction have been identified and are located mostly in Kent and Sussex Counties. New Castle County is the best potential site for hard rock and clay.[14] The presently active sand and gravel pits have been mapped and are dispersed throughout the State.[15] The only active clay pit in the State is slightly south of New Castle City.[16]

Not much is known about offshore mineral resources in Delaware, but the Delaware Geological Survey--with financial assistance from the Delaware Coastal Management Program--is devoting a good deal of time to evaluating the hydrocarbon potential. Recent work has led the Survey to believe that the geology is more favorable for offshore resources than originally believed.[17]

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VII. Prime Agricultural Lands

A. The national interest

> "The great national and world problems of our age are those pertaining to the environment, energy and food."[1]

Most of this paper focuses on environmental or energy-related problems. This section, however, discusses that resource which is vital to solving food problems, namely, prime agricultural lands.

By national definition, prime agricultural lands must have: an adequate water supply; an average annual temperature of more than 32 degrees Fahrenheit at a depth of 20 inches, and an average summer temperature greater than 59 degrees Fahrenheit; a ph of 4.5 to 8.4 within 40 inches; either no water table or a water table that can be maintained below 1.5 feet during the cropping season; soils that are not frequently flooded during growing season nor easily eroded; permeability of at least .06 inches per hour in the upper 20 inches; and a surface layer less than 10 percent rock which is courser than 3 inches.[2]

The U. S. Soil Conservation Service and the Universities of Delaware and Maryland have developed a list of soil types that meet the national definition.[3] A great deal of farmland in Delaware falls within that definition, although much of the State's successful agriculture is found on other than prime farmland.[4] New Castle and Kent Counties' prime agricultural lands have been delineated on published soil maps and published in tri-color format at 1: 100,000 scale, and the Sussex County tri-color map is being prepared for publication.[5]

Prime agricultural land maps have not been completed for the entire Nation either. Although there is much information on the farming of all lands, the relative contributions of prime farmlands and other farmlands have not been carefully documented. Thus, most of this subsection quantitatively describes the national and regional interest in farmlands in general, and is not limited to prime agricultural lands.

The importance of prime agricultural lands can be evaluated in qualitative terms. Such lands are the most productive farmlands and contribute more food per acre at less cost than other lands. Among other things, this translates into transportation-related energy savings when a relatively small, buth highly productive farm area meets the food needs of its region.

Prime agricultural land is also better from a water quality standpoint. A March 1974 study by the U. S. Senate Agriculture and Forestry Committee points out that

sediment from land erosion is by far the major pollutant of surface waters, with approximately 2 billion tons of sediment annually entering our Nation's waters from some 400 million acres of cropland.[6] Much of this sediment carries with it nutrients and pesticides, compounding the water quality problem. Prime agricultural land, because it is relatively level, generates less sediment from soil erosion than more steeply graded farmlands.

Cover crops on all farmlands help mitigate erosion, recharge water aquifers, and improve air quality. Crops and farmland also provide open-space and are generally esthetically pleasing.

For the most part, though, agricultural land is of national interest because it produces food and contributes to the economy. The national farmlands are ample enough to meet all the country's domestic food needs and a sizeable portion of world needs, both now and in the near future.[7] In 1974, our farmers produced nearly 1.8 billion bushels of wheat; over 4.6 billion bushels of corn for grain; more than 1.2 billion bushels of soybeans; 621 million bushels of oats; 22 million short tons of sugar beets; and 628 million bushels of sorghums for grains.[8] They also harvested well over 20 million short tons of other vegetables.[9] Over 6.3 billion pounds of apples, more than 2.7 billion pounds of peaches, 710,000 tons of pears, nearly 4.2 million tons of grapes, 276,000 tons of cherries, 654,000 tons of plums and prunes, more than 221 million boxes of oranges and tangerines, over 65 million boxes of grapefruit, and around 17.5 million boxes of lemons were also produced in 1974.[10]

Livestock, of course, also relies on farmlands for its food. In 1974, the United States produced a total of nearly 38 billion pounds of meat, exluding edible by-products.[11] In addition, poultry farms raised over 131 million turkeys, produced nearly 3 billion broilers, and over 66 billion eggs.[12] Finally, the 1974 production of milk, butter, cheese, and cottage cheese equalled 115 billion pounds, 952 million pounds, nearly 2.9 billion pounds, and almost 1.7 billion pounds, respectively.[13]

It is not surprising that such bountiful harvests play an important role in the national economy. In 1974, American farmers received over $16 billion for corn; more than $7.7 billion for wheat; in excess of $1 billion for oats; over $1.3 billion for sugar beets; more than $1.2 billion for rice; nearly $2 billion for sorghums for grain; almost $2.6 billion for cotton; over $5.7 billion for hay; close to $9.5 billion for soybeans; nearly $1.5 billion for irish potatoes; and more than $2.1 billion for tobacco.[14] The total value of the fruit crop exceeded $2.6 billion.[15] The 1974 value of American cattle was estimated at $41 billion and the value of hogs and pigs was about $3.7 billion; and the production value of chickens, eggs, and turkeys was approximately $114 million, $2.9 billion, and $680 million,

respectively.[16] The total realized gross income of all United States farmers in 1974 exceeded $100 billion.[17]

The national farm population in 1974 was nearly 9.3 million, or about 4.4 percent of the total population.[18] In 1975 there were approximately 2.8 million farms comprising over a billion acres of farmland, or an average of 385 acres per farm.[19] The number of farm acres changed by only 2 million acres between 1940 and 1969, but the value of farm lands and building increased almost 15-fold in that period.[20]

Associated agricultural services--animal husbandry services, veterinarians, poultry hatcheries, feed lots, horticultural services, grist mills, cotton ginning, dusting, spraying, picking, sorting, grading, cleaning, packing, and so forth--comprise a multi-billion dollar/year business by themselves.[21] The manufacturing of farm machinery and equipment is also economically significant. In 1974 such machinery and equipment was valued at over $44 billion.[22]

The United States balance of trade is favorably affected by farmlands. Exports accounted for about 20 percent of crops harvested up to 1972.[23] In 1974, the Nation exported over $21 billion worth of agricultural products--excluding forest products and distilled liquors--and imported slightly more than $9.5 billion worth of these products.[24] Agricultural exports comprised 25 percent of all United States exports in 1974, agricultural imports made up only 12 percent of all imports.[25]

United States agricultural lands are also making important contributions to feeding the world's hungry population. In 1974, the Nation produced 13 percent of the world's wheat, 42 percent of the grain, 52 percent of the soybeans, and 52 percent of the sorghums for grain.[26] From 1954 to 1974, United States economic assistance under Food for Peace Programs equalled nearly $23 billion, with $973 million loaned or donated in 1974.[27]

Individuals in the United States, of course, are also impacted by farm production and the federal government has, through various support programs, paid farmers billions of dollars, including $530 million in 1974 alone.[28] Americans spent approximately $216.9 billion for food in 1977.[29] For all of 1977, grocery store food prices averaged roughly 6 percent above 1976 prices.[30] The Consumer Price Index for food reveals that food prices have nearly doubled in the last 10 years. Although some of the increase can be explained by inflation, the implications of continuing price hikes--particularly for people with incomes which do not keep pace with inflation--are foreboding. One method for stabalizing prices is to utilize the most efficient farmlands, that is, prime agricultural lands. The next subsection discusses farmlands in Delaware and describes how the State contributes to the national interest served by this resource.

B. Delaware farmlands

Farmlands in the State help feed the Washington-New York megalopolis. In 1974, Delawarean farmers sold nearly 121 million broilers, close to 11 million bushels of corn, over 5 million bushels of soybeans, slightly less than 1.5 million bushels of wheat, almost 1.3 million bushels of irish potatoes, and approximately 14 million pounds of apples.[31] In 1976, the State produced in excess of 640 million pounds of broilers, over 18 million bushels of corn, nearly 5 million bushels of soybeans, over 1 million bushels of wheat, and approximately 11.5 million pounds of apples.[32]

Only Arizona, California, and Florida have a higher net income per farm than Delaware.[33] In 1972, Delaware's net income per farm was around 7 times greater than that of New Jersey or Pennsylvania, and more than twice that of Maryland and the average for the entire Nation.[34]

Cash receipts from farming in Delaware reached an all time high of $281.6 million in 1976.[35] Broilers accounted for slightly more than half of that total, with corn, soybeans, dairy products, hogs, eggs, potatoes, mushrooms, wheat, green peas, cattle, snap beans, cucumbers, turkeys, and barley--all million dollar businesses--following in that order.[36]

In 1970, there were 3,639 farmers and 2,995 farm laborers in Delaware.[37] In 1974, farmlands equalled roughly 630,000 acres, of which approximately 483,000 acres were croplands.[38] The average value of land and buildings per farm and per acre was $180,023 and $971, respectively.[39]

The amount of farmland in Delaware has dwindled gradually over the years. In 1954, the State had 814,316 acres; in 1959, 762,526 acres; in 1964, 717,015 acres; in 1969, 673,895 acres; and in 1974, 630,605 acres.[40] Total cropland has also diminished, but there is some evidence that more cropland is actually being utilized. For example, Delaware cropland decreased from 505,356 acres in 1969 to 483,342 acres in 1974, but harvested cropland increased from 422,984 acres to 447,833 acres during the same period.[41]

A good deal of that acreage is prime agricultural land. In Kent County, prime farmland totals 142,377 acres, almost half of that county's farmland.[42] This especially good farmland lies primarily in the eastern half of the county. The flatness of that area--and indeed most of the State--makes it suitable for the utilization of large farm machinery, and minimizes erosion problems.

Delaware's high farmland productivity can also be attributed, in part, to good management practices. The State Department of Agriculture and the Division of Soil and Water Conservation within DNREC are the most active State agencies involved in farmlands management. The Division concentrates on maintaining the level of technical and financial assistance

available from federal, state and county programs, with the most assistance coming from the U. S. Department of Agriculture's Soil Conservation Service.[43]

The Delaware Department of Agriculture functions both as a regulatory and a service agency. As a regulatory agency, the Department enforces 5 major State agricultural laws; issues various licenses, permits and certifications; oversees product registration; and requires diverse types of surety bonds.[44] The non-regulatory services provided by the Department are designed to improve the quality of Delaware's agricultural products through the Department's inspection and grading services and its cooperation with the Delaware Extension Service, as well as the federal agencies.[45]

The Delaware Coastal Management Program document incorporates the agricultural programs of the Division and the Department. Further, it adopts the following findings and policy formulated by the Delaware Tomorrow Commission:

"Agriculture and Farmland Findings

1. Protection of the Delaware's prime farmland will assure continuation of a viable agricultural industry, including food, fibre and timber production and making sure Delaware residents have locally grown food available and taking advantage of Delaware's climate and nearby markets in Eastern population centers.
2. Now as in the past, the agricultural sector is the largest single user of land in Delaware and the population-at-large shares in the benefits.
3. Protection of prime farmland has the corollary benefit of protecting open lands for aquifer recharge where farmlands are located over aquifers.
4. Adoption of an agricultural land use policy implies development of a water policy as well. Current agricultural prices, production costs and technology all encourage the use of supplemental irrigation. The irrigated acreage in Delaware increased from 15,867 in 1959 to 20,421 in 1969 (29 percent). Water requirements for agriculture should be provided for along with the requirements for other uses of water--residential, industrial and recreational.

Agriculture and Farmland Policy

DELAWARE SHOULD PRESERVE AND PROTECT ITS PRIME FARMLAND..."[46]

Additional Coastal Management Program policies and discussion which pertain to agricultural lands appear in the document itself.

C. Facilities which may be harmful to prime agricultural lands

The U. S. Department of Agriculture is "concerned about any action that tends to impair the productive capacity of American agriculture."[47] As the Delaware Governor's Task Force on Marine and Coastal Affairs has pointed out,

> "Such impairment may occur directly through the conversion of agricultural land to nonagricultural uses. Indirect effects of urban development may include escalation of agricultural land costs and property taxes."[48]

Other indirect effects of non-agricultural land uses can be identified briefly. Facilities which impair agricultural production by air pollution have been discussed in the section on air resources. To the extent that there is competition for a limited water supply between facilities and agricultural lands, facilities may interfere with farmland productivity. Finally, facilities which exacerbate saltwater intrusion or otherwise impinge upon the quality of water utilized by farmlands, may be harmful. Earlier sections of the paper discuss such facilities in detail.

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VIII. Floodplains And Erosion Hazard Areas

A. Floodplains

1. the national interest

> "The floodplains which adjoin the Nation's inland and coastal waters have long been recognized as having special values to our citizens. They have provided us with wildlife habitat, agricultural and forest products, stable ecosystems, and park and recreation areas. However, unwise use and development of our riverine, coastal, and other floodplains not only destroy many of the special qualities of these areas but pose a severe threat to human life, health, and property." (Statement by the President Accompanying Executive Order 11988. May 24, 1977).

Additional national values of floodplains include convenient access to water transportation corridors; relatively low construction costs due to level terrain; substantial nearby water supplies to meet municipal industrial and power plant requirements; and, generally, aesthetic attractiveness.

Unfortunately, from time to time, floodplains are also valuable to streams, lakes, rivers, and coastal waters. As of September, 1976, there had been over 10,000 documented floods in this country.[1] When water bodies exercise their right to expand, the floodplain frequently must accommodate incompatible uses. When that happens, human life is endangered; the public must pay for rescue and relief efforts; factories and businesses are closed; transportation routes are disrupted; public services are interrupted; soils are eroded; water quality is diminished, and homes are destroyed.[2]

Floodplains are popular sites for homes because they are picturesque, near recreational areas, and have been merchandised as desirable locations to live, work and retire.[3] It is likely that flood protection works, along with highway construction, provide additional stimulus for floodplain invasion.[4] At any rate, coastal population is growing 3 to 4 times faster than the national average.[5]

Many of those new coastal residents have never experienced major coastal storms and do not fully appreciate the force of a flood, its depth and velocity, nor the attendant economic, health and safety aspects of flood debris and pollution.[6] Even those who are aware of floodplain hazards can be fooled. Nature does not always follow statistical probability. One eastern city, for example, has experienced three floods since 1969--all exceeding the previously predicted 100-year flood level.[7]

The losses sustained in those and other floods have been borne by citizens in all parts of the Nation, while other individuals have been busily developing floodplain areas in ways which "promise" recurrence of losses. A Presidential Task Force has summarized the problem, stating that "The country is faced with a continuing sequence, of losses, protection, and more losses."[8] The U. S. Water Resources Council has described the customary sequence of events as follows:

> "(1) flooding, (2) flood losses, (3) disaster relief, (4) flood control projects attempting to modify the flood potential through provisions for storing, accelerating, blocking, or diverting flood waters, (5) renewed encroachment onto the flood plain, (6) flooding, (7) flood losses, (8) disaster relief, (9) more projects, (10) more encroachment, etc."[9]

The Congress has declared that "the Nation cannot afford the tragic losses of life caused annually by flood occurrences, nor the increasing losses of property suffered by flood victims..."[10] Fortunately, relatively few people perish due to flooding alone. In 1974, for example, only 89 people in the Nation lost their lives in floods.[11]

Property damage is of a much higher magnitude. Fully 90 percent of the damage caused by natural disasters in this country is caused by floods.[12] The U. S. Corps of Engineers explained, during the formulation of Delaware's Coastal Management Program, that one of the "overriding factors" in its involvement in floodplain management is the stake in the national economy.[13] The economy is affected because flooding erodes beaches, damages structures and their contents, kills wildlife, reduces soil fertility from saline intrusion, contaminates water supplies, and destroys crops and livestock. The average annual loss from floods in recent years has been about $1.5 billion.[14] A single hurricane has caused flood damage of more than $3.2 billion.[15] The U. S. Water Resources Council has predicted that yearly national flood losses could be as high as $3.5 billion by the year 2000,[16] and another estimate projects year 2020 flood damage as high as $5 billion.[17]

Those losses do not take into account the money spent to control flooding. Since adoption of a national flood control policy in 1936, the federal government has invested approximately $10 billion in flood protection works.[18] In both fiscal years 1975 and 1976, federal expenditures for urban and rural flood damage reduction totalled several hundred million dollars.[19]

The federal effort has been fragmented. Data for urban flood damage reduction activities in fiscal year 1974 show that 797 projects involving $795 million were implemented by 11 agencies operating under 44 different

legislative authorities.[20] The extent of the national interest in floodplains is reflected by the federal services performed by the Department of Agriculture--Soil Conservation Service, Department of Army--Corps of Engineers, Department of Commerce--NOAA and National Weather Service, Department of Housing and Urban Development--Federal Housing Administration and Federal Insurance Administration, Department of the Interior--Geological Survey, Bureau of Land Management and Bureau of Reclamation, and the Tennessee Valley Authority. A brief description of those services appears in the September 30, 1977 Federal Register, Volume 42, Number 190, at page 52597.

In the past 20 years, the federal government has placed more emphasis on relief, rehabilitation and insurance, and less on control and protection works.[21] The U. S. Army Corps of Engineers has recommended, through its designated contact for the Delaware Coastal Management Program, that facilities of national interest be built in floodplains in accordance with plans which mitigate flood-loss potentials.[22] For example, sewage treatment plants--which are normally built in floodplains because their systems are based on principles of gravity--should be constructed such that expensive machinery is elevated at a sufficiently high level in the plant to avoid floodwater.[23]

The Federal Insurance Administration administers a program which offers incentive for local communities to impose such building standards for facilities. Under the National Flood Insurance Program, owners of property located in designated flood-prone areas may purchase federally subsidized flood-loss insurance at affordable rates if affected communities prudently regulate development in flood hazard areas.

Prudent floodplain regulation might include: zoning ordinances which prohibit uses in designated floodways if they might be incompatible with passing floodwaters; subdivision regulations which show the floodplain on subdivision maps, prohibit fill in channels and floodways that would restrict flow, and require that subdivision roads be above the elevation of a selected flood level; and building codes which require proper anchorage, establish minimum basement and first floor elevations, restrict the use of materials which deteriorate rapidly in water, prohibit equipment or materials which are hazardous when submerged, and require structural strength.[24]

2. floodplains in Delaware

The State government assists political subdivisions to understand and meet the requirements of federal insurance programs. The towns of Leipsic and Millville were the lone Delawarean communities located within identified flood-hazard areas which were not participating in the national flood program as of August 31, 1977.[25] Nineteen of the 39

participants have implented floodplain management controls, the remaining communities are in the process of developing them.[26]

The State of Delaware, like approximately one-half of the States, does not specifically regulate floodplains.[27] However, many of the State statutes--for example, the Wetlands Act, the Beach Preservation Act and the Coastal Zone Act--are broad enough to incorporate aspects of floodplain management into the regulatory process. Further, the State manages floodplains through various indirect controls, such as budget policies, as described in the Coastal Management Program document.

Unfortunately, those controls may not be enough. As a small State with no portion further than 8 miles from tidewater, Delaware is very vulnerable to flooding.[28] In 1962, a winter storm accompanied by a record tide and waves over 20 feet high caused 7 deaths and $16-22 million worth of damages.[29] A 1974 storm caused another $3+ million in damages.[30]

Those events, of course, have not gone unnoticed by the Coastal Management Program. Under the auspices of the program, a working paper was prepared which analyzes coastal storm hazards.[31] The floodplain management policies which appear in the program document are, in part, a by-product of that study. Most of these policies are recommended or "encouragement" policies. If the encouragement policies, indirect State controls, current State statutes and on-going local floodplain management efforts are unable to satisfactorily control floodplain development, the Delaware Coastal Management Program will seek stronger enforcement capability, which will result in mandatory policies.[32] To that end, a statute designed to prevent flood and erosion damage has been drafted.

B. Erosion hazard areas

Approximately one-quarter of the 20,500 mile national shorefront is subject to significant coastal erosion.[33] Average annual losses due to erosion have been conservatively estimated at $300 million.[34] Most of that damage is to private homes, beaches and shore protection structures.[35] Erosion fills in channels which must be dredged for navigation, thereby incurring additional costs.

The toll of losses is certain to increase as coasts continue to attract industries seeking tidewater sites, support facilities for offshore continental shelf oil and gas development, nuclear power plants and a stream of second home owners and retirees.[36] Not only are coastal property values and resultant losses driven up by development, but human activities--especially construction of structures which impede beach sand supplies--exacerbate soil erosion problems.

Coastal erosion in Delaware is well-documented.[37] Erosion is caused primarily by winter storms and occasional hurricanes, although navigation and shore protection structures are contributory factors.[38] Erosion is critical along the entire ocean and bay coasts, except for a one mile reach south of Indian River Inlet.[39] Shoreline recessions vary from 3 to 20 feet per year on the bay and 3 to 10 feet per year on the ocean.[40]

The Coastal Management Program has examined erosion problems carefully. In addition to the working paper on coastal storm hazards, program efforts were responsible for a report entitled "Delaware's Changing Shoreline."[41] The program document designates public lands along the coast as a Geographic Area of Particular Concern and discusses shoreline erosion in detail. Management authority is based primarily on the State's Beach Preservation Act, also described thoroughly in the program document.

Very briefly, that authority prohibits construction of facilities on the seaward side of the dune, unless no other property is available for construction. In any case, whenever the beach is to be materially altered, a permit from DNREC is required. The threat and possible effect of beach erosion--as described in the program document and incorporated herein by reference--are the primary considerations in the permit disposition.

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IX. Historic Sites, Districts And Areas Of Unique Cultural Significance

A. The national interest

> "In its land and its history, a nation finds the things which give it continuity. By preserving places that have special natural, historical, cultural, and scientific value, we can ensure that our children and grandchildren have a chance to know something of the America that we--and our ancestors--simply took for granted."[1]

Although it is perhaps impossible to quantify the value of knowing that "something of...America" to which our President refers, there is no difficulty in identifying in descriptive terms the national interest in preserving historic and cultural areas of the nation. Such areas give us a sense of belonging, an opportunity to add to our knowledge of the human race, a chance to share other life experiences, objects of art for appreciation and enjoyment, resources for recreational utilization, the use of facilities without further depletion of dwindling resources, a sense of pride in our past, and a stake in our future.

The Congress has declared it a national policy to preserve historic sites, buildings, and objects of national significance "for the inspiration and benefit of the people of the United States."[2] Federal legislation also "finds... that the spirit and direction of the Nation are founded upon and reflected in its past."[3] As the U. S. Advisory Council of Historic Preservation has put it,

> "the most vital energy resource for this country is its sense of purpose. That sense of purpose, of national identity and destiny, is nourished by symbols of our past, reminders of our unique experiences and goals. The conservation of these symbols, and their integration into our daily lives, is a vital national interest...never more so than in periods of crisis and rapid change."[4]

Rapid change often causes mental stress. Nearly a quarter of our population changes its residence each year.[5] Psychologists have recognized that frequent change of residence is a major cause of mental dislocation, particularly among children.[6] Accordingly, the Congress has declared "that the historical and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people."[7]

The preservation of historic buildings not only serves to ease the emotional trauma of re-location, it also

makes economic sense. The cost of new construction for a 15 to 20 story downtown building has been estimated at an average of $70.75 per gross square foot, compared to $39.90 for the major renovation of an old building of similar size.[8] One reason new buildings are more expensive is that they require new materials, typically at the expense of national resources.

The operating costs of new buildings are also frequently higher than for restored buildings. The net operating cost for new single-tenant floor space, for example, has been estimated at $3.90 per square foot, compared to $2.85 for renovated space.[9]

The impracticality of "saving" cities by wholesale demolition and reconstruction of existing urban areas has been illustrated by the Council on Environmental Quality, which has calculated that it would take more than 150 years and substantial amounts of money to remake even a portion of a city active in renewal.[10]

The national interest in historic and cultural resources is reflected in the number and nature of programs designed to preserve them. History and preservation groups in towns and cities throughout America have proliferated from less than 2,500 in 1966 to more than 6,000 in 1975.[11] The federal government alone spent approximately $240 million on historic preservation between 1973 and 1977.[12]

Federal preservation legislation addressing preservation problems dates back to 1906 with the Antiquities Act. That statute established a system for protecting prehistoric sites and artifacts on federal lands. Eighty-two national monuments have been designated and priceless archeological sites have been protected pursuant to the legislation.[13]

In 1916, the Congress created the National Park Service, entrusting it with the care and protection of historical as well as natural parks. That agency has been the primary focus for federal preservation efforts, managing many prominent historic properties and initiating non-federal programs. The Historic Sites Act of 1935 authorized the Department of Interior, through the National Park Service, to survey sites of exceptional value in United States history, regardless of ownership. As an outgrowth of that effort, the Registry of National Historic Landmarks was created in 1960 to formally recognize properties that possess exceptional value for commemorating or illustrating American history.[14] By the end of 1974, over 6,000 properties had been surveyed and roughly 1,200 designated as National Historic Landmarks.[15]

The National Park Service, through the Coastal Management Program, has identified a few national historic landmarks in Delaware in which the Service has a "specific interest." These are: John Dickinson House, 5 miles southeast of Dover and 3 miles east of U. S. Route 113 on Kitts

Hummock Road; Aspendale, 1 mile west of Kenton on Delaware Route 300; Jacob Broom House, 1 mile northwest of Wilmington; Old Courthouse, New Castle; Stonum, New Castle; Corbit-Sharp House, Odessa; Fort Christiana Monument, Wilmington; Holy Trinity (Old Swedes) Church, Wilmington; Lombardy Hall, Wilmington; and Eleutherian Mills, north of Wilmington on Delaware Route 141 at Brandywine Creek Bridge.[16]

The National Historic Preservation Act of 1966 expanded the federal government's concern for historic resources to include those of State and local significance, and firmly established a partnership between the federal government and the states in preservation activities. The statute directed the Secretary of Interior "to expand and maintain a national register of districts, sites, buildings, structures, and objects significant in American history, architecture, archeology and culture..."[17] The National Park Service has referred to this, the National Register of Historic Places, as "the official list of the Nation's cultural resources worthy of preservation."[18] In early 1976, the Register was roughly 20 percent complete and contained about 12,000 individual entries.[19]

The Act also created a grants-in-aid program administered by the National Park Service, with funds being apportioned to the states on a 50-50 match basis for the development and implementation of State historic preservation plans. From an initial authorization of $2 million in 1967, the grants-in-aid program had grown to $45 million by 1978.[20]

Finally, the National Historic Preservation Act set up a mandatory federal project review mechanism. It established the Advisory Council on Historic Preservation, an interdepartmental body with Cabinet-level officials, to administer the review procedure. Prior to the approval of any federal, federally assisted, or federally licensed project which may affect a National Register property, the Advisory Council must be afforded a reasonable opportunity to comment. The relevant action-taking agency must then consider the comments, as well as the project's impact on National Register properties, prior to reaching a final decision. The National Environmental Policy Act of 1969 requires similar consideration.

The preceding laws related generally to historic properties. Two additional statutes, the Reservoir Salvage Act of 1960 and the Archeological and Historical Preservation Act of 1974, deal specifically with the protection of archeological resources. Those 2 laws require notice to the Secretary of the Department of Interior whenever a federal, federally assisted, or federally licensed project might cause the loss of significant historical or archeological data. In such cases, the Secretary is authorized to undertake salvage operations.

Additional historic preservation measures appear in the Department of Transportation Act of 1966, the Federal Property and Administrative Services Act of 1949, and the National Trust for Historic Preservation Act of 1949.

The Executive Branch of the federal government has also expressed in legal terms its concern for historic preservation. Executive Order 11593, issued on May 13, 1971, requires that the heads of federal agencies, in cooperation with the liaison officers of historic preservation for the States, to "locate, inventory, and nominate...all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing" in the National Register.

For the most part, however, implementation of the National Historic Preservation Act within Delaware is accomplished by the Division of Historical and Cultural Affairs within the Delaware Department of State. The next subsection describes preservation efforts in Delaware.

B. Historical sites, districts and areas of unique cultural significance in Delaware

Pursuant to the National Historic Preservation Act of 1966, the Division of Historical and Cultural Affairs has prepared and published a State plan for historic preservation. Volume One of the plan, entitled Linking Past and Future, outlines the State's history back through prehistoric times; discusses past and present historic preservation efforts in Delaware; identifies specific preservation problems and solutions; describes various historic survey efforts, including the survey currently funded under the federal statute; explains Delaware's preservation philosophy; and provides a bibliography on historic preservation.[21]

Volume Two of the State plan, Delaware Preservation Checklist, presents a lengthy and detailed compilation and description of Delaware historic sites surveyed prior to 1976.[22] It also inventories archeological resources in Delaware.

The Annual State Historic Preservation Plan For Fiscal Year 1978 was also prepared by the Division and submitted to the National Park Service, in part, for continued funding under the National Historic Preservation Act of 1966. The annual plan identifies State personnel involved in the historic preservation program; summarizes survey and planning, acquisition, and development activities accomplished during the previous year; outlines activities to be undertaken during fiscal year 1978; and estimates federal funding needs.[23]

The Division's role in historic preservation is to identify and provide information concerning the sites to appropriate State and federal management agencies, not to directly manage and preserve the sites.[24]

Much of the information has been gathered during the course of the latest survey, initiated in 1971 and still underway. Eight thousand historical and cultural sites have been identified.[25] The Division describes those sites generally, and subjectively evaluates the respective importance of each, based on frequency, age, discrete characteristics, relationship to historical events, degree to which the site has changed, and relative significance to the population where the site is located.[26] The Delaware Office of Management, Budget and Planning, with the aid of Coastal Management Program funding, provides a graphic service which maps the sites.[27]

The Division also initiates the process by which sites are added to the National Register. It prepares a nomination form which a professional State review board considers at a public meeting.[28] The nomination is judged by the criteria established for the National Register, and, if approved, is forwarded to Washington for final review and action.[29]

Unfortunately, the process is slow. Only 30-40 nominations are made annually.[30] The Division is attempting to improve upon that record by making grants available to various local preservation societies and to local units of government for the purpose of accomplishing the survey work which must precede the nominations.

There are approximately 250 Delaware entries in the National Register, representing about 500 discrete properties.[31] Those properties are eligible for federal funding under the National Historic Preservation Act of 1966. The Division assists the owner in applying for the funds, which must be matched equally and used to stabilize, restore, preserve or reconstruct the site. In the last 5 years, over $1 million has been "passed through" the Division from the federal government for those purposes.[32] As of October 25, 1977 more than $500,000 was slated for allocation in the near future.[33]

The funding is especially important because private properties listed in the National Register are not protected in a regulatory manner. The Division comments, through the "A-95" review process, on all federally funded or licensed projects which may affect those properties. When there is a possibility of adverse effects, the Division and the federal Advisory Council on Historic Preservation suggest alternative plans to the federal agency involved.[34] The Soil Conservation Service and the Corps of Engineers do not participate in the A-95 process, thus the Division maintains a close liasion with those federal agencies.[35]

As indicated above, Executive Order No. 11593 requires federal agencies to survey federal holdings for all known historic and cultural resources. Unfortunately, the

Division reports that, despite its willingness to assist in the design and evaluation of such surveys, not all the federal agencies have complied with the Order.[36] As a result, valuable resources in the State may be destroyed unknowingly.[37]

Much better cooperation has been forthcoming from political subdivisions of the State. The Division has established ad hoc arrangements with all 3 Delaware counties to informally review potentially significant actions, such as subdivision proposals.[38] The State is then afforded an opportunity to accomplish historical and archeological work before the sites are destroyed.[39]

State projects are also generally reviewed by the Division. For the most part, the State agencies have been very responsive to the needs and concerns of the Division, particularly the State Division of Highways.[40] However, according to the Division of Historical and Cultural Affairs, DNREC has not always coordinated its activities with the Division to the degree desirable.[41] Inasmuch as the historical and cultural preservation program is incorporated into the Coastal Management Program and all State agencies must, by Executive Order, coordinate with each other to the extent necessary to implement the program once it is approved, that problem should be alleviated upon program approval.

C. Facilities which may be harmful to historical and cultural sites in Delaware

Any facility which requires the displacement of historical or cultural sites or buildings obviously may be harmful. Many archeological sites can be excavated and studied if there is forewarning. Regrettably, the Delaware survey is far from complete and it is presently impossible to evaluate the impact of facility siting in many areas. Some sites, such as the prehistoric site at Bowers Beach, could not be excavated without irreparable damage in any case.[42]

The National Register program in Delaware has paid special attention to the historical assets in the nearshore areas because much of Delaware's early development was along the waterways and because the Division wanted to have adequate source materials available for administration of the State Coastal Zone Act and other planning efforts.[43] The area between Lewes and Rehoboth has been surveyed carefully, with approximately 95 percent of the archeological survey and 85 percent of the historical survey completed.[44] A product of that effort is the recent listing in the National Register of a portion of Lewes, a city frequently mentioned as a possible site for a supply base for outer continental shelf oil and gas operations.[45]

Other nearshore areas still need more work. The Bay coast survey has been finished only in spots and the Atlantic coast work from Rehoboth to Fenwick is far from complete.[46]

Nearby facilities that emit air pollutants in significant quantities will impact whatever historic sites are in the surrounding areas. As discussed in an earlier section, air pollution defaces materials. Further, it interferes with carbon dating techniques and increases maintenance costs.[47]

Oil also skews or absolutely invalidates carbon dating techniques.[48] All historic sites within the limits of tidal influence on major rivers, and tributaries thereof, which empty into the Delaware River and Bay are endangered by facilities which threaten oil spillage into the River or Bay.[49] The greater number of potentially affected sites are located in Kent and Sussex Counties due to the increased network of drainage systems extending across the low elevation coastal plain of those counties.[50] The impact of oil spills on historic structures, while not irreparable, could be costly.[51] The Division, therefore, has prepared and mapped sensitive areas where oil spill impacts on known resources may occur.[52]

Offshore pipelines not only threaten historical resources by oil spillage, but also by construction activities. Several ships have been sunk and never recovered from the Delaware Bay, some as early as in the 17th century.[53] Cold water and mud have been preserving those treasures for centuries.[54] The careless placement of a pipeline could end all hope of ever tapping significant stores of knowledge.

Finally, facilities may harm historical and cultural sites from a purely aesthetic perspective. Many of the resources owe much of their attraction to their surroundings. An ugly, smelly, or noisy "neighbor" detracts from the site and the quality experience it is intended to bestow.

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FACILITIES

I. National Defense And Aerospace Facilities

A. Defense facilities

Defense facilities include military bases and installations, as well as defense manufacturing plants. These facilities primarily serve the essential national interest of security. As the Department of Navy has explained to the Delaware Coastal Management Program, without the attainment of national defense and security, "all other goals and objectives can be threatened."[1]

The Coastal Zone Management Act recognizes the paramount importance of the national defense by providing that specified federal actions inconsistent with approved coastal management programs and the objectives of the Act may be permitted only if necessary in the interest of national security.[2]

The extent of the national interest in defense is also reflected in the financial commitment made for it. According to the U. S. Department of Defense, President Carter has presented to Congress a military budget of $111,947 billion for fiscal year 1978, nearly one quarter of the total budget.[3] As of June 30, 1976, the total original cost of real property purchased for the control of U. S. Military Departments was $44.3 billion.[4] Most of that expenditure was for facilities, with only 1.6 percent of the total attributable to the cost of land.[5]

Nonetheless, U. S. Department of Defense land holdings are sizeable. As of June 30, 1976, the Department controlled a total of 27.8 million acres of land throughout the world, 91 percent of which was within the United States.[6] More than 74 percent of the United States acreage is located in 6 large states, namely: California; Arizona; Nevada; New Mexico; Alaska; and Utah.[7]

The installations in California, Alaska and the remaining coastal states are especially important. The Atlantic and Pacific Oceans lie between the United States and the other world powers. Thus the portion of the country nearest to a potential enemy is the coastal area, making it strategically important both for purposes of defense and counter-attack. Moreover, the coastal zone is much more densely populated than the rest of the Nation, making it a more likely point of attack and more critical to defend. Finally, the Atlantic coastal zone represents the country's closest land area to its European allies. World War II

demonstrated the need, still present, for facilities which can most expeditiously supply friendly Nations across the ocean.

Defense installations are coastally dependent, in some cases, due to the nature of the installations. The Navy and the Marine Corps, which operate the Nation's most expensive defense property, obviously need to be close to the oceans to be effective.[8] In turn, the other military departments require coastal facilities to support and defend Naval facilities.

Although such facilities and defense manufacturing plants are ideally situated in the coastal zone in some respects, it is important that they not be concentrated in a few coastal areas. As Congress has pointed out,

> "In order to insure productive capacity in the event of...an attack on the United States, it is the policy of the Congress to encourage the geographical dispersal of the industrial facilities of the United States in the interest of the national defense, and to discourage the concentration of such productive facilities within limited geographical areas which are vulnerable to attack by an enemy of the United States."[9]

Geographical dispersion of military bases and installations is critical for the same reason. Thus, it is in the national interest that the coastal states apportion the responsibility of meeting defense siting requirements in the coastal zone.

The State of Delaware is doing its share. Though only one state has a smaller land area than Delaware, 10 states have less territory controlled by the U. S. Department of Air Force; 5 states have less acreage controlled by the U. S. Department of Army; and 15 states have less land controlled by the U. S. Department of Navy.[10] The Air Force maintains a 4,522 acre base near Dover.[11] Most of that acreage is comprised of an aerodrome, although nearly 800 acres are used for family housing.[12] The U. S. Department of Defense has informed the Delaware Coastal Management Program that one of the strategically important aspects of the Dover Air Force Base is its proximity to Fort Dix, the New Jersey Army Base.[13]

The Navy operates naval facilities in Wilmington and Lewes.[14] The Wilmington facility is an 8 acre reserve center, consisting of an instruction building, garage, storehouse, and underground fuel tanks. The Lewes facility, approximately 377 acres large, is basically a communications site. Various restrictions on the use of surrounding air, land and water space--described in the Coastal Management Program's Working Paper No. 5--are observed by the State.

There are no plans, at present, to expand military operations in Delaware, but the U. S. Department of Air Force has asked the Delaware Coastal Management Program to recognize "the potential requirement for new or expanded defense siting requirements on land, in the air, on and under the water, in the coastal zone."[15]

Such potential siting requirements presumably include those for defense manufacturing plants, but there are no present U. S. Department of Defense plans to build any of these in Delaware either.[16] Indeed, the general policy of the Department since 1970 has been to let the private sector meet the Nation's supply needs in order to lower costs and to improve local tax structures.[17]

When and if an industry or the U. S. Department of Defense selects Delaware as a potential site for a defense manufacturing plant or other defense-related facility, chances are very good that the State will accommodate such interest. The Delaware Coastal Management Program has adopted the following policy statement, recommended by the U. S. Navy:

> "CLEARLY, NATIONAL DEFENSE AND NATIONAL SECURITY ARE AMONG THE HIGHEST PRIORITIES IN THE MANAGEMENT OF THE COASTAL ZONE."[18]

Thus, the State recognizes the national importance of defense facilities, as well as their substantial contribution to the State and local economies. As in all regions of the country, State statutes and local zoning ordinances preclude intensive development in specified areas. There is, however, ample space available for new or expanded military bases, installations, and manufacturing plants. For instance, a military base, while not permitted in a wetlands area, would be welcome in other areas where environmental standards are protected.

For the most part, those environmental standards have been established pursuant to federal law--namely, the Federal Water Pollution Control Act and the Clean Air Act--and have been incorporated in the Coastal Management Program pursuant to a third federal law, the Coastal Zone Management Act. It is obvious, too, that other national interests are served by protecting the environment--as described in the resource section of the report--and that such standards do not specifically preclude any military use within the State.

The State's maintenance of such standards is also consistent with Executive Order 11752 which adopts the following general policy:

> "It is the purpose of this order to assure that the Federal Government, in the design, construction, management, operation, and maintenance of its facilities, shall provide

> leadership in the nationwide effort to protect and enhance the quality of our air, water, and land resources through compliance with applicable standards for the prevention, control, and abatement of environmental pollution in full cooperation with State and local governments. Compliance by Federal facilities with Federal, State, interstate, and local substantive standards and substantive limitations, to the same extent that any person is subject to such standards and limitations, will accomplish the objective of providing Federal leadership and cooperation in the prevention of environmental pollution."[19]

Although the Order continues with a statement which seems to exempt federal facilities from State and local pollution laws, it expressly orders that the construction and operation of such facilities conform to the following requirements:

> "(1) Federal, State, interstate and local air quality standards and emission limitations adopted in accordance with or effective under the provisions of the Clean Air Act, as amended.
>
> (2) Federal, State, interstate, and local water quality standards and effluent limitations respecting the discharge or runoff of pollutants adopted in accordance with or effective under the provisions of the Federal Water Pollution Control Act, as amended.
>
> (3) Federal regulations and guidelines respecting dumping of material into ocean waters adopted in accordance with the Marine Protection, Research, and Sanctuaries Act of 1972, and the Federal Water Pollution Control Act, as amended.
>
> (4) Guidelines for solid waste recovery, collection, storage, separation, and disposal systems issued by the Administrator pursuant to the Solid Waste Disposal Act, as amended.
>
> (5) Federal noise emission standards for products adopted in accordance with provisions of the Noise Control Act of 1972 and State, interstate, and local standards for control and abatement of environmental noise.

(6) Federal guidance on radiation and generally applicable environmental radiation standards promulgated or recommended by the Administrator and adopted in accordance with the Atomic Energy Act, as amended (42. U.S.C. 2011), and rules, regulations, requirements, and guidelines on discharges of radioactivity as prescribed by the Atomic Energy Commission.

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Many of the State environmental statutes--which are incorporated into the Coastal Management Program--are effective under the provisions of federal law. Thus, the Executive Order requires that federal facilities be constructed in accordance with such statutes.

The Order also provides a procedure for exempting facilities from these requirements if it is in the interest of national security. To the extent that that procedure is successfully implemented and the federal supremacy clause of the U. S. Constitution applies, the State exempts national defense facilities from State and local pollution controls. At the present time, however, the State does not adopt the U. S. Department of Air Force recommendation that the Coastal Management Program immunize military departments from substantial development permit requirements for activities undertaken on defense property.[21] To do so would be to unnecessarily undermine the objectives of the Executive Order, the Coastal Zone Management Act, and the Delaware Coastal Management Program. The U. S. Department of Defense can exercise the procedure for exemption if the national security is truly in issue. It is noteworthy that the Department acknowledges the importance of the federal environmental programs, whoever may administer them, and, accordingly, complies with the Intergovernmental Coordination Act (A-95), the National Environmental Policy Act (Environmental Impact Statement preparation), as well as the Federal Water Pollution Control Act and the Clean Air Act.[22] It would seem, therefore, that the Coastal Management Program policy will not materially alter the current siting and operating practices of the Department.

B. Aerospace facilities

Aerospace facilities serve diverse national interests, but primarily are involved in either gathering or disseminating information. Earth satellites and space-

crafts, usually launched from aerospace facilities near or in the coastal zone, provide a wide range of data at relatively low cost. The State of Maryland, for example, calculated that it spent 35 cents per square mile to collect data by satellite which would have cost it 5 dollars per square mile by traditional methods.[23]

Aerospace data is used to help monitor changes in land conditions; determine the types and distributions of non-point sources of water pollution; conduct watershed inventories which enable states to foresee flood, drought, and water supply problems; measure and monitor surface water levels; measure boundaries; and produce detailed crop-related information on water needs, insect infestations, salinity detection and general agricultural land capability.[24]

The National Aeronautics and Space Administration (NASA) claims that space technology can also be used to transmit educational and medical programs to remote places; report on weather conditions and warn against natural destructive forces; amass new information about the earth and the universe; serve commercial communication by overcoming the limitations of submarine cables, land lines, and ground radio stations; tap the energy of the sum; and, due to the advantages of manufacturing in weightless space, reduce the costs of drugs, create new alloys, and produce new drugs and lenses of unusual purity.[25]

There is also a less tangible national interest in aerospace facilities. As former President Ford expressed it,

> "our exploration of outer space has added another dimension to our outlook and made us more effective explorers of peace on Earth and goodwill among its people.
>
> All Americans should be proud of what the space program has accomplished in the past--and excited by the prospect of future achievement and discovery."[26]

Congress has also recognized the national interest in the space program. NASA was appropriated over $3 billion in each fiscal year from 1969 to 1974.[27] From fiscal year 1964 to fiscal year 1968, appropriations were approximately $5 billion annually.[28]

Much of that sum has been invested in aerospace facilities. According to NASA, the coastal zone is ideally suited for such facilities because of the interest in firing spacecraft over water and retrieving the same from the water.[29] NASA, however, has indicated to the Delaware Coastal Management Program that it does not anticipate that the State will be needed as a site for aerospace

facilities.[30] The Goddard Space Flight Center in Greenbelt, Maryland is designed to serve the current and future needs of the region.[31]

In the event that NASA becomes interested in siting aerospace facilities in Delaware, the Coastal Management Program, through the various State agencies which implement the program, will carefully evaluate the impact of the proposed facilities and provide assistance in the selection of a suitable site.

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II. Energy Production And Transmission Facilities

This section discusses the national interest in energy facility siting in the coastal zone; describes the impacts of such facilities on coastal resources; and explains, in general terms, how the Coastal Management Program addresses energy facility siting requirements.

Due to the relative length of this section, the format varies from that used in the rest of the paper. The first subsection--"Energy and the national interest"--describes the national, regional, and State interest in energy resources, and focuses on supply and demand issues. The second subsection is divided into many parts, with each part addressing a specific energy facility and related facilities. Those parts discuss the facilities with respect to their related national interest, potential demand, siting criteria, and impacts on coastal resources. They also explain how the Coastal Management Program balances the need for the facility with the need to protect resources. Finally, many of the parts respond to major energy facility siting concerns raised by federal agencies during the course of program development.

A. Energy and the national interest

1. world and national supply and demand

The President's National Energy Plan states that

> "The diagnosis of the U. S. energy crisis is quite simple: demand for energy is increasing, while supplies of oil and gas are diminishing. Unless the U. S. makes a timely adjustment before world oil becomes very scarce and very expensive in the 1980s, the nation's economic security and the American way of life will be gravely endangered."[1]

The American way of life's dependence on energy is pervasive. Americans use energy to heat and cool their homes; light their buildings and streets; manufacture and transport goods; furnish medical care and educational services; reach their places of employment and recreational areas; provide for national security; grow food and so on.

To take one example of interest in Delaware, where there is a great deal of farming--modern agriculture relies on relatively cheap power to support farm mechanization, greater use of chemicals, manufactured inputs, and transportation services. With the decline in use of horses and mules (pasture and feed requirements for these animals have dropped from 80 million acres to 5 million acres), energy needs have soared.[2] Mechanization has brought about

more effective use of land and labor on farms and a resultant steady decline in total farm employment. Only 2 percent of the total population today is engaged in farming.[3]

Cheap energy has enabled the Nation to produce food and other goods and services at a low enough cost to permit general prosperity and a relatively high standard of living. The economic importance of energy to the Nation cannot be overstated. The United States consumed approximately 60 quadrillion (60,000,000,000,000) Btu--one btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit--of energy in 1970.[4] In 1975, the United States consumed 73 quadrillion Btu.[5] At current consumption levels, the national use of energy is projected to reach 125 quadrillion Btu by the year 2000.[6] If the cost of all that energy rises appreciably, the economic consequences will obviously be profound.

Unfortunately, rising costs seem almost inevitable. The cost of energy will, to a large extent, be determined by the familiar principle of demand and supply. As demand increases and supply dwindles, prices will escalate. The world-wide demand for energy has been projected to jump from 250.4 quadrillion Btu in 1973 to 406.1 quadrillion Btu in 1990, an average annual growth rate of 2.9 percent.[7] Supplies, on the other hand, are expected to become more scarce. Of the 250.4 quadrillion Btu consumed in 1973, only 15.1 quadrillion Btu were from other than non-renewable fossil fuels.[8] As the world runs out of those fuels, the price of energy will rise unless alternative energy sources can fill the void.

Petroleum alone accounted for close to one-half of the world's energy consumption in 1973.[9] The world now consumes over 20 billion barrels of oil each year.[10] World demand for oil has grown at an average annual rate of 6.6 percent since 1940, and grew by as much as 8 percent annually during the 1960s.[11] If world demand for oil grows at an annual rate of only 3 percent, the world's estimated recoverable oil resources will, according to one source, be completely exhaused by 2020.[12]

Like the rest of the world, the United States depends on fossil fuels almost exclusively. About 95 percent of the Nation's energy is supplied by non-renewable fossil fuels.[13] Oil and gas provide 75 percent of the country's energy needs, although they constitute less than 8 percent of its energy resources.[14] In 1975, the Nation used more than 16 million barrels of oil per day, compared to less than 7 million barrels per day in 1947.[15] Oil is used heavily in the residential, commercial and transportation sectors, but is needed most for transportation, where no substitute is currently available.[16] In early 1977, the United States imported 9 million barrels of oil per day, one-half of the domestic supply.[17]

The impact on the Nation's balance of trade--an important measure of the country's economic health--has been substantial. The impact, of course, has been aggravated by rising prices. World-wide oil prices increased four-fold in 1973-1974 alone.[18] In 1974, the United States imported $15.2 billion worth of petroleum crude, $6 billion worth of fuel oil, and $.5 billion worth of natural gas; while it exported only $13 million worth of crude oil, $46 million worth of fuel oil, and $68 million worth of natural gas.[19] During an 8 month period in 1977, oil imports were reportedly worth $23 billion.[20]

An unfavorable balance of trade is only one unpleasant economic aspect of dwindling energy supplies. Another is the loss of jobs. Supply disruptions in the winter of 1976-1977 caused short-term unemployment for more than one million workers nationally.[21] The Executive Office of the President claims that the loss of millions of additional jobs could result from future energy price increases.[22] Moreover, entire industries, such as the recreation industry, could be in serious trouble if energy prices continue to rise.

Energy-induced economic vulnerability jeopardizes the country's position in the world and may adversely influence foreign policy. The distribution of the remaining oil in the world is such that OPEC and the Soviet bloc together control approximately 85 percent of the remaining potential recoverable resources.[23] It has been estimated that by the year 2000, about 73 percent of world's oil production will probably come from OPEC and the Soviet bloc.[24] In addition, the Mid-east Nations and the Sino-Soviet bloc combined, hold more than 1.3 quadrillion cubic feet of the less than 2.2 quadrillion cubic feet remaining estimated world reserve of natural gas.[25] United States holdings amount to only 237.1 trillion cubic feet, about one-third of the amount in the Sino-Soviet bloc.[26]

A report by the U. S. Central Intelligence Agency predicts that the United States' demand for oil imports in 1985 could reach between 12 and 15 million barrels per day, most of which will be sought from OPEC countries.[27] The Shell Oil Company has predicted that the Nation will import about 10 to 11 million barrels of oil per day by 1985, with imports leveling off after that date.[28] The Federal Energy Administration--now part of the Department of Energy--has reported that oil imports could reach 13.5 million barrels per day in 1985 if oil and gas prices are regulated, but that gradual deregulation could drop the figure to 5.9 million barrels per day.[29] However, the Federal Energy Administration has also warned that imports could increase again in 1990 as domestic production declines.[30] Finally, the National Energy Plan projects a 12-16 million barrel per day import figure for 1985.[31]

The U. S. Central Intelligence Agency report also predicts that the West European import demand will reach between 11 and 14 million barrels per day by 1985.[32] As the report points out, the willingness and ability of OPEC countries to meet this and the United States' demand is far from certain.[33]

The Nation does not yet depend much on gas imports because it is expensive to transport gas overseas.[34] Natural gas is heavily used by industry, and it is the premium fuel for residential and commercial use because it is a clean, efficient, and convenient heat source.[35] For that reason, most of the limited natural gas supplies in the country will probably be diverted from industrial uses to residential-commercial markets.[36]

Natural gas constitutes only 4 percent of domestic energy reserves, but, in 1976, furnished 27 percent of national energy needs--the equivalent of 10 million barrels of oil per day.[37] The National Energy Plan declares that "the growing imbalance between America's domestic natural gas resources and its annual consumption is of particular concern."[38]

Projections of the national gas supply vary. The U. S. Bureau of Mines has predicted that domestic supplies will decrease steadily between now and 2000.[39] The Shell Oil Company has concurred.[40] A Federal Energy Administration forecast of gas supplies is more optimistic, and estimates that there will be a small increase, until at least 1985.[41] On the other hand, more dire predictions have been made. The National Research Council, for example, has reportedly warned that the United States will completely run out of both oil and natural gas by 2000.[42]

Coal is unlikely to be exhausted in the near future. Coal constitutes 90 percent of the country's conventional energy reserves, but supplies only 18 percent of energy consumption.[43] Within the lower 48 states, the United States has about one-third of the known economically recoverable coal reserves in the world.[44] Full utilization of America's coal resources has been hampered by constraints on demand, rather than lack of supply. Demand has been curtailed by environmental side-effects, as well as equipment and transportation limitations.

According to the National Energy Plan, the country must overcome such problems. The Plan states that "Expansion of U. S. coal production and use is essential if the Nation is to maintain economic growth, reduce oil imports, and have adequate supplies of natural gas for residential use."[45]

The Federal Energy Administration has projected a coal production increase from 603 million tons in 1974 to 1040 million tons in 1985.[46] Most of the coal will be used in the generation of electricity. The Federal Energy Administration has guessed that coal's use in electric generation could increase by 77 percent from 1975 to 1985.[47]

In 1974, coal was already used to generate more electricity than any other source.[48]

The demand for electricity--currently greater than 20 quadrillion Btu annually--may more than double by 1990.[49] According to the Federal Energy Administration, nuclear energy could represent about 26 percent of electric generation in 1985, as compared with 8.6 percent in 1975.[50] Nuclear plants now supply about 10 percent of the Nation's electricity, or 3 percent of the total energy output.[51] The Shell Oil Company has forecasted an even larger role for nuclear energy, but recent setbacks to that industry would seem to cast doubt on the projections.[52]

New technology, of course, will also play a role in meeting national and world energy needs, but major contributions from solar, geothermal, and synthetic fuels are not expected to be felt until after 1990.[53] For the near-term, the Nation must rely primarily on oil, gas, coal, and nuclear fuel. In 1974 domestic oil and gas provided approximately 20 quadrillion Btu each; coal generated roughly 14 quadrillion Btu; and nuclear energy produced only 2 quadrillion Btu.[54] The Federal Energy Administration has predicted that by 1985 gas production will increase slightly from the 1974 level, oil will increase by about 8 quadrillion Btu, coal will increase by roughly 9 quadrillion Btu, and nuclear energy will increase by 5 quadrillion Btu.[55] In contrast to the Federal Energy Administration projections, the U. S. Bureau of Mines has predicted the country will use less gas, but the Bureau has agreed the Nation will utilize more nuclear power and more oil.[56]

2. regional and statewide supply and demand

Even with adequate national energy resource reserves, the country may suffer regional or statewide energy shortages due to resource distribution or other factors impinging on regional or statewide receipt of energy resources.

The regional energy situation, as it relates to the State of Delaware, is difficult to summarize because different reports place Delaware in different regions. Some of those locate the State in the "Northeast," which typically includes states from Maine to Maryland; other studies group Delaware with the "Mid-Atlantic" states; and still other reports "claim" the popular State for the "Southeast"--which extends all the way to the tip of Florida. In a few cases, the reports simply do not identify which states comprise which regions. Finally, regional data compiled from statistics on the states which immediately surround Delaware is suspect because those states do not comprise the area which best reflects "Delaware's region." For example, much of Pennsylvania is farther from Delaware than parts of Virginia.

This paper, therefore, focuses on statewide demand and supply issues. However, Table I on the following page presents relevant data for the year 1975, compiled for nearby states and the United States as a whole.

TABLE I
1975 Energy Data

	Energy Production ($x10^{12}$Btu)	Energy Consumption ($x10^{12}$Btu)	Consumption (%) By Source	Electric Utility (%) Consumption By Source	1970-1975 Annual Consumption Growth Rate	Per Capita Consumption ($x10^{6}$Btu)	Oil Consumption ($x10^{12}$Btu)
Delaware	insign-ificant	349.8	87.4 oil 5.7 gas 7.0 coal	61.5 oil 2.7 gas 35.8 coal	+2.2%	604.1	305.6
Maryland	coal-67	1028.4	59.1 oil 14.4 gas 19.7 coal 2.3 hydro 4.5 nucl.	40.3 oil .2 gas 34.5 coal 8.6 hydro 16.4 nucl.	+1.0%	251.0	607.5
New Jersey	insign-ificant	1920.0	82.2 oil 13.2 gas 3.0 coal 1.7 nucl.	63.3 oil 3.4 gas 21.8 coal 12.6 nucl.	-4.1%	262.4	1577.5
Pennsylvania	oil-18.6 gas-87 coal-2349	3976.5	38.5 oil 17.0 gas 39.9 coal .4 hydro 4.2 nucl.	8.3 oil * .1 gas 75.1 coal 1.5 hydro 10.0 nucl.	- .4%	336.2	1530.4
Virginia	gas-6.24 coal-961	1325.7	69.2 oil 9.9 gas 12.8 coal 1.0 hydro 7.1 nucl.	46.3 oil .1 gas 25.2 coal 3.5 hydro 24.9 nucl.	+ .4%	266.9	917.2
District of Columbia	insign-ificant	113.7	67.4 oil 23.6 gas 9.0 coal	83.6 oil 16.4 coal	-9.0%	158.7	76.6
United States	----	71800.9	45.6 oil 29.1 gas 18.4 coal 4.3 hydro 2.5 nucl.	15.7 oil 15.7 gas 44.8 coal 15.1 hydro 8.7 nucl.	+ 1 %	336.9	32757.6

Source: A Briefing Book for the ERDA Pittsburg Public Meeting (Draft), Brookhaven National Laboratory, National Center for Analysis of Energy Systems, Upton, New York, April 1977

* Figures do not add to 100% in original source.

According to the data source, the relatively high Delaware energy consumption in the industrial sector (202.8×10^{12} Btu) is partially a result of the large volume of energy intensive products produced in Delaware for use outside the State.[57] The refinery products from the Getty Oil Company operation at Delaware City are examples. Delaware's high per capita consumption of energy, therefore, is partially accounted for by its contribution to meeting energy needs outside the State.

The Federal Energy Administration has prepared energy forecasts to 1980 for each of the states. The Delaware Energy Resources Conservation and Development Commission, created by Executive Order No. 106 and discussed below, has independently predicted State energy needs based on State population projections and national economic growth forecasts. With no allowance for energy conservation, the Commission prediction shows a 19 percent increase in demand between 1975 and 1980, a 33 percent increase between 1975 and 1985, and a 50 percent increase between 1975 and 1990.[58] The Federal Energy Administration forecasts show slightly higher consumption rates, in part because it uses higher population projections.[59] Inasmuch as the State anticipates substantial savings from implementation of energy conservation measures, both projections are probably pessimistic.

Delaware, like other states along the East Coast, has already experienced gas shortages. In the winter of 1976-1977, several industries in the State were forced to close temporarily because of a 1.8 billion cubic feet shortage.[60] The Federal Energy Administration predicted in the fall of 1977 that similar shortages would confront Delaware again in the upcoming winter.[61] Both the Federal Power Commission and the Delmarva Power and Light Co. disagreed.[62]

The long-term energy situation of the State and the Nation is equally uncertain. The next part discusses efforts at the federal level for addressing such uncertainties.

3. federal energy initiatives

One measure of the national interest in energy is the quantity and quality of federal concern expressed in it. This part is intended to impart a general sense that national energy problems are indeed generating a great deal of federal interest and response.

The Congress has expressed its concern over energy resources in several statutes. One of those, the Federal Energy Administration Act of 1974, states that:

> "The Congress hereby declares that the general welfare and the common defense and security require positive and effective action to conserve scarce

> energy supplies, to insure fair and efficient distribution of, and the maintenance of fair and reasonable consumer prices for, such supplies, to promote the expansion of readily usable energy sources, and to assist in developing policies and plans to meet the energy needs of the Nation."[63]

The Coastal Zone Management Act, of course, also addresses energy problems. In it, the Congress finds that

> "The national objective of attaining a greater degree of energy self-sufficiency would be advanced by providing Federal financial assistance to meet state and local needs resulting from new or expanded energy activity in or affecting the coastal zone."[64]

Energy activities are broadly defined in the Act and must be considered during Coastal Management Program development. Substantial sums of money are appropriated under Section 308--the so-called Coastal Energy Impact Program--for energy impact assistance.

More recently the Congress has expressed its concern with energy problems in the Department of Energy Organization Act, which became law on August 4, 1977. The legislation creates a Department of Energy to carry out a comprehensive national energy policy. Among the major programs under the new Department are conservation, resource development and production, research and development, data information management, and regulation. The Department inherited nearly 20,000 employees under the reorganization and received a first-year budget of almost $10.4 billion.[65]

The purposes of the Energy Policy and Conservation Act are:

> "(1) to grant specific standby authority to the President, subject to congressional review, to impose rationing, to reduce demand for energy through the implementation of energy conservation plans, and to fulfill obligations of the United States under the international energy program;
>
> (2) to provide for the creation of a Strategic Petroleum Reserve capable of reducing the impact of severe energy supply interruptions;
>
> (3) to increase the supply of fossil fuels in the United States through price incentives and production requirements;

(4) to conserve energy supplies through energy conservation programs, and, where necessary, the regulation of certain energy uses;

(5) to provide for improved energy efficiency of motor vehicles, major appliances, and certain other consumer products;

(6) to reduce the demand for petroleum products and natural gas through programs designed to provide greater availability and use of this Nation's abundant coal resources; and

(7) to provide a means for verification of energy data to assure the reliability of energy data."[66]

Among other things, the Act provides federal funding and technical assistance to State conservation programs. To qualify, states must prepare and implement energy conservation plans to achieve conservation energy savings of at least 5 percent by 1980. Delaware's federally supported conservation efforts are discussed in the program document.

The Energy Policy and Conservation Act also authorized the Federal Energy Administration to force power plants and other major fuel-burning installations to convert to coal. This authority extends powers conferred in the Energy Supply and Environmental Coordination Act of 1974, and may impact energy facility siting choices, as well as the environment.

The potential conflict between energy needs and environmental quality is acknowledged in a number of statutes, including the Clean Air Act, as amended in 1977. That Act provides that the Governor may petition the President to determine that a national or regional energy emergency exists of such severity that air quality standards may be temporarily suspended.[67] Suspension is permissible only if there exists in the vicinity of the pollution source a temporary energy emergency involving loss of necessary energy supplies for residential dwellings or high levels of unemployment.[68]

The President's National Energy Plan, cited several times already, documents the energy crisis facing the Nation and presents a strategy for dealing with the problems. Three basic objectives of the Plan are to reduce the quantity of imported oil, to decrease the growth rate in domestic energy usage, and to shift to consumption of renewable energy sources.[69] As of this writing, the strategies suggested by the President to implement the

goals have not been adopted by the Congress. The Congress has, however, committed a great deal of time and effort to the issue and will undoubtedly enact major energy legislation in the near future.

Part of the solution to energy problems, of course, is the siting of facilities which make efficient use of energy resources. Those facilities are discussed in the next subsection.

B. Energy facilities

1. petroleum refineries and associated facilities

a. the national interest: The oil which the country needs for energy and other purposes will have to be refined at petroleum refinery facilities. Petroleum refineries serve the national interest primarily be converting crude oil, natural gas liquids or synthetic crude into gasoline, jet fuels, kerosene, diesel fuel, fuel oils, lubricants, waxes, petrochemical feedstocks, etc. Refineries also provide jobs, although not many can be attributed directly and solely to refinery operations.

b. potential demand: As of November, 1976, there were approximately 140 refining companies operating 276 refineries in the United States.[70] The total national refining capacity that year was about 16.0 million barrels per day, slightly less than the 16.4 million barrels per day of total domestic demand for petroleum products.[71]

Private industry typically initiates the siting process for petroleum refineries and associated facilities when the demand for facilities is such that there is a reasonable opportunity for profit. The public knows less about the demand for petroleum refineries than for electric generating plants because government is not as actively involved in assessing the need for the former, or in providing for their siting. Private industry, of course, is reluctant to release data, if it has it, on its analysis of the demand for facilities in specific areas. Thus it is difficult to quantify the potential demand for additional petroleum refineries in Delaware to the extent that the future demand for power plants can be quantified.

It appears, however, that there is no present need in the region for new petroleum refineries or any anticipated need in the near future. Representatives of the American Petroleum Institute and the U. S. Department of Energy have acknowledged as much to the Delaware Coastal Management Program.[72]

Major refineries in New Jersey--at Linden, Perth Amboy, Bayonne, Port Reading/Sewaren, Westville, and Paulsboro/Greenwich; Pennsylvania--at Philadelphia and

Marcus Hook; and Delaware--at Delaware City--give the Mid-Atlantic area a total refining capacity of more than one and a quarter million barrels per day.[73] Petroleum refineries in the Delaware Valley alone had a capacity in 1976 of nearly one million barrels per day.[74] Eight hundred-fifty thousand barrels of crude oil per day were shipped into the Delaware Valley during 1975,[75] and the growth rate of imported oil from all sources into the entire Delaware Valley indicates that the total regional refining capacity should expand at a very gradual rate.[76] With the replacement of old equipment and increases in refining capability of presently operating refineries, the need for new sites will be reduced.[77] Industry officials have explained that refining capacity in the Delaware Valley Region could be almost doubled by upgrading equipment.[78]

A large oil find on the outer continental shelf (OCS) off the East Coast could, on the other hand, increase the demand such that industry will seek new refinery sites. New refineries may also be in demand if the type of OCS crude varies substantially from the type presently refined, although it may be cheaper to modify existing refineries.

That OCS development will create new demand for refineries is not clear, however. The Council on Environmental Quality has pointed out that

> "In some outer continental shelf frontier areas, the refinery siting problem may not arise at all. Insofar as outer continental shelf oil simply replaces imports, there will be no call for new refineries to handle it."[79]

That possibility, perhaps, accounts for the methodology of a study conducted for the American Petroleum Institute--Mid-Atlantic Regional Study - An Assessment of the Onshore Effects of Offshore Oil and Gas Development--which assumes no new refineries or petrochemical plants will result from OCS development.[80]

In any event, the oil industry is undoubtedly mindful that one principle of the National Energy Plan is that "resources in plentiful supply must be used more widely, and the nation must begin the process of moderating its use of those in short supply."[81] As oil reserves dwindle, so likely, will the need for new sites for oil refineries.

c. siting criteria: Direct waterfront access--with, for example, a pier or wharf--is not a requirement for a refinery. The Federal Energy Administration has offered oil refineries as an example of energy facilities which are not absolutely coastal dependent.[82] National Oceanic and

Atmospheric Administration regulations, which "implement" the Coastal Zone Management Act, do likewise.[83] Finally, the Council on Environmental Quality notes that refineries are energy facilities that have been "especially" suggested for inland siting.[84]

Cheap and convenient transporation of crude oil by pipeline makes it feasible to site refineries inland.[85] Mobil Oil Company, for example, operates a 175,000 barrel per day refinery in Illinois which utilizes crude oil transported by pipeline from fields as far away as 1500 miles.[86]

Nonetheless, many elements work together to favor coastal sites, including good markets in populous coastal cities, access to crude oil from abroad, and cheap water transportation.[87] With OCS development and, possibly, superports looming on the horizon, the pressure to locate refineries in the coastal zone will probably continue.[88]

Petroleum refineries and associated facilities typically include processing units; storage tanks; influent and effluent water treatment facilities; ancillary buildings and services, such as administration buildings, machine shops, warehouses, electrical substations, firehouses, pumping stations, truck load terminals, and so forth; transportation systems; and buffer zones.[89]

A transportation system might include roads, pipelines, railroad spurs, parking lots, and so on.[90] Tank trucks, railroad tank cars, tankers, barges, and pipelines are all used, the choice depending on the distance travelled, the product being transported, and the availability of alternatives.[91] Other sections of the paper and the program document discuss transportation systems. Here, it is sufficient to note that tank trucks and highway networks are useful for small quantities carried less than 500 miles; railroad tank cars and railroad networks are competitive with tank trucks for distances of more than a few hundred miles and for quantities large enough to fill at least one car; tankers and barges are used for long-distance, large quantity transportation but are limited by available ports; and pipelines are competitive with both waterborne transportation and railroads but lack flexibility of route and destination.[92]

Refineries are usually land intensive. Refineries with a capacity of at least 100,000 barrels a day are able to yield different products to meet seasonal--for example, gasoline in the summer, fuel oil in the winter--geographic, and marketing variations in demand.[93] This flexibility encourages the siting of large refineries, with attendant demands for space. A new domestic refinery in the 250,000 barrel per day range requires roughly 1,000 to 1,500 acres of clear, flat, industrially zoned land.[94] The site should have a maximum slope of 5 degrees, moderately well-drained soil and the capability to support large storage tanks and processing units.[95]

Refineries also use large quantities of water. The amount of water used depends upon the size of the refinery, the complexity of the product mix, the processing and cooling system technology, and water quality.[96] With an efficient mix of water and air cooling, a 250,000 barrel per day refinery uses between 5 and 15 million gallons of water a day.[97]

Finally, refineries require substantial amounts of energy. Electricity, fuel oil, and gas are the major power sources, with purchased electricity typically providing nearly 80 percent of the refinery's energy needs.[98] Heavy-duty transmission lines and electrical substations are therefore, normally necessary adjuncts to a refinery complex.

d. impact on resources: Some of the resource sections of the paper discuss the impacts of oil refineries on resources and are incorporated by reference into this section.

The potential of a refinery for adverse impact on resources is directly related to its product mix and the processes employed; the refinery size; and the sulfur content of the crude or intermediate feedstock being processed.[99] Potential refinery pollutants include heat released either to the atmosphere or to a nearby water body; atmospheric contaminants from combustion required to generate heat and from the safety flare(s); from the evaporation of hydrocarbons and from catalyst regeneration; liquid contaminants resulting from contact of process streams with water; and solid and semi-solid contaminants which occur as bottom sediment from tank cleaning, sludges from waste treatment processes, and spent catalysts.[100]

Noxious-smelling sulfur is potentially a serious source of air, land, and water pollution requiring special attention. Several hundred tons of elemental sulfur may be disposed of each day.[101] For a 100,000 barrel per day refinery processing crude oil with a sulfur content of 2 percent, recovery of 90 percent of the sulfur in the elemental form would mean that about 270 tons of sulfur per day would require disposal.[102]

Air emissions of a 250,000 barrel per day refinery have been estimated at the levels shown in Table II on the following page. As the table indicates, emission levels vary according to the quality of fuel oil utilized.

Hydrocarbons, however, are difficult to control regardless of fuel quality. These chemicals, a precursor of the infamous photochemical smog is Los Angeles, escape by evaporation of petroleum products from storage tanks, valves, pipes, and hoses in the refinery complex.[103] Hydrocarbons are transformed by atmospheric processes into oxidants, which the Council on Environmental Quality warns affect human health.[104] Regrettably, most Atlantic coast regions are already in violation of the federal standards for oxidant levels.[105]

TABLE II
Estimated Air Emissions
From a 250,000 Barrel Per Day Refinery
(lbs/day)

Type of Emission	Fuel Oil Yield	
	Low	High
Particulates	20,820	17,220
Sulfur Dioxide	97,420	83,950
Carbon Monoxide	5,640	5,750
Nitrogen Oxides	42,082	35,145
Hydrocarbons	90,130	91,870

Source: Modular Results, "Effects on New England of Petroleum-Related Industrial Development", Vol. 2, (Arthur D. Little, Inc., April, 1975), pp. II-35.

Liquid refinery wastes include: wastes containing feedstock or process product; process by-products; spills and tank cleaning wastes; non-process effluents, such as blowdown, water treatment and sanitary wastes, ballast from tankers, etc; and storm water, where the degree of contamination depends on the nature of the drainage area.[106]

Undesirable components of refinery wastewater include: floating and dissolved oil; suspended solids; dissolved solids; phenol and other dissolved organics; cyanide; chromate; organic nitrogen; phosphate; sulfides and mercaptans; and caustics and acids.[107] Storm water runoff, the inescapable result of any large construction project which disturbs the land surface, may move and redeposit soil particles--thereby spoiling water quality.

A 100,000 barrel per day refinery typically produces the following effluents which may require land disposal: 225 barrels per day of waste treating unit sludge; 325 barrels per day of raw water sludge; 700 barrels per day of spent caustic, which may contain sodium hydroxide, sodium sulfate and sodium sulfide; 20 barrels per day of settling pond sludge; 3 barrels per day of tank cleaning sludge; 4.8 tons per day of electrostatic precipitator output; 6 tons per day of cyclone separator output; 35 tons per day of coke fines from bag filters; .3 ton per day of coke chunks; .3 ton per day of waste catalysts; and .2 ton per day of spent sulfur plant catalyst.[108]

If a coastal location is chosen for an oil refinery, environmental disturbances will occur primarily to marine or estuarine communities.[109] A coastal refinery is usually co-located with a marine terminal.[110] Jetties, piers, and crude oil delivery and oil product transshipment facilities typically comprise a marine terminal for refineries.[111] The construction impacts of those structures can be significant.

More critically, oil transfer operations pose accidental spillage risks. The impacts of oil spills on resources is discussed in several portions of the paper and most thoroughly in the deepwater ports section with follows.

The severity of impact on fauna and flora will depend in part on their tolerance, the toxicity of the wastewater discharge, the size of the receiving waters, the flushing rates of the receiving waters, and the physical-chemical characteristics of the receiving waters.[112] Also important, of course, is the amount and nature of habitat destroyed or disrupted by the construction or operation of the refinery or associated transportation facilities. Often, for example, the dredging or filling of wetlands is required to provide access for tankers or other vessels using the refinery.[113]

In sum, oil refineries may impact resources substantially. The next part describes how the Coastal Management Program mitigates such impacts and provides for the siting of oil refineries in Delaware.

e. petroleum refineries in Delaware: The Delaware Coastal Management Program absolutely prohibits the construction of new petroleum refineries in wetlands or in the coastal strip lying between a series of inland roads and the Delaware River and Bay--a stretch of land which varies from a few hundred yards wide in northern Delaware to a maximum of 12 miles in the south. This coastal strip is the Delaware Coastal Zone Act's "coastal zone." It averages approximately 4 miles in width and comprises about 20 percent of the State's total land area. The area is mapped in the program document.

Most of the State's wetlands are within the coastal strip. Large-scale construction of any kind is prohibited in wetlands. The Coastal Management Program designates wetlands as Geographic Areas of Particular Concern and a full discussion of this invaluable resource is presented in the program document. Wetlands are also discussed in this paper because they serve the national interest in many ways. Very briefly, wetlands contribute to food production, recreational opportunites, water quality, coastal stabilization, the economy, and education.

Comparing the value of wetlands with the value of oil refineries or other facilities is much like comparing apples with oranges. Although it may be impossible to state with certainty that a given wetlands area is more valuable to the State or the Nation in its natural state than it would be if it were utilized for a refinery site, the Coastal Management Program policy against wetlands destruction can be justified on several grounds. First, and most important, alternate sites with less natural value are available and suitable for development. The reverse is not true, an existing wetlands area cannot be relocated with the same ease as an unbuilt and unplanned facility. As the President has pointed out, the Nation is losing wetlands at the rate of 300,000 acres per year and "must now protect against the cumulative effects of reducing (its) total wetlands acreage."[114]

A second reason for the policy precluding refineries in wetlands is that the Coastal Management Program provides mechanisms, described in the program document, which assure that the need for new facilities will be continuously evaluated during program implementation, and which also enable amendment of the policies if there is a compelling reason to do so. If the need for an oil refinery in Delaware becomes more critical, the policy may be changed.

Finally, and closely related to the first 2 justifications for exclusion, the decision to develop is generally more irreversible than the decision not to develop. Thus, to the extent that there exists uncertainty about the highest value use, a "waiting" policy makes sense. Perhaps this accounts, in part, for the President's statement that he is "pleased at the number of States taking positive action to protect their natural resources."[115]

The Coastal Management Program policy which prohibits refineries in the coastal strip is also defensible on the aforementioned grounds. The U. S. Department of Energy has unofficially expressed its concern that the prohibition might, in effect, partake of a regulatory process which does not assure that oil refineries in the prohibited area will be given reasonable consideration.[116] That view overlooks 2 important factors. One, the future siting of oil refineries in that area has already been given reasonable consideration. If the rationale for any standard of conduct must be re-examined each time the standard is applied to a set of circumstances, then the standard serves little purpose and outcome predictability is negligible. Thus, for example, each time the State issues a permit for the discharge of wastewater into a stream, it should not and is not required to examine anew whether the resulting stream pollutant levels, pre-established by regulation, guarantee that the receiving waters will remain suitable for swimming. Rather, the State justifiably relies on the analysis which underlies the establishment of the levels in the first instance.

The second factor bearing on the Department of Energy's concern is, as mentioned earlier, that the Coastal Management Program will continue to examine the viability of the policy, and include in that examination consideration of the national interest in the facility.

The prohibition, of course, eliminates, for the time being, some of the most attractive sites in Delaware, namely those fronting the Delaware River and Bay, where waterfront access is assured. As mentioned above, however, direct waterfront access is not absolutely necessary. Moreover, the northern portion of the prohibited strip is very narrow, which means that non-restricted areas are close to the River and Bay. Transportation costs of refined products generally exceed those of the crude oil, so a refinery site near a population center is, all other things being equal, preferable to one near the source of the crude.[117] Thus, even though the southern and wider strip of the prohibited area is closer to the OCS and the oil exporting nations, the narrower northern strip is nearer the area where transportation economics are likely to dictate the siting of a refinery.

It is also noteworthy that the prohibition does not apply to the expansion of existing refinery facilities. This policy coincides with the regional trend of attempting to meet additional refinery capacity demand with the expansion of existing facilities, rather than the construction of altogether new ones.[118] The only oil refinery in Delaware is located within that area where new refineries are prohibited, but existing ones are allowed to expand.

The Coastal Management Program prohibits new refineries in the coastal strip in order to protect the quality of the natural environment and the coastal uses which that quality permits. The resource sections of this paper and the program document describe the national and State interests in preserving the resources and also briefly discuss the impacts of facilities, including oil refineries. Those sections, of course, form part of the basis for excluding refineries from the coastal strip. The resources within the coastal strip are accorded more protection than inland areas primarily because they are generally either more valuable, or more fragile.

The examples are evident. An oil refinery near the Atlantic beaches is incompatible with the recreational uses of that resource--air quality, visual impact, and additional demands on limited water supply and quality are all problems. The potential difficulties of a coastal oil refinery near a wetlands area is discussed in the Fish and Wildlife section. Inland sites pose lesser threats to wetlands, and the fish and wildlife these support, because the sites are generally farther from them. In addition, inland sites are frequently farther from the floodplain.

Expansion of existing refinery facilities is permitted largely because of the relatively minor impacts of expansion in the already developed area.

The Coastal Energy Impact Program (CEIP), established by the Coastal Zone Management Act, may help compensate for State and local environmental losses attributable to new oil refineries sited in the coastal zone, but it is presently unclear how much and under what circumstances such assistance will be forthcoming. In any event, the federally funded CEIP is designed to protect State and local, not national, interests.

A final reason for excluding refineries from the coastal strip is that refineries have the capacity to stimulate additional development in the same area because they produce products which are useable by other industries. As one study points out, "...industries which use refined products either as fuel or as raw materials, particularly the petrochemical industry, will find it desirable to locate near refineries."[119] The Council on Environmental Quality supports that hypothesis:

"With offshore production, the petrochemical development (in the Mid-Atlantic Region) is expected to increase roughly in proportion to refinery development..."[120]

Thus, the secondary environmental impacts of an oil refinery in the coastal strip, if permitted, could be substantial.

Again, it is difficult to compare, for example, the national and State recreational value of beaches with the interest in the products processed by oil refineries. From a national perspective, Delaware's beaches seem to be a rarer, and thus perhaps more valuable, resource than existing oil refinery sites, which dot the Mid-Atlantic region, or potential sites, which occur in many more locations.

Some of those locations are in Delaware, and, as alluded to above, are permitted outside the coastal strip provided specified environmental quality standards are assured. Those standards are described in detail in the program document and various supporting materials, such as DNREC's regulations on air emissions standards. Those and other standards establish criteria by which industry can predict whether the State will approve a specific site for development. An Energy Facilities Siting Liaison Committee, whose functions are also described in the program document, assists industry in site selection and understanding the various regulatory requirements.

State requirements do not comprise the Coastal Management Program's sole regulatory device which applies to oil refinery and other facility siting. The program delegates considerable facility siting authority to county and municipal units of government. With the familiar zoning powers, local units of government of the State assure local compatibility of land use. The Coastal Management Program delegates that authority because political subdivisions of the State are impacted the most by new development within their jurisdictions and, therefore, should have a "strong voice" in what development is permitted. Facility siting, for example, may enlarge the population, increase levels of pollution, impose needs for new services, and otherwise materially change the character of the community.

The Coastal Management Program policy of delegating facility siting authority, of course, also recognizes that facilities offer certain attractions which make them difficult to resist in more than isolated cases. Sizeable contributions to the tax base and other economic benefits generated by oil refineries and other facilities provide incentive for local communities to set aside areas for development. In addition, the Coastal Management Program requires local communities to consider the national interest in the siting of facilities of more than local benefit. That requirement is discussed in the program document. Finally, Congress has the authority to preempt local zoning decisions when it believes the national interest warrants it.

It is possible, after adequate consideration of the national interest, that a given oil refinery will not be permitted at a specific site under the Coastal Management Program. The Federal Power Commission informed the Delaware Coastal Management Program during program development that the Commission had to be certain that each program "provided" for its own future energy needs and its fair share of regional and national needs."[121]

That view seems flawed for several reasons, not the least of which is the unlikelihood that the coastal resources of each diverse state are best suited for energy production. The best management of coastal resources in some states, such as Texas, may very well favor energy production or transmission. In other states, the national and state interest in resource preservation or other facilities may for good reasons preclude the siting of energy facilities.

In any event, the current oil refinery capacity in Delaware exceeds State demands, and makes Delaware a net exporter of petroleum products.[122] The Getty Oil Co.'s 140,000 barrel per day capacity oil refinery in Delaware City is larger than either refinery on the New Jersey side of the Delaware River, and contributes substantially to the total refining capacity in the Mid-Atlantic region.[123] That region--comprised of New Jersey, Pennsylvania, Maryland and Delaware--receives far more crude oil than any other East Coast area.[124] New England, despite its heavy demand for heating oil, is practically without refineries, and, with the exception of a medium-sized plant near Norfolk, Virginia, there is virtually no refining capacity on the Atlantic coast south of Delaware.[125]

2. gasification plants

a. national interest: Crude oil production is usually associated with the production of substantial quantities of natural gas.[126] Gas processing plants are designed to recover valuable liquefiable hydrocarbons not removed by normal separation methods from the raw gas stream before it enters commercial transmission lines.[127] Gas treatment plants are designed to remove impurities, such as sulfur, from the gas.[128] Any one facility may include processing and treatment plants.

Gas plant products are liquefied petroleum gases; including propane, butanes, and propane-butane mixtures; natural gasolines; ethane; plant condensate; and small amounts of other hydrocarbon mixtures.[129] The Nation's dependence on gas products is noted above. The importance of removing impurities is considered in earlier sections of the paper, most notably the Air section.

b. potential demand: According to a 1977 U. S. Bureau of Mines Report, there were 768 gas processing plants

in the United States in 1974, with a total capacity of 73,874 million cubic feet per day.[130] Only 3 of those plants were in East Coast states--2 in Pennsylvania (but with a total capacity of just 5 million cubic feet per day) and one in Florida.[131] Two coastal states, Louisiana and Texas, produced roughly three-quarters of the marketed natural gas production in 1974, and 40 of the lower 48 states consumed more natural gas than they produced.[132]

The eastern states, particularly those in colder climates, are heavily dependent on gas. Should large amounts of natural gas be available for production in the OCS off the East Coast, nearby onshore gasification plants will probably become cost effective. The price of shipping gas west for processing and then transporting it back east for consumption is obviously prohibitive.

The level of gas production, if there is any, from the Atlantic OCS is highly uncertain.[133] If, however, gas is produced at an offshore platform, it likely will be separated from the oil and water contained in the well stream; piped to shore; treated at a gas plant to remove impurities and processed to recover valuable liquid hydrocarbons; and delivered to a commercial gas transmission line at a specified pressure and quality.[134] The pipeline, if there is one, may dictate where the gas plant(s) is needed. Pipeline siting in Delaware is discussed below.

c. siting criteria: Gas processing plants, like oil refineries, are not absolutely dependent on a coastal location.[135] Gas company representatives have indicated that such facilities can be located as far as 10 miles from an OCS gas pipeline landfall.[136] Difficulties arise at greater distances because of pipeline construction costs; the interference with telemetrics, which enable onshore control of offshore production wells; and the cooling of gas as it passes through the line from production to shore, which causes liquids to form in the pipelines.[137] On the other hand, the high cost of some coastal land may outweigh the advantages of a coastal site.[138] Assuming, however, that a gas processing plant is needed in Delaware because of OCS development, a coastal location obviously would be the closest point to the gas field.

There are no standard designs or sizes for gas plants, each plant is specifically designed for the particular gas stream that it processes.[139] The amount of land required is related but not directly proportional to throughput capacity.[140] A typical billion cubic foot per day plant may require 75 acres of land, of which 20 may be used for building and structures.[141] For planning purposes, a 50 to 75 acre site would be required for a gas plant processing between 200 and 1,000 million cubic feet per day.[142]

The land, preferably flat and well-drained, is needed for buildings, storage facilities, pipes, towers, compressors, buffer zones, and parking lots.[143]

Onshore partial processing facilities may be used to process natural gas or oil. A combined partial processing facility requires approximately 15 acres of land per 100,000 barrels of oil and associated gas processed.[144]

Most gas processing plants use less than 200,000 gallons of water daily, but water demand can range from zero to 750,000 gallons depending on the cooling process used.[145] A modern design would probably utilize an air cooled system with minimal water requirements.[146]

Gas plant products are transported by rail, truck, pipeline, or barge, according to the transportation available and the location of markets for a particular product. Small plants may have products shipped by truck, but pipelines or rail are usually more economical for large product volumes.[147]

d. impact on resources: Gas plants generally pollute the environment less than oil refineries. Accidents occur more frequently in natural gas operations than in corresponding crude oil operations, but gas operation accidents usually cause far less environmental damage. For example, water pollution resulting from pipeline leaks or other malfunctions is less severe than for similar oil mishaps.

Wastewater contaminants include sulfuric acid, chromium, zinc, and chlorine, from cooling water; phosphates, sulfite, and bases, from boiler water; and dissolved hydrocarbons from diverse sources.[148] Lubricating oils and caustics may also be discharged in the course of plant operations.[149] In addition, the U. S. Department of Energy has pointed out that gas processing plants may cause thermal pollution, lowering or raising the water temperature several degrees before the water is returned to its source.[150]

Substances concentrated in the effluent and heat, according to a comprehensive report by the New England Basin Commission, "can produce serious impacts on the receiving waters."[151] The same report states that the chemicals added to the cooling stream to reduce corrosion and fouling within the condensor system may be "extremely toxic to aquatic organisms."[152] Finally, the report points out that "If a waterfront location is chosen, environmental disturbances due to dredging, filling, channel alteration, and spoil disposal may result. If an inland location is chosen, such disturbances would be minimal. Since a wide selection of potential inland sites is usually available, environmentally sensitive regions can be avoided."[153]

Sources of air emissions at gas plants include: processing, evaporation, flares, and combustion from machinery and vehicles. Major air emissions are noxious smelling hydrogen sulfide, sulfur oxides, and hydrocarbons.[154]

Nitrogen oxides may also be significant.[155] The estimated, though disputed, process emissions from one plant with a 1.3 billion cubic feet per day throughput was 6.63 tons per day of sulfur dioxide and 1.65 tons per day of hydrogen sulfide.[156] The magnitude of impacts from such emissions is determined by ambient air conditions at and near the site.

Noise can also be a problem. Gas plant compressors, boilers, scrubbers, and flare stacks are all 24-hour noise makers.[157] In undeveloped areas, noise from a gas plant can be serious. A flare stack emitting 81 decibels of noise, for example, exceeds ambient noise levels as far as .7 mile from the stack.[158]

Aside from odors and noise, gas plants are visually unattractive with their tall smokestacks, 24-hour lighting, and denuded landscape. Adequate landscaping in a buffer zone can mitigate that problem if an inland site is chosen.

Finally, solid wastes generated by a gas plant include scale and sludge from boiler and cooling tower clean-outs; tank cleaning sludge; spent dessicants; filtration media and oil absorbants.[159] Also included are hazardous materials, which are defined in the Federal Water Pollution Control Act as

> "such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States or adjoining shorelines or the waters of the contiguous zone, present an imminent and substantial danger to the public health and welfare, including, but not limited to fish, shellfish, wildlife, shorelines, and beaches."[160]

Hazardous waste materials from gas plants may include accidentally spilled liquid gas or other hydrocarbons, and processed sludge containing chemicals and residuals from brine evaporation.[161]

e. gasification plants in Delaware: The discussion of oil refineries in Delaware in the previous part applies to gas plants with only minor exceptions, and is incorporated herein by reference.

The Delaware Coastal Management Program, for regulatory purposes, treats gasification plants like oil refineries. Although the real and potential impacts of the former are generally less severe than those of refineries, they are, nonetheless, serious enough to warrant exclusion from the coastal strip and all wetlands.

The Coastal Management Program recognizes that many of the environmental problems associated with gas

processing plants can be overcome with proper planning, careful waste treatment, and strict operational standards. Unfortunately, human error, at diverse levels, often defeats the best laid plans and intentions. To minimize the possible implications of such error for coastal recreation, natural habitat, and other unique values in the coastal strip, the Coastal Management Program only allows gasification plants outside that area.

3. LNG facilities

a. national interest: Liquefied natural gas (LNG) is formed by cooling natural gas to -260 degrees Fahrenheit, when it occupies one six-hundredth of its original volume.[162] Large volumes of gas may be transported by tankers especially designed to handle LNG.

An LNG export-import system includes the following components: a source of natural gas; transportation from the source to the liqueficiation plant; the liquefaction plant; storage, loading, and port facilities at the exporting site; transportation by ocean tanker; unloading and storage facilities at the importing site; a regasification plant; and transmission facilities from the regasification plant to a major pipeline.[163] Given the gas demand and supply situation of the Delaware region, only LNG import facility sites are within the scope of this paper.

As noted above, that demand-supply situation is bleak. Because of its low cost, clean-burning and handling characteristics, natural gas demand in the United States and the Delaware region is threatening to far outstrip natural gas supply in the country. The world's greatest gas reserves lie overseas, which for purposes of gas transport, can be reached economically only by LNG tankers.[164] For that reason, LNG facilities are essential if the Nation is to receive substantial help towards meeting its gas needs from overseas.

Imported LNG accounted for about one-twentieth of one percent of the natural gas consumed in this country during 1977, but LNG is expected in some quarters to make up between 5 and 15 percent of the total U. S. natural gas consumption in 1985.[165] If a pipeline is used to transport Alaskan gas to the continental United States, the percentage will probably be in the lower range of that estimate.[166]

It is important to note, however significant the contribution of LNG may prove to be, that it is not a new source of energy which will allow unrestrained use of natural gas or solve the long-term national or regional gas supply problems. LNG could satisfy a portion of the U. S. energy demand for at least the next 20 years, but the world's limited natural gas supply serves as an uncompromising constraint on continued utilization.[167]

Rather, LNG is seen--even by its proponents as a "stop-gap" measure. The Federal Power Commission, for example, has stated that LNG projects

> "must be operational soon to assure smooth transition from a petroleum and natural gas economy to an economy operating at its full conservation potential and under alternate energy technologies."[168] (emphasis supplied)

That view is consistent with the National Energy Plan, which says:

> "Due to its extemely high costs and safety problems, LNG is not a long-term secure substitute for domestic natural gas. It can, however, be an important supply option through the mid-1980s and beyond, until additional gas supplies may become available."[169]

LNG safety problems are described below. The "extremely high costs" to which the Plan refers are attributed to the gas price, royalties, taxes and other payments in the exporting country; production, transmission, liquefaction, storage, and loading costs in the exporting country; tanker transportation costs from the exporting country to the United States; and unloading, storage, revaporization, and transmission costs in the United States.[170] Energy conversion inefficiencies also tend to drive the cost upward. The liquefaction, storage, and vaporization of natural gas requires about 23 percent of the energy of the gas, with liquefaction alone consuming 17 percent.[171] A study prepared for the U. S. Energy Research and Development Administration concludes that "their (LNG) imports will be very costly, perhaps more than $4 per million Btu...and their...cost will be reflected in the ultimate price paid by the consumer."[172] Extrapolating from a second study, that price may be close to twice the uniform national rate for sales of interstate natural gas established by the Federal Energy Regulatory Commission.[173]

The first study also points out, in 1976, that "The importation of natural gas, like that of oil is counter to the national policy of energy independence."[174] Although the current national policy seems to be drifting away from the principle of energy independence, the dangers of dependence are as real as ever. Economic drain and the ever present threat of a crippling embargo are salient and alarming features of substantial reliance on foreign imports. Nor is there any solace in the fact that one of the 2 major foreign suppliers of LNG, Algeria, is a country with which United States relations have been strained over the past decade.[175]

That the national interest in promoting LNG is unclear, was underscored in a December, 1977 report by the U. S. General Accounting Office, generally identified as the financial oversight agency of the Congress. The report charges that the President's LNG policy falls short of what is needed on several grounds, including the following: (1) the LNG policy is not related to "the over-all national energy plan so as to identify LNG import goals;" (2) the policy "does not adequately address the concerns of vulnerability"--that is, criteria defining "overdependence" are not established; and (3) the policy contains "numerous obscure statements which only add to the confusion regarding LNG's future role in supplying U. S. energy needs."[176]

b. potential demand: Uncertainties make it difficult to evaluate the potential demand for LNG facilities in Delaware. Potential safety hazards and low economic returns, as well as uncertainties in the market, here and abroad, make investment risky. In 1973, when the Nation imported 4 billion cubic feet of LNG, the Federal Power Commission estimated there would be a 1500-fold increase in the amount of LNG imported into the United States between 1973 and 1980.[177] In 1974, the Commission reported zero LNG imports, and importation has continued to lag behind the projection.[178] A 1976 study concludes that uncertainties make it difficult to estimate LNG imports, if any, to the Northeast in 1985 and 2000, and that the year 2000 supply can be estimated "only in the crudest way."[179] The quantity of imports, of course, is also largely a function of the capacity of facilities to receive it. Thus, utilizing LNG supply projections to determine the potential demand for facilities is a non sequitor in some respects.

Another factor laden with uncertainty and bearing on the demand for LNG facility sites is regulatory attitudes. Until recently, the Federal Power Commission could influence the demand for facilities in 3 ways: (1) it had the authority to establish the price at which gas was sold; (2) it determined whether or not the public interest would be served by LNG importation; and (3) it authorized construction or extension of any facilities to be used in the transporation or sale of interstate natural gas.[180] Under the Department of Energy Organization Act, the Federal Energy Regulatory Commission now has the lead federal role in LNG facility siting. Uncertain federal policy, already discussed, clouds the predictability of the Commission's actions.

In 1973, the Federal Power Commission identified 19 potential LNG receiving areas based on at least some of the criteria discussed below.[181] One of those areas was along the Delaware River, where several sites are in high gas demand areas and also near major transmission lines.[182] Two New Jersey sites near the Delaware River not far from Philadelphia, oil refineries and power plants, were proposed. The Federal Power Commission's environmental staff recently concluded, however, that there were "unacceptable risks" in

carrying LNG by tanker up the crowded Delaware River, and recommended that approval be denied.[183]

The report, however, emphasized safety hazards that are less prominent southward along the River and Bay. Should the New Jersey sites be abandoned, the southward areas might be considered potential sites for meeting the demand evidently present near Philadelphia. On the other hand, those areas might also be too distant from the attractions which generated the interest in the New Jersey sites.

Some, if not all, of the regional demand can be met by the new import facility at Cove Point, Maryland, which was scheduled to go into operation in late 1977.[184] The Cove Point terminal has 2 tanker berths, 4 storage tanks and several process areas.[185] The initial operating plans call for about 140 ship arrivals per year, delivering the daily equivalent of two-thirds of a billion cubic feet of gas.[186] Other major LNG receiving terminals in the Northeast are located in Everett, Massachusetts and Staten Island, New York.[187]

With all the above caveats in mind, a study by the National Center for Analysis of Energy Systems estimates that imports of LNG into the Virginia to Maine area in 1985 will be from .8 to 1.1 trillion cubic feet per year.[188] Assuming that the terminals complete or nearly complete will be fully operable in 1985, the frequency of deliveries of LNG tankers will be roughly 2 per week per terminal.[189]

c. siting criteria: The site selection process for LNG facilities is currently conducted by a company or consortium proposing the project. A company makes it application to the federal authority only after it has done as much preliminary work as possible, which includes at least gaining control over, if not outright ownership of, the proposed site. Thus, neither the public nor the federal government become involved in the site selection decision until it has already been made by the company.[189] There are no federal siting criteria, and the currently proposed projects are located in a variety of sites, ranging from remote coastal and riverine areas with 1,000-acre buffer zones to as little as a 90-acre site on Staten Island.[191]

Most proposed LNG plant sites occupy at least 200 acres of shorefront land, which include a buffer zone.[192] Larger areas are usually needed to accommodate all the associated facilities. Generally there are 3 or more storage tanks containing 300,000 to 600,000 barrels at each plant, with each tank surrounded by deep dikes to contain the liquid gas if it spills.[193] Present technology dictates that the tanks be no more than 2 or 3 miles from the marine terminal where ships unload, and some of this distance is likely to be over water because terminals may be sited a mile or more from land in order to reach deep water.[194]

Along the Delaware shore, for example, the Delaware River and Bay depth is too shallow in most places to accommodate the large, bulky LNG tankers with their 40 foot drafts. Wilmington may be the only exception, but, because of its population density, is not a desirable site for an LNG terminal. A recent study, for reasons discussed below, recommends that population near proposed sites be "zero or very low" density within a one-mile radius, and low within a 6-mile radius.[195]

Also recommended is a 450 foot wide, relatively straight and unobstructed approach channel.[196] A turning basin of at least 2000 feet is desirable near the berth.[197]

Channel requirements for LNG tankers will dictate utilization of pipelines in many cases. Piping LNG is very expensive. The stainless steel or aluminum cryogenic piping system that it requires is 7 to 8 times costlier than the carbon steel used for piping ordinary gas.[198] Moreover, the energy required to pump LNG tends to heat and vaporize the liquid.[200]

For those reasons LNG facilities need land space near the marine tanker terminal, and the Federal Energy Administration has identified such facilities as absolutely coastal dependent.[201]

Offshore terminals have been suggested as a means of reducing safety risks in populated areas or congested harbors, but again piping costs may be prohibitive. At the present time, preliminary offshore terminal designs limit site selection to locations with water depths of 600 feet.[202]

Onshore LNG terminal sites must be on solid bedrock or other geological formations which will support the facilities. The site should avoid earthquake and climatic hazards, and allow year-round operation.

A report prepared for the U. S. Energy Research and Development Administration, says the site

> "should be so located to minimize disruption to the environment of the area during the construction phase. This includes the ability to control runoff erosion and the ability to limit damage to the area wildlife and foliage. As an example, a rocky shoreline or stable sand beach is preferable to a tidal marsh land whose ecology is more susceptible to disruptions. Deep water close to shore is desirable to minimize dredging."[203]

The same report recommends a site where there is little local maritime traffic because such traffic can be expected to be interrupted to insure the safe passage of LNG tankers.

Proximity to local utilities is also important in order to support construction and operation activities. Water demand is minimal for operations, but supplies are needed to satisfy fire protection regulations.

The site also should be in proximity to transportation systems, especially an existing major natural gas pipeline. The major line through Delaware is closest to the Delaware River and Bay at a point in New Castle County, in the Wilmington vicinity.[204] In Sussex County the line is closer to Maryland than the Bay.[205] On the other side of the Bay, in New Jersey, there is an existing major gas pipeline near Cape May. On neither side, however, do the lines approach the shore as closely as several other pipelines on the East Coast.[206]

An alternative to pipelines, once the LNG is landed, is trucks. As of September, 1977, it was estimated that there were 75 LNG trucks in operation in the United States.[207] Railroads and barges have also been proposed as means for transporting LNG, but have been defeated by economics or other opposition.[208]

Such opposition suggests that one of the most important criterion for the siting of LNG facilities should be safety considerations. The next part explains why.

d. impact on resources: As the Office of Technology Assessment puts it,

> "Postulating an LNG disaster scenario is clearly an almost limitless task. There are countless combinations of events which could lead to an accident...to infer, as most LNG safety reports do, however in advertently, that all the important possibilities have been "covered," may be shortsighted."[209]

One of the possibilities that has been analyzed involves the result of LNG spillage on water in a large-scale accident. In such a case the water would warm the floating LNG, vaporize it, and form a cold, low-lying "gas cloud." The heavy cloud would continue to hug the earth until the gas becomes so dilute as to be no longer flammable, and eventually, warms enough to rise and dispense.[210] Researchers disagree on the shape, size, movement, and composition of the cloud, but it is generally agreed that if the vapor ignites, it would be beyond the capability of existing firefighting methods to extinquish it.[211]

Thus, from a safety perspective, the key issue is how far and how broadly a vapor cloud travels before it dissipates. There has never been a massive LNG spill on water.[212] Estimated distances vary from less than one mile to more than 50 miles, depending on different assumptions.[213] Work by the U. S. Bureau of Mines has indicated that a 25,000 cubic meter spill--the contents of one of the 5 cargo tanks in a big LNG tanker--could produce a 1500 foot long plume, the major part of it highly flammable.[214] With stable weather conditions and a steady wind of about 7 miles an hour, the plume could theoretically travel some 19 to 38 miles.[215] As one commentator points out, however, "it is highly probable that the cloud would encounter a source of ignition soon after touching land, if not before."[216] In Delaware, some of that land would correspond to the densely populated beaches.

A Navy study calculates that the front edge of a vapor cloud from a 10,000 cubic meter spill could travel 2.1 miles in 35 minutes, with winds of about 5 miles per hour.[217] By that time, the flammable part of the cloud would be 2000 meters, or more than 1 mile, in length and width.[218]

Other reports by industry and the Federal Power Commission conclude that the vapor cloud travel would be much shorter.[219] For a hypothetical "worst case" accident at an Alaskan terminal, however, the Commission conceded that a massive spill of 350,000 cubic meters--the contents of 4 large storage tanks--would produce a cloud that might travel downwind 5.7 miles with 5 mile per hour winds and persist 1 hour and 8 minutes before dispersing.[220]

The ignition of a vapor cloud could obviously cause calamity. A burning vapor cloud would destroy anyone or anything unfortunate enough to be caught in it, and an explosion would carry the threat beyond the cloud. Current evidence suggests that unconfined vapor clouds will not explode.[221] But it is conceivable that vapors entering a confined space might ignite, leading to an explosion that could detonate the whole cloud.[222] The Naval Weapons Center at China Lake, California is exploring that possibility now.[223]

It is also researching the hazard from an LNG pool fire, which some experts believe is worse than a vapor cloud.[224] The Council on Environmental Quality describes the danger:

> "The characteristics of these fires on water, like the behavior of vapor clouds, are subject to great uncertainties, and estimates of the safe distance from their intense radiant heat vary significantly. According to a recent FPC (Federal Power Commission) analysis, a generally safe

> distance from a 25,000-cubic-meter pool fire would be about 8,300 feet, or 1.6 miles. People standing 3,600 feet away would blister in 5 seconds, and exposure for longer times--perhaps 10 seconds--would be fatal. Estimates based on bureau of Mines figures indicate that the danger might extend farther. According to these figures, on a windless day when thermal radiation is greatest, unsheltered people at a distance of 9,600 feet, or nearly 2 miles, could suffer fatal burns."[225]

The world's worst LNG accident occurred in 1944 when a storage tank in Cleveland ruptured, spilling 6,200 cubic meters of LNG into adjacent streets, sewers, and storm basements.[226] In those confined spaces vapor and air combined in an explosive mixture which ignited and demolished sizeable buildings. Intensely hot fire burst into 2,800 foot flames, and combustible material 1000 feet away caught fire by radiation.[227] The accident resulted in 130 deaths, between 200 and 400 injuries, and approximately $10 million in property damage.[228]

For a while, interest in LNG waned, but by the 1960s LNG facilities became increasingly common.[229] In 1973, a second significant accident occurred at a Staten Island import facility, where 40 workmen repairing and "empty" LNG tank were killed by an LNG-related fire.[230]

Those and other potential disasters call for extremely strict safety controls. In some respects, the LNG industry and government have successfully met the challenge. LNG tankers are now equipped with double bottom hulls special navigation equipment, and other safety features not normally present on other ships; dikes are used to contain the LNG in the event a storage tank ruptures; and better materials are used in all LNG handling equipment. Those and other improvements have led some to believe that LNG risks are acceptable.[231]

Many problems remain however. A major one, already discussed, is the "countless combinations of events which could lead to an accident." Coupled with the uncertainty about whether all the "important possibilities have been covered," doubt emerges.

Despite years of planning and utilization of the best technology available, the proposed terminal sites in New Jersey were considered "unacceptable risks" by members of the Federal Power Commission. Part of the conclusion was based on the location of the shipping channel--within a few hundred miles of shore in places--and the history of tanker accidents near the site.[232]

A standard LNG tanker is a high-powered ship, with an optimum service speed in the 20-knot range--about 5 knots faster than most oil tankers--and a capacity so large that an 8-story building could fit inside each of its 5 cargo tanks.[233] By the end of 1975, there had been only 31 LNG shipments to the United States.[234] At that time, there were only 34 LNG tankers in operation worldwide, a minuscule number compared with the 6800 oil tankers in service.[235] Thus, experience with transporting and unloading the behemoth tankers is not extensive, and researchers do not have enough data with which to predict the likelihood that a major LNG spill will occur, how the spilled liquid and resulting vapors will behave, or what impacts will result.[236]

Historically, oil tankers casualty data have indicated a need for improved marine traffic safety in U. S. ports and waterways.[237] The Delaware River handles 5000 ships per year. By comparison, Boston Harbor handles only 1500 ships per year, while 4000 ships visit Chesapeake waters yearly.[238] Most of those ships are not equipped with special navigational aids or with crew versed in the LNG threat. Although the U. S. Coast Guard has proposed regulations setting minimum standards for persons employed on United States flag LNG carriers, foreign flag ships entering United States harbors are not subject to the regulations.[239] The U. S. Office of Technology Assessment, accordingly, has questioned the training and competence of foreign crews.[240]

The Council on Environmental Quality has pointed out that there are no formal safety criteria for LNG facility siting and that no broad programmatic environmental impact statements have been prepared for LNG terminals or storage facilities.[241] Those deficiencies led, in 1976, to a petition by Delaware, New York, New Jersey, Pennsylvania, and others for a court order directing the Federal Power Commission to develop uniform and comprehensive standards for site selection and operation of LNG facilities.[242] As of September, 1977, the petition was set for hearing and the standards were not in force.[243]

Finally, apart from potentially inadequate site selection controls, there is little onsite inspection to assure compliance with stipulations contained in the licenses issued previously by the Federal Power Commission, and presently by the Federal Energy Regulatory Commission.[244]

Although human safety hazards pose the pre-eminent LNG facilities "impact" problem, resource impact is also significant. Approximately 800 to 1200 acres of land may be necessary for docks, storage, and vaporization facilities, depending on the terminals' daily capacity.[245] Land mass compaction can re-route aquifers and underwater streams.[246] Onsite wetlands, wildlife and wildlife habitat, historical and archeological areas, agricultural land, forest, and so

on may all be destroyed or damaged. Pipeline corridors can have similar impact, at least temporarily. The impact of offshore pipelines is discussed separately.

At rural sites, the effect of dredging, fill and waste disposal upon the aquatic environment may be a problem. In addition, movement of LNG carriers in shallow areas may disturb bottom life both from the turbulence generated by propellors and the ship's wake.[247] Water circulated through the revaporization plant at 300,000 gallons per minute catches fish in its flow and kills them at intake streams, much in the same manner as power plants.[248] Biocides, used to kill small organisms that pass through the screens, may also kill organisms outside the screen.[249] Thermal pollution--water returned to the water supply source comes out 12 degrees colder than it came in--is still another source of disturbance to aquatic life.[250]

Air and noise problems are usually minimal after construction of the terminal is completed,[251] but aesthetic considerations and the safety hazard may drive surrounding property values downward.[252]

e. LNG facilities in Delaware: The Coastal Management Program prohibits the siting of LNG facilities in Delaware. The national interest in and policies on LNG are unclear. A study by the National Center for Analysis of Energy Systems even lists the possibility of an LNG moratorium as one uncertainty in projecting LNG imports.[253]

Although the Coastal Management Program acknowledges that there is a national interest in facilities which help supply natural gas, it also recognizes the limitations of LNG facilities. Such facilities promote dependence on expensive and uncertain energy supplies, pose grave safety hazards, and may interfere with domestic development of oil and gas on the outer continental shelf--development which serves the national interest far better than increased importation of foreign LNG. One Senator from Rhode Island, for example, has already expressed fears that his State cannot support both a staging area for offshore oil and gas operations and an LNG terminal.[254]

Indeed the criteria for siting LNG facilities are such that no Delaware site seems to be suitable, regardless of what role the State may play in offshore development. Ideally, the site should be: in a low density population area, but close to utility services and major transportation systems; on a bedrock foundation, but near the water; close to a deep channel, but away from maritime traffic.

If such a site exists, it is not in Delaware. The State's best transportation systems, including a major natural gas pipeline, occur near its highest area of population density--Wilmington. The undeveloped shorefront is

largely valuable, but hardly firm wetland, and the geological stability of some of the remaining shorefront is in very grave doubt.[255] Finally, the closest point of the main shipping channel to Delaware's shore, which might arguably be suitable for LNG tankers, lies near Wilmington--a Port with considerable traffic and population.

The main shipping channel up the Delaware River and Bay also passes, in places, within a mile or 2 of Lewes, and not much farther from Rehoboth Beach--both densely populated in the summer. A tanker accident near that city could spell disaster. The U. S. Energy Research and Development Administration informed the Coastal Management Program during program development that its environmental and safety programs are mandated by the requirement that the Nation's energy be provided in a way that is safe, clean, adequate, and acceptable to society.[256] The Coastal Management Program concurs with that requirement, and finds that LNG facilities at Delaware sites are neither safe nor acceptable.

Further, the land requirements of LNG facilities, coupled with their tendency to induce additional development, make LNG facilities unsuitable for the area they would otherwise occupy--the Delaware coastal zone. The paper's discussion of oil refineries, as it pertains to the balancing of the need to protect coastal resources with the need for the facility, applies again, as do several other sections of the paper which describe the national interest in resource preservation.

According to one source, it has been the Federal Power Commission's position that, unless otherwise stipulated, federal approval of an LNG site allows preemption of State and local laws related to siting. The program document appendix identifying federal actions subject to federal consistency provisions of the Coastal Zone Management Act explains which LNG-related actions will be affected under the program. Briefly, any action preempting a State exclusion of an LNG site in Delaware is subject to the consistency provisions, unless it is an action which presents extraordinary circumstances and is approved by the Governor.

4. deepwater ports

a. national interest: There is no port in the contiguous 48 states with deep enough water to accommodate the 60-foot draft of the standard 200,000 ton "very large crude carriers," the so-called supertankers; and no East Coast port can handle anything larger than 80,000 tons fully loaded--most are restricted to tankers of 35,000 to 50,000 tons.[257] Yet, because of economies of scale, supertankers are carrying an increasingly large part of petroleum in world trade.[258] In 1966 there was only one tanker in the world over 200,000 deadweight tons (dwt).[259] By the end of 1975, there were over 583 supertankers this size in service, and 205 more were under construction or on order.[260] Only

10 percent of the world's fleet, those 583 ships carried 40 percent of the crude oil shipped in world commerce.[261]

The cost advantage of supertankers is demonstrated by comparing a 250,000 dwt tanker and a 50,000 dwt tanker. The latter normally serves Delaware Bay and New York Harbor and averages 40 feet in draft.[262] A 250,000 dwt requires 70 feet of water, but can carry oil over long trades at about half the cost-per-barrel of the smaller tankers.[263]

The U. S. Maritime Administration believes that deepwater ports can help keep the Nation's industry competitive, and, accordingly, has informed the Coastal Management Program that the exclusion of a deepwater terminal could affect the entire United States economy.[264]

The Congress has also acknowledged the national interest in deepwater ports. The Deepwater Port Act of 1974 establishes a federal program to license ownership, construction, and maintenance of ports located outside the states' territorial limits to unload oil for transportation to onshore receiving facilities by pipeline or shallow draft lighter.[265] The Act includes provisions for environmental review, public access to information, citizen civil actions, and strict liability for oil pollution. It also recognizes state and local concerns, and requires the prior approval of the Governors of coastal states adjacent to proposed deepwater ports.

One consideration in any gubernatorial approval or rejection undoubtedly will be the possibility of oil spills. Deepwater ports are generally regarded as safer than lightering, assuming equal amounts of oil are transferred. For example, the U. S. Office of Technology Assessment has estimated that a hypothetical deepwater port 30 miles off the New Jersey coast would spill half as much oil as small tankers based on the probable total spillage within 50 miles of shore.[266]

A deepwater monobuoy-pipeline system avoids many of the hazards which have given tankers a "splotchy" oil spill record. Tankers groundings and collisions, oil transfer operations, oil ballast water discharges, and tank cleaning discharges are some of the tanker pollution sources which, to date, have been difficult to control.

Four factors make the risks of oil spills from deepwater port operations generally lower than the risks from small tanker operations: one, a deepwater port reduces the number of tankers that must be used to move the oil; 2, close surveillance of oil transfer and handling is possible, allowing stricter enforcement of safety standards; 3, oil tanker traffic can avoid crowded harbors; and 4, the distance between the port and the shoreline may reduce damage to valuable coastal areas.

On the other hand, stricter tanker operation standards, improved communications technology and tanker design, and more intensive training of crews, combine to raise the hope that oil transport by tanker will become appreciably safer in the future. To the extent that stricter ballast regulations, computer and radar assisted marine traffic managements systems, double bottom hulls and twin screws, and training and licensing of crews can reduce tanker accidents, the environmental interest in deepwater ports will be lessened.

As a result of (1) past oil catastrophes; (2) a lawsuit against the State of Washington--where the plaintiff is arguing that Coast Guard tanker operation standards should preempt State controls; and (3) other reasons, the Coast Guard is "toughening up." It has the authority under the Ports and Waterways Safety Act of 1972 to implement most, if not all, the remedies mentioned above.

An additional factor reducing the environmental interest in deepwater ports is that the potential impact of those facilities is in some respects greater than that of tanker transportation, especially if the terminal is close to shore. That impact is discussed below.

b. potential demand: In early 1977, the United States imported 9 million barrels of oil per day.[267] In 1976, tankers delivered more than 1.2 million barrels of crude daily to 9 Mid-Atlantic refineries.[268] According to a recent study by the College of Marine Studies at the University of Delaware, approximately 70 percent of all the oil that is delivered to the East Coast moves by water up the Delaware Bay and River.[269]

Despite the high volume of crude oil traffic in the Bay and the relatively cheaper cost of supertankers vis-a-vis smaller tankers, economics have not yet justified construction of a deepwater port in the Mid-Atlantic region. A 1975 study of the feasibility of a deepwater port in the Delaware Bay concluded that a port-pipeline system--especially if modest in size--was not economically competitive with a lightering operation.[270]

Rapidly rising construction costs have dissipated the advantages a deepwater port may have enjoyed 7 or 8 years ago. The costs of a port inside Delaware Bay range from $193 million to more than $400 million.[271] Moreover, the estimated direct cost of dredging some 15 million to 20 million cubic yards of bay bottom for a channel to the port that would handle 250,000 dwt tankers is estimated at an additional $40 million.[272]

In 1971, the Delaware Bay Transportation Company calculated that oil could be transferred through its proposed port for 12 cents a barrel.[273] At 1975's inflated construction costs, the price would have been 25 cents,

even without imposition of a State tax.[274] By comparison, the 1975 lightering charge was between 8 and 11 cents per barrel.[275]

Only large supertankers on the longest trips between the Persian Gulf and the Mid-Atlantic region could take economic advantage of the port at such inflated prices.[276] For tankers less than 100,000 dwt, lightering would be cheaper.[277] Since most oil imported in the Delaware Valley is not brought from long haul distances, a deepwater port today would seem to be untenable.[278]

If future oil imports to the Mid-Atlantic region increase dramatically, or if the source of imports changes, there may be greater demand for a deepwater port in the Delaware Bay or off the Atlantic Coast. In the former case oil refinery capacity will have to be sufficiently large to make a port attractive. However, opposition to oil refineries, federal air quality regulations, inflated construction costs, and federal tax policies and import quotas are some of the factors which may deter industry from expanding refinery capacity in the Mid-Atlantic.[279] Thus, as the discussion above indicates, only a very gradual increase in refinery capacity in the Delaware Valley region is anticipated.

On the other hand, if oil consumption increases dramatically, there may be pressure for more refineries, more oil imports, and a deepwater port. The Federal Energy Administration has, perhaps pessimistically, predicted that oil consumption in New York, New Jersey, Delaware and Pennsylvania will climb from 2.7 million barrels a day in 1975 to 3.8 million barrels a day.[280] Based on that estimate, the Federal Energy Administration has also predicted that crude oil imports supplied through New York Harbor and the Delaware Bay will increase from 1.2 million barrels a day to 2 million barrels a day.[281] Moreover, a lone deepwater port on the East Coast could attract supertankers which would otherwise head for other eastern harbors. Finally, a large find on the outer continental shelf and a pipeline hook-up to the port might make the port profitable.

Those speculations probably account, in part, for the current enthusiasm for a proposed monobuoy port to be located not less than 18 miles east of the high water mark on the Delaware Shore. Still in the planning stages, private industry has contacted Delaware with a proposal to operate a fixed structure resembling an outer continental shelf oil development platform. Under the proposal, the State would be the licensee of the port and exert direct control over it.

c. siting criteria: The least expensive, most versatile, and most likely deepwater port design is the monobuoy.[282] There are different types of monobuoys, but generally they consist of a floating platform anchored to the sea bottom, with a hose which connects to a buried

pipeline. During the construction phase of the port, about 20 acres of waterfront land is required for support.[283] Onshore tank farms--typically storing 10 times the port's daily capacity to assure refineries of a continuous crude supply in the event of a bad-weather induced port shutdown--could require an additional 125 acres to 300 acres.[285]

New refineries, of course, would need still more space. Several years ago, the Delaware Bay Transportation Company purchased 1800 acres of coastal land at Big Stone Beach--a site discussed in conjunction with oil refineries in the Wildlife section of the paper--for storage tanks, landside headquarters, and a supply base for a deepwater port which the company had hoped would be sited in the Delaware Bay.[286]

Very briefly, the economic advantages of a Bay site include the relative proximity to energy consumers and processors, as well as shelter from high seas; the chief advantage of a deep ocean site is the lack of dredging requirements.

Bad weather can temporarily close the port because seas higher than 6 to 8 feet make tanker mooring operations impossible.[287] Only on rare occasions does weather stop tanker traffic in the Delaware Bay, and off-loading in the Bay is restricted only on an average of 30 days per year.[288]

The reported depth of the channel in the Delaware River and Bay varies according to the source and location reported. It is clear, however, that the channel is not deep enough to justify a port near the refineries on either side of the River. The estimated cost of dredging the 40 foot River channel to 45 feet has been estimated at $300 million, 50 feet would cost $750 million.[289] Moreover, maintenance costs, spoil disposal and saltwater intrusion into freshwater aquifers all present additional difficulties.[290]

The Bay is deeper. Southeasterly portions of the Bay are between 58 and 65 feet in places.[291] One study concludes that with some dredging an area from Cape Henlopen approximately 12 miles long and one mile wide could sustain operating depths of 70 to 80 feet.[292] Unfortunately, it would be expensive. A 1969 feasibility study by the United States Coast Guard estimated that the then annual direct cost for deepening the Bay as far as Big Stone Beach to a 72 foot level would be in excess of $13 million.[293]

Finally, an obvious and important deepwater port siting consideration is its possible effect on navigation, national defense, or other uses of the sea.

d. impact on resources: The Deepwater Port Act requires that the ports be constructed and operated "using best available technology, so as to prevent or minimize adverse impact on the marine environment."[294] U. S. Coast

Guard regulations, however, do not specify standards for site selection with criteria such as water depth, dredging requirements, proximity to spawning areas, or sea bottom characteristics.[295] Nor do the regulations include requirements for specialized tanker design to reduce the risk of superport-supertanker oil spills.[296] Absent those provisions and probably even with them, the most serious threats to resources posed by deepwater ports are oil spills, dredging operations, and onshore support activities.

Most oil spilled in the ocean floats long enough for wind and water forces to distribute the petroleum hydrocarbons into the water column, sediments, atmosphere, and organisms.[297] The immediate and lethal effects of large oil spills have been demonstrated over and over. The Council on Environmental Quality, reports on one spill in a semi-enclosed harbor and wetlands area:

> "(T)he number of marine animals in the affected area declined in the week after the accident from 200,000 per square meter to 2 animals per square meter. The day afterwards, dead sea animals lay in windrows on the beaches. 'There were all kinds of things, mixed up like a soup, at the waterline,' one observer noted.
>
> A week or so later the animals stopped dying, because there were none left."[298]

The Council also reported that populations of commercially important shellfish died in the spill, and that 4 years later new colonies were still too tainted to eat.[299]

In some cases marine communities can recover remarkably fast. For instance, the biological recovery after a year and a half of the Santa Barbara oil spill was just about complete.[300] However, the Santa Barbara spill was in an open ocean channel and never reached wetlands.[301]

Both Delaware and New Jersey contain miles and miles of wetlands which are located immediately behind the bay sand beaches.[302] Access to the wetlands is through small creeks and rivers, which are more plentiful on the Delaware side of the Bay.[303] Transported by tides and winds through those waterways, a massive oil spill would be disastrous. Wetlands can, without ill effect, clean up moderate amounts of oil by trapping and holding it.[304] But it can take 2 or more years to recover from a heavy dose, and repeated exposure may be lethal.[305] Marsh grasses die if constantly coated with oil, and denuded marsh banks erode rapidly.[306]

Oil spills kill birds in several ways. The natural buoyancy and insulation provided by feathers are

removed by oil, causing hapless birds to freeze and drown.[307] Forty thousand to 100,000 birds were reported killed in the Torrey Canyon oil tanker spill disaster, a tragedy compounded by the slow capacity of birds to recoup population losses.[308] The Wildlife section of this paper describes the very large number of waterfowl that rely on clean Delaware wetland.

The number of people relying on beaches for recreational enjoyment is also described in the paper. The impact of a spill near beaches was illustrated in a supertanker spill close to Chilean beaches. In that spill, oil, sand and pebbles combined to make something that resembled asphalt paving on 40 miles of beaches.[309] One remedy for that type of disaster, utilization of detergents, introduces into the environment chemicals frequently more toxic than the oil itself.

It is not clear, of course, that the oil spill threat posed by deepwater ports is graver than the lightering threat. Indeed, the higher probability of total oil spillage of the latter's operations would seem to indicate the opposite. Several considerations, however, detract from a Delaware Bay deepwater port vis-a-vis lightering. One, despite probability analysis to the contrary, there have been no accidental spills in the Delaware Bay from lightering since its inception in 1959.[310] Two, the potential impact of a grounding, collision, or other accident by a lighter does not compare to that of a 225,000 ton capacity supertanker. Three, any deepwater port site on the Delaware side of the Bay would have to be in close proximity to valuable wetlands and/or beaches. A large spill in that area would be catastrophic. Four, a deepwater port in the Delaware Bay would likely result in an increase of the total volume of oil entering the fragile ecosystem. Thus, while the spillage might theoretically be less for a port than for an equal amount of lightered imports, a port could in fact mean more total spillage due to the higher volume of oil imports generated by a port.

A deepwater port in the ocean fares far better by comparison. The likelihood of collision is probably less, but the greatest advantage is that a supertanker accident 20 miles offshore would be much easier on coastal resources than a Bay port. Even if oil was able to reach shore from that distance, its toxicity would be substantially reduced. A report to the National Science Foundation estimates that whatever oil from a 30,000 ton spill 20 miles off the Delaware coast was able to reach the Bay would be roughly one-sixth as concentrated as it would be were it spilled directly in the Bay.[311] Moreover, oil spill models indicate that oil slick trajectories would disperse much of the oil in the ocean, an unlikely result in the confined Bay.[312] As the report of the Delaware Bay Oil Transport Committee to a former Governor puts it, "A massive spill of 100,000 or more barrels of crude oil would remain in the

Bay for several weeks. The general counterclockwise circulation pattern would distribute the oil throughout the Bay..."[313]

That result is very unlikely with a port 20 miles offshore. Closer to shore, the spills have a better chance of reaching the beaches and possibly wetland. According to one source, for instance, a spill 6 miles from land

> "has little chance of dispersing to open ocean; the beach and the rich animal and plant life near shore bear the full force of the spill."[314]

The adverse impact of dredging operations also gives ocean ports a decisive environmental advantage over Bay alternatives. The Council on Environmental Quality reports:

> "the dredge spoil for a nearshore Delaware Bay location at Cape May, New Jersey, would amount to 150 to 200 million cubic yards--enough to cover 10 square miles to a depth of 14.5 to 19 feet...
>
> In all likelihood repeated dredging would also be necessary to keep a Delaware Bay channel and port open. An important direct effect of dredging would be the destruction of sea floor (or benthic) creatures, which are food for the valuable finfish of the bay. Indirectly, dredging new deep channels could lead to higher salinity farther up the bay, inviting such saltwater predators as the oyster drill to the southern edge of the Cape May flat, which is one of the finest oyster setting areas in the United States."[315]

Although the other side of the Bay--Delaware's side--would require less dredging than the Cape May site, a Governor's Task Force on Marine and Coastal Affairs has concluded that the potential environmental harm is "incalculable."[316]

Even 8 miles offshore in the Atlantic Ocean, a fair amount of dredging would be necessary.[317] As much as 8 to 10 square miles of surf clam habitat would be affected in the building and maintenance of a deepwater port at such a site.[319] Farther out, 20 miles offshore where the water is more than 90 feet deep, no dredging would be necessary.[319]

Regardless of where the terminal is built, nearly everyone seems to agree that impacts induced by support activities would be very substantial. One scientist expects a deepwater port to produce

> "enormous secondary environmental effects which perhaps would dwarf primary ones (construction, single massive spill, regular low level spills). Probably the minimum amount of onshore development would be extensive tracts of tank farms in the lower bay area."[320]

The Delaware Bay Oil Transport Committee report concurs:

> "The Committee believes that the most serious consideration from Delaware's point of view is the potential for uncontrolled development of refineries and other heavy industry in the Coastal Zone."[321]

Still another study--perhaps the definitive study on onshore impacts of deepwater oil terminals--concludes:

> "Whether a deepwater terminal in the Delaware Bay handles a low-level or high-level crude import volume, the effect upon the Mid-Atlantic Belt will be specific and noticeable, not only from an economic standpoint, but from visual, psychological and physical standpoints as well."[322]

The same study envisioned a port in the Delaware Bay transferring approximately 6.6 million barrels per day to new refineries in Cumberland and Cape May Counties of New Jersey.[323] The study said that 14 square miles of the counties--now devoted to farming and resort activities much like southern Delaware--would be required for at least 9 new refineries and 13 new petrochemical plants.[324] As a result of the port and associated industries, the 2 counties would become "a new industrial center" with employment doubling to 300,000 workers by the year 2000.[325]

The Delaware Bay Transportation Company proposal was more modest, with a planned 2 million barrel per day capacity.[326] Nonetheless one new refinery, expansion of existing refineries, and other onshore facilities, mentioned above, were anticipated.[327]

One method for alleviating onshore impacts in undeveloped areas is to run the pipeline directly to existing storage and refinery facilities. Such a pipeline already connects the Raritan Bay-New York Bay region with southern refineries along the Delaware River.[328] Thus, those 2 Bays have been considered "logical possible locations for the importation of large crude volumes via VLCC (very large crude carriers)."[329] Another possibility, discussed below, is construction of a new pipeline either up the Bay or on either side of it.

e. deepwater ports in Delaware: Deepwater ports on the Delaware side of the Delaware River and Bay are prohibited by the Coastal Management Program. The program recognizes that deepwater ports may serve the national interest under certain economic and environmental conditions. At present, however, those conditions do not exist in the Delaware Bay.

Not only does there appear to be no current economic justification for a Bay port, but the environmental problems seem insurmountable. The Delaware Bay already receives more than twice as much crude oil as all the other East Coast bays, rivers, harbors, and ports combined. A deepwater port would probably increase the Bay's imports substantially, placing a grossly disproportionate share of the burden on the region, and possibly, through sheer volume, raising the probability of an oil spill.

That spill, because of the enormity of today's supertankers could be catastrophic. The long and clean "track record" of lightering in the Bay raises additional doubts about a substitute method. Finally, there is no guarantee that a deepwater port in the Bay would preclude lightering.

All those factors take on added significance when the critical and fragile Bay environment is considered. The national interest in wetlands, wildlife, beaches, and other resources--detailed in other sections of the paper--deserve as much protection as can be reasonably afforded. Although the Nation is assured that oil will reach the refineries on the Delaware River, without a deepwater port, it is not assured that some of its most productive, but dwindling, coastal resources can tolerate the blow such a port may deliver.

At the State level, the geographical boundaries of Delaware are of such small proportions that a coastal disaster is much more difficult to bear than is the case in larger states, the federal Coastal Energy Impact Program notwithstanding.

The Coastal Management Program prohibition of a Delaware Bay deepwater port also takes into account that other sites appear more suitable. As one author puts it, "Based on environmental criteria, a (Delaware) bay site would be the worst place for a deepwater port."[330] For its part, the Council on Environmental Quality, after a course of research on superports that involved 5 university reports, special Coast Guard studies, work with the Department of Transportation, and a comprehensive report on shoreside effects from a private contractor, evolved 2 principles for siting deepwater ports: "keep them away from shore and disperse them in a number of locations."[331] The first of those principles has to do with protection of the coastal

environment from oil spills and dredging operations; the second concerns social, economic, and environmental stresses onshore due to oil-related development.[332]

Dispersion of oil imports would be served by any East Coast location of a deepwater port other than the Delaware Bay. New York Harbor, because of its nearby onshore transportation network, is suitable in that respect at least. Existing oil industry on the Delaware River is far from any similar network connecting it to a Delaware Bay site.

Notwithstanding the Coastal Management Program objections to a Delaware Bay deepwater port, the program does support the concept of a port offshore the Atlantic Coast, provided it meets certain minimum standards. Those standards include a location far enough off shore to minimize oil spill threats to the coast and to obviate dredging requirements; stringent environmental safeguards; and a demonstrated reduction of tanker traffic and lightering in the Bay.

An offshore port 20 miles off the coast could handle supertankers that a Bay port could not. Hopefully, the economies of scale would offset the additional transportation costs occasioned by a more distant site. The coastal resource savings, although difficult to quantify, are more certain.

It also seems certain that the Congress intended that coastal states be given a clear and loud voice in deepwater port siting decisions. Under the Deepwater Port Act, it is conceivable that a coastal state Governor could veto a deepwater port in federal water 40 miles from State shores. It is not conceivable that the Congress would abrogate that authority for sites in State waters and within a long splash of its most important resource. Thus, it is apparent, at least from the perspective of the Nation's legislative body, that the national interest in deepwater ports does not necessarily over-ride the national interest in coastal resources. As the Deepwater Port Act itself states,

> "It is declared to be the purpose(s) of the Congress in this Act to--
>
> ...protect the rights and responsibilities of States and communities to regulate growth, determine land use and otherwise protect the environment in accordance with law."[333]

5. <u>OCS oil and gas development facilities</u>

a. the national interest: The national interest in OCS development can be inferred in large part from the discussion in the first subsection.

With the country's onshore oil and gas supplies dwindling, there are only 4 ways to satisfy national energy demands: (1) reduce consumption; (2) switch to other energy sources; (3) import oil and gas from foreign countries; or (4) develop new national sources. The first 2 alternatives are not expected to solve projected short-term energy shortages, the third choice is unattractive politically and economically. Indeed, as the U. S. Department of Interior's OCS Office has informed the Delaware Coastal Management Program, the primary objective of the national OCS development program--the fourth option--is to decrease dependency on oil imports.[334]

No one knows for certain whether any recoverable oil and gas lies off the Atlantic Coast, however, the U. S. Geological Survey has estimated that between 5 and 14 trillion cubic feet of recoverable gas resources may be found there.[335] Offshore undiscovered recoverable resources have been estimated at nearly one-third of total U. S. oil reserves, nearly one quarter of the total U. S. gas reserves.[336] OCS oil and gas development may reach 2-4 million barrels a day in 10 or 15 years, a substantial increase from the one million barrels a day now produced.[337] With the Nation already using about 18 million barrels of oil daily, half of it imported, the OCS contribution will not by itself make the United States energy independent. It can, however, reduce the degree of dependency.

Some feel that it is important to reduce that dependency, that is develop the OCS resources, as quickly as possible. For example, in its 6th Annual Report, the National Advisory Committee on Oceans and Atmosphere advises the President and the Congress that worldwide energy trends have made the exploration and development of OCS oil and gas an urgent element in a national energy program, and that "delay could turn out to be a grave mistake."[338] The Report also says that "concerns about the environment and about possible adverse impacts on the coastal States" may cause such delay.[339]

What the report does not do is explain how just a few years delay would alter the situation or what the Nation will do when OCS supplies are exhausted. Evidently, the President does not share the Committee's view, for the National Energy Plan states:

> "it is essential that they (OCS resources) be developed in an orderly manner, consistent with national energy and environmental policies. The Congress is now considering amendments to the OCS Lands Act, which would provide additional authorities to ensure that OCS development proceeds with full consideration of environmental effects and in consultation with States and communities...The Administration strongly supports passage of this legislation.[340]

The lead time for major offshore oil and gas development is long enough to enable proper planning for the inevitable OCS development impacts, provided the President's advice is heeded.

Apart from the national interest in supplementing national oil and gas supplies with minimal environmental damage, OCS development is in the national interest because of the revenue it generates. Offshore oil and gas royalties of approximately $848 million made up the bulk of revenues collected in fiscal 1977 from mineral operations on federal land.[341]

b. potential demand: OCS development related facilities may include oil and gas platforms, platform fabrication yards, pipeline coating yards, storage depots, crew and supply bases, pipelines, and tank farms.

The potential demand for the first of these--oil and gas platforms--is a function of where the oil and gas may be recovered. Although there are no economically recoverable quantities of oil and gas onshore in Delaware, there is a fairly good possibility that there may be natural gas in Delaware's offshore lands. With funding provided by the Coastal Management Program, the Delaware Geological Survey is investigating that possibility.

The potential demand for Delaware facilities to support OCS operations depends on 5 factors: (1) the quantity of production estimated from exploratory drilling results; (2) the composition of the find--all oil, all gas or a mixture; (3) the rate of production; (4) the suitability of Delaware sites; and (5) the availability and suitability of alternative sites.

The first of those factors, estimated production, is presently the most important unknown in the entire Atlantic OCS development equation. A very large strike will create demand for many support facilities. If nothing is found, onshore support facilities will not be needed.

It will not be very long before more is known about the resources. The U. S. Geological Survey has approved exploratory drilling permits for the "Stone Dome," which lies off the southern coast of New Jersey and is perhaps the most promising structure leased in Sale Number 40.[342] Exploratory plans have been approved--though as of this writing no drilling permits have been issued--for additional Sale 40 tracts off the coasts of Delaware and Maryland.[343] Moreover, additional lease sales are scheduled for the Mid-Atlantic.[344]

Delaware's proximity to the Stone Dome and other promising tracts already leased or scheduled for leasing make the State a possible location for a variety of support facilities. The potential demand for specific facilities is discussed below.

c. siting criteria: Absent guidance from State and local government, oil producers ordinarily make their siting decisions on the basis of least cost.[345] Oil industry representatives state a strong preference to locate their onshore bases as close as possible to their lease tracts because of transportation costs.[346] Thus, while some OCS support facilities are not absolutely coastal dependent, the coast is usually a preferable site.

Platform fabrication yards are coastal dependent. These are large, waterfront facilities consisting mostly of cleared land, buildings, shops, and administrative offices set back from the waterfront.[347] The yards are used for the construction of jackets and platforms for offshore oil production, and for the construction of exploratory drilling rigs.[348] Two hundred to 1000 acres of land, a waterfront with 15 to 30 foot depths at the pier, and 100,000 gallons per day of water are some of the typical requirements for a steel platform fabrication yard.[349] Concrete platform fabrication yard requirements are somewhat different, but are not considered here because they are used only in weather conditions uncommon to the Mid-Atlantic region.[350]

The siting of a new fabrication yard depends on a significant oil or gas discovery because platforms can be towed from the Gulf region at less cost if many platforms are not required.[351] If the find is of sufficient size to warrant new fabrication facilities, industry spokesmen believe only one fabrication yard will be needed on the East Coast.[352]

Two sites in the Chesapeake Bay area are under consideration. One is on Sparrows Point in Baltimore City, the other is a 1000 acre site proposed by Brown and Root Company near Cape Charles, Virginia.[353] The combined land and waterfront requirements of the facilities make Delaware an unlikely site.

Pipe coating yards generally use less space than platform fabrication yards, but still require from 100 to 150 acres of waterfront land.[354] A marginal wharf of 750 feet on water 20-30 feet deep; 15,000 gallons of water per day; and one million kilowatt hours of energy are also typically needed.[355] Pipe coating yards are in demand for relatively short periods of time, thus a site easily adapted to another use at the end of the pipe coating activity is indicated.[356] Access to rail and major highways is desirable for transporting cement and other supplies.[357]

Storage depots also benefit from nearby transportation networks. Storage depots vary in size according to the operation requiring support, the facilities available, and the materials requiring storage. The typical area occupied by a storage depot used only to store pipes may be between 10 or 20 acres, and a large number of such depots could result in a cumulative land requirement which would be very difficult to meet in Delaware's coastal strip.[358]

The OCS operations base also generally includes storage facilities and port facilities.[359] It is used for the storage, handling, and shipment of supplies whose next and final destination is at the site of the OCS operation. Temporary bases are used during exploratory drilling and require limited acreage--sometimes public facilities are used. A 15-20 foot channel, uncongested harbor and easy ocean access are desirable port characteristics.

Permanent service bases are used during the OCS development stage. They are larger, typically utilizing between 25 to 50 acres; a 200 foot wharf, with 15-20 feet of water depth at the pier; and 8.2 million gallons of water per platform per year.[360] As with temporary service bases, the location is influenced by distance, cost, land availability, available harbor facilities, and even entertainment facilities.[361] The facility may include storage warehouses, open storage yards, oil storage tanks, limited construction facilities, oil spill containment equipment, crew boats, supply barges, and a heliport.[362] In Louisiana, where over 400 helicopters service the Louisiana offshore area, a single helicopter base occupies over 200 acres by itself.[363]

Repair and maintenance yards may be associated with the operations base. Many firms use these areas to provide repair services for vessels and equipment. Fast and efficient service by highly skilled labor are primary requirements by the oil industry for this type of work.[364] Depending on the vessel type, flotation barge, mobile lift, haul out, or slideway facilities may be required.[365] Quick access to road, rail, and air transport is necessary for fast delivery of supplies and parts.[366]

Steel platform and pipeline installation bases both require approximately 5 acres of waterfront land, with 200 feet of wharf space and a water depth of 15-20 feet at the pier.[367] Distance is the most important siting consideration once those requirements are satisfied.

The marine pipelines themselves generally use a landfall site closest to the production area. The offshore route likewise follows the shortest path possible, but may be modified by anchorages, active faults, shifting bottom sediments, rock outcrops, environmentally sensitive areas, or other features.[368] A gently sloping sand or shingle shore approach is preferred, and shifting currents and sediments are avoided if possible.[369] For gas, proximity to the nearest transmission line is important.[370] For oil piped for transshipment, the landfall site will be influenced by the availability of a terminal and tank farm site.[371]

The marine terminal typically includes a berthing system for vessels; loading and unloading equipment; storage tanks; terminal control and safety equipment; and navigational facilities.[372] Transshipment terminals load crude oil received by pipeline from offshore platforms onto tankers

for refining elsewhere.[373] Crude oil receiving terminals receive crude from tankers for delivery to a nearby refinery, with off loading facilities either onshore or offshore depending on depth requirements of the crude carriers.[374]

If oil produced offshore is loaded directly onto tankers or barges, a new marine terminal is unlikely in the Mid-Atlantic region because existing facilities can accommodate such oil. Even with a pipeline, a new marine terminal is usually not needed unless new refineries are planned or the distance to the refineries is very far, as in Alaska, for example.[375] Neither exception currently applies in the Mid-Atlantic region.

The size of a terminal depends on the throughput from offshore, the number of berths at the terminal, the size and frequency of tankers, and the extra storage required for loading downtime.[376] For a 250,000 barrel per day throughput with a storage capacity of one million barrels, the site would need approximately 30 waterfront acres--mostly for the storage tanks; 50 to 60 feet of sheltered water at a mid-depth pier or mooring buoy; and roughly 11 million kilowatt hours per year of energy.[377]

d. impact on resources: Offshore exploration, development, and production may impact commercial fishing, navigation, defense facilities, long-term ecosystem equilibrium, aesthetics, and so on.

Offshore exploration drillships, and development and production platforms use an area between 2 and 5 acres large, although semi-submersibles require much larger areas.[378]

There are 3 major potential sources of water pollution: (1) drill cuttings and muds; (2) water brines; and (3) oil spillage caused by blowouts, fires, explosions, or transportation accidents. Offshore oil production contributes only a small percentage of ocean oil pollution.[379] Gas well blowouts and other gas mishaps do not generally pollute water.

Drill cuttings are produced when the wells are drilled, and contain pulverized rock, sediment, and--possibly--harmful metals. Depending on the width and depth of the hole, cutting volumes can be large and would create a disposal problem if drilling takes place in the Delaware Bay. Drilling muds are circulated through the wellbore to provide pressure control, lubrication of the drill bit, and removal of drill cuttings from the hole.[380] Mud disposal is not a problem in the ocean, but again could present difficulties in the Bay where disposal sites are scarce.

When oil and gas are produced, waters associated with oil and gas pools are often produced also. Those waters are characterized by mineral contamination and require treatment under the Federal Water Pollution Control Act before they can be discharged back into receiving waters.[381]

The potential conflict between fishing and offshore development is a Coastal Management Program concern. Water contamination and bottom alteration threaten the fishery; the area used for drillships and platforms is altogether closed for fishing; and subsurface obstruction, such as pipelines, valves, and dumping debris can snag and destroy fishing gear. Such gear also poses the threat of rupturing pipelines, thereby causing oil pollution.[382]

Despite the potential for offshore impact problems, the major environmental impacts of OCS development occur onshore from the construction and operation of the support facilities. Most of those use waterfront sites, the alteration of which may impact wetlands, marine biota, water quality, air quality, beaches, and so forth. If dredging is required, the impact on marine organisms in the dredge area or at the spoils disposal site may be extensive.

Air emissions in platform fabrication yards can result from pipe and metal cleaning by sand blasting; painting; and the transportation emissions of cranes, trucks, trains, tugs, barges, and automobiles.[383] Because of the large land requirements, sedimentation and runoff problems may be substantial. Soil compaction caused by the constant movement of heavy equipment may decrease groundwater recharge.[384] Wastewater contaminants--from cooling water, process water, and sewage--include heavy metals, and may be lethal to animal and plant life. Moreover, fabrication yards produce large quantities of solid waste, some of which is contaminated with hazardous substances.[385] Noise pollution generated by heavy machinery may be noticeable by communities more than one-half mile from the site.[386] Finally, 24 hour lighting and 200 foot high platforms cause aesthetic impacts.[387]

The impacts of pipe coating yards and fabrication yards are similar. Air emissions from the former include carbon monoxide, sulfur oxides, nitrogen oxides, hydrocarbons, and particulates.[388] Wastewater contaminants consist of thermal effluent, anti-fouling chemicals, and a variety of polluted process waters.[389] Noise generally presents less difficulty than with fabrication yards, but solid waste and aesthetic problems do exist.[390]

Temporary service bases have much less impact than any of the foregoing facilities, especially if the bases are located at or near existing facilities. Air emissions include hydrocarbons from fuel storage tanks and vehicle operations. Wastewater contaminants from bilge and ballast water consist of hydrocarbons and heavy metals. Twenty-four hour noise and up to 6 tons per day of solid waste cause additional impacts.[391] Platform and pipeline installation service bases have about the same impacts as a temporary service base.

Permanent service bases have the same types of impacts, but on a larger scale. The land requirements for

the larger service bases impose substantial impacts if undeveloped land is chosen.

Offshore pipelines are buried, except in very deep waters.[393] The trenching method used removes sediments under the pipeline and causes temporary localized increases in turbidity which may affect benthic organisms.[394] Impacts are greater near industrial areas where sediments are polluted. At the shore approach and landfall site special construction procedures are necessary to protect the integrity of beaches and wetlands.

Onshore pipeline construction temporarily disrupts soil, vegetation, and animal habitats.[395] In wetlands, care must be taken to restore the site to pre-construction conditions or the impacts may be long-term.[396] Onshore pipelines also preempt the erection of permanent structures on the right-of-way, sometimes encouraging the development of parks or other recreational facilities.[397]

Some of the most important environmental impacts of both offshore and onshore pipelines may result from petroleum spills. Pipelines can leak because of faulty pipe seams, external corrosion, damage from equipment or other forces, and improper operation by personnel.[398] Compared to other modes of oil and gas transport, however, pipeline safety fares rather well.[399]

Secondary impacts from pipelines may be the most significant. As the Delaware Bay Oil Transport Committee has explained, "A pipeline running through Delaware would have the highest potential for changing land use."[400] According to another report,

> "a large onshore crude oil storage facility would presumably be erected close by the point where the pipelines come ashore.., because of the economies involved, industry would wish to locate new refining or refinery-related processing facilities as close to the storage area as possible."[401]

Although that reasoning may be somewhat circular, a pipeline terminus far from existing storage and refining facilities may stimulate heavy industrial development at the terminus or at the terminals of lateral pipelines fed from the main lines.

If storage tanks are built near the pipeline outfall, the inducement to add refineries may be irresistable. Even where present regulatory prohibitions exist, the law-making authority may yield to the combined pressures of industry, management and labor unions, real estate operators, and others.

A Storage tank facility, by itself, can cause serious environmental harm. In 1970, for example, onshore storage tanks were the principle source of oil spills.[402] Oil spill impacts

in coastal areas are described in the deepwater ports discussion, above.

The land requirements for storage tank facilities, as mentioned above, can be substantial. The impact of site alteration depends on the characteristics of the site and the surrounding area prior to alterations. Drainage, run-off and erosion patterns are likely to be affected. Moreover, the welding, riveting, sand blasting, and other metal fabrication required in building the storage facilities may contaminate runoff with heavy metals.[403] The day-to-day operations of a marine terminal may also generate the following types of wastewater: domestic; bilge water; ballast water; cooling water; boiler water; process water; and stormwater runoff.

If associated with transshipment facilities, the site may require channel dredging and maintenance. Those activities impact marine biota, and may change coastal water circulation and sediment supply--thereby affecting shoreline and beach erosion and accretion patterns.[404]

Air emissions from storage tanks are cuased by evaporation. The estimated leakage for one proposed storage facility with a capacity of more than one million barrels of crude oil was 115.3 tons per year.[405] Evaporative emissions also result when oil is transferred from tanker to the storage tank. The impact of hydrocarbons on air quality is discussed in the Air section. Here, it is sufficient to note that they are partially responsible for photochemical smog and directly affect human health.[406]

There are also other problems. Although small fires can usually be contained, the heat may cause explosions of adjacent stored oil.[407] Highly toxic chemical wastes are found in the large quantities of sludge associated with storage facilities.[408] Finally, marked visual deterioration of the area around the site cannot be avoided in flat open areas with little industrial development.[409]

e. OCS oil and gas development facilities in Delaware: The Coastal Management Program recognizes the importance of OCS development to the Nation, the Mid-Atlantic region, the State and local communities. It acknowledges that the potential for adverse environmental impact is, in some instances, comparable with that of facilities which the program is less inclined to support-- although the potential impact of OCS development facilities is not as catastrophic as some other facilities. The program generally encourages and supports OCS development facilities due to the compelling national interest and lack of viable alternatives. LNG facilities, for example, are deemed not worth the risk, in part, because the facilities promote dependence of foreign energy supplies. OCS development facilities decrease such dependency and are therefore a higher national priority. To take another example--deepwater ports in the Delaware Bay are prohibited, in part because better alternatives are available. Such alternatives are less obvious in the case of facilities used to extract oil or gas from the Bay.

The Coastal Management Program supports OCS development for 2 additional reasons. One, such development affords the State and the Mid-Atlantic coastal region an opportunity to contribute to the national supply of vital resources which the State and region use, but heretofore have been unable to produce. Two, with proper coordination--among State, federal and local governments, as well as industry--and vigorous environmental safeguards, most of the problems associated with OCS development can be overcome. Coastal Management Program coordination efforts as they relate to OCS development are described in the program document, and subscribe to the President's recommendation to the Congress that consultation with States and communities improve "to assure that they have a real role in decisions which affect them."[410] The U. S. Bureau of Outdoor Recreation, has agreed with at least the second half of the second reason, having informed the Coastal Management Program that it believes OCS development is compatible with recreation if done in a manner to protect the environment.[411]

A wide array of federal, State, and local measures provide pollution controls for OCS development operations. The Outer Continental Shelf Lands Act and the Federal Water Pollution Control Act allow the federal government to impose strict offshore operation standards. The Underwater Lands Act, Environmental Protection Act, and other Delaware statutes give the State similar powers to control offshore and onshore operations in Delaware territory. Local zoning ordinances, building codes, and other devices protect local interests, although--as the program document explains--those devices cannot be used to arbitrarily exclude OCS development support facilities.

The Coastal Management Program permits offshore oil and gas exploration and development in Delaware waters, on a case-by-case basis, provided adherence to strict environmental safeguards is assured. The following criteria are among those used in the siting of offshore drillships and platforms: (1) the number and size of the facilities should be as small as possible; (2) sensitive environmental areas, such as important fishery habitat, should be avoided whenever possible; (3) a high level of coordination shall be pursued with New Jersey officials responsible for fishery management, the Mid-Atlantic Fisheries Resources Council, the National Marine Fisheries Service, and the U. S. Department of the Interior; and (4) the desirability and availability of alternative sites should be considered, as well as the probability of oil or gas recovery.

Although demand for a Delaware platform fabrication or pipeline yard is unlikely, the Coastal Management Program provides for their consideration. Because those facilities are land intensive, require locations near the State's most important resources, may cause severe and unacceptable impacts, and may be sited in other coastal regions with

less serious impacts, the Coastal Management Program reviews proposed sites on a case-by-case basis. Approval of the sites is conditioned on meeting State environmental standards as well as local zoning approval. In addition, the following criteria are used to judge the suitability of the site: (1) applicable county and municipal comprehensive plans; (2) the effect on neighboring land uses; (3) the number and type of supporting facilities required and their impact; (4) the economic effect; (5) environmental impact; and (6) aesthetics. In addition, no major onshore facilities except pipelines are allowed in wetlands for reasons explained elsewhere in the paper and the program document.

Storage depots and service bases are permitted provided State environmental standards and local zoning approval present no obstacles. There appears to be little potential demand for Delaware service bases during exploratory drilling operations. American Petroleum Institute members informed the Coastal Management Program that the Davisville, Rhode Island facility would probably be used exclusively for exploratory operations in the Mid-Atlantic.[412]

Both State and Sussex County officials are actively promoting Lewes as a supply base.[413] Lewes is the primary location of active industry in coastal Sussex County. About 12 industrial firms occupy 75 acres of land in and around Lewes, which is the closest Delaware port to the OCS activity.[414] However, the water depth at the port may not be deep enough to accommodate supply boats without dredging. Moreover, New Jersey locations--especially Atlantic City--appear to enjoy the closest proximity to the OCS activity in the Mid-Atlantic. Industry spokesmen have accordingly expressed a preference for the Atlantic City area should commercial quantities of oil and gas be discovered.[415]

Rising real estate costs, a shift in the location of OCS activity, and inadequate facilities may make the Atlantic City site less attractive. In that case the Port of Wilmington may be selected. Wilmington has the capability of handling large and heavy quantities of supplies; is served by major rail, airport, and highway facilities; can provide public and commercial services; has a skilled labor force which may be needed for quick repair operations; and is the closest port to much of the OCS activity that can provide all these services. State and city officials are promoting the Port as a possible supply base and industry has expressed interest.[416]

The Coastal Management Program encourages the siting of supply bases at Wilmington or wherever else they are compatible with (1) the preservation of environmental resoures in accordance with the resource protection measures described in the document, and (2) any legal constraints established by the State's Judiciary. The City of Georgetown, which is located away from large critical natural areas, but close to facilities which can accommodate trains and helicopters, is an example of an especially suitable site for a supply base in Sussex County.

Offshore and onshore pipelines are permitted by the Coastal Management Program, again provided that State environmental standards and local zoning approval present no problems. In addition, the terminus of offshore pipelines from both OCS operations and deepwater ports is prohibited in the coastal strip. Exceptions are made for the Port of Wilmington and any existing industrial facility, as long as the pipeline serves only that facility. An example is a pipeline serving the Getty Oil Co. at Delaware City. If an OCS pipeline runs up the Delaware Bay, a lateral pipeline to the refinery would probably be economical, not induce further coastal development, and receive Coastal Management Program approval. Another possibility for a lateral pipeline connection is the Sun Oil Co. pier in Delaware near the Marcus Hook, Pennsylvania refinery.

The discussion of deepwater ports explains some of the problems associated with pipeline landfalls in the coastal strip and the rationale for exclusion. In any event, the refineries and associated industries likely to be serviced by a Delaware pipeline are in Delaware City and Pennsylvania and the Coastal Management Program prohibition therefore is unlikely to create a problem.

Neither offshore nor onshore pipelines are likely to confront insurmountable regulatory obstacles. Unlike many coastal states, Delaware has a mechanism for leasing its offshore lands for pipeline right-of-way. The State Division of Highways procedures for granting onshore right-of-ways are clear, inexpensive, and expeditious. Further, State law provides condemnation powers to oil and gas corporations to acquire private property for the purpose of transporting oil and gas, if necessary.[417] Finally, local officials appear enthusiastic about an OCS pipeline.[418]

The State, of course, is also very interested in an OCS pipeline possibility. State representatives are working with the College of Marine Studies at the University of Delaware to identify sensitive Bay areas likely to be impacted by oil spills at specified locations and seasons. That work may be used to define low risk areas where pipelines would be most acceptable environmentally. In addition, the Coastal Management Program plans to allocate part of its Coastal Energy Impact Program planning grant to a pipeline corridor study.[419] Finally, intergovernmental planning programs--just underway--for transporting OCS oil and gas have the State's attention.[420]

With the exception of oil storage facilities in Seaford, Delaware's storage facilities are located in the northern part of the State near the Delaware Valley refineries. The siting of new storage tanks to accommodate OCS production will not be needed if such production merely replaces foreign imports, and may be unnecessary in any case.

New storage tanks connected to OCS facilities are permitted outside the coastal strip, provided State and local standards, described in the program document, can be met. Due to the potentially severe environmental impacts--direct and induced--new storage tanks are not permitted in the coastal strip, with 2 exceptions. One, expansions of existing tank farms on a case-by-case basis are permitted. The criteria used to determine the suitability of specific sites in the coastal strip are identical to those criteria discussed in conjunction with platform fabrication and pipeline coating yards. Air quality standards, of course, must be maintained for reasons explained elsewhere in the report. Two, storage tanks are also allowed in the coastal strip if they serve a single industrial facility. Transshipment facilities are not included in the exception.

The inland siting of storage tanks is encouraged to avoid impacts on sensitive coastal/environmental areas and the possibility of induced impacts, as discussed previously. New storage tanks in the southern portion of Delaware's coastal strip could, for example, generate political and other pressure for oil refineries or petrochemical plants. If pipelines are not used to transport OCS resources, dredging would likely be required to provide access to a coastal located storage facility.

The Coastal Management Program also encourges the siting of inland storage tanks at locations near the refineries, pipelines, or other transportation networks. The possibility of moving OCS oil by tank train has been proposed, suggesting the following transportation route: OCS production site-pipeline-storage tank-rail-storage tank-refinery.

6. power plants

a. the national interest: The first subsection discusses the Nation's reliance on energy and dependence on foreign energy resources, as well as the national importance of providing a continuous supply of energy with as little foreign assistance as possible. Power plants and their associated facilities can contribute significantly to that objective because electricity can meet a great variety of energy needs without necessarily consuming oil or gas.

Ninety percent of the Nation's conventional energy reserves are coal, a fuel which can be used to generate electricity but which currently accounts for only 18 percent of the country's energy consumption.[421] The National Energy Plan urges that the use of coal be increased to maintain economic growth, reduce the quantity of oil imports, and save gas for residential use. Although coal is used to generate nearly half of the Nation's electricity,

new or expanded coal-fueled power plants can further promote essential national energy policies.[422]

Nuclear power plants also decrease reliance on oil imports. Nuclear energy accounts for only 3 percent of all the energy used by the Nation and only 10 percent of the electricity.[423] New nuclear facilities are expected to increase the latter figure as much as 20 percent by 1985.[424] If the risk associated with nuclear facilities can be reduced by new technology, the contribution of nuclear power plants will probably become even more significant.

Finally, geothermal facilities can produce electricity from previously untapped natural resources. The national interest in utilizing such resources--as well as coal and nuclear fuel--with the siting and construction of new power plants and associated facilities is underscored in the next part.

b. potential demand: Electric power consumption in the United States has grown much more rapidly than total energy consumption during the last several years. The national demand for electricity--now more than 20 quadrillion Btu annually--may double by 1990, and some projections indicate that electricity production will account for 40 percent of total United States energy consumption by the year 2000.[425] On the other hand, most recent consumption patterns show that the rate is slowing down. As a result, long-term projections of the average annual electric demand growth have declined steadily in each of the recent years.[426]

The Federal Energy Administration has informed the Coastal Management Program that "there does not appear to be a significant probability of a capacity shortage through 1980 on a national basis."[427] Indeed, the Federal Power Commission has reported that the total United States generating capacity reserve will be 22 percent in 1986 and 20 percent in 1995.[428]

Such projections, of course, assume several new plants will be constructed before those dates. In 1976, the Federal Power Commission reported that 905 new units with a total 328,204 megawatt capacity had been proposed for addition to United States' electric generating facilities between 1976 and 1985.[429] Many of the additional units, of course, will be expansions of existing power plants. Forty-six percent of the scheduled new units were fossil steam plants, 42 percent were nuclear steam plants, and only one-half percent was geothermal plants.[430]

Most of the utility companies in the Mid-Atlantic region operate in a coordinated power pool, known as the Pennsylvania-New Jersey-Maryland Interconnection (PJM).[431] The PJM is supervised by the federal government and run

according to a plan which is updated every 10 years.[432] The plan specifies how much electricity each utility company will provide, but the companies decide individually how to meet their shares.[433] Thus, the plan does not address facility siting planning per se.

The planning unit of the pool is called the Mid-Atlantic Area Council (MAAC), and is comprised of 11 member utilities and 3 Associated Utilities.[434] The Delmarva Power and Light Co. is the utility company member from Delaware. The MAAC projected reserve capacity for the Mid-Atlantic region, at an annual average of 25 percent for the 1986-1995 period, is higher than the national average.[435] As of 1976, 49 new PJM units,with a 23,972 megawatt capacity, were proposed for the period between 1976 and 1985.[436]

A survey of MAAC and the non-member companies indicates that they would like the nuclear fuel share of electricity generation to increase from 15 percent in 1975 to 44 percent in 1985, while allowing the coal-fueled share to drop from 59 percent to 42 percent during the same period.[437] In 1976 there were 13 nuclear plants under construction in the Mid-Atlantic region.[438] Although the industry has demonstrated a strong preference for nuclear power, spirited public and private opposition may alter its plans. The Council on Environmental Quality, for example, supports deferring further commitment to nuclear power "until there is an acceptable solution to the radioactive waste problem."[439]

In Delaware, the Delmarva Power and Light Co. recently postponed plans for a nuclear power plant at Summit until at least 1989.[440] The projected State energy demands, discussed in the previous subsection of the paper, appear to be excessive in light of the utility's postponement and its own recently revised forecasts. The Environmental Action Foundation recently reported that the excess generating capacity in the State was nearly 28 percent in 1976, ranking it among the top 10 in the Nation.[441] The Delmarva Power and Light Co. has denied that the excess capacity is that great.[442]

Company officials have also recently estimated that no new electric plants will be needed in Delaware until 1989.[443] The site selection process for the new plant will begin around 1980, and the Summit site will be given serious consideration whether the new plant is nuclear or fossil fueled.[444] The Company is also adding a fourth generating unit, now under construction, to its plant at Indian River in Sussex County. The new unit is scheduled to go into operation in 1980 and will give the State another 400,000 kilowatts of coal-fired generation.[445]

The Delmarva Power and Light Co. estimates that its electric generating facilities and transmission lines within the State of Delaware export about as much energy

from the State as is imported.[446] When Dover City utility generation is added, facilities within the State are probably producing more electricity than Delaware residents use.

c. siting criteria: Summit is still regarded by the Delmarva Power and Light Co. as the best site in Delaware for a new plant.[447] The site can be readily served by railroad, barge, and nearby transmission lines. The land is relatively cheap and unpopulated, yet it is close to major population centers, meaning that transmission penalties are low. Like most of northern Delaware, the land is higher and on firmer foundation than land in most of lower Delaware. Perhaps most important, Summit is near a large water source which is needed for cooling and other requirements.

The siting methodology used by the State's largest utility company, presented below in a very abbreviated form, offers additional insight in power plant siting criteria. A thorough discussion of each of the criterion appears in Eastern Shore Power Plant Siting Study.[448]

The Delmarva Power and Light Co. methodology identifies promising sites more or less by the process of elimination. First it eliminates population centers, which are especially unsuitable in the case of nuclear power plants. Next, areas not reasonably close to major transportation networks--and fuel availability--are rejected, as are lands far from a large water source.

Also eliminated are lands preserved by the federal or State government--such as the Bombay Hook Wildlife Refuge and wetlands areas. Company officials have informed the Coastal Management Program that due to the environmentally sensitive nature of wetlands, the utility would not seek to site a power plant in wetlands--even with State and local approval.[449] Of course, the foundation requirements of power plants are not well served by wetlands in any case.

Other areas with poor foundations or geologic hazards are eliminated next. Also avoided, if possible, are floodplains and lands especially vulnerable to coastal processes, such as low-lying beach. Finally, the potential for groundwater and other types of pollution is examined. Many of the power company's criteria correspond with State environmental concerns for obvious reasons.

There are many advantages and disadvantages of coastal locations. Cooling water supply makes such areas attractive from that perspective, but potential difficulties with population, fragile environment, coastal processes, and salt water must also be overcome. On the other hand, the U. S. Nuclear Regulatory Commission has pointed out to the Coastal Management Porgram that coastal locations

offer one safety feature absent at inland sites, namely that 50 percent of the downwind directions on the coast are away from people.[450] Offsetting that advantage somewhat is the threat of hurricanes, tsunamis, and LNG accidents.[451]

According to the Commission, the disadvantages of siting nuclear plants offshore include shipping hazards and the lack of proven technology.[452] The lack of foundation problems and water discharge problems, as well as the relatively few number of competing uses, are advantages of offshore sites.[453] Delmarva Power and Light Co. officials believe offshore power plants may be a good idea, but because Summit is such a good site and because they would prefer to see someone else "work the bugs out," they have not considered the possibility "seriously."[454]

The possibility of geothermal energy in Delaware is beginning to attract interest. Geothermal energy is derived from the natural heat in the Earth's crust, and has a large potential for direct thermal use and for electricity generation. When surface waters oozes down through the outer "layers" of the crust and comes into contact with "hot spots," the water turns to steam and forces its way to the surface--either as steam or water, depending on the temperature of the "hot spots" and the path to the surface.[455]

When the "hot spots" are hot enough and close enough to the surface, they are potential sources of geothermal energy. There are indications dating back to a 1940 oil test hole near Ocean City, Maryland, that large useable reservoirs of hot water may lie in southern Delaware.[456] The Delaware Geological Survey and the U. S. Department of Energy are working together to investigate that possibility.[457]

Regardless of which type of power plant is built, the siting of transmission lines is important. In 1975, it was estimated that there were more than 40,000 miles of overhead transmission lines utilizing about 4 million acres of land for right-of-way, and about 2,000 miles of underground transmission cables in the United States.[458] Most of the primary land required for nuclear plants is transmission line acreage, with a single nuclear power plant using roughly 1500 acres for transmission lines.[459]

Shortest distance is usually the goal in siting transmission facilities, but several factors--the price of real estate, environmentally sensitive areas, conflicting uses, and so forth--can compel alternative routes. The use of ultrahigh voltage and more intensive utilization of underground transmission lines are being researched to reduce environmental losses and right-of-way costs.[460]

d. impact on resources: Power plants and associated facilities impact the land, water and air. As such, the facilities may adversely affect any or all of the resources discussed in earlier sections.

The land requirements for fossil fueled power plants are typically greater than nuclear plants due to the need for fuel storage and fuel transportation. For example, a 300 megawatt fossil fuel plant might require 1200 acres of land, compared to a 400 acre nuclear facility with a similar capacity.[461] The impact of the land use on resources--such as forests, agricultural lands, wildlife, etc.--obviously depends on where the structure is built. The Office of Coastal Zone Management has declared that "The land areas least suitable from an environmental viewpoint for the construction of power plant facility components would be coastal wetlands and mangrove swamps, dunes and flood prone areas."[462]

Water impacts are due mostly to the use of large quantities of cooling water to condense spent steam. At intake pipes, small fish can be pulled onto screens used to protect cooling systems from damage caused by floating and suspended debris. Referred to as "impingement," this has resulted in some major fish kills.[463] Entrainment, the killing process by which smaller organisms--some of them commercially important fish in the younger stages of life--pass through the screen and into the cooling system, can reduce the abundance of important fish and shellfish.[464] Chemical and thermal pollution discharged into the receiving waters is responsible for the death of still more aquatic life.[465] One beneficial effect, however, is that during the winter some fish seem to thrive on the warmer water.[466]

Generally though the areas around enclosed waters--such as estuaries, bays, lagoons, tidal rivers, grass beds, and reefs--which serve as habitat for the fishery, are the worst sites for power plants from an impact perspective.[467] Nuclear power plants typically require more cooling water than fossil fuel plants to produce the same amount of electricity, thus the water-related impacts of the former are usually more severe than of the latter.[468]

As the Air section of the paper indicates, fossil fueled plants do not fare so well with air emissions. According to the Office of Coastal Zone Management, fossil fueled power plants account for 50 percent of the sulfur dioxide, 25 percent of the nitrogen oxides and 25 percent of the particulate matter discharged into the atmosphere.[469] Because health can be seriously impacted by such emissions, a site away from population centers is indicated. Inasmuch as air quality standards near the cities leave little, if any, margin for more pollution, there is usually no choice anyway.

According to a study by the U. S. Nuclear Regulatory Commission, the nuclear fuel cycle "is considerably less harmful to man that the coal fuel cycle."[470] As mentioned above, however, the Council on Environmental Quality has advocated deferring further commitment to nuclear power until waste disposal problems are solved. Radioactive wastes, which are created as uranium fissions and releases energy in nuclear reactors, are, in the Council's words,

> "a significant potential environmental hazard. They must be isolated from the biosphere for hundreds of thousands of years. The wastes contain both highly radioactive but "shorter lived" wastes, with half-lives of tens to hundreds of years, and less radioactive but longer-lived species, such as plutonium, which has a half-life of about 25,000 years. The half-life of a radioactive element is the time required for a given quantity of the element to decay or disintegrate into one-half of the original quantity. Isolated storage over many half-lives is necessary before most wastes become harmless.
>
> The lack of permanent, safe storage or disposal for high-level radioactive wastes from nuclear reactors has become a major concern in recent years."[471]

Other concerns common to all power plants include noise, aesthetics, the problem of "drift," and impacts from transmission lines. The first are the obvious products of a large industrial facility. Drift is caused by evaporation of water from cooling towers, which transmits salt into the atmosphere. As the vapor travels downwind, salts fall out, and may enter groundwater systems or kill vegetation.[472]

One of the primary environmental impacts of overhead transmission and distribution lines is aesthetic. Towers, poles, and their associated cables are not pleasing sights to most people, especially in forests, across open waters, or through scenic areas.[473] The extensive use of land, of course, also impacts resources and can cause soil erosion problems, among other things.[474] Finally, high voltage lines are frequently deadly to wildlife, particularly birds.

The impacts of geothermal plants are unique in some respects. Although they use about the same amount of land as a coal plant, the land is used much less intensively. At Lardello, Italy, it is possible to grow grapes at the site, and cattle grazing is being experimented with at the Geysers in California.[475] Further, noises at geothermal

plants are not much above those found in relatively quiet residential neighborhoods.[476] Still another advantage is that reinjection of the water into the earth does not appear to contaminate surface water.[477]

Although geothermal facilities are threatened by blowouts, the major drawback is sulfur emissions. A 1000 megawatt plant emits approximately 110 tons of sulfur daily, much more than coal.[478] The health and odor problems associated with sulfur are well known, but there is hope that technology can do more to reduce the sulfur emissions from geothermal facilities than it has with conventional power sources.[479]

e. power plants in Delaware: Existing electric generating facilities in Delaware are located at Edgemoor, Delaware City, Indian River, and Dover.[480] The facilities provide slightly more electricity than the State is using, and the reserve capacity is more than in most states. No new plants are expected until 1989.

There are no nuclear or geothermal plants in Delaware and only the Indian River addition under construction is designed to run on coal only.[481] Under the Energy Supply and Environmental Coordination Act, the Federal Energy Administration has preliminarily ordered the Edgemoor Station to convert from oil to coal firing.[482] The U. S. Environmental Protection Agency has completed its review and certified the plant for conversion with the installation of particulate controls.[483] As of this writing, the final conversion order of the Federal Energy Administration had not been issued.[484]

The Coastal Management Program recognizes the national interest in the use of coal fueled power plants and encourages the siting of such plants over others when air quality standards can be met. Such conversion will also help reduce Delaware residents' electric bills, which in 1975 were 33 percent higher than the national average.[485]

Many of the same considerations discussed in other parts of the paper apply equally to power plants. Power plants are permitted only where compatible with the State environmental laws, although that policy will be reviewed particularly carefully if and when the Congress relaxes air quality standards for coal fueled power plants. Both air and water quality in Delaware are generally good, giving the utilities some alternatives in the small State. Wetlands may not be filled to construct power plants or transmission lines because there are better alternatives and because the resource is so valuable.

Power plants do not threaten environmental destruction to the surrounding vicinity as much as some other energy facilities and, accordingly, are permitted in the coastal strip on a case-by-case basis. Criteria

used to determine the suitability of the site include: (1) applicable county and municipal plans; (2) the effect of neighboring land uses; (3) the number and type of supporting facilities required and their impact; (4) the economic effect; (5) the environmental impact; and (6) aesthetics. Those criteria were applied not long ago to the Indian River plant addition, now under construction.

The Coastal Management Program also permits nuclear energy facilities, but recommends alternative fuels when feasible. The Summit site had been approved by both State and local authorities before its postponement, making the site a likely choice for the 1989 plant, whether nuclear or fossil fueled.[486]

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III. Recreational Facilities

A. The national interest

1. general

The national interest in sport fishing and hunting is described in the Fish and Wildlife section. The Forests and Wetlands sections mention the recreational benefits of those resources. This section discusses large and outstanding beaches, parks, and recreational waterfronts.

In the Coastal Zone Management Act, Congress finds that "The coastal zone is rich in...recreational...resources of immediate and potential value to the present and future well-being of the Nation."[1] The National Outdoor Recreation Plan prepared and implemented by the U. S. Department of the Interior, has identified the coastal zone as an area of critical concern because of its high recreational potential and need to be protected from uncontrolled development.[2]

The National Outdoor Recreation Plan also has summarized the national interest in all recreational facilities:

> "Recreation yields three basic types of benefits: 1) direct satisfaction to the individual; 2) enhancement of the overall mental and physical quality of the individual--an investment in human capital adding to the productivity of the individual and society; 3) important third party benefits such as increased business and property values. Therefore, recreation, like education, yields benefits of both a monetary and nonmonetary nature."[3]

Recreational benefits have also been described by the Congress and the President. The Land and Water Conservation Fund Act of 1965 states that the purpose of the Act is to:

> "assist in preserving, developing and assuring accessibility to all citizens of the United States of America of present and future generations and visitors who are lawfully present within the boundaries of the United States of America such quality and quantity of outdoor recreation resources as may be available and are necessary and desirable for individual active participation in such recreation and to strengthen the health and vitality of the citizens of the United States."[4]

The President has added that recreational areas "offer priceless opportunities for us to refresh ourselves amid the tensions of our fast-paced world."[5]

The positive mental benefits of recreational activities should not be underestimated. One psychiatrist has said that recreation should give the Nation's people

> "a sense of their own ability to experience and enjoy the natural world around them" and enable each person to "achieve physical, emotional or intellectual well-being."[6]

2. economic interest

The economic value of recreational opportunities is difficult to determine. Generally, the value of a site is a function of its distance from potential users, alternative nearby sites, the attractiveness of its facilities and beaches, the amount of water, and so forth.[7] The use of most water bodies is free or very inexpensive, therefore it is hard to know how much people would be willing to pay if required to do so.

It is known, however, that the economic impact of recreational activities is very significant. Americans spent roughly $146 billion on recreation in 1976, $77 billion on equipment, admissions and dues; $55 billion on transportation, food, lodging and entertainment; $11 billion on foreign travel; and $3 billion on vacation homes and land.[8] 1977 expenditures are expected to be higher, and, if past trends are a guide, recreational spending can be expected to double every 8 or 9 years.[9]

In many coastal regions, including that of Delaware, recreation and tourism are among the most important industries. It is estimated, for instance, that those activities in the coastal region of New Jersey generate approximately $3 billion annually in goods and services.[10] In Delaware, the 24.5 mile ocean border is the primary attraction for a tourist trade worth around $200 million a year, making tourism the State's third largest industry.[11]

In 1976, Americans bought almost 700,000 boats and 470,000 outboard motors with a total value of about $2.3 billion.[12] When the sale of used boats, accessories, club memberships, launching fees, and insurance are added, the boating industry is more than a $5 billion per year business.[13] Another aquatic pastime, waterskiing, does approximately $100 million worth of business annually.[14] Diving and snorkeling also generate hundreds of millions of dollars worth of business.[15]

Recreational opportunities attract millions of visitors to this country each year. In 1975, foreign travellers spent nearly $6 billion in the United States.[16] As might be expected, government spends a good deal of money to improve recreational opportunities in the country. In 1977, the federal government spent an estimated $573 million for outdoor recreation alone.[17] State governments invested

roughly $661 million that same year on outdoor recreation, and local governments spent another $2.5 billion on the same activity.[18]

3. demand for recreational facilities

The commitments mentioned above have been made to help satisfy the accelerating demand for outdoor recreational facilities. Increased mobility, greater affluence, and more leisure time, are enabling more and more Americans the opportunity to recreate. Emerging work patterns include shorter workweeks, diversified and flexible work schedules, longer vacation periods, and earlier retirements. More than 23 million American workers now get at least 3 weeks' vacation each year, and about 1.2 million full-time workers are on schedules that require them to put in less than 5 days a week on the job.[19]

Not only do individuals have more time to devote to recreation, but there are more individuals than ever doing so. The U. S. Bureau of Outdoor Recreation reports that between 1960 and 1970, 24 million people were added to the population of the United States, and that population projections indicate a possible increase of between 57 million and 96 million by the year 2000.[20]

In 1975, visitors spent over 7 billion hours on approximately 1.6 billion days at federal recreational facilities.[21] Around 103.5 million Americans went swimming in 1976, making this form of sport the most popular in the country.[22] The third most popular sport was fishing, with 63.9 million participants.[23] Camping ranked fourth with 58.1 million; boating was seventh, with 35.2 million; waterskiing finished seventeenth with 14.7 million; and sailing was twenty-second with 7.3 million people.[24] Boating was also among the fastest growing sports,[25] and is expected to grow rapidly in the decades ahead.[26]

It is also anticipated that the future demand for all the major types of summer outdoor recreation will be substantial.[27] Projected demand for swimming, waterskiing, canoeing, sailing, and other boating is from 1.23 to 1.40, 1.46 to 1.67, 1.24 to 1.43, 1.88 to 2.05, and 1.38 to 1.54, respectively, times greater for the year 2000 than for the year 1975.[28] Projected demand for the same activities is from 1.42 to 1.98, 1.95 to 2.70, 1.57 to 2.20, 3.62 to 4.85, and 1.83 to 2.51, respectively, times greater for 2020 than for 1975.[29]

4. supply of recreational facilities

Much of the demand will have to be met at or near the Nation's shorelines. In 1971, 3,400 miles of public shorelines and 5,800 miles of private shorelines were used for recreational purposes.[30] Combined, this mileage equaled 25 percent of the country's shorelines.[31] Nearly 60 percent

of all the Nation's shorelines were undeveloped as of 1971, much of this privately owned.[32] By that same year, only 11 percent of all United States' shorelines were federally owned and only 12 percent were owned by State or local governments.[33] It is noteworthy, however, that government does own a larger percentage of coastal shorelines. Only 31 percent of those shorelines are privately owned.[34]

The United States has approximately 250 freshwater lakes with surface areas of 10 square miles or more.[35] All of those are located in 23 states with nearly 100 in Alaska and around 100 in the 5 States of Minnesota, Wisconsin, Michigan, New York, and Maine.[36]

More than three-quarters of the states have manmade reservoirs with 10 square miles or more of surface area.[37] All reservoirs provide millions of surface acres of water for potential recreational use.[38]

The U. S. Bureau of Outdoor Recreation published the first inventory of the Nation's island resources in August 1970.[39] It included all islands 10 or more acres large. In all, the inventory included 26,325 islands comprising 28.6 million acres.[40] About 21 million of the acres are in Alaska. Florida, Michigan, and Texas have nearly half of the remaining 1.5 million acres of publicly owned islands.[41] Of the 7.5 million acres outside Alaska, about 6.4 million have little or no development and possess high recreational potential.[42]

The federal government owns the vast majority of the total public outdoor recreational acreage. As of 1972, there were over 319 million such acres, of which approximately 267 million were federally owned; roughly 42 million State owned and about 11 million county or town owned.[43] Less than 6 million acres of the total were located in the Mid-Atlantic region.[44] In 1975, federally owned areas included 38 national parks, comprising over 15 million acres, and 10 national seashores, comprising nearly 425 thousand acres.[45] By comparison, State and local park facilities totaled 8.5 million acres and 1 million acres, respectively, in 1970.[46]

The private sector--clubs, farmers, industries, and so forth--owns and operates nearly twice as many recreational areas as do public agencies, but the public owns almost all of the larger areas (100,000 acres or more), considered by the U. S. Bureau of Outdoor Recreation to be of highest recreation resource quality.[47]

5. federal programs

It is difficult to estimate whether national recreational resources will be able to meet future demands, but it is obvious that the quality of outdoor recreation is a function of how much and in what manner the resources are used.

The national interest in recreation is reflected by the number and quality of federal programs designed to maximize the recreational benefits of the Nation's resources. By the end of 1972, over 80 federal agencies, commissions, committees, and councils were engaged in over 300 separate outdoor recreation-related programs.[48] Those programs ranged from management of parklands to general advisory functions and included programs for technical and financial assistance, planning, research, resource use regulation, and coordination.[49] Federal agencies providing recreation facilities and services include: the Bureau of Outdoor Recreation, the Bureau of Land Management, the National Park Service, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Reclamation in the Department of the Interior; the Forest Service in the Department of Agriculture; the Department of Defense, at various Army, Navy, and Air Force installations, and through the Army Corps of Engineers; and the Tennessee Valley Authority.[50]

The Bureau of Outdoor Recreation is the federal focal point for recreational planning and policy making. It is responsible for developing and updating the National Outdoor Recreation Plan, which serves as a guide for federal, State, and local governments, and the private sector in identifying and meeting future recreational needs of America.[51] The initial and current plan, "Outdoor Recreation-A Legacy for America," was published in 1973, and identifies states as key providers of recreational opportunities.[52]

Federal outlays for outdoor recreation totaled $1.5 billion in fiscal year 1975.[53] The largest expenditures were for Grants, which accounted for 55 percent of the total.[54] Operation, Maintenance, and Management were second at 21 percent, followed by Development and Construction--11 percent; Land Acquisition--7 percent; Miscellaneous--4 percent; and Credits--2 percent.[55]

The Land and Water Conservation Fund Program administered by the Bureau of Outdoor Recreation is one of the largest outdoor recreation grant programs. The program provides for the acquisition of lands for federally administered recreational areas. It also provides sizeable matching grants for State recreational planning, as well as State and local land acquisition and development.[56] To be eligible for the grants, the State must develop a Statewide Comprehensive Outdoor Recreation Plan and update it on a continuing basis.[57] The Statewide Comprehensive Outdoor Recreation Plan describes ways in which the State will help satisfy recreational needs at all levels of government. It also identifies capital investment priorities for acquiring, developing, and protecting all types of outdoor recreational resources within the planning area. Finally, the Statewide Comprehensive Outdoor Recreation Plan assures continuing opportunity for local units of government and private citizens to take part in their State's outdoor recreational and environmental planning programs. Recreational facility projects--such as bicycle

trails, roadside picnic stops, and swimming pools--are eligible for funding if they meet the high priority recreational needs identified in the plan. The next subsection discusses Delaware's Statewide Comprehensive Outdoor Recreation Plan and describes the State of Delaware's contribution to satisfying the national need for recreational facilities.

B. Recreational facilities in Delaware

1. supply

There are no national parks or seashores in Delaware. Nonetheless, as the U. S. Bureau of Outdoor Recreation has pointed out to the Delaware Coastal Management Porgram, Delaware's coast is a national recreational resource.[58] The Bureau's analysis is consistent with the National Outdoor Recreation Plan, which defines the term "national recreation systems" as "all recreational lands and facilities available for public use."[59]

Delaware has 381 miles of tidal shoreline, including the Atlantic Ocean, the Delaware Bay, and a few large "interior" bays.[60] Ocean frontage extends from the mouth of the Delaware Bay to the Maryland border at Fenwick Island.[61] Of the State's 2057 square miles, 79 square miles are inland water.[62] Delaware has several small streams and approximately 80 freshwater ponds.[63] There is recreational development at about one-third of those ponds.[64]

Delaware's State Park System includes 5 parks in New Castle County--Bellevue, Brandywine Creek, Lums Pond, Walter S. Carpenter, Jr. and Fort Delaware; 1 park in Kent County--Killens Pond; and 4 parks in Sussex County--Delaware Seashore, Cape Henlopen, Trap Pond and Holts Landing.[65] Those facilities are described in detail in the Statewide Comprehensive Outdoor Recreation Plan.

The combined acreage of the parks is roughly 7,214 acres.[66] The number of State-owned acres of parklands nationwide in 1970 was more than 8.5 million.[67] As those figures suggest, the State's per capita parkland holdings do not compare favorably with those of the entire country. Despite a 60 percent increase in State parklands from 1960 to 1970, there were only 11 acres of such lands in Delaware for every 1000 residents in 1970--compared to 42 acres per 1000 people nationwide.[68] Delaware's neighbors were not much better off. Every 1000 Maryland residents had 12 acres of State parklands, Pennsylvania citizens had 23 acres, and New Jersey residents had 32 acres.[69]

Delaware Municipal and County parklands help offset the relatively small amount of State parklands. In 1970, there were about 5 acres of Municipal and County parklands in Delaware for every 1000 state residents, compared to 4 acres for every 1000 citizens in the entire Nation; 2 acres per 1000 Pennsylvania residents; 1 acre per 1000 citizens of

New Jersey; and 7 acres for every 1000 residents of Maryland.[70] Overall, however, public parklands in Delaware comprise a small area relative to the population which they must serve.

Fortunately, all of Delaware's parks are well suited for recreation. Included are 12 miles of ocean beaches; saltwater bays; dunes; surf; 3 inland ponds; grassy meadows; running brooks; rolling slopes; and diversified woodlands in picturesque settings.[71] The parks have a total shoreline frontage of 176,300 feet, including 87,000 feet at the Cape Henlopen and Delaware Seashore State Parks, which front the Atlantic Ocean.[72]

County and Municipal waterfront areas and parks also offer recreational opportunities. Those facilities have been inventoried and are listed in Delaware's Statewide Comprehensive Outdoor Recreation Plan. Particularly important are the municipally controlled beach areas in Rehoboth Beach, Bethany Beach, and Lewes; which consist of 33 acres, 26 acres, and 22.9 acres, respectively.[73]

2. demand

Non-federal lands are especially important to the national recreational system along the East Coast. Most of the federal land holdings are concentrated in the West and Alaska, yet a great many Americans live near the East Coast.[74] In 1970, only 2 western States, California and Hawaii; had a population density greater than 100 people per square mile.[75] Thirteen of the 17 Atlantic Coastal States had more than 100 people per square mile.[76] California had the fourteenth densest population in the Nation, with 127.6 people per square mile.[77] The District of Columbia was first, with 12,401.8; New Jersey second, with 953.1; Maryland sixth, with 396.6; Delaware eighth, with 276.5; and Pennsylvania ninth, with 262.3.[78] Millions of urbanites live only a few hours drive from Delaware's beaches and other recreational areas.

The Outdoor Recreation Resources Review Commission has pointed out that people living in metropolitan areas have the greatest need for outdoor recreation, and that their need will be the most difficult to satisfy as urban centers generally have the fewest per capita facilities.[79]

Delaware's location in the central section of the vast megalopolis extending from Washington to New York places it in an area of intense recreational demand.[80] On an average summer weekend, 80 percent of the 170,000 people who populate the Sussex Coastal area from the Prime Hook Wildlife Refuge to the Maryland State line are from out of State.[81] In 1972, non-resident use of the 3 State parks of the southern coastland comprised nearly 70 percent of the total utilization.[82] Nearly half of all State park visitors in that year were from out of State, with Pennsylvania and

Maryland residents accounting for 19 percent and 15 percent, respectively, of the total.[83]

During fiscal year 1977, State parks provided recreational opportunities for 3,395,117 visitors.[84] Swimmers were the most frequent park visitors, with 596,445 people enjoying swimming at the inland ponds and ocean beaches.[85] Nearly 340,000 visitors engaged in fishing and boating, the second most popular activity at the parks.[86] A survey of Delaware residents confirms ocean and pond swimming as the most popular form of outdoor recreation in the State.[87]

It is difficult to predict future demand for outdoor recreational facilities. State park visitation from 1965 to 1969 increased tenfold, underscoring the potential for substantial increased participation over a short period of time.[88] That potential, combined with the dynamics of more leisure time, increased mobility, and so on--discussed above--would seem to indicate that future demand might be great. On the other hand, park attendance has been relatively constant since 1969, although the seashore has been increasingly popular.[89]

Many of the most popular recreational areas, of course, are not State parks. The summer weekend population in the Sussex Coastal area has been projected at between 178,330 and 190,324 for the year 1980; between 189,107 and 201,831 for 1985; between 200,615 and 214,117 for 1990; and 214,084 and 228,531 for 1995.[90] Delaware's Statewide Comprehensive Outdoor Recreation Plan has estimated that in 1980 Delaware residents alone will spend over 14.2 million days swimming, nearly 2.9 million days fishing, and over 1.8 million days boating, canoeing or waterskiing.[91] Although those figures do not represent substantial increases over the estimated current activity, it cannot be concluded that future demand will not be significant.[92] The fact is that current activity is great and that maintenance or any increase of the level of use of recreational facilities in the State means that future demand will be great.

3. the coastal management program and recreational facilities

Most of the measures adopted by the Coastal Management Program to protect the State's physical resources, discussed in earlier sections of this report and the program document, are also intended to promote enjoyment of Delaware's recreational facilities. For example, the State's Coastal Zone Act reduces the threat of water and air pollution near Delaware's most significant recreational facility--the beach. As such, that Act is consitent with the National Outdoor Recreation Plan, which states:

> "There is a tremendous opportunity for conservation organizations, States, and the Federal Government to cooperate in the protection of the Nation's remaining shorelines and estuaries for the benefit of all citizens. Shoreline protection depends primarily on State and local government land use controls."[93]

State and local management planning activities which are specifically related to recreational facilities are described in Delaware's 1976 Statewide Comprehensive Outdoor Recreation Plan. That Plan is the product of an on-going outdoor recreation planning process. The Coastal Management Program incorporates that process and adopts the specific policies of Delaware's 1976 Statewide Comprehensive Outdoor Recreation Plan.

The valuable ocean frontage receives particular Coastal Management Program attention. Public land near the ocean is designated as a Geographic Area of Particular Concern and special measures, described in the program document, are taken to protect and preserve this area for future public use. Measures are also included to prevent beach erosion and provide public access to State beaches.

C. The impact of recreational facilities on resources

The use of the seashore, parks and recreational waterfronts affects natural resources in several ways. Probably the most significant impacts occur as a result of resort development of the ocean and bay nearshores.

The Lewes CCD Pilot Study, a Delaware Coastal Management Program effort involving the participation of State, County, and local officials, as well as members of the general public, identified "water pollution from poorly designed landfills, malfunctioning or poorly located septic tanks, lagoon construction, ocean dumping of sewage effluent, private package treatment plant malfunctions and improperly placed water wells," as one such impact.[94]

Boating, of course, is another source of water pollution. In 1969, the State Game and Fish Commission, State Park Commission, State Planning Office, State Water and Air Resources Commission, Delaware Geological Survey, and the University of Delaware reported to the Governor that

> "The tremendous influx of summer residents, the increased population of the towns in the basin, and the impact of the day use areas have added to the nutritional load of the Rehoboth, Indian River and Assawoman bays to the extent where there is need now to be alarmed."[95]

In 1938 less than one mile of the Rehoboth Bay shoreline and 9 miles of the Indian River Bay shoreline were developed.[96] By 1969, 25 miles of Rehoboth Bay's 48 miles were developed and 44 miles of Indian River Bay's 45 miles were developed--mostly with summer residences.[97] As of 1972, significant portions of the Rehoboth and Indian River Bays were closed to the taking of shellfish because of domestic pollution resulting from improper development of the shoreline.[98] The problem has not been solved in the intervening years. The U. S. Environmental Protection Agency has recommended that the Delaware Coastal Management Program designate Rehoboth and Indian River Bay as a Geographic Area of Particular Concern because of the water quality problems.[99] The program document responds to that recommendation.

Water is not the only resource affected by recreational facilities. Air quality is adversely affected by increased vehicular traffic and congestion. Plant life is trampled by hikers. Woodlands, agricultural lands, and, possibly, archeological sites are destroyed to make room for more development. The dredging of bottom muds and sand to accommodate boats buries or otherwise disrupts aquatic life. Summer houses, trailer camps, and public facilities--built to serve the population influx--occupy floodplains, make minerals inaccessible, and create erosion problems. Natural beauty is destroyed by litter, buildings, people, and so on.

Finally, as pointed out in earlier sections, despoilation of one resource tolls the end of others. For example, wildlife cannot flourish without clean water and an otherwise protective habitat provided by wetlands or other natural areas; air pollution damages historic buildings; and removal of forest areas impinges on water quality.

More detailed discussion of the interrelationships between resources and the Nation's use thereof appears elsewhere in the report. Here, it is sufficient to note that resources indirectly "pay" for the Country's use of recreational facilities, just as they "pay" in a more direct manner for the use of other facilities.

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IV. Transportation Facilities

The Congress has declared that

> "the general welfare, the economic growth and stability of the Nation and its security require the development of national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith and with other national objectives, including the efficient utilization and conservation of the Nation's resources."[1]

The Delaware Coastal Management Program acknowledges that the federal transportation programs serve a national interest and cooperates with such programs to the extent possible.

The U. S. Department of Transportation has stated that it is in the national interest to provide facilities "for the movement of people, goods, and services, to, from, along and through the coastal zone" for the following purposes: (1) to provide for the national defense--for example, access to military installations and ports of embarkation; (2) to maintain public safety and welfare--for example, hurricane evacuation routes; (3) to manage public lands in the coastal zone--for example, access to wildlife sanctuaries; (4) to provide for public recreation--for example, access to beaches; to facilitate interstate and international commerce--for example, access to seaports; and (5) to develop and use natural resources in the coastal zone and the outer continental shelf--for example, access to oil and fishery resources.[2]

The Delaware Coastal Management Program has adopted the following policy statement, which also appears in the U. S. Department of Transportation's statement of the national transportation interest in the coastal zone:

> WHEN ESSENTIAL IN THE NATIONAL INTEREST, THE CONSTRUCTION, MAINTENANCE AND IMPROVEMENT OF PRESENT AND FUTURE TRANSPORTATION SYSTEMS ON AND UNDER THE SURFACE OF THE LAND, ON AND UNDER THOSE WATERS SUBJECT TO THE JURISDICTION OF THE UNITED STATES, AND IN THE AIR, SHALL PREDOMINATE OVER LESS ESSENTIAL INTERESTS.[3]

Some of the transportation facilities which serve the national interest in meeting energy requirements are discussed in an earlier section of the report. This section considers interstate highways, railroads, airports, ports and aids to navigation, all of which are necessary adjuncts to a balanced national transportation system.

A. Interstate highways

There is a tremendous demand for highways in the United States. In 1972, trucks travelled approximately 244.5 billion miles in this country.[4] In 1973, private automobile traffic exceeded 1.1 trillion miles.[5]

By 1974, the demand for highways was being met by close to 4 million miles of highways, 224,000 miles of which were under federal control.[6] Delaware highways in 1974 exceeded 5100 miles.[7] Although the ratio of Delaware highway mileage to Delaware population is less than the national average, the State's ratio is better than that of Maryland or New Jersey, and comparable to Pennsylvania's ratio.[8] Moreover, the per capita expenditure of State and local governments for highways is the best in the 4-state region and ranks favorably among all states.[9]

Great sums of money are spent on highways. In 1973, State and local highway disbursements totaled nearly $19 billion, $107 million of which was spent in Delaware.[10] The total unpaid highway debt of State and local governments in 1976 has been estimated at more than $24 billion.[11] Federal-aid payments to State and local governments in 1975 for highways were nearly $5 billion.[12] Delaware received $13 million of that sum.[13]

Delaware does not anticipate applying for or receiving any more federal money to complete those highways located in Delaware which are part of the national system of interstate highways--namely, Interstate 95 and Interstate 495--because the State has sufficient finds to finish the highways in the near future.[14] At the outset of 1975, only 41 of the 42,500 miles which comprised the national interstate highways were located in Delaware.[15]

There are, of course, other interstate highways in the State which are not part of the national system. Of particular importance are U. S. Routes 9, 13, and 113. Route 9 is the major East-West connection between the recreational beach areas and the Baltimore/Washington metropolitan areas. Route 13 serves the Delmarva Peninsula by connecting Delaware to Maryland and, ultimately, Virginia. Route 113 connects northern Delaware, and thus the Philadelphia area, with Delaware Route 1, a 4-lane divided highway along the coast.

The Delaware Department of Transportation monitors traffic patterns in Delaware and analyzes the need for new or improved highways, including interstate highways.[16] The Department's planning process relies on a great deal of public participation; complies with federal planning requirements, which enables the State to receive 80 percent federal funding for highway planning; utilizes computer models which forecast needs based on population, employment, automobile ownership, and so forth; and develops alternative solutions for

meeting the long-range highway transportation needs for the State.[17] The planning process includes coordination with OMBP and DNREC, the agencies primarily responsible for planning and implementing the Coastal Management Program, respectively.

No construction of new interstate highways is currently planned. Route 13, the North-South connection between New Castle County and Maryland, has been the source of controversy for a long while. Many people feel the traffic and safety problems associated with the highway warrant improving the road or building a new one. It is unclear, however, how such a road would be financed. In 1974, a public survey revealed a not-too-surprising sentiment against a North-South toll road.[18] Only 23 percent of the respondents agreed that Delaware should build such a road.[19] Nonetheless, the issue is still unresolved and a gubernatorial committee is now studying it anew.

Another long-standing interstate highway issue of concern to Delaware residents and interstate travellers has been the summer traffic to and from the beaches. The Coastal Management Program considered that problem in the Lewes CCD Pilot Study.[20] The Study concludes that the highway system is sufficient to carry the existing traffic, if averaged over the entire year, but that summer traffic exceeds highway capacity as measured by its ability to maintain free-flowing traffic at or near the speed limit.[21] This seasonal problem will be alleviated somewhat when the State completes dual-ization of Routes 1 and 13, projects currently in progress.

A final highway problem of obvious interest relates to the impact these facilities have upon resources. One disadvantage to interstate highway systems is that they allow so much mobility that it is convenient for people to go places which they previously considered "not worth the trouble." Thus a 6-lane highway from Philadelphia to Rehoboth would probably increase summer visitation to the beaches enough to exacerbate a host of environmental problems which typically accompany large numbers of people using a small resource area.

The increased use of highways, of course, aggravates air quality problems. Automobile emissions are identified in the air resource section of this report as a major source of air pollutants. Recent attempts to control the problem with catalytic converters have not met great success. The U. S. Environmental Protection Agency has discovered that such converters can discharge sulfuric acid mists and sulphates at levels significantly higher than uncontrolled automobiles, and that these emissions can create health problems.[22] Moreover, a recent study has demonstrated a correlation between highway traffic and levels of lead in human bodies.[23]

New highways may also raise noise pollution levels; intrude on the visual attractiveness of an area; replace vegetation and displace wildlife; impinge upon historic

resources; cause erosion problems; and utilize land which might otherwise be suitable as forest, prime agricultural lands or wetlands.

B. Railroads

A few statistics demonstrate the national interest in railroads. There are hundreds of thousands of miles of railroad tracks in the United States.[24] Railroads move more domestic intercity freight than trucks or ships.[25] In 1974, the equivalent of more than 1.5 trillion tons of train-transported freight was carried one mile and generated revenue in excess of $16 billion.[26] Trucks moved approximately one-third that amount in the same year.[27] Also in 1974, trains carried 275 million passengers over 10 billion miles, and more than one-half million employees earned roughly $7.7 billion in the railroad industry.[28]

In the early 1970s, much of the rail network serving the Northeast and the Midwest faced the loss of essential rail services because the Penn Central Transportation Company could no longer afford to maintain the railroad lines.[29] With the failure of Penn Central in 1973, the Congress enacted the Regional Rail Reorganization Act of 1973.[30] That Act establishes a Rail Service Continuation Subsidy Program to assist states that might otherwise lose rail service.[31] The Delaware Transportation Authority--with federal assistance and in cooperation with the State Rail Plan Advisory Committee (composed of representatives of State and local government, members of the business community affected by rail services, and officials of the rail carriers in Delaware)--develops an annual State Rail Plan which must be approved by the Federal Railroad Administration before the State can receive rail service continuation subsidies.[32]

The Plan describes the State's railroad network; summarizes Delaware rail concerns and issues; identifies the economic, social, and environmental impacts of branch line rail service changes, as well as rehabilitation alternatives; enunciates a State transportation policy relative to railroads; and discusses the past, present, and future volume and type of rail service usage on the Delmarva Peninsula, and on specific lines in Delaware.[33]

Delmarva rail traffic has experienced an overall decline in volume between 1974 and 1976, corresponding to a national trend partially attributable to a slump in the economy.[34] Volumes, however, have remained constant enough so that the Delmarva rail system should remain viable if the current usage can be maintained.[35] Continuance of the northern Delaware lines seems certain, but the lines south of the Delaware Chesapeake Canal may be in jeopardy.[36] It is a goal of the State Rail Plan and a policy of the Delaware Coastal Management Program

TO ENCOURAGE THE MAINTENANCE OF AN ADEQUATE AND EFFICIENT RAILROAD NETWORK SERVING DELAWARE AND LINKED TO THE REGIONAL AND NATIONAL RAIL NETWORK.[37]

That policy reflects the fact that State, regional, and national railroad needs can be satisfied without the siting of any new major railroad lines in the State.[38] In some cases, the lines need to be rehabilitated to increase efficiency. The Georgetown-Lewes line is one example. The State, with federal assistance, is planning to upgrade that line.[39] If new industry locates in the State, there may be a need to site a line which connects industry with a major line.

In that event, resources may be impacted. For the most part, the impacts are similar to those of highways. Air emissions from trains have been compared to trucks, the probable alternative. Using an equal amount of diesel fuel, trains emit much less carbon monoxide, many more hydrocarbons, the same amount of nitrogen oxides, and more sulfur oxides.[40] Significant noise pollution can result from train operation and the coupling and uncoupling of railroad cars. The washing of those cars or the cleaning of chemical tanks at train terminals, and the spillage of diesel fuel and oil can impact water quality.

C. Airports

In 1974, the United States aircraft carrier industry flew over 4 billion miles, carried more than 3 billion ton-miles of domestic air cargo, transported better than 200 million passengers, and employed 305,000 people.[41] In 1974, there were 13,062 civil airports in operation in the United States.[42] Only 32 of those were located in Delaware.[43]

Nonetheless, the State of Delaware Aviation and Airports System Plan is in full compliance with the National Airport System Plan, developed pursuant to the federal Airport and Airway Development Act of 1970.[44] Due to its small size and proximity to several large international airports, there is no need for Delaware to have more than a very small proportion of the total number of airports in the country. Thus, Delaware's 3 major public-use airports--the Greater Wilmington Airport, Delaware Airpark (located one mile west of Cheswold and approximately 8 miles north of Dover), and Sussex County Airport (located in Georgetown)--meet the criteria established in the national plan which are intended to address the national interest in the siting of airports.[45]

The State plan formulates broad objectives; inventories the existing aviation system in Delaware; determines the capacity of existing airports to accommodate air traffic;

forecasts aviation demand; investigates alternatives for accommodating the projected air transportation demand; and makes recommendations for meeting future demands.[46] Federal, State, regional, county and local planning departments, as well as a Governor's Task Force, participated in the development, monitoring, and review of the plan.[47]

The plan concludes that citizens of the State do not have easy access to the national air transportation system because aviation economics do not permit direct service from any locations in Delaware to distant points in the foreseeable future.[48] Major airport facilities and service by the national air carriers cannot be economically justified by the small amount of air traffic generated in the State.[49]

If aviation economics ever do dictate siting of an airport of national interest in Delaware, the State environmental laws would apply and address Coastal Management Program concerns. Neither the laws nor the Coastal Management Program preclude the siting of such a facility. The program document policy on airports of national interest is to encourage their siting in Delaware if consistent with the objectives of the national and State aviation plans, the State environmental laws, and the Coastal Management Program.

Airports, like all facilities, impinge upon resources to some extent. Noise pollution is among the most important impacts because of its effect on communities, residences, wildlife, and activities within the noise area.[50] A new airport usually requires a fairly large area for a construction site and an adequate noise buffer zone. The natural environment is disrupted by runways, hangers, offices, passenger terminals, parking lots, access roads, and so on. Water quality can be degraded by increased surface water runoff or changed groundwater flow patterns. Operation of the airport facilities generates wastewater from sewage, aircraft-handling wastes, stormwater, and industrial wastes.[52] Passengers, visitors, and employees each use approximately 20, 10 and 100 gallons of water, respectively, per day.[53] Air pollution from aircrafts, automobiles, aircraft fueling systems, airport heating plants, and fuel storage losses, may make it difficult for an airport to meet regional air quality standards.[54] Finally, development induced by the airport may aggravate these problems and create additional difficulties.

D. Ports

1. the national interest

Port facilities are the vital link between water and inland transportation systems. The ability of ports to move large amounts of military equipment and personnel serves the national interest in security. For the most part, however, the national interest in port facilities is economic. In 1974, more than 1.7 billion short tons of cargo were waterborne.[55] Four hundred seventy-four million short tons of

that total were sent abroad from those ports.[56] Due to relatively low fuel costs and other economic advantages, more than 90 percent of all world trade moves via marine transportation.[57] In 1975, over 538.5 billion pounds of cargo were exported from this country by vessel, compared to approximately 1.4 billion pounds of airborne cargo.[58] In the same year, over 855 billion pounds of freight were imported by ship, while only 1.1 billion pounds were brought into the country by plane.[59] The total value of the imported cargo at all United States ports in 1974 was more than $68 billion, the value of exports was $56.5 billion.[60]

More of the import traffic is served by Atlantic ports than ports in any other region of the Nation. In 1974, the total tonnage of waterborne imports at Atlantic ports exceeded the combined tonnage of the Pacific, Gulf, and Great Lakes ports.[61] Ports along the Delaware River and its tributaries handled nearly 80 million short tons of cargo in that year, roughly one-seventh of the Nation's total and more than any other port including the Port of New York and New Jersey.[62] Waterborne trade is vitally important to the Delaware Valley because most of the essential fuels and basic raw materials necessary for a vigorous economy come to the Valley via ports along the Delaware River.[63]

To handle the huge tonnages involved in the country's waterborne commerce, the port industry has invested nearly $5 billion in facilities since 1966.[64] That investment produces a "multiplier" effect in the form of employment and income to the port community. Although it is difficult to isolate the job opportunities and the investment in industrial and commerical development that can be directly attributed to ports, the economic impact of ports is extensive. According to a recent study by the Federal Maritime Administration, the port industry in 1972 generated over $30 billion in direct dollar income, contributed over $1.1 billion to the balance of payments account, and provided jobs for over 1.2 million people.[65]

Despite the great national interest in ports, the United States has never had a national port plan, and no commercial port or group of ports has ever been under the complete control of the national government.[66] There are, however, over 40 organizations in the Executive Branch of the federal government with functional responsibilities directly or indirectly affecting the operations or future development plans of ports in the United States.[67] Some of those organizations promulgate and enforce regulations for port safety, pollution control, navigation control, tariffs, customs, and so forth. Others assist local port authorities dredge harbor channels, predict weather conditions, finance public works, and so on.

For the most part, though, the siting of ports is determined by principles of free enterprise and the exercise of local controls. Individual ports compete with each

other for the available traffic. Factors that can influence the selection among ports for routing include: quality and frequency of ship service and connecting land transportation; efficiency of transfer facilities at the ports; availability of services associated with shipping, such as steamship agencies, custom brokers, banks, and freight forwarders; steamship rates; port charges and regulations; and rates of connecting land transportation.[68] The principal variables affecting the future growth of a port are technological developments, the present port capacity, regulation and rates, port financing, environmental and economic conflicts, and the demand for port facilities.[69]

Domestic and foreign waterborne commerce data collection programs currently conducted by the various federal agencies are generally insufficient for assessing future port requirements, capacities and related activities.[70] Nonetheless, forecasts for selected commodities--including crude petroleum, petroleum products, aluminum ores, grains, iron ore, phosphate rock, iron and steel scrap, and general cargo--have been derived from a number of studies prepared for either the United States Maritime Administration or the United States Corps of Engineers, and are summarized in Port Development in the United States, by the National Research Council.[71] Some of those studies project regional port traffic for the listed commodities, others estimate only national trends. In both types of studies, the conclusions are similar--namely that port traffic, except with respect to iron and steel scrap, will increase substantially in the decades ahead.

The uncertainty of the data, coupled with such unknowns as technological developments, port financing, and so on make it impossible to state that an efficient national port system is assured. The lack of a national port plan and the coastal dependency of ports also indicate that it is especially important that coastal management programs carefully consider port development.

2. ports in Delaware

A 1968 U. S. Corps of Engineers report lists 103 piers, wharves, docks, and ports on the Delaware River--33 of which are located in Delaware.[72] With the exception of the Wilmington Marine Terminal, facilities in Delaware are predominantly small, privately owned and operated, specialized piers and docks.[73]

One other facility of national significance consists of a few piers at Delaware City and Pea Patch Island which are owned and operated by the Getty Oil Company. The piers are used to receive crude oil, ship petroleum products, and bunker tankers. As of 1972, the Getty refinery imports averaged between 100 and 120 thousand barrels (1 barrel equals 42 gallons) of crude oil per day, all of which was received by water.[74] Nearly all of the refinery shipments are also by

water.[75] Since full operation began in 1958 until at least 1972, the refinery had used about the same tonnage of crude oil each year.[76] Plans in 1972 called for the same levels of usage to continue for the foreseeable future.[77]

The Port of Wilmington is the State's most important port facility and the most promising one in terms of capacity for expansion. The Port is in an already developed area, reducing the potential environmental impact. Although the Delaware Coastal Management Program encourages port development wherever it is economically desirable and consistent with environmental objectives and policies, the program recognizes the Port of Wilmington as an especially attractive site for meeting regional and national port needs. As such, the program has designated the Port as a Geographic Area of Particular Concern, and devotes a section in the program document to Port development issues, problems, and policies.

The Port of Wilmington is wholly owned and controlled by the City of Wilmington. An average of 225 members of the International Longshoremen's Association and 130 full time Port employees are responsible for the Port's daily operation, management and maintenance.[78]

The Port is located on the right bank of the Christina River at its confluence with the Delaware, 62 nautical miles above the Delaware Capes.[79] Wilmington is the first major inbound port in the Delaware River Complex.[80] Comprising 250 acres with several hundred acres available for expansion, the Port's uncongested facilities are geared for the rapid loading and discharge of trucks and rail cars.[81] Hundreds of truck lines service the Port, utilizing Interstate Highways I-95 and I-495 for easy access to Washington, Baltimore, Philadelphia and New York.[82] Full service railways and 7 1/2 miles of Port owned track also facilitate efficient overland movement of cargo from the Port.[83] Moreover, the Chesapeake and Delaware Canal, which connects the Delaware River and Bay to the upper reaches of the Chesapeake Bay across a 14-mile strip of Delaware and Maryland countryside, provides convenient water access to and from the Port of Baltimore.

The Port now has berths with 37 foot depths able to accommodate 8 of the largest ships that travel the Delaware River and Bay.[84]

Discharge of cargo is expedited with the use of 3 Gantry cranes with capacities of up to 100 tons.[85] Equipped with 54 inch magnets and cargo block and buckets to 14 cubic yard capacity, those cranes are capable of handling all types of large, bulk or palletized cargo.[86]

A giant bulk tower equipped with a 9 1/2 cubic yard bucket for the loading and unloading of basic ores such as fluorspar, gypsum, titanium, chrome, illemenite, petrocoke, urea and many others dominates the Port's bulk handling

facilities.[87] The tower is also equipped with a cargo block capable of handling lifts of up to 25 tons.[88] Cargo can be dispatched directly from ships to freight cars, trucks, or lighters, saving handling costs and speeding delivery.[89]

Over 2 million square feet of open storage area are available to both exporters and importers at the Port.[90] Here, thousands of Fiats and other foreign cars await shipment across the United States on a 33 acre blacktop parking lot, now making the Port of Wilmington the largest import point for Fiats in the United States.[91] In addition, the Port imports tractors and heavy construction equipment, while exporting large numbers of General Motors, Chrysler Corporation and American Motors vehicles.[92] Other cargos which the Port provides open storage for are lumber, pumice, steel automotive parts, lead and iron.[93]

Four hundred seventy-two thousand square feet of enclosed warehouse and storage space are within a few hundred feet of dockside, offering quick and efficient storage for both package and bulk goods, as well as rapid loading and unloading.[94] The Port also has bagging facilities for those bulk items which need to be packaged for shipment.[95]

In Fiscal Year 1977, the Port handled almost 2.4 million tons of cargo, valued at nearly $500 million.[96] Roughly one-half the total tonnage was crude oil, and approximately three-fifths was some form of fuel.[97] Port officials report that use of the facility is on the upswing, but future demand will depend on many unpredictable variables, including the world trade picture.[98]

A good deal of effort has been expended in planning the future course of the Port. A comprehensive Port Development Plan was prepared in 1972 under the direction of the City of Wilmington. The Plan analyzes port markets; develops short-term market forecasts; describes port facilities and future facility requirements; schedules port development activities; calculates revenue and expense projections; and recommends financing strategies.[99] Unfortunately, some of the Plan will be outdated in the near future. The 1972 market forecasts, for example, were developed only for the ensuing 6-year period.[100]

The City of Wilmington, of course, has not been alone in considering the Port's future. In July 1972, a Governor's Task Force on Marine and Coastal Affairs issued a lengthy plan for action with respect to Delaware's coastal zone. The Plan describes the existing port facilities in the State; reports the volume, nature, and importance of port traffic; briefly reviews potential port growth trends; identifies existing and potential port hazards; discusses problems impeding improvements in marine transportation; and recommends measures for addressing the problem.[101]

Briefly, the problems identified in the plan include: (1) insufficient financial commitment for maintenance and development of the channels, harbors, ports and shore facilities to fully utilize the water resource; (2) the need for study and research to prepare for the rapidly changing technology and specialization of cargoes and ports and the creation of new deepwater ports and harbors to service the next generation of superships; (3) the inadequacy of the depth of river and bay channel for long-haul cargo ships; (4) and the lack of suitable sites for spoil disposal from dredging operations.[102]

The Task Force recommendations include one that consideration be given to establishing a Delaware Port Authority responsible for all waterborne commerce and riparian and shore facilities within the State.[103] The rationale for the recommendation is based on the fact that the City bears the operating costs of the port and receives no support for paying its bonded debt, while port benefits extend to State and county governments, as well as private businesses.[104]

In 1974, another Gubernatorial Committee was formed, this time by Executive Order and for the exclusive purpose of studying the Port of Wilmington. The final report of the Committee reviews the Port's finances, operational functions and tonnage activity trends.[105] It also forecasts port utilization, develops an investment strategy, describes institutional alternatives, and makes findings and recommendations.[106]

One of the findings of the report is that the City has assumed all the financial burdens of the Port, while benefits are dispersed throughout the State and region.[107] One of the recommendations is that the Port's institutional structure be modified to: (1) assure that the long-range commercial interests of the State, City and region are developed; (2) allow a broader financial base for improvements; and (3) support and inspire Port management in reaching specific goals and objectives.[108]

In 1976, still another Gubernatorial Commission, the Delaware Tomorrow Commission, recommended that the activities and employment at the Port be expanded "by carrying out the recommendations of the "Port of Wilmington Study Committee" including the necessary capital investment."[109]

Many of the Study Committee's recommendations have been heeded. For example, the City has expanded the size of Port and upgraded its facilities to meet what the Committee thinks will be a gradually increasing use of the facility. From 1970 to 1975 the City allocated over $3 million in capital expenditures for Port development.[110] Another $10 million has been recommended by the City Planning Commission for capital inprovements to the Port over the 6-year period from 1976 to 1981.[111] Nearly half of this sum is ear-marked for repairs and improvements to existing facilities.[112] The

remaining money is slated for land reclamation, crane purchase, annual improvements, and freezer conversion and expansion.[113]

The City is currently negotiating with New Castle County for the purchase of land along the Delaware River from the mouth of the Christina River to Pidgeon Point.[114] The acquisition would not only quadruple the Port's total docking space,but also would require little dredging because the 40 foot channel is close to what would be the docking space.[115] Suitable spoils disposal areas in the Delaware River area are scarce and cannot sustain the long-term dredging needed to keep the channel to the Christina docks open.[116] Thus, by re-locating the Port on the Delaware River, a major environmental problem would be solved.

Port officials are also actively seeking the interest of the oil industry with respect to Port utilization as a supply base for outer continental shelf oil and gas development.[117] The Port is the closest freshwater port capable of handling heavy cargo, such as pipe, to many of the offshore tracts leased for oil and gas exploration. Moreover, a fully developed inland transportation network is located in Wilmington, not Lewes--the City frequently mentioned in connection with offshore development. Lewes could, of course, handle light supplies, house crews, and so on.

The Delaware Coastal Management Program has developed policies which are generally consistent with the findings and recommendations of the several Gubernatorial Commissions which have studied Port development, as well as with the legislative intent of the General Assembly. Port development is encouraged to the extent that it is economically desirable and environmentally safe. The Coastal Management Program takes no position on whether the institutional structure for managing the Port of Wilmington should be modified, but it does recommend that the State and New Castle County contribute financially to the Port's development and participate in the planning process. It also recommends utilization of the Port for the support of outer continental shelf development. Likewise, it encourages expansion of the Port, particularly along the Delaware River, to meet future national and regional needs and to reduce the need for dredging and spoils disposal operations.

3. impacts of port facilities

The greatest potential hazard of port facilities is associated with off-loading crude oil, especially in the open lower Delaware Bay.[118] The Energy section of this report addresses that problem in detail. In addition, collision, grounding, fire, and sinkings all present obvious hazards to life and property. Interactions between ports and coastal environments also raise problems of air, water and land quality. Environmental problems caused by ports arise from

2 sources: facilities, which permanently alter the environment; and operations, which may result in temporary or permanent effects caused by cargo spillage, waste discharges, and vessel movement.[119]

The primary problems associated with harbor and channel development arise from maintenance dredging and spoils disposal. Potential effects of dredging include changes in water and groundwater quality, disruption of benthic habitats and resident organisms, and alteration of water circulation patterns.[120] Increased turbidity reduces light penetration, causing a decrease in local photosynthetic production and interference with the feeding apparatus of filter-feeding species such as commercially important shellfish.[121] Currents may carry suspended sediments long distances from the dredging area, and eventually deposit them on productive bottom areas where settlement and colonization by certain species is otherwise possible.[122] The deposition of dredge spoils in water is an aggravated form of water and bottom disturbance. Unfortunately, the natural site of land sites used for dredge spoils is also typically destroyed by such deposition. Auxiliary structures--including breakwaters, jetties, dikes and locks--used to facilitate vessel manueverability by changing circulation and flow patterns, also change wildlife habitats and may be aesthetically unpleasant.[123]

Berthing and terminal facilities often require substantial amounts of space for storage of large quantities of bulk commodities. Usually that displaces other land uses and causes significant visual impacts. Also, where large surfaces are paved or otherwise covered, precipitation runoff will increase.

As the U. S. Corps of Engineers has pointed out, the development of processing facilities near or at the Port may generate wastes with more significant environmental impact than any other component of a port system.[124] Indeed, the prohibition of offshore oil terminals in the Delaware Bay is based in good measure on the observation that such facilities attract undesirable industrial development. In addition, new growth almost always accompanies port development--increasing area population and the demand for housing, roads, sewers, and schools.

Finally, ship movement and operation may affect resources due to their physical presence and because of discharges and spillages during cargo handling. For example, dust may be generated from the handling of dry bulk cargos. The Port of Wilmington now utilizes pumpers to sprinkle the air when ore is being unloaded, thereby reducing air particulate problems. The Air section of this report discusses additional air quality problems at the Port.

E. Aids to navigation

Federal law provides that:

> "In order to aid navigation and to prevent disasters, collisions of vessels and aircraft, the Coast Guard may establish, maintain, and operate...aids to maritime navigation required to serve the needs of the armed forces or of the commerce of the United States."[125]

The same law makes it unlawful for any entity to erect, maintain or operate aids to navigation in navigable waters without the permission of the Coast Guard.[126] Further, it provides that no one may remove or interfere with aids to navigation established by the Coast Guard.[127] Finally, the law authorizes the Coast Guard to acquire lands by any means necessary, provided it is for the purpose of executing duties and functions of the Coast Guard.[128]

As of September 14, 1977, the Coast Guard was operating 24 Delaware facilities in aid of navigation.[129] All of those facilities are located on 63.5 acres of federal property, with the exception of 6 warning light systems.[130] The Coast Guard uses the areas for the latter systems by permission or lease.[131] Normally the Coast Guard does not need or receive State approval to site an aid to navigation, but if the aid is to be sited on State property, DNREC is consulted.[132] In such cases, approval is almost automatic.[133]

Coast Guard regulations prescribe conditions under which states may regulate aids to navigation in navigable waters, if the Coast Guard does not do so.[134] The State of Delaware, however, does not site, operate or maintain aids to navigation.[135] The State role is limited to reviewing, commenting, and making recommendations on navigational aids of the Coast Guard.[136] The State's interest in such aids is that maritime safety be assured.[137] As such, it coincides with the national interest.

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V. Regional Water Treatment Plants

This section discusses the national interest in sewage treatment plants and desalinization plants. The national interest in clean water is described in the Water section. The purpose of regional water treatment plants, of course, is to improve water quality. Thus, the national interest in these facilities coincides with the national interest in clean water to a large extent and narrows this discussion considerably. For a fuller appreciation of the national interest in regional water treatment plants, this section should be read in conjunction with the one on water.

A. Sewage treatment plants

1. the national interest and sewage treatment plants in Delaware

Sewage is the waste matter carried off by sewers or drains. Untreated, these materials can find their way into coastal and other water bodies. There, they interfere with swimming, boating, drinking and other beneficial water uses.

Much is known about the effects of different types of wastes, as well as what factors must be considered to determine whether their discharge at specified concentrations into given water bodies will cause environmental problems. One study of this subject, Waste Disposal in Waters, has been prepared by the Delaware Coastal Management Program.[1]

As the Water section explains, a tremendous effort is being made to protect receiving waters from wastes that cannot be harmlessly assimilated. Much of the work has proceeded pursuant to Section 201(g)(1) of the Federal Water Pollution Control Act of 1972, which provides that the U. S. Environmental Protection Agency "is authorized to make grants to any State, municipality, or intermunicipal or interstate agency for the construction of publicly owned treatment works." Under this provision, the federal wastewater treatment plant construction grants program has become the largest public works effort in the Nation.[2] In the 1972 statute, $18 billion was authorized to help support the construction of publicly owned wastewater collection and treatment systems.[3] Thirteen billion dollars of this had been obligated by March 1977.[4] The President has encouraged obligation of the remaining $5 billion, and has requested $4.5 billion in additional long-term funding for the program over 10 years.[5]

The direct economic ramifications of water treatment plants are significant. It has been estimated that for every $1 billion in construction outlays, 20,000 to 25,000 on-site workers are employed.[6] Off-site employment in the raw material industries, manufacturing, and so forth,

is likewise substantial.[7] Further, the construction grant program means new jobs for plant operators, technicians, and maintenance personnel.[8] In August 1976, the U. S. Environmental Protection Agency estimated that wastewater treatment construction activities would support at least 200,000 jobs by mid-1977.[9]

The first step in obtaining the grants that generate all this activity is submission of a "201 plan," which consists of those necessary plans and studies required to evaluate and ultimately select the most desirable alternative prior to detailed design and construction of publicly owned waste treatment works.[10] The objective of the overall program, as expressed in the statute and reiterated in President Carter's 1977 Environmental Message to the Congress, is to ensure that treatment works are environmentally sound and cost effective.[11]

Theoretically, the Act does not permit the U. S. Environmental Protection Agency to approve a construction grant for wastewater treatment works, unless the "size and capacity of such works relate directly to the needs to be served by such works..."[12] In practice, however, many systems are overbuilt. As several studies have pointed out, communities often view the program as a one-time-only opportunity to obtain federal funds and, therefore, design their plans based on the greatest conceivable need.[13] When inflated population projections prove inaccurate, the result is often underutilization of expensive treatment plants. Delaware's Coastal Management Program has addressed that problem in the section of the program document dealing with public investment policy.

DNREC, as "the appropriate State water pollution control agency," must approve the proposed plant before the U. S. Environmental Protection Agency can award a construction grant.[14] Moreover, the grant cannot be awarded unless the proposed works are included in any applicable areawide waste treatment plan developed under section 208 of the federal statute.[15] The State participates in the 208 planning process, which is described in the Water section of this report. The proposed works must also be consistent with the Statewide Comprehensive Plan. In addition, the State requires permits under the Delaware Environmental Protection Act for liquid waste treatment systems, water discharge systems, and sewers.[16] Thus, the State plays an important role in siting sewage treatment plants.

The U. S. Environmental Protection Agency, State, counties, and municipalities work together to determine the need for sewage treatment plants in Delaware and to select the most suitable sites. Section 303(e) of the Federal Act requires that each State have a continuing planning process which includes "an inventory and ranking, in order of priority, of needs for construction of waste treatment works required..." to meet State water quality standards for streams and water quality related effluent limitations for point source discharges.[17]

That inventory and priority ranking serves as a basis for the siting of sewage treatment works in Delaware under the Coastal Management Program. Much information has been compiled under the section 208 planning process. For example, New Castle County's Areawide Waste Treatment Management Program has not only inventoried sewage treatment plants, but has also evaluated municipal treatment facilities, major interceptor systems, domestic treatment facilities, and private non-domestic treatment facilities.[18] In fiscal year 1977, the State completed the 1976 municipal needs survey for wastewater treatment facilities in Delaware.[19]

The section 201 planning areas have also been identified and mapped by DNREC.[20] In New Castle County, the Non-Regional Sewer System Area has been divided into 4 planning areas, namely: North St. Georges; Port Penn; Middletown-Odessa; and Townsend.[21] The Kent County Non-Regional Sewer System Area consists of 2 planning areas, Kenton and Marydel.[22] In Sussex County, there are 11 planning areas, including the: Bridgeville-Greenwood Area; Seaford-Blades Area; Laurel-Bethel Area; Delmar Area (Delaware and Maryland); Georgetown Area; Millsboro Area; Frankford-Dagsboro Area; Selbyville Area; LeCato Regional Area; South Coastal Regional Area; and the Milton Area.[23]

In some of those areas, regional wastewater treatment plants have been built and are in operation. In others, construction is underway or final plans for construction have been approved by the State and grant money committed by the U. S. Environmental Protection Agency. In addition, DNREC has developed and published the fiscal year 1978 priority list for construction grants. That list ranks 84 projects with a total estimated cost of nearly $80 million.[24]

2. impacts of sewage treatment plants

The environmental impact of sewage treatment plants is a function of plant design and operation, as well as the nature of the surrounding environment. Plants which use spray irrigation to dispose waste materials obviously affect resources differently than ones which burn them or discharge treated waste into water bodies.

Spray irrigation systems impact soils and vegetation as a result of water and nitrogen application to the land.[25] Resting periods are sometimes necessary to maintain aerobic conditions and restore soils surface activity. Existing vegetation is often replaced. Animal life, as well as historic and archeological sites, may also be displaced. Wastewater may percolate past the root zone of the irrigation area and ultimately reach the groundwater table.[26] If the soil is not particularly permeable, surface runoff may occur. Aerosols, with unknown effects on human health, may drift from the spray before they reach the soil or vegetation.[27] Noxious odors may further degrade air quality.

Odors may also emanate from sewage plants which either burn the waste or discharge it into a water body. The former type of plant may degrade air quality in other ways as well.[28] The impact of wastewater discharged through an outfall pipe depends largely on the characteristics of the receiving waters, including size, flushing properties, and so on.

The ocean, of course, possesses tremendous assimilative capacities. However, there are limits and ocean disposal of sewage sludge has caused increasing concern. Both Philadelphia and Camden, New Jersey have been permitted by the U. S. Environmental Protection Agency to dump massive quantities of sewage sludge at a site 35 miles due east of the Delaware-Maryland border. U. S. Environmental Protection Agency biologists have discovered that heavy metals have accumulated in both benthic organisms and sediments, and that apparent changes in biotic communities, including mortality, have occurred in the vicinity of the sewage sludge dumpsite.[29] The U. S. National Marine Fisheries Service and the Delaware Coastal Management Program oppose the current dumping activities at this site.[30] The Coastal Management Program also has adopted the following policy with respect to ocean dumping outside the State's territorial waters:

> THE USE OF THE OCEAN AS A SITE FOR THE DUMPING OF LARGE QUANTITIES OF SEWAGE SLUDGE AND OTHER MATERIALS WHICH MAY ADVERSELY AFFECT RESOURCES, INCLUDING FISHING AND RECREATIONAL RESOURCES, IMPORTANT TO THE STATE OF DELAWARE AND THE NATION IS INCONSISTENT WITH THE COASTAL MANAGEMENT PROGRAM AND SHOULD NOT BE PERMITTED.

Regardless of the type of facility or the point of discharge, the construction of sewage treatment plants may create temporary local air quality problems caused by heavy equipment operation, vehicular traffic, and wind.[31] Longer and more pervasive effects, of course, result from physical occupation of the land by the plant, access roads, sludge dumping sites, sewer interceptors, and so forth. If the sewage system is sited in a floodplain, storms can cause overflowing. Raw sewage is then deposited on land and in streams until the system can be cleaned out and put back on line.

The long-range secondary impacts of sewage treatment plants are frequently more serious than the direct impacts. The decision to extend sewerlines into previously undeveloped areas opens up large amounts of land for residential development.[32] Such development helps pay for the system, but, tends to: degrade air quality because of increased traffic; create runoff and erosion problems due to construction activities, roads, parking lots, and so forth; and encroach on agricultural lands, recreational areas, forests, wildlife habitats, or any other resource which "makes way" for development.

The Delaware Coastal Management Program has analyzed some of the problems caused by sewer extensions in a paper entitled Planning and Fiscal Implications of the Municipal Wastewater Treatment Grant Program.[33]

B. Desalinization plants

Seawater is a virtually inexhaustible supplementary supply of water. Removal of salt from water could provide many areas of the country with new water sources for drinking, agricultural practices and other purposes. The Congress acknowledged this potential as long ago as 1952, when the saline water conversion program was originally authorized.[34]

Water desalinization is now employed in many parts of the world, but it is more expensive than existing wastewater renovation processes because of higher fuel and construction costs.[35] It is used in some areas, including parts of Florida, Oklahoma, Arizona, California and in the American Virgin Islands, where shipping or piping of freshwater would be even more costly.[36]

Although Delaware does have water quality and quantity problems, the State's water supply situation is not such that a desalinization plant would be cost-effective. The cost of transporting desalinated water from a saline conversion plant in Delaware to other regions of the country would likewise be prohibitive. Thus, the siting of a desalinization plant in Delaware's coastal zone would not serve the national interest now, or in the foreseeable future.

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CONCLUSION

The importance of clean water to the Nation and the State--especially with respect to health, recreational activities, and fish and wildlife--gives the resource a prominent status in the Coastal Management Program. The siting of all facilities must meet certain minimal criteria which guarantee that water quality will be maintained at a high enough level to support the activities identified in the Federal Water Pollution Control Act and the Coastal Management Program as important to the country and the State. The importance of clean water to health is obvious and uncompromising. The significance of the State's recreational facilities--to the Nation and the State--and their dependence on clean water are described in several sections of the paper and the program document. The same is true of fish and wildlife.

Strictly speaking, the authority used to implement the Coastal Management Program's water control policies does not necessarily preclude the siting of any facility which may be in the national interest. For example, an oil refinery designed to meet the various State water quality standards would not be excluded on the basis of the Coastal Management Program water policies alone. However, the concern for water quality is among the considerations for the exclusion of oil refineries and a few other specified facilities in that portion of the State where water quality is deemed especially important, namely the coastal strip. That strip, as the paper explains, is particularly significant because of its recreational and natural value. Thus, the Coastal Management Program provides safeguards not otherwise assured by water quality standards and fallible operation procedures.

While it is perhaps impossible to state with certainty that the recreational and natural values of the coastal strip are more crucial to the Nation or the State than the values of the prohibited facilities, several factors--discussed in the energy section--compel the Coastal Management Program policy. First, the prohibited facilities can generally be accommodated in less critical areas. Two, it is not always clear that new facilities are in the national interest. Three, the resources receiving protection are unique, valuable and sensitive. Because of Delaware's size, their importance to the State overshadows even their importance to the Nation.

Like water, air is given deference in the Coastal Management Program. The siting of all facilities must meet minimum air quality standards. In the case of some power plants, oil refineries, and other heavy air polluters, the air quality in a given region may preclude the siting of the facilities. Delaware's air quality is generally good, however, and it is anticipated that all facilities can be accommodated in several locations.

Air quality considerations dominate facility siting in the Coastal Management Program primarily because of its importance to health. Ultimately human health is the Nation's and the State's most important resource, and one not to be traded for any facility--especially when alternatives are available.

Another resource deemed too worthy to trade is wetlands. That program decision, based on much well reasoned input--including that of the President's--is not tantamount to deciding that wetlands are more important than, for example, power plants. Instead it simply means that the program recognizes that power plants--or other facilities--can be built in less fragile and vital areas. Thus the program decision is that wetlands in Delaware are more important that power plants in Delaware wetlands, but the program acknowledges that the national interest in power plants--or other facilities--is enormous and must be accommodated somewhere.

Wetlands are accorded preferential treatment because of their unique value, as outlined in the wetlands section of the paper and the program document. No other portion of land or water, or combination thereof, on Earth can compare with the natural value of wetlands. Their importance to fish alone might be reason enough to prohibit their despoilation. Because the resource is typically located in areas under intense developmental pressure, the Nation and the State have already lost vast amounts of the limited resource. The Coastal Management Program is determined that those wetlands which have survived in Delaware continue to survive.

The survival of fish and wildlife, of course, is also important. The protection of the water, air, and wetlands is only one measure taken by the program to preserve a place for other life. Federal, State and private land acquisition programs also guarantee that a certain amount of space is set aside for that purpose. Much of the space in Delaware, of course, is wetlands, which is preserved for other reasons as well. The remaining area is scattered throughout the State, and does not comprise a large enough area to preclude the Delaware siting of any facility.

When the location selected for a facility is in an undeveloped area, wildlife habitat is normally lost. The

Coastal Management Program permits such losses because of the national, regional and State interest in certain facilities, and also because other protected areas guarantee that the losses cannot exceed certain acceptable parameters.

The Coastal Management Program also generally permits the siting of facilities in forested areas. The State-owned forests comprise only a small portion of forested land in Delaware. Thus, the private owners of timberland control--and may sell for development--most of the State forest areas which may be needed for facilities. The program policy does not underestimate the value of trees, but rather recognizes that the projected available cut for all timber in the State through the year 2000 leaves a comfortable margin for the losses new facilities may incur.

The Coastal Management Program also adopts pretty much of a "laissez-faire" attitude towards a potential "facilities-mineral resources conflict." Much effort has been expended prior to and during program development to make certain that mineral resources valuable to the State and the country are not being wasted, but the program policy that the market place best determines the highest value of lands containing minerals resources is rationale. If the value of sand and gravel in an area is great enough, for example, the price of that area will be high enough to preclude the siting of a facility. If the mineral resources are not so valuable, facility construction may reasonably proceed.

That reasoning, of course, cannot be applied equally to other resources. The wetlands owner, for instance, cannot capture as much money from his property in its natural state as he can by selling it for development. The value to the public--as wildlife habitat, buffer zone, and so on--is not considered if facilities are sited purely according to the principles of free enterprise.

The Coastal Management Program policy on prime farmland lies somewhere between that for wetlands and lands with mineral resources. Although the program does not regulate farmland to the extent that wetlands are controlled, it does actively advise and otherwise assist farmers to manage the resource wisely.

There are at least 3 reasons why the program permits the siting of facilities in prime farmland. One, the national and regional energy problems seem more critical at this time than do food supply problems. Likewise, the needs served by other facilities discussed in the paper are generally more pressing than requirements for agricultural space. The Nation still has vast areas committed for food production, and no national food shortages are foreseen. Two, the high net income of Delaware farmers and various tax incentives act as constraints on the rapid loss of prime

farmland. Three, and very importantly, the rate of farmland loss will be monitored closely during program implementation to ascertain whether the constraints are working and what remedies, if any, are needed. Given the national and State importance of many of the facilities, it is likely that regulatory attempts to limit the loss of farmlands will first be directed towards prohibiting the conversion of such land for uses less essential than, for example, energy facilities.

Floodplains are another resource over which the Coastal Management Program exerts only indirect controls. The federal and local governments are working together in a program of floodplain management which at present seems to need no new partners. The regulation of facilities in floodplains is therefore left to the discretion of local government, provided such government considers the national interest in the facility.

The floodplains policy recognizes 3 important facts. One, most facility siting decisions will avoid the hazard of a floodplain location if possible. Utility companies, for example, are unlikely to want to build a new power plant where it may be flooded. Two, the floodplain may, under exceptional circumstances, be the most logical location for a specific facility. Thus the policy requires enough flexibility to permit exceptions. Three, once the federal-local government programs have had an opportunity to succeed, the Coastal Management Program will be in a better position to determine whether another layer of governmental control is necessary.

Coastal erosion problems and policies are detailed in the program document. The Coastal Management Program oversees facility siting decisions which may result in coastal erosion. Again it is unlikely that a facility of national importance will require a site which is deemed unsuitable by the Coastal Management Program solely on the grounds of a coastal erosion problem. In many cases, a slight setback from the shore will eliminate potential erosion problems.

Problems of preserving historic sites and areas of unique cultural significance are handled directly and indirectly. The State Division of Historical and Cultural Affairs identifies and explains the importance of the sites and areas, and suggests ways of protecting them. Various environmental laws reduce the threat of despoilation by oil spills, air contaminants, and so on. The Coastal Zone Act, which protects the coastal strip from heavy industrial development, is particularly important inasmuch as the State's ocean and bay coastline comprise some of Delaware's most significant historical areas.

The Coastal Management Program does not preclude the siting of facilities in important historical or cultural

areas, as long as the decision to do so is made with knowledge of the consequences. That policy recognizes the national interest in sites for the facilities discussed in the paper, and also that the current program is successfully preserving the State and national heritage without regulatory authority.

The Coastal Management Program policy on defense facilities does not exempt such facilities from Coastal Management Program regulations, as per one suggestion submitted during program development. That policy is consistent with the spirit and letter of the Coastal Zone Management Act, the Federal Water Pollution Control Act, the Clean Air Act, Executive Order No. 11752--standards for the construction and operation of federal facilities--and Executive Order No. 11990--wetlands. Given the U. S. Department of Defense's authority to avoid those provisions if the national security warrants such avoidance, the Coastal Management Program works no hardship.

The imposition of environmental safeguards on the design, construction and operation of aerospace facilities likewise causes no insurmountable difficulty--particularly because there is not apparent need for a Delaware site to accommodate such facilities.

The same cannot be said of many energy facilities because several uncertainties make it difficult to estimate the future need for such facilities in the State. There is no doubt, though, that several energy facilities pose potential or actual problems for resources. The Council on Environmental Quality says, on page 109 of its 6th Annual Report, that "the production and consumption of energy probably influence environmental quality more than any other activities of our society." Unfortunately many of the facilities needed to produce, process or transport energy not only influence environmental quality generally, but also because they are frequently at least somewhat coastal dependent, endanger the Nation's most fragile and vital resources.

In Title 7, Chapter 70 of the Delaware Code, Delaware's General Assembly finds that "the coastal areas of Delaware are the most critical areas for the future of the State in terms of quality of life in the State." As the paper points out, the State's coastal areas are also critically important national resources. The relative quantity and quality of State wetlands, for example, are unsurpassed in the Mid-Atlantic region. In addition, the State's beaches are an important national recreational resource. Although air and water quality standards adopted and enforced pursuant to federal statutes help protect the critical coastal resources of the State, they cannot prevent the catastrophic events which may be precipitated by the siting of certain energy facilities. Indeed, the

enactment of the Coastal Zone Management Act is one indication that the Congress is not satisfied that air and water quality programs adequately protect coastal resources.

Delaware's Coastal Management Program adopts the necessary additional protective measures. At the same time, it accommodates the national interest in the siting of those energy facilities deemed most critical to the Nation and which may, of necessity, impinge on Delaware's resources. Thus, for example, the Coastal Management Program permits oil and gas pipelines through its environmentally sensitive coastal strip, in part, because such pipelines offer the shortest route and there may be no economically viable alternative. It also permits, with stringent precautions, the deployment of oil and gas rigs in the Delaware Bay in order to relieve acute national oil and gas shortages. It supports OCS development for the same reason. Finally, all types of power plants are accommodated.

The Coastal Management Program also provides for the inland siting of facilities which are unsuitable for coastal locations. As the paper points out, oil refineries have been recommended for inland sites by a number of commentators. Delaware's Coastal Management Program follows those recommodations. It also discourges heavy industrial development in the coastal strip by requiring the inland siting of other energy facilities which may induce such development.

Thus, the Coastal Management Program protects the State's and the Nation's vital resources as much as possible without unduly hampering national energy objectives. LNG facilities are the only facilities not in some fashion supported by the Coastal Management Program, and that policy may serve the national energy interest inasmuch as it discourages reliance on foreign imports. There is little doubt that it promotes the national interest in health, safety, and resource preservation.

There is also little doubt that the State recreational facilities merit the extra precaution taken in the regulation of the coastal strip. Delaware's beaches and parks serve the vast megapolis from Washington to New York, an area with somewhat limited outdoor recreational facilities. The Mid-Atlantic region is one of the most densely populated areas in the country. With swimming the Nation's favorite outdoor recreational pastime and other water-related sports not far behind, the importance of Delaware's recreational facilities takes on added significance. Moreover, the current demand for outdoor recreational opportunities may be far from the peak it will reach in the next few decades.

The Coastal Management Program acknowledges that the heavy use of the State's beaches and other recreational

facilities imposes burdens on other resources, but attempts to accommodate as many visitors as possible without seriously reducing the quality of the recreational opportunities. That policy recognizes that there is a very strong national interest in providing recreational facilities, as well as a State interest in promoting tourism.

Transportation facilities--including highways, railways, airports, ports, and aids to navigation--help promote tourism, as well as other interests of national concern. The Coastal Management Program incorporates several planning efforts which consider both the national interest in transportation facilities and the environmental consequences of such facilities. The program encourages transportation policies that meet national and State needs while minimizing adverse impacts. The promotion of the Port of Wilmington is one example.

In many cases, of course, the siting of transportation facilities is inconsistent with resource preservation. New highways, railways or airports typically disrupt natural areas. The Coastal Management Program allows such disruption if it does not exceed limits specified by the resource preservation policies. Thus it is conceivable that prime agricultural land could be lost to a new highway, while loss of wetlands for the same purpose would not be allowed. That result reflects a greater concern for the latter resource, and affirms the importance of adequate transportation systems to the Nation and the State. However, the program policy permitting new transportation facilities where needed, even if these adversely impact certain resources, also recognizes 2 facts. One, the planning process which is responsible for the siting of new transportation facilities considers resource preservation and can usually mitigate potential impacts. For example, before a new highway is built, the historic and cultural features of the proposed and alternative routes are considered and protected, if possible. Two, the State transportation system is unlikely to require many new sites. Although existing highways, railways, airports, and ports may be upgraded, such improvements will not impact resources to the extent that altogether new facilities would.

Finally, the Coastal Management Program provides for siting of regional water treatment plants, with the close cooperation of the U. S. Environmental Protection Agency. Such siting involves direct trade-offs between the protection of one resource--water--and the possible degradation of other resources, for example, air. The high priority accorded water quality in the Coastal Management Program reflects the State's long and pervasive reliance on that resource. It also reflects careful consideration of the national interest--in water, other resources, and facilities.