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NEW JERSEY TURNPIKE AUTHORITY

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Governor Alfred E. Driscoll Expressway





Environmental Impact Statement





NEW JERSEY TURNPIKE AUTHORITY

SEPT. 1972

ALFRED E. DRISCOLL, CHAIRMAN
ROBERT J. CITRINO, JR., VICE CHAIRMAN
ANGUS M. HARRIS, TREASURER
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WILLIAM J. FLANAGAN, EXECUTIVE DIRECTOR
LILLIAN M. SCHWARTZ, SECRETARY

NEW JERSEY TURNPIKE AUTHORITY

(201)247-0900 NEW BRUNSWICK, N.J. 08903

November 10, 1972

Mr. Robert Halsey
Director, Planning Board
Monmouth County
Hall of Records
Freehold, New Jersey

Dear Mr. Halsey:

We are pleased to send you a copy of the draft Environmental Impact Statement for the Toms River Extension. The statement is being transmitted well in advance of the public hearing so that there will be ample time for you to review it.

We have also enclosed a schedule giving information about the informal preview and the public hearing in each county. Each hearing will be devoted primarily to the county in which the meeting is held.

The informal preview should provide an opportunity to discuss the project with representatives of the Turnpike Authority and to inspect the exhibits that will be presented at the public hearing.

Written statements and other exhibits in place of, or in addition to oral statements may be submitted to the Turnpike Authority at the hearing or at any time within ten days after the hearing for inclusion into the record.

Very truly yours,

William J. Flanagan

William J. Flanagan
Executive Director


CRANES CREST

SCHEDULE FOR PRE-HEARING EXHIBIT DISPLAY AND PUBLIC HEARINGS

OCEAN COUNTY

Pre-hearing exhibit display (Dover Township Municipal Building)

Monday	November 13, 1972	8:00 P.M. County & Municipal Officials
Tuesday	November 14, 1972	8:30 A.M. to 4:30 P.M.
Wednesday	November 15, 1972	8:30 A.M. to 4:30 P.M.
Thursday	November 16, 1972	8:30 A.M. to 4:30 P.M.
Friday	November 17, 1972	8:30 A.M. to 4:30 P.M.
Saturday	November 18, 1972	8:30 A.M. to 4:30 P.M.

Public Hearing - Toms River North High School
Wednesday - December 13, 1972 - 7:30 P.M.

MONMOUTH COUNTY

Pre-hearing exhibit display (Freehold Township Municipal Building)

Monday	November 20, 1972	8:00 P.M. County & Municipal Officials
Tuesday	November 21, 1972	8:30 A.M. to 4:30 P.M.
Wednesday	November 22, 1972	8:30 A.M. to 4:30 P.M.
Saturday	November 25, 1972	8:30 A.M. to 4:30 P.M.
Monday	November 27, 1972	8:30 A.M. to 4:30 P.M.
Tuesday	November 28, 1972	8:30 A.M. to 4:30 P.M.

Public Hearing - Manalapan High School
Tuesday - December 12, 1972 - 7:30 P.M.

MIDDLESEX COUNTY

Pre-hearing exhibit display (Old Bridge First Aid and Rescue Squad)

Wednesday	November 29, 1972	8:00 P.M. County & Municipal Officials
Thursday	November 30, 1972	8:30 A.M. to 4:30 P.M.
Friday	December 1, 1972	8:30 A.M. to 4:30 P.M.
Saturday	December 2, 1972	8:30 A.M. to 4:30 P.M.
Monday	December 4, 1972	8:30 A.M. to 4:30 P.M.
Tuesday	December 5, 1972	8:30 A.M. to 4:30 P.M.

Public Hearing - Cedar Ridge High School
Thursday - December 14, 1972 - 7:30 P.M.

November 1, 1972

Governor Alfred E. Driscoll
Chairman
New Jersey Turnpike Authority
Administration Building
New Brunswick, New Jersey 08903

Re: Governor Alfred E. Driscoll Expressway
Environmental Impact Statement

Dear Chairman Driscoll:

In May 1972, the citizens of New Jersey, by formal action of their elected representatives, instructed the New Jersey Turnpike Authority to proceed with the planning, design and construction of a limited access highway through Ocean, Monmouth and Middlesex Counties. This new 35-mile multi-lane roadway, formally designated the Governor Alfred E. Driscoll Expressway, will extend from a point about 1,500 feet south of the state police barracks on the Garden State Parkway in Dover Township, Ocean County, Mile Post 0, to a northern terminus at the New Jersey Turnpike in South Brunswick, Mile Post 35.5. A two-mile portion of the Route 9 - Garden State Parkway free section from a point about 1,200 feet south of Dover Road to where the Expressway begins will be widened.

A major consideration in this endeavor is the impact that such construction may have on the existing environment and on the quality of life along the route of the proposed Expressway. The New Jersey Turnpike Authority has always been cognizant of its responsibility for the preservation of the environment. Prior to the authorizing legislation, the Authority had assembled a team of expert consultants who have been engaged in an evaluation of the potential environmental effects of the new highway. The attached report contains the findings of that evaluation.

Based on this evaluation, we have not identified any significant damage that might occur to the environment as a result of the proposed Expressway. Further, appropriate safeguards and controls can be included in the design and implemented during construction so that the Governor Alfred E. Driscoll Expressway will actually enhance and improve many areas through which it traverses.

We appreciate the opportunity of having been associated on this project and look forward to the successful completion of this major transportation facility.

Very truly yours,

Howard, Needles, Tammen & Bergendoff
Bolt Beranek and Newman, Inc.
Coverdale & Colpitts, Inc.
Environmental Research & Technology, Inc.

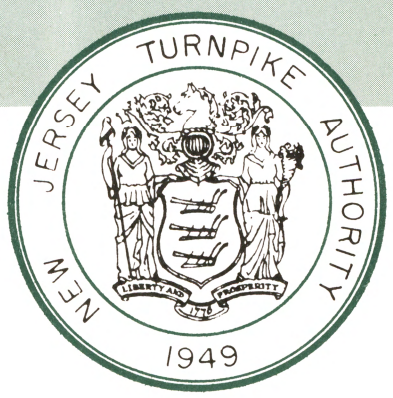
Attachment

Governor Alfred E. Driscoll Expressway

NEW JERSEY TURNPIKE AUTHORITY

ALFRED E. DRISCOLL ..... *Chairman*
ROBERT J. CITRINO, JR. ..... *Vice Chairman*
ANGUS M. HARRIS ..... *Treasurer*
WILLIAM F. TAGGART ..... *Commissioner*
FREDERICK M. ADAMS ..... *Commissioner*

WILLIAM J. FLANAGAN ..... *Executive Director*
DAVID W. DOWD ..... *General Counsel*
LILLIAN M. SCHWARTZ ..... *Sect.-Ass't. Treasurer*





Governor Alfred E. Driscoll Expressway

SECTION I

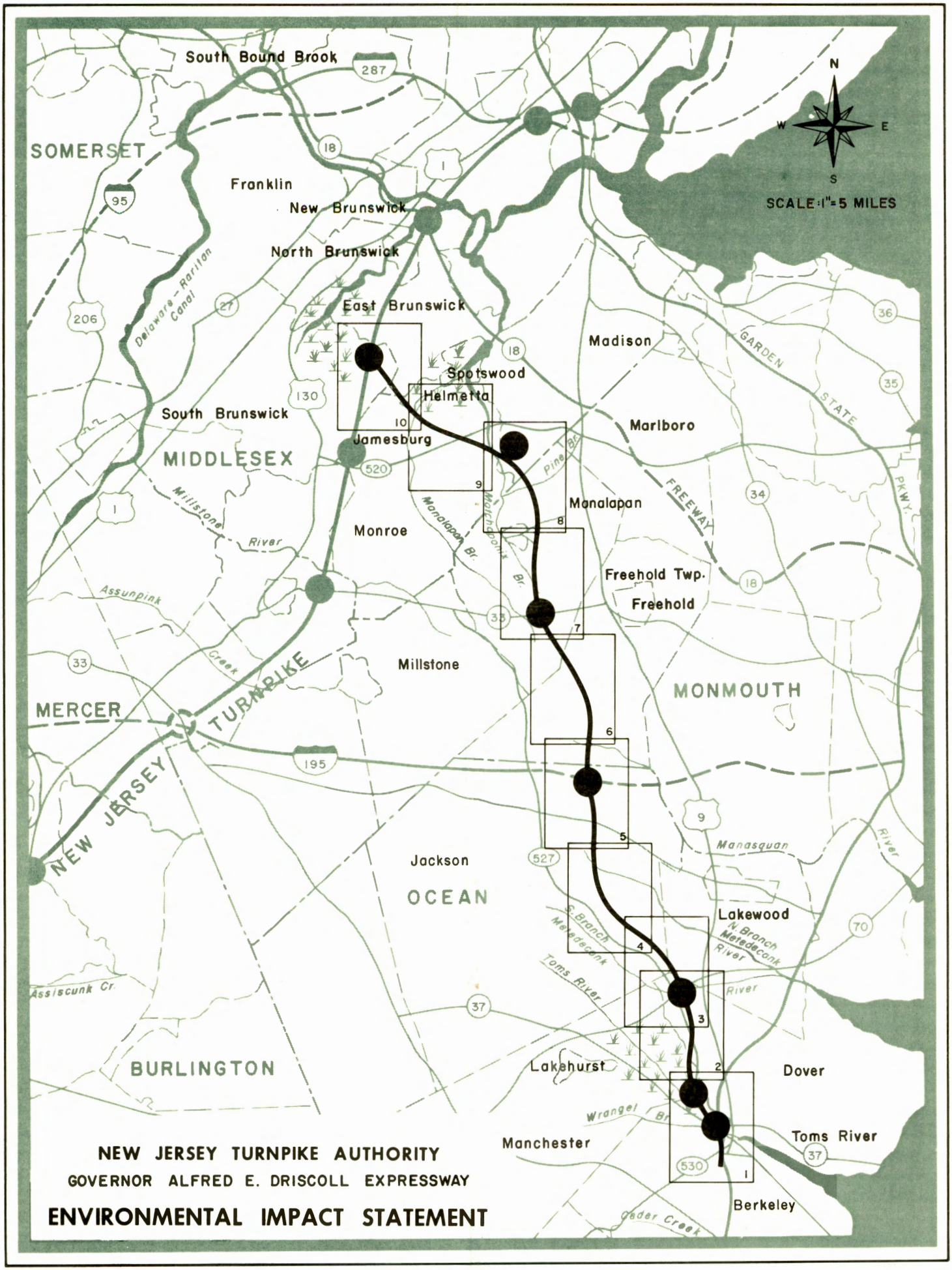
INTRODUCTION

A. General Description of the Project

B. Reason for the Project

C. Environmental Study Areas and Consultant Responsibility

D. Status of Required Licenses, Permits and Approvals



NEW JERSEY TURNPIKE AUTHORITY

GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

A. GENERAL DESCRIPTION OF THE PROJECT

The proposed Governor Alfred E. Driscoll Expressway is planned as a four-lane, high speed, limited access highway encompassing all of the latest techniques in engineering design and construction. More important, operational safety features and other patron considerations will be primary objectives in the design. Smooth, easy alignment, gentle curves and flat gradients will enable patrons to travel the proposed route with minimum expenditures of both time and effort. The highway right-of-way will be carefully and completely landscaped to minimize any community intrusion and maximize preservation of the existing environment. When complete, the Expressway will provide a vitally needed transportation corridor for south and central New Jersey.

The Expressway has its southerly origin at Mile Post 0, a point 6,000 feet south of the state police barracks, located on the free section of Route 9 - Garden State Parkway in Dover Township, Ocean County. The free section of the Route 9 - Garden State Parkway will be widened from a point 1,200 feet south of Dover Road (Route 530) to where the Expressway begins, approximately 2 miles. In this section, an additional lane in each direction will be constructed in the existing median between Dover Road and Route 37. This will be accomplished wholly within present right-of-way without additional property acquisition. North of Route 37 for an additional mile, lanes will be added to effectively create an eight-lane parkway section which will alleviate present traffic congestion.

North of the two-mile improvement of the Garden State Parkway, the Expressway will occupy an entirely new corridor. Generally parallel to and west of Route 9, the new roadway will traverse a northwesterly alignment, terminating at the existing New Jersey Turnpike in the Township of South Brunswick. Slightly over 35 miles in overall length, the Expressway will be served by interchanges to be constructed at seven locations along the route.

There are many notable engineering features that will be incorporated into the new facility. A wide variable median will be constructed to allow for separated roadways and pleasing aesthetics. Full 12-foot shoulders adjacent to the main roadways will allow for vehicle break-down and repair. These shoulders will be carried over bridge structures without interruption. Where appropriate and possible, existing vegetation within the right-of-way will be carefully preserved and made a part of the final design. The completed Expressway will provide a pleasing, functional and economically sound addition to the southeastern part of New Jersey.

B. REASON FOR THE PROJECT

Stretching between two broad rivers on a direct path between New York and Philadelphia, New Jersey's location has been both its vigor and the source of much of its transportation difficulties since Colonial times. In a century or more, no state has carried a greater volume of rail or motor traffic on its transportation arteries.

Densely developed and heavily populated in its northeastern section, growth patterns in New Jersey are shifting toward the central and southern parts of the state. Rapid suburban development is being accompanied by increasing recreational demands. New Jersey still abounds with streams, lakes and mountains. Nearly half the state is still forested. With such geographical features, New Jersey can offer unspoiled plant and animal life, scenic views and miles of seashore to explore by automobile and on foot. Primarily, the New Jersey Turnpike, the Garden State Parkway and Route 9 bear the brunt of the enormous volume of traffic that daily flows through these dynamic areas.

The need for additional access to serve commercial, passenger and mass transit traffic has been apparent for many years. The recreational character of this traffic has long since changed to a mixed demand that continues on a year-round basis. Long ago, the "summer-time" volumes had exceeded all possible capacity of the several available roadways. Intolerable congestion, stop-and-go traffic and unconscionable delays have been too typical of May-October travel. This situation now extends virtually to an all-year travel pattern.

The Governor Alfred E. Driscoll Expressway is planned to meet these needs in a growing, vital area of New Jersey. The problem is real and relentless. To delay meeting it is to sentence these areas to continuing inconvenience and increasing traffic congestion.

C. ENVIRONMENTAL STUDY AREAS AND CONSULTANT RESPONSIBILITY

The New Jersey Department of Environmental Protection has stated in its guidelines for the proposed Governor Alfred E. Driscoll Expressway that the environmental impact statement "shall provide the information needed to evaluate the effects of a proposed project on the environment".[1] In order to prepare an environmental impact statement to meet these requirements, the New Jersey Turnpike Authority engaged several consultants, each expert in one or more of the areas under consideration, to fully study and report upon the environmental impact of the Expressway. The consultants' conclusions and recommendations constitute this draft environmental impact statement on the Governor Alfred E. Driscoll Expressway. The environmental study areas for which each consultant assumed responsibility are outlined below.

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[1] Guidelines for Environmental Impact Statement, New Jersey Turnpike Extension, New Jersey Administrative Code, Title 7, Chapter 1A.

The firm of Howard, Needles, Tammen & Bergendoff was responsible for the following areas of study:

1. Project description, including:
   a. Reason for the project
   b. Recommended right-of-way alignment mapped and described

2. Alternatives to the proposed project
   a. Alternative right-of-way alignments mapped and described
   b. "No project" alternative described

3. Any probable adverse environmental effects which cannot be avoided, including:
   a. Aesthetic values
   b. Displacement of people and businesses
   c. Destruction of man-made resources
   d. Health, safety and well-being of the public

4. Steps to be taken to minimize adverse environmental impacts on:
   a. Aesthetic values
   b. Displacement of people and businesses
   c. Destruction of man-made resources
   d. Health, safety and well-being of the public

The firm of Bolt Beranek and Newman, Incorporated, was reponsible for the following areas of study:

1. Any probable environmental effects of noise which cannot be avoided, including:
   a. Location and intended use of noise sensitive areas and buildings within a mile of the Expressway corridor, e.g., park areas, residential areas, schools, hospitals, churches
   b. Estimation of ambient noise levels prevailing in the various areas along the corridor
   c. Development of tentative noise criteria for the different land use and noise sensitive buildings along the corridor
   d. Development of initial estimates of toll road noise based upon projected traffic volumes, car-truck mix and roadway configuration
   e. Comparison of initial noise estimates with tentative noise criteria to determine the potential noise impact of the Expressway

2. Steps to be taken to minimize adverse environmental impacts
   a. Selection of final design criteria for toll road noise based on detailed computation of noise levels in sensitive and critical areas

The firm of Coverdale and Colpitts, Incorporated, was responsible for the following areas of study:

1. Project description, including:
   a. Existing land use, zoning and master plan delineation of project area mapped and described

2. Any probable adverse environmental effects which cannot be avoided, including:
   a. Land use patterns
   b. Displacement of viable farms
   c. Employment and property tax
   d. Disruption of community and regional growth

The firm of Environmental Research & Technology, Incorporated, was responsible for the following areas of study:

1. Project description, including:
   a. Parks, recreational sites, wildlife refuges and historic sites mapped and described
   b. Ambient environmental assets mapped and described

2. Any probable adverse environmental effects which cannot be avoided, including:
   a. Water quality
   b. Air quality
   c. Disruption of significant plant or wildlife systems
   d. Destruction of natural resources
   e. Disruption of community and regional growth

3. Relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity

4. Quantifiable identification of any irreversible and irretrievable commitments of resources which would be involved in implementation of the project

D. STATUS OF REQUIRED LICENSES, PERMITS AND APPROVALS

The general policy guidelines established by the New Jersey State Department of Environmental Protection include a listing of all licenses, permits or other approvals as required by law, and a report on the status of each one.[1] Construction of the proposed Governor Alfred E. Driscoll Expressway will require three permits: New Jersey Law (R. S. 58:1-26) Diversion of Surface Waters of the State for Domestic, Commerical, Industrial, Agricultural and Irrigation Uses and Other Private Purposes; and United States Coast Guard bridge permit.

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[1]Guidelines for Environmental Impact Statement, New Jersey Turnpike Extension, New Jersey Administrative Code, Title 7, Chapter 1A.

N.J. Law (R.S. 58:1-26) requires a State Department of Environmental Protection permit for the installation of any kind of structure or permanent fill-in, along or across the channel or flood plain of any stream within the natural and ordinary high water mark.[1] At the present time, no application for this permit has been submitted to the Bureau of Water Control of the Division of Water Resources for review and recommendations or to the Water Policy and Supply Council for approval.

A United States Coast Guard bridge permit is required for the widening of the existing structure over Toms River.[2] At the present time, an application for this permit is being prepared.

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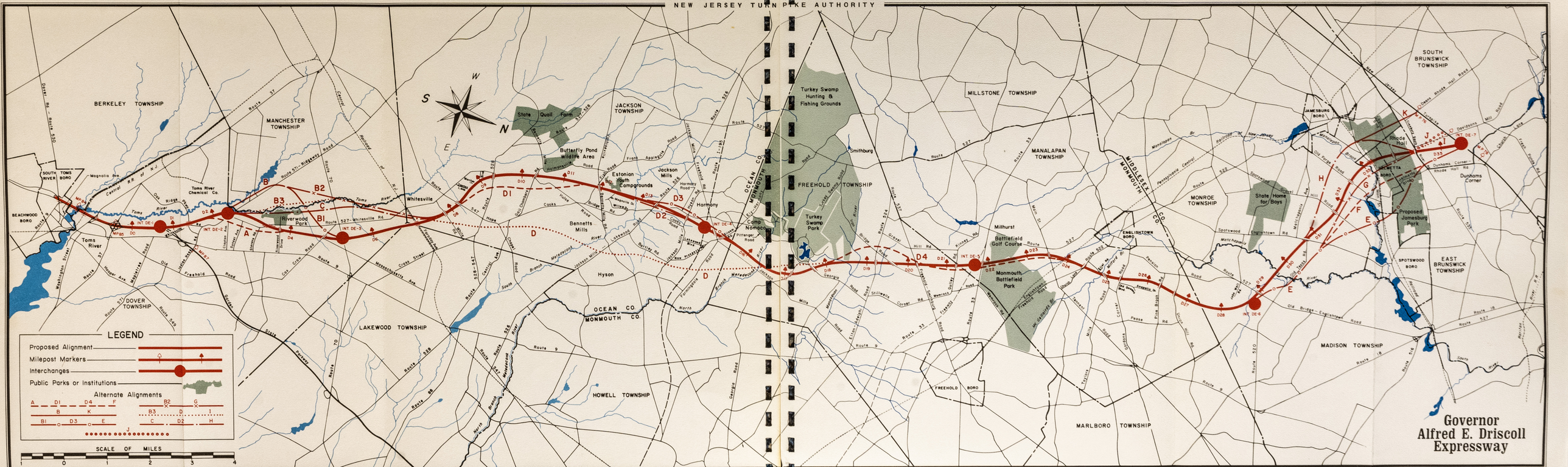
[1]Industrial Building and Equipment (and other) Permits required by the New Jersey State Department of Environmental Protection.

[2]Letter from Capt. G. W. Wagner, U.S. Coast Guard, Chief of Operation Division, July 6, 1972.


NEW JERSEY TURNPIKE AUTHORITY
BERKELEY TOWNSHIP
MANCHESTER TOWNSHIP
JACKSON TOWNSHIP
MILLSTONE TOWNSHIP
MANALAPAN TOWNSHIP
SOUTH BRUNSWICK TOWNSHIP
FREEHOLD TOWNSHIP
MONROE TOWNSHIP
EAST BRUNSWICK TOWNSHIP
MADISON TOWNSHIP
MARLBORO TOWNSHIP
LAKEWOOD TOWNSHIP
DOVER TOWNSHIP
HOWELL TOWNSHIP
BEACHWOOD BORO
SOUTH TOMS RIVER BORO
JAMESBURG BORO
ENGLISHTOWN BORO
SPOTSWOOD BORO
FREEHOLD BORO
OCEAN CO.
MONMOUTH CO.
MIDDLESEX CO.
Toms River
Whitesville
Riverwood Park
Bennetts Mills
Hyson
Harmony
Camp Nomoco
Turkey Swamp Park
Turkey Swamp Hunting & Fishing Grounds
Smithburg
Millhurst
Battlefield Golf Course
Monmouth Battlefield Park
State Home for Boys
Proposed Jamesburg Park
Rhode Hall
Dunhams Corner
State Quail Farm
Butterfly Pond Wildlife Area
Estonian Youth Campgrounds
Jackson Mills
Toms River Chemical Co.
LEGEND
Proposed Alignment
Milepost Markers
Interchanges
Public Parks or Institutions
Alternate Alignments
SCALE OF MILES
Governor
Alfred E. Driscoll
Expressway

SECTION II

SUMMARY OF ENVIRONMENTAL IMPACT STATEMENT

A. Howard, Needles, Tammen & Bergendoff

B. Bolt Beranek and Newman, Inc.

C. Coverdale & Colpitts, Inc.

D. Environmental Research & Technology, Inc.

SUMMARY-PART A

The firm of Howard, Needles, Tammen & Bergendoff was requested to analyze the alignments for the proposed Governor Alfred E. Driscoll Expressway and to study certain environmental impacts which could result from construction of the Expressway. The findings of the study are summarized below.

The aesthetic impacts of the roadway will be primarily visual. A temporary adverse visual impact will be caused by the presence of heavy equipment along the alignment during construction. The other major adverse visual impact will be the right-of-way fences erected for the safety of members of the communities along the Expressway. Landscaping along the fences can minimize this impact. Naturalized landscaping of the areas adjacent to the roadway and the central median will enhance the environment along the Expressway by providing a green belt and open space which will be preserved through other development which may occur in southern New Jersey. This landscaping will also serve to minimize any visual impact of the roadway.

There are no major positive or negative impacts on man-made resources anticipated during or after construction of the Expressway.

When a major expressway is constructed in a populated area, some people and businesses will usually be displaced. The Governor Alfred E. Driscoll Expressway will displace residents of 73 homes and 11 mobile homes. Six active businesses will be displaced, however, two of these businesses are considered eyesores by members of the communities in which they operate. In those two instances, the landscaping which will be provided with the Expressway is welcomed by the affected communities. The roadway will also provide commuters a time-saving artery to work, as the Expressway is a limited access, high speed road.

No negative impacts on the health, safety or well-being of the public are anticipated as a result of the construction, maintenance and operation of the Expressway. The Expressway is designed to minimize monotonous, straight stretches of roadway. Rest areas will provide driving breaks to maintain driver alertness and service areas to maintain safe cars. Emergency services will also be provided along the Expressway to give efficient aid to disabled cars or injured persons. It is anticipated that the limited access Expressway will have a reduced accident rate compared with other non-limited access, high speed highways in New Jersey. In addition, construction of new grade separated intersections between local streets and major highways with the Expressway will result in safer intersections because many of the affected streets and highways were constructed years ago when safety was not a primary consideration in road design.

SUMMARY - PART B

The firm of Bolt Beranek and Newman Inc. was requested to study any possible environmental impacts relating to noise resulting from the construction of the Governor Alfred E. Driscoll Expressway. The findings of the study are summarized below.

In the absence of shielding by structures and terrain, the impact region for residences and parks extends out to 200 feet from the edge of the near traffic lane at the south end of the Expressway, increasing to 300 feet at the north end near the New Jersey Turnpike interchange. Since the right-of-way line is typically about 175 feet from the near lane, the only impact along the south end of the Expressway occurs near interchanges where the accelerating truck traffic expands the impact zone to a distance of 275 feet. Only toward the north end, where the traffic volume increases, do a few residences along the main roadway fall within the noise impact zone. A total of 25 residences, including 10 mobile homes and 15 scattered houses, fall within the noise impact region defined by the proposed Federal highway noise standards.

Less than 15% of three parks and recreation areas are expected to be impacted by the Expressway traffic noise. The noise sensitive areas of all other park and public recreation areas are outside the noise impact region.

For acoustically sensitive non-residential buildings, the impact zone could extend to distances of 400 and 600 feet from the near lane of the Expressway at the south end and north end respectively, depending upon the noise reduction properties of the structures. After acoustic field measurements were made at all acoustically sensitive non-residential buildings within 2000 feet of the Expressway, the Manalapan High School and Taylor Mills School were found to be impacted. Because of the large window areas of these buildings, the open window noise reductions are low, resulting in projected interior noise levels in excess of the proposed Federal standards for interior spaces. Noise shields are planned, however, for the purpose of protecting these schools from noise impact, reducing the impact on non-residential buildings to zero.

The noise levels predicted for the 1976 traffic when the Expressway opens are 4 to 5 decibels lower than the "worst case" 1990 traffic noise levels for which the impact has been assessed. Due to reductions in the noise emissions of individual vehicles over the next 10 to 20 years, it is likely that the noise levels along the alignment will never exceed the 1976 predictions. If vehicle noise levels are reduced by only five decibels, the impact zone as presently defined by the proposed Federal noise standards will not extend beyond the Expressway right-of-way.

A beneficial acoustic improvement from the Expressway is expected as a result of the removal of traffic, especially truck traffic, from local roads. For example, 80 feet or so from Route 9, where the present noise levels are about 70 dBA L_{10}, the noise levels after construction of the Expressway are expected to be 65 dBA L_{10}.

SUMMARY—PART C

The firm of Coverdale & Colpitts, Inc., was requested to study the socioeconomic impact which could result from construction of the proposed Governor Alfred E. Driscoll Expressway. The findings of the study are summarized below.

The study shows that the Expressway will:

- Relieve peak-hour and summer congestion on existing roads, with the greatest impact on US 9.
- Provide the only limited-access route to southeastern New Jersey fully open to trucks.
- Improve highway safety by diverting traffic from existing highways.
- Decrease vehicle operating costs.
- Increase speed and convenience of truck deliveries.
- Have no measurable impact on existing rail service.
- Improve prospects for better commuter-bus service. (Particularly if combined with park-and-ride facilities.)
- Generally increase land values (and tax bases).
- Help maintain high residential growth rates.
- Increase demand for commercial and community service facilities.
- Attract light industry.
- Have a direct impact on less than one percent of viable farms in tri-county area. (Many farms will be converted to higher-valued uses.)
- Provide the opportunity for increase in land committed to permanent green belt areas.

The following conclusions are a result of the study:

- The Expressway is only one of several socioeconomic factors influencing the tri-county area.
- Local zoning laws and ordinances, properly enforced, can control area developments to the satisfaction of most impact area residents.
- Appropriate interdisciplinary planning can maximize the socioeconomic benefits of the Expressway and mitigate undesirable effects.

SUMMARY - PART D

The team of Environmental Research & Technology, Inc. (ERT) in association with David H. Marks, P. E., Jack McCormick & Associates, and Abt Associates was asked by the New Jersey Turnpike Authority to undertake an analysis of certain areas of environmental impact for the proposed Governor Alfred E. Driscoll Expressway. These areas have been broadly defined in our study as air quality, water resources, natural resources, and social and physical resources. This summary provides a brief description of the results of our study.

AIR QUALITY

No adverse environmental impacts on air quality were found by our analyses.

Carbon monoxide concentrations, even under the "worst" conditions, and assuming conservative estimates for background levels, are predicted to be well below the established one-hour standard of 35 ppm for 1976 and 1990. No sensitive receptors will be adversely impacted. Nitrogen oxide concentrations for the annual average case do not exceed standards as a result of the road alone. The data does not presently exist to estimate whether levels <u>including</u> background will exceed standards in 1976.

The hydrocarbon less methane concentrations predicted for 1976 are generally close to the established three-hour standard near the road; the values are an order of magnitude less than conservative estimates for background levels. They are also an order of magnitude less than current levels found simultaneously with oxidant levels which meet the one-hour standard. Only the hydrocarbon levels are anticipated to exceed the Ambient Air Quality Standards and no serious impacts on sensitive receptors have been found.

Regional air quality, particularly in urban areas such as Freehold, Lakewood and Toms River, probably will be improved due to the relieving of traffic on Route 9 and other major roads.

WATER RESOURCES

No major adverse environmental impacts on water resources have been found. Seven local and largely avoidable impacts have been identified, six of these are not route specific. The route specific impact involves the crossing of the South Branch of the Metedeconk River and the area north to Interstate 195. The channelization and filling of wet areas here should be carried out with care to avoid local and downstream changes in hydrologic and quality conditions.

In addition two areas have been identified which are very sensitive in water resources aspects to general development expected in the future of which the Expressway is only a part. These are (1) the proposed Jamesburg Park area, where extremely careful construction practices and supervision are required and are to be employed to guard against highway impacts

and (2) the Manalapan and Matchaponix Brooks, where the contribution of the highway to future impact will be minimal compared to that caused by other development in the area, and where careful planning for all types of development will lead to lessened impact.

NATURAL RESOURCES

Several potentially adverse environmental impacts on natural resources have been identified from the analyses of cranberry bogs and vegetation. The locations of these potential impacts are shown in Figure i. The Beauty Bogs, Iron Bog, and Bunker Hill Bogs in Jackson may be adversely impacted by sedimentation, water pollution, and alteration of water flow as a result of the construction of the proposed alignment. Several steps can be taken to minimize the effects. The possibility of damage from accelerated sedimentation virtually can be eliminated by the use of careful construction practices in this area of low relief. The potential for adverse impact from an alteration in water flow in Sandy Hollow can be minimized by the use of special engineering features as appropriate.

Many areas of low land forest and bog, and one sensitive upland forest, will be impacted severely by the proposed alignment. These types occur primarily in areas in which the alignment parallels streams or passes through extensive lowlands in headwater regions. Consideration should be given to the use of special design and construction techniques in these areas. Many less extensive areas of sensitive vegetation along the alignment could be damaged or destroyed. A variety of special design and construction techniques can be utilized to minimize these impacts.

The analyses of topography, geology, soils, and aquatic life did not identify any specific adverse impacts. Recommendations are made, however, as to sensitive conditions which may warrant special design considerations as a part of the detailed engineering design studies. It is anticipated that there will be certain adverse impacts on wildlife populations along the proposed alignment.

SOCIAL AND PHYSICAL RESOURCES

No major adverse environmental impacts have been found for those social and physical resources studied. An adverse impact was identified for a bird sanctuary in Monroe; however, steps can be taken to minimize this impact. The location of the bird sanctuary is shown in Figure i. Potential secondary impacts warranting detailed analysis during design were found for recreational activities at the Estonian Youth Camp in Jackson and the proposed Jamesbury Park, community social institutions in Manalapan, and compatibility of neighborhood land uses in several areas, particularly Helmetta. In Helmetta continuing efforts are being made to investigate alternative alignments and/or possible steps to minimize potentially debilitating impacts. In general, good design practices should minimize any potential adverse impacts.

Positive impacts were identified in a number of cases, including enhancement of potential open space uses for the Monmouth Battlefield and redefinition of neighborhood boundaries to community benefit in Freehold and Madison.

SECTION III

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

Prepared for the New Jersey Turnpike Authority

by

HOWARD, NEEDLES, TAMMEN & BERGENDOFF

This Section covers the following areas of study:

Recommended Alignment
Alternate Alignment Studies
No Project Alternative
Impact on Aesthetics
Impact on Man-Made Resources
Displacement of People and Businesses
Health, Safety and Well-Being of Public

SUMMARY

The following summary outlines the results of the study prepared by Howard, Needles, Tammen & Bergendoff on certain environmental impacts of the Governor Alfred E. Driscoll Expressway.

I. Impacts on Aesthetics

A. Negative Impacts
1. Visual impact of heavy construction equipment during construction phase
2. Visual impact of right-of-way fences

B. Positive Impacts
1. Landscape areas adjacent to roadway and median to provide green belt and open space
2. Landscape to minimize visual impact of roadway

II. Impacts on Man-Made Resources

A. Negative Impacts - none anticipated
B. Positive Impacts - none anticipated

III. Displacement of People and Businesses

A. Negative Impacts
1. Displacement of residents of 84 houses and mobile homes
2. Displacement of six businesses

B. Positive Impacts
1. Provide time effective route for local commuters
2. Remove unsightly businesses

IV. Health, Safety and Well-Being of Public

A. Negative Impacts - none anticipated

B. Positive Impacts
1. Provide rest areas to maintain driver alertness
2. Provide safety of limited access roadway for high speed travel
3. Improve local streets and major highways at grade separated intersections
4. Provide emergency services for drivers

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CHAPTER I

RECOMMENDED ALIGNMENT

The Governor Alfred E. Driscoll Expressway has its southerly origin at Mile Post 0, a point 6,000 feet south of the state police barracks, located on the free section of Route 9 - Garden State Parkway in Dover Township, Ocean County (see Map 1). However, the improvement will start about 1,200 feet south of Dover Road (Route 530) in Ocean County where Dover Road crosses the Garden State Parkway. Proceeding northward, two twelve-foot lanes will be built in the existing median of the Garden State Parkway to a point about 2,000 feet north of Route 37, Mile Post 0, thereby creating a six lane section.

Between Mile Post 0 and the point at which the alignment leaves the Parkway, two additional twelve-foot lanes will also be constructed, providing for eight lanes in this section. After leaving the Parkway, the Expressway will have two twelve-foot lanes in each direction with a variable median. It will then pass over Oak Ridge Parkway. Proceeding northwest, the route will run between Route 571 and the east shore of Toms River (see Map 2). It will curve to the northeast near Clayton Avenue and cross under Ridgeway Road (Route 571) west of Whitesville Road (Route 527). Route 571 has been relocated to improve traffic movements with Clayton Avenue and Route 527 and to provide an interchange with movements to and from the north. A service road will provide access to areas west of the proposed extension. The Expressway will continue almost due north, crossing over Whitesville Road (Route 527) about 1,000 feet from the intersection of Route 527 and Stevens Road. The route will pass under Riverwood Drive about 600 feet from Route 527 and continue north, almost paralleling Route 527 until it crosses under Cox Cro Road about 200 feet west of Massachusetts Avenue. The Expressway will cross under Route 70 about 1,500 feet west of Massachusetts Avenue with an interchange providing movements to and from the north. Right-of-way will be purchased for future movements to the south. About 2,000 feet north of Route 70, a barrier Toll Plaza will be built where toll tickets will be issued to vehicles going to the north and tolls collected from cars going south.

Continuing northwesterly (see Map 3), the route will cross the west tip of Lakewood Township and pass into Jackson Township. After crossing over the Central Railroad of New Jersey, about 2,300 feet east of Route 527, the alignment will curve toward the west, passing under White Road and Hope Chapel Road (Route 547). The Expressway will curve again to the north (see Map 4), passing under Vanhiseville-Lakewood Road (Route 528) just east of Vanhiseville-Whitesville Road (Route 527). The alignment will pass to the east of the cranberry bogs and Butterfly Pond Wildlife Area and under Fish Road.

Continuing northward (see Map 5), the Expressway will pass to the east of the Estonian Youth Camp Grounds and under Jackson Mills-Lakewood Road (Route 526) a few hundred feet west of Harmony Road. About 1,700 feet of Harmony Road will be relocated. The new intersection of Harmony Road with Route 526 will be about 600 feet west of the present intersection. Continuing northward, the route will pass east of Harmony Cemetery and under Jackson Mills-Hyson Road about 700 feet east of its intersection with Harmony Road. A Toll

Plaza area and interchange with Interstate 195 (I-195) will be in the northeast quadrant of the intersection. Local streets will access the Expressway here. After passing under I-195, the Expressway will cross under Jackson Mills-Freehold Road and Siloam Road about 400 feet west of their present intersection. A service road along the westerly side of the route will provide access to adjacent areas. The route will then enter Freehold Township in Monmouth County just north of Siloam Road.

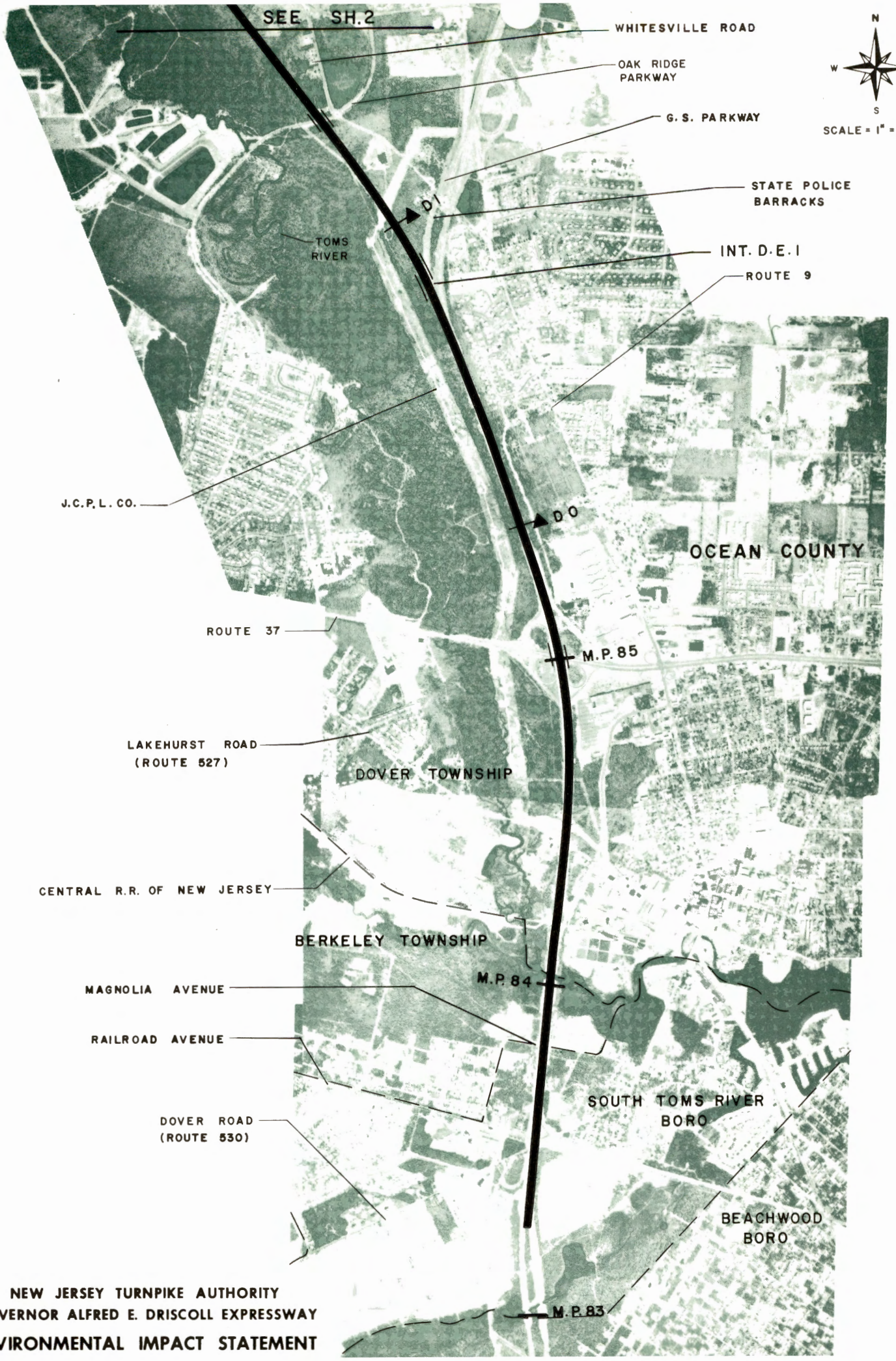
Crossing over a branch of the Metedeconk River (see Map 6), the route will swing gently northwest, crossing under Georgia Road about 1,000 feet east of the entrance to Turkey Swamp Park. After crossing the Manasquan River, the Expressway will pass under Elton-Adelphi Road (Route 524) and Iron Bridge Road. Continuing northwesterly, the alignment will pass under Freehold-Smithburg Road (Route 537) into Manalapan Township.

Passing under Gulley Road (see Map 7), the route will interchange with the proposed Route 33 Freeway and then pass between the Battlefield Golf Course and the Monmouth Battlefield Park. The Expressway will pass under Main Street about 1,000 feet east of Route 527 and over the Pennsylvania Central Railroad. Continuing northward, the route will pass under the Englishtown-Freehold Road (Route 522), several hundred feet west of the Manalapan High School, over McGellairds Brook, and under relocated Taylors Mills Road.

Continuing in a northerly direction (see Map 8), the alignment will pass under relocated Gordons Corner Road about 400 feet east of Taylors Mills School. After crossing under relocated Pine Brook Road and Union Hill Road, the route will continue in a northerly direction into Madison Township in Middlesex County just east of the Drag Strip Raceway. Immediately north of the raceway, the alignment will curve gently in a westerly direction to an interchange with Old Texas Road (Route 520) just east of Route 527.

Crossing under Route 527, the route will continue in a westerly direction (see Map 9), passing over Matchaponix Brook into Monroe Township and under Englishtown Road and Spotswood-Gravel Hill Road.

After passing under Old Forge Road (see Map 10), the route will cross over the Manalapan Brook and into the Borough of Helmetta. After passing over Main Street and the Pennsylvania Railroad, seven hundred feet south of Holy Trinity Church, the route will curve to the north and into East Brunswick Township. The Expressway will pass under Cranbury-South River Road (Route 535), 600 feet east of Davidsons Mill Road and will terminate by interchanging with the existing New Jersey Turnpike just north of Mile Post 77. Davidsons Mill Road over the existing Turnpike will be closed and a new frontage road will be built connecting Davidsons Mill Road to Deans Rhode Hall Road on the westerly side of the existing Turnpike. A small portion of the proposed Ireland Brook Park will be taken to provide connecting ramps between the existing Turnpike and the proposed Governor Alfred E. Driscoll Expressway.



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GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT



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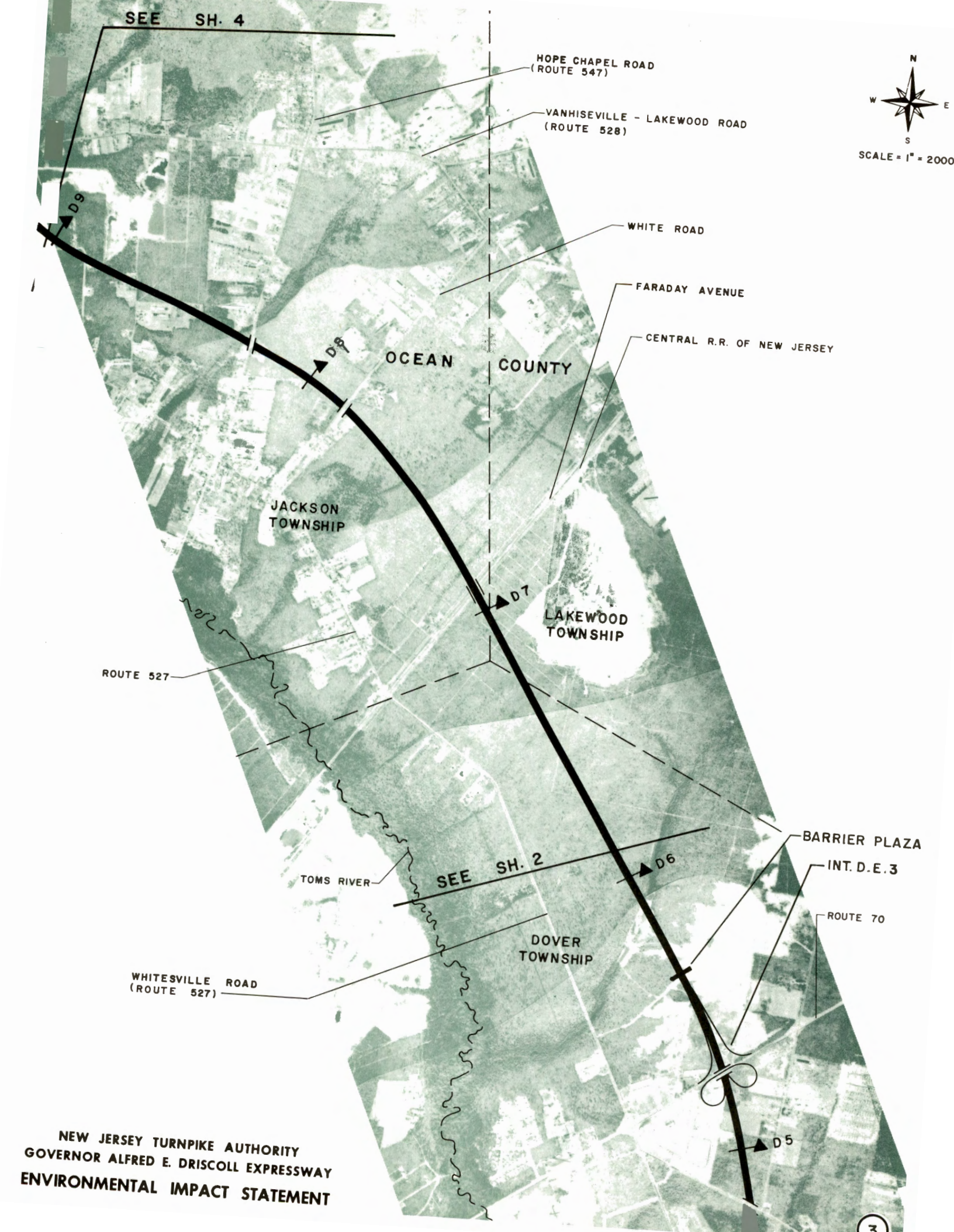

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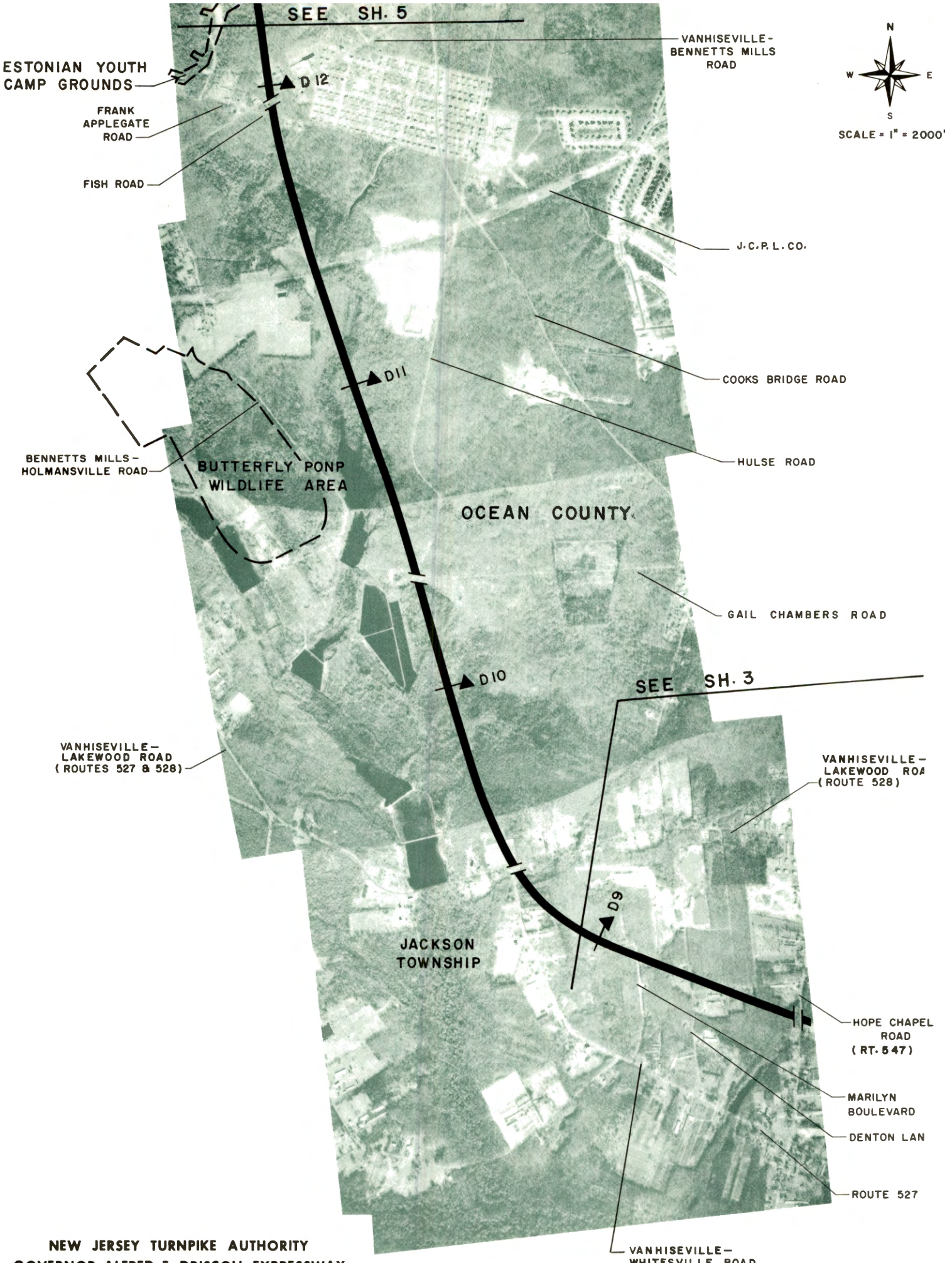

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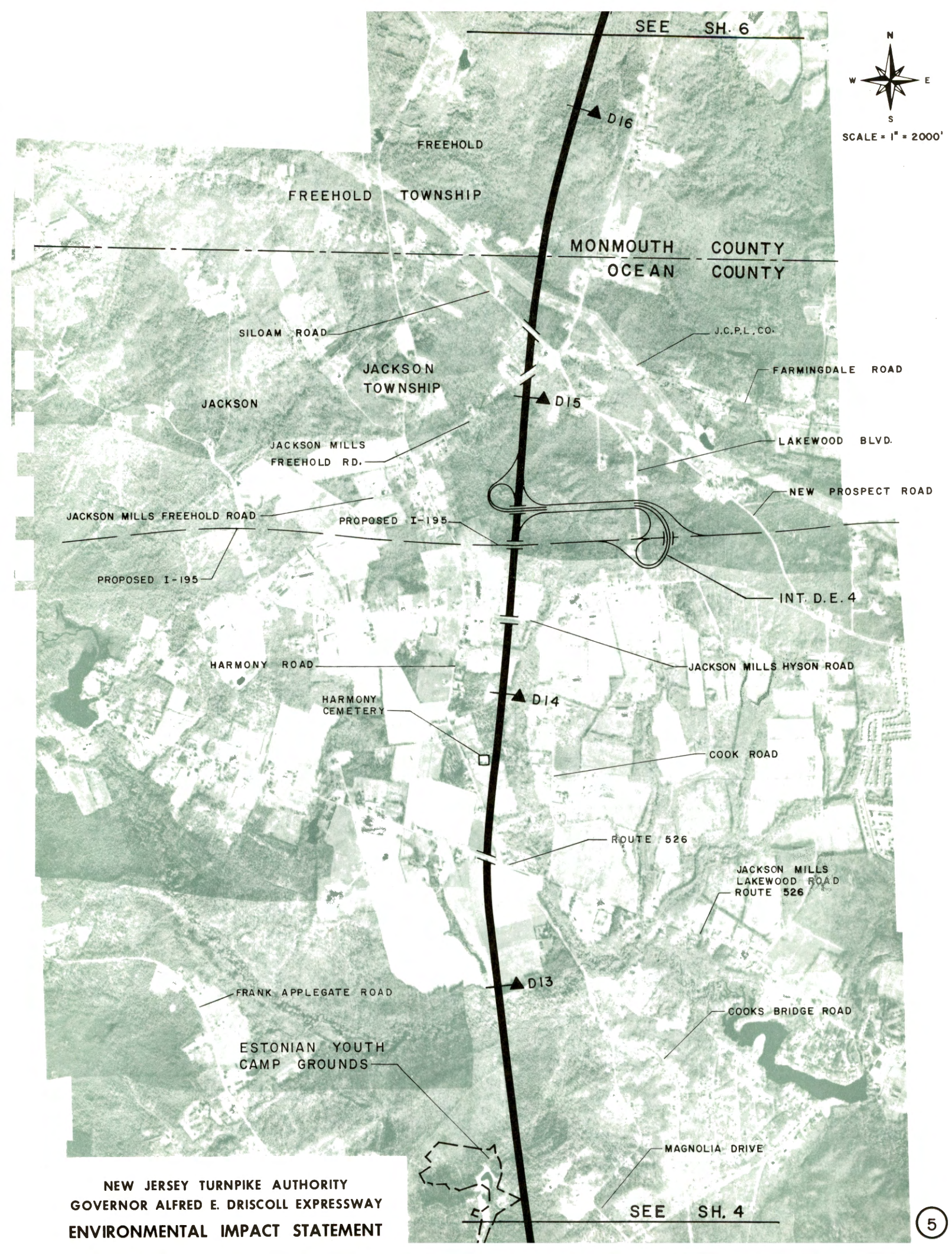

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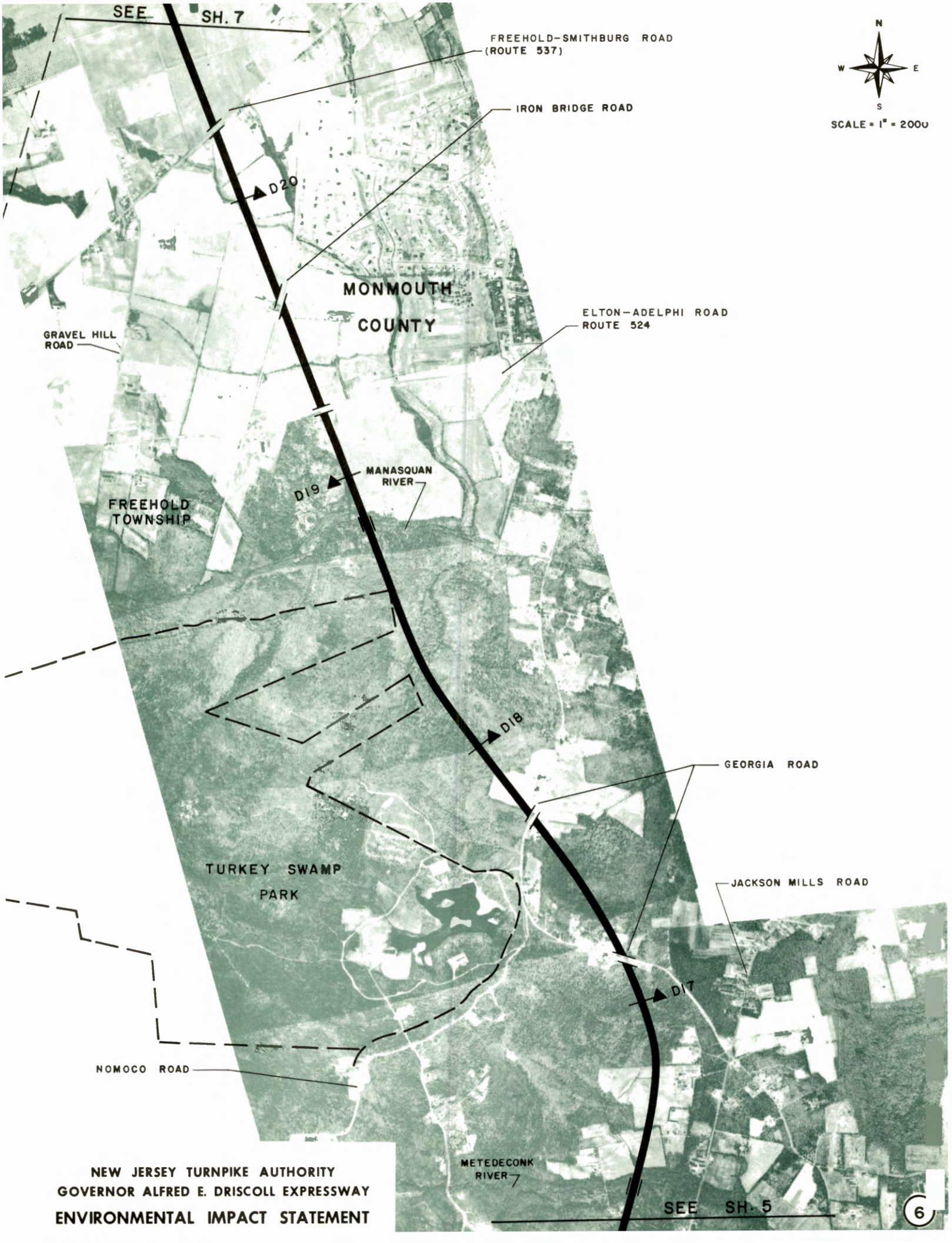

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CHAPTER II

ALTERNATE ALIGNMENT STUDIES

DESCRIPTION OF ALTERNATIVE PROJECTS AND RECOMMENDATIONS

The alignment of the Governor Alfred E. Driscoll Expressway was not a unilateral effort by the New Jersey Turnpike Authority. For almost a year, meetings were held with municipal officials, conservation groups and taxpayer associations to discuss an alignment that would be most compatible with present and future plans for commercial, industrial, residential and recreational development of the area.

As a result of the many meetings held with various groups associated with the affected counties and municipalities, sixteen alternate studies were made. The descriptions and alignments of these studies are shown on the following pages.

Dover Township Alternate Studies

Alternate A, shown on Map 2 as a short dashed line, would leave the recommended alignment about 3,000 feet south of Clayton Avenue, cross Route 571 - 600 feet south of Clayton Avenue, proceed northward parallel to and 700 feet east of Route 527 and tie into the recommended alignment about 1,100 feet north of Riverwood Drive.

Alternate A was not recommended because it was not compatible with municipal planning for the area; officials of Dover Township and Ocean County requested the alignment be moved to the recommended location.[1]

Alternate B, shown on Map 2 as a narrow line, would diverge from the recommended alignment about 1,000 feet south of Clayton Avenue, cross the Toms River, and run parallel to and 300 feet south of Route 571 until it crossed Route 571 in the vicinity of a gravel pit. At this point, two studies were made, Alternate B1 shown as a long dashed line with circles between the lines and Alternate B2 shown as a long dashed line with X between the lines. Alternate B1 would head northeast through the gravel pit, cross Toms River, pass over Route 527 and Cox Crow Road and tie into the recommended alignment at Route 70.

Alternate B2 would continue almost due north, crossing Route 70 just west of its intersection with Toms River. The alignment would continue north, following the river for about a mile, see Map 3, crossing Route 527 about 1,000 feet south of the Central Railroad and tying into the recommended alignment 3,000 feet north of the railroad.

Alternate B3 shown on Map 2 as a dotted line, would diverge from the recommended alignment just north of Clayton Avenue and head northward along the westerly bank of Toms River, adjacent to Pine Lake Park. Just north of Pine Lake Park the alignment would pass into the gravel pit area and meet Alternate B2 in the vicinity of Route 70.

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[1]Meeting with officials of Dover Township and Ocean County, September 10, 1971.

Alternate B was not recommended due to its proximity to the Pine Lake Park, a retirement village, and its adverse impact on the flood plain of Toms River. Alternates B1 and B2 were not recommended since they were contingent upon Alternate B; lay in the flood plain of Toms River; had additional river crossings, one in the vicinity of Clayton Avenue and another in the vicinity of the gravel pit; and took more homes in the vicinity of Route 70. Alternate B3 was not recommended due to its proximity to Pine Lake Park.

Alternate C, shown on Maps 2 and 3 as a long dash line with dots between, would diverge from the recommended alignment just north of Clayton Avenue and follow the east side of Toms River to a point about 4,000 feet south of its crossing with Route 527. Passing over the Central Railroad, Alternate C would tie into the recommended alignment about 1,500 feet south of White Road.

Alternate C was not recommended because it passed through Riverwood Park and was not compatible with future municipal plans for development of a green acres area adjacent to the river.[1]

Jackson Township and Freehold Township Alternate Studies

Alternate D, shown on Maps 3, 4, 5 and 6 as a dotted line, would traverse Ocean and Monmouth Counties within the same corridor proposed by the New Jersey Highway Authority several years ago. The corridor paralleled the boundary between Jackson and Lakewood Townships about 2,500 feet west of the boundary line, crossed Route 526 east of Bennetts Mills and west of Hyson. An interchange with I-195 was planned about 1,500 feet east of Jackson Mill Road. Alternate D would intersect Georgia Road at the entrance to Turkey Swamp Park and join the recommended alignment 3,500 feet to the north.

Alternate D, the original alignment studied through Jackson Township, was reviewed by municipal officials and found to be incompatible with municipal plans. It was abandoned at the request of Jackson Township officials.[2]

Alternate D1, shown on Maps 3 and 4 as a short dashed line, would diverge from the recommended alignment in the vicinity of White Road, continue in a northwesterly direction, east of the recommended alignment, cross Route 547 and Route 528 about 4,000 feet west of Hope Chapel Road. It would then continue in a northwesterly direction until it intersected the recommended alignment just west of the housing development on Vanhiseville-Bennetts Mills Road.

Alternate D1 was presented by Jackson Township as their suggested corridor[2]. The alignment was revised by the New Jersey Turnpike Authority to the recommended alignment. This resulted in fewer homes being taken, less impact on developed areas and, therefore, Alternate D1 was abandoned.

Alternate D2, shown on Map 5 as a long dash, dot, long dash line, would diverge from the recommended alignment in the vicinity of Vanhiseville-Bennetts Mills Road, cross Route 526 between Cooks Bridge Road and Harmony Road and tie back into the recommended alignment at Jackson Mills-Hyson Road.

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[1]Meeting with Committeeman from Dover Township on June 1, 1972.
[2]Meeting with officials of Jackson Township on November 9, 1971.

Alternate D2 was not recommended since it passed through a possible future Green Acre area located in the northeast quadrant of the intersection of Route 526 and Harmony Road.

Alternate D3, shown on Map 5 as a long dash, circle, long dash line, would diverge from the recommended alignment in the vicinity of Route 526 and parallel Harmony Road about 200 feet to the west. The alignment would curve northward, crossing under the proposed I-195 about 800 feet west of the recommended alignment, and would meet the recommended alignment in the vicinity of Siloam Road.

Alternate D3 was not recommended because of its impact on the Harmony Methodist Church and residences along Harmony Road.

Freehold & Manalapan Townships' Alternate Studies

Alternate D4, shown on Maps 6 and 7 as a short dashed line, would start where Alternate D meets the recommended alignment and would head in a more northwesterly direction, crossing Route 524 about 2,000 feet west of the preferred alignment. Alternate D4 would curve gently to the north, crossing the proposed alignment at Route 537. It would continue in a northwesterly direction almost parallel to the recommended alignment, crossing Gulley Road 800 feet east of the boundary line between Freehold and Manalapan Townships. After interchanging with the proposed Route 33 Freeway, the alternate alignment would pass through Monmouth Battlefield Park, under Main Street and would tie back into the recommended alignment a few hundred feet north of the Pennsylvania Railroad.

Alternate D4 was not recommended because of its greater impact on the Freehold Hospital, its circuitous route through the feeders to the Manasquan River and its requirement for more property from the Monmouth Battlefield Park than the recommended alignment.

Madison, Monroe, Helmetta, East Brunswick & South Brunswick Township's Alternate Studies

Alternate E, shown on Maps 8, 9 and 10 as a long dash line with circles, would leave the recommended alignment in the vicinity of the Route 520 interchange and cross under Route 527, 600 feet north of the recommended alignment's crossing of Route 527. After crossing Route 520, the alignment would curve to the west and pass into Monroe Township. The alternate alignment would parallel Route 520, passing just to the south of a major housing area. After crossing under Englishtown Road, the alignment would swing to the northwest, crossing the Manalapan Brook just north of a large housing area and passing into Spotswood Boro. The alignment would pass over Main Street and the Pennsylvania Railroad and into East Brunswick Township. The alternate would pass under Cranbury-South River Road and interchange with the existing Turnpike 200 feet north of the recommended alignment.

Alternate E was not recommended because it did not conform to future development plans of Monroe Township; it had great impact on two major housing areas in Monroe Township and Spotswood Boro; and took more homes than the

recommended alignment. The recommended alignment in eastern Monroe Township was suggested by the Monroe Township Engineer as more suitable than Alternate E.[1]

Alternate F, shown on Maps 9 and 10 as a short dashed line, would diverge from Alternate E at Englishtown Road and continue in a more westerly route, passing within 300 feet of a housing area in Monroe Township. The alignment would cross the Manalapan Brook into the Borough of Helmetta. Crossing Main Street and the Pennsylvania Railroad a few hundred feet north of the Helme Products, Incorporated, plant and about 200 feet south of St. George's Episcopal Church, the alignment would continue in a northwesterly direction, passing under Cranbury-South River Road and tying into Alternate E about 1,500 feet north of Cranbury-South River Road.

Alternate F was not recommended because of its impact on housing areas in Monroe Township, its close proximity to the church and its route through the future expansion area of Helme Products, Incorporated.[2]

Alternate G, shown on Maps 9 and 10 as a long dashed line with X's, would diverge from Alternate E at Englishtown Road and continue in a westerly direction until it crossed Old Forge Road where it would swing into a more northerly direction. Alternate G would cross the Manalapan Brook into the Borough of Helmetta, crossing over Main Street and the Pennsylvania Railroad and through the company-owned homes and warehouses of Helme Products, Incorporated, into East Brunswick Township. The alternate study alignment would tie into the recommended alignment at Cranbury-South River Road.

Alternate G was not recommended because its adverse impact on the Borough of Helmetta would be greater than that of the recommended alignment. Several more homes and warehouses owned by the Helme Products, Incorporated, would be taken by Alternate G.

Alternate H, shown on Maps 9 and 10 as a long dash dotted line, would diverge from the recommended alignment in the vicinity of Englishtown Road in Monroe Township and head in a westerly direction. After crossing Old Forge Road, the alignment would swing to the northwest and cross Main Street and the Pennsylvania Railroad in the area of a large gas line, about 1,500 feet west of the boundary line of Helmetta. Passing within a few hundred feet of a large housing area, the alignment would swing to the north and pass diagonally through the proposed Jamesburg Park and tie into the recommended alignment in the vicinity of Cranbury-South River Road.

Alternate H was not recommended because it had greater impact on the proposed Jamesburg Park; it was three thousand feet longer than the recommended alignment; and there would be about the same impact on homes adjacent to this alignment as to the recommended alignment.

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[1]Meeting with Mayor and Township Committeeman on September 22, 1971.

[2]Meeting with officials of Helmetta, Spotswood and Monroe Township on August 4, 1971.

Alternate I, shown on Map 10 as a dotted line, would diverge from the recommended alignment at Cranbury-South River Road and head more westerly, crossing Davidsons Mill Road about 2,000 feet northwest of its intersection with Route 535. This alignment would interchange with the existing Turnpike about 1,000 feet south of Davidsons Mill Road.

Alternate I was not recommended because it was not compatible with Middlesex County's master plan.[1] In addition, the location of the interchange with the New Jersey Turnpike would be adjacent to a Green Acre area, Pigeon Swamp.

Alternate J, shown on Map 10 as a line of circles, would diverge from the recommended alignment at Cranbury-South River Road and head in a more westerly direction almost paralleling Alternate I until it intersected the New Jersey Turnpike about 1,500 feet south of Davidsons Mill Road.

Alternate J was not recommended because it was not compatible with Middlesex County's master plan.[1] The location for the interchange with the New Jersey Turnpike would also be adjacent to Pigeon Swamp, a Green Acre area.

Alternate K, shown on Map 10 as a solid thin line, would diverge from Alternate Study H in the vicinity of the Pennsylvania Railroad, passing to the south of and adjacent to the cemetery on Cranbury-South River Road and intersecting the New Jersey Turnpike 200 feet north of Deans Rhode Hall Road.

Alternate K was not recommended because the location for the interchange with the New Jersey Turnpike would be in Pigeon Swamp and objections to this alignment were raised by Middlesex County and South Brunswick.[1]

DESCRIPTION OF THE "NO PROJECT" ALTERNATIVE

The Expressway will pass through Ocean, Monmouth and Middlesex Counties, three of the fastest growing counties in New Jersey (see Chapter II in Coverdale and Colpitts section of this report). A decision not to build the Governor Alfred E. Driscoll Expressway would mean a continuance of the existing inconvenience to local highway users, an increased seasonal inconvenience to vacationers traveling to south shore towns, an intensification of traffic congestion and the ignoring of master plans prepared by affected municipalities and counties. Presently, the two major routes serving southeastern New Jersey are Route 9 and the Garden State Parkway. The Parkway is subject to numerous periods of stop-and-go traffic in many areas, preventing it from providing the high-speed service for which it was constructed. Additionally, the Parkway prohibits use by trucks in this area, forcing parallel Route 9 to accommodate all truck traffic south of the Raritan River. Signals along Route 9 slow traffic flow; and in the summer months, overflow Parkway traffic makes Route 9 almost impassible, even during non-commercial hours. Expansion of the present corridors does not seem to offer a long-range solution to the ever-expanding traffic problems of the area.

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[1]Meeting with officials of Middlesex County and South Brunswick on September 22, 1971

For several years, the communities affected by the Expressway have (1) shown the alignment on their master plans and traffic circulation plans; and (2) planned for the orderly growth of the area with the Expressway an intrinsic part of the development.

Dover Township shows the alignment in its Circulation Plan, Plan for Community Facilities and in its Master Plan from which the following is quoted. "In modern times, transportation factors have contributed to Dover's growth and importance. Once a lack of high-speed roadways maintained the Township's rural character. This is no longer true. Dover will, in the not too distant future, be linked with the two most important highway systems in the State, the Garden State Parkway and the New Jersey Turnpike."

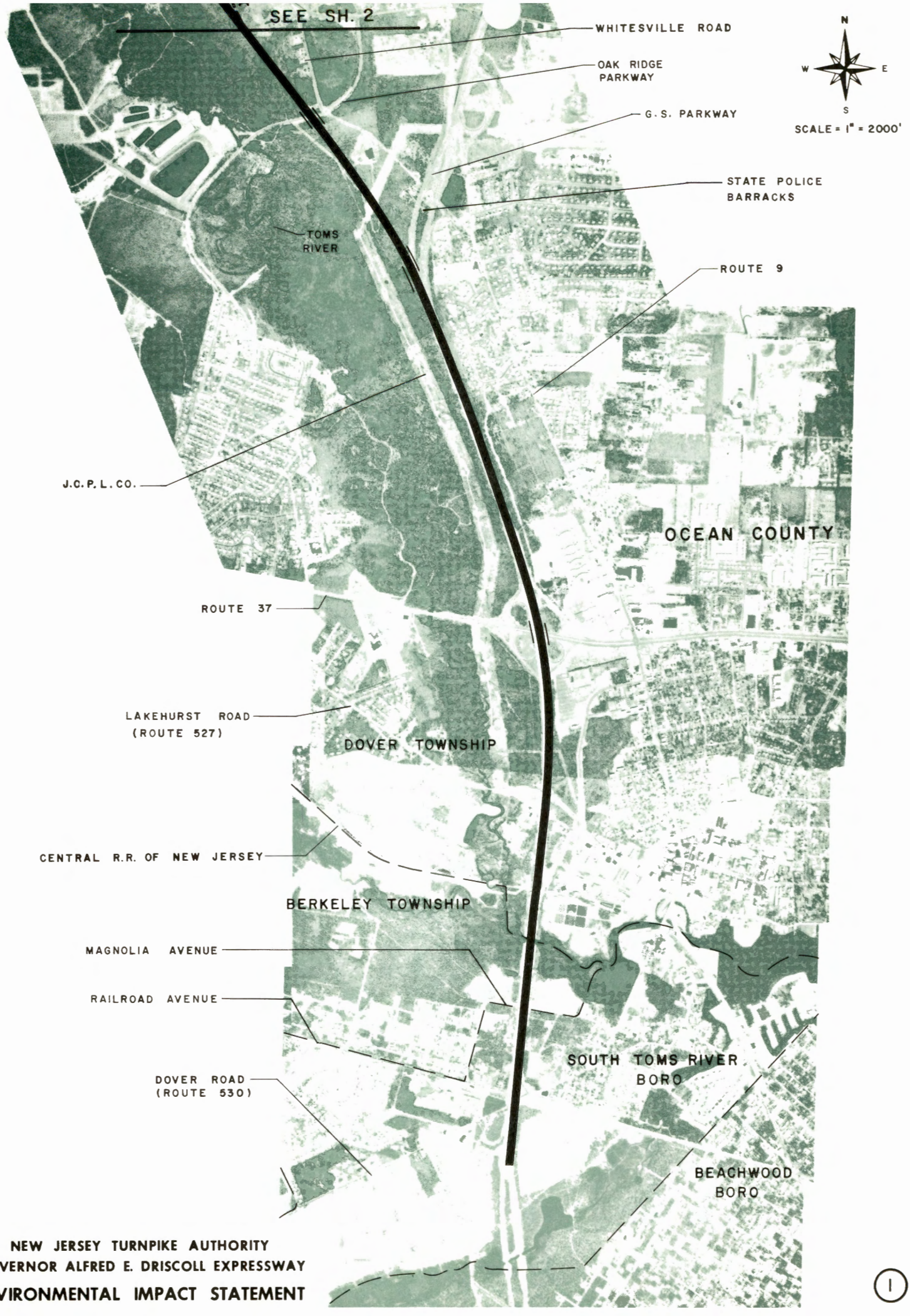
Ocean County shows the proposed Expressway on its Master Plan and Future Circulation Plan from which the following statement is quoted. "The proposed circulation and transportation system presented in this plan will continue to provide Ocean County with convenient, safe and economical highways which will be sufficient to accommodate the population growth expected in the coming fifteen to twenty years."

Monmouth County has shown the alignment in its General Development Plan. A recommendation included in the Circulation and Transportation Report follows. "There is an urgent need for a north-south freeway paralleling Route 9 and extending from Ocean County through Monmouth County and most importantly providing a new crossing of the Raritan River."

The Middlesex County Planning Board released a Preliminary Evaluation of Three Proposed Alignments for a Toms River Toll Road. The alignment of the Expressway through Middlesex County concurs with the recommendations of the Board. The following is quoted from the report. "The specific advantages of this alignment of the Toms River Toll Road is that it helps to shape desirable future regional development patterns by (1) following the general corridor route suggested in the conceptual transportation system of the County's Interim Master Plan; (2) connecting with the New Jersey Turnpike to provide opportunity for express commuter transit service; (3) providing interchanges at locations at or near sites feasible for new planned unit communities; and (4) avoiding as much as possible future open space and natural resources proposals, including Ireland Brook and Pigeon Swamp."

The report also states that the proposed alignment protects local patterns of development by (1) weaving between major residential concentrations in North Brunswick, South Brunswick and Helmetta; (2) avoiding proposed school and park sites in North Brunswick and Monroe; and (3) passing through largely vacant land to provide opportunity for carefully designing future residential and industrial growth in harmonious relationship to the road.

A decision not to construct the Governor Alfred E. Driscoll Expressway would waste the efforts of the affected municipalities and counties to shape desirable future regional development patterns, protect existing and potential county parks, roads and correctional facilities and protect local patterns of development.



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ENVIRONMENTAL IMPACT STATEMENT



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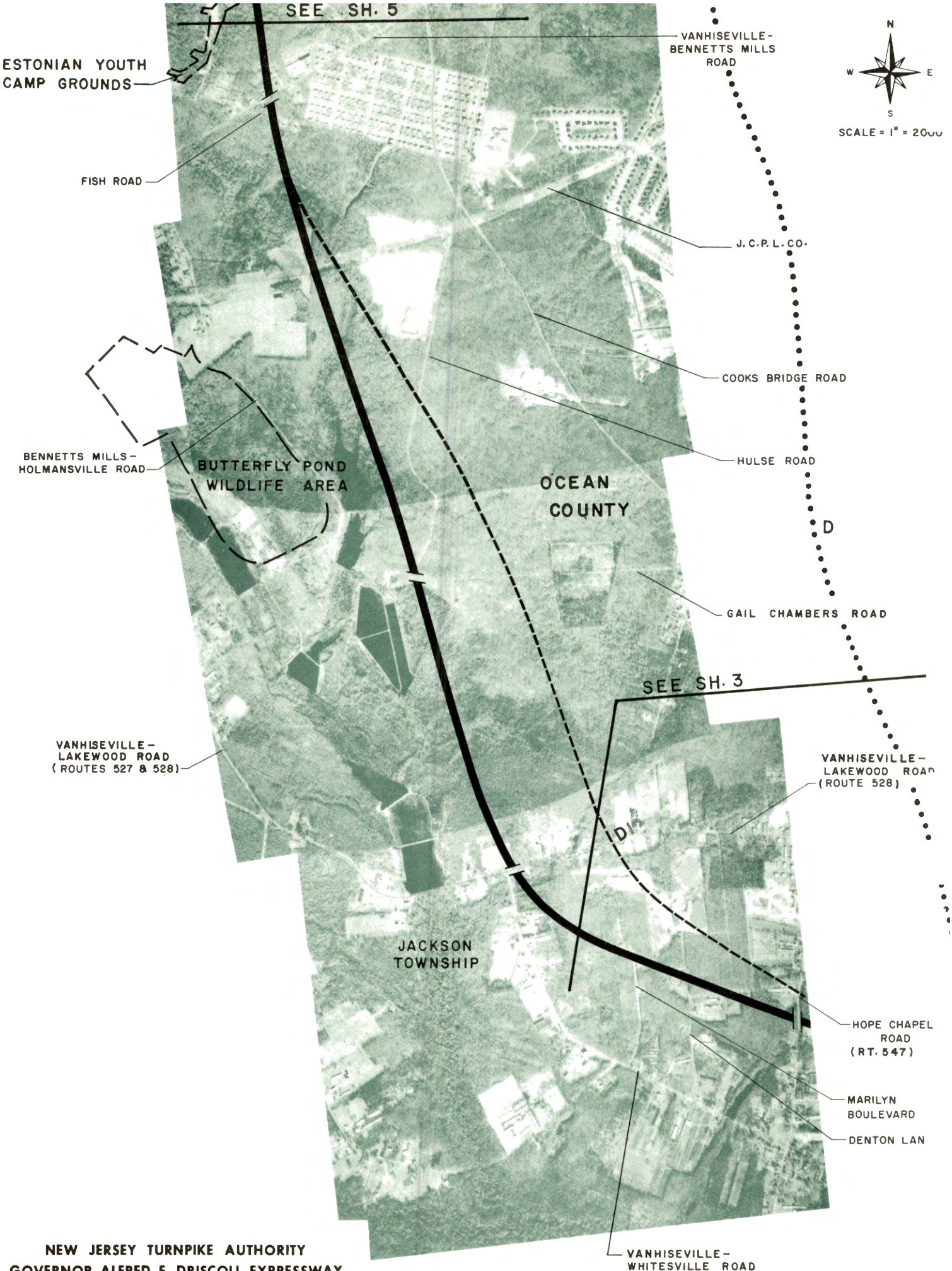

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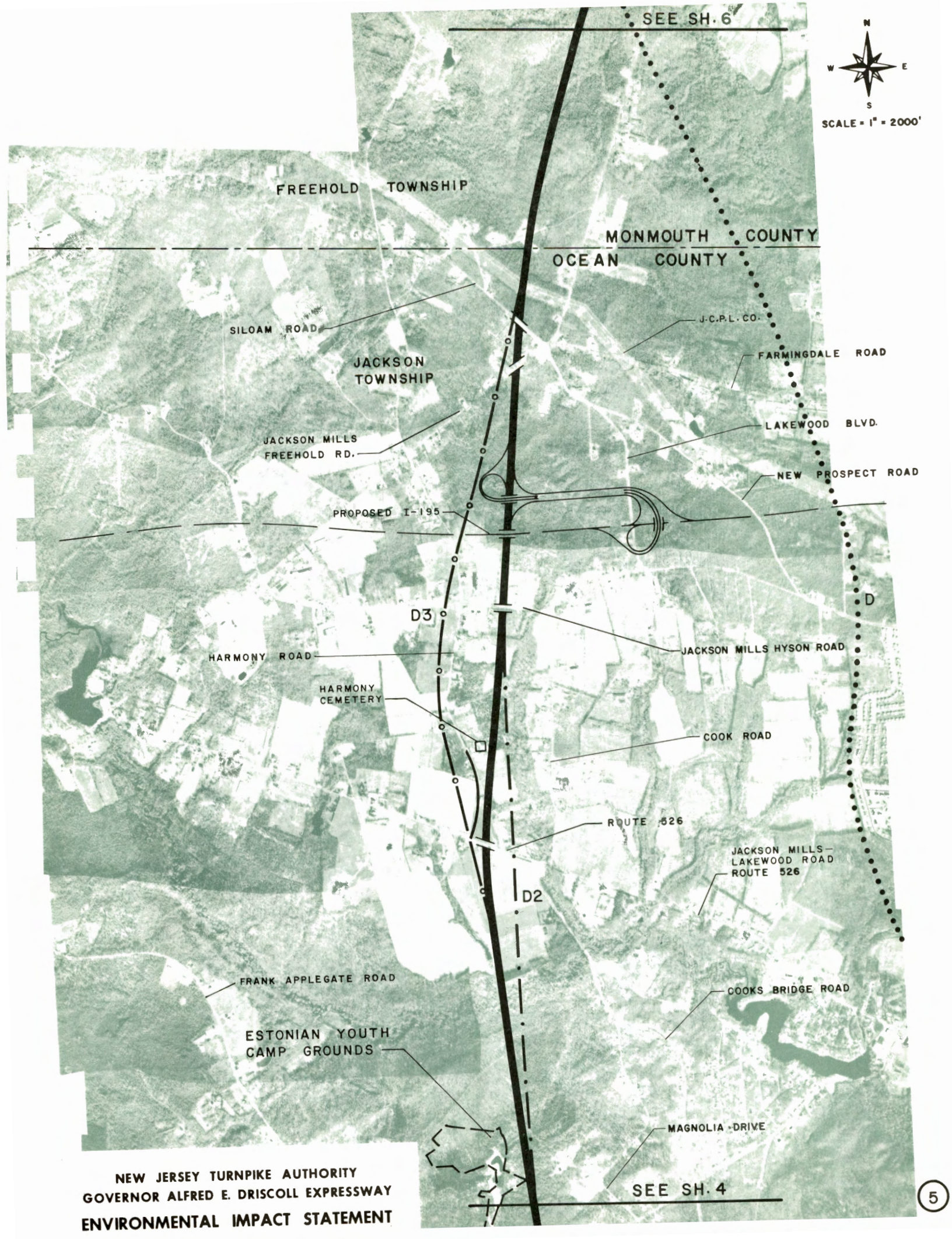

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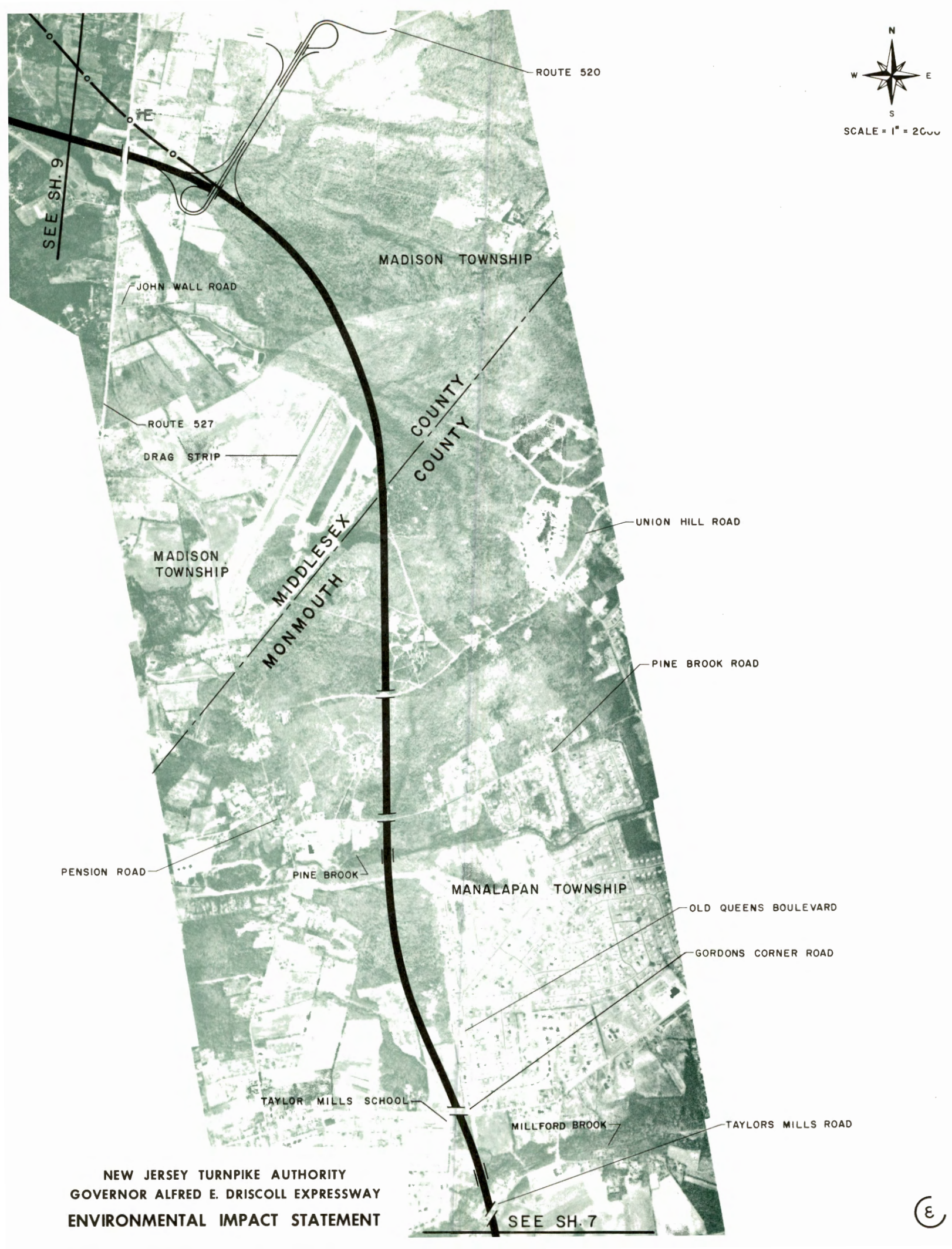

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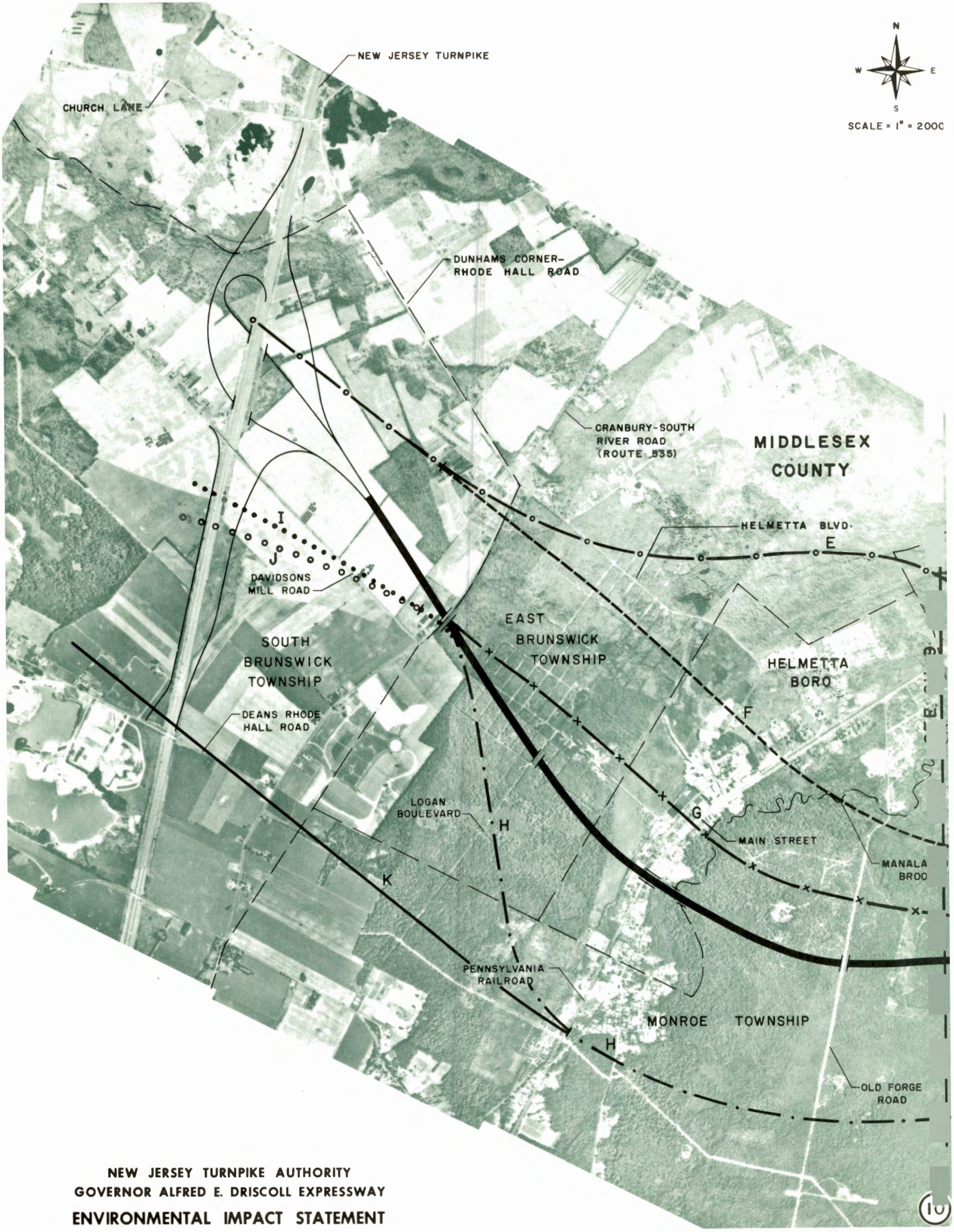

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GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
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CHAPTER III

ENVIRONMENTAL IMPACT OF PROJECT

AESTHETICS

The aesthetic impact of a highway depends mostly on the initial design and construction procedures of the project. The greatest impact along the Expressway corridor will be the temporary visual impact of heavy highway construction. Most of the corridor traverses flat tree-covered land, and the alignment will remain close to the natural contours of the terrain, resulting in very little visual impact in rural areas. Only ten towns will be impacted by the Expressway. Again, the major visual impact will be the presence of right-of-way fences along the roadway. This impact could be decreased with proper landscaping. Other than the fences, the Expressway will have no more aesthetic impact than any of the other major arteries in the area, and in some cases, less impact.

DESTRUCTION OF MAN-MADE RESOURCES

No destruction of man-made resources in the construction of the Expressway is anticipated. For a more complete discussion of the impact of the alignment on man-made resources, see the section on Community Services in Chapter Four of the analysis prepared by Environmental Research & Technology, Incorporated.

DISPLACEMENT OF PEOPLE AND BUSINESSES

The construction of any major highway facility in a populated area inevitably requires relocating some houses and businesses. The preferred alignment of the Governor Alfred E. Driscoll Expressway has been carefully selected to minimize the number of individual homes and businesses which must be displaced. Nevertheless, 73 residences and 10 commercial or industrial buildings will be acquired for the 35-mile right-of-way. This is an average of 2.2 buildings per mile. Based on about 2,100 acres of property being acquired, the density is one building per 25 acres of land. Not all of these buildings are occupied as residences or used for businesses at this time. The actual number of home owners and current business operations which will be displaced is slightly less than these figures.

The proposed route will generally displace middle-class home owners in relatively small homes priced from about $15,000 to $25,000.[1] Because the route displaces individual home owners randomly along the alignment rather than requiring a large number of homes from one location, no ethnic or other organized community will be totally displaced by the Expressway. However, certain communities may be disrupted psychologically in those cases where the

[1]Field research by Howard, Needles, Tammen & Bergendoff, February 1972

roadway bisects a township, although local roads will continue to connect the sections of the community.

In Ocean County, a total of 33 homes, 11 mobile homes, and four businesses will be displaced by the alignment. In Dover Township, the alignment will require the acquisition of an automobile repair shop and the management and sales office of a mobile home park, the relocation of 11 mobile homes from the impacted mobile home park, and the acquisition of 15 homes. There is a possibility that the auto repair shop, the mobile homes and the mobile home park office could remain on the same property if they can be relocated to other sections of the property. There is no displacement of people or businesses in Lakewood Township. In Jackson Township the alignment will require the acquisition of a general store, a junk yard and 18 homes. Only the general store could be relocated on the property it now occupies.

In Monmouth County, a total of 28 houses will be displaced by the Expressway. One business will be disrupted and possibly displaced. Five homes will be acquired in Freehold Township for the alignment and 23 homes in Manalapan Township will be acquired. A training track for harness horses which lies in both Freehold and Manalapan Townships will be severed by the proposed Route 33 By-Pass. A portion of the remaining property will be acquired by the Expressway. The result of these combined acquisitions could mean the termination of this business.

In Middlesex County, a total of 12 houses and one business will be displaced by the alignment. One house will be acquired in Madison Township; there is no anticipated displacement in Monroe Township. The alignment will require the acquisition of 10 houses in Helmetta Boro and one house in East Brunswick Township. A nursery will be partially displaced in South Brunswick Township. The right-of-way acquisition will include half of a storage building and will sever one section of a nursery stock field. It is possible that the nursery building could be relocated on the remaining property and the nursery could continue operations in the same location, but on a smaller scale.

HEALTH, SAFETY AND WELL-BEING OF PUBLIC

The impact of the Expressway on the air quality and noise levels for the communities along the corridor is discussed in the Air Pollution section of the analysis prepared by Environmental Research & Technology, Incorporated, and the Acoustic Impact of the Governor Alfred E. Driscoll Expressway prepared by Bolt Beranek and Newman, Incorporated, respectively. There are no other anticipated adverse impacts of the Expressway on the safety and well-being of the residents of any community along the corridor.

CHAPTER IV

MEANS TO MINIMIZE ENVIRONMENTAL IMPACT

AESTHETICS

During preliminary design, an effort was made to make the geometry of the Governor Alfred E. Driscoll Expressway as aesthetically pleasing as possible to both the highway users and the communities traversed by the roadway. Relatively flat terrain through most of the corridor will allow the alignment to remain close to existing ground where the roadway can be more easily shielded from its surroundings by vegetation. At most grade separated crossings, a depressed alignment will be incorporated so that local crossroads remain close to their existing grade.

Although the Expressway follows a fairly straight course, long smooth horizontal curves will dominate the alignment so that patrons will not be faced with the monotonous, dull driving experienced on a long straight roadway.

More than half of the right-of-way to be purchased is covered by small trees. The remaining area includes farms, rolling pastures, flat marshes and cranberry bogs with a very small percentage of the land residentially or industrially developed. Due to the existing topography, the alignment can be fairly easily shifted during preliminary design to avoid most adverse impacts in the area. Proper landscaping of the route's 450-foot or more right-of-way will avoid most adverse visual impacts to the land traversed by the alignment.

Wherever feasible, existing trees and other vegetation will be preserved in the median as well as on both sides of the roadway to allow the Expressway to blend more easily with its surroundings. In areas where existing vegetation is lacking or where the land has been scarred by gravel pits, junk yards, past forest fires, or acres of barren trees which have fallen victim to the gypsy moth, full landscaping within the right-of-way will effectively improve the appearance of the existing countryside.

Purchase of a wide right-of-way will not only help make the roadway aesthetically pleasing today, but will be of even more value in future years as the corridor develops. A wide right-of-way will permanently insure a green area between the travelled roadway and development of any kind.

To further improve the appearance of the roadway, final design can include a split alignment with independent profiles for north-and southbound lanes separated by a wide, varying median.

At local road crossings along the proposed roadway, simple open end span structures, similar to those used on the existing Turnpike, will be used. The Expressway will give the landscape architect the opportunity to enhance the natural appearance of the environment. The appearance of toll road facilities such as toll plazas and service areas will also be the responsibility of the landscape architect.

An important factor to the highway's future appearance and aesthetic impact will be the maintenance required to keep the highway in its original state. The Expressway will be continually maintained by the Turnpike Authority to preserve its design function and appearance. A clean, well-maintained roadway will be an asset to the project's on-going aesthetic impact.

DESTRUCTION OF MAN-MADE RESOURCES

No destruction of man-made resources in the construction of the Expressway is anticipated. However, the section on Community Services in Chapter Four of the analysis prepared by Environmental Research & Technology, Incorporated, discusses steps to minimize any temporary disruptions which may occur during construction of the roadway.

DISPLACEMENT OF PEOPLE AND BUSINESSES

Since the initial conception of the Governor Alfred E. Driscoll Expressway, the alignment has been shifted to avoid as many developed areas as possible. For example, the westward shifting of the roadway in Jackson Township will avoid a large residential development. The relatively sparse housing through the study area means fewer homes and businesses will be displaced.

The Turnpike Authority is required by law to make relocation payments, provide advisory assistance and assure the availability of standard housing.[1] The Turnpike's Relocation Representative will give assistance in finding replacement houses and business locations; moving expense reimbursement, and business discontinuance allowance in lieu of moving reimbursement. The Relocation Assistance Program will also provide for payment of replacement housing supplements, mortgage interest rate differentials and closing costs on new homes; payment of rent supplements; down-payment alternates and closing costs on new homes (when applicable), and provision of related supporting services and assistance.[2] All of these steps to minimize disruption will, by necessity, be implemented before construction on the roadway begins.

HEALTH, SAFETY AND WELL-BEING OF PUBLIC

In order to avoid adverse impacts to the health, safety and well-being of the public, steps were taken during the selection of the recommended alignment and preliminary design of the Expressway to incorporate the Turnpike Authority's tested safety measures for design, construction and operation of the roadway. The effectiveness of the Turnpike Authority's approach to highway design and construction is illustrated by recent

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[1] Chapter 36, Laws of New Jersey, Section 71.

[2] Buying Land for the Governor Alfred E. Driscoll Expressway, Public Information Department, New Jersey Turnpike Authority, September 1972.

accident statistics for the New Jersey Turnpike compared with statistics compiled over the same period of time for Route 9 and Route 18 in Ocean, Monmouth and Middlesex Counties:

Accidents per 100 Million Vehicle Miles[1]

		Middlesex		Monmouth	Ocean
	N.J. Turnpike	Rte. 9	Rte. 18	Rte. 9	Rte. 9
Accident Rate:	90	496	334	341	286

These figures indicate a better than 4 to 1 safety record of a limited access divided highway over a highway, such as Route 9 or Route 18, presently available in southern Jersey for long and short distance trips.

A wide fully fenced right-of-way will separate local pedestrians from highway traffic. One of the first items of work will be the installation of a right-of-way fence. This early installation will help prevent public access to the construction area and serve to contain the construction contractor within the limits of the right-of-way (normal practice is to construct the fence at the completion of the highway).

Intersections with local streets and major highways will all be grade separated crossings. In many cases, these intersections will improve existing local facilities, providing safer driving conditions.

Interchanges with major highways have been designed using modern geometric design standards. All ramps will be properly illuminated and delineated (marked with reflectors). Toll plazas will be bathed with lights from towers designed to prevent "spill-over" into adjoining properties. All the elements of the existing Turnpike interchanges, which have contributed to the Turnpike's safety record, will be included in the design of the Governor Alfred E. Driscoll Expressway.

In the interest of safety for the highway user, plans for the proposed route include a wide, variable, landscaped median to prevent head-on collisions, free drivers from the headlight glare of oncoming vehicles and prevent monotony. Entrance to and exit from the roadway will be made from the slower right lane. As discussed earlier in this study, the alignment will consist mainly of long, smooth, horizontal curves with minimum vertical grades. The cross sectional design of the Expressway will include attractive landscaping adjacent to the roadway which will still permit safe visibility for drivers. Where feasible, slopes adjacent to the roadway will not be steeply graded. Where this is not possible, the motorist will be protected by steel beam guardrails. Minimizing abrupt changes in the geometry of the roadway will contribute to maintaining traffic flows and limiting development of potential accident situations. Speed warning signs will be electronically controlled to vary speed limits for different sections of the route as required by local driving conditions or the occurance of accidents. In the event of an accident or a mechanical failure,

[1]The accident rates for state highways were calculated by the Turnpike Authority Traffic Engineering Department from accident records for 1970 supplied by the New Jersey Department of Transportation.

wide shoulders along the entire Expressway will give drivers a place to pull off the road at a safe distance from the stream of traffic. Grade separated U-turns and emergency access points along the roadway will allow safe and efficient emergency service to be provided to either side of the Expressway.

The New Jersey Turnpike Authority will be responsible for supplying emergency services along the Expressway. Currently, the Authority has agreements with 39 first-aid squads and 25 fire departments along the existing New Jersey Turnpike to service emergencies. While these groups volunteer to service their respective sections of the Turnpike, the Authority makes contributions to each group. Similar agreements will be made for emergency services along the new facility with access points located along the entire route.

The New Jersey Turnpike Authority will bear the cost of the patrol and enforcement of traffic regulations on the Expressway by members of Troop "D" of the New Jersey State Police. In 1971, these Troopers assisted an average of 289 drivers a day or 12 cars every hour.[1]

In addition, the New Jersey Turnpike Authority will provide service areas for the traveling public. Spacious, properly landscaped parking facilities will be provided where the tired driver can take a break and stretch his legs. Modern air-conditioned buildings will house rest-room and eating facilities. Car and truck services will be available at well-stocked service centers. Radio-controlled maintenance vehicles will be available to answer State Police calls for aid to disabled vehicles.

CONCLUSIONS

With the increasing availability of leisure time, the demand for an additional "shore route" is growing. There must be an alternate to draw commercial traffic from Route 9 and passenger vehicles from the Parkway, attracting primarily those vehicles with destinations south of Toms River. If this new route is not provided, many vacationers may be discouraged from traveling to or through southern Jersey, which could impact the economies of shore resorts and towns.

There is presently a movement of both individuals and businesses toward suburban southern New Jersey. Inadequate traffic arteries will slow traffic flow in this area. Since the Expressway passes through the central part of southern Jersey, it will provide a high speed corridor for efficient traffic movement for the entire area. The route will create a green belt about which development could occur. Both Ocean and Monmouth Counties have been aware of the location of the Expressway and have incorporated the corridor into their long-range master plans for county development.[2]

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[1]Annual Report, New Jersey Turnpike Authority, 1971. The averages were based on 105,342 aids to cars reported in 1971.

[2]Meeting with officials of Dover Township and Ocean County, September 10, 1971.

With the saturated traffic situation on Route 9, the demand for bus mass transit systems is not growing and cannot be stimulated. Bus travel permitted on the Expressway will relieve some of the mass transit demands on Route 9 and the Parkway and permit growth of bus service. Without the roadway, additional Park/Ride facilities for commuters will be limited.

Any further delay in the construction of this facility can only result in greater environmental impacts along the entire corridor as individuals and businesses move into the area and decrease the amount of undeveloped land available for the most advantageous planning of the corridor. In addition, the cost of purchasing right-of-way will become prohibitive as far as acquiring optimum amounts of land for the environment-enhancing green belt along the Expressway corridor.

REFERENCES

The following meetings were held with various municipal officials and groups or materials were submitted to them for their review and comments:

August 3, 1971 - Meeting with officials of Freehold Township, Manalapan Township and Monmouth County - review aerial index map scale 1" = 2,000 feet.

August 4, 1971 - Meeting with officials of Jackson Township, Lakewood Township and Ocean County - review aerial index map scale 1" = 2,000 feet.

August 4, 1971 - Meeting with officials of Helmetta, Spotswood and Monroe Township - review aerial index map scale 1" = 2,000 feet.

August 9, 1971 - Aerial index map scale 1" = 2,000 feet sent to Middlesex County Engineer.

August 24, 1971 - Meeting with officials of East Brunswick, Dover Township, Madison Township and Middlesex County - review aerial index map scale 1" = 2,000 feet.

August 26, 1971 - Alignment sent to Dover Township for their review and comments - map scale 1" = 200 feet.

September 2, 1971 - Alignment sent to South Brunswick, Helmetta, East Brunswick, Franklin Township, Monroe Township, North Brunswick, Middlesex County, Somerset County for their review and comments - scale of map 1" = 400 feet.

September 10, 1971 - Meeting with officials of Dover Township and Ocean County to discuss comments from their review - map to scale 1" = 200 feet.

September 14, 1971 - Meeting with officials of Helme Products to discuss comments on the alignment - map to scale 1" = 400 feet.

September 14, 1971 - Revised alignment sent to officials of South Brunswick, East Brunswick, North Brunswick, Helmetta, Monroe Township, Middlesex County and Somerset County - map to scale 1" = 400 feet.

September 15, 1971 - Meeting with South Brunswick and Middlesex County officials to discuss revised alignment shown on map scale 1" = 400 feet.

September 15, 1971 - Sent revised alignment dated September 4, 1971 to all affected municipalities.

September 16, 1971 - Revised alignment dated September 4, 1971 sent to Mr. Guido of the Department of Environmental Protection for his review and comments.

September 17, 1971 - Alignment sent to officials of Monroe Township, Manalapan Township, Dover Township, Madison Township, Freehold Township, Jackson Township, Lakewood Township, Middlesex County, Monmouth County and Ocean County for their review and comments - map scale 1" = 200 feet.

September 22, 1971 - Meeting with officials of Dover Township, East Brunswick Township, Freehold Township, Franklin Township, Helmetta, Jackson Township, Lakewood Township, Manchester Township, Madison Township, Manalapan Township, Marlboro, Monroe Township, Middlesex County, Monmouth County, New Jersey Department of Environmental Protection, New Jersey Department of Transportation, North Brunswick Township, Ocean County, Somerset County, South Brunswick Township and Spotswood Boro to discuss comments from their review of alignment - scale of maps 1" = 200 feet and 1" = 400 feet.

October 7, 1971 - Meeting with officials of Jackson Township and Lakewood Township to discuss comments from their review of alignment - maps to scale 1" = 200 feet.

October 11, 1971 - Revised alignment through Six Mile Run Reservoir scale 1" = 400 feet sent to Mr. Guido.

October 12, 1971 - Plans sent to New Jersey State Department of Transportation - map to scale 1" = 200 feet.

October 13, 1971 - A representative of the Turnpike Authority showed and discussed the preliminary alignment through Monroe Township at a public meeting sponsored by Monroe Township officials.

October 21, 1971 - Revised alignment sent to North Brunswick, South Brunswick and Director of County Planning for Middlesex County. These plans showed revised interchange at Route 1 and Park and Ride facility with railroad.

November 8, 1971 - A representative of the Turnpike Authority spoke about the Expressway and the environment before the Citizens Conservation Council of Ocean County. It was announced that the Turnpike Authority would undertake an Environmental Impact Study for the proposed Expressway.

November 9, 1971 - Meeting with Mr. George Gottuso, Business Administrator, and Mr. John Ernst, Jackson Township Engineer, to discuss a revised alignment which was more compatible with their future plans for development. Scale of map 1" = 200 feet.

November 9, 1971 - Alignment sent to Director of Parks and Forestry for review and comments.

November 12, 1971 - Meeting with officials of Middlesex County Planning Board, New Jersey Department of Transportation, South Brunswick Township and North Brunswick Township to discuss Park and Ride Facility at Route 1 - map to scale 1" = 400 feet.

February 14, 1972 - Alignment sent to Commander of Coast Guard District for his review - scale 1" = 2,000 feet.

February 18, 1972 - Alignment through Freehold Township map scale 1" = 200 feet sent to Township Engineer for his review and comments.

February 22, 1972 - Alignment through Ocean County sent to County Engineer for his review and comments.

February 22, 1972 - Alignment through Jackson Township sent to Business Administrator for his review and comments - map scale 1" = 200 feet.

February 24, 1972 - Revised alignment through Jackson Township sent to Mayor for his review and comments - map scale 1" = 200 feet.

March 1, 1972 - Alignment from Toms River to Route 287 in Bound Brook sent to New Jersey Department of Transportation for their information - scale of maps 1" = 200 feet and 1" = 2,000 feet.

March 16, 1972 - Meeting with officials of South Brunswick Township to discuss revisions to alignment.

March 30, 1972 - A representative of the Authority, Mr. Allen Lewis, showed and discussed the preliminary alignment to the Jackson Township Taxpayers' Association.

April 11, 1972 - Meeting with officials from Monmouth County, Ocean County, Monmouth County Planning Board, Dover Township, Jackson Township, Ocean County Engineering Department, Ocean County Planning Board, Ocean County Environmental Agency, Citizens Conservation Council of Ocean County, Ocean County Senior

- Coordinating Council, Ocean County League of Women Voters, Ocean County Public Information Officer to discuss alignment and impact of the highway on various municipalities.

April 13, 1972 - Meeting with officials of Jackson Township to discuss alignment and additional interchanges.

April 25, 1972 - Meeting with Mayor of Jackson Township to review his request for a revision to alignment.

April 25, 1972 - A representative of the Turnpike Authority, Mr. Allen Lewis, spoke to the Jackson Township Rotary Club about the proposed Expressway.

May 11, 1972 - Revised alignment sent to Mayor of Jackson Township for his review and comments - map scale 1" = 200 feet.

May 15, 1972 - Alignment through Ocean County sent to officials for development of zoning areas in Jackson Township.

May 26, 1972 - Revised alignment sent to Dover Township Engineer for his review and comments.

June 1, 1972 - Meeting with Committeeman Frederick Brochon from Dover Township to discuss alternate alignments in Dover Township.

June 8, 1972 - Meeting with Mr. John Gallagher, Chairman of New Jersey Highway Authority, and Mr. Fred DePhillips, Assistant Commissioner for New Jersey Department of Transportation to review proposed improvements of Route 9 - Garden State Parkway section.

June 2, 1972 - Revised alignment sent to Ocean County Engineer for his information.

June 6, 1972 - Set of 1" = 200 feet plans sent to Dover Sewerage Authority for their information.

June 15, 1972 - Recommended alignment plans and alternate studies, scale 1" = 2,000 feet through Jackson Township sent to Monroe Township Conservation Commission.

June 22, 1972 - Alignment to scale 1" = 200 feet through Manalapan Township sent to municipal official for review and comments.

June 26, 1972 - Alignment to map scale 1" = 200 feet through South Brunswick sent to Planning Director.

June 27, 1972 - Alignment to map scale 1" = 200 feet and 1" = 2,000 feet sent to Manalapan Township Conservation commission for review and comments.

July 14, 1972 - Meeting with Mayor of Helmetta to discuss alternate alignments.

July 17, 1972 - Alignment to map scale 1" = 200 feet sent to Mayor of Helmetta.

OTHER SOURCES CONSULTED

Annual Report, New Jersey Turnpike Authority, 1971.

Buying Land for the Governor Alfred E. Driscoll Expressway
Public Information Department, New Jersey Turnpike Authority, September 1972.

Chapter 36, Laws of New Jersey, Section 71.

Field research by Howard, Needles, Tammen & Bergendoff, February 1972.

SECTION IV

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

Prepared for the New Jersey Turnpike Authority

by

BOLT BERANEK AND NEWMAN, INC.

This Section covers the following areas of study:

Any probable environmental effects of noise which cannot be avoided, including:

- Location and intended use of noise sensitive areas and buildings within a mile of the Expressway corridor, e.g., park areas, residential areas, schools, hospitals, churches
- Estimation of ambient noise levels prevailing in the various areas along the corridor
- Development of tentative noise criteria for the different land use and noise sensitive buildings along the corridor
- Development of initial estimates of toll road noise based upon projected traffic volumes, car-truck mix and roadway configuration
- Comparison of initial noise estimates with tentative noise criteria to determine the potential noise impact of the Expressway

Steps to be taken to minimize adverse environmental impacts:

- Selection of final design criteria for toll road noise based on detailed computation of noise levels in sensitive and critical areas

PROJECT APPROACH

The acoustic impact of the Expressway was assessed by comparing the predicted Expressway traffic noise levels corresponding to the "worst case" 1990 summer season traffic conditions to the proposed Federal highway noise standards. Although the New Jersey Turnpike Authority is not bound by the Federal highway noise standards, the standards have been widely applied throughout the country in connection with Federal-aid highways and, hence, have been applied to the Expressway also.

A preliminary impact assessment was made based upon a somewhat simplified noise prediction and analysis procedure that ignored the shielding effects of roadside structures, depressed roadways and terrain. The results of the preliminary assessment were used to define areas of potential impact requiring noise control measures, to select areas where acoustic field measurements should be made, and to determine areas where detailed noise prediction computations would be required.

Acoustic measurements were made at all acoustically sensitive non-residential buildings within 2000 feet of the proposed alignment to define the sound insulating properties of these structures. Measurements were also made of the ambient noise levels presently existing in the study area. The ambient noise measurement results were used to determine how much the noise environment would be changed by the Expressway traffic.

Based on the results of the acoustic measurement program, location and general dimension requirements were determined for noise shields that would reduce and eliminate, where feasible, the acoustic impact.

Revised noise levels were computed taking into account the noise shielding offered by depressed roadway designs, terrain and the planned noise shields. Detailed noise contours were drawn for the entire alignment. The final acoustic impact was assessed in terms of the number of residences impacted, the particular non-residential buildings impacted, and the percentages of park and recreational areas impacted. For undeveloped and/or unzoned lands, the noise contours may be used as guidelines for future land use planning.

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THE ACOUSTIC IMPACT
OF
THE GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

SUMMARY

The analysis of the acoustic impact of the proposed Governor Alfred E. Driscoll Expressway has involved the following steps:

a) The Expressway traffic noise levels were estimated corresponding to the traffic expected during the busiest three hours of the day in the summer season of the design year 1990.
b) A preliminary impact assessment was made by comparing the above levels to proposed Federal highway noise standards for outdoor and indoor land use.
c) A noise measurement survey of the area along the alignment was made to better define the sound insulation properties of the acoustically sensitive non-residential buildings, and to help define the existing ambient noise environment.
d) Based on the results of the acoustic measurement program, location and general dimension requirements for noise control shields were determined, revised noise levels were computed, and detailed noise contours were drawn for the entire alignment. The final acoustic impact was assessed by comparing the predicted noise levels (indoor and outdoor, as they apply) with the proposed Federal noise standards.

Some of the more important results of the final impact assessment are as follows:

a) A total of 25 residences, including 10 mobile homes and 15 scattered houses, fall within the noise impact region defined by the standards.
b) Two schools, the Manalapan High School and the Taylor Mills School, would be marginally impacted if no special noise control treatments are provided. Noise shields are planned for these areas, however, that will reduce the Expressway traffic noise to levels well below the standards. No other non-residential buildings require acoustic protection.
c) Less than 15% of three park and recreation areas and approximately 40 to 50% of a private bird sanctuary are expected to be impacted by the Expressway traffic noise. The noise sensitive areas of all other parks and public recreation areas are outside the noise impact region.
d) The noise levels predicted for the 1976 traffic when the Expressway opens are 4 to 5 decibels lower than the "worst case" 1990 traffic noise levels for which the impact has been assessed. Due to reductions in the noise emissions of individual vehicles over the next 10 to 20 years, it is likely that the noise levels along the alignment will never exceed the 1976 predictions. If vehicle noise levels are reduced by only five decibels, the impact zone as presently defined by the proposed Federal noise standards will not extend beyond the Expressway right-of-way.

1. FUNDAMENTAL CONCEPTS OF HIGHWAY NOISE

This section contains background information to provide the reader with an understanding of some of the fundamental concepts involved in this noise impact study.

Dimensions of Environmental Noise

Three dimensions of environmental noise are important in determining man's subjective response. These are:

1. The intensity or level of the sound;
2. The frequency spectrum of the sound;
3. The time-varying character of the sound.

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound level is a descriptor of the magnitude of these fluctuations and is usually measured and expressed in decibels (dB), with 0 dB corresponding roughly to the threshold of sensitivity of hearing.

The "frequency" of a sound refers to the number of complete pressure fluctuations per second in the sound. The unit of measurement is the cycle per second or Hertz (Hz). Most of the sounds which we hear in the environment do not consist of a single frequency, but of a broad band of frequencies, differing in relative level. The quantitative expression of the frequency and level content of a sound is its sound spectrum. Many rating methods have been devised to permit comparison of sounds having quite different spectra. Fortunately, the simplest method correlates with human response practically as well as the more complex methods [*1,2,3,4*]. This method consists of evaluating all of the content of a sound in accordance with a weighting that progressively and severely de-emphasizes the importance of frequency components below 1000 Hz, with mild de-emphasis above 5000 Hz. This type of frequency weighting reflects the fact that human hearing is less sensitive at low frequencies and extreme high frequencies than in the frequency midrange. The weighting curve most often used is called "A" weighting, and the level so measured is called the "A-weighted sound level", or simply "A-level".

The A-level in decibels is expressed "dBA"; the appended letter "A" is a reminder of the particular kind of weighting used for the measurement. In practice, the A-level of a sound source is conveniently measured using a sound level meter that includes an electrical filter corresponding to the A-weighting curve. All U.S. and international standard sound level meters include such a filter.

Although the A-level may adequately describe environmental noise at any instant in time, the fact is that the community noise level varies continuously. Most environmental noise includes a conglomeration of distant noise sources which creates a relatively steady background noise in which no particular source is identifiable. These distant sources may include traffic, wind in trees, industrial or farming activities, etc. These noise sources are relatively constant from moment-to-moment, but vary slowly from hour-to-hour as natural forces change or as human activity follows its daily cycle. Superimposed on this slowly-varying background is a succession of identifiable noisy events of brief duration. These may

include nearby activities or single vehicle passages, aircraft flyovers, etc., which cause the environmental noise level to vary from instant to instant.

Typical examples of noise fluctuations are illustrated in Figure 1.1. This figure shows how the noise at several locations varies with time during a two-minute period, and identifies the sources of some of the conspicuous intruding sounds. In each case the noise level tends to hover about some rather low value much of the time and individual events intrude upon this level to create peaks of noise. In a general way, the low noise level is regarded as "background noise" that comes from all directions and from a multitude of sources, none of them recognizable. In this report, as has become standard practice, the time-varying character of environmental sound is accounted for statistically [5,6,7,8,9]. Hence, this "background" level is defined as the noise level exceeded (sometimes only slightly) about 90% of the time; the noise level drops below this value only 10% of the time. Noise from individual intrusions, such as truck passages or airplane flyovers, cause the noise level to reach considerably higher "peak" values. These are the noisy intrusions that often disturb sleep or interrupt a train of thought and are associated to some extent, with the 10% level, the noise level exceeded 10% of the time. The average noise level is usually about equal to the 50% level, and lies about halfway between the 90% and 10% levels. The sound levels exceeded, respectively, 90%, 50%, and 10% of the time are designated by the symbols L_{90}, L_{50}, and L_{10}.

In locations where short-term fluctuations of noise levels are not too great (for example, where the major source is traffic on a distant, heavily traveled roadway), L_{50} serves well as a predictor of human response.

Quite close to a highway, however, noise levels vary much more from moment-to-moment, and human response relates more to the noise from individual vehicle passages, rather than to the median sound level. Very close to a highway, therefore, the A-level exceeded 10% of the time, is considered a good indicator of "human reaction" to the noise.

[Note that the choice of the 90% level to represent the "background" noise and the 10% level to represent "peaks" is rather arbitrary; the statistical analysis of the noise exposure is given by a continuous curve in which these particular levels are in no way conspicuous. Some countries (e.g., Australia) have chosen the 95% level to represent "background noise" and the 5% level for "peak noise."]

The Highway Noise Design Guide [9] recommends using L_{10} to predict human response when L_{10} exceeds L_{50} by 6 dB or more; proposed Federal highway noise standards [10] use L_{10} exclusively.

In summary, this study uses single-number descriptors to account for the three dimensions of environmental noise: its level, frequency spectrum, and time-varying character. The descriptors are the A-level in dB exceeded for a specified percentage of time; 50% (L_{50}), 10% (L_{10}), or 90% (L_{90}) as appropriate.

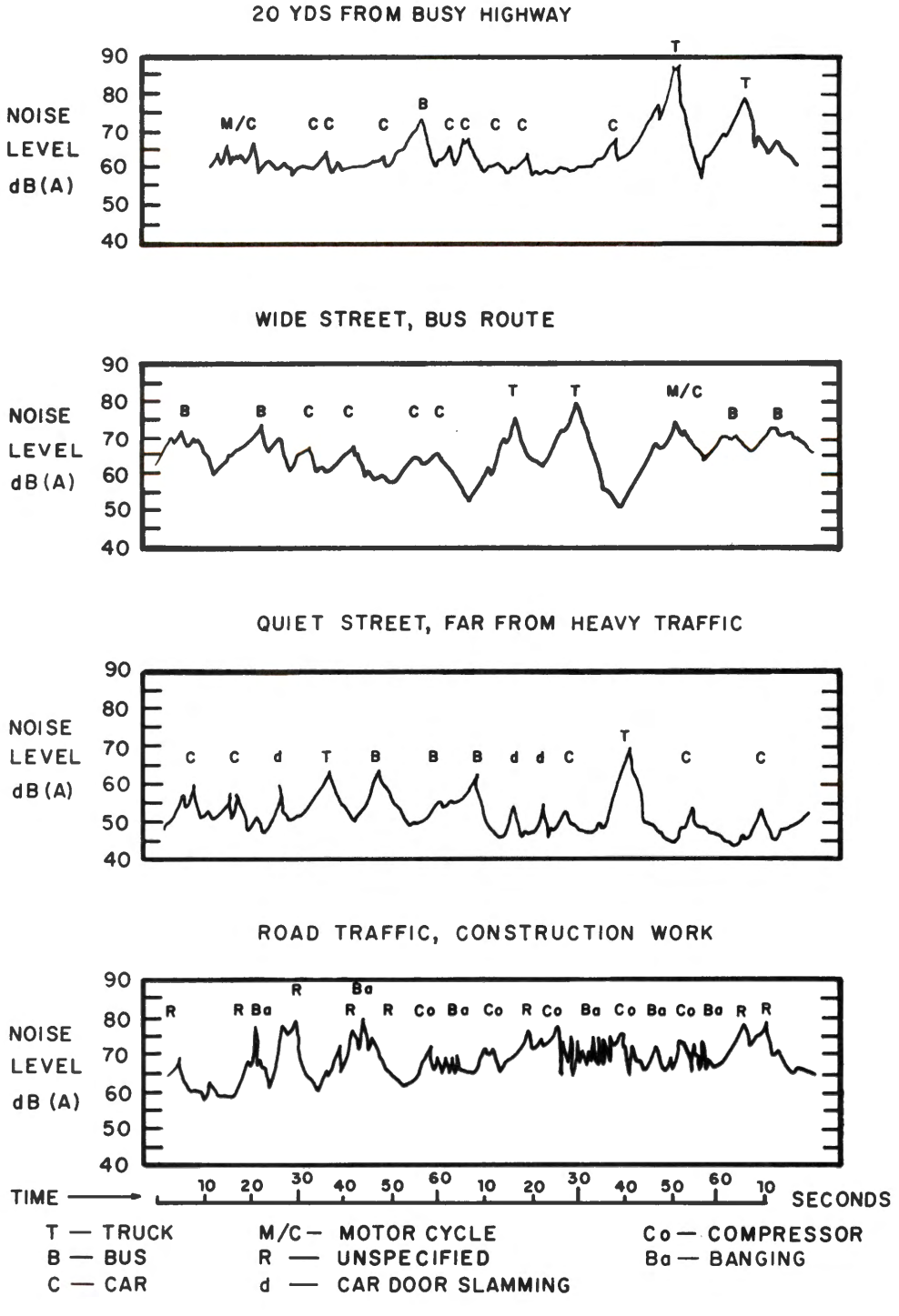


FIG. 1.1 - PATTERN OF SHORT TERM FLUCTUATIONS OF NOISE LEVELS AT VARIOUS SITES

Human Reaction to Environmental Noise

The effects of noise on people can be listed in three general categories:

1. Subjective effects of annoyance, nuisance, dissatisfaction;
2. Interference with activities such as speech, sleep, learning;
3. Physiological effects such as startle, hearing loss.

The sound levels associated with traffic noise, in almost every case, produce effects only in the first two categories.

Unfortunately, there is as yet no completely satisfactory measure of the subjective effects of noise, or of the corresponding reactions of annoyance or dissatisfaction. This is primarily because of the wide variation in individual thresholds of annoyance, and habituation to noise over differing individual past experiences with noise [11]. Some trends, however, are generally considered to be reliable. For example, a well known English acoustician has suggested that the annoying quality of a sound increases not only with the increase in its level, but also with the increase in fluctuation in the noise. His descriptor, termed "Noise Pollution Level" [27], takes accounting of both the steady content of the noise and fluctuations in level. The 10% level, L_{10}, is also an indicator of the peakiness of the fluctuations.

Another widely held view is that the more a new noise increases the previously existing ambient noise, the more objectionable it will be judged. It is for this reason that many criteria for allowable noise hinge upon an estimate of the existing ambient noise levels. It is also for this reason, in part, that the recent federal guidelines to be discussed later in the text, for preparation of environmental impact statements urge that a noise measurement program be undertaken to define the presently existing ambient noise levels in the vicinity of a proposed new highway.

With regard to increases in noise level, knowledge of the following relationships will be helpful in understanding the quantitative sections in this report [11,12]:

1. Except in carefully controlled laboratory experiments, an increase of only one dB in A-level cannot be perceived.
2. Outside of the laboratory, a three dB increase in A-level is considered a just-noticeable difference.
3. A change in A-level of at least five dB is required before any noticeable change in community response would be expected.
4. A ten dB increase in A-level is subjectively heard as approximately a doubling in loudness.

Social surveys have shown that interference with sleep is a major source of environmental noise annoyance [13]. Direct quantitative study of sleep interference is difficult because of the different physiological states of sleep, and because of the fact that sleep interference can exist without a person being consciously awakened. The greater part of the early work in this field relied upon data gained in social survey response and in

unsolicited complaints indicating the noise conditions resulting in the complainants loss of sleep.

In the laboratory, recent investigations [16,25] have involved the assessment of sleep interference where the noise source is a recording of a passing truck. Other investigators [26] have used a steady sound source as a stimulus increased periodically in level. In every investigation, an extremely wide variation was found in reaction from individual to individual. For example, for the recorded truck noise having a peak noise level of 50 dBA, some subjects awakened more than 50% of the time, while others practically never awakened, even at 75 dBA. When a steady noise level was raised periodically in 5 dB steps, more than half the subjects awakened when the level reached 45 decibels; while the range of levels that awakened individual subjects was 35 decibels.

No schemes for predicting sleep interference on an individual basis have been universally accepted. However, some methods are becoming available to statistically describe sleep interference of a sample population at large. Standards in use to date are based on these statistical descriptors and do not necessarily apply to any particular individual.

Because techniques of investigating speech interference relationships lend themselves to systematic laboratory experiment, a considerable amount of data has been collected on the subject and the relationships are fairly well defined. For example there are well documented estimates of continuous noise levels which should not be exceeded if satisfactory group discussion or TV listening is desired [9]. The specific relationships that apply in a host of various situations that we encounter daily vary widely. The most appropriate limit for maximum background noise in a given situation is just below that point at which the speaker finds the required voice effort too demanding or otherwise unsatisfactory.

Effect of Noise on Wildlife

The question of highway noise effects on wildlife cannot be answered quantitatively at this time. All of the testing that has taken place has been either with noise of very high levels or of rather brief durations (less than one month), and virtually all in the laboratory rather than in the natural habitat.

A body of data has been gathered that confirms similarities in the reactions of noise of the lower animals and man. Animals suffer temporary hearing impairments upon exposure to high (over 90 dBA) noise levels. Sustained high noise levels, repeated exposure to these levels, or brief exposures to very high noise levels can cause permanent hearing losses. Repeated exposures to a noise with rest periods are less harmful than a continuous exposure to noise of equal total duration. Exposures to very high noise levels cause both detectable internal (adrenal activity, blood hormone levels, etc.) and observable external (avoidance of noise source, decreased learning ability, decreased sexual activity, etc.) indicators of stress. Stress levels decrease with repeated exposures to a given noise as the animal adapts to the new environment. Again, these experiments have been performed in the laboratory with noise levels far in excess of

those levels encountered in the vicinity (200 feet) of a major limited access highway.

It may be conjectured that animals would tend to move away from noise areas that cause impairment of their natural activities such as communication in prey and preditor location and mate attraction. However, the literature offers no conclusive findings in this regard.

Briefly, the conclusions reached regarding the effects of noise on wildlife can be summarized in two statements as follows:

1. It appears unlikely that highway noise will produce severe physical effects such as deterioration of hearing. [14]
2. Methods for assessing the impact of highway noise (if any) on the normal life habits of animals does not exist at this time. [15]

No further consideration, therefore, will be given in this report to the impact of the Expressway noise on wildlife.

Parameters of Highway Noise

In the procedure for developing highway noise predictions, three groups of parameters are analyzed; those relating to (1) traffic, (2) the roadway, and (3) the observer.

The traffic parameters that affect noise are the number and type of vehicles which pass a point during a time period of interest and the average speed of the vehicles. Because speed affects the noise generated by cars and trucks differently, these vehicle categories are analyzed separately; the predicted noise levels from the two sources are then combined.

Highway noise increases as the number **and** the average speed of automobiles on it increase. For example, if the automobile traffic volume should double, the noise level from automobiles would increase by about 3 dB. Should the speed decrease to half, the noise level from automobiles would decrease by about 6 dB. The engine-exhaust system and the tire-roadway interaction are prominent contributors to the overall automobile noise.

Truck noise behaves differently. An average truck generates A-levels about 15 dB higher than those of a car; the noise contribution from a single truck is approximately equal to that from thirty cars. Because trucks are usually operated at nominally constant engine rpm, the engine-exhaust noise does not change with road speed; the noise of an individual truck is, therefore, virtually independent of its speed [3]. The condition of the truck muffler is very important, however. A-levels 15 dB higher than average can result from improperly muffled trucks [16].

The major roadway parameter that affects highway noise is the slope, or gradient. For example, a 5% road grade adds about 3 dB to truck noise (automobile noise is not affected by the roadway grade) [17]. Noise resulting from the tire-roadway interaction can be influenced by the characteristics of the tires and the roadway surface. This report assumes

a "normal" surface: moderately rough asphalt or concrete. Variations in A-level of ± 5 dB can be expected for surfaces of rough asphalt with large voids or grooved concrete at one extreme to very smooth, seal-coated asphalt at the other [3,18].

The "observer" parameters are those that affect the relationship of the receiver's position to the vehicle-roadway noise source. The major factor in this category is the distance from the observer to the highway: the greater the distance, the lower the noise level. A doubling of the distance from the highway (for example, going from 200 ft. to 400 ft., or from 2000 ft. to 4000 ft.) will reduce the traffic noise at the observer's position by about 4 dB. Beyond distances of a mile, the drop-off rate is about 6 dB per doubling of distance; the additional attenuation results in part from the effect of atmospheric absorption of sound [9].

Noise shields that block the line-of-sight from the observer to the highway are another "observer" factor affecting highway noise propagation. These shields include natural features such as hills or other changes in ground elevation, and vegetation, including trees. Man-made shielding elements include houses or other structures, walls, earth berms, etc.

The acoustical effectiveness of the shielding depends upon the extent to which it blocks the line-of-sight to the highway, as well as upon the characteristics of the barrier itself. For example, if a shield blocks only half the view of a length of highway which would otherwise be fully exposed, the noise level reduction would be limited to only 3 dB, regardless of the structure of the barrier itself.

If a view of the highway vehicles is completely shielded, the A-level attenuation by a solid wall may vary from 5 dB for low walls to a maximum of about 24 dB for very large walls [19]. A single row of houses may reduce highway noise about 5 dB; multiple rows of houses will provide a reduction of up to 10 dB [20,21]. Trees, if densely planted, and at least 15 ft. tall, may provide a reduction of as much as 5 dB per 100 ft. of woods depth, approaching a maximum of 10 dB [22,23,24].

2. HIGHWAY NOISE STANDARDS

The noise standards used in this impact statement are those proposed standards of the Federal Highway Administration in the Draft Policy and Procedure Memorandum (PPM) 90-2 [10]. These standards are intended to "assure that possible adverse economic, social and environmental effects relating to any proposed project on any Federal-aid system have been fully considered in developing such project...". Although the New Jersey Turnpike Authority is not bound by this standard, the standard has been widely applied throughout the country in connection with Federal-aid highways and, hence, will be applied to the Expressway also.

The maximum noise levels designated in PPM 90-2 are expressed in terms of the dBA L_{10} descriptor for various land uses as described in Table 2.1.

The exterior noise levels apply to outdoor areas which have regular human use and in which a lowered noise level would be of benefit. The standards do not apply to an entire tract upon which the activity is based, but only to that portion in which the activity occurs.

The interior design noise level in category E applies to indoor activities for those situations where no exterior noise sensitive land use or activity is identified, or in special situations when such consideration is in the best public interest. Of course, the inside standard can be converted to an equivalent outside standard for any structure by the addition of the outside-to-inside noise reduction intrinsic to the structure itself. In the absence of the noise reduction values for specific structures, PPM 90-2 suggests using the typical values shown in Table 2.2.

PPM 90-2 also recognizes that an excess of a new noise over the existing ambient is a major factor in human annoyance. While no specific standards are defined in this regard, the PPM requires that the existing ambient noise be estimated and compared to the predicted noise of the proposed highway.

For particularly low traffic volume, the L_{10} standards may no longer be meaningful. The peak noise level, however, of a passing truck accelerating up a graded ramp may be the source of considerable annoyance and sleep interference. While PPM 90-2 does not address this particular situation, for purposes of this impact statement, a standard for the limiting peak noise of a passing truck has been set at 75 dBA. For a typical truck during acceleration up a ramp from a low speed condition, this standard would be satisfied at distances from the ramp of 275 feet and greater.

TABLE 2.1

DESIGN NOISE LEVEL / LAND USE RELATIONSHIPS [10]

Land Use Category	Design Noise Level - L_{10}	Description of Land Use Category
A	60 dBA (Exterior)	Tracts of lands in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, or open spaces which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 dBA (Exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreation areas, playgrounds, active sports areas, and parks.
C	75 dBA (Exterior)	Developed lands, properties or activities not included in categories A and B above.
D	---	For requirements on undeveloped lands (see paragraphs 5.a(5) and (6) of PPM 90-2 [10]).
E	55 dBA (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

TABLE 2.2

TYPICAL NOISE REDUCTIONS OF STRUCTURES [10]

Building Type	Window Condition	Noise Reduction Due to Exterior of the Structure	Corresponding Highest Exterior Noise Level Which Would Achieve an Interior Design Noise Level of 55 dBA
All	Open	10 dB	65 dBA
Light Frame	Ordinary Sash Closed	20	75
	with Storm Windows	25	80
Masonry	Single Glazed	25	80
Masonry	Double Glazed	35	90

3. PRELIMINARY IMPACT ASSESSMENT

In order to define areas of potential impact requiring noise control measures, to select areas where acoustic field measurements should be made, and to determine areas where detailed noise prediction computations are required, a preliminary impact assessment was made based upon a somewhat simplified noise prediction and analysis procedure.

Traffic Noise Computations

The expected Average Annual Daily Traffic (AADT) volumes used in this report to compute traffic noise levels have been provided by Coverdale & Colpitts, Inc., transportation consultants for the New Jersey Turnpike Authority. The estimated traffic volumes and truck percentages are given for 1976, the expected first full year of operation, and for 1990, the design year of the highway, for each of the roadway sections between interchanges.

It is expected that the hour-to-hour traffic patterns on the Expressway will be quite similar to those on U.S. Rt. 9, an existing major highway running approximately parallel to the Expressway. Thus, the hourly traffic data on Rt. 9 was applied to the Expressway as percentages of the AADT.

The proposed Federal highway noise standard, PPM 90-2, allows some latitude in the selection of traffic flow conditions: "If design hourly volume or level of service C traffic conditions are not anticipated to occur on a regular basis during the design year, the average hourly volume for the highest 3 hours on an average day for the design year may be used." For this impact study, the 1990 average summer day traffic volume is used in place of the "average day" traffic volume, the former having a greater automobile volume by a factor of 1.5.

Traffic noise is also a function of vehicle speed. The Highway Capacity Manual includes a chart shown in Figure 3.1 which can be used to determine average vehicle speed, given the traffic volume per lane and the design speed of the highway.

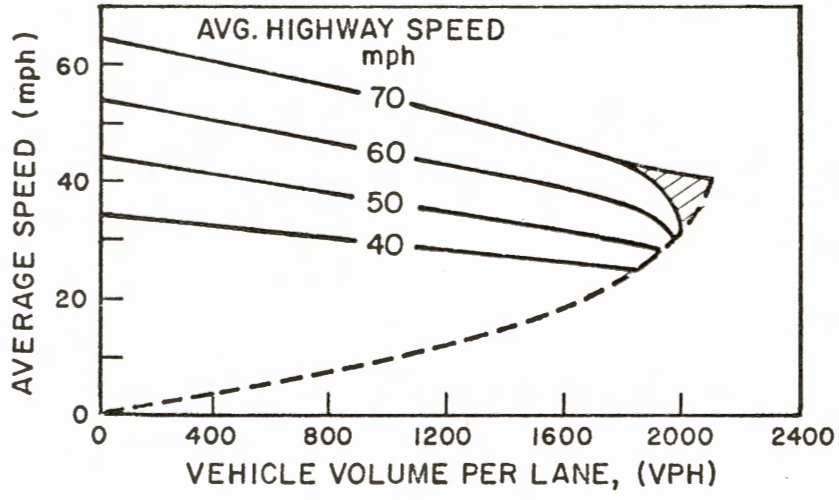


FIGURE 3.1

VEHICLE VOLUME AND SPEED RELATIONSHIPS [9]

Based upon this traffic data, estimates of Expressway noise along each segment were computed according to the procedures given in the Highway Noise Design Guide [9]. For example, Figure 3.2 shows the predicted noise levels in dBA L_{10} as a function of distance from the near lane of the Expressway segment between the I-195 interchange and the N.J. Rt. 33 interchange. The computations are based upon a predicted AADT of 21,000 vehicles with 3.7% trucks corresponding to 5837 cars per hour and 55 trucks per hour at an average speed of 55 mph for the 1990 peak three hour traffic conditions. The estimated 3.7% trucks include only vehicles of NJTPA designations class 3 and above. These categories exclude light, gasoline powered trucks which behave acoustically like automobiles.

Preliminary Analysis Procedure and Results

Preliminary noise level contours were superimposed upon aerial photographs and maps of a two-mile wide corridor along the alignment. The alignment geometry was taken into account in these computations; but, shielding by natural land forms, roadside structures, and buildings was not considered, nor was the sound attenuation offered by forested areas. Residences and acoustically sensitive non-residential buildings within 2000 feet of the alignment, and parks and recreational areas within one mile of the alignment, were identified on the aerial photographs and maps.

All residences and portions of parks and recreation areas lying within the 70 dBA L_{10} contour were classified as impacted. For the schools, churches, hospitals and rest homes identified along the alignment, the inside standard of 55 dBA L_{10} was used and the 10 dBA typical open window noise reduction was assumed resulting in the equivalent outside noise standard of 65 dBA L_{10}. Hence, acoustically sensitive non-residential buildings within the 65 dBA L_{10} contour were classified as impacted.

In general, the impact region for residences and parks extended out to a distance from the edge of the near traffic lane of 200 feet at the south end of the Expressway increasing to 300 feet at the north end near the New Jersey Turnpike interchange.

All of the acoustically sensitive non-residential buildings within 2000 feet of the alignment are listed in Table 3.1 along with their distances from the near traffic lanes and the respective predicted external noise levels.

This preliminary assessment provided the information necessary for determining where noise control requirements might be needed and where acoustic field measurements and more detailed study were required.

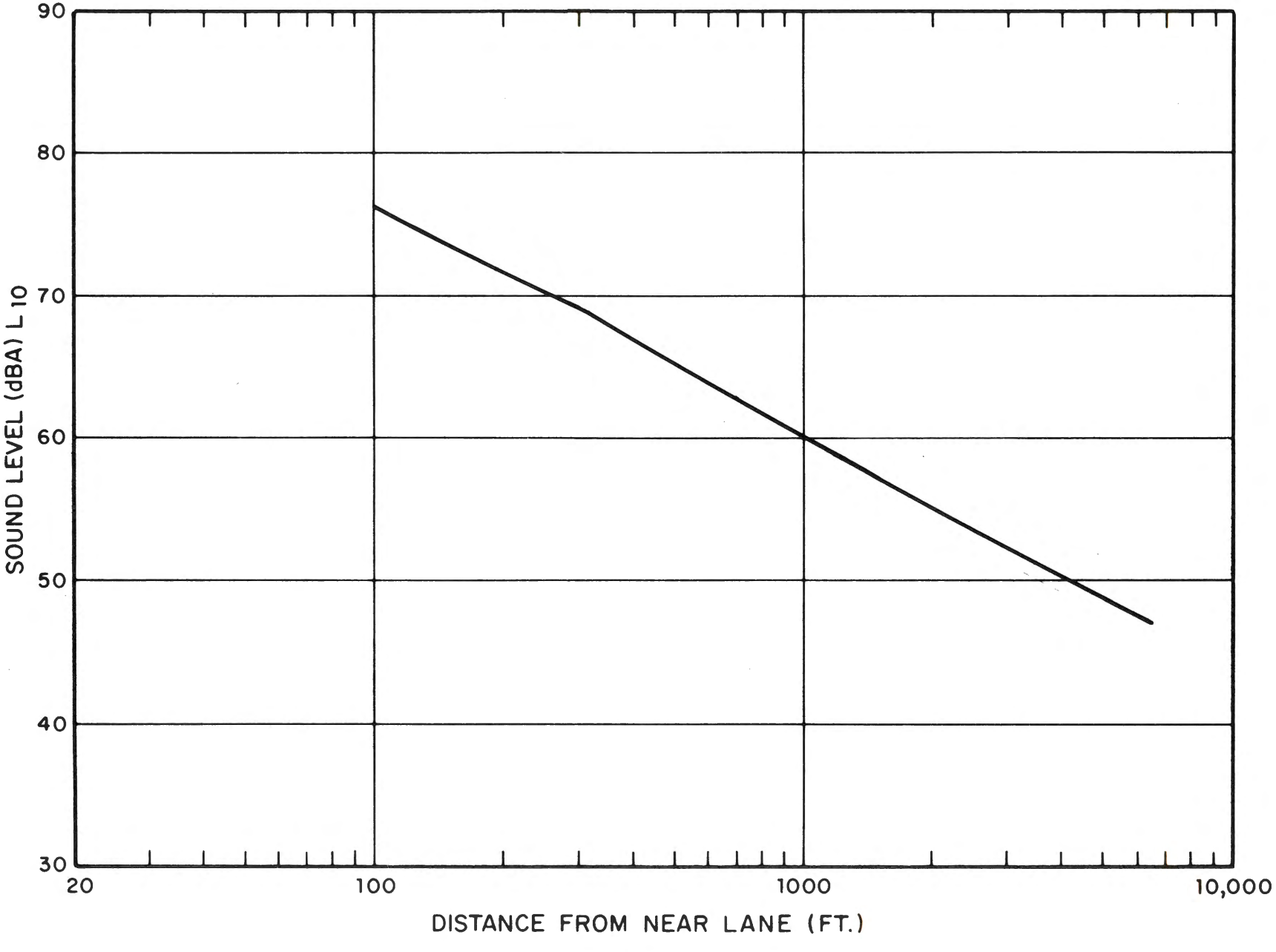


FIG. 3.2 - SAMPLE L_{10} LEVELS FOR 1990 SUMMER PEAK HOUR TRAFFIC

TABLE 3.1

PRELIMINARY IMPACT ASSESSMENT FOR ACOUSTICALLY SENSITIVE NON-RESIDENTIAL BUILDINGS

Building and Location	Distance from near lane, feet	Exterior Noise Level, dBA L_{10}
Second Baptist Church* Toms River Township	500	62
First Church of Christ Scientist Toms River Township	800	58
Church of God Toms River Township	900	58
Country Manor Nursing Home** Toms River Township	1000	61
Whitesville United Methodist Church Whitesville	1800	55
Harmony Methodist Church Jackson Township	500	66
First Assembly of God Church Freehold Township	1100	60
Freehold Hospital Freehold Township	1400	58
Manalapan High School Manalapan Township	800	61
Taylor Mills School Manalapan Township	500	65
Clark Mills School Manalapan Township	1300	59
Carver Nursing Home Manalapan Township	1200	59
Holy Trinity Church Helmetta	500	67

* Building is south of Rt. 37.
** Building is closer to Garden State Parkway than the Expressway.

4. NOISE MEASUREMENT PROGRAM

In Section 3 the acoustic impact was estimated by assuming a uniform 10 dBA noise reduction for all buildings along the alignment. After a brief review of the building types involved, it was clear that some of the buildings may have more than the 10 dBA noise reduction and some may have far less. The actual amount was determined by the measurement program described in this section.

Measurements were also made of the ambient noise levels presently existing in the study area. This data will be used to determine how much the noise environment will be changed by the traffic from the Expressway.

Noise Reduction Measurements

A series of acoustic measurements was made at particular buildings to evaluate their outside-to-inside noise reduction properties. The noise reduction values reported here are the differences between the sound pressure levels measured in the field of an artificial sound source outside a structure, and the resulting levels measured inside the structure. Thus, the property of noise reduction combines effects of the acoustic transmission loss properties of the individual building construction with other factors such as size of openings, composite construction (two or more materials), cracks and leaks, size of room, absorption in the space, and line-of-sight from the measurement location to the noise source.

Measurement Procedure - Since there is no firmly established system for measuring the noise reduction of an exterior wall construction, the method used was tailored to fit the particular problem at hand.

First, a constant sound power source was placed outside the buildings. The frequency spectrum of this source was predetermined to match a typical spectrum of a mix of trucks and cars similar to that expected on the proposed Expressway at an arbitrary distance of 300 feet. Since this type of noise reduction measurement is a measure of the difference between sound pressure level inside a building and outside, in theory, any sound having sufficient power in all significant octave bands, could serve as a noise source. However, because the noise source spectrum matched the expected highway noise spectrum, the noise reduction provided by the construction could be evaluated by measuring the outside and inside A-weighted levels only. The single number "A-weighted" noise reduction which resulted is a value which reflects the effectiveness of each building investigated in reducing the noise from highway traffic as stated in units that correlate well with human response.

The noise source was always located 50 feet from the outside of the wall to be studied. Sound level measurements were then made: 1) at the exterior wall, 3 feet from the surface; 2) inside the building with windows open; 3) inside the building with all openings closed; 4) 50 feet from the source in free-field conditions.

Measurements 1, 2 and 3 were repeated with the noise source at different angles of incidence to the wall because the transmission loss properties of a wall may vary slightly with the angle of incidence of the impinging sound. Since these variations were found to be small, the noise reduction

for each construction was determined by averaging the test results.

Measurement 4 was made at each location to corroborate the measurement 1 results which may have been influenced by the proximity of the wall under investigation.

Measurements 2 and 3 inside the buildings were made near those locations most sensitive to intrusive levels from outside; i.e., church pews, classroom seats, or bed locations nearest the windows, as applicable.

For a noise source, a pre-recorded magnetic tape of the sample highway noise spectrum was played through a Kudelski Nagra III tape recorder; the signal was amplified by a power amplifier and reproduced acoustically by a pair of loudspeakers. Sound level measurements were made with a Bruel & Kjaer Sound Level Meter Type 2203, having a one inch Bruel & Kjaer 4131 condenser microphone, with a random incidence corrector. The sound level meter was calibrated at the beginning of each test with a Bruel & Kjaer Acoustic Pistonphone, Type 4220.

Noise Reduction Measurement Results - Wherever possible, the noise source was located so that its bearing with respect to the building was similar to that of the proposed alignment. The measurement results (in "A-weighted noise reduction values" at each site) are given in Table 4.1. Descriptive notations about each building are given below.

Notes to Table 4.1

1. The proposed alignment runs about 500 feet from the side of the Holy Trinity Roman Catholic Church in Helmetta, across the far end of the parking lot. There are 12 operable pivoted windows, each about 3 square feet in area, facing the parking lot, and approximately 10 feet above ground level. The loudspeaker was located at ground level 50 feet from the side of the church.

2. First Assembly of God Church in Georgia faces the alignment at an oblique angle. The far end of the church has no operable windows, while the side of the church has 5 double hung sash windows. The church appears to be masonry block or frame construction with a stucco exterior finish. There are two window air conditioners which are used to cool the church before services or during extremely hot weather. The noise source location was 45° from the corner of the church nearest the alignment, and the measurement was taken at the front and side pews nearest the source. The relatively low noise reduction values measured with "windows closed" is attributable to numerous clearly visible air leaks around the window air conditioners.

3. The United Methodist Church is a small wood-frame building. The noise source location was made at a 45° angle from the rear of the corner of the church; the alignment is to the rear of the church. There was only one of three operable sash windows which could be opened on the side of the church facing the test noise source. The remainder had aluminum storm windows in place. The "windows closed" measurement was somewhat lower than expected due to a loosely fitting window with no

TABLE 4.1

OUTSIDE-TO-INSIDE NOISE REDUCTION MEASUREMENT RESULTS

Building and Location	Noise Reduction, dBA	
	Windows Open	Windows Closed
A. Wood frame or masonry block construction: churches		
1. Holy Trinity Roman Catholic Church, Helmetta	14	30
2. First Assembly of God, Georgia	18	24
3. Whitesville United Methodist Church, Whitesville	16	25
4. Methodist Church, Harmony	16	28
B. Brick construction: schools		
5. Clark Mills School, Englishtown	11	30
6. Taylor Mills School, Englishtown	10	25
7. Manalapan High School, Englishtown	6	26
C. Brick construction: institutional		
8. Freehold Area Hospital, Freehold	14	29
9. Carver Nursing Home, Englishtown	19	30

storm window at the chancel. There are several buildings to the rear of the church between the church and the alignment.

4. Harmony Methodist Church was measured in a similar manner to the Georgia First Assembly of God and the Whitesville United Methodist; the loudspeaker was located 45° from the side wall. The results were typical for this type of wood frame construction.

5. The operable windows of the Clark Mills School are two 4' x 6' double hung sash windows having 24 square feet of open area. Overall, the total area of glazing facing the loudspeaker was almost 100 square feet, or about 38% of the exterior wall. The classroom size was about 950 square feet. The classroom in which the measurements were made has an exposure to the proposed alignment. The fact that all the school buildings investigated have large areas of glass explains the low noise reduction values for "windows open" and also indicates a weakness in the sound isolation construction for the "windows closed" condition. In addition, the open windows allow direct line-of-sight between the loudspeaker and the measurement position of classroom seats near the window.

6. At the Taylor Mills School, the entire upper part of the exterior wall, or 144 square feet, is glass; this is about 65% of the total wall surface. The floor area of the room investigated is only about 600 square feet, and the room windows are two 4' x 6' operable windows for 24 square feet of opening. The open window noise reduction compares well with that of the Clark Mills School having a similar open window area; the greater percentage of glazing at the Taylor Mills School is revealed by the lower closed window noise reduction.

7. The room which was evaluated at Manalapan High School is similar to those on the other side of the building facing the alignment. There are three sets of two double-hung sash windows, each window having about 10 square feet of opening for a total of about 60 square feet. Overall, the exterior wall is about 40% glass.

8. The room used for measurements at the Freehold Area Hospital is similar to rooms facing the alignment and is air conditioned. The window openings are about 15 square feet. The pivot of the window broke the line-of-sight to the loudspeaker.

9. The operable windows at the Carver Nursing Home are two rectangular panels with a total opening of only about 6 square feet. The nursing home noise reduction for "open windows" is consequently better than that for the Hospital. Also, because the windows are near the ceiling, there is no line-of-sight during "windows open" to the loudspeaker - the sound path has at least one reflection.

Ambient Noise Measurement Program

A series of ambient noise measurements was made along the alignment to help define the existing acoustic environment. This data is required to determine how much the existing environment can be expected to change as a result of the Expressway traffic. Because most outdoor activities in parks

and residential areas take place during the daylight hours, most measurements were conducted during the daytime. Sample measurements were also made during nighttime hours so that comparisons could be made at typical locales.

Measurement Procedure - In order to gather a data sample of statistically significant duration, tape recordings twenty minutes long were made at each location. The reference site number, the location description, the date and time of the recordings, the L_{10} values, and the principal noise sources as subjectively evaluated by the field engineer are all shown in Table 4.2. The source evaluation was made on a scale running from "1" to "3"; "1" indicates a major contributor toward the recorded level, "3" indicates a minor contributor.

Figure 4.1 shows block diagrams of the noise measurements and data analysis equipment. Bruel and Kjaer (B&K) 4220 pistonphones were used for system calibration at each measurement site. With the sound level meter set for "flat" weighting, the pistonphone was applied to the microphone and the calibration signal was recorded on magnetic tape. For data recording, the sound level meter was reset for "A" weighting and the microphone was placed approximately 5 ft. above the ground, away from nearby reflecting objects. The recorded pistonphone signal was also used for calibration purposes during data reduction.

The weather conditions shown in Table 4.3 are those observed at the measurement sites at the times of the measurements. Measurements were not conducted under weather conditions that would adversely affect the validity of the noise data. Wind speed was measured with a Deuta-Werke hand-held cup anemometer; relative humidity and temperature were measured with a Bendix Model 566 mechanically-aspirated psychrometer. Other observations were visual.

Daytime Measurement Results - The 57 measurement sites can be divided into four general categories:

a) Sites in campgrounds, parks, and other isolated areas far from any identifiable noise sources
b) Sites sufficiently near regularly travelled roads so that the ambient noise levels were controlled by traffic noise
c) Sites in developed residential or commercial areas
d) Sites not clearly falling into any of the above three categories.

There were twenty-three sites in category a). These included 12 sites at campgrounds, parks, picnic areas, a Girl Scout Camp, and a bird sanctuary; 6 sites at residential communities or housing developments far from major highways; and 5 sites at isolated areas having no local traffic nor other identifiable local noise sources. The remote site noise measurements are shown together of Fig. 4.2.

For the 24 sites in category b), the AADT data for the major roads in the vicinity of the alignment was used to estimate the ambient noise levels, assuming 5% AADT for mid-afternoon hourly traffic and 3% trucks. Comparisons of measured data with the predicted noise levels are shown in Fig. 4.3.

TABLE 4.2

SUMMARY OF AMBIENT NOISE SURVEY

10-14 July 1972

Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
1A	2nd Baptist Church Toms River, 700' from Garden State Parkway	11 July 1972 11:20 a.m.	55	1. Garden State Parkway
1B	Housing Development, 500' from truck route, 1000' from Garden State Parkway	11 July 1972 10:05 a.m.	60	1. Local truck route 2. Garden State Parkway
1C	Toms River 1st Baptist Church Youth Building, 100' from Main St., Route 9	11 July 1972 12:05 p.m.	62	1. Local traffic on Main Street
1E	First Church of Christ Scientist, 150' from Route 9	11 July 1972 2:15 p.m.	59	1. Traffic on Route 9
1G	Country Manor Nursing Home, 120' from Garden State Parkway	11 July 1972 3:00 p.m.	65	1. Garden State Parkway
1H	Albocondo Campgrounds	11 July 1972 5:20 p.m.	45	1. Wind in trees
1I	KOA Campgrounds	12 July 1972 11:45 p.m.	47	1. Wind in trees 2. Campground activities
1J	Riverwood Park, Parking Lot	12 July 1972 4:50 p.m.	46	1. Distant traffic 2. Birds, wind in trees

TABLE 4.2
(continued)

Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
1K	Riverwood Park	12 July 1972 4:10 p.m.	46	1. Park activities 2. Birds, wind in trees
1L	Whitesville United Methodist Church, 80' from Route 527	14 July 1972 9:35 a.m.	61	1. Traffic on Route 527
1M	On Locust Street, 400' West of Route 9, 500' North of Route 70	13 July 1972 6:00 p.m.	51	1. Traffic on Route 70, with rough road surface 2. Traffic on Route 9
1N	Cedar Glen Retirement Community, Recreation Center	12 July 1972 12:45 p.m.	47	1. Air conditioners 2. Activity in community 3. Distant traffic
1P	Pine Lake Park, Corner 10th Avenue and Burnside Avenue	12 July 1972 2:20 p.m.	45	1. Distant traffic 2. Wind in trees
1Q	Cedar Glen Retirement Community, corner of Central & Magnolia	12 July 1972 1:35 p.m.	48	1. Residential air conditioners 2. Distant traffic
1R	Beaver Dam Road, 1000' from intersection of Church Street, 1000' from Garden State Parkway	11 July 1972 4:20 p.m.	53	1. Garden State Parkway
1S	Todd Road, 2400' from intersection with Freehold Road, 400' from Garden State Parkway	11 July 1972 3:45 p.m.	57	1. Garden State Parkway

TABLE 4.2
(continued)

Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
1T	Volante Road, 1 mile NE of Route 571	13 July 1972 4:55 p.m.	49	1. Distant diesel railroad engine 2. Birds, wind in trees 3. Distant traffic
1U	Wilbur Road, 500' West of Route 70	12 July 1972 3:15 p.m.	53	1. Traffic on Route 70 2. Traffic on Route 571
2A	Pleasant Gardens Adult Community, 300' from both Routes 528 and 547	14 July 1972 9:30 a.m.	58	1. Traffic on Routes 528 and 547 2. Aircraft 3. Air conditioners
2B	Housing Development South of Bennetts Mills, Bennett Road and Gregory Blvd.	13 July 1972 3:55 p.m.	56	1. Traffic on Bennett Mills road 2. Wind in trees
2C	Recreation Area, off Frank Applegate Road	13 July 1972 2:55 p.m.	46	1. Distant traffic
2D	Butterfly Campgrounds	13 July 1972 3:20 p.m.	43	1. Birds, wind in trees
2E	Harmony Methodist Church, 80' from Harmony Road	12 July 1972 4:35 p.m.	60	1. Birds, wind in trees 2. Distant traffic 3. Local traffic
2F	Community of Bennetts Mills Locust Drive, 800' from Route 526	12 July 1972 5:00 p.m.	49	1. Distant traffic on Route 526 2. Wind in trees

TABLE 4.2
(continued)

Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
2G	Frank Applegate Road, off Jackson Mills Road	12 July 1972 4:00 p.m.	45	1. Wind in vegetation
2H	Nomoco Girl Scout Camp	12 July 1972 11:00 a.m.	50	1. Wind in trees 2. Camp activity
2I	First Assembly of God Church, Georgia, 200' from crossroads	12 July 1972 10:25 a.m.	56	1. Local traffic passing at intersection
2J	Pfister Road 2000' off Farmingdale Road	12 July 1972 5:45 p.m.	48	1. Birds, wind in trees 2. Distant traffic
2K	Turkey Swamp Picnic Area	12 July 1972 11:50 a.m.	56	1. Birds, wind in trees 2. Picnic activity noise
2L	Turkey Swamp Campgrounds	12 July 1972 12:20 p.m.	51	1. Birds, wind in trees
2M	Housing Developments, South of Freehold Area Hospital, Ticonderoga Blvd. & Havens Mill Road	12 July 1972 2:40 p.m.	50	1. Distant traffic 2. Occasional activity
2N	Freehold Area Hospital, 200' to Route 537	11 July 1972 5:10 p.m.	55	1. Traffic on Route 537
2P	Schanck Road, corner of Stonehurst Blvd., 500' West of Route 9	13 July 1972 11:40 a.m.	60	1. Traffic on Route 9
2P	"	12 July 1972 3:40 a.m.	53	1. Traffic on Route 9

TABLE 4.2
(continued)

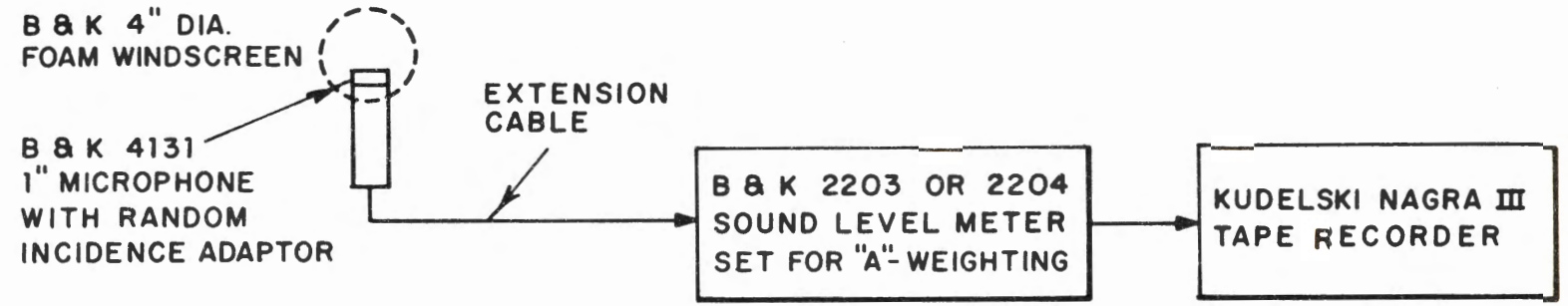
Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
2Q	Between Routes 524 & 537, Thompsons Grove Road, 800' from each road	12 July 1972 3:15 p.m.	51	1. Traffic on Route 537
2R	600' off Route 33, in Monmouth Battlefield Park	13 July 1972 5:15 p.m.	57	1. Traffic on Route 33
2S	600' off Route 33, at Millhurst intersection	11 July 1972 4:00 p.m.	53	1. Traffic on Route 33
2T	Middle of Monmouth Battlefield Park, between Routes 522 & 33	13 July 1972 5:55 p.m.	51	1. Wind in vegetation 2. Distant traffic
2U	In Freehold, on Broad Street between Manalapan Ave., one block from W. Main Street	12 July 1972 2:00 p.m.	59	1. Urban traffic
3A	Manalapan High School	10 July 1972 11:40 a.m.	50	1. Local traffic
3B	Taylor Mills School, 200' from Gordons Corner Road	11 July 1972 12:05 p.m.	55	1. Local traffic on Taylor Mills Road
3C	Clark Mills School, 400' from Gordons Corner Road	27 June 1972 4:00 p.m.	53	1. Local traffic on Taylor Mills Road
3D	Old Tennent Church, 200' from Tennent Road, 1700' to Route 522	11 July 1972 2:30 p.m.	53	1. Local traffic on nearby roads 2. Distant traffic

TABLE 4.2
(continued)

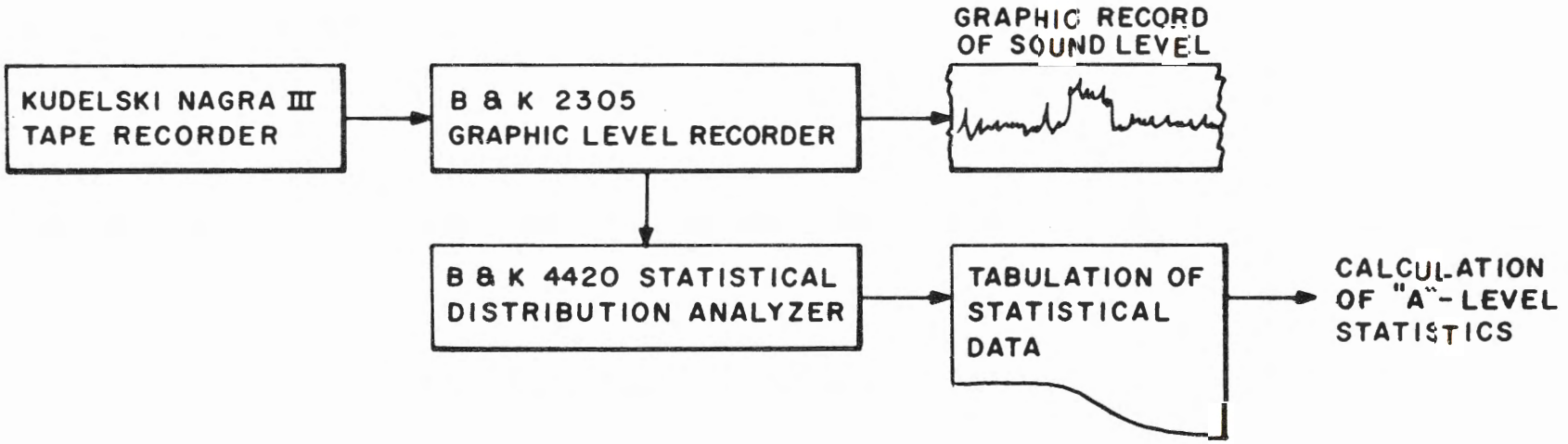
Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
3E	Englishtown, on Harrison Street between Main Street and Route 522	11 July 1972 1:15 p.m.	58	1. Urban traffic
3F	Housing Development, 1200' from Route 522, off Taylor Mills Road	11 July 1972 1:55 p.m.	52	1. Wind in trees 2. Distant traffic
3G	Housing Development, Cornell Place and Warwick Road	27 June 1972 5:00 p.m.	54	1. Air conditioners 2. Distant traffic
3G	"	12 July 1972 5:00 a.m.	37	
3H	Carver Nursing Home, Pension Road	11 July 1972 11:25 a.m.	52	1. Wind in trees 2. Aircraft flyovers 3. Distant construction
3I	300' from Route 527	11 July 1972 10:30 a.m.	53	1. Traffic on Route 527
3J	Old Texas Road, South of Route 520	11 July 1972 10:00 a.m.	54	1. Wind in trees 2. Traffic on Route 520 3. Distant traffic on Route 527
3K	Housing Development North of Old Texas Road	11 July 1972 9:20 a.m.	43	1. Distant traffic
3L	Lower Matchaponix Avenue	10 July 1972 5:45 p.m.	52	1. Wind in trees 2. Distant traffic 3. Local traffic

TABLE 4.2
(continued)

Site No.	Location	Date & Time	dBA L_{10}	"Background Sources"
3M	Near Bird Sanctuary on Old Forge Road, 3000' from Main Street	10 July 1972 5:05 p.m.	53	1. Distant traffic 2. Wind in trees
3M	"	13 July 1972 2:00 a.m.	42	1. Distant traffic on New Jersey Turnpike
3N	Outcalt Community, 2500' from Main Street	10 July 1972 4:40 p.m.	46	1. Wind in trees 2. Distant traffic
3P	Holy Trinity Roman Catholic Church, Helmetta, 150' from Main Street	10 July 1972 3:30 p.m.	61	1. Local traffic on Main Street
3Q	300' off Main Street, (Bordentown-Amboy Turnpike)	10 July 1972 4:00 p.m.	51	1. Traffic on Main Street
3S	In park off Helmetta Boulevard, 150' from local road	10 July 1972 2:15 p.m.	52	1. Wind in trees 2. Distant traffic
3T	Off Dunham's Corner Road, 800' from New Jersey Turnpike	10 July 1972 1:40 p.m.	68	1. New Jersey Turnpike
3U	300' from Route 522, North of Jamesburg	10 July 1972 1:00 p.m.	53	1. Local traffic on Route 522



NOISE MEASUREMENT EQUIPMENT



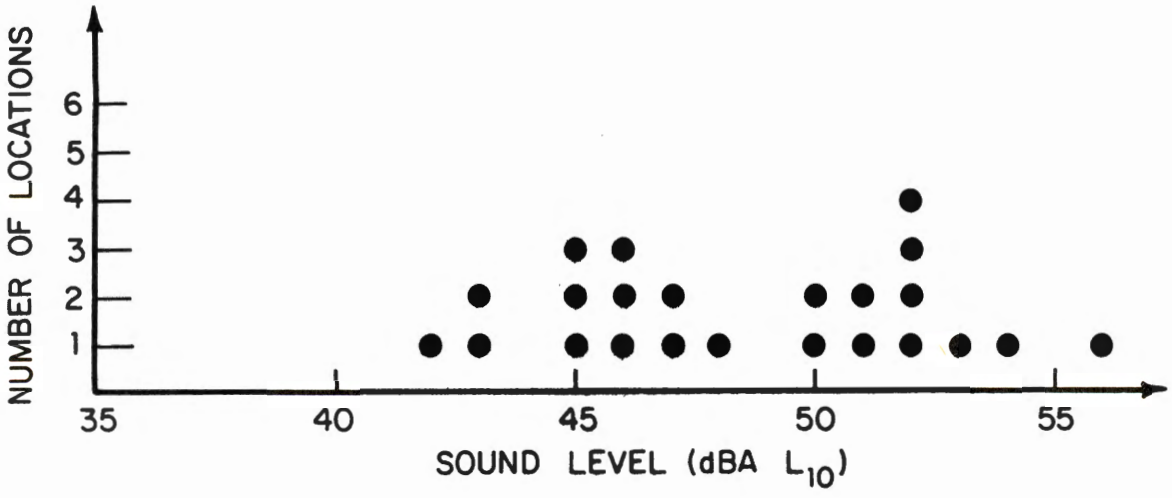
DATA ANALYSIS EQUIPMENT

FIG. 4.1 - AMBIENT NOISE MEASUREMENT AND ANALYSIS INSTRUMENTATION

TABLE 4.3

AMBIENT NOISE SURVEY WEATHER CONDITIONS

Date, Time	Wind Speed	Wind Gust Speed	Sky Condition	Temperature ^{o}F	Relative Humidity
27 June afternoon	negligible	5 mph	clear	75°	45%
10 July afternoon	0-6 mph	10 mph	clear	85°	50%
11 July afternoon	negligible	5 mph	clear	85°	65%
12 July early morning	0-2 mph	5 mph	cloudy	73°	80%
12 July afternoon	negligible	5 mph	clear	85°	55%
13 July early morning	negligible	5 mph	cloudy	70°	70%
13 July afternoon	6-10 mph	15 mph	cloudy	80°	80%
14 July morning	negligible	5 mph	clear	82°	70%



SITES AT WHICH MEASUREMENTS WERE TAKEN*		
1H	2C	3F
1I	2D	3G
1J	2G	3H
1K	2H	3K
1N	2J	3L
1P	2K	3M
	2L	3N
	2M	3S
	2T	

*REFER TO TABLE 4.2

FIG. 4.2 - RANGE OF DAYTIME AMBIENT NOISE LEVELS MEASURED AT REMOTE LOCATIONS

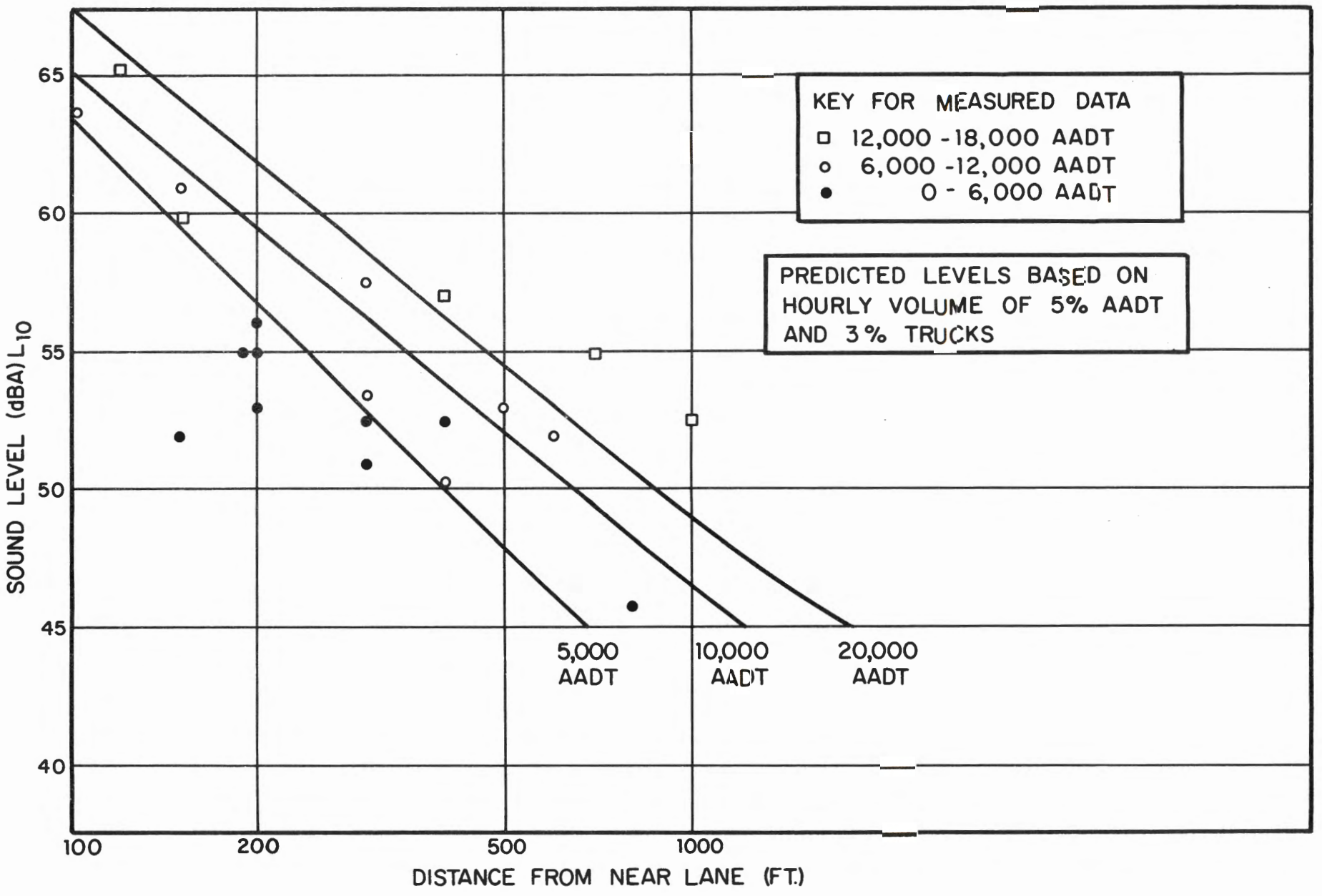


FIG. 4.3 - THE COMPARISON OF PREDICTED AND MEASURED NOISE LEVELS FOR DIFFERENT VEHICLE VOLUMES

There were two sites in category C; one in Freehold and one in Englishtown. Each site was in a residential area within one block (300') of a main street. The ambient readings were 59 dBA L_{10} for the Freehold site and 53 dBA L_{10} for the Englishtown site.

Nighttime Measurement Results - At three locations both nighttime and daytime measurements were made. One of these sites was in a residential community; one was near a major highway; and one was in a remote area far from roads. The daytime-nighttime comparisons shown by the data in Table 4.4 are typical of the locations selected. Where human activity is highest, the difference between daytime and nighttime noise levels is greatest. Near heavily traveled traffic routes and in remote areas, far from people, the variations in noise level over the daily cycle are not so marked.

TABLE 4.4

COMPARISON OF DAY AND NIGHTTIME
AMBIENT NOISE SURVEY MEASUREMENTS

Site	Type of Location	Sound Level dBA L_{10}	
		Day	Night
3G	Residential	54*	37
2P	500' from Rt. 9	60	53
3M	Remote Locale**	53	42

* High daytime noise level due to air conditioners not on at night.

** Sound level controlled by distant New Jersey Turnpike. Significant contribution by insects at night.

5. THE ACOUSTIC IMPACT OF THE EXPRESSWAY

In this section, the detailed noise computations are discussed and the results of the final impact assessment are presented.

Computation of the Noise Contours

For computing the final noise contours, a slightly modified version of the computer program of the Transportation Systems Center [*32*] was used. The ground attenuation computations available with the program were not used because of the great quantity of input data required to describe, to a useful degree of accuracy, the varied ground effects at all locations along the alignment. Instead, the program was simplified to compute attenuation over level terrain in accordance with the averaging relationships provided in the Highway Noise Design Guide.

The traffic volume used was the average hourly volume for the highest 3 hours on a typical summer day as discussed in Section 3.

The roadway geometry data was taken from plan and profile drawings of the roadway. Receiver location data was taken from elevation contour maps.

Shielding by natural land forms shown on elevation contour maps, and cuts of the roadway through hills as indicated by the profile drawings, were considered in the computations.

Where large forested areas appeared in the aerial photographs and on the United States Geological Survey Maps, a modest excess attenuation was assumed. For trees at least 15 feet tall and very dense, an excess attenuation of 5 decibels per 100 feet of woods is typical [*23,24*]. For the study area along the alignment, only 5 decibels reduction per 1000 feet of forest, to a maximum of 10 decibels, was assumed because of the lower density of trees.

Noise Control Provided

After measuring the noise reduction properties of the non-residential buildings along the alignment, the inside noise levels could be predicted more accurately as shown in Table 5.1. The inside noise levels at all the buildings are within the acceptable limits defined by the proposed Federal standards except for the levels predicted for Manalapan High School and Taylor Mills School, each 55 dBA, precisely the standard. To eliminate the possibility of adverse acoustic impact on these two schools, the roadway will be depressed in the vicinity of the schools, and an earth berm or wall will be constructed if required, to provide adequate noise control. Therefore, for the computation of the noise contours, it was assumed that, in the vicinity of the two schools, the tops of the noise shields provided are at least 15 feet above the pavement level.

The Acoustic Impact Results

The final acoustic impact was determined by comparing the predicted Expressway traffic noise levels to the existing ambient levels and to the proposed Federal standards.

TABLE 5.1

PREDICTED INTERIOR NOISE LEVELS

FOR NON-RESIDENTIAL BUILDINGS

Structure	Predicted Noise Level dBA L_{10}	Measured Noise Reduction, dBA	Resulting Inside Noise Level, dBA L_{10}
First Church of Christ Scientist Toms River Township	58	10*	48
Church of God Toms River Township	58	10*	48
Country Manor Nursing Home Toms River Township	61	10*	51
Whitesville United Methodist Church Whitesville	55	16	39
Harmony Methodist Church Jackson Township	66	16	50
First Assembly Church of God Freehold Township	60	18	42
Freehold Hospital Freehold Township	58	29**	29
Manalapan High School Manalapan Township	61	6	55
Taylor Mills School Manalapan Township	65	10	55
Clark Mills School Manalapan Township	59	11	48
Carver Nursing Home Manalapan Township	59	19	40
Holy Trinity Church Helmetta	67	14	53

* These are adjacent to Garden State Parkway.
No noise reduction measurements were made.
A 10 dBA noise reduction (an average value) was assumed.

** Air conditioned, windows are never opened.

Expressway Noise in Excess of the Existing Ambient - With the field measurement program presented in Section 4 as a guide, the existing daytime ambient noise levels along the alignment have been estimated. In general, the levels have been assumed to be determined by local traffic. In regions far from the influence of traffic, a daytime level of 45 dBA L_{10} has been assumed based on the results of the ambient noise measurements made in such regions. Since the noise levels measured in these areas were produced by wind in vegetation, birds and insects, aircraft, etc. (see Table 4.3), it is probable that there will be days and specific areas where the noise levels will be somewhat lower than those measured; however, it is believed that 45 dBA L_{10} fairly represents the noise environment typical of most days in the more remote regions. Hence, the existing ambient noise levels, estimated from calculations based on traffic data for local routes, are highest near the roads, decreasing to the 45 dBA minimum at points far from the roads.

Figure 5.1 shows the areas in which the Expressway noise is expected to be in excess of the existing ambient noise by 5 to 15 dBA, and by more than 15 dBA. Far from heavily traveled routes, the impacted areas extend out to the 50 dBA L_{10} predicted noise contours. The unshaded areas extending along major routes into the impacted regions reflect the fact that high noise levels already exist near these roads. The collapse of the impact areas around the Garden State Parkway, Route 9, and the New Jersey Turnpike is also an indication of the presently large traffic volumes and high noise levels associated with these Routes.

Also shown in Figure 5.1 are the locations of the measurement positions and the A-weighted sound level measured at each location.

Expressway Noise in Excess of the Standards - The acoustic impact upon residences and non-residential buildings for the entire alignment is summarized in Table 5.2 where 70 dBA L_{10} is the outside standard for residences and 55 dBA L_{10} is the inside standard for non-residential buildings. The total of 25 dwelling units impacted consists of 10 mobile homes near an interchange and 15 isolated houses, some near interchanges and others lying within the narrow strip between the right-of-way line and the 70 dBA L_{10} contour line. The number has been kept to a minimum by slight adjustments in the alignment and right-of-way line where appropriate, and as a result of depressing the roadway where local roads cross the Expressway. The non-residential impact has been intentionally reduced to zero by designing for noise control as discussed earlier in this section.

TABLE 5.2

IMPACT ASSESSMENT FOR RESIDENTIAL AND NON-RESIDENTIAL STRUCTURES

Type of Structure	Number Impacted
House	15
Mobile Home	10
Non-residence	0
Total	25

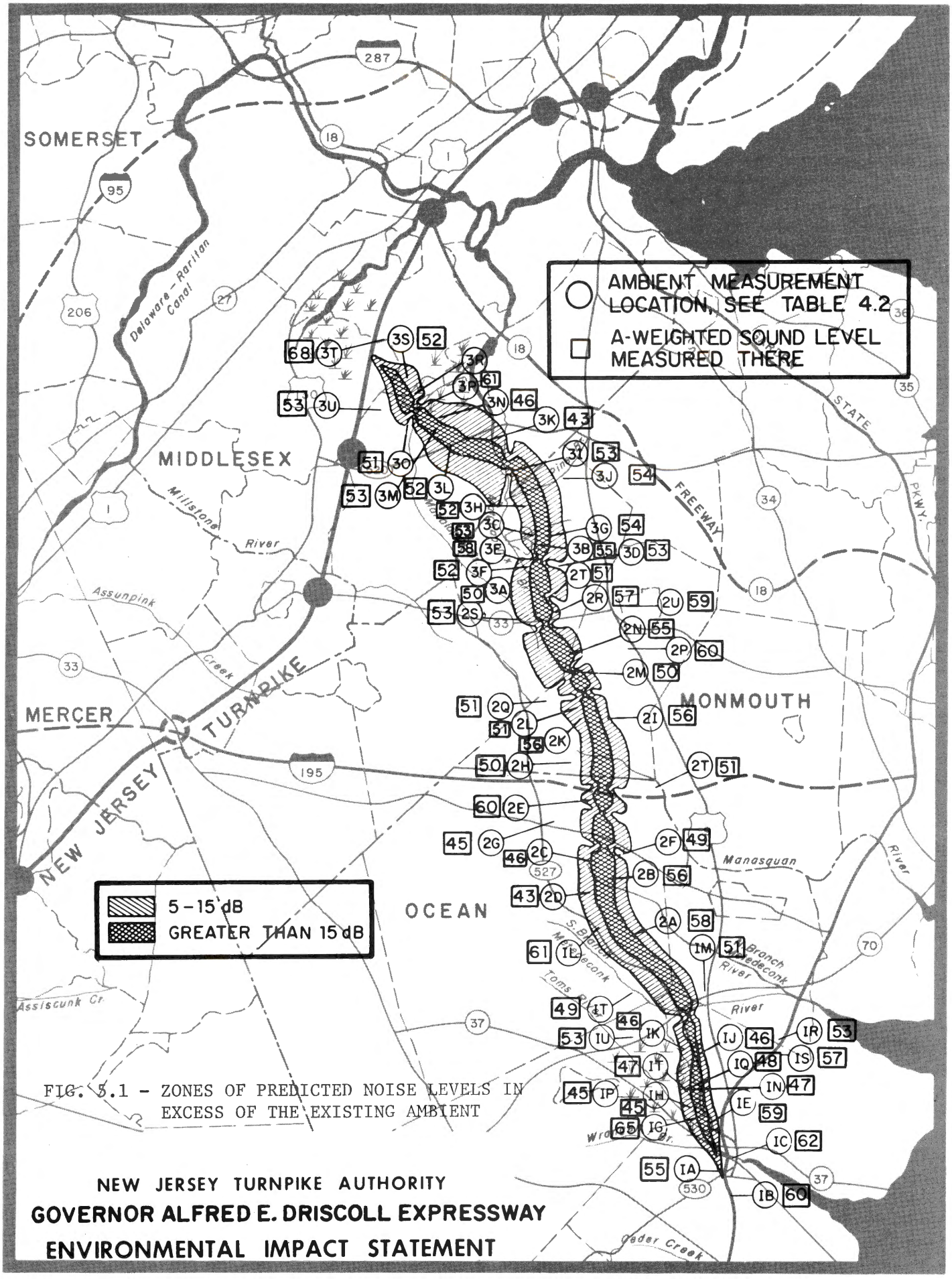


FIG. 5.1 - ZONES OF PREDICTED NOISE LEVELS IN EXCESS OF THE EXISTING AMBIENT

NEW JERSEY TURNPIKE AUTHORITY

GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

The impact upon parks and recreation areas is summarized in Table 5.3. The areas have been divided into two categories; 1) areas where noise sensitive activities are planned or are known to take place presently, and, 2) the remainder of the park or recreation area not designated for use for noise sensitive activities. The impact is presented for each park in terms of the percentages of the noise sensitive area falling within the 70 dBA L_{10} contour. For small recreation areas, no distinction between noise sensitive and non-noise sensitive areas is made, the entire area being classified in the former category.

Figure 5.2 is a key for the series of 10 impact maps to follow. Each impact map can be located relative to the complete alignment by finding its position on the key.

The acoustic impact along the alignment is illustrated in the ten sheets of Figure 5.3. The locations of the residences impacted are shown on these impact maps as shaded areas, all lying within the standard 70 dBA L_{10} noise contour, or near ramps. The locations of the acoustically sensitive non-residential buildings are shown as open circles. None of these fall into the impact region based on either the 70 dBA L_{10} outside standard or the 55 dBA L_{10} open window indoor standard.

The locations of parks and recreation areas are also shown in Figure 5.3. The noise sensitive areas are located within the heavy dashed line, and are shaded to denote noise impact where they lie within the 70 dBA L_{10} contour.

Park areas lying within the 70 dBA L_{10} contour, but where no noise sensitive activities are planned or presently take place, have not been shown as impacted. The set of noise contours can, however, be used as a guide to planning for the locations of park activities, housing and other buildings.

Remarks on the Impact Results

Throughout this study, discussion of the acoustic impact of the Expressway has been directed toward describing the adverse acoustic effects. The eventual removal, by the Expressway, of some of the traffic from other roads in the area, however, should result in a modest beneficial acoustic impact. Noise level computations based on present U.S. Route 9 traffic indicate that residences as far as 80 feet from Route 9 traffic will be impacted with respect to the 70 dBA L_{10} proposed Federal Standards. Since this route has many intersections with local roads, a large number of houses lie within the 80 foot-wide impacted strip each side of the highway. After construction of the Expressway, the automobile traffic volume on Route 9 is expected to be reduced to two-thirds of its present volume, and the truck traffic will be reduced to approximately one-fifth of its present volume. At the 80 foot distance, the resulting reduction in traffic noise should be about 5 dBA L_{10}.

It should be borne in mind that the acoustic impact results described in this section have been based upon the "worst case" 1990 traffic conditions foreseeable, and on the assumption that 1990 vehicles will produce noise levels typical of 1972 vehicles. However, as illustrated in Figure 5.4,

TABLE 5.3

IMPACT ON PARKS AND RECREATION AREAS

Park/Recreation Area	% of Noise Sensitive Area Impacted
Albocondo Campground Dover Township	5-10
KOA Campground Manchester Township	0
Riverwood Park River Township	0
Gurfen's Picnic Ground Jackson Township	0
Butterfly Campground Jackson Township	0
Butterfly Pond, Fish & Wildlife Mgmt. Area* Jackson Township	0
Estonia Youth Camp Jackson Township	10-15
Camp Nomoco Freehold Township	0
Turkey Swamp Park Freehold Township	0
Proposed Woodgate Farms Freehold Township	0
Monmouth Battleground State Park Freehold Township	0
Monmouth Battleground Golf Course Freehold Township	0-5
Private Bird Sanctuary Monroe Township	40-50
Proposed Jamesburg Park* E. Brunswick Township	0
E. Brunswick Community Park E. Brunswick Township	0

*No noise sensitive activities presently defined or planned for these areas.

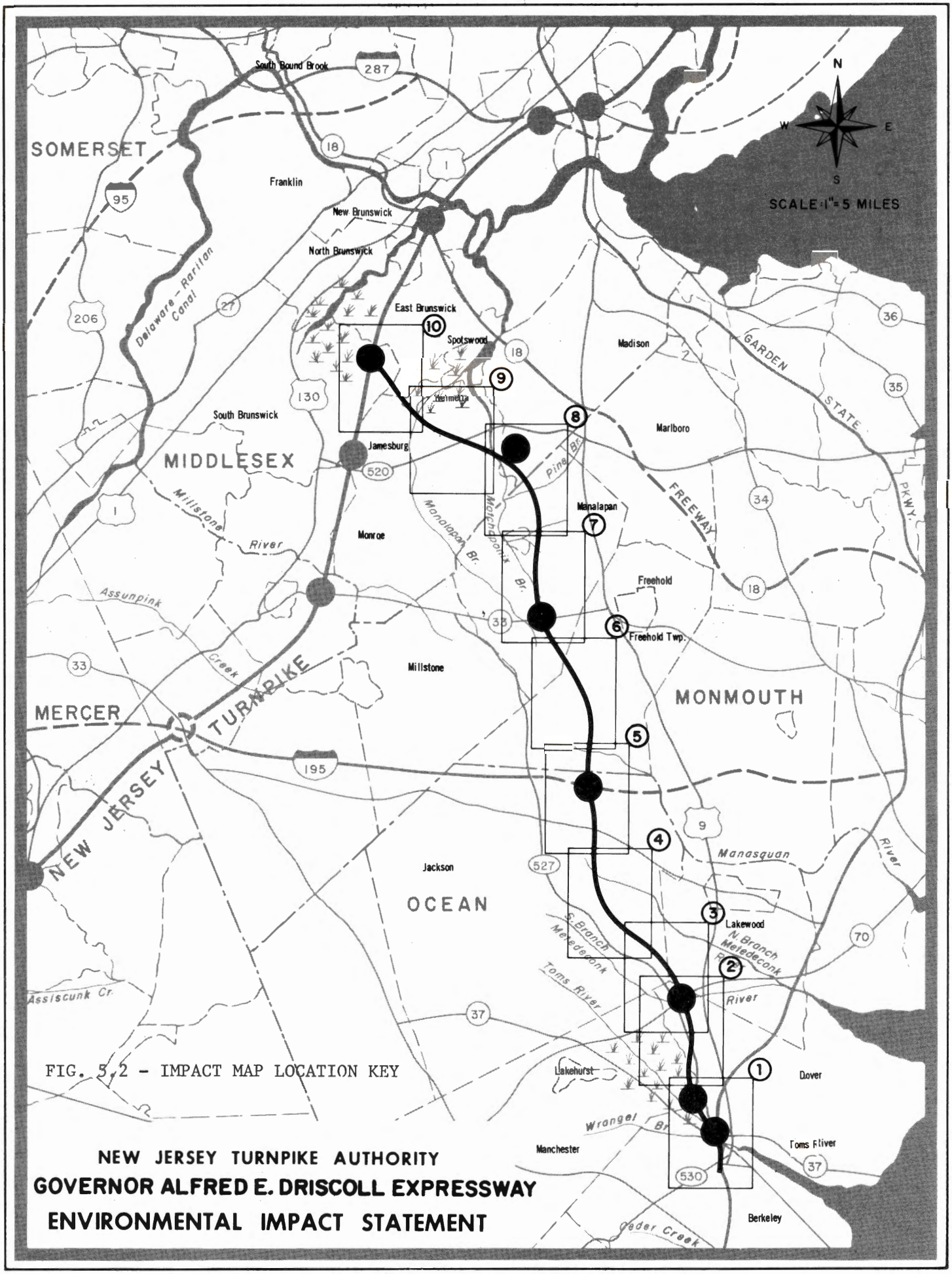


FIG. 5.2 - IMPACT MAP LOCATION KEY

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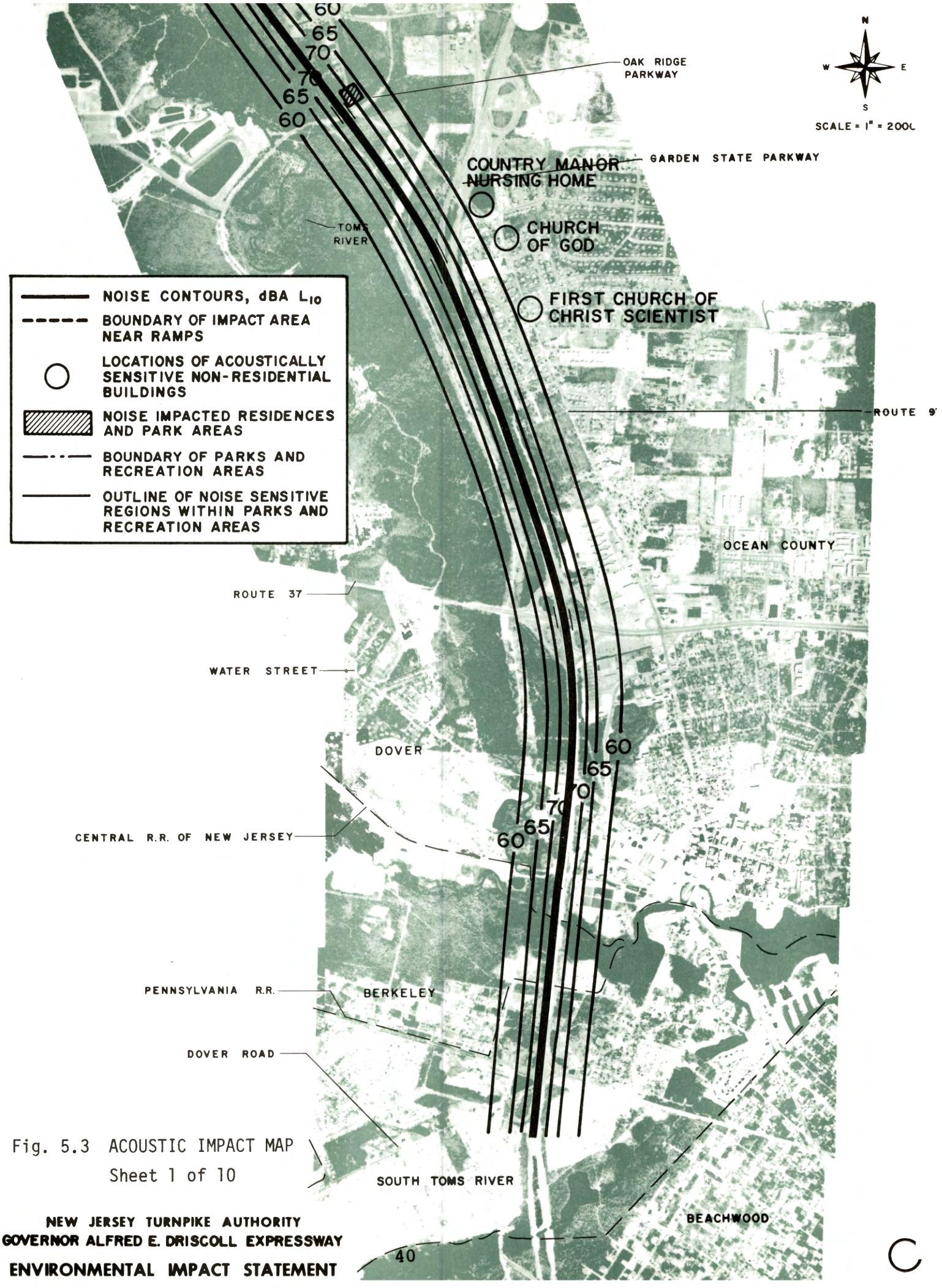

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 1 of 10

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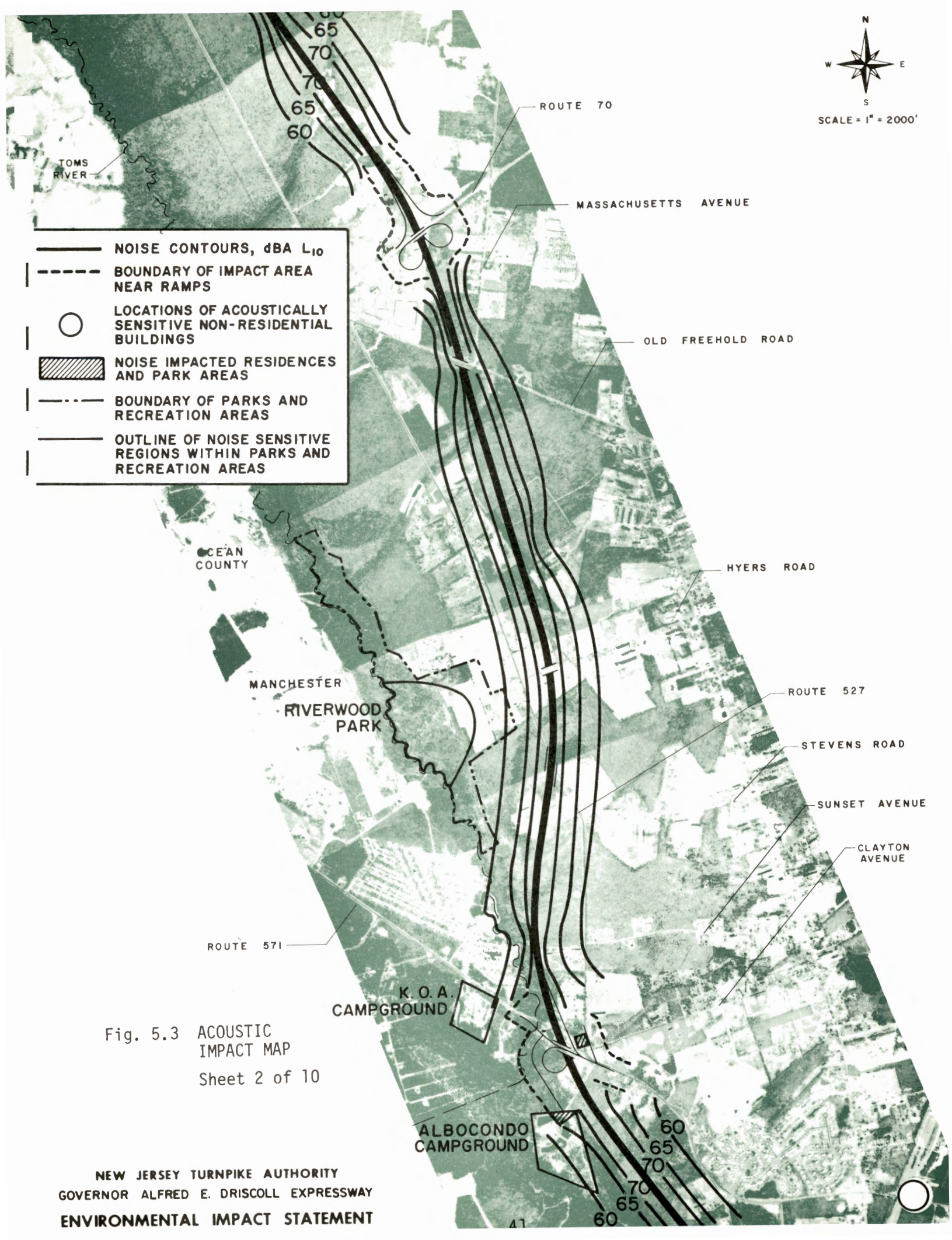

Fig. 5.3 ACOUSTIC IMPACT MAP

Sheet 2 of 10

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GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT

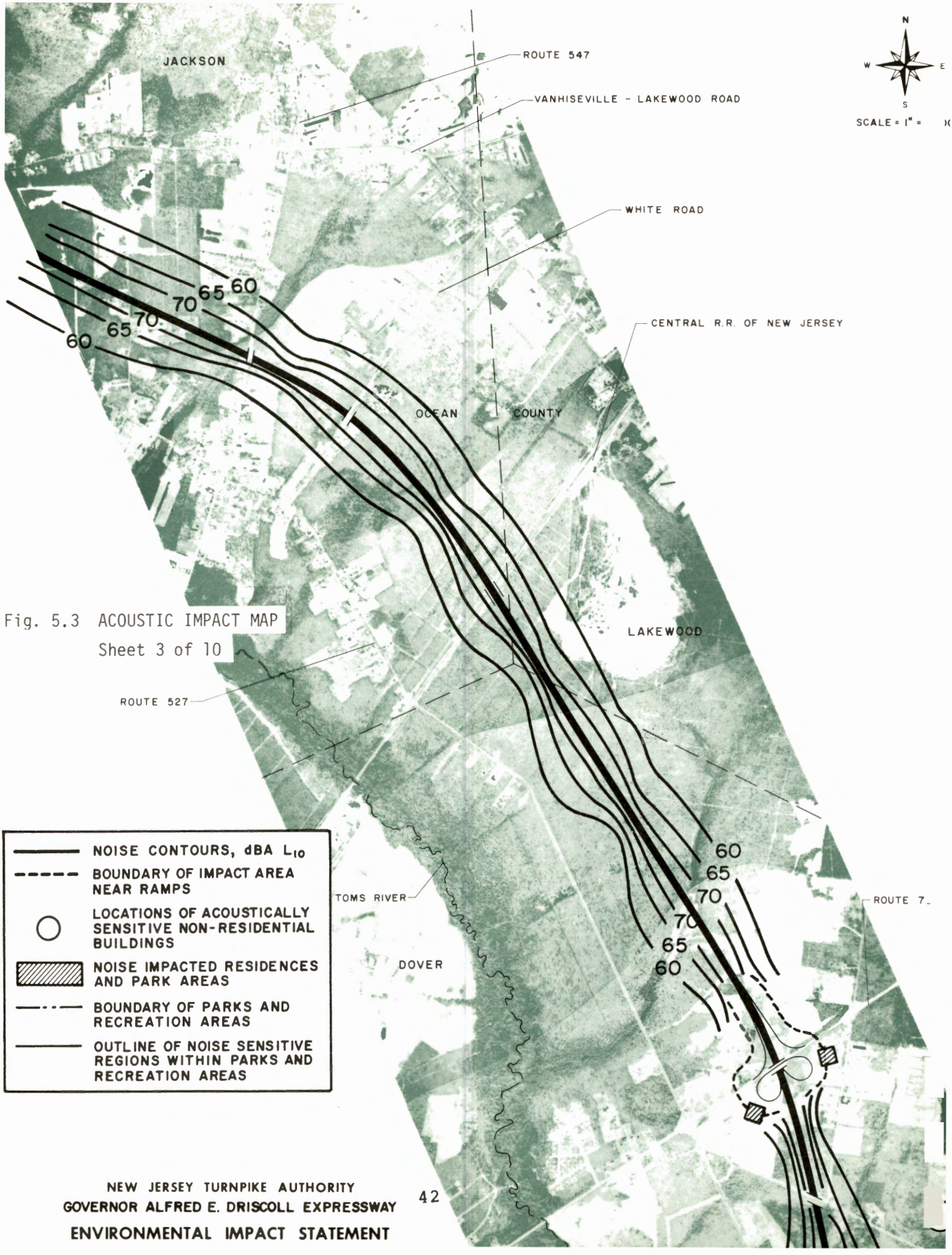

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 3 of 10

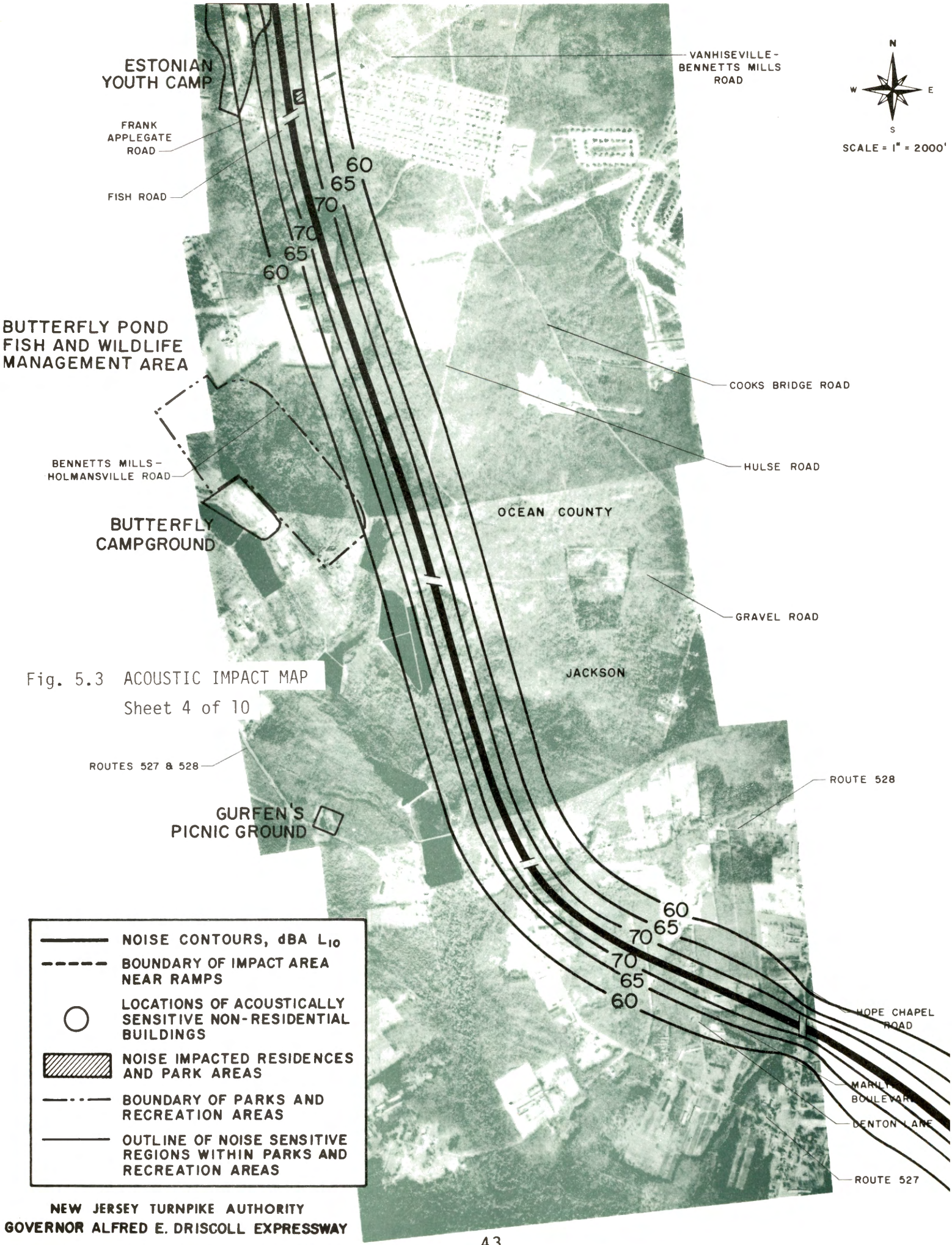

Fig. 5.3 ACOUSTIC IMPACT MAP

Sheet 4 of 10

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT

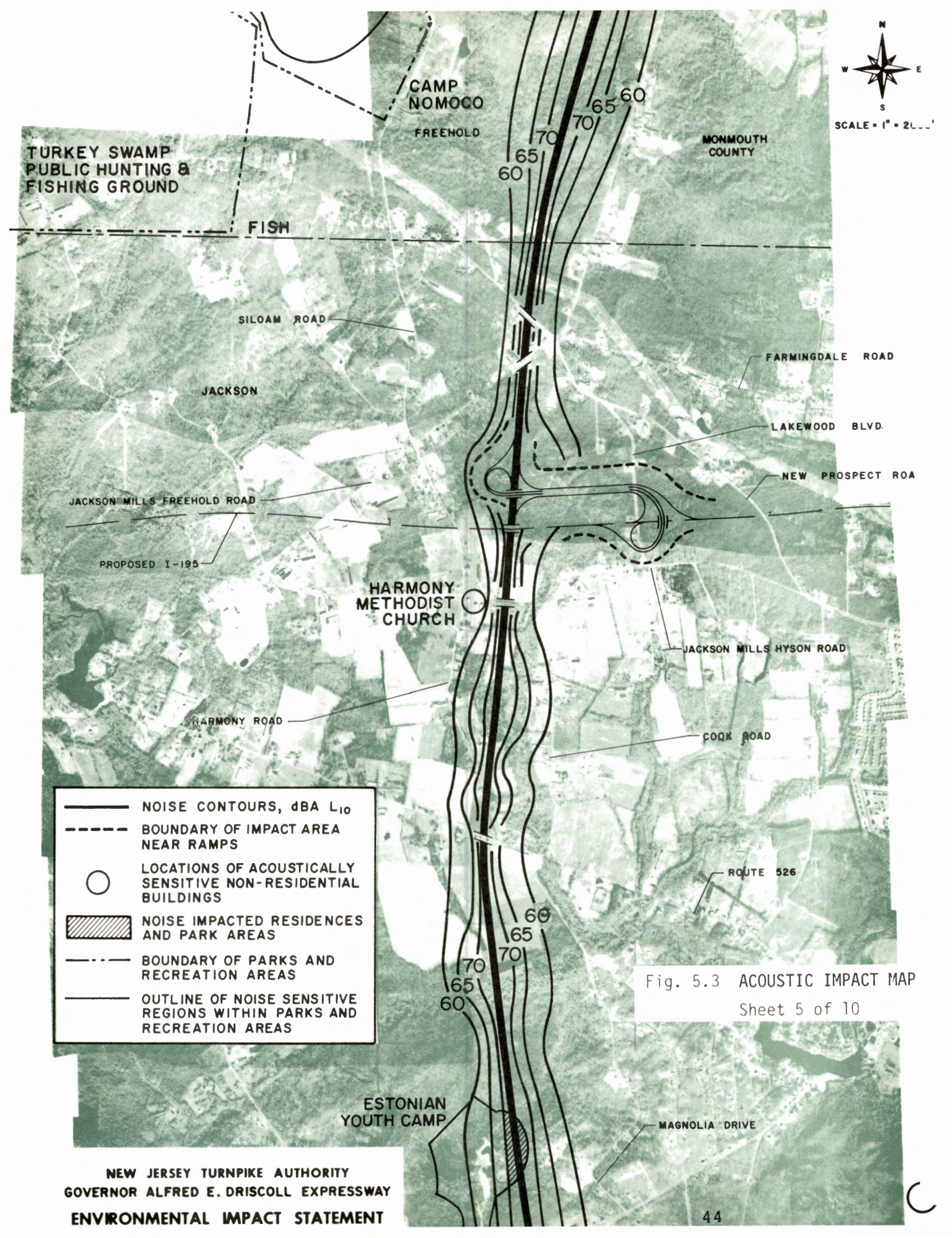

Fig. 5.3 ACOUSTIC IMPACT MAP

Sheet 5 of 10

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT

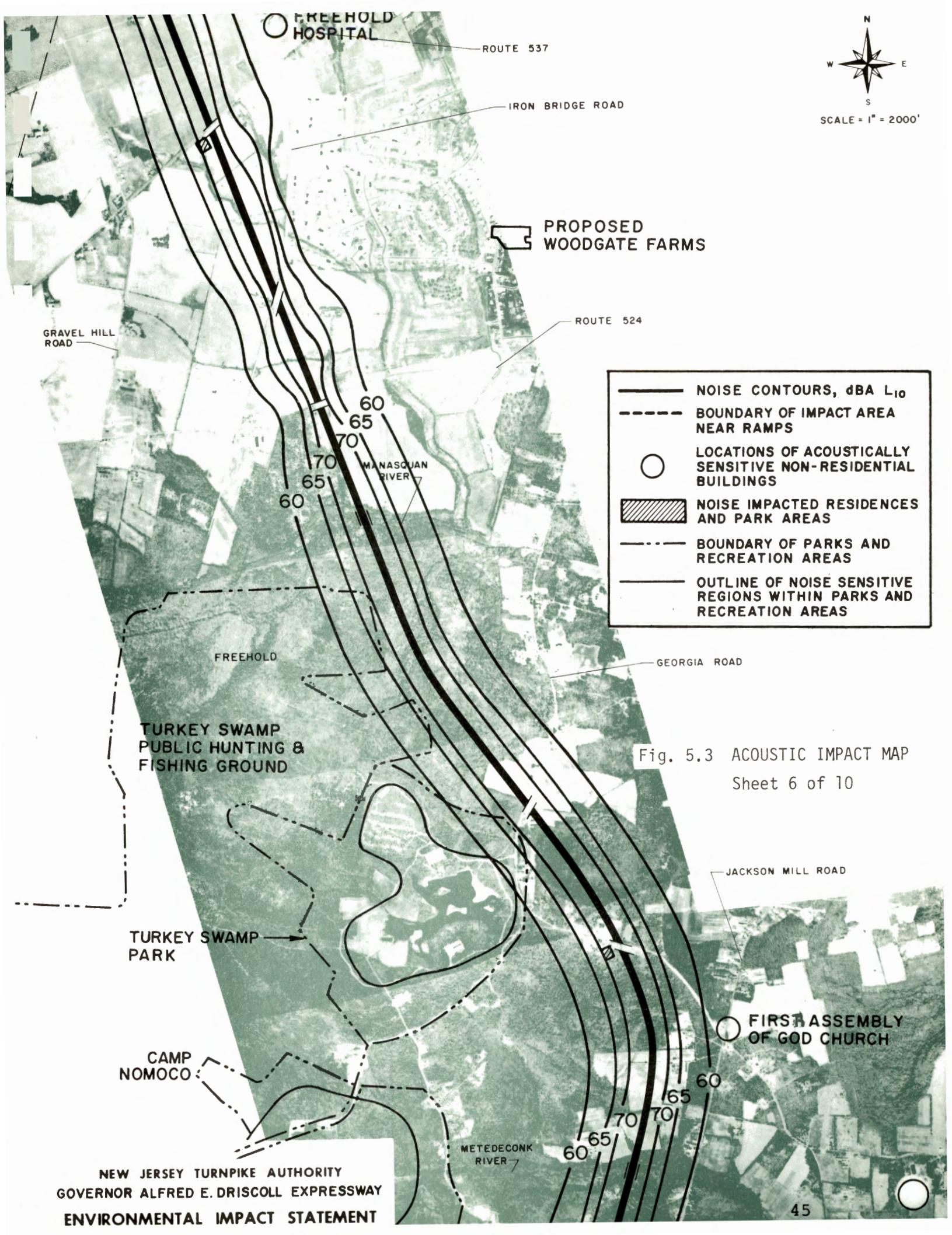

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 6 of 10

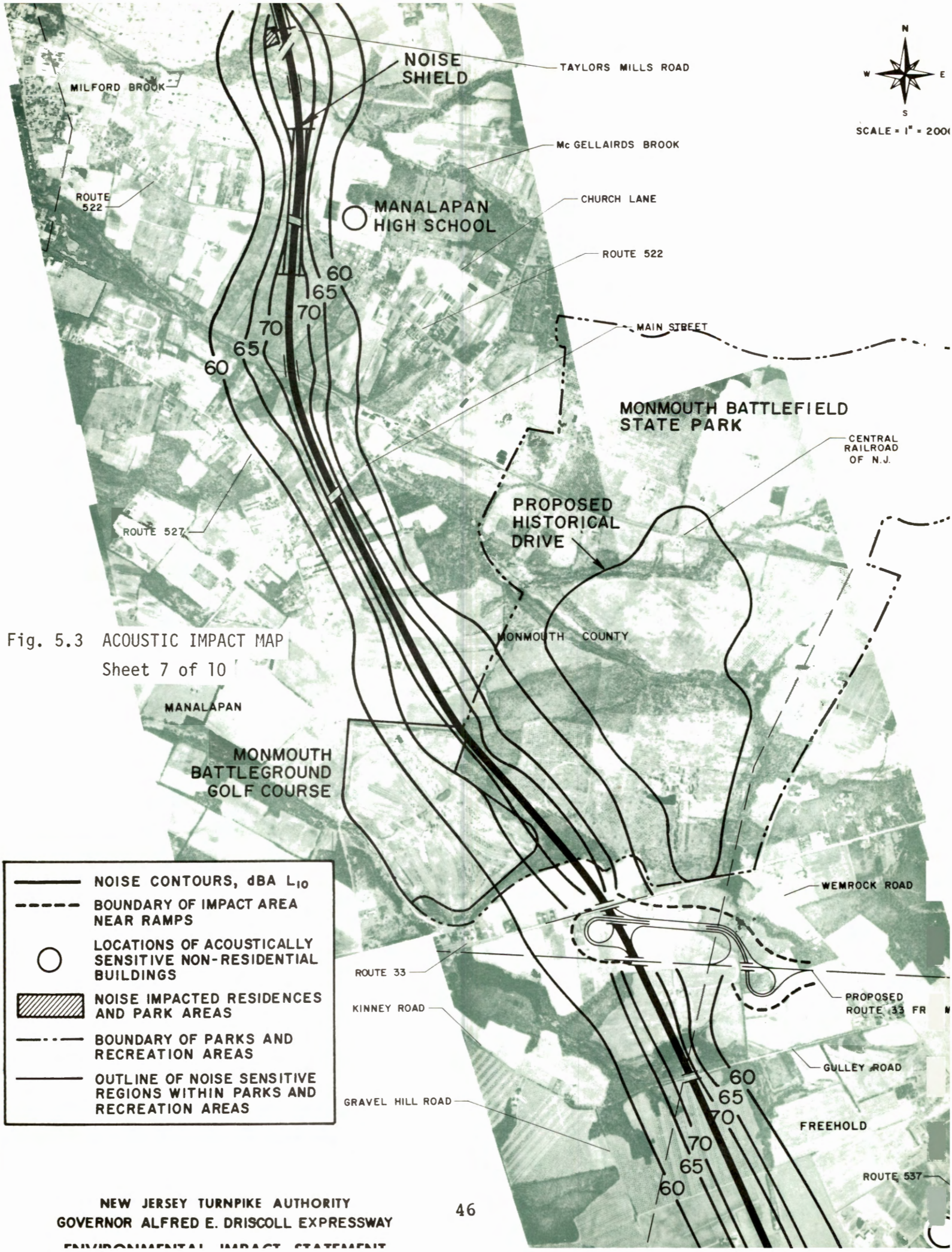

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 7 of 10

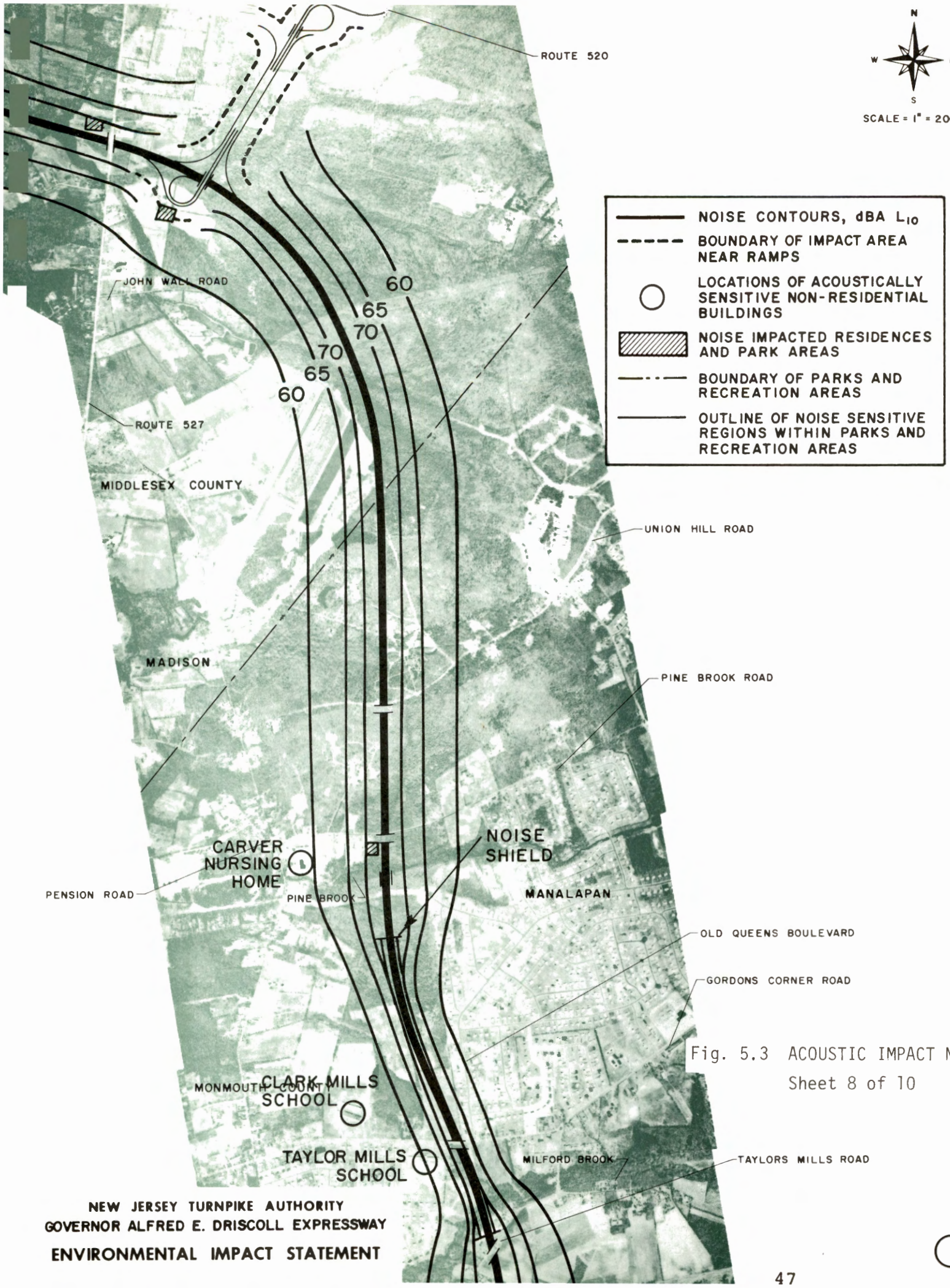

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 8 of 10

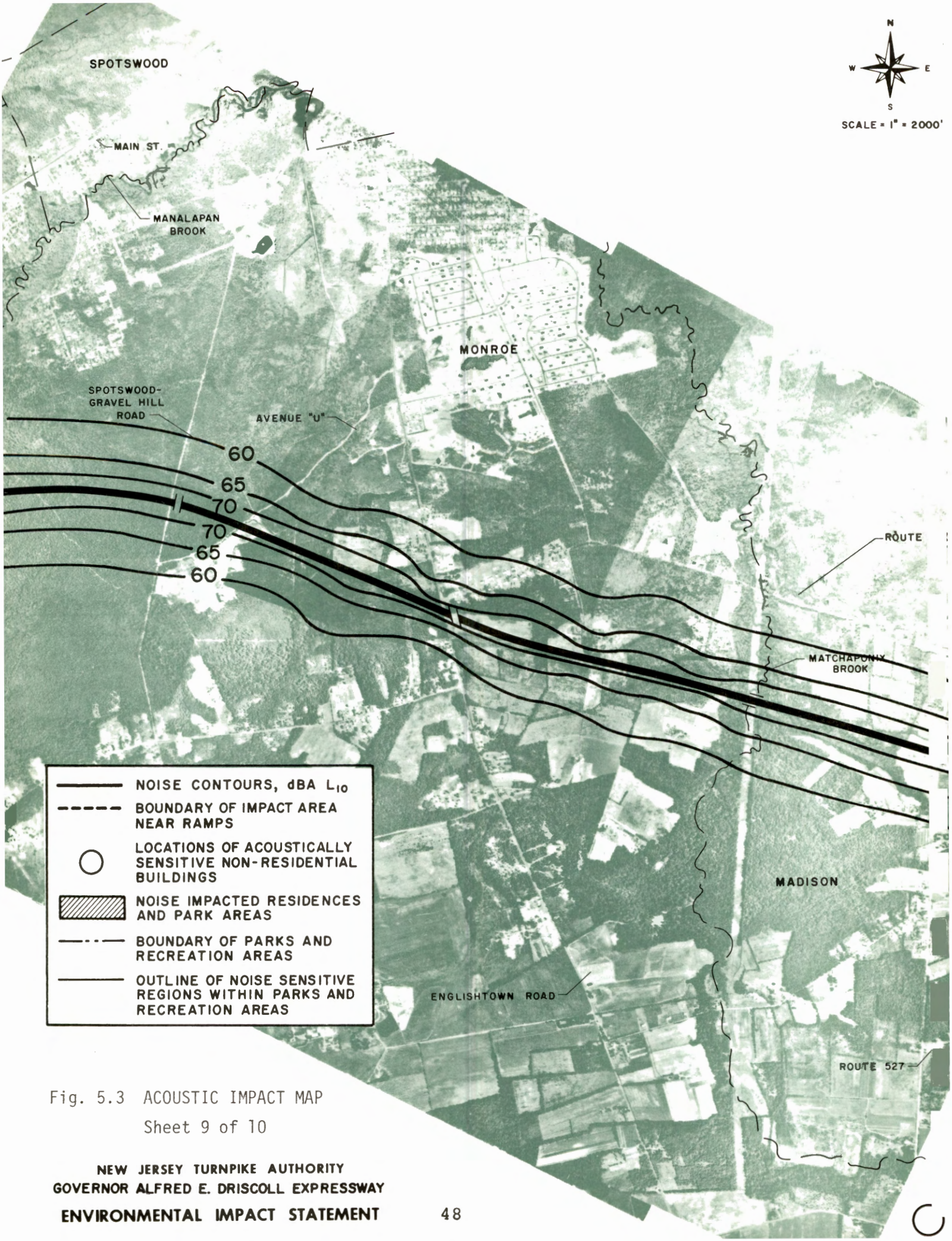

Fig. 5.3 ACOUSTIC IMPACT MAP
Sheet 9 of 10

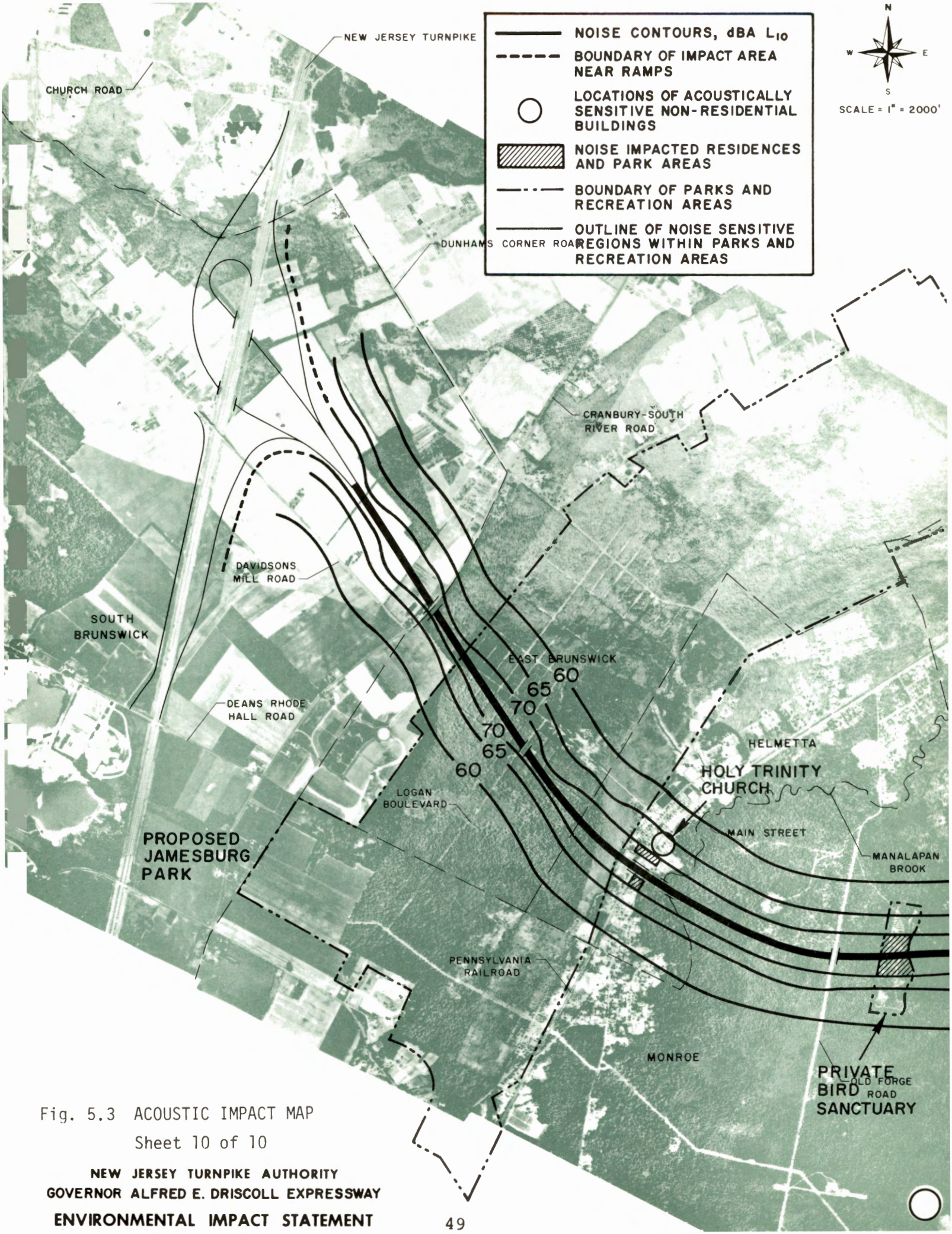

Fig. 5.3 ACOUSTIC IMPACT MAP

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NEW JERSEY TURNPIKE AUTHORITY
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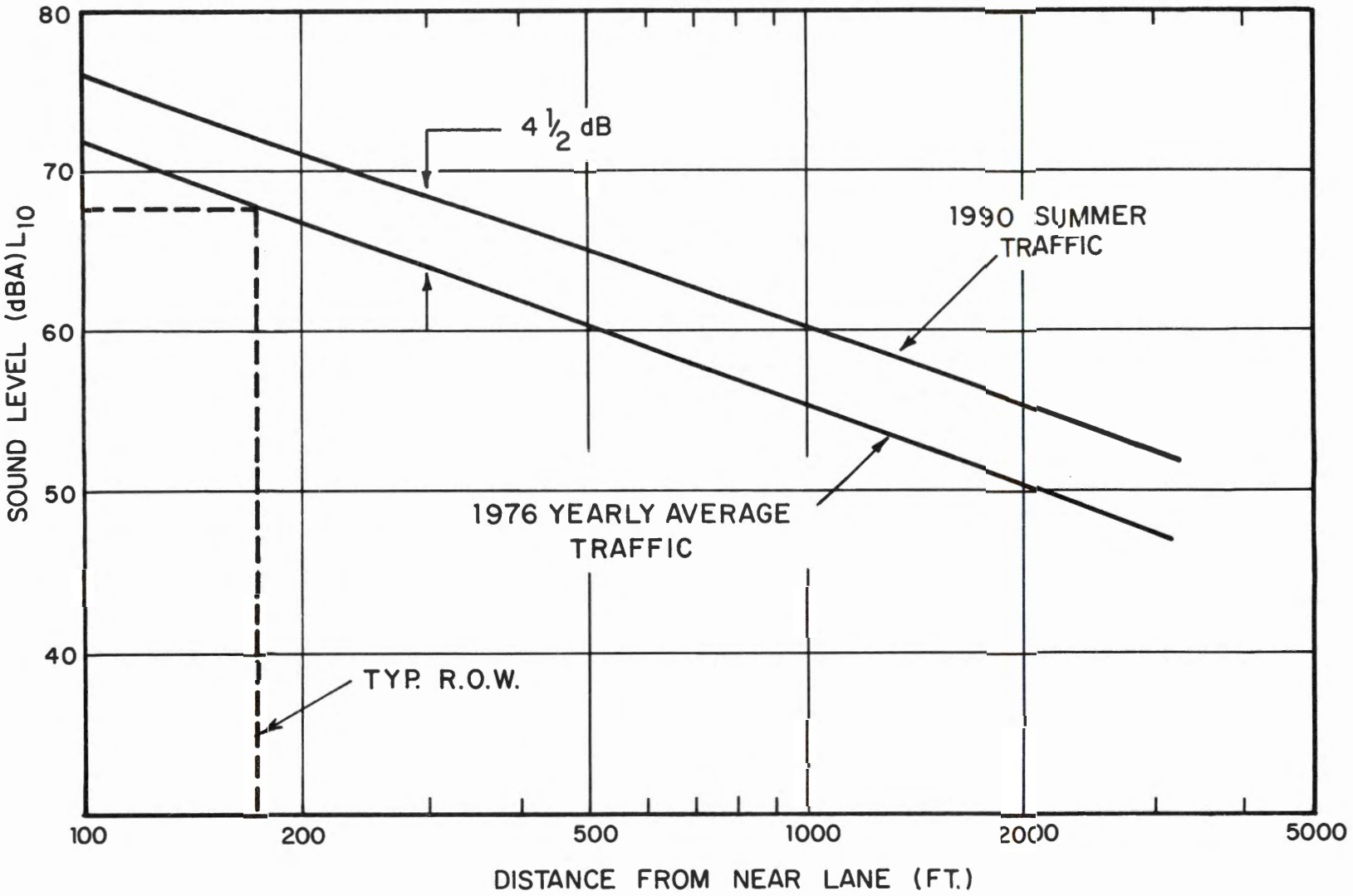

FIG. 5.4 - COMPARISON OF 1990 AND 1976 EXPRESSWAY TRAFFIC NOISE (BETWEEN THE I-195 AND N.J. RT. 33 INTERCHANGES)

due to the considerably lower traffic volumes expected in 1976, the noise levels expected when the Expressway opens are 4 to 5 decibels lower than the 1990 noise levels for which the impact has been assessed. In fact, for an average day in 1976, the 70 dBA L_{10} contour is expected to fall inside the typical right-of-way.

Considerable effort is being made currently toward quieting motor vehicle noise at the sources themselves. For example, W.N. Scott of the Chrysler Corporation writes [*25*], "Looking in our crystal ball, we would guess that by applying today's technology to a future truck, 1980 or later, it would be possible to reduce the component noise levels by about 6 dB." Also in view of the increasing consideration of motor vehicle noise legislation at Federal, state, and municipal levels, (e.g., the recently adopted Chicago noise code [*26*]), a BBN report on the noise assessment of Route H-3 in Hawaii [*27*] reads, "...as a conservative projection, we have assumed that in 1993, heavy truck noise levels under highway conditions would average 10 dB less than current levels, while automobile levels would be 6 dB less than current levels."

The point here is that it is likely that the noise levels along the alignment will never exceed the 1976 predictions. If vehicle noise levels are reduced by only five decibels between now and 1990, the 70 dBA L_{10} contour will never extend beyond the Expressway right-of-way line, and all noise contours shown in Figure 5.3 will decrease in level by five decibels.

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SECTION V

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

Prepared for the New Jersey Turnpike Authority

by

COVERDALE & COLPITTS, INC.

This Section covers the following areas of study:

Project description, including:

- Existing land use, zoning and master plan delineation of project area mapped and described

Any probable adverse environmental effects which cannot be avoided, including:

- Land use patterns
- Displacement of viable farms
- Employment and property tax
- Disruption of community and regional growth

SUMMARY

This brief summary provides a description in capsule form of the results of the work performed by Coverdale & Colpitts, Inc. in determining the socioeconomic impact of the proposed Governor Alfred E. Driscoll Expressway in Middlesex, Monmouth and Ocean Counties.

Our study concludes that the Expressway is only one of the several socioeconomic forces which will influence developments in the tri-county area. There has been, and will continue to be, a trend of increasing population, increasing land use for both residential and light industrial purposes and a general rise in the level of the economy through increasing land values and increasing tax bases. Our investigation also indicates a significant increase in the area's vehicular traffic with a commensurate growth in population and developmental activity. The proposed Governor Driscoll Expressway will, in Coverdale & Colpitts' opinion, maintain these trends or, in some areas immediately adjacent to the highway, accelerate development along lines already in progress. In no instance have we determined that there will be any major negative impact if the proposed Expressway is built as planned.

Specifically our study shows that the Governor Driscoll Expressway will result in the following impacts:

1) Relieve peak hour and summer traffic congestion on existing routes —

   At the present time Route 9 and other local roads through the area become congested, particularly during morning peak hours due to the heavy commuter traffic and on weekends during the summer months due to the attraction of the recreational facilities along the shore. The proposed Expressway will provide a parallel route to many of these highways and will significantly reduce the current level of traffic during these critical periods.

2) Provide the only limited-access truck route from the industrial northern areas of New Jersey to the southeastern portion of the State —

   Present restrictions prohibiting trucks on portions of the Garden State Parkway and the congestion on local roads preclude the direct routing of over-the-road trailers into Monmouth and Ocean Counties. Our study indicates that over 95 percent of the goods and materials coming into these areas arrive by truck. At the present time it is often necessary for the shipper to transfer cargo from large over-the-road trailers to smaller vehicles for local distribution. This procedure results in lost time and an economic disadvantage to commercial enterprises and the residents in these areas. The proposed Expressway will substantially alleviate this problem.

3) Improve highway safety by diverting traffic from existing highways —

Numerous studies have shown that modern divided limited-access highways have significantly lower accident rates than older undivided free-access roads. Studies comparing accident rates on the main line of the New Jersey Turnpike and accident rates developed by the New Jersey DOT for highways such as Route 9 and Route 18 support this conclusion.

4) Decrease vehicle operating costs thereby providing an economic benefit to both private and commercial users of the facilities —

National studies have shown conclusively that operating costs for vehicles on high-speed limited-access highways such as the proposed Governor Driscoll Expressway are lower than the operating costs on more congested highways with traffic controls and similar features which reduce overall operating speeds and require occasional stopping and starting.

5) Have no measurable impact on existing rail services —

Currently Monmouth and Ocean Counties and that portion of Middlesex County through which the proposed Expressway will pass are poorly served by rail systems. There has been a continual decline in rail freight service and there is no reason to believe that future developments in these areas will reverse that trend with or without the Expressway being built. The current planning for improvements in rail passenger service, particularly commuter service, are yet to be fully defined and planned. We recommend that planning for such improvements consider the existence of the Expressway and investigate the potential for coordinated facilities, such as park-ride stations.

6) Significantly improve prospects for better commuter bus service —

Bus operations on the Governor Driscoll Expressway combined with park-ride facilities along the Expressway will enhance the opportunity for commuters to travel by bus into the northern New Jersey and New York metropolitan areas. The lessening in travel time and increase in convenience afforded by these facilities will provide a significant improvement over the level of service which exists today.

7) Generally increase land values and, as a result, increase the tax base in the area —

Studies of the effect on land values by the construction of I-287 in New Jersey and other major limited-access highways in other parts of the county have indicated that the land values on properties along these roads have increased at a higher rate than on other properties. We believe that this phenomena will also occur in the areas adjacent to the proposed Expressway.

8) Help maintain the present high growth rate of residential development in the tri-county area —

It is our conclusion that the Expressway, by providing improved access to the metropolitan regions of New York and Philadelphia, will attract that portion of the population that can afford to purchase single family residences on quarter acre to two-acre lots. The Expressway will also generate an increase in multiple-resident development, such as garden apartments, in areas near the interchanges and commuter facilities. This development is part of the continuing growth in the tri-county area. In our opinion the Expressway will not materially increase the rate of growth, but will maintain the present high level for a longer period than could have been expected if the Expressway were not constructed.

9) Increase the demand for commercial and community service facilities concomitant with the increase in residential development —

Anticipated population growth and commercial activity will increase demands for schools, water supply, sewage, garbage disposal and other services. The development creating these demands will increase the tax base, but at the same time, increase costs by requiring more community service.

10) Continue the expansion of light industrial development in the area —

At the present time there is a trend towards the development of light industries such as assembly of electronic components. The advent of improved transportation brought about by the Expressway and the increase in population oriented towards such industrial employment will accelerate a trend already established in the tri-county area. Our studies further conclude that there will be no insurgence of heavy industry into the area as a result of the construction of the Expressway.

11) Minimally affect existing farm land —

The direct impact of the Expressway will affect less than one percent of the viable farms in the tri-county area. Viable farms are those which are five or more acres in size, have been farmed for the last two years and produced an income of at

least $500 in the last year. Many of the farms now in operation will be converted to higher value uses as the demand for residential and industrial property continues as a result of constructing the Expressway. Conversion of many of the existing farms from production of edible produce or from government-sponsored soil banks into other higher income agricultural uses such as sod farms and horse farms, is expected to continue.

12) Provide an opportunity to increase the amount of land committed to permanent green belt and recreation areas —

A number of takings, particularly surplus farm land, will result in excess undeveloped land not needed for construction of the Expressway. In some instances these areas could be developed as picnic areas, rest areas, and similar green belt and recreational areas for use either by highway users or adjacent communities.

Coverdale & Colpitts, Inc. concludes as a result of our studies that a positive impact from the construction of the Governor Driscoll Expressway can be anticipated if local zoning laws and ordinances are developed and properly enforced. The unique opportunity exists at this time for local communities to develop plans and establish zoning controls for the areas adjacent to the Expressway and its interchanges. By so doing, these communities can assure that the developments which take place after construction of the road are those which will be of socio-economic benefit to their area. We have every reason to believe that the three Counties are enthusiastic about the construction of the Expressway and the benefits that it will bring to their area. The ultimate determination as to the impact of the facility to a large degree, however, rests in their hands.

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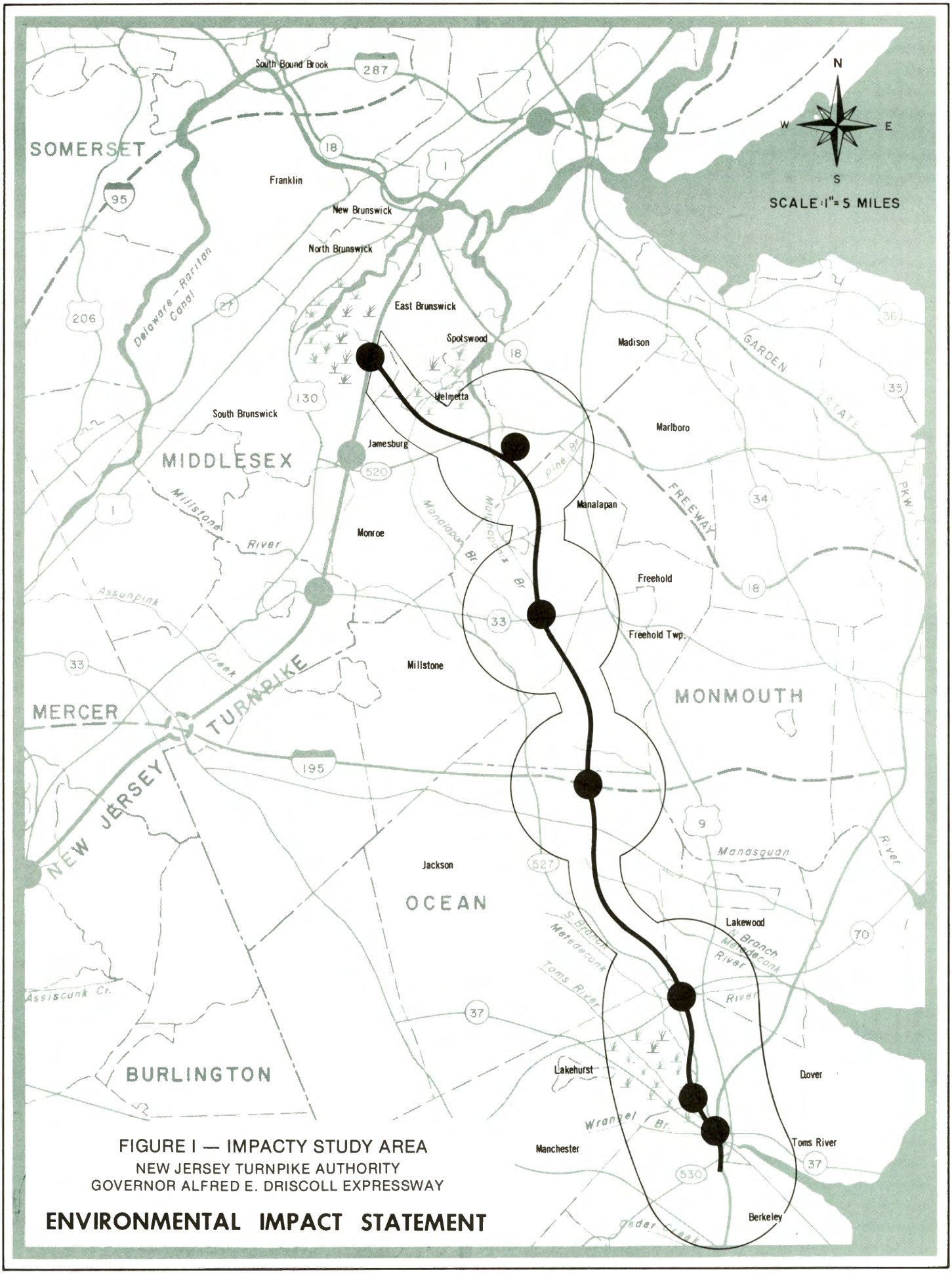


FIGURE I — IMPACTY STUDY AREA

NEW JERSEY TURNPIKE AUTHORITY

GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

CHAPTER I - INTRODUCTION

OBJECTIVES OF THE STUDY

This Section of the Environmental Impact Statement of the proposed Governor Alfred E. Driscoll Expressway has been prepared by Coverdale & Colpitts, Inc., for the New Jersey Turnpike Authority as an appraisal of possible future socioeconomic effects in Middlesex, Monmouth and Ocean Counties. In particular, this Section describes the projected impact of the Expressway on: property values; future land uses; local tax bases; employment; transportation services; existing road and street networks; and highway user costs.

THE STUDY AREA

While the direct and indirect effects of the proposed Expressway will be many and varied, it is important to recognize at the outset that other social and economic forces have shaped — and will continue to shape — the development of this dynamic tri-county region in Central New Jersey. Not the least of these forces is the migration from large city centers to less confined, more pleasant suburban areas typified by many communities in the tri-county region. As a starting point for our work, therefore, it was necessary to focus specifically on those areas where the Expressway would have a direct recognizable impact, first during its construction and later when the completed facility is open to traffic.

During its construction, the Expressway's "impact corridor" may be defined as a strip of land one mile wide on each side of the study alignment. Homes, farms, and businesses in this corridor will be affected to some extent by the construction of the Expressway. Some persons will be merely inconvenienced by such construction side-effects as the delay of the existing traffic flow, while others, whose homes or businesses are situated on the Expressway's right-of-way, must be relocated. Except for the latter, the impact of actual Expressway construction will be largely transitory.

When the Expressway is completed, the long-term impacts will be felt in terms of changes in land use, altered population growth rates and density patterns, new attracted industry and changed traffic patterns. Since the Expressway will be operated as a limited-access facility, its primary direct impact will be concentrated near interchanges with the existing and planned highway network. For this reason, we have selected an area within a three-mile radius of each interchange for detailed analysis of the Expressway's future impact.

Figure I shows the combined study area for the full 35-mile length of the proposed Governor Alfred E. Driscoll Expressway. The impact area encompasses portions of communities that account for about 20 percent of the total population of Middlesex County in the north and approximately 50 percent of the population of Ocean County in the south. Comparatively, Monmouth County is least affected with only 10 percent

of its population in communities in the study area.

We have pointed out that the Expressway is only one of many socio-economic forces in the study area. A key element in the control of all these forces — including those directly related to the Expressway — is the development of local zoning laws and ordinances so that the communities affected may plan and control their own futures.

In the course of our study we have discussed the possible results of constructing the Expressway with a number of local planning agencies. We are impressed with the degree of commitment to organized future development to which these groups are directing their efforts. It is our conclusion that the extent to which long-term impacts enhance or detract from the economic and social development of the study area will in a large part be a result of the control exercised by these groups and official agencies.

Our study and this report cite many instances where the ultimate impact can be controlled by zoning laws. It is our hope that this document will assist local communities in preparing to meet this challenge and assure that the impacts from the proposed Expressway are oriented to positive long-term effects.

CHAPTER II - SOCIOECONOMIC HISTORY OF THE STUDY AREA

INTRODUCTION

Before projecting the possible impact on the social and economic structure of the study area, the current developmental and economic trends and forces should be identified and quantified to the extent possible.

Many parts of the area trace their beginnings back to revolutionary and pre-revolutionary times and as such, historical development has played a large role in the area's growth.

Coverdale & Colpitts has, therefore, undertaken a review and analysis of certain physical, economic and demographic characteristics in the study area and the three counties which become the base for the assessment of future developments. These characteristics are: Population and population growth trends; Existing Land use; Commerce; Industry and employment trends; Existing transportation facilities and patterns; and Agricultural trends.

Ocean, Monmouth and Middlesex Counties have experienced sporadic development over the last three centuries. The earliest settlement was at Englishtown, settled in pre-revolutionary times. The Jersey shore originally attracted seasonal communities which now are becoming more year-round, resulting in a widening strip of development along the coast. As the cities in the northern New Jersey-New York City metropolitan area became more densely populated and transportation to the outlying areas improved, residential areas were established in the three counties. In addition, government establishments, such as Fort Monmouth and N.A.D. Earle Ammunition Depot in Monmouth County and the U.S. Naval Air Station at Lakehurst in Ocean County, are also located in the area.

In many cases, development was not planned and occurred before adequate facilities were provided, resulting in haphazard pockets of residential, agricultural, recreational and industrial areas. The present and potential state of the region can be more fully understood if the facets that make up the total economy are examined separately.

POPULATION

The Expressway will pass through Ocean, Monmouth and Middlesex Counties, three of the fastest growing counties in New Jersey. The following table shows the population and rates of increase in population for these counties and the State for the period 1950-1970. Also shown are densities for the counties and the State in terms of the number of persons per square mile.

Population Trends in Area Served by Driscoll Expressway

Year	Total New Jersey	Ocean County	Monmouth County	Middlesex County
		Square Miles		
	7,521	642	476	312
		Population		
1950	4,835,329	56,622	225,327	264,872
1960	6,066,782	108,241	334,401	433,856
1970	7,168,143	208,470	459,379	583,813
		Growth Rate		
1950-1960	25.5%	91.2%	48.4%	63.8%
1960-1970	18.2	92.6	37.4	34.6
		Gross Density (Persons Per Square Mile)		
1950	643	89	474	849
1960	806	169	703	1,391
1970	953	325	965	1,871

Source: U.S. Department of Commerce, Bureau of the Census

In the last two decades Ocean County experienced the highest rate in population growth in the State, increasing by 91.2 percent for the period 1950-1960 and by 92.6 percent for the period 1960-1970. The population of both Monmouth and Middlesex Counties more than doubled over the twenty-year period 1950-1970. In the decade 1960-1970, the rate of growth for both counties was less than in the decade 1950-1960; however, in both periods the rates were substantially above the State average. In July, 1972 the Monmouth County Planning Board predicted that the County's population will reach a half million by the end of the year. For the decade 1960-1970, the annual average rate of growth was 3.2 percent. If the population reaches 500,000 in 1972, the annual average rate of growth for the first two years of this decade will have been maintained at 3.2 percent.

In Ocean, Monmouth and Middlesex Counties, migration has been the prime reason for population expansion. The following table shows the percent of population growth attributable to migration and the percent resulting from natural increase for the decades 1950-1960 and 1960-1970.

Components of Population Change

	Percent of Population Growth Due to			
	Net Migration		Natural Increase	
	1950-1960	1960-1970	1950-1960	1960-1970
New Jersey	46.8%	44.3%	53.2%	55.7%
County				
Ocean	81.7	85.9	18.3	14.1
Monmouth	67.2	69.0	32.8	31.0
Middlesex	66.3	57.6	33.7	42.4

Source: U.S. Department of Commerce, Bureau of the Census

For each of the three counties, the percent increase due to migration is substantially greater than the percent increase due to natural growth.

In many cases, those moving into the three counties are from northern New Jersey or the New York City area and continue to commute to jobs in these areas. A study by the New Jersey Department of Labor and Industry published in 1961 showed that more than 25 percent of the workers living in Ocean, Monmouth and Middlesex Counties commute to jobs outside the county of residence. As an example, a recent profile of Twin Rivers, a development in Mercer County located near the study area on Route NJ 33 just east of New Jersey Turnpike Interchange 8, indicates that more than 25 percent of the residents formerly lived in northern New Jersey or New York City and that more than 40 percent of the residents commute to jobs in northern New Jersey or New York City.

In addition to the New York commuters, during the last twenty years many new residents have been attracted by retirement communities in Ocean and Monmouth Counties. These villages are located in areas that are separated from densely populated city centers, yet near highways providing access to them. By living in these special communities, the retirees also avoid the tax burden of educating the children of commuters. In 1950 there were 6,228 persons over the age of 65 living in Ocean County, accounting for 11 percent of the population. By 1970 the number had increased to 32,820, more than 15 percent of the population and almost half the registered voters. This is an important group to consider when discussing the local government's regulation of growth patterns.

Geographically, Ocean, Monmouth and Middlesex Counties constitute 19 percent of the land area of the State. In 1950 they accounted for 11 percent of the State's population; by 1970, due to the above average growth rates, their share increased to 17.5 percent of the population.

Of these three counties, Middlesex has the highest gross density due to its large urban population. Monmouth County has the largest population of any non-metropolitan county in the United States. In 1970 the number of persons per square mile was about equal to the average for the State of New Jersey. Density in Ocean County is low compared to the State average; the area of highest concentration is in the north around Toms River.

Table I gives the population for 1950, 1960 and 1970 and the rate of growth for the decade 1960-1970 for townships and boroughs within the study area.

In several instances (Dover and Jackson Townships and South Toms River Borough in Ocean County; Freehold and Manalapan Townships in Monmouth County and Madison Township in Middlesex County), the population more than doubled during the decade 1960-1970. Only Englishtown Borough decreased during this period resulting in a 1970 population only slightly greater than the 1950 population. In general, the least growth occurred in the well-established town centers where land was not available for development and the greatest growth occurred in the surrounding areas where former farm lands were available for expansion. For example, Freehold Borough grew by only 15.4 percent between 1960 and 1970, while Freehold Township grew by 175.9 percent.

EXISTING LAND USE

The interrelationships between land use, transportation, and other socioeconomic indicators can be used to forecast future regional trends and to evaluate alternative plans for regional development. An overview of land-use trends in the three counties will help define land-use pressures and growth patterns within the study corridor. Land-use in the three counties is shown on the maps in figures II, III, and IV.

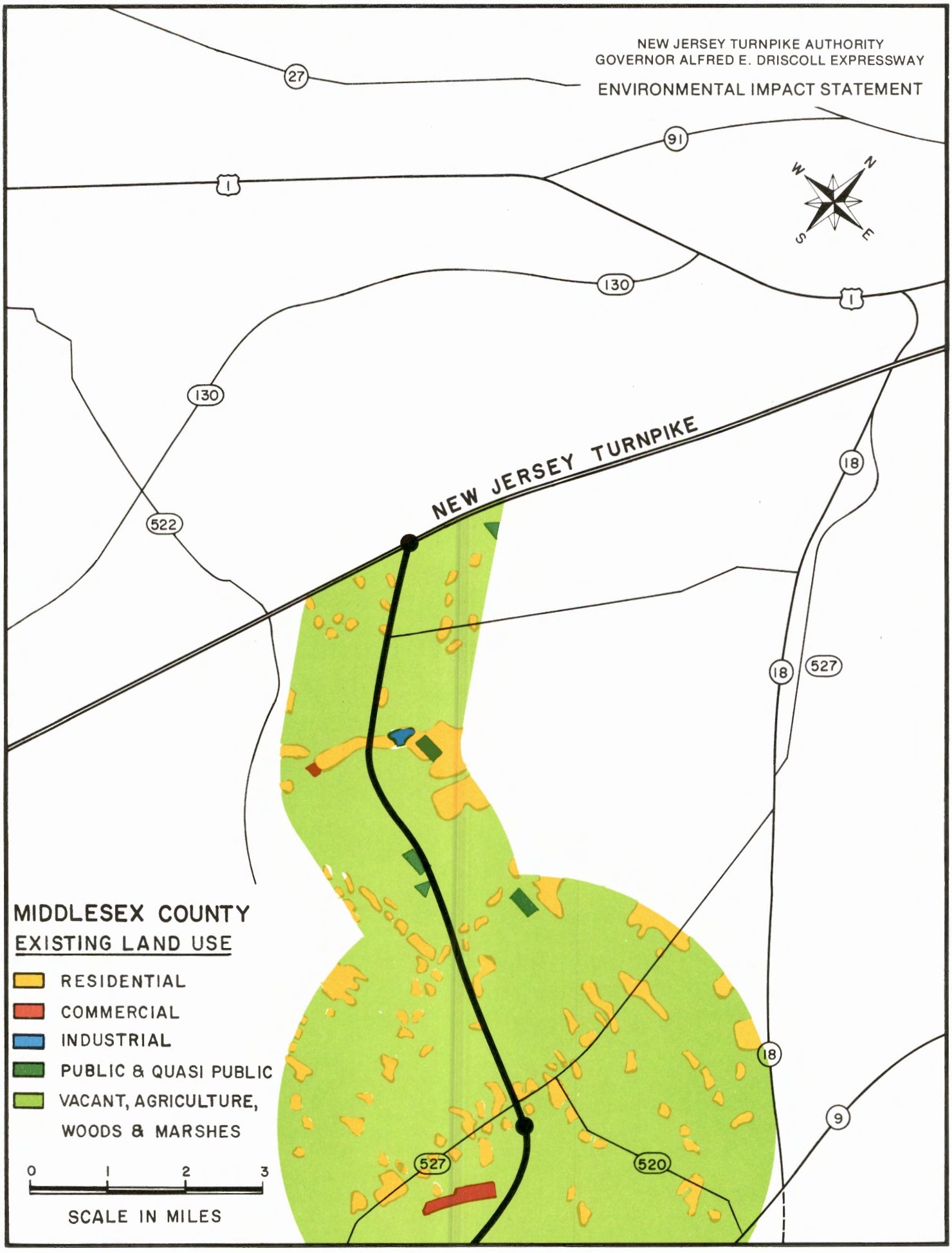
The Tri-County Area

The three counties through which the proposed Expressway will pass remain primarily undeveloped, although located in the most urban State in the Nation. Land use inventories conducted in the late 1960's indicate that over 60 percent of the land in Middlesex and Monmouth Counties consist of vacant woodlands, swamps, marshes and farms. Over 80 percent of the total area of Ocean County is undeveloped or farm land. Yet, each county is under considerable development pressure due to population growth and economic expansion in the New York metropolitan area and the scarcity of vacant land in other sections of the State.

TABLE I
Population Trends
Townships and Boroughs within the Study Area

	1950	1960	1970	Percent Change 1960-1970
Ocean County:	56,622	108,241	208,470	92.6%
Berkeley Township	1,550	4,272	7,918	85.3
Dover Township	7,707	17,414	43,751	151.2
Manchester Township	1,758	3,779	7,550	99.8
Lakewood Township	10,809	16,020	25,223	57.4
Jackson Township	3,513	5,939	18,276	207.7
Beachwood Borough	1,251	2,765	4,390	58.8
South Toms River Borough	492	1,603	3,981	148.3
Monmouth County:	225,327	334,401	459,379	37.4%
Freehold Township	3,443	4,779	13,185	175.9
Manalapan Township	3,137	3,990	14,049	252.1
Freehold Borough	7,550	9,140	10,545	15.4
Englishtown Borough	1,004	1,143	1,048	(-8.3)
Middlesex County:	264,872	433,856	583,813	34.6%
Madison Township	7,336	22,772	48,715	113.9
Monroe Township	4,082	5,831	9,138	56.7
East Brunswick Township	5,699	19,965	34,166	71.1
South Brunswick Township	4,001	10,278	14,058	36.8
Helmetta Borough	580	779	955	22.6
Jamesburg Borough	2,307	2,853	4,584	60.7
Spotswood Borough	2,325	5,788	7,891	36.3

Source: U.S. Department of Commerce,
Bureau of the Census


NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT
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NEW JERSEY TURNPIKE
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E
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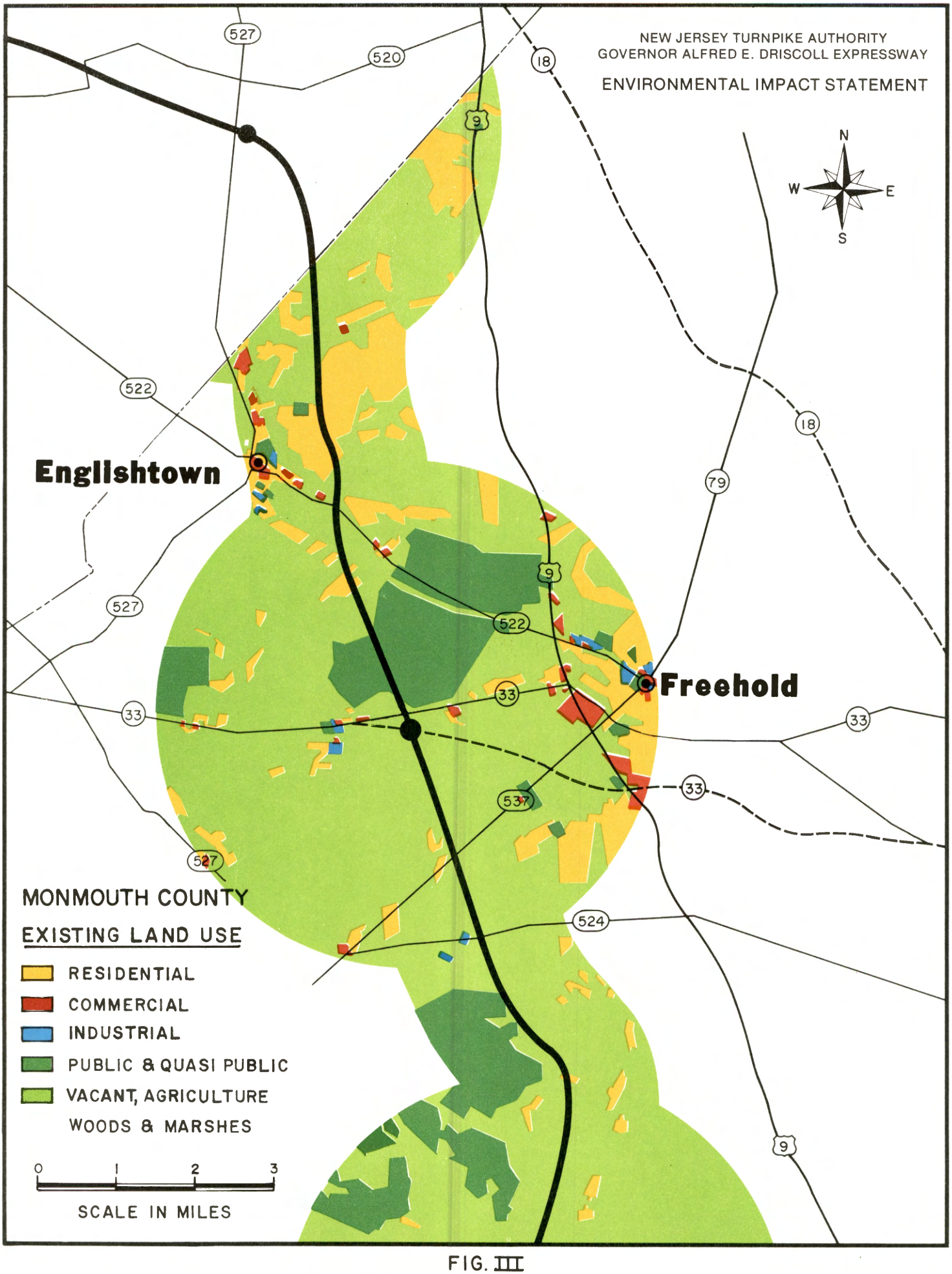
MIDDLESEX COUNTY
EXISTING LAND USE
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
PUBLIC & QUASI PUBLIC
VACANT, AGRICULTURE,
WOODS & MARSHES
0 1 2 3
SCALE IN MILES

FIG. II

Middlesex County - By 1967 about 90 percent of the residential development in Middlesex County was within the eastern and central parts of the County where employment opportunities existed. The heavy residential densities decline as one travels further to the south away from New York. The differences can be attributed to higher single-family housing densities and greater multiple dwelling units and apartments particularly in the older communities with more extensive public water and sewer facilities. In the formerly less dense areas, there has been a spread of apartment construction along expressways and major highways serving commuters working in New York and other major employment centers. In the more densely developed eastern and central portions of the County, the major land use activities are transportation and communications companies and both public and private utilities.

The greatest supply of vacant and developable land lies in the southern and western portions of the County and consists of farm fields and wooded areas. In addition to these "open" space areas, there are Government-owned tracts of land providing park and recreational facilities. In the eastern part of the County, school sites provide the bulk of public open space, while in the central part there is a greater proportion of county parks. In the southern region, public space consists almost entirely of county parks with very few municipal parks. There are several State parks including Cheesequake Park in Madison Township, Edison Memorial Park in Edison Township, and the Delaware and Raritan Canal.


NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT
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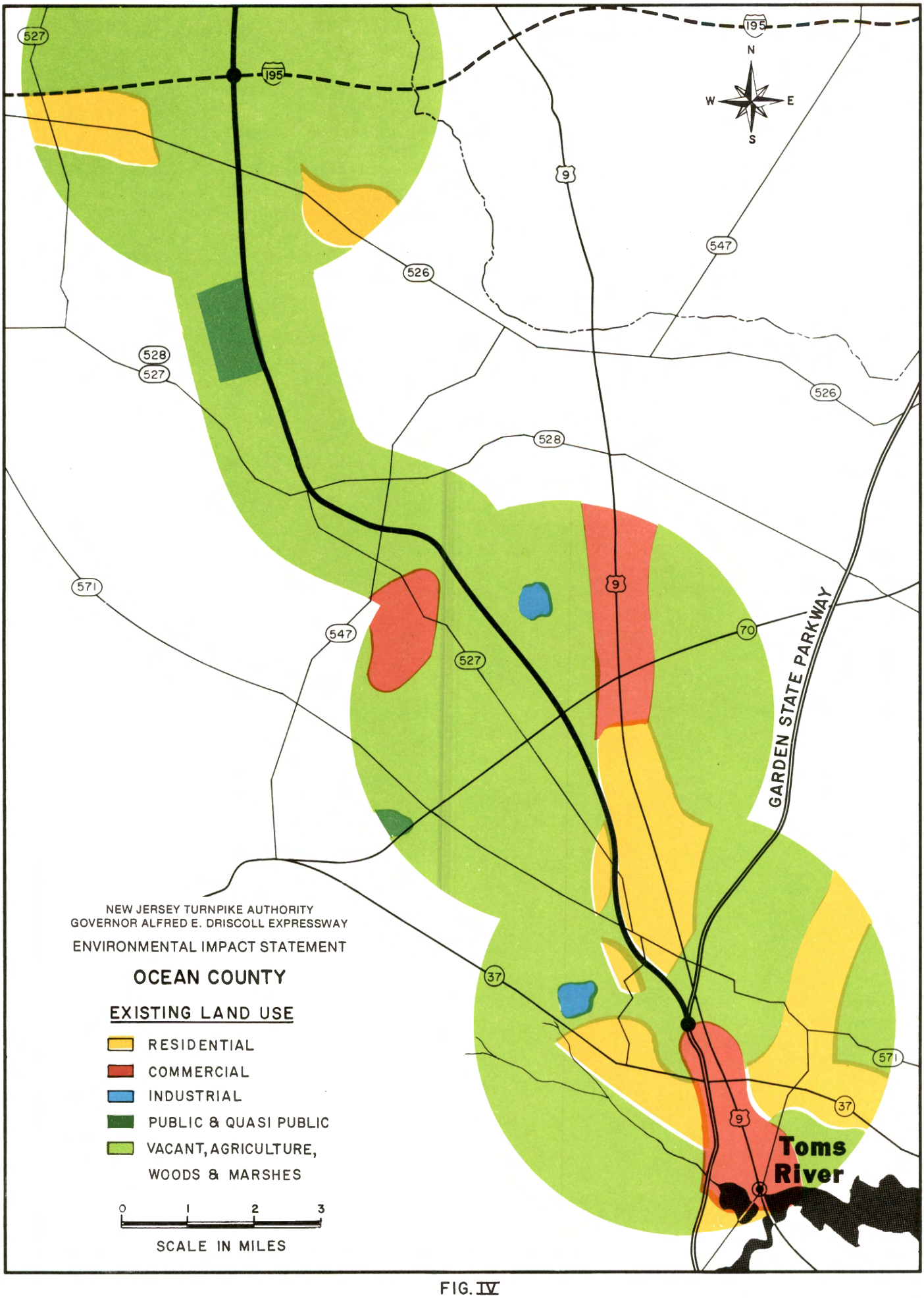
MONMOUTH COUNTY
EXISTING LAND USE
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
PUBLIC & QUASI PUBLIC
VACANT, AGRICULTURE
WOODS & MARSHES
0 1 2 3
SCALE IN MILES

FIG. III

Monmouth County - Over 40 percent of all developed land in Monmouth County is residential. Early residential development occurred in areas adjoining the Ocean and bays and in the older rural centers such as Freehold, Farmingdale, Englishtown and Allentown. This development was characterized by dwellings built either on very small lots in the town centers or on large lots (over two and one-half acres) in the outlying rural areas. The most recent residential development has been in the corridors along Routes 9, 34, 35 and 36, and the Garden State Parkway. While this development consists mostly of one-family houses built on subdivision lots of between 10,000-30,000 square feet each, the number of multiple dwellings and hotel, motel and rooming houses have also been increasing, particularly along Routes 35 and 36.

A large portion of the developed land in Monmouth County, about 15 percent, is owned by the Federal government, and includes military installations such as Fort Monmouth, Camp Wood, Camp Cole, Camp Evans, Earle Naval Ammunition Depot and Sandy Hook. Other public lands include county parks at Holmdel, Shark River and Turkey Swamp and State parks at Sandy Hook, Allaire, Turkey Swamp and Monmouth Battlefield. Complementing these recreational facilities are the widely-known beaches along the coast and its concomitant resort commercial activity. Finally, the remaining land, over 60 percent, is undeveloped or used for agricultural purposes. Traditionally, agriculture has been based on grain and potato produce, pastures, poultry and truck farms, and it is declining. Newer uses of farm land are landscaping nurseries, sod farms and horse farms. The wooded areas primarily lie adjacent to streams in the County and are extensive in areas south of the Manasquan River in southern Freehold and Howell Township, as well as in the topographically rougher areas of Millstone, Middletown, Holmdel, Marlboro and Colts Neck Township.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Toms River
NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT
OCEAN COUNTY
EXISTING LAND USE
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
PUBLIC & QUASI PUBLIC
VACANT, AGRICULTURE, WOODS & MARSHES
0 1 2 3
SCALE IN MILES

FIG. IV

Ocean County - Most of the development of Ocean County is concentrated along the coast and in the areas around Toms River, Lakewood and Point Pleasant. The growth experienced by the County has ranged from subdivision sprawl to strip development along major highways. In the northern section of the County, large-scale single-family subdivisions have been built primarily to serve commuters to the New York metropolitan area. The County's proximity to the Atlantic Ocean and its ample and beautiful beaches have made it a summer resort area, with a large number of summer homes and a multi-million dollar resort industry. Garden apartment construction has also increased, particularly in the northeastern part of the County. Some of these complexes have been planned as "retirement communities", designed for persons who formerly lived in other parts of the State and want to remain within commuting distance of their families.

Industrial activity has been limited and is concentrated primarily in the northeastern section of the County.

The remainder of the County consists of relatively open land characterized by privately owned farms, woods and marshes and State-owned public recreational fish and game properties. Finally, two military installations in the northwestern part of the County, Fort Dix and Lakehurst Naval Air Station, complete the County-wide land use picture.

The Corridor Area

The proposed Expressway passes through some of the least developed areas within the three counties, i.e., the southern portion of Middlesex County, and the western areas of Monmouth and Ocean Counties.

The maps on the following pages, which were produced using several County Planning Boards' publications and recent aerial photographs of the proposed alignment, indicate the classification of land within the study area.

The predominant land uses in the study area are vacant, agricultural, wood, and marsh lands. There are only a few scattered industrial sites within the corridor. Commercial activity only occurs in nominal amounts, although it is more prevalent than industrial activity. In sum, this corridor lies in a rural area that is just beginning to feel the pressures of urban development manifested in the form of small residential, subdivisional development. Pockets of these subdivisions exist throughout the corridor and the alignment of the Expressway weaves its way around most of them. The corridor also encompasses older residential areas such as the Toms River section of Dover Township in Ocean County, Freehold and Englishtown in Monmouth County and Jamesburg and Helmetta in Middlesex County. The remaining area in the corridor consists of public lands and parks. In Middlesex County, there are plans for a Jamesburg Park in the East Brunswick-Helmetta-Spotswood area through which the Expressway will pass. Monmouth Battlefield Park and Turkey Swamp in Monmouth County and Butterfly Pond Fish and Wildlife area in Ocean County are also within the study corridor.

COMMERCE, INDUSTRY AND EMPLOYMENT

This section of the impact study discusses historical industrial and commercial activity and employment in the region to be affected by the Governor Driscoll Expressway. Excluded is agriculture which is discussed in another section of the report as an industry of declining importance in the corridor.

Commerce

Commercial activity first began in the old business districts such as New Brunswick and Perth Amboy in Middlesex County; Asbury Park, Long Branch and Red Bank in Monmouth; and Toms River, Point Pleasant Beach, Lakewood and Tuckerton in Ocean. Expansion in these centers has been prohibited by traffic congestion and limited parking facilities and discouraged by scattered residential development in outlying areas. The latest commercial development, in the form of shopping centers and "strip development", has been following the pattern of population growth as residents leave the older established city centers and move to the less dense and more scattered areas penetrated by regional highways. For example, Route 35 in Monmouth County, once a through-route from northern New Jersey to the shore is now characterized by strip development; and at the junction of Routes 35 and 36 in Eatontown there is a large shopping center. US 9 is also a strip of development running through Monmouth and Ocean Counties. Currently, plans are being developed for Ocean County's first regional shopping center. It will be located in Toms River on Route 571, east of the Garden State Parkway, and will be served by the Governor Driscoll Expressway. Bamberger's will be one of the occupants.

Industry

Industrial activity in the area is varied. Of the three counties, Middlesex is the most industrialized since 1) it is centrally located between New York and Philadelphia; 2) it is easily accessible by rail and highway facilities; 3) it has a good supply of labor and ample water and sewer facilities; and 4) much of the land is zoned for industrial use. The northern part of the County ranks with Elizabeth, Newark, and Hudson County as one of the focal points of manufacturing and distribution facilities in northern and central New Jersey. In southern Middlesex there are a small number of industrial sites located along major highways. In the more densely developed eastern and central portions of the County, transportation and communication companies and public and private utilities account for a major portion of industrial land use. Mining, an activity of lesser importance, is also present in the County and consists primarily of sand, gravel, stone and clay pits.

Monmouth County, in comparison to the other counties in New Jersey, lags the rest of the State in industrial development. In the area, industry is predominantly "light" rather than "heavy". Early industrial development, like early residential and commercial development, occurred in the older town centers along the coast but recently it has spread to the west, particularly to areas served by highways and utilities.

Ocean County has little industrial activity. It is concentrated in the northeastern section of the County, with some scattered development in the northwestern and southern sections. The bulk of industrial land use is devoted to chemical, garment and concrete products manufacturing as well as boatbuilding, food processing and other activities.

Employment

The following table, giving figures for the civilian work force in the tri-county area for the years 1961, 1966 and 1971, presents an overall view of employment in the tri-county region.

Civilian Work Force

	Ocean County	Monmouth County	Middlesex County[1]
	(Thousands)		
1961	33.1	108.9	169.5
1966	43.8	134.7	197.5
1971	62.2	159.5	251.7
Increase, 1961-1971	29.1	50.6	82.2
	Increase (Percent)		
1961-1971	87.9%	46.5%	48.5%

Source: N.J. Department of Labor

1/ The Civilian Labor Force figures for Middlesex County were derived by proportioning the total work force for Somerset and Middlesex Counties according to the relative population of the counties.

The figures come from estimates made by the Division of Planning and Research of the New Jersey Department of Labor for the Lakewood-Toms River Labor Market Area (Ocean County), the Long Branch Labor Market Area (Monmouth County), and the Perth Amboy-New Brunswick Labor Market Area (Middlesex and Somerset Counties). The Civilian Work Force includes workers employed in the county plus unemployed workers and workers involved in labor disputes.

As shown in the table, growth in each of the three counties was substantial. For the ten years 1961-1971, the greatest increase was in Ocean County where the Civilian Work Force increased by nearly 88 percent. During the same period Monmouth and Middlesex experienced increases of more than 45 percent.

EXISTING TRANSPORTATION SERVICES

In order for the analysis of the impact of the proposed Governor Driscoll Expressway to be complete, it must not be limited to analysis of the highway mode alone, but must also consider the other modes that make up a transportation "system". In this light, we have examined the impact of the Governor Driscoll Expressway on existing bus, rail, truck and air transportation. Described below is the transportation system now in operation within each of the three counties by mode. The impact of the Expressway which can be anticipated on each mode is described in Chapter III of this report.

Existing Traffic Conditions

Highway traffic in the study area has grown in astronomical proportions over the past twenty years. The amount of automobile traffic generated in Monmouth County alone has grown from 880 million vehicle miles in 1950 to 2.2 billion vehicle miles in 1968, an increase of 150 percent. Projections by the Monmouth County Planning Board show an expected increase to 4.2 billion vehicle miles in 1985. Middlesex County traffic is also expected to more than double today's volume by 1985. Traffic in the northern part of Ocean County has been growing at a similarly high rate. Within the area travel is primarily by private automobile, with the use of public transportation restricted almost entirely to commuter use with a small volume of local bus traffic. Reflecting this condition is the following table which shows that the number of persons per passenger vehicle in 1970 was somewhat less in each of the three counties than the statewide average.

Persons Per Passenger Vehicle

	1970 Population	1970 Passenger Vehicles	Persons Per Passenger Vehicle
New Jersey	7,168,143	3,052,983	2.35
County			
Ocean	208,470	99,851	2.09
Monmouth	459,379	203,177	2.26
Middlesex	583,813	250,630	2.33

Sources: New Jersey Office of Business Economics, U.S. Department of Commerce, Bureau of the Census

Historically, Monmouth and Ocean Counties have had highly seasonal traffic due to the large resort industry along the coast. However, the once vast gap between year-round and seasonal traffic volumes has been narrowing, as a result of large increases in year-round residential development as well as increases in local employment and commercial activity. Considerable peak-hour commuter traffic has developed since much of this residential development has been oriented toward serving the housing needs of persons employed in northern New Jersey and New York City. This commuter traffic has put a considerable strain on existing highway facilities as evidenced by the overloading of Routes 9, 18, 34, 35, 36 and the northern sector of the Garden State Parkway. For example, traffic on Route 9 tripled to 28,200 AADT during the 11-year period between 1960-1971. The rapid rate of land development in Marlboro, Manalapan, Freehold and Howell Townships in Monmouth County and in the Jackson-Lakewood area in Ocean County is largely responsible for this increase. The following are AADT figures for other major roads: Rt. 18 in Old Bridge - 44,500; Rt. 34 in Middletown - 13,100; and Garden State Parkway Asbury Park Toll Plaza - 44,900.

Many of the roads serving the area are congested not only on summer weekends but during daily commuter peak periods as well, and there are several sections that have earned an infamous reputation insofar as safety is concerned.

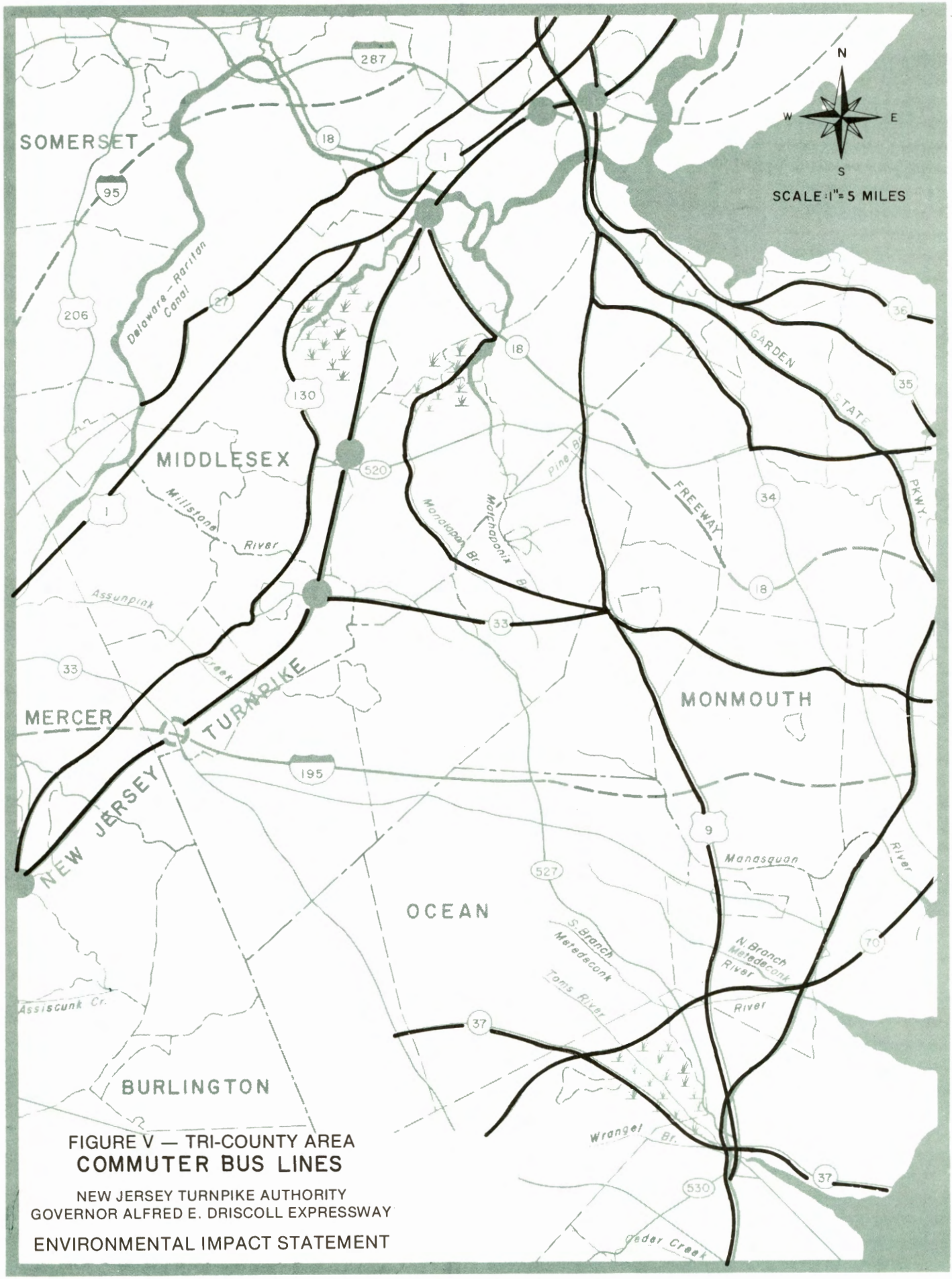


FIGURE V — TRI-COUNTY AREA
COMMUTER BUS LINES

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

Bus Transportation

The existing commuter bus routes in the tri-county region are shown on the map in Fig. V.

In Middlesex County there are two basically separate forms of bus service, local and commuter. The local bus routes serve the high density and low income areas linking the older city centers, such as Perth Amboy, New Brunswick, and others. As in many other urban areas, local bus patronage has declined sharply, followed by subsequent cutbacks in service. For example, in the five-year period 1961-1966, local bus patronage declined from about 6.2 million passengers to 4.9 million — a decrease of 21 percent.

The commuter routes, on the other hand, are oriented toward New York City with some service to Newark, Union County, Trenton and the shore area. There have been gains in ridership for the New York service, with losses for the intrastate service. The existing regional commuter routes face heavy competition from the three commuter rail routes within the County, namely the Jersey Central Mainline, the Penn Central Mainline and the New York and Long Branch corridors. Highways such as Routes 1, 9 and 130 and the New Jersey Turnpike and arterial routes are the major roads accommodating the regional bus routes.

Bus service in Monmouth County is primarily devoted to long-distance commuter runs; however, local bus service is also provided along many of the commuter routes. The principal service routes for the existing commuter lines are along Routes 9, 35 and 36 and the Garden State Parkway. During the peak hours, commuter service is at frequent intervals but tapers off drastically during the non-commuting hours; some areas have peak period service only. The bulk of the commuter service, amounting to over 5,000 passengers daily, is oriented toward the Newark and New York metropolitan centers; there is also some bus service to the Trenton, Philadelphia and Atlantic City areas. Commuter service has been constantly growing particularly in the developing sections of the County. Due to the lack of passenger rail service in the western region of the County, there have been significant increases in bus commutation along the Route 9 corridor. However, increases in bus commutation have not been without problems. Since many bus commuters drive their automobiles to the bus stops, parking problems have been created, particularly in Freehold Borough and Manalapan Township where all-day commuter parking conflicts with shopper and residential parking. Furthermore, increasing traffic congestion, especially during the periods of heavy resort travel in the summer, creates traffic delays that adversely affect the commuter service.

Local bus service is extremely limited within Monmouth County. Increased ownership and usage of private automobiles and the scattered distribution of low-density development in the County have caused local bus patronage to decline severely. This factor, coupled with rising operating costs, has resulted in increasing operating losses and, in turn, subsequent declines in service.

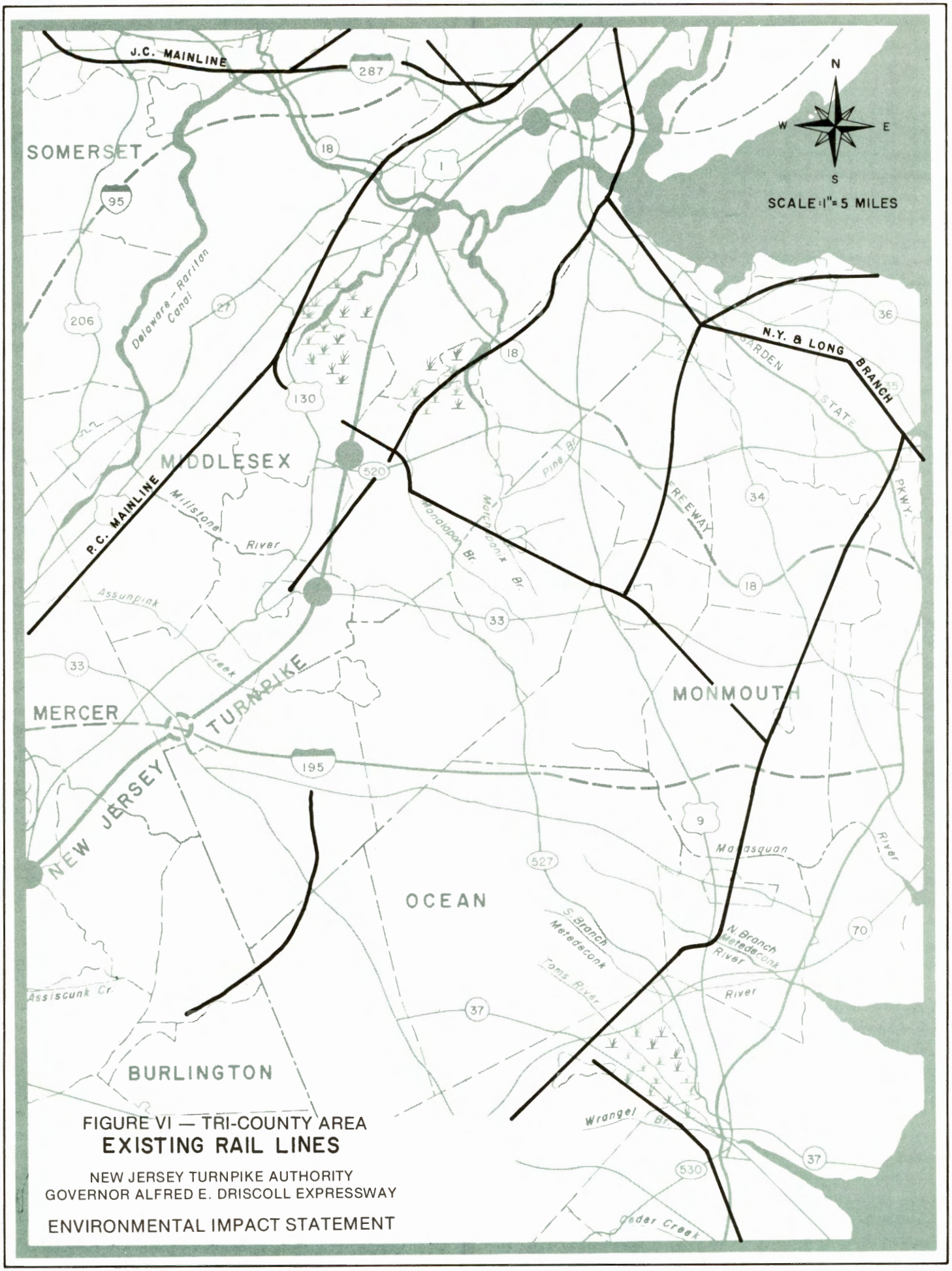


FIGURE VI — TRI-COUNTY AREA
EXISTING RAIL LINES

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

Bus service in Ocean County, as in Monmouth, consists primarily of commuter service oriented toward the northern New Jersey and New York metropolitan regions with Route 9 and the Garden State Parkway the major travel corridors for this commuter service. Local service in Ocean County has also been declining almost to the point of extinction. The Ocean County Planning Board is conducting studies to see if this trend can be reversed.

Truck Transportation

There is a lack of limited-access truck routes within a good portion of the three-county area. This causes added expense and delay in deliveries to plants in Monmouth County since some long distance truckers refuse to come into the area and off-load in northern New Jersey instead. The goods are then transferred to local trucking firms for delivery a day or more later. Middlesex County has several excellent truck routes including Routes 1, I-287 and 130 and the existing New Jersey Turnpike. However, except for that portion of the Garden State Parkway south of Exit 97A, there are none in Monmouth and Ocean Counties. For access to the major industrial centers in the north, trucks must use the heavily traveled arterial roads such as Routes 9, 18 and 34.

Railroad Transportation

The existing rail routes in Middlesex, Monmouth and Ocean Counties are shown on the map in Fig. VI.

There is an extensive network of railroad lines traversing Middlesex County. The Main Line of the Penn Central provides commuter service to both New York City to the east and Philadelphia to the west. In addition, with the recent opening of the Metropark station in Woodbridge, area residents have ready access to AMTRAK's Metroliner service that provides high speed, long distance service to Boston, New York, Philadelphia and Washington. The Jersey Central Mainline and the northern branch of the New York and Long Branch Line also provide passenger service to the New York and Newark areas. All three passenger services are oriented to the commuter rather than to the local passenger. Freight service is also provided on these lines augmented by a number of freight lines and industrial spurs including Penn Central's Amboy and Monmouth Junction branches out of Jamesburg and its Camden Division serving points southwest of the County.

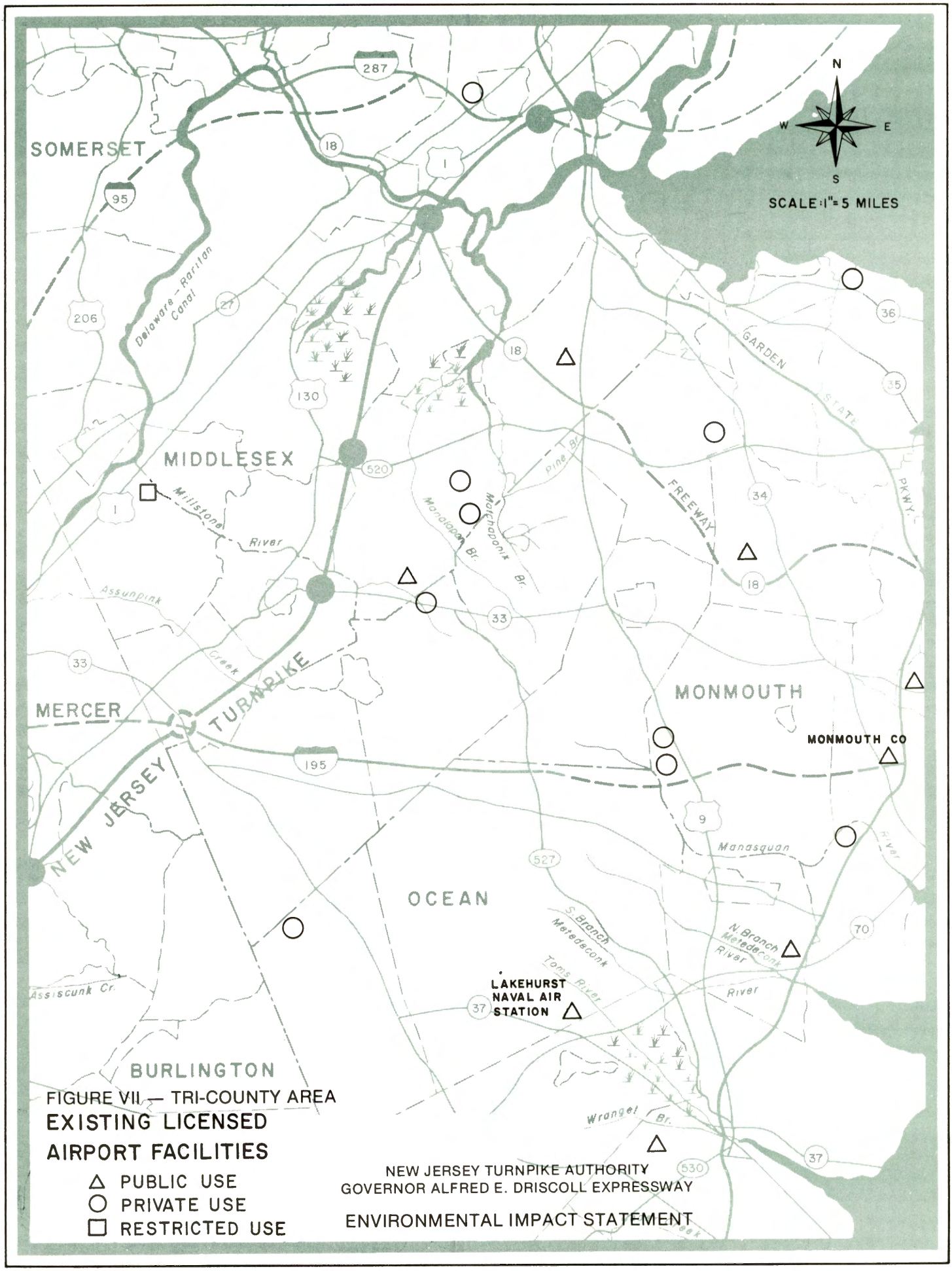


FIGURE VII — TRI-COUNTY AREA

EXISTING LICENSED AIRPORT FACILITIES

- △ PUBLIC USE
- ○ PRIVATE USE
- □ RESTRICTED USE

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

Within Monmouth County there is only one passenger rail line, the New York and Long Branch serviced by both Penn Central and the Jersey Central railroads. Extending from Bay Head in Ocean County to New York City, the passenger service is a commuter type operation. There are proposals, however, for providing a branch to this service along the currently little-used freight tracks of the Jersey Central between Freehold and Matawan. This would bring commuter rail service to the central portion of the County currently lacking passenger service but with a latent demand for high speed commuter operations. Freight service is provided on the New York and Long Branch Line and the Central Division extending from Red Bank southwestward into Ocean County. Additional freight lines run between Freehold and Jamesburg, and between Camden and Upper Freehold.

In Ocean County, as in Monmouth County, the only rail passenger service is the New York and Long Branch serving the coastal areas. Freight service is provided by the Penn Central and Jersey Central railroad companies. The Penn Central distributes freight at the western fringe of the County along its Union Branch with a spur extending from the western line of the County in Manchester Township to Toms River. The Jersey Central provides freight service along its main branch that extends from Lakewood to the County line in western Manchester Township. An industrial spur originating in Lakehurst parallels Route 37 into Toms River and continues south to Barnegat.

Existing Airports

Fig. VII, showing the locations of the licensed airport facilities within the study area, was developed from the Licensed Airport Facilities Maps prepared by the Bureau of Aviation Planning, New Jersey Department of Transportation.

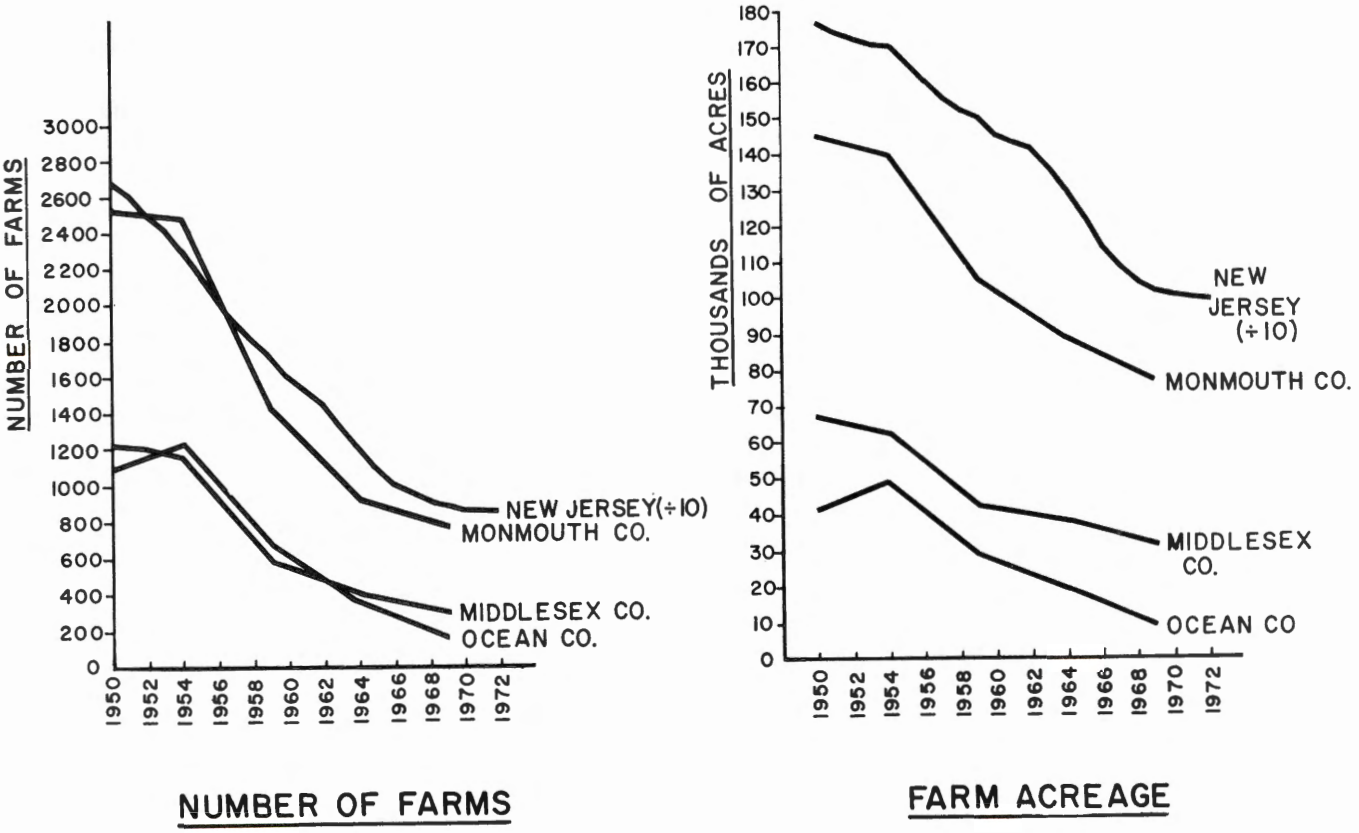
Most of the air facilities shown on the map cannot be considered part of a public transportation system. They are primarily used for pleasure and private business purposes. Monmouth County Airport in Farmingdale provides public transportation service in the form of scheduled flights to JFK Airport in New York and Washington, D.C., and air taxi service to the major metropolitan airports. A major U.S. Naval Air Station located at Lakehurst in Ocean County is an important segment of the Eastern Seaboard Defense System.

AGRICULTURE

Within the three-county study area agriculture is both declining as an industry and changing in nature.

Monmouth County, and in particular the Western Monmouth Region, has long been a leader in agricultural production in the State. In fact, the historic economic foundation of the Region was based on agriculture. Due to many factors, the number of farms and the acreage devoted to farming has decreased to a point where in many areas it is no longer a significant economic factor. The reduction in both number of farms and in farm acreage in the three counties can be seen in Fig. VIII. It is probable that this trend will continue as non-agricultural uses become more and more economically attractive.

FIGURE VIII — NUMBER OF FARMS AND FARM ACREAGE — NEW JERSEY AND THREE COUNTIES



Agricultural profit margins are shrinking as production costs and land taxes are rising. The equipment needed to operate a farm at a competitive cost is increasing in complexity, size and price. Therefore, the size of farms capable of economically supporting this equipment is growing and smaller farms must either merge or operate at an economic disadvantage. From 1961 to 1971 the average size of farms in New Jersey increased from 95 to 118 acres. As stated in a publication by the U.S. and N.J. Departments of Agriculture:

> "The past decade saw a 25-percent decline in number of farms while only a 4-percent drop was recorded in land in farms. These changes are associated with a 27-percent increase in average size farms. The continued disappearance of small farms along with mergers into larger, more efficient operations contributed most to the change in farm numbers. Urbanization and highway construction were the major causes of decline in land in farms."[1]

Another indication of the declining state of agriculture in the area is the age of the farmers themselves. The children of the farmers are entering other, more remunerative occupations. The Census of Agriculture revealed that the average age of farmers in Monmouth County is over 53 years.

Even with the reduced number of farms, efficiency has been increased to such a point that more crops are produced than can be consumed. The result has been payments by the Federal Government to farmers for withholding acreage from productive use. These payments help offset the loss of revenue on cropland which is not cultivated and on which the farmers are obliged to continue to pay taxes. This year 385 farmers in Monmouth County alone received set-aside payments. The decline in the number of farms would have been even greater if they had not been artificially sustained by this subsidy.

Our analysis of the outlook for agriculture in the study area is that the rate of reduction in acreage devoted to farming will level off more quickly in Ocean and Middlesex Counties than in Monmouth. This is primarily because Monmouth has more acreage to lose. The remaining farmland will gradually change to higher value, less labor-intensive operations which can withstand the economic pressures of urban development. For instance, cranberry bogs, which require rigid control of water levels in order to operate, are a declining activity in New Jersey.

The Monmouth County Agricultural Agent feels that high value per acre crops requiring as little labor as possible have a definite future in Monmouth County. Truck farming, gardening and direct marketing to the public at roadside stands as well as horse and nursery stock operations are examples of this type of agriculture. According to surveys done by the State Department of Agriculture the number of horses in Monmouth County increased from about 2,200 in 1960 to approximately 10,000 in 1968. Nearby race tracks in the area and in the region will

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1/ U.S. Department of Agriculture and N.J. Department of Agriculture Facts for Decision. January 18, 1972.

encourage the development of the horse farms and will provide an economically stabilizing effect on their continuation.

Another type of desirable agricultural land use is "sod" farming which has grown significantly in the County in the last several years. The nurseries and sod farms will be sustained by the urban development which has enveloped and taken over the other portions of farm land.

The Economic Development Program of the Monmouth County Planning Board is directing efforts to stimulate this trend since the justification for the preservation of agriculture in the Region is not based on the need for agricultural products but for the secondary benefits which accrue to the urban development.

The impact on specific farm parcels on the right-of-way of the Expressway will be discussed in another section of this Report.

CHAPTER III - ESTIMATED SOCIOECONOMIC EFFECTS OF THE GOVERNOR DRISCOLL EXPRESSWAY ON THE STUDY AREA

INTRODUCTION

This study by Coverdale & Colpitts, Inc. of the socioeconomic impact of the proposed Governor Alfred E. Driscoll Expressway indicates that the Expressway will not materially effect the trends that have been established in the tri-county area. In areas immediately adjacent to the highway itself the Expressway may accelerate development along the lines already in progress. There has been, and will continue to be, a trend of increasing population, increasing land use for both residential and light industrial purposes and a general rise in the level of the economy through increasing land values and an increasing tax base. Further developments in the area have indicated a significant increase in vehicular traffic commensurate with the population growth and development activity.

The Expressway, by diverting traffic from existing routes, will relieve congestion and improve highway safety. It will also provide a limited-access truck route in southern New Jersey and improve prospects for better commuter bus service. Our study concluded that the Expressway is only one of the several socioeconomic factors which will continue to influence developments in the tri-county area. In no instance have we determined that there will be any major negative impact if the proposed Expressway were to be built as planned.

To estimate the impact of the proposed Expressway on the study area, we examined land use, zoning, population and employment trends; reviewed changes in land use in comparable situations, particularly the effect of the completion of the Garden State Parkway; analyzed several previous planning studies and aerial photographs of the study area and met with county planning officials, real estate developers and others. The following paragraphs describe our conclusions resulting from these discussions and analyses regarding the construction of the Expressway and its consequent impact.

COUNTY MASTER PLANS

The concept of a north-south limited-access highway through the study area is not a new idea and has in fact been incorporated into many of the counties' Master Planning Studies. In the early sixties it was proposed that such a route be built generally parallel to the existing Garden State Parkway extending from Toms River north as far as Wayne. Ocean, Monmouth and Middlesex Counties each subsequently adopted master plans taking cognizance of this concept.

Ocean County's Master Plan, adopted in 1966, incorporated a "Woodbridge-Toms River Garden State Thruway" in the overall circulation plan for the County. It was proposed that the highway extend from the Toms River area to Woodbridge with interchanges in Lakewood and Jackson Townships, intersecting Route 70 and what is now known as I-195.

WESTERN MONMOUTH PLAN - 1965 ?

To accommodate the growth in north-south commuter traffic along the Route 9 corridor and to provide a new crossing of the Raritan River, the Monmouth County Planning Board, in its General Development Plan, proposed a "Garden State Thruway", to extend from Toms River to the New Jersey Turnpike in the vicinity of its present interchange with I-287 in Edison Township.

One of the components of the conceptual transportation system adopted in the Middlesex County Interim Master Plan is a limited-access highway across the south central part of the County, roughly paralleling Route 18 and extending to I-287.

Within Ocean and Monmouth Counties the proposed Expressway does follow the basic corridor alignment adopted in the Master Plan for each County. In Middlesex County, north of Englishtown, the proposed Expressway differs from the corridor shown in the Ocean and Monmouth County plans by bending to the west and running parallel to Route 18 as proposed in the Middlesex County Interim Master Plan, instead of continuing due north to Woodbridge. The proposed Expressway terminates at the existing Turnpike. The Middlesex County Planning Board still recommends continuing the Expressway northwesterly to I-287 or at least to US 1.

It is apparent that the County Planning Boards have long been aware of the proposed Expressway and have taken measures to plan and direct its impact in their individual counties.

FUTURE LAND USE

Our studies indicate that the proposed Expressway will maintain the present high growth rate of residential development in the tri-county area and the concomitant demand for increased commercial and community service facilities. The construction of the proposed Expressway is also expected to result in the continuing expansion of light industrial development in the area.

The interaction between land use and transportation is a dynamic and complicated process still not fully understood. The process often operates in a self-justifying manner whereby land use around a given transportation facility intensifies after the facility is built. The intensified land use generates a greater travel demand, which in turn develops the need for an expanded transportation facility, which may intensify land use again, etc. This process is further complicated by additional factors related to either the facility, the land or external conditions. For a highway or expressway, such factors as access control, geometric design, traffic controls and restrictions, as well as interconnections with other highways play a role in influencing land use development. The characteristics of the land traversed that interact with the expressway to influence land use include: the location and intensity of existing development, topography and drainage, zoning and other land use controls and proximity to urban centers. In addition, there are external factors, both social and physical, that must be

considered, too. The social factors include: the state of the economy, consumer demands, entrepreneurial preferences, population and employment distributions, political climate, fiscal and regulatory policies and others, while the physical factors include: the adequacy and location of water, power, and sewer facilities; other existing and planned transportation facilities; environmental conditions and the particular physical needs of industrial and commercial establishments.

The Expressway is expected to maintain, rather than increase the current high residential growth rates in Middlesex, Monmouth and Ocean Counties. The growth fostered by the road will consist primarily of low to medium density development, i.e., one-half to four dwelling units per acre. Some of this development may be in the form of planned units developments (PUD's) that allow a mixture of land uses to provide a variety of housing facilities. However, one factor that may mitigate against the larger PUD's is the difficulty in obtaining large contiguous tracts of land. This is caused by the number of owners of small plots. It is much easier to deal with two or three owners to form a large tract than it is to bargain with five or ten owners of plots completely surrounded by the main tract. It is more likely therefore that smaller cluster sites such as garden apartments will be developed, especially near interchange areas and major collector roads and arterials leading to the Expressway. Traditional subdivision developments with little variety in design and lending a monotonous picture of uniformity to the landscape may also be built. The effective implementation of land use controls conducive to planned growth by county and local community officials and planning boards is necessary to insure desired patterns of development.

Heavy industrial development is not expected in the study corridor as a result of the Expressway. Anticipated industrial development will consist of the "light" type: office facilities, research parks and other facilities that do not create noise, smoke, odors and other objectional nuisances and dangers. In Monmouth County manufacturing development is expected to occur in the Englishtown area that is encompassed by Route 33 and a rail freight line as well as the Expressway. In Ocean County, this activity would be expected in the Jackson area in the vicinity of the proposed interchange of the Expressway with I-195. However, this area would only be attractive to a business that has no need for rail facilities.

In the study area in Middlesex County the proposed Expressway will be less significant in promoting industrial activity. Both the Eastern and Central regions of this County are more favorably endowed than the corridor area with such key industrial location factors as transportation accessibility, public utilities, and proximity to labor pools.

Commercial development will follow residential and population growth. Regional and community shopping centers on major intersecting roads such as Route 33 will be built to accommodate the new residential developments. Strip development will not occur along the Expressway since it is a limited-access route but could along the major arterials

near the corridor as a result of the residential development fostered by the Expressway.

The land use developments fostered by the Expressway support the general land use patterns shown in the three-county master plans intended to guide comprehensive, long-range growth. These developments create demands for increased urban services such as water, power, sewerage and educational facilities. Whether the induced development grows in undesirable patterns creating an excessive burden on one or more of these services depends on how well land use controls are implemented. Subdivision controls, green belt and zoning ordinances, plan and performance standards will be required, along with the cooperative efforts among planning boards, residential and commercial developers, public officials and community groups to ensure that the projected development results in acceptable design.

EFFECTS ON LAND VALUES AND THE LOCAL TAX BASE

Our studies indicate that the Governor Driscoll Expressway will generally increase land values and, as a result, the tax base in the area will also increase. Studies on the effect on land values adjacent to Route I-287 in New Jersey and other major limited-access highways similar to the Expressway in other parts of the country indicate that the land values of properties along these roads have increased at a higher rate than on other properties. We believe that this phenomena will also occur in the areas adjacent to the proposed Expressway.

The effects of the construction of a highway on the local area tax base are twofold: (1) the immediate reduction of a community's taxable assessed valuation due to the taking of right-of-way by a non-taxpaying agency, and (2) the long-term change in the value of property not taken for right-of-way. For the most part, the 35-mile alignment of the Governor Driscoll Expressway passes through undeveloped lands. Since only 73 homes or less and no major businesses are being displaced, the loss imposed upon the municipalities will be negligible, with one exception. Current planning indicates that 10 of the 73 residences are in the Borough of Helmetta and, because the municipality is small (512 acres, 932 population), they represent three percent of the community's total dwelling units. The impact of the Expressway could be lessened by moving the houses to available vacant lots in Helmetta, if possible.

To get a better understanding of the expected long-term change in value of the property not taken for right-of-way, we discussed this issue with representatives of real estate firms and members of each County's Board of Realtors, as well as members of the County Planning Boards and several housing development firms. They were all of the opinion that land values within the impact corridor would increase due to the construction of the Expressway and further, that the most rapid increases would occur on land adjacent to the interchanges. However, they would not estimate a specific rate of increase that can be expected.

It has been demonstrated many times that land values in a growing area will increase if that area's accessibility to large employment markets and distribution centers is improved. However, we should keep in mind that factors other than improved accessibility contribute to the overall effect on land values. For example, land adjacent to the proposed Expressway currently being used for farm land will increase in dollar value if it can be converted to commercial use after the construction of the Expressway. Also, land located near an interchange of this limited-access highway could increase in value, but only if zoning regulations, etc., allow developers to take advantage of this proximity. After a good access route has been constructed, realistic zoning regulations, tax structures and other local government policies can insure growth patterns beneficial to the entire community.

To provide a basis for evaluating the future impact of the proposed Expressway, we examined the historical record of assessed valuation of property along I-287 in New Jersey.

Due to variations in tax rates, assessment rates and timeliness of valuations, the differences in taxable property value between municipalities using assessed valuation loses significance. To combat this problem the Director of the Division of Taxation for the State of New Jersey has devised a method called "equalized valuation" which places all municipalities within the State on an equal basis with regard to the true value of property. From municipal tax records, we obtained the equalized valuations of all property in those political subdivisions contiguous to I-287 in Middlesex and Somerset Counties extending from Route US 1 at Metuchen to Route US 22 in Bridgewater Township. The trends in valuations of these communities were compared with general county trends and specifically with communities in the same county but non-contiguous to the road. The results for the years 1962-1970 (the first segment of the road opened in the middle of 1961) are shown in the table below.

Equalized Valuation Increases

Year	Municipalities in I-287 Corridor	Municipalities Not in I-287 Corridor
	Percent Increase Over Previous Year	
1962	3.0	7.4
1963	6.8	9.6
1964	7.0	3.0
1965	12.4	6.1
1966	9.3	9.2
1967	8.5	6.7
1968	3.6	6.6
1969	8.4	6.8
1970	19.3	10.7

As can be seen from the table, in the first two years the municipalities contiguous to the road had a lesser growth rate than the remaining municipalities in the two counties. This could be attributed to the reduction in assessed valuation of the contiguous area due to right-of-way acquisitions. In six of the seven years following, the municipalities traversed by I-287 had a greater growth rate. This could be indicative of the rise in property values due to the new road, which in turn offset the reduction in valuation due to right-of-way acquisitions.

As a result of further analyses of the trends in equalized valuation in Middlesex, Monmouth and Ocean Counties, it is worthy of note that 25 of the 30 municipalities leading in population growth were also among the leading municipalities in valuation growth.

There have been numerous other studies on the effects of a limited-access highway on land values by highway departments, transportation engineering firms, etc. One such study states, "the changes varied greatly between reports and in some were of enormous dimension. An example, in Colorado the average price of ground per acre, in a zone located a half-mile on each side of a newly built Interstate highway, increased 37 times between 1949-1953 and 1960-1961, from $208 prior to its construction to $8,026 subsequent to its completion, an annual average rate of increase of 35 percent."[1] A table showing the figures of a number of such studies throughout the county indicated the greatest rise to be 87 times the initial values, during a period in which a control area increased 52 times; most of the increases, however, were considerably smaller, on the order of two or three times the original values.

One of the most detailed studies on land value increases due to limited-access highway improvements was done for the Texas Highway Department.[2] It was an analysis of the post-construction changes in the values of lands located within a half-mile of interchanges. The study was based on a statewide random sample of highway segments and included over 43,680 acres of property. The following table shows the increases after construction in the mean value of the land by category. Prior to construction, all land had a mean value of $4,735 per acre.

Increase in Property Value by Location
Within the Interchange Complex

Distance from Interchange	Increase in Value	
	Dollars	Percent
1. Interchange Property	$12,907	273%
2. Property on Ramps	9,697	205
3. Under 500 feet	11,996	253
4. 500-1,000 feet	5,562	117
5. 1,000-1,500 feet	3,694	78
6. 1,500-2,000 feet	2,282	48
7. 2,000-2,500 feet	793	17

1/ Milgram, Grace U.S. Land Prices - Directions and Dynamics. Washington, D.C., 1968

2/ Franklin, William D. "The Highway" 'Interchange Complex' and Economic Development, "Traffic Quarterly", January, 1970.

Another study, this one by the Stanford Research Institute, estimated that losses due to right-of-way costs for an expressway in Houston would be offset by the increase in property value in seven years. It should be noted that the Houston right-of-way takings were more highly developed and therefore a greater loss to the tax base than the right-of-way takings for the Governor Driscoll Expressway.

In summary, we believe that most of the land within the impact area of the Governor Driscoll Expressway will increase in value. Since so many factors are involved, it is impossible to project the future value of specific parcels of land. However, we believe increases in valuation of the order of magnitude quoted above are reasonable and therefore expect the overall effect upon the local tax base to be favorable.

It is possible that developers could improve the land while the Expressway is being built so that the loss incurred by the right-of-way taking could possibly be made up by the time the Expressway opens for operation.

FUTURE INDUSTRY AND EMPLOYMENT

It is expected that the construction of the Expressway will result in continuing expansion of light industrial development in the area. At the present time there is a trend towards the development of industries such as electronics and light manufacturing. The advent of improved transportation and the prospect of increased population oriented towards such industrial employment will accelerate a trend which has already been established in the tri-county area. Our studies conclude that there will be no insurgence of heavy industry into the area as a result of the construction of the Expressway.

In the tri-county region employment has been growing at a rapid rate. The table below shows employment figures for each county as of June, 1972 and the projections for 1985 according to the County Planning Boards. There were no projections available from the Ocean County Planning Board.

	Employment	
County	June 1972	1985
	(Thousands)	
Ocean	63.0	NA
Monmouth	157.7	216.5
Middlesex	238.5	348.8

FIGURE IX
INDUSTRIAL QUESTIONNAIRE
NEW JERSEY TURNPIKE AUTHORITY
TOMS RIVER EXTENSION
ENVIRONMENTAL IMPACT STUDY

FIRM NAME _____

NUMBER OF EMPLOYEES _____

1. DO YOU HAVE ANY PLANS FOR EXPANSION OR RELOCATION?	YES ___ NO ___
IF YES, HOW MANY EMPLOYEES WILL YOU HAVE: AT PRESENT LOCATION	# ___
AT NEW LOCATION ALONG PROPOSED ROAD	# ___
AT NEW LOCATION AWAY FROM PROPOSED ROAD	# ___
2. HOW ARE MOST DELIVERIES MADE TO YOUR PLANT?	
RAIL	___ %
TRUCK	___ %
3. HOW ARE MOST SHIPMENTS MADE FROM YOUR PLANT?	
RAIL	___ %
TRUCK	___ %
4. DO YOU FEEL THE TRUCKS WILL USE THE PROPOSED ROAD SUBSTANTIALLY?	YES ___ NO ___
5. HOW MANY EMPLOYEES COMMUTE BY CAR?	# ___
6. WHAT IS PRESENT CAPACITY OF YOUR PARKING LOT?	# ___
7. DO YOU HAVE ANY PLANS TO EXPAND IT?	YES ___ NO ___
8. IN YOUR ESTIMATION HOW MANY EMPLOYEES WOULD USE THE PROPOSED ROAD TO COMMUTE?	# ___

9. IN WHAT WAY DO YOU FEEL THE PROPOSED ROAD WILL EFFECT YOUR BUSINESS?

10. ANY OTHER COMMENTS?

Employment in manufacturing, commercial and service industries will increase in importance while there will be a steady decline in agricultural employment due to the trend toward urbanization and less labor-intensive agricultural operations. In the Monmouth County Master Plan, small established municipalities such as Englishtown and Freehold Borough are projected to have relatively small percentage increases in employment as well as population, while relatively undeveloped areas with low population densities and space available for expansion such as Manalapan and Freehold Township are expected to have tremendous growth rates in employment.

In order to gain a better understanding of future demands for labor in the region and the possible effects of the Expressway, we developed a questionnaire (shown in Fig. IX) which was sent to the 37 largest employers in the area who were determined by consulting the 1971 New Jersey Industrial Directory which lists 189 firms located in the study area, 99 with 20 or less employees, 53 with 20 to 50 employees and 37 with 50 or more employees. Table II lists the 37 largest employers by Standard Industrial Classification and shows for each the number of employees given in the 1971 Directory. We received 15 replies to the questionnaire. In general, the responses indicate that the firms depend on a good highway system for truck deliveries and shipments and for employee commuting.

The specific results of the interviews follow.

1) Officials of nine of the 15 firms believe the new road will have a positive effect on their business because of the improved access for truck deliveries and shipments and time savings and reduction of driving strain for their employees and clients who will use the Expressway. Five were uncommitted and would not state whether or not they thought the Expressway would have a positive or negative effect on their business. Only one official thought the Expressway, due to its noise and appearance, would have a negative effect on his business. It should be noted that this business is located in an area that will have no access to the Expressway, but will be in close proximity to it.

2) Three out of nine employers in favor of the Expressway have plans for expansion at their present locations and believe the Expressway will aid in their expansion. The one employer not in favor of the Expressway also had plans for expansion and thought they might be hindered by the Expressway. None of the firms responding had plans for expansion at a new location in the area. Therefore it can be assumed that growth in the area will result primarily from the entry of new firms.

3) It was the opinion of the employers responding that about 12 percent of their employees would use the proposed Expressway to commute to and from work.

Perhaps this low percentage is caused by the fact that few employees presently live along the proposed route since it is difficult to commute to the area. Home-to-work studies have shown a strong correlation between employment location and the ease of commuting via the existing roads.

4) About 80 percent of the deliveries to the firms and 95 percent of the shipments from the firms are made by truck.

5) The 15 firms reported a total employment of 3,737. (Not all of the employment figures in the 1971 Directory were correct and, in a majority of cases, the firms currently have more employees.) It was estimated that approximately 97 percent of this total commutes to work by car.

TRANSPORTATION

The greatest impact of the Governor Driscoll Expressway will be on transportation in the tri-county area. By diverting traffic from existing highways, the Expressway will relieve peak-hour and summer congestion on existing roads and improve highway safety. It will also significantly improve prospects for better commuter service. The Expressway will be the only limited-access truck route from the industrialized northern areas of New Jersey to the southeastern portion of the State. Decreased vehicle operating costs will benefit both private and commercial users of the Expressway. Our studies also indicate that there will be no measurable impact on existing rail service. The following portion of the Report reviews the direct transportation benefits of the Expressway and discusses the road's impact on future traffic conditions, highway safety, road user benefits and public transit improvements.

Future Traffic Conditions

We believe that the Governor Driscoll Expressway will generally help relieve traffic congestion in the study area. Some roads giving access to the Expressway will serve more traffic than they would if the Expressway were not built, however, we cannot foresee any traffic problem caused by the Expressway which compares in magnitude to the problems that will result from "normal" traffic growth in the impact corridor.

The operation of the Expressway will result in a very significant increase in traffic on the common section of US 9 and the Garden State Parkway. This section of the Parkway after its junction with the Expressway will be widened (by using the median strip and shoulders) to four lanes in each direction as far south as Route 37, and to three lanes in each direction between Route 37 and Dover Road where US 9 and the Parkway again separate. After this widening, traffic flow in the common section will be more satisfactory than at present.

The effect of the Expressway on Route 18 congestion has been given particular consideration. Our estimates indicate that the construction of the Expressway will alleviate the Route 18 congestion, but only to the extent that the situation would measurably worsen without the

TABLE II

MAJOR INDUSTRIAL EMPLOYERS IN MUNICIPALITIES INCLUDED IN IMPACT AREA

Employer	Number of Employees (1)	Standard Industrial Classification Number	Products (2)
Ocean County			
Acme Cabinet Corp.	77	2431	Kitchen Cabinets, Bathroom Vanities(High Pressure Laminated Only)
Excel Wood Products Co., Inc.	110	2511	Kitchen Cabinets
Level Lines, Inc.	145	2431	Window Units, Door Units, Mill Work
New Jersey Pulverizing Co.	66	3295	Silica Sand Silica Floor, Sand Blast Sand, Filter Sand, Filter Gravel and Imported French Grinding Pebbles
Toms River Chemical Corp.	100	2861	Dyes, Pigments, Related Intermediates and Other Chemicals
Torwico Electronics, Inc.	220	3679	Transformers, Inductors, Chokes, Tordinal Coils and Components, Magnetic Amplifiers
Wagner Plastic Corp.	70	3079	Plastic Moldings
Monmouth County			
Airflote, Inc.	54	3069	Missile Tents, Protective Clothing, Life Preservers, Shelters
Bennett Industries, Inc.	57	3079	Plastics
Brockway Glass Co., Inc.	314	3221	Glass Containers
Hawthorne - Sommerfield, Inc.	150	2771	Greeting Cards
Howe Plastics of N.J., Inc.	80	2392	Heat Sealing
Minnesota Mining & Mfg Co.	580	3567	Dielectric Materials, Magnetic Products
The Nestle Company, Inc.	193	2099	Instant Coffee
Parnes Brothers, Inc.	53	2337	Ladies Coats
Precision Filaments, Inc.	73	3679	Filaments and Heaters for Radio Tubes and Special Purpose Tubes
Vikoa, Inc.	265	3679	Wire and Cable
Washington Forge, Inc.	220	3421	Cutlery
Worthington Biochemical Corp.	102	2831	Research Biochemicals and Diagnostic Reagents
Middlesex County			
Brunswick Bituminous Products Corp.	82	2951	Paving Mixtures and Blocks - Mfg.Ind.
Cerro Wire and Cable Co.	116	3999	Portable Fire Extinguishers
Dow Jones & Co., Inc.	270	2711	News Service
Dreier's Sporting Goods, Co.	50	3949	Sporting Goods
Fibre Can Division(Div.of Container Corp.of America)	300	2655	Fibre Cans, Aluminum and Steel Ends
Forsgate Farms, Inc.	115	2024	Milk and Ice Cream
Fyr - Fyter Co.	70	3999	Manufacturing Industries not Elsewhere Classified - Mfg.Ind.
Grefco, Inc.	101	2661	Building Paper and Building Board Mills - Mfg. Ind.
Helme Products, Inc.	155	2131	Snuff
Inland Container Corp.	143	2655	Corrugated Cartons
Interpace Corp.	166	3272	Concrete Pipe and Fittings
Levey, Frederick H. Co., Inc.	66	2893	Printing Ink
Chas. Lomar & Sons Inc.	89	2341	Women's, Misses', Children's and Infants' Underwear and Nightware-Mfg.Ind.
Poly Horizons, Inc.	60	2821	Polymeric Films and Coated Materials
Schweitzer, Peter J. Div.(Div.of Kimberly Clark Corp.)	705	2621	Cigarette Paper
Sentinel Publishing Co.	50	2711	Newspaper Publisher
South River Metal Products Co.,Inc.	71	3499	Fabricated Metal Products, not elsewhere classified- Mfg. Ind.
Stephens Edwards East, Inc.	50	2515	Bedding Corner Groups

(1) As given in 1971 New Jersey Industrial Directory.

(2) As given in 1971 New Jersey Industrial Directory. If not given, description is for SIC code.

Expressway. (Coverdale & Colpitts learned from our previous traffic survey in mid-1971 that much of the traffic on Route 18, about 60 percent, consists of local area movements such as trips between East Brunswick and New Brunswick. These trips, which include those generated by the shopping attractions along Route 18, are not susceptible to diversion to the Expressway.)

The table below gives actual 1970 traffic volumes on selected routes in the Expressway's impact corridor and estimated 1976 volumes (1) without the Expressway and (2) with the Expressway in full operation. We have estimated 1976 traffic without the Expressway as 20 percent greater on the average than 1970 traffic. Note also that volume measurements are expressed as AADT (Annual Average Daily Traffic) in both directions. Peak summer traffic, when the congestion relief provided by the Expressway is most necessary will, in most instances, be considerably greater than the volumes shown.

Actual 1970 traffic and Estimated 1976 Traffic
at Selected Locations — With and Without the Expressway

Route	Segment	1970 Actual (A)	AADT 1976 Estimated	
			Without Expressway	With Expressway
US 9	Toms River to I-195	15,000	18,000	12,000
	I-195 - Route 33 (B)	17,000	20,400	14,000
	Route 33 - Route 18	27,000	32,400	27,000
	Route 18 - Route 34	27,000	32,400	27,000
Route 33	West of Expressway	11,000	13,200	10,000
	East of Expressway	10,000	12,000	14,000
Route 34	Common Section Routes 33 and 34	20,000	24,000	23,000
Garden State Parkway	Common Section with US 9 (C)	21,000	25,200	30,000
	North of Toms River Toll Plaza	22,000	26,400	21,000
Route 539	North of NJ 70 (D)	3,000	3,600	3,000
Route 527	South of Route 526 (D)	1,500	1,800	(no change)
Route 18	South of Turnpike/US 1	50,000	60,000	55,000

(A) Several traffic counts are given on each segment; representative value selected.
(B) Traffic volumes as high as 30,000 AADT near Freehold traffic circle.
(C) This section to be widened as part of Expressway project.
(D) Based on 1971 summer count.

The traffic volumes in the table show quite clearly the estimated effect of the Expressway. Traffic volumes on US 9 in 1976 will be at — or even below — 1970 volumes, a particularly important consideration if planned highway improvements described below are not carried to completion. On Route 33, west of the Expressway, the traffic volume in 1976 is forecast to be lower than in 1970; east of the Expressway, 1976 traffic volume will be slightly higher with the Expressway than it would otherwise have been. A modest, not significant reduction in 1976 traffic volume on the common section of Routes 33 and 34 will result if the Expressway is built.

As indicated, no significant change is anticipated in the local roads serving the Expressway. Route 18 will still continue to be congested as local traffic demands increase.

In preparing our estimates we took into account planned new highway construction and major improvements which may reasonably be expected to be completed by 1976, the first full year of the Expressway's operation. The specific highway projects considered (and our parenthetical comments) are listed below.

1) The Garden State Parkway will be widened to a 10-lane facility between Interchange 129 and the Asbury Park Toll Plaza which will be rebuilt. (This major Parkway improvement has been financed, construction work is on schedule, and the entire project will probably be completed by 1975.)

2) US 9 from Route 33 to Toms River is to be widened and dualized to a four-lane highway and the two-lane section of US 9 between Route 18 and Route 34 is to be widened to at least four lanes. (Work on one section of US 9 from Adelphia Road in Freehold Township to Strickland Road in Howell Township may start this fall. Unless the 1972 transportation bond issue is approved in the coming November election, the balance of this improvement program will be seriously delayed beyond 1976. If US 9 is not improved as planned, the Expressway will be needed more than ever to relieve traffic congestion on this overworked highway.)

3) The Route 33 Bypass around Freehold will be constructed and will connect with the Expressway by 1976. (Should this project be delayed, the Expressway will connect with existing Route 33.)

4) Route 18 will be extended easterly as the Route 18 Freeway to connect with the completed section from Deal Road to Route 38 by 1975. (The completion of this new highway will not have important effect on traffic in the Expressway's impact corridor.)

5) Route I-195 is scheduled to be completed by 1977, one year after the Expressway; it will connect with the Expressway and provide a high-speed east-west route across central New Jersey. (Segments of this road have been completed; it is expected to be completed between the New Jersey Turnpike — Interchange 7A is under construction — and the Expressway by 1976. The eastern segment I-195 between the Expressway and the junction of Route 38 and the Garden State Parkway is to be completed by 1977. We do not anticipate any impact on local traffic or local roads from the construction of an interchange between I-195 and the Expressway.)

Highway Safety

It is expected that the Governor Driscoll Expressway, together with accompanying improvements undertaken as part of the Expressway project, will decrease traffic volumes and congestion on the non-limited-access highways in the tri-county area. This will result in a decrease in the number of accidents, as a direct relationship exists between Average Annual Daily Traffic (AADT) and accident rates. On a two-lane undivided highway, such as Route 9 in Ocean County, accident rates have been found to decrease by 45 percent when the volume drops from 15,000 to 10,000 vehicles per day. On a four-lane undivided highway, the same reduction in daily traffic will reduce the accident rate by about 30 percent.

There will be approximately 10 million vehicles per year diverted from the many existing roads and highways of varied design to the limited-access, median divided, Governor Driscoll Expressway. The existing New Jersey Turnpike way, which is similar to the proposed Expressway, has an accident rate which is about one-fifth the rate on state and county highways. It is estimated that there will be a major decrease in the accident rate in the area as a result of the construction of the Expressway. This increase in roadway safety will result not only in a reduction in costs but, more importantly, a reduction in accident-caused personal grief and pain as well.

Road User Benefits

The cost of operating a vehicle varies on different types of roads, depends upon such factors as type of vehicle, fuel consumption, travel time and accident rate. A vehicle diverted from a rural road to a limited-access highway will travel at a faster speed, possibly incurring higher fuel consumption, but requiring less time to complete a given trip. Annual fixed costs per mile of commerical vehicles will decrease since the Expressway will enable them to be driven more miles each day.

If operating costs were based solely on fuel consumption, the optimum speed would be about 30 mph for automobiles. If, however, the driver's time were the only consideration, the fastest speed attainable would be best.

The benefit or cost saving per vehicle-mile is found not by using either of these two alternatives but rather by a process of weighing and trading off of many factors.

The table below shows the estimated cost of operation for four types of vehicles on a limited-access highway of Interstate design standards, such as the Expressway, as well as the costs incurred by driving on a rural non-limited-access highway of a design standard prevalent in the study area.

1971 Road User Cost

Type of Vehicle	Limited-Access Highway (Cents Per Mile)	Non-Limited-Access Highway (Cents Per Mile)
Automobile	12.3	14.6
Bus (intercity)	61.3	67.5
Single Unit Truck	58.5	63.5
Tractor-trailer combination	70.9	77.7

Sources: "How Much Does It Cost To Own and Operate An Automobile", U.S. Department of Transportation, 1972.
Kain J.F., Wohl M., Meyer, J.R., The Urban Transportation, Harvard University Press, 1965.
Stevens Hoy, "Line-Haul Trucking Costs Upgraded", Highway Research Record Number 127, 1966.

Vehicle costs taken into consideration were maintenance, tires and tubes, fuel, oil, driver's time, insurance depreciation, any overhead charge involved with the operation of the vehicle and tolls.

Public Transportation Improvements

The principal impact of the Governor Driscoll Expressway on existing bus service in the study area is expected to be on long-distance commuter and charter service runs in Monmouth and Ocean Counties. Long-distance runs connecting points south of Toms River with New York City and the Newark area are currently using Route 9 or the Garden State Parkway. These runs are experiencing considerable delays since Route 9 is a very heavily travelled road without access control and the Garden State Parkway often becomes congested during the summer months. It is expected that some of these runs will divert to the Expressway to take advantage of time savings.

Discussions with management officials of the principal carriers in the study area confirmed this expectation. All but one carrier felt that the Expressway would reduce travel time and would relieve some traffic congestion on Route 9 and the Parkway. The discussions also indicated that the bus carriers are very interested in the establishment of a park-and-ride service along the proposed Expressway corridor, similar to the facilities that are currently operated at the New Jersey Turnpike, Interchange 9 and other Interchanges south of I-195 and the one that is planned for Interchange 8 near Twin Rivers, The Planned Unit Development in Mercer County. As residential development occurs in the area, additional park-and-ride facilities will be necessary to serve bus commuters who currently park along the Route 9 corridor.

If convenient parking facilities are not provided at intermediate points, commuters will pass up modes of public transportation and complete their trips by auto. The result could be traffic congestion in the heavily travelled northern areas. As a solution to the problem we recommend innovative park-and-ride facilities of the following types:

1) Park-and-ride facilities along the Expressway between interchanges where boarding is done at special sidings. Buses will not lose time by going through interchanges to pick up passengers but only enter and leave the system at the beginning and end of the journey.

2) Park-and-ride facilities for commuters who enter the Expressway system in private autos and park in an Expressway lot where they board a bus to complete their journey and avoid driving in congested areas. Commuters would pick up a toll ticket once — on initial entry to the Expressway — have it stamped in the parking lot and pay a round-trip toll when exiting from the system. This solution to the parking problem would relieve congestion in the heavily travelled areas, but at the same time the Expressway would not lose commuter tolls.

In summary, the impact of the Governor Driscoll Expressway is expected to be favorable to the long-distance commuter and charter bus service in Monmouth and Ocean Counties. Commuter bus service in

Middlesex County, as well as local service in all three counties, is not expected to be affected either favorably or unfavorably by the construction of the Expressway.

Impact On Airports

Since most of the airports in the region are in the coastal sections near the Garden State Parkway and Route 35, it is highly doubtful that the Expressway would have an impact on them. The Governor Driscoll Expressway would increase accessibility from those airports located near the highway to the interior sections of Monmouth County and to points in Northern New Jersey, particularly Lakehurst Naval Air Station and the R.J. Miller Airport. The small private-use airfields near Monroe in Middlesex County are not expected to be directly affected by the road. An indirect effect is possible: increases in land values associated with the Expressway could induce pressures to discontinue airfield operations and develop the land. However, other existing and projected development pressures in Middlesex County overshadow this potential and would probably be the determining factor in the demise of the airfields.

Impact On Rail Transportation

The Governor Driscoll Expressway will have no measurable impact on existing rail service in Ocean, Monmouth and Middlesex Counties. In Middlesex, the existing commuter rail lines serve the northern and western regions, and the Governor Driscoll Expressway will serve the southeastern part of the County. Similarly, the Expressway will have no impact on the commuter rail lines currently serving the coastal areas of Monmouth and Ocean Counties.

Regarding freight traffic, our study determined that almost all goods and materials into the tri-county area served by the Expressway are delivered by truck. Those materials now being delivered by rail are of a type requiring large capacity vehicles and as such will probably not be materially affected even when a greater volume of freight can be delivered into the area by direct over-the-road truck service.

IMPACT ON VIABLE FARMS

Since the Governor Driscoll Expressway will have a direct impact on less than one percent of the viable farms in the tri-county area, it will have a minimal effect on existing farm lands. A number of takings, particularly surplus farm land, will result in excess undeveloped land not needed for the construction of the Expressway. These areas will provide an opportunity to increase the amount of land committed to permanent green belt and recreation areas.

The Expressway will pass through a number of areas now devoted to farming and other agricultural uses. The impact on viable farms will be twofold. Initially, certain portions of farm land will be taken as part of the right-of-way.

Future overall changes in land use and transportation patterns will

affect agricultural activity in the State and the three counties as discussed in a prior section of this Report.

Before we assess the impact of the Expressway upon the agricultural industry, it is first necessary to define what is meant by a "viable farm". The definition used in this study is the one set up in "Farmland Assessment Act of 1964". A "viable farm" is one that is "qualified", that is, it must be five or more acres, must have been farmed for the last two years and must have earned at least $500 last year.

Along its 35-mile path, the right-of-way will cross 57 of the 1,200 farms in the three counties. The farms crossed have each been identified on aerial photographs shown in Figures X-A through X-H.

The farm number, the total number of farms impacted and the category of impact are shown in the table on the following page. The breakdown involves three types of takings with certain sub-categories as defined below:

1) The entire farm can be taken. Considering the fact that the farm must be at least five acres to be considered a viable farm, it is unlikely that any farm will be taken in its entirety, and in fact for this Expressway, no farm will be completely taken.

2) The right-of-way taking can be totally along one edge of a farm. The remaining acreage can be either "qualified" or "non-qualified". A remainder would qualify as a viable farm even if it is landlocked, that is, if it is surrounded by the Expressway and other people's property with no access. Such a parcel of land might be sold to the adjacent owner and still maintained as farm land. However, for purposes of this study the conservative approach was taken and landlocked parcels were considered to be non-viable remainders along with the remainder of less than five acres.

3) The Expressway right-of-way can split a farm into several sections. As in Category 2, the remainders can be "qualified" or "non-qualified", or "qualified" but landlocked. For listing purposes Category 3 has been stratified as:

    3A - No viable sections remaining
    3B - One viable section remaining
    3C - Two viable sections remaining.

Specific Viable Farms

Category		Total Farms Impacted
1	None	0
2	13, 14, 20, 26, 27, 33, 34, 35, 36, 37, 38, 39, 46, 51, 53, 54, 55, 58, 59, 60, 61	21
3A	45, 48, 49	3
3B	2, 5, 7, 17, 19, 22, 23, 24, 25, 28, 32, 41	12
3C	1, 4, 6, 8, 9, 10, 11, 12, 15, 16, 18, 21, 29, 30, 31, 40, 43, 47, 52, 56, 57	21
Total		57

As stated earlier, no farm will be taken in its entirety, however, the owners of those farms falling in Category 3A (no viable remainder) might prefer to have the entire parcel appropriated. The disposition of these parcels will be discussed later in this section.

The following table shows the farmland acreage that will be removed from the "qualified farm" category by municipality and the resultant impact on the total farm acreage of each county.

Qualified Farm Acreage Taken For Right-of-Way

Municipality County	Farm Acreage Taken For R-O-W	Farm Acreage Rendered Non-Qualified	Total Farmland Lost to Agriculture	Percent of County Farmland
Monroe	30.5	2.7	33.2	
Madison	28.0	4.0	32.0	
S. Brunswick	165.5	0	165.5	
Total Middlesex Co.	224.0	6.7	230.7	0.7%
Freehold	159.6	6.2	165.8	
Manalapan	212.4	16.2	228.6	
Total Monmouth Co.	372.0	22.4	394.4	0.5%
Dover	14.3	1.5	15.8	
Jackson	47.6	3.3	50.9	
Total Ocean Co.	61.9	4.8	66.7	0.7%
Total Study Area	657.9	33.9	691.8	

In the five-year period 1964-1969 the farm acreage in Middlesex, Monmouth and Ocean Counties declined 14, 12 and 50 percent respectively. As the historic annual loss of farm acreage has been so much greater than that imposed by the Expressway and only three farms (Category 1 and 3A) will be put out of business directly, it can be said that the immediate impact of the Expressway upon the agricultural industry will be slight.

The development fostered by the Expressway operation will further reduce the acreage devoted to farming. This acreage benefits the community as much by its presence as by its produce and, therefore, if it cannot be retained as agricultural land, some form of zoning should be enacted that will require the preservation of "green belt acres" as a condition for development.

In line with this concept, the non-viable remainders of parcels taken might be utilized as reserved green acres in a manner beyond the scope of usual highway landscaping. Small parks with picnic tables and similar facilities could be set up on these remainders in such a manner that they will be accessible both to Expressway users and local residents. Ground water recharge basins, if needed, could be shaped in a pleasing natural look and included in these parks as a desirable feature rather than as a necessary eyesore. While a small amount of farm acreage, approximately 34 acres, will be lost to the agricultural industry, in this manner, at least a portion of it will still be serving to retain the local ambiance.

CHAPTER IV - CONCLUSION

The impact of the proposed Governor Alfred E. Driscoll Expressway on its environment began as soon as plans for the road were announced. Our studies conclude that a positive impact from the Governor Driscoll Expressway can be anticipated in that developments in the tri-county area will continue along trends now in effect. Local zoning laws and ordinances should be developed and properly enforced to insure that no serious negative impacts develop through lack of proper planning and control.

The specific impact of the construction of the highway on its environment can be divided into three categories, the first being the actual construction of the road, the second the early years of the highway's operation, and third that which occurs as the road matures and secondary impacts begin to influence the developmental trends and land use patterns of the region.

CONSTRUCTION PHASE

Some positive impacts from the construction phase of the highway will result from the land acquisition process which will bring outside funds into the communities. In addition, some of the construction money may be spent in the local area for goods or for salaries and therefore contribute to the region's prosperity.

There will, however, be some erosion of the local communities' tax bases at this time due to the taking of land and buildings for right-of-way. This reduction is expected to be more than offset by an increase in land values at or near interchanges. Other lands abutting the road could also increase in value depending on particular circumstances such as zoning, access and topography.

Other effects of construction are temporary and experienced only in this phase; for example, the displacement of residents, firms and businesses, and the temporary environmental problems directly caused by the construction, such as traffic dislocations, dust and noise. While not anticipated to a high degree in this instance, one effect that can be created during the construction phase is the partition of the community. Coverdale & Colpitts did not find that this pattern will create a long-term negative impact.

THE EARLY DAYS OF OPERATION

Initially, after the road is completed, it can be expected that some of the land area around interchanges will be developed with facilities to accommodate travelers. Further development could be expected by light industrial plants, residential development or a variety of commercial users, depending upon other factors such as zoning, the nearby presence of a large metropolitan area, or the availability of the labor supply, utilities and raw materials. As this development progresses, other needs will make themselves felt, such as the need for more sophisticated local

government to provide planning and administrative functions, security, and essential services such as refuse disposal, water, sanitation and power. A demand may be felt for other modes of transportation, such as water, pipeline, rail and air. In all probability there will be increased housing construction with resulting demands for medical and educational facilities and other types of services and commercial establishments.

IMPACT IN LATER YEARS

Construction of the Governor Driscoll Expressway can result in an orderly, efficient utilization of the inherent potential of the area. In order to insure the desired growth pattern of the area, long-range comprehensive master planning and zoning, taking into consideration committed transportation facilities in the area, is mandatory.

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FIGURE X — IMPACTED VIABLE FARMS – A

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT



FIGURE X — IMPACTED VIABLE FARMS – B

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

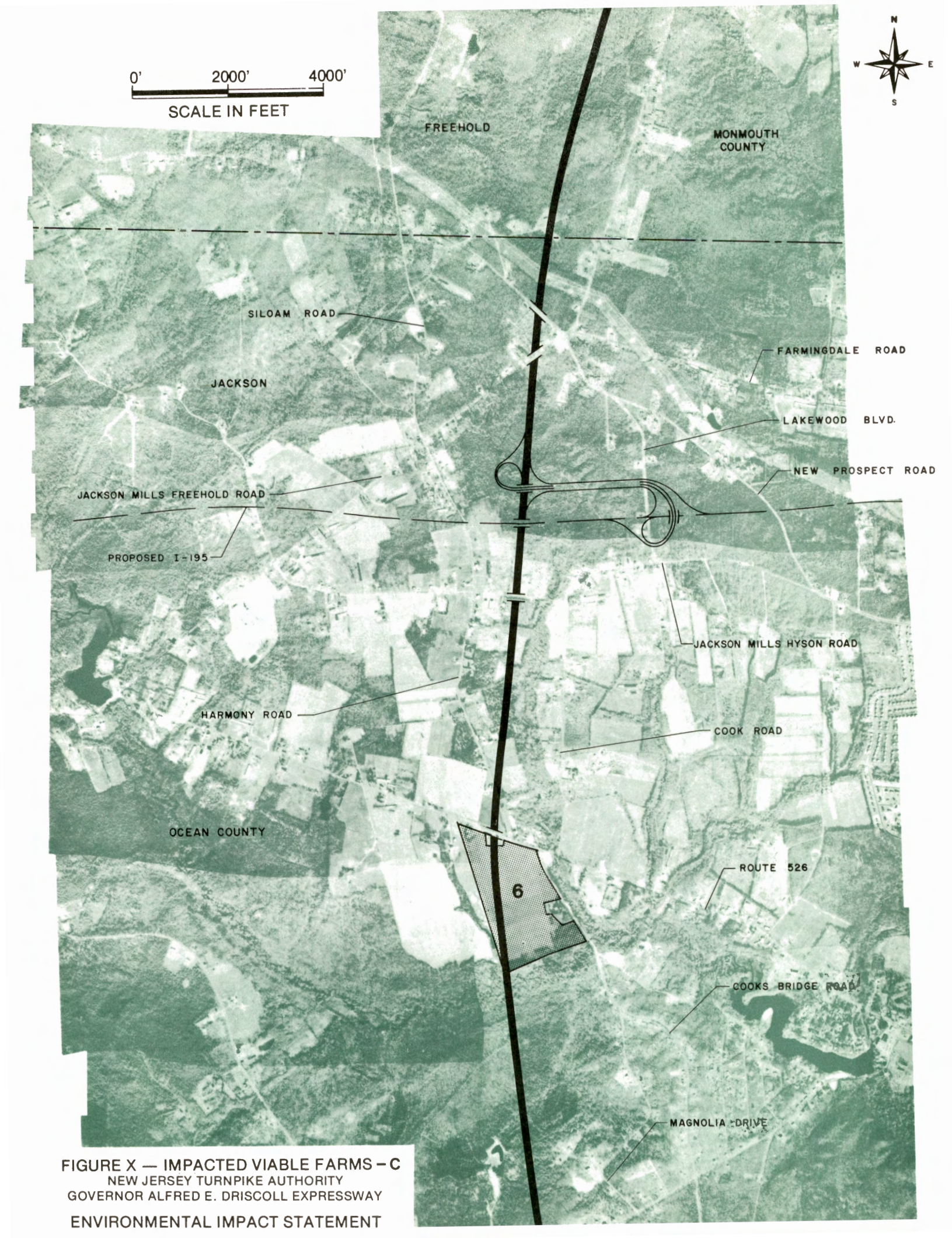

FIGURE X — IMPACTED VIABLE FARMS – C
NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY
ENVIRONMENTAL IMPACT STATEMENT



FIGURE X — IMPACTED VIABLE FARMS – D

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT



FIGURE X — IMPACTED VIABLE FARMS – E

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT



FIGURE X — IMPACTED VIABLE FARMS – F
NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT



FIGURE X — IMPACTED VIABLE FARMS – G

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

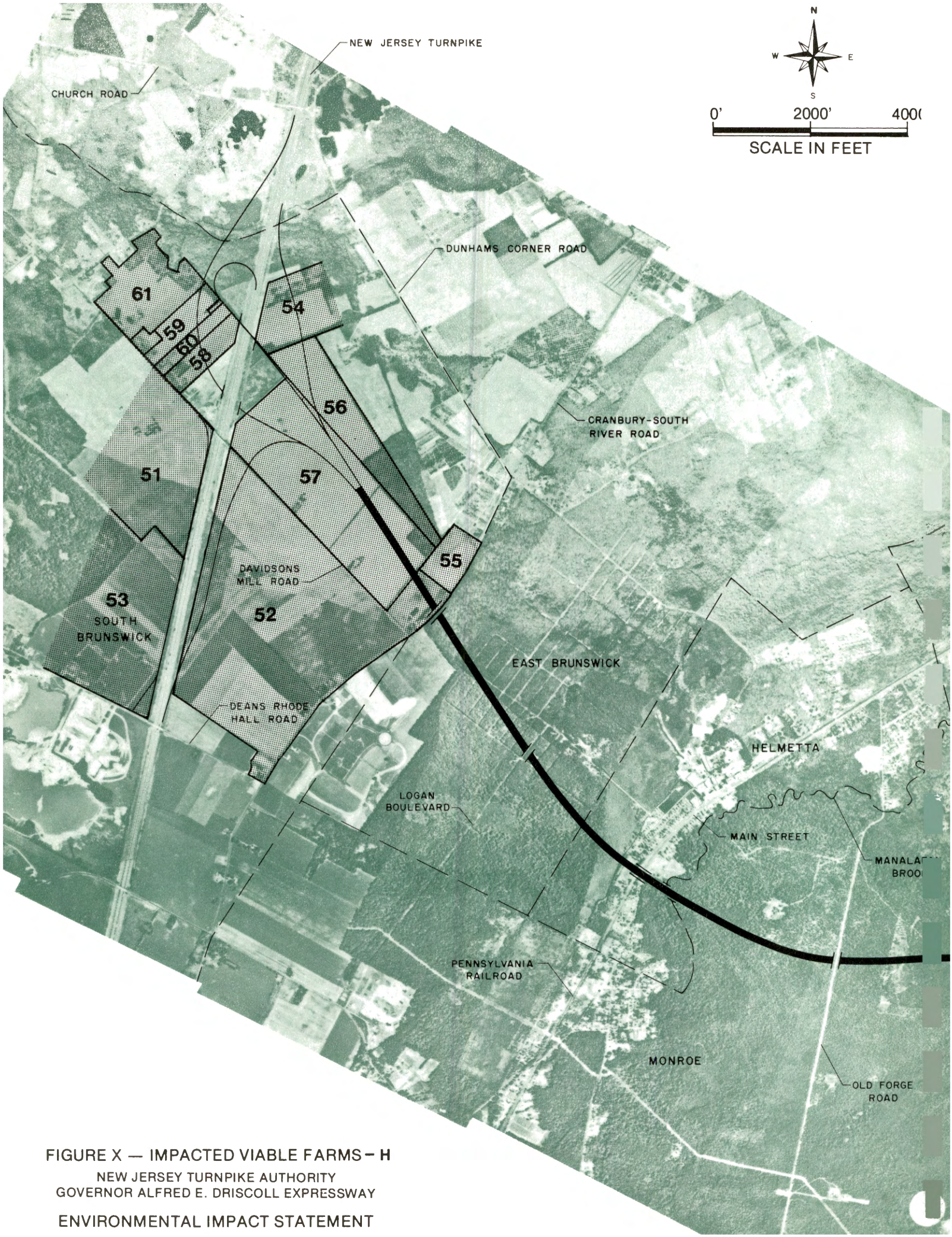

FIGURE X — IMPACTED VIABLE FARMS – H

NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

SECTION VI

ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

Prepared for the New Jersey Turnpike Authority

by

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.

in association with

David H. Marks, P. E.
Jack McCormick & Associates
Abt Associates

This Section covers the following areas of study:

Impact on Air Quality
Impact on Water Resources
Impact on Natural Resources
Impact on Social and Physical Resources

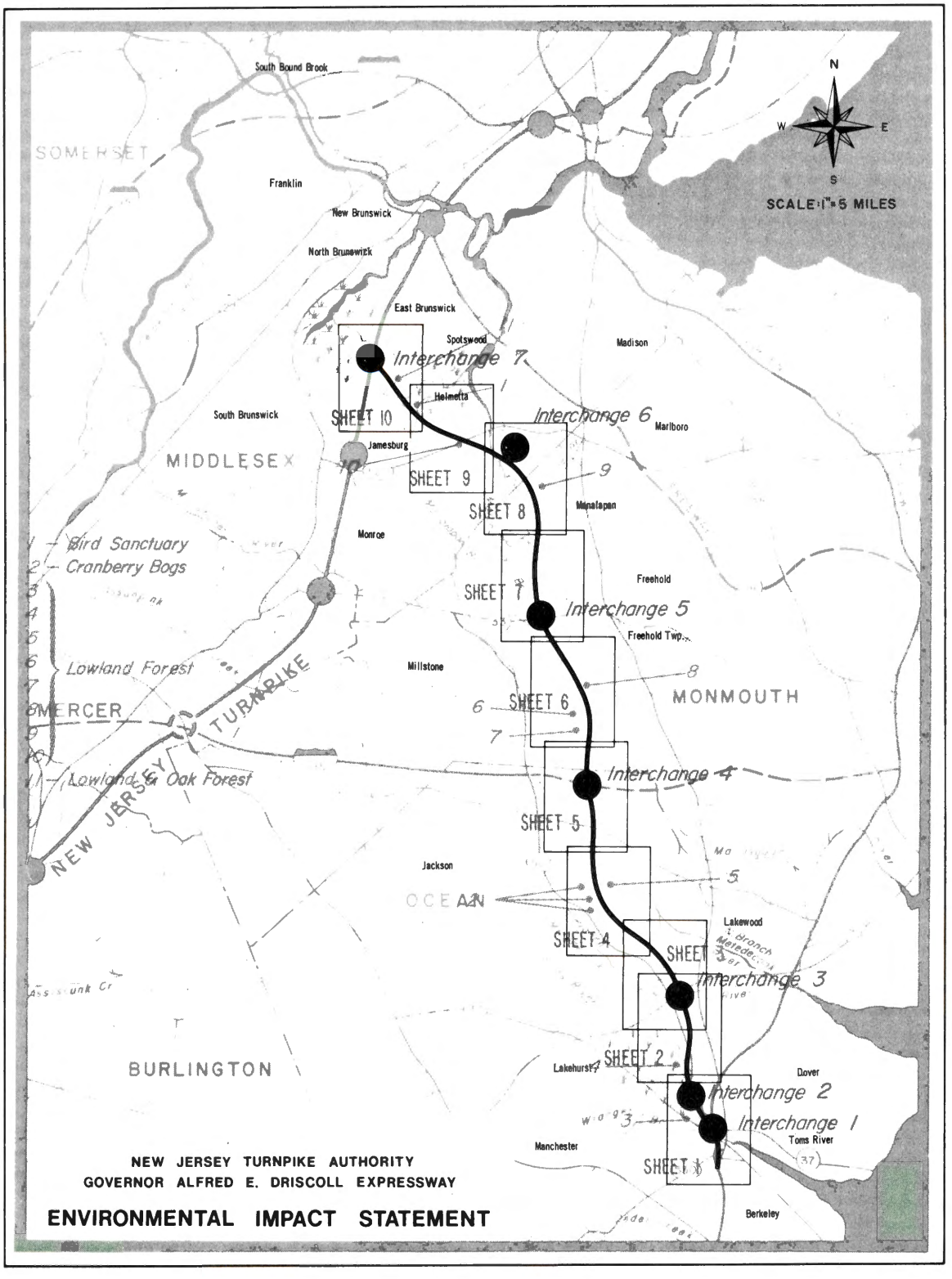

FIGURE I. LOCATION OF POTENTIALLY ADVERSE ENVIRONMENTAL IMPACTS

PREFACE

The team of Environmental Research & Technology, Inc. (ERT) in association with David H. Marks, P. E., Jack McCormick & Associates, and Abt Associates was asked by the New Jersey Turnpike Authority to undertake an analysis of certain areas of environmental impact for the proposed Governor Alfred E. Driscoll Expressway. These areas have been broadly defined in our study as air quality, water resources, natural resources, and social and physical resources.

In assessing the potential impact of the Expressway we have followed guidelines for an environmental impact statement as prepared by the New Jersey Department of Environmental Protection in accordance with the New Jersey Turnpike Authority Act of 1948 (Public Law 348, C.454, amended May 25, 1972, Section 3).

In particular, we have inventoried existing environmental conditions at the project site and in the surrounding region for air quality, water quality, water supply, hydrology, geology, soils, topography, vegetation, wildlife, aquatic organisms, ecology, archeology, and certain aspects of demography, land use, aesthetics, and history. The common data base for all analyses has included an area 2000 feet either side of the proposed Expressway. We have assessed the probable impact of the project upon all the above topics studied. We have listed the adverse environmental impacts which cannot be avoided insofar as we could identify them and have discussed some of the steps that can be taken during design and construction to minimize adverse environmental impacts. We have prepared lists of pertinent published information used in our study. In discussing the steps to be taken to minimize any adverse environmental effects, we have taken into account rules, regulations, and standards promulgated under State and/or Federal environmental statutes.

This study could not hope to identify and assess all potential environmental impacts. Instead, we have tried to assemble as much currently available information to determine as many adverse impacts as possible, as well as the important positive impacts to the environment.

Our portion of the report is divided into four chapters which contain the assumptions, data, findings of impact and conclusions and recommendations for air quality, water resources, natural resources, and social and physical resources, respectively. These chapters were the responsibility of the different team members as follows:

Air Quality	-	Environmental Research & Technology, Inc.
Water Resources	-	David H. Marks, P. E.
Natural Resources	-	Jack McCormick & Associates
Social and Physical Resources	-	Abt Associates, and Environmental Research & Technology, Inc.

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IMPACT OF THE GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY ON AIR POLLUTION

INTRODUCTION

The assessment of the impact of the Governor Alfred E. Driscoll Expressway on air pollution is divided into three sections. The first section discusses various important considerations in assessing impact, including the National Ambient Air Quality Standards, National Vehicular Emission Standards, effects of vehicular-related pollutants, current ambient air quality levels and various meteorological and modeling principles.

The second section presents the assumptions, data used and findings for our modeling of the impact of the Expressway. The final section presents conclusions and recommendations.

The scope of our study dictated that we rely upon existing state air quality measurements for an assessment of current air quality. No field measurements have been taken. We have used the best available data and state of the art modeling techniques in assessing the likely air quality impact of the proposed Expressway. In particular, we have endeavored to remain on the conservative side. Our analyses are based on the examination of "worst case" meteorological conditions and peak hour traffic. The worst case occurs only about 3% of the time; furthermore, this worst case does not necessarily occur during peak traffic conditions, thereby further decreasing the frequency with which the air quality levels modeled would be attained.

Our analysis of worst case conditions for 1976 and 1990 has shown that concentrations would be well below the established standards for carbon monoxide in all areas. The annual nitrogen oxide concentrations resulting from the road are predicted to be below the established standard; however, the uncertainty as to background levels does not make it possible to estimate whether or not total air quality would exceed standards at any locations. Background hydrocarbon levels are expected to exceed the established standards at all locations by a factor of ten or more whether or not the road is built, although the oxidant standard should be met. (The original purpose of the hydrocarbon standards was to insure that the oxidant standards would be met.) The Expressway is expected to add no more than 10% to estimated background levels.

Regional air quality will probably be improved due to the relieving of traffic on presently congested roads.

CONSIDERATIONS IN ASSESSING IMPACT

The National Ambient Air Quality Standards

The National Ambient Air Quality Standards for the vehicular-related pollutants are given in Table 1. This table clearly illustrates that there are various time exposure periods associated with each of the pollutants. These exposure periods have been determined by related health effects.

TABLE 1. AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Period	Federal Secondary Standard
Carbon Monoxide	1-hour average	35 ppm(1)
Nitrogen Oxides	Annual Average	0.05 ppm(2)
Hydrocarbons	3-hour (6 to 9 AM)	0.24 ppm(1),(3)
Oxidants	1-hour average	0.08 ppm(1)

(1) Maximum values in Federal Standards are not to be exceeded more than once per year

(2) Arithmetic mean

(3) Nonmethane hydrocarbons, expressed as methane (CH_4)

By Federal Law, New Jersey enforces the Federal Standards

Source: Environmental News Press Release, Friday, April 30, 1971; National Primary and Secondary Ambient Air Quality Standards; the secondary standards are equal to or more stringent than the primary standards.

For example, for carbon monoxide (CO), there are 1-hour and 8-hour standards whereas for oxides of nitrogen (NO_X), there is only an annual standard. Health effects studies have indicated that short-term exposures to high concentrations of CO have definite effects on the human body while similar acute exposure to oxides of nitrogen does not. The converse is apparently true for long-term exposure.

The specific time period, 6 to 9 AM., chosen for the hydrocarbon (HC), standard is related to the fact that the most important effects of hydrocarbons are their photochemical reaction with oxides of nitrogen. This reaction produces oxidants, among other things, which have a 1-hour standard. It has been found that the amount of photochemical smog produced during a day is directly related to the amount of hydrocarbons released during this period, and emissions released during other times of the day have no significant effect on the production of smog and other photochemical pollutants.

The adoption of these standards has been accompanied by an ongoing controversy concerning their applicability and validity. They have been largely criticized by the automotive and petroleum industries as being too stringent while environmental groups have countered that they are too lenient and are not based on sufficient health effects studies.

It is not the intent of this study to question the validity of these standards. They have been adopted by the U.S. Environmental Protection Agency and are currently accepted as law. By federal law, New Jersey enforces these federal standards. They are used in this study as the accepted guidelines for comparing the pollution levels predicted for the Expressway under various operating assumptions.

The National Vehicular Emission Standards

Vehicular exhaust has been known for some years to be a very large contributor to poor air quality on and near roads. In order to improve this situation, the federal government has promulgated emissions standards to reduce automobile emissions. All 1975 model vehicles sold in the United States are to be equipped with emission control devices to limit exhaust emissions of CO and HC. NO_X emissions will be controlled by 1976 model vehicles.

Figures 1 and 2 are presented to give some idea of the effect of the new standards on emissions. Figure 1 illustrates the change in emissions expected from uncontrolled to controlled automobiles for CO. If the standards are met, CO emissions will be reduced by a factor of 7 to 10 from the average pre-1968 model emissions to the post-1975 models at all speeds. Similarly, as shown in Figure 2, total hydrocarbons (less methane) will be reduced by a similar factor from the pre-1968 automobiles to the fully controlled post-1975 vehicle. Nitrogen oxides are expected to be reduced by more than a factor of 10 between the uncontrolled and controlled automobiles.

An interesting feature of these figures is the relationship between speed and emissions. For both carbon monoxide and hydrocarbons, and for both pre-1968 and post-1975 emissions, lower emission rates per vehicle

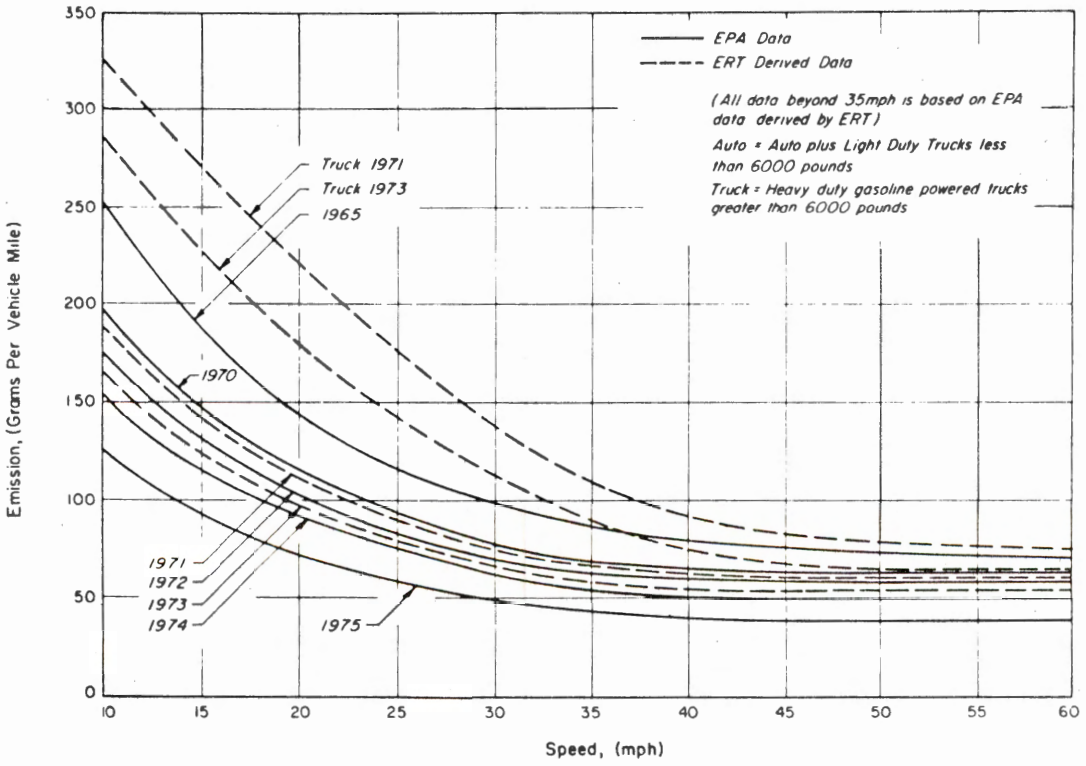

FIGURE 1. VARIATION OF CARBON MONOXIDE EMISSION FACTORS WITH SPEED

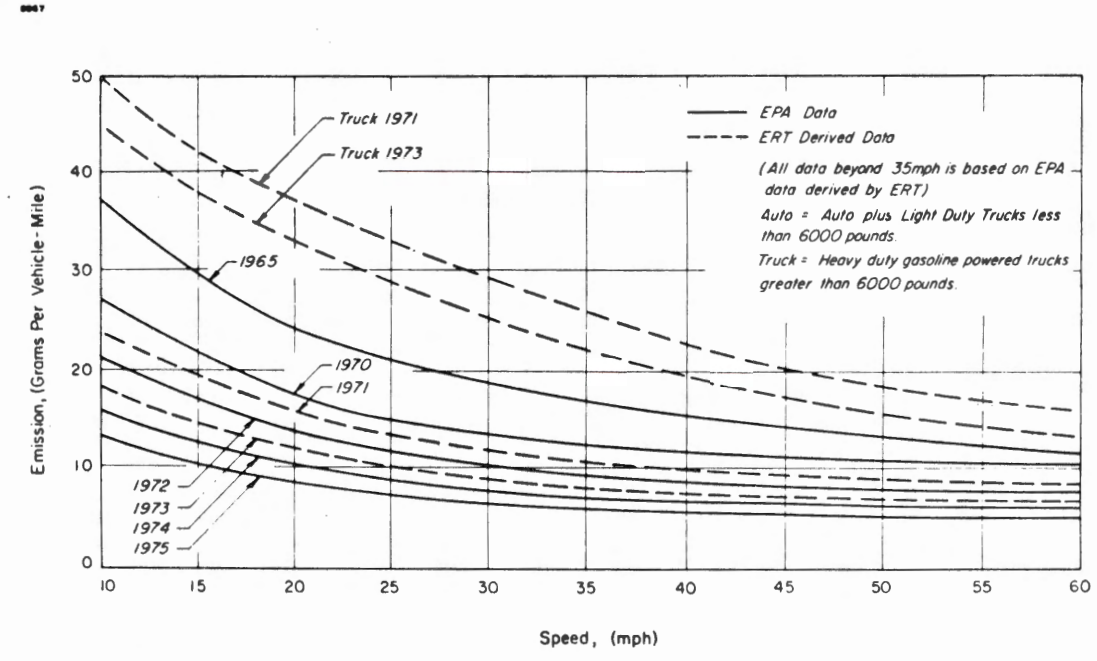

FIGURE 2. VARIATION OF HYDROCARBON EMISSION FACTORS WITH SPEED

mile are measured at higher speeds than at lower speeds. In each case, differences by factors of two or three are indicated between emissions at 10 and 50 mph. For nitrogen oxides it is believed that the speed-emissions curve does not exhibit this variability but remains nearly constant over this speed range. The information is based on tests made in 1964 and currently being updated (1971 to 1972) by further tests conducted by the Environmental Protection Agency under contract.*

The emissions are expected to decrease as the impact of the interim and final emission standards for automotive vehicles takes effect. The 1968 standards have already begun to reduce emissions per vehicle on the average. Improvement will continue until all vehicles have controls. The improvement will not be complete until approximately 1990. Therefore, for any given year, one must use a set of emission factors for cars, gasoline powered trucks and diesel trucks and buses which represent the mix of controlled and uncontrolled automobiles on the highway.

Effects of Vehicular-Related Pollutants

The pollutants of primary concern associated wtih motor vehicles consist of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_X), and oxidants. In general, we are concerned with the effects of these pollutants on human health, vegetation, materials, weather modification, visibility and aesthetic considerations. However, each of these categories of "receptors" has different (and frequently non-determinable) susceptibility and sensitivity to the different pollutants.

Carbon Monoxide - The only effect of CO is on human health; concentrations of 115 mg/m^3 (100 ppm) cause practically no effects on higher forms of plant life. The primary effect is the formation of carboxyhemoglobin (COHb) which reduces the capacity of the blood to transport oxygen from the lungs to the tissues of the body. A 2% COHb level can result in the impairment of time interval discrimination in normal persons. This level is achieved in a sedentary person through exposure over an 8-hour period to 12 mg/m^3 (milligrams per cubic meter) or 10 ppm (parts per million). At a 5% COHb level, a normal person experiences impaired performance on psychomotor tests and visual discrimination. This level is achieved in non-smokers upon exposures to 35 mg/m^3 for 8 to 12 hours. By comparison, cigarette smokers may have carboxyhemoglobin levels as high as 8%. At concentrations of slightly more than 1000 ppm, CO kills quickly. Most people experience dizziness, headache, lassitude and other symptoms at approximately 100 ppm, a level which is generally considered the upper limit of safety in industry for healthy persons when exposure may continue for an 8-hour period.

In addition, highly active persons, young persons, elderly persons and persons with preexisting illnesses are considered to be much more highly susceptible to the effects of exposures to pollutants and may be classed as high risk or critical receptors. A summary of the more significant effects of carbon monoxide is given in Table 2.

*EPA Contract No. 68-04-0042: *"Study of Emissions from Light Duty Vehicles in Six Cities"*, Automotive Environmental Systems, Inc., San Bernardino, California.

TABLE 2. HEALTH EFFECTS OF CARBON MONOXIDE

Environmental Conditions	Effect	Comment	Reference
35 mg/m^3 (30 ppm) for up to 12 hours	Equilibrium value of 5 percent blood COHb is reached in 8 to 12 hours 80 percent of this equilibrium value, (4 percent COHb) is reached within 4 hours.	Experimental exposure of nonsmokers Theoretical calculations suggest exposure to 23 (20 ppm) and 12 mg/m^3 (10 ppm) would result in COHb levels of about 3.7 and 2 percent, respectively, if exposure was continuous for 8 or more hours.	Smith
58 mg/m^3 (50 ppm) for 90 minutes	Impairment of time-interval discrimination in nonsmokers.	Blood COHb levels not available, but anticipated to be about 2.5 percent. Similar blood COHb levels expected from exposure to 10 to 17 mg/m^3 (10 to 15 ppm) for 8 or more hours.	Bears & Wertheim
115 mg/m^3 (100 ppm) intermittently through a facial mask	Impairment to performance of some psychomotor tests at a COHb level 5 percent.	Similar results may have been observed at lower COHb levels, but blood measurements were not accurate.	Schulte
High concentrations of CO were administered for 30 to 120 seconds, and then 10 minutes was allowed for washout of alveolar CO before blood COHb was measured	Exposure sufficient to produce blood COHb levels above 5 percent has been shown to place a physiologic stress on patients with heart disease.	Data rely on COHb levels produced rapidly after short exposure to high levels of CO; this is not necessarily comparable to exposure over a longer time period or under equilibrium conditions.	Ayres et al

Source: Air Quality Criteria for Carbon Monoxide, EPA (NAPCA) Publication No. AP-62

Hydrocarbons - No direct effect on human health is attributable to hydrocarbons at usual ambient atmospheric concentrations. Hydrocarbons are, however, directly hazardous to vegetation. Of the constituents of gaseous hydrocarbons, ethylene represents one of the greatest hazards to vegetation since it is phytotoxic and contributes to the formation of photochemical air pollution. At low concentrations, the principal effect of ethylene is to inhibit the growth of plants. However, injury to sensitive plants has been reported after exposure to ethylene concentrations of 1.15 to 575 micrograms per cubic meter (0.001 to 0.5 ppm) for an 8 to 24 hour time period. Studies of the effects of ambient air concentrations of gaseous hydrocarbons have not demonstrated adverse effects on human health. However, it has been demonstrated that ambient levels of photochemical oxidants (which do have adverse effects on health as well as vegetation) are a direct function of gaseous hydrocarbon concentrations. Consequently, the ambient air quality standard for hydrocarbons is primarily based on inhibiting the formation of such oxidants.

Nitrogen Oxides - Nitrogen oxides are major participants in photochemical reactions. The most significant of these is nitrogen dioxide (NO_2). Nitrogen dioxide is a yellow-brown gas which significantly reduces visibility in high concentrations and is also known to be toxic to man at high concentrations. Nitrogen dioxide also adversely affects vegetation when exposed to high concentrations. However, the main concern for NO_2 is its participation with hydrocarbons to produce photochemical oxidants, primarily peroxyacetyl nitrate (PAN) and ozone (O_3) both of which are highly phytotoxic to vegetation. In addition, ozone and other oxidants are known to have highly damaging effects on materials such as rubber, textiles, and dyes.

Current Ambient Air Quality

The New Jersey State Department of Environmental Protection, Bureau of Air Pollution Control, maintains a network of Air Monitoring Stations* measuring the hourly averages of carbon monoxide, sulfur dioxide and smoke shade. In addition three comprehensive Air Monitor Laboratories in Camden, Newark, and Bayonne measure the hourly averages of nitrogen oxides (nitric oxide and nitrogen dioxide), sulfur dioxide, oxidants, aldehydes, carbon monoxide, hydrocarbons, smoke shade and carbon dioxide. The monthly summary data for the last full year (1971) were analyzed for purposes of:

1. Identifying stations representative of the areas through which the proposed Expressway would pass;
2. Identifying stations representative of the areas where existing traffic might be relieved by the proposed Expressway;

*In 1971 there were 18 sites throughout the state: Atlantic City, Hackensack, Burlington, Camden, Ancora, Paulsboro, Jersey City, Trenton, Perth Amboy, Asbury Park, Freehold, Morristown, Toms River, Paterson, Pennsgrove, Somerville, Elizabeth, and Phillipsburg.

3. Comparing appropriate measured values with the National Ambient Air Quality Standards; and

4. Estimating "background" levels of air quality (from all sources except the Expressway) for future time periods.

The air monitoring station at Ancora appears to be the most representative of the predominantly rural areas through which the proposed expressway would pass, according to Vincent Marchesani of the N.J. Bureau of Air Pollution Control. The maximum hourly value for CO during 1971 occurred in January and was 13.8 ppm, compared to the 1-hour standard of 35 ppm (see Table 3). Our best estimate of the maximum hourly average for CO for the area of the proposed Expressway is, therefore, "less than 14 ppm." Since the recorded maximum is likely to vary significantly from place to place and through time, we also examined that value which was exceeded one percent (1%) of the time during the month; this is approximately 7 hours per month. The highest value for this measure was 11.87 ppm and also occurred in January during 1971.

Route 9, which presently carries a large percentage of the region's truck traffic which would be diverted to the Expressway, passes through urban portions of Freehold and Toms River. Current maximum values for CO (for 1971) were found to be 34.44 ppm in Freehold and 48.41 in Toms River, compared to the 1-hour standard of 35 ppm. Reduction in traffic along Route 9 probably will be accompanied by improved air quality.

Nitrogen oxides were measured only at the three comprehensive Air Monitoring Laboratories. These are located in highly urbanized areas where we would expect air quality levels for all pollutants to be significantly greater than more rural sites such as found in Ancora. For example, the maximum CO levels in Camden and Newark were more than twice the Ancora levels and the values exceeded 1% of the time were 1-1/2 times the corresponding Ancora value. The monitoring site in Bayonne is located such that measured values may not be representative of the surrounding area.

Because of the lack of data at representative sites our best estimate of annual average nitrogen oxide levels in the area of the Expressway is less than 0.08 ppm; it is not possible to estimate how much less than this value would be expected without directly taking measurements in the area.The standard is 0.05 ppm.

The values which were exceeded 1% of the time for oxidants were analyzed for the same three stations. Our best estimate is a 1-hour value of less than 0.08 ppm, equal to the standard. The maximum 1% hydrocarbon value for the same month as the oxidant maximum was found to be about 20 times the 3-hour standard as shown in Table 3. This shows that extremely high levels of hydrocarbon may be found relative to standards even when the oxidant standard (which is of more direct interest than hydrocarbons) is met.

TABLE 3. SUMMARY OF CURRENT AIR QUALITY
(parts per million)

Pollutant	AAQ[1] Standard	Time Period For Measured Values	Current[2] "Best. Est."	Measured Air Quality[3]					
				Ancora	Freehold	Toms River	Camden	Newark	Bayonne
Carbon Monoxide	35.0 1 hr	Max. Hr. (January)[4]	Less Than 15.0	13.80	34.44	48.41	29.48	29.34	15.28
Carbon Monoxide	35.0 1 hr	Exceeded 1%[5] of hours (January)	Less Than 12.0	11.87	20.53	24.67	17.66	17.77	7.15
Nitrogen Oxides	0.05 annual	Annual average	Less Than 0.08	-	-	-	0.080	0.132	0.081
Oxidants	0.08 1 hr	Exceeded 1%[5] of hours (August)	Less Than 0.08	-	-	-	0.085	0.080	0.083
Hydrocarbons	0.24 3 hr (6-9 AM)	Exceeded 1%[5] of hours (August)	Less Than 5.0	-	-	-	5.05	4.92	7.97
Hydrocarbons	0.24 3 hr (6-9 AM)	Exceeded 10%[5] of hours (October)	Less Than 4.0	-	-	-	3.30	4.16	5.98

Notes:

(1) Federal and New Jersey Ambient Air Quality Standards for various time periods as noted. See Table 1.

(2) "Best Estimate" of current air quality levels in area of Expressway made by ERT.

(3) N.J. Department of Environmental Protection measured hourly air quality concentrations for 1971.

(4) Maximum hourly value occurred in December for Freehold and Bayonne, February for Newark.

(5) The value exceeded only 1 percent of the time during the month. It is felt that this is a more representative number than the maximum hourly reading for purposes of determining an average value for the "worst case"; the value exceeded 10 percent of the time is also compared to the 3-hour hydrocarbon standard.

We also looked at the maximum value exceeded 10% of the time (occurring in October for 1971) as being more representative of a running 3-hour average; the best estimate value is still greater than 16 times the 3-hour hydrocarbon standard.

It is not possible to definitively state what the expected current levels of air quality are in the area of the proposed Expressway. Clearly air quality levels are higher in the more urbanized northern area of Middlesex County than in Monmouth or Ocean County. Locally, they are higher in developed areas and where major roads, such as Route 9, presently exist.

For purposes of this study, we have estimated current maximum CO levels of less than 15 ppm, compared to the 1-hour standard of 35 ppm; annual average nitrogen oxide levels of significantly less than 0.08 ppm, compared to the standard of 0.05 ppm; and worst case hydrocarbon levels of less than 4 ppm, compared to the 3-hour (6 to 9 AM) standard of 0.24 ppm.

Diffusion Meteorology and Stability Statistics

The transport and diffusion of pollutants emitted into the ambient air from a given source are governed primarily by the dynamic and thermal structure of the atmospheric layer adjacent to the ground. The intensity of local turbulence and the general horizontal wind flow are responsible for dispersing the pollutants originating from a pollutant source region such as a road. Studies of the spatial and temporal distributions of pollutants must therefore take into account the statistics of several meteorological elements including wind speed, wind direction and the stability of the lower atmosphere (an indirect measure of turbulence).

For convenience, the stability of the lower atmosphere may be divided into three categories: unstable, neutral and stable. Past field measurements and diffusion studies have shown that under stable (inversion) conditions, vertical air motions are inhibited. Any pollutant emitted at the ground tends to stagnate and accumulate while effluents emitted within or above the inversion do not reach the ground and, therefore, do not contribute significantly to ground-level concentrations. These conditions occur primarily during clear nights with light wind speeds.

At the opposite end of the spectrum, unstable conditions tend to enhance vertical motions. The result is thorough mixing of the lower atmosphere and the enhancement of turbulence. These conditions cause rapid diffusion of any pollutant emitted into the atmosphere. They occur during the day and are characterized by strong solar heating and light to moderate wind speeds.

A third stability category called neutral, occurs during cloudy and/or windy conditions. These conditions occur quite frequently and tend to cause good mixing and the generation of mechanical turbulence due to the wind interacting with topographical features.

Effects of Large-Scale Meteorological Phenomena

The effects of large-scale atmospheric motions on pollutant concentrations in the vicinity of roadways are important to the micrometeorological (localized) effects described above. The intensity and direction of the wind field near the source region are closely related to the intensity and direction of the general wind field. The stability of the atmosphere will be related to the stability of the air covering the entire region in which the road or other source of pollutants is located.

The proposed Expressway is in a region where weather systems normally pass from west to east across the area. These weather systems are associated with different air masses and the passage of each system results in a change in air mass across the region. These changes occur about twice per week on the average. Because of these large-scale and relatively frequent changes of air mass, prolonged buildup and large advection of background pollution levels from other major metropolitan areas such as Philadelphia, Baltimore or Washington, D. C., are a relatively rare event. There are, however, occasional periods of air mass stagnation that occur most frequently during the fall; these are usually associated with regional episodes.

Because of the relatively infrequent occurrence of these episodes, the mean micrometeorological conditions are, in general, the most important elements in determining the average air quality in the vicinity of a roadway.

Description of the ERT Highway Impact Model

In order to examine the air pollution impact of a highway, an atmospheric diffusion model is used to predict ambient pollutant concentrations for representative meteorological conditions. The ERT highway impact diffusion model MARTIK was used in this study. This computer program represents the state of the art in diffusion modeling. Its validity has been accepted by many state control agencies including the New Jersey Department of Environmental Protection and the U. S. Environmental Protection Agency. This model can simulate atmospheric transport and diffusion processes for either steady-state (short term) or varying meteorological conditions (long term).

The ERT model provides the means for studying air pollution in the complex environment of an urban area. MARTIK is based upon a diffusion model developed by Martin and Tikvart.* Basic input to the program consists of a description of the emission sources located within the region of interest, together with meteorological data appropriate to the region. The program computes mean pollutant concentrations as a function of position within the region at any set of specified points or receptors.

To properly evaluate the air pollution impact of a highway, many factors affecting the resulting air pollution must be considered. The

*Martin, D.O. and J.A. Tikvart: *"A General Atmospheric Diffusion Model for Estimating the Effects on Air Quality of One or More Sources,"* Air Pollution Control Association Annual Meeting Paper, 1968.

meteorological parameters required include the wind speed, the wind direction and a measure of the vertical mixing or stability of the atmosphere. The amount of pollutants released into the atmosphere is directly proportional to the number of vehicles using the roadway. In addition, the speed of the traffic must be considered because the emission rates of some pollutants are a function of speed. And the mix of types of vehicles will influence the exact quantities of pollutants emitted.

The MARTIK program requires an input of all pertinent traffic and road information for the time period of interest. It then converts this information into a spatial distribution of emissions, applies the meteorological inputs to the emission distribution and finally computes the steady state distribution of the pollutants over any downwind region for the appropriate time period.

For a complete analysis, regional background pollution levels from sources other than the road must be added in. These represent best estimates for the time period of interest, based upon known current levels of ambient air quality.

MODELING THE IMPACT OF THE EXPRESSWAY

The impact of the proposed Expressway was assessed by (1) defining areas along the alignment which, due to the projected traffic counts might be expected to experience the poorest air quality, and (2) determining which, if any, of these areas would violate the established air quality standards for the vehicular-related pollutants.

A total of five cases were selected for analysis. Three of the cases represented the interchanges along the proposed Expressway having the highest projected traffic flows. A fourth case examined the current joint section of the Garden State Parkway and Route 9. The fifth case examined a section of the roadway to consider the worst air quality expected anywhere along the Expressway exclusive of the interchanges.

For each of the cases, the MARTIK model was used to predict pollutant levels for peak hour traffic flows for 1976 (the year of the opening of the proposed Expressway) and 1990 when all motor vehicles should meet the national vehicular emission standards.

Cases Selected for Study

In order to assess the impact of the proposed Expressway the poorest air quality at each of the potential problem areas was modeled. Therefore, peak hour traffic flows for the peak month and those meteorological conditions which yield the highest pollutant concentrations were selected for study.

In each of the cases under study, no background contributions were modeled for several reasons. First of all, the geographic area in which the proposed Expressway is to be built is for the most part rural: therefore, pollutant emissions from the surrounding regional roadway network and other sources are not considered to significantly vary.

Furthermore, the determination of traffic counts, speeds and mix of traffic for 1976 and 1990 for all roads within the region could not be accomplished. Consequently, emissions from just the Expressway, interchanges, and roads adjacent to the interchanges were modeled.

Figure 3 shows the location of the cases modeled:

- Case 1 - The intersection of the Expressway with the Garden State Parkway, Route 9 and Route 166.

- Case 2 - The Garden State Parkway, Route 9 and Route 166 excluding the proposed Expressway. By comparison of this case with Case 1 the differenees in air quality between the existing and proposed configurations can be made. Because the proposed Expressway will lessen the load on the existing roadways, the traffic volumes used in Case 1 were lower than those in Case 2 for each corresponding roadway exclusive of the Expressway.

- Case 3 - The intersection of the proposed Expressway with the Route 33 Bypass. This interchange area is expected to experience the highest traffic volumes of any interchange along the Expressway, excluding the two ends.

- Case 4 - The intersection of the proposed Expressway with the existing New Jersey Turnpike. This case will provide information on concentrations of the various pollutants in the area where the largest total volume of traffic is expected.

- Case 5 - A hypothetical roadway and toll plaza under maximum traffic conditions. This case was selected to conservatively determine representative air quality along the mainline of the proposed Expressway.

Vehicular Emission Factors

Vehicular emission factors were determined for various speeds for the years 1976 and 1990 as shown in Table 4. These were developed according to the following three-step criteria:

1. Use of published data where available from the Environmental Protection Agency.*

2. Use of the latest unpublished data available from EPA through July 1972. (Obtained by personal communication with Harry Sigworth, September 1971, and David Kircher, July 1972.)

3. Use of professional judgment to interpret the data where necessary.

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*"*Compilation of Air Pollutant Emission Factors (Revised)*," U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, February 1972.

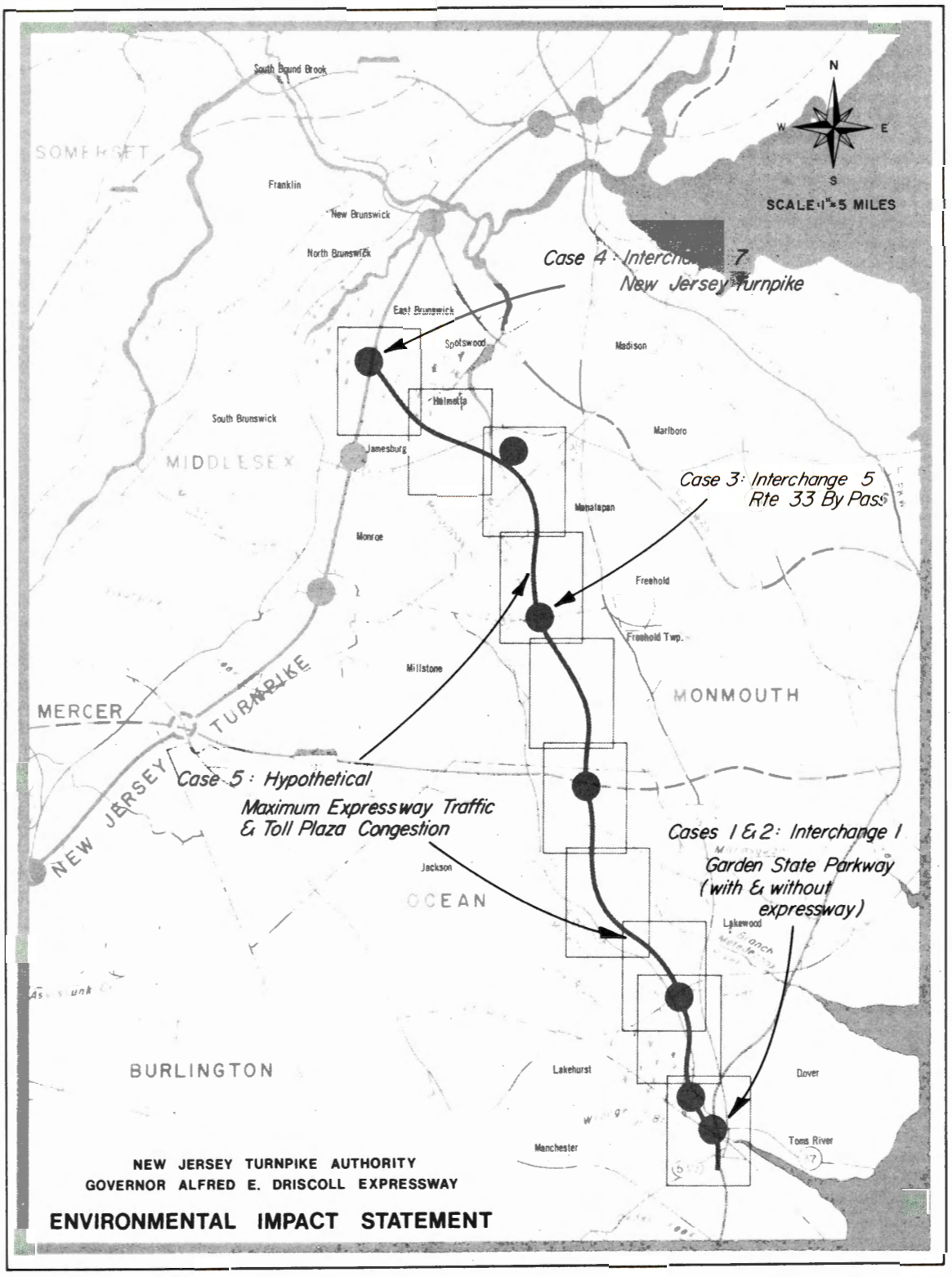


FIGURE 3. LOCATION OF AIR QUALITY CASES EXAMINED

TABLE 4. MOTOR VEHICLE EMISSION FACTORS
(grams per vehicle mile)

		1976		
		Carbon Monoxide	Hydrocarbon	Nitrogen Oxides (NO_2)
15 mph				
	Cars	80.32	8.80	4.52
	Trucks	131.00	18.50	6.33
	Diesels	12.39	1.75	27.74
25 mph				
	Cars	49.19	6.96	4.52
	Trucks	81.40	13.79	6.33
	Diesels	12.39	1.75	27.44
50 mph				
	Cars	29.40	5.28	4.52
	Trucks	38.10	11.34	6.33
	Diesels	12.39	1.75	27.44

		1990		
		Carbon Monoxide	Hydrocarbon	Nitrogen Oxides (NO_2)
All Speeds				
	Cars	5.00	0.454	0.688
	Trucks	6.70	0.907	0.998
	Diesels	3.62	0.399	0.770

Note: Mix of vehicles used in study was 94.5% cars
3.5% heavy duty gasoline trucks
2.0% diesel trucks and buses.

This mix was derived from data estimated by Coverdale and Colpitts.

Source: Based on EPA publication AP-42, private communication, and various ERT studies conducted in New Jersey.

Traffic Volumes

The traffic data used was supplied by the New Jersey Turnpike Authority and their consultant, Coverdale and Colpitts. The traffic counts and vehicular speeds for each roadway modeled are listed in Table 5. It is expected that a pronounced seasonal variation in traffic volumes will occur. For 1976, it was assumed that the traffic volumes for the summer months would be twice as high as the average month while for 1990, they would be one and one-half times as high; the peak hour volumes for summer were modeled.

The model also requires as input, the mix of automobiles, heavy duty trucks and diesel trucks and buses. The mix used for all cases was 94.5% automobiles, 3.5% trucks and 2% diesel. These percentages were estimated from data provided by Coverdale and Colpitts.

Meteorological Conditions Modeled

As previously discussed the National Ambient Air Quality Standards for each of the vehicular-related pollutants correspond to various time-averaging periods. For carbon monoxide the time period is one hour, for hydrocarbons three hours, and for oxides of nitrogen one year.

A preliminary analysis of peak pollutant concentrations as a function of wind direction indicated that an east wind would be indicative of highest short-term levels. Because we wished to determine the poorest air quality in the vicinity of the specified roadway configurations, the "worst" meteorological case - stable stability and 5 mph wind speed - was selected for analysis. This case occurs about 3% of the time, as shown in Table 11. It should be noted that the combination of low wind speed and stable atmospheric conditions (which contribute to poorer air quality) do not necessarily occur during high volume traffic conditions. However, since the analysis was performed to determine the poorest air quality, they were assumed to be occurring simultaneously.

For nitrogen oxides, an annual average condition was modeled using the Newark Airport stability wind rose (joint frequency of occurrence of stability, wind direction and speed) as input to the model because no on site data were available. However, conditions at the airport are representative of the region being studied and thus provide a good estimate of conditions near the Expressway on an annual basis. This information is used to compute the air quality resulting from every wind direction and wind speed listed for each stability class (atmospheric condition); these values are summed and weighted by frequency of occurrence to produce the annual average.

Tabulated wind roses for each of the stability classes (using the Newark Airport data) are presented in Tables 7 through 11. The wind speed and stability class definitions are presented in Table 6. Table 12 illustrates the wind speed and direction distribution for all stabilities; i.e., the numbers in the table indicate the approximate number of hours per year that the given wind speed and wind direction occur simultaneously.

TABLE 5. TRAFFIC DATA USED FOR MODELED CASES

Case 1: Interchange 1 - Garden State Parkway	Speed (mph)	1976 Total Number of Vehicles, both directions		1990 Total Number of Vehicles, both directions	
		Peak Hour	Avg Hour	Peak Hour	Avg Hour
Expressway, Garden State Parkway, & Rt. 9	50	6,000	1,200	10,800	2,880
Expressway	50	2,900	600	5,256	1,400
Garden State Parkway	50	3,400	700	6,300	1,680
Toll Plaza on Garden State Parkway	15	3,400	700	6,300	1,680
Rt. 9	50	2,600	600	4,824	1,285
Garden State Parkway & Rt. 9	50	3,100	600	5,544	1,400
Rt. 166	50	2,500	500	4,500	1,200
Case 2: Interchange 1 - (without Expressway)					
Garden State Parkway	50	4,000	800	7,200	1,920
Toll Plaza on Garden State Parkway	15	4,000	800	7,200	1,920
Rt. 9	50	3,700	750	6,625	1,765
Garden State Parkway & Rt. 9	50	4,700	950	8,425	2,245
Rt. 166	50	2,500	500	4,500	1,200
Case 3: Interchange 5 - Rt. 33 Bypass					
Rt. 33 Bypass Westbound to Toll Plaza	25	960	192	1,920	520
Rt. 33 Bypass Eastbound to Toll Plaza	25	340	68	680	185
Toll Plaza	15	2,600	520	5,200	1,400
Toll Plaza to Expressway Northbound	25	960	192	1,920	520
Toll Plaza to Expressway Southbound	24	340	68	680	185
Expressway Southbound to Toll Plaza	25	950	192	1,920	520
Expressway Northbound to Toll Plaza	25	340	68	680	185
Toll Plaza to Rt. 33 Bypass Westbound	25	340	68	680	185
Toll Plaza to Rt. 33 Bypass Eastbound	25	960	192	1,920	520
Expressway South of Rt. 33 Bypass	50	4,200	840	8,400	2,270
Expressway North of Rt. 33 Bypass	50	5,450	1,090	10,900	2,950
Rt. 33 Bypass West of Expressway	50	1,880	375	3,760	1,010
Rt. 33 Bypass East of Expressway	50	3,120	525	6,240	1,400
Rt. 33	50	1,468	295	2,936	795
Case 4: Interchange 7 - New Jersey Turnpike					
Expressway Westbound to NJTP Northbound	50	2,400	480	4,790	1,278
Expressway Westbound to NJTP Southbound	50	265	50	535	140
NJTP Southbound to Expressway Eastbound	50	2,400	480	4,790	1,278
NJTP Northbound to Expressway Eastbound	50	265	50	535	140
Expressway	50	5,200	1,090	10,710	2,856
NJTP South of Expressway	50	15,000	3,000	27,189	7,250
NJTP North of Expressway	50	19,800	3,950	17,550	4,680
Case 5: Hypothetical Maximum Expressway Traffic*					
Expressway	50	5,400	1,100	10,800	2,970
Toll Plaza	15	5,400	1,100	10,800	2,970

Notes: Peak hour = $1/10^{th}$ of the Average Daily Traffic (ADT) for the peak month.

Average hour = $1/24^{th}$ of the Annual Average Daily Traffic (AADT) the average hour traffic is used only for determining annual average concentrations of nitrogen oxides in Case 4.

*Case 5 represents both maximum traffic (between Interchanges 5 & 6) and maximum congestion (at toll plaza between Interchanges 3 & 4)

TABLE 6. DEFINITIONS OF STABILITY AND WIND SPEED CLASSES

Stability Class	Definition
1	Very unstable
2	Unstable
3	Slightly unstable
4	Neutral
5	Stable

Wind Speed Class	Definition (Speed in Knots)
1	0 - 3
2	4 - 6
3	7 - 10
4	11 - 16
5	17 - 21
6	>21

TABLE 7. STABILITY CLASS 1

TABULATED ANNUAL WIND ROSE FOR VERY UNSTABLE ATMOSPHERIC CONDITIONS FOR NEWARK, NEW JERSEY

(1-Year average in hours)

Stability Class 1

Wind Direction	Wind Speed Class					
	1	2	3	4	5	6
N	-	-	-	-	-	-
NNE	-	-	-	-	-	-
NE	-	3	-	-	-	-
ENE	-	-	-	-	-	-
E	-	-	-	-	-	-
ESE	-	3	-	-	-	-
SE	-	-	-	-	-	-
SSE	-	-	-	-	-	-
S	-	-	-	-	-	-
SSW	-	-	-	-	-	-
SW	3	3	-	-	-	-
WSW	-	-	-	-	-	-
W	-	-	-	-	-	-
WNW	-	-	-	-	-	-
NW	-	-	-	-	-	-
NNW	-	-	-	-	-	-

TABLE 8. STABILITY CLASS 2

TABULATED ANNUAL WIND ROSE FOR UNSTABLE ATMOSPHERIC CONDITIONS FOR NEWARK, NEW JERSEY

Stability Class 2

Wind Direction	Wind Speed Class					
	1	2	3	4	5	6
N	3	-	9	-	-	-
NNE	3	12	3	-	-	-
NE	9	12	6	-	-	-
ENE	3	15	6	-	-	-
E	-	9	6	-	-	-
ESE	6	15	3	-	-	-
SE	6	6	21	-	-	-
SSE	3	12	9	-	-	-
S	6	-	3	-	-	-
SSW	6	6	9	-	-	-
SW	3	18	3	-	-	-
WSW	6	6	12	-	-	-
W	-	12	6	-	-	-
WNW	-	3	6	-	-	-
NW	-	3	3	-	-	-
NNW	-	6	3	-	-	-

TABLE 9. STABILITY CLASS 3

TABULATED ANNUAL WIND ROSE FOR SLIGHTLY UNSTABLE ATMOSPHERIC CONDITIONS FOR NEWARK, NEW JERSEY

(1-Year average in hours)

Stability Class 3

Wind Direction	Wind Speed Class					
	1	2	3	4	5	6
N	6	6	39	6	-	-
NNE	0	21	36	-	-	-
NE	0	9	18	-	-	-
ENE	0	6	12	-	-	-
E	0	3	9	-	-	-
ESE	3	15	15	3	-	-
SE	6	15	39	21	-	-
SSE	0	3	42	6	-	-
S	9	21	27	3	-	-
SSW	3	18	15	3	-	-
SW	3	15	48	21	-	-
WSW	3	21	51	27	-	-
W	6	6	63	21	-	-
WNW	6	12	24	9	3	-
NW	-	-	15	9	-	-
NNW	0	3	12	3	-	-

TABLE 10. STABILITY CLASS 4

TABULATED ANNUAL WIND ROSE FOR NEUTRAL ATMOSPHERIC
CONDITIONS FOR NEWARK, NEW JERSEY
(1-Year average in hours)

Stability Class 4

Wind Direction	Wind Speed Class 1	2	3	4	5	6
N	0	27	168	174	12	0
NNE	6	42	195	144	18	3
NE	3	36	99	69	3	0
ENE	9	54	63	48	3	0
E	13	81	108	72	3	0
ESE	19	69	117	57	6	0
SE	15	63	129	69	0	0
SSE	19	66	69	42	6	0
S	28	117	204	72	6	0
SSW	9	54	75	51	3	3
SW	16	69	156	165	15	0
WSW	22	78	165	219	27	6
W	12	45	108	225	45	15
WNW	3	15	72	300	168	36
NW	0	21	75	249	54	12
NNW	0	12	39	120	15	6

TABLE 11. STABILITY CLASS 5

TABULATED ANNUAL WIND ROSE FOR STABLE ATMOSPHERIC
CONDITIONS FOR NEWARK, NEW JERSEY
(1-Year average in hours)

Stability Class 5

Wind Direction	Wind Speed Class 1	2	3	4	5	6
N	13	57	45	-	-	-
NNE	14	93	30	-	-	-
NE	7	21	15	-	-	-
ENE	10	18	6	-	-	-
E	7	24	6	-	-	-
ESE	10	36	6	-	-	-
SE	13	30	18	-	-	-
SSE	7	39	6	-	-	-
S	33	141	54	-	-	-
SSW	12	132	63	-	-	-
SW	28	198	111	-	-	-
WSW	31	174	120	-	-	-
W	27	147	78	-	-	-
WNW	13	54	153	-	-	-
NW	3	18	54	-	-	-
NNW	3	6	36	-	-	-

TABLE 12. ALL STABILITIES

TABULATED ANNUAL WIND ROSE FOR ALL ATMOSPHERIC
CONDITIONS FOR NEWARK, NEW JERSEY
(1-Year average in hours)

All Stabilities-1 year average in hours

Wind Direction	Wind Speed Class 1	2	3	4	5	6	Sum
N	23	90	261	180	12	-	566
NNE	24	168	264	144	18	3	621
NE	19	81	138	69	3	-	310
ENE	22	93	87	48	3	-	253
E	19	117	129	72	3	-	340
ESE	38	138	141	60	6	-	383
SE	41	114	207	90	-	-	452
SSE	28	123	126	48	6	-	331
S	77	279	288	75	6	-	725
SSW	30	210	162	54	3	3	462
SW	53	303	318	186	15	-	875
WSW	62	279	348	246	27	6	968
W	46	210	255	246	45	15	817
WNW	23	84	255	309	171	36	878
NW	4	42	147	258	54	12	517
NNW	3	27	90	123	15	6	264
Sum	512	2358	3216	2208	387	81	8762

Findings

In the following sections the modeled concentrations are compared to the appropriate standards directly without consideration of the background sources; then, an assessment is made of the total concentration including estimates of background levels.

Carbon Monoxide - An analysis of the concentrations of the vehicular pollutants as "predicted" by the highway impact diffusion model indicates that the carbon monoxide levels for all cases, for both 1976 and 1990, are well below the established standard of 35 ppm. The highest concentrations were found for the interchange area of the Expressway and the existing New Jersey Turnpike (Case 4) as shown in Figure 4. Typical values in this "worst" case range between 2 and 4 ppm with the highest value being 6.21 ppm. If we assume that the background values for 1976 are as high as those estimated for the current worst hour (see Table 3), we would add 15 ppm to the 6.21 ppm to produce 21.21 ppm for the maximum concentration. This is well within the 1-hour standard.

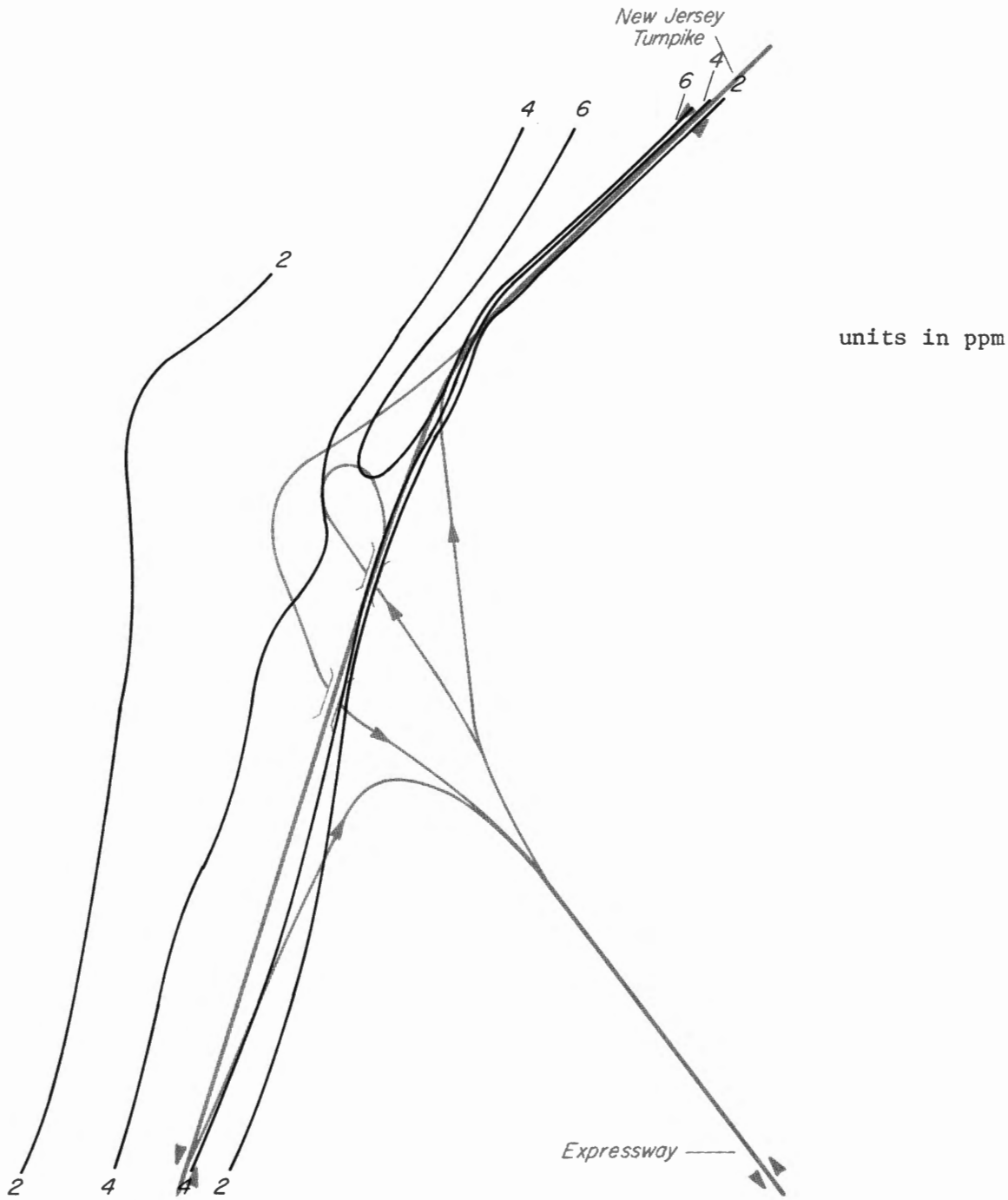
Hydrocarbons - The hydrocarbon concentrations for 1976 are, in general, above the three-hour standard of 0.24 ppm as a result of the road directly. For Case 5 (hypothetical roadway), hydrocarbon concentrations were lowest and for Case 4 they were highest (Figures 5 and 6 respectively).

Examination of Figure 5 shows that along the main line of traffic flow the hydrocarbon values are above the standard only within 300 feet of the roadway. In the toll plaza area, because of the reduced speed of the vehicles, the zone of values above standard expands to 2000 feet downwind from the roadway. For Case 4, however, almost all of the area modeled exceeded the 3-hour standard with the highest values being found, as might be expected, along the existing Turnpike north of the intersection with the proposed Expressway.

Comparison of Cases 1 and 2 for 1976 shows that, in general, the air quality is improved by the addition of the Expressway. The hydrocarbon concentrations for these two cases are as shown in Figures 7 and 8, respectively. The maximum hydrocarbon concentration in Case 1 is 0.55 ppm which is a reduction of approximately 33% from the maximum concentration of 0.72 ppm in Case 2.

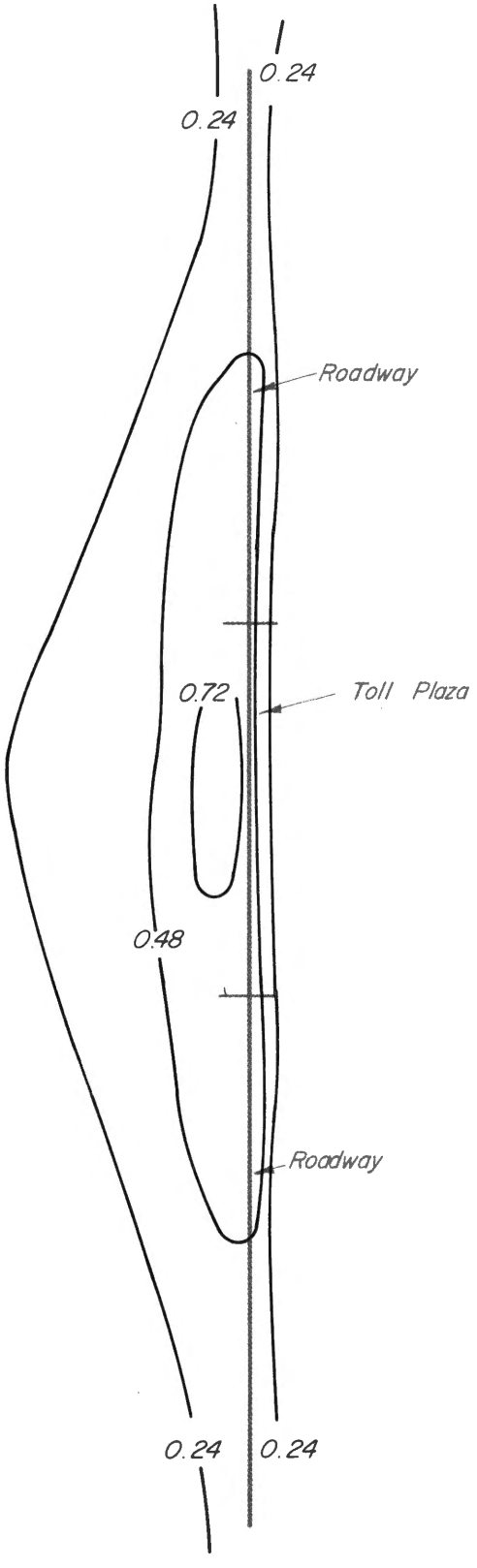
The background levels, assuming no reduction from the current "best estimate" shown in Table 3, are in general an order of magnitude greater than the concentrations due to the road. This tempers the relative differences between cases as determined for the Expressway directly.

By 1990, because of the emission control devices, hydrocarbon concentrations predicted for all cases were sharply reduced. This is illustrated by Case 4 for 1990 (shown in Figure 9). In this case, nearly all hydrocarbon levels are well below the standard. Similar reductions of hydrocarbon levels from 1976 values were found for the other four cases under study (see Case 5 in Figure 10). It is not possible to predict the background levels of hydrocarbons for 1990, although various projections could place them above the standard.



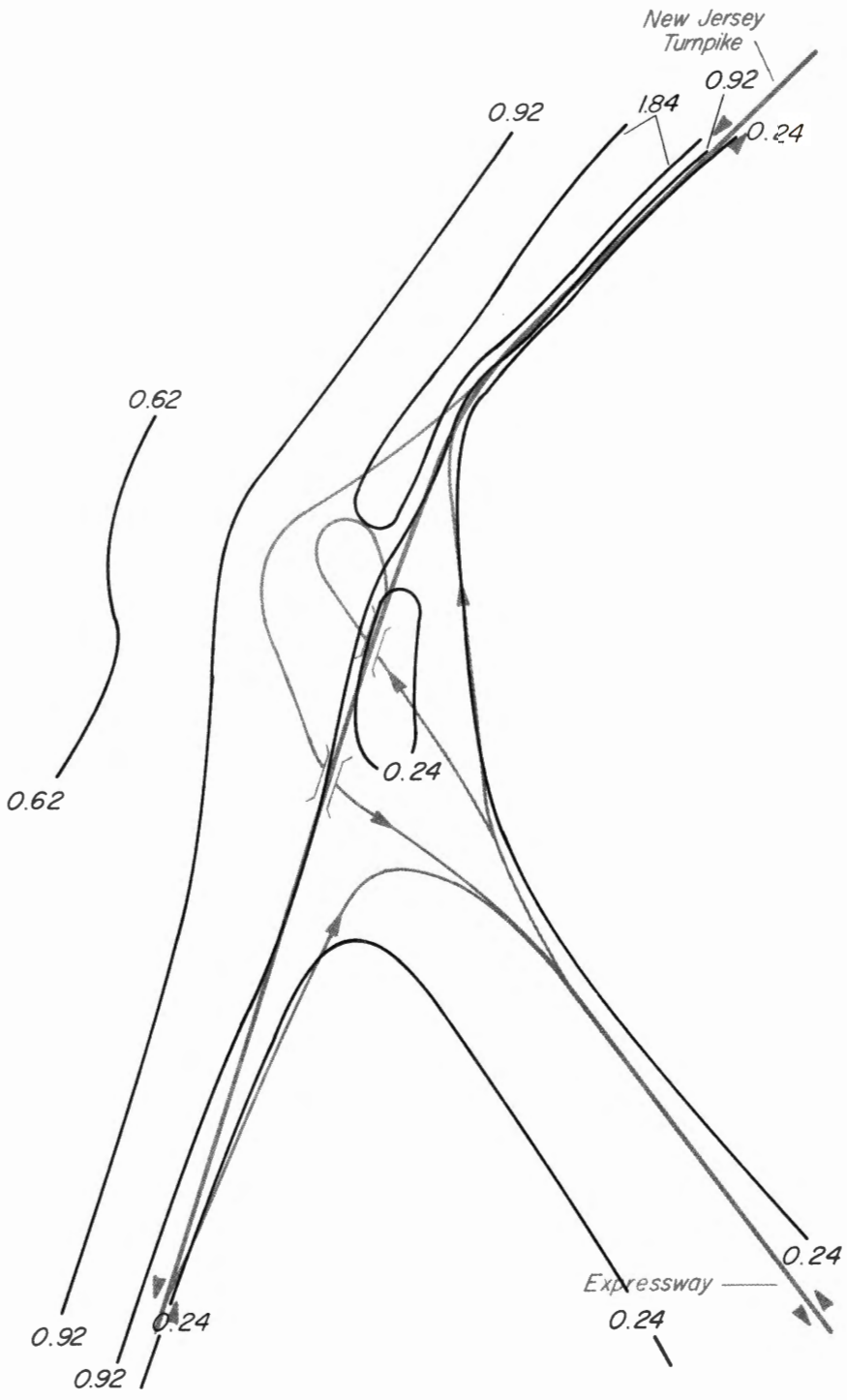
units in ppm

FIGURE 4. 1976 CARBON MONOXIDE CONCENTRATIONS -- CASE 4



units in ppm

FIGURE 5. 1976 HYDROCARBON CONCENTRATIONS -- CASE 5



units in ppm

FIGURE 6. 1976 HYDROCARBON CONCENTRATIONS -- CASE 4

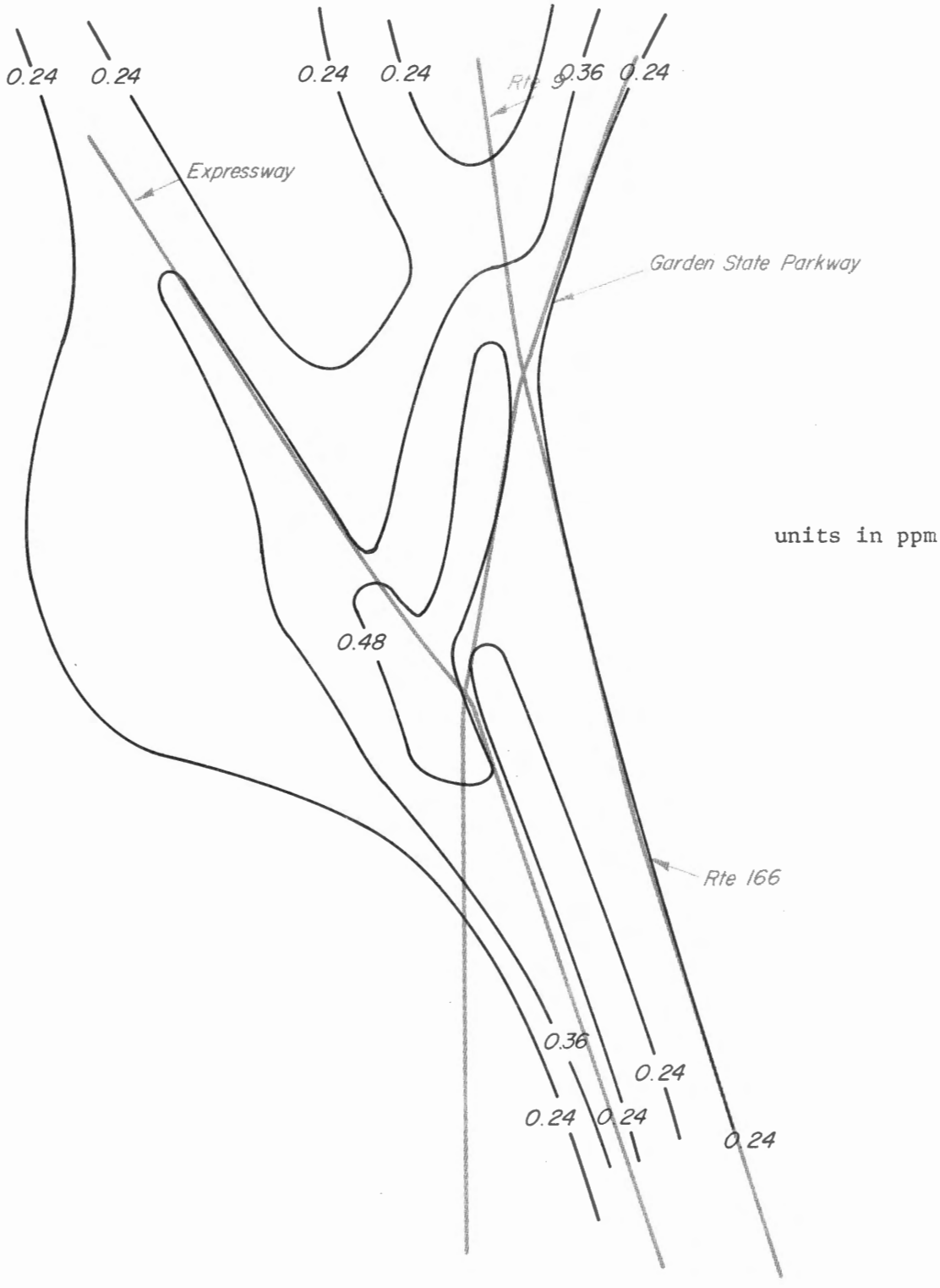


FIGURE 7. 1976 HYDROCARBON CONCENTRATIONS -- CASE 1

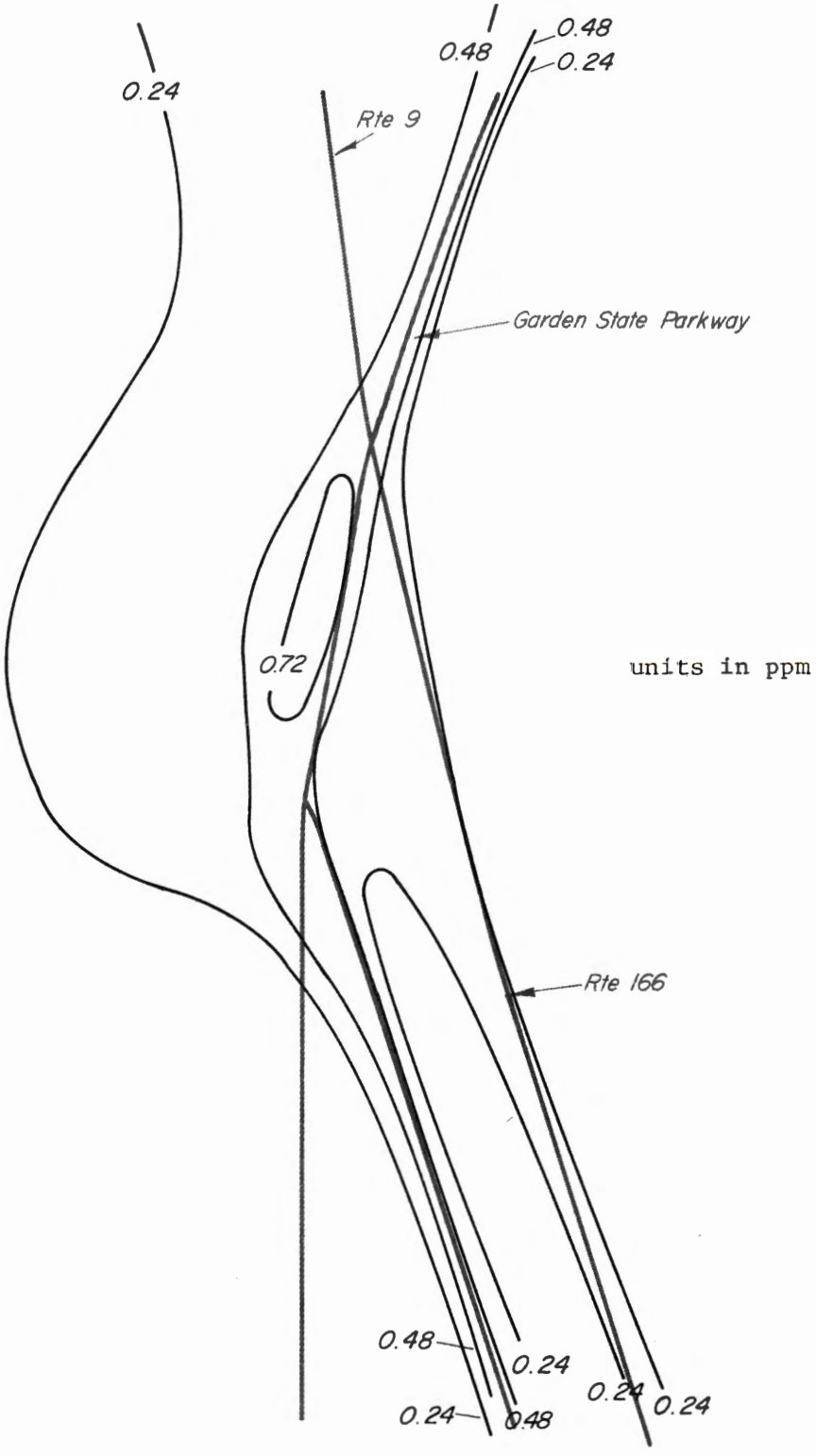


FIGURE 8. 1976 HYDROCARBON CONCENTRATIONS -- CASE 2

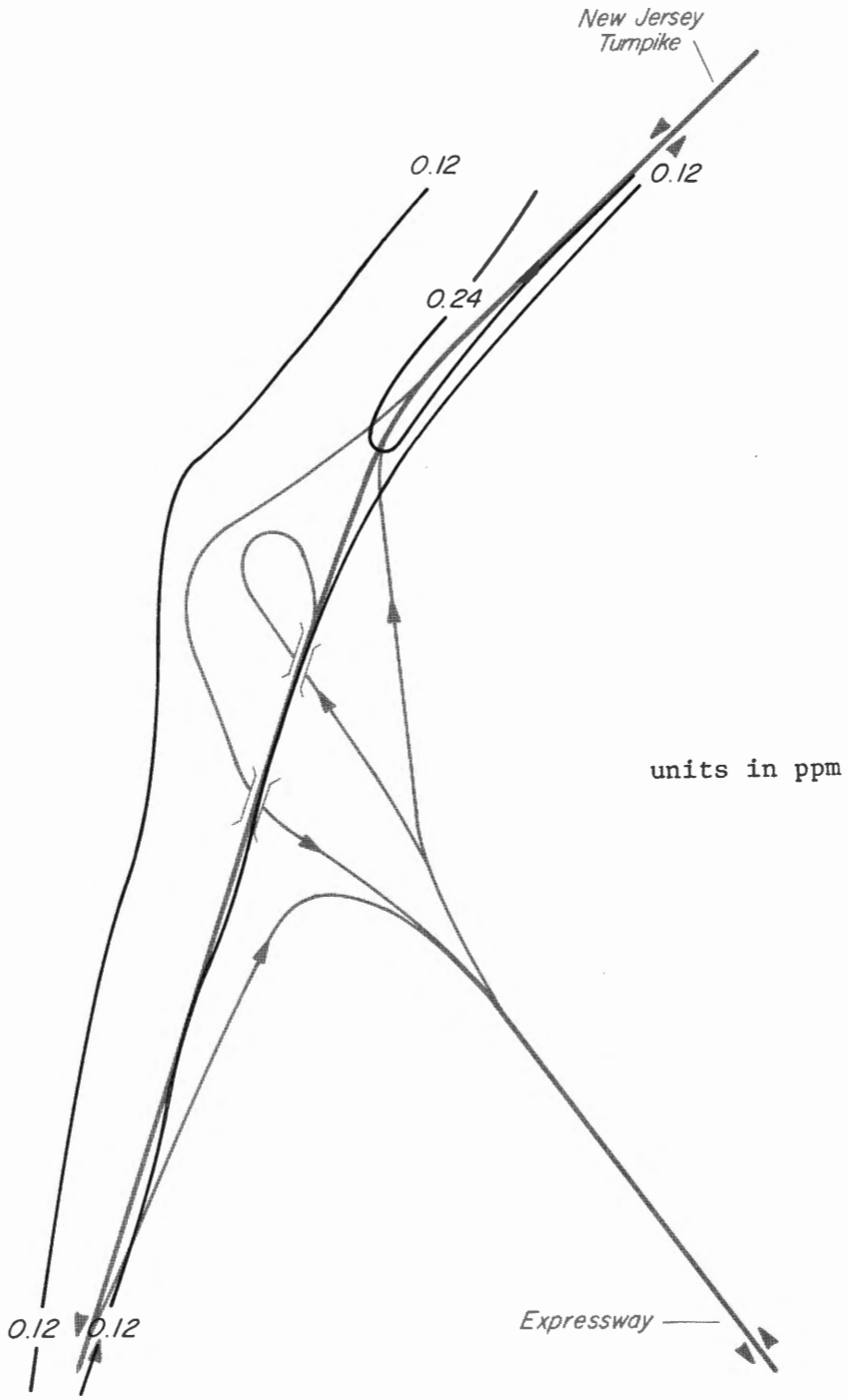


FIGURE 9. 1990 HYDROCARBON CONCENTRATIONS -- CASE 4

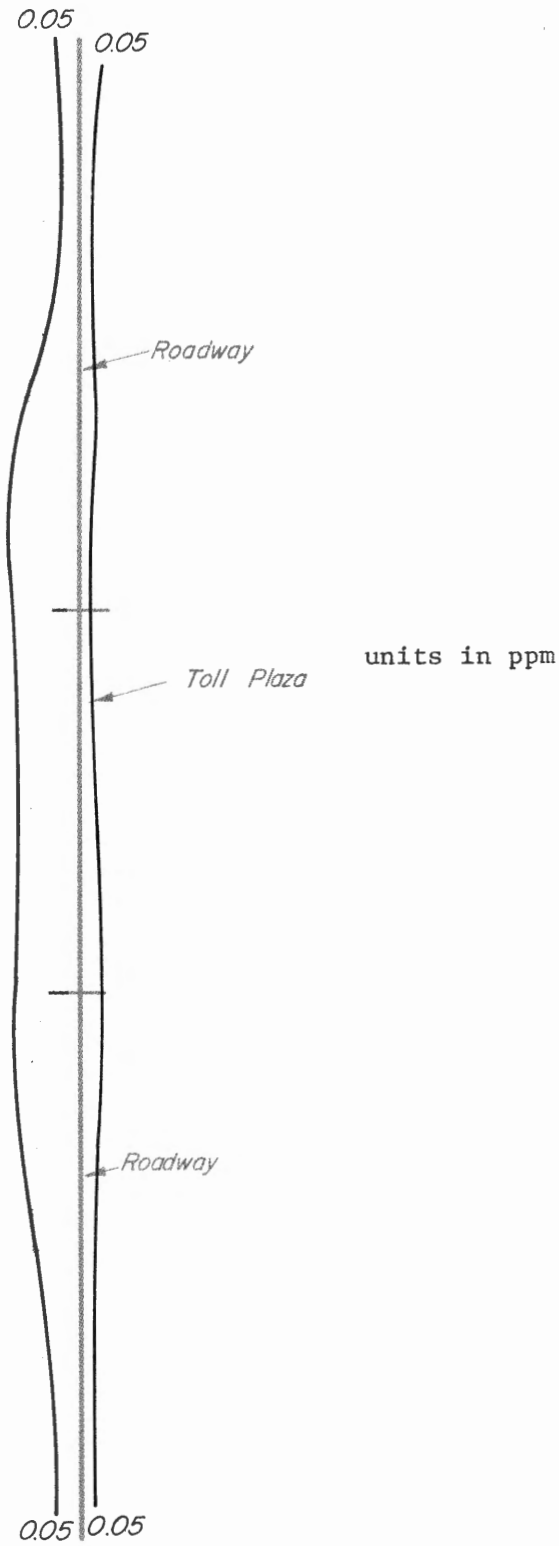


FIGURE 10. 1990 HYDROCARBON CONCENTRATIONS -- CASE 5

Nitrogen Oxides - The annual NO_X concentrations for Case 4 (worst case) for 1976 are well below the annual standard of 0.05 ppm, with the maximum predicted value being 0.015 ppm. Because Case 4 represents the poorest air quality, it is safe to state that for the other four cases, the annual NO_X concentrations are also well below the annual standard. The nearly universal use of emission control devices in 1990 insures that for all cases NO_X values should remain significantly below the established annual standard.

The background levels of NO_X, according to the best estimate of the current annual average, are potentially above the standard. With the data available it is not possible to determine whether the total concentrations resulting from the road and background will be above the established standard for 1976.

Impact on Sensitive Receptors

In addition to predicting "worst case" concentrations for comparison with the Ambient Air Quality Standards, we are concerned with the impact on specific sensitive receptors. This is particularly true when accurate background levels are not known.

In previous studies* ERT has used a health-related criterion of "10% of the CO 1-hour standard resulting from the road directly. "This assumes that the background levels are not accurately known but that they are below the standard, as is the case here. The criterion has generally been applied to schools and hospitals.

A hospital, professional building, and hospital zone are found grouped together on Rt. 537 in Freehold (see Sheet 6 in the social resources section). Some of the hospital zone land is taken but the buildings are about 2000 feet from the road.

Figure 11 shows the plot of 1-hour CO values for the "worst case" as a function of distance from the downwind edge of the most downwind lane of traffic. Case 5 traffic was used for this analysis which gives a conservative estimate; traffic passing the hospital is expected to be less than that assumed for Case 5. A distance of 100 feet represents the minimum distance from the roadway to the edge of the ROW. The predicted CO values are well below 10% of the CO 1-hour standard.

Four schools are close to the alignment in Manalapan between Interchanges 5 and 6 where the Case 5 traffic estimates apply directly (see sheet 8 in the social resources section). Figure 11 again shows that no serious worst hour CO impact is expected.

*"*Draft Environmental Impact Statement,*" Boston Transportation Planning Review (North Shore), May 1972 (Comm. of Massachusetts Dept of Public Works - MBTA)

"Air Pollution Impact Study of the New Jersey Sports Complex" Environmental Research & Technology, Inc. (Prepared for J. McCormick & Associates), June 1972, Lexington, Mass.

Because of the very high background hydrocarbon levels generally found and the uncertainty as to how to best interpret the hydrocarbon standard, ERT has previously used a vegetation-related criterion of "100% of the hydrocarbon 3-hour standard resulting from the road directly." Figure 12 shows that for 1976 for the traffic volumes expected between Interchanges 5 and 6 this hydrocarbon criterion would be exceeded out to a distance of about 250 feet from the road. Since the concentrations predicted by the model can be scaled directly as a function of traffic volumes, the impact zone for the other links of the Expressway would probably not go outside of the area contained within a 450 foot ROW.

Regional Impact

In general we would expect significant positive impact on air quality as a result of the Expressway in all areas where there is a substantial relieving of existing local traffic. This was shown for Cases 1 and 2 (Interchange 1 at the Garden State Parkway). Figures 11 and 12 show that the impact of the road is quite localized.

The major positive impacts will result from less traffic (particularly truck traffic) along Route 9. Table 3 showed that the current maximum CO values measured in Freehold and Toms River are high. Relieving of Route 9 traffic in these towns should lessen the CO levels.

An indirect assessment of the impact can be made by analyzing hypothetical changes in 1971 annual average daily traffic (AADT) for various roads assuming the Expressway were open. The common section of the Garden State Parkway and Route 9 would show a drop in 1971 AADT of 3300. A proportional reduction was modeled in Cases 1 and 2 for 1976. This can be compared to the projected drop in 1971 AADT for the following sections of Route 9:

I-195 to Toms River	5000
Route 33 to Route 34	3000

An increase of about 12% in traffic volume is anticipated for the common section of the Garden State Parkway and Route 9 south of Interchange 1 as a result of induced traffic. We would expect 1976 concentrations in this area to be less than those found in Case 5 as a direct scaling of traffic volumes.

CONCLUSIONS AND RECOMMENDATIONS

- Carbon monoxide concentrations, even under the "worst" conditions, and assuming conservative estimates for background levels, are well below the established one-hour standard of 35 ppm for 1976 and 1990. No sensitive receptors will be adversely impacted.
- The hydrocarbon less methane concentrations for 1976 are generally close to the established three-hour standard near the road; the values are an order of magnitude less than conservative estimates for background levels. They are also an order of magnitude less than current levels found simultaneously with oxidant levels which meet the one-hour standard.

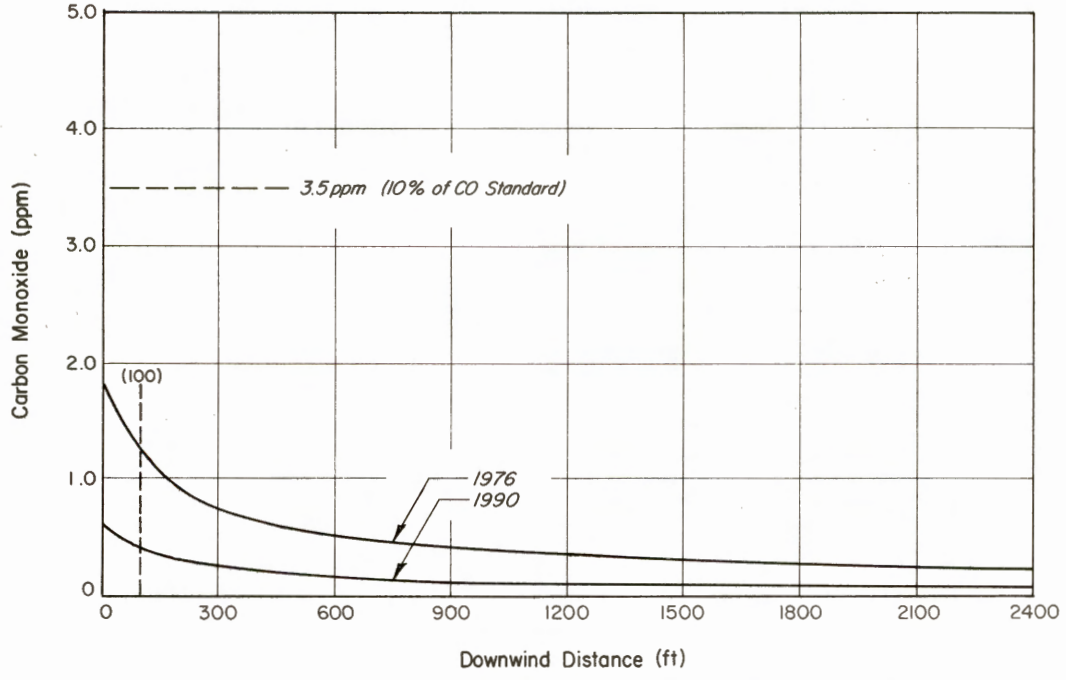


FIGURE 11. VARIATION OF CARBON MONOXIDE CONCENTRATIONS WITH DISTANCE

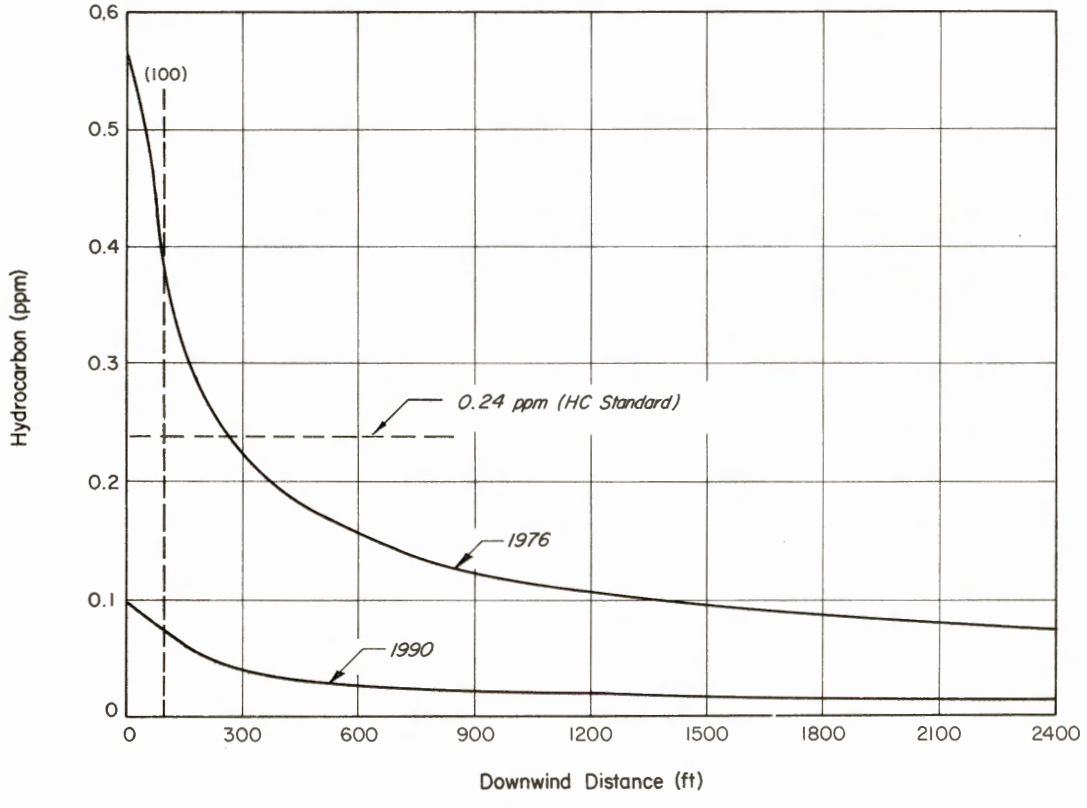


FIGURE 12. VARIATION OF HYDROCARBON CONCENTRATIONS WITH DISTANCE

- Nitrogen oxide concentrations for the annual average case do not exceed standards as a result of the road alone. The data does not presently exist to estimate whether levels including background will exceed standards in 1976.

- Regional air quality, particularly in urban areas such as Freehold, Lakewood and Toms River, probably will be improved due to the relieving of traffic on Route 9 and other major roads.

- We have not identified any unavoidable adverse environmental impacts. Only hydrocarbon levels are anticipated to exceed the Ambient Air Quality Standards and no serious impacts on sensitive receptors have been found.

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IMPACT OF THE GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY ON WATER RESOURCES

INTRODUCTION

The objective of this section is to identify and analyze potential impacts on the water resource system in the area surrounding the proposed Governor Driscoll Expressway. The impacts to be investigated are those that may result from the construction, prolonged use and maintenance of the highway, and those due to development and urbanization expected in the area which are not generated by the highway.

The water resource system is defined as all water found in streams, lakes, and ground water aquifers. Impacts on this system are assessed with respect to surface water, ground water quantities and quality and all water uses. The analysis and identification of these impacts is frequently complicated by the many complex interactions among the constituents of water resource systems.

The report is divided into three major sections. In the next section, a brief presentation of the major water resource features of the area is presented with the aid of aerial photographs. (Figure 13 - referred to as Sheets 1 through 10, starting with the southernmost end of the alignment.) Available data and their sources are also discussed.

The section which follows is concerned with general highway impacts. The theoretical and practical considerations which enter into the analysis of water resource impacts are presented.

The last section is a presentation of all identified impacts. The impacts are those that are not route specific as well as impacts resulting directly from route location.

No major adverse environmental impacts have been found. Seven local and largely avoidable impacts have been identified; six of these are not route specific. The route specific impact involves the crossing of the South Branch of the Metedeconk River and the area north to Interstate 195. The channelization and filling of wet areas here should be carried out with care to avoid local and downstream changes in hydrologic and quality conditions.

In addition two areas have been identified which are very sensitive in water resources aspects to general development expected in the future of which the Expressway is only a part. These are (1) the proposed Jamesburg Park area, where extremely careful construction practices and supervision are required and are to be employed to guard against highway impacts, and (2) the Manalapan and Matchaponix Brooks, where the contribution of the highway to future impact will be minimal compared to that caused by other development in the area, and where careful planning for all types of development will lead to lessened impact.

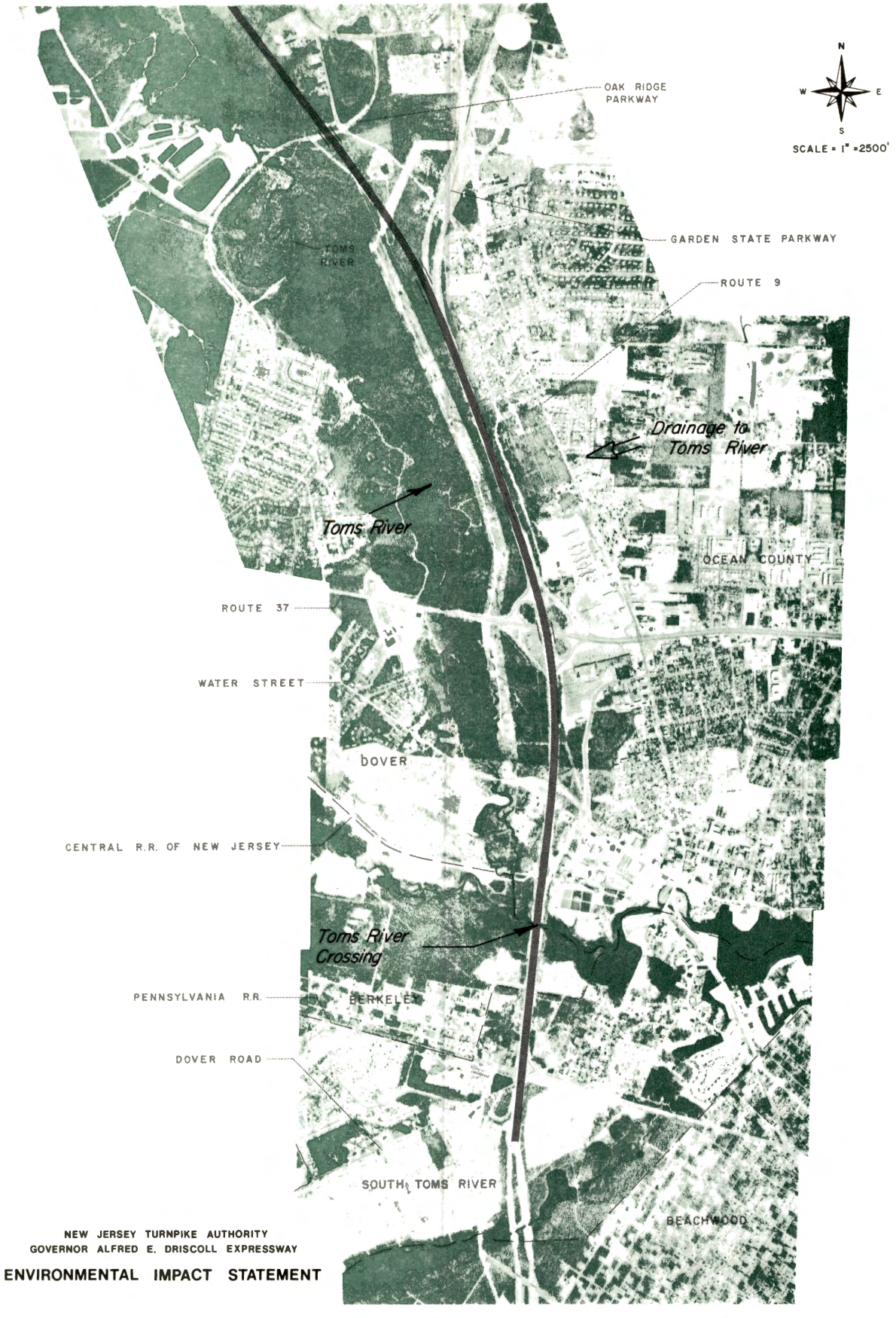

FIGURE 13. WATER RESOURCES: SHEET 1 OF 10



FIGURE 13. WATER RESOURCES: SHEET 2 OF 10



FIGURE 13. WATER RESOURCES: SHEET 3 OF 10



FIGURE 13. WATER RESOURCES: SHEET 4 OF 10

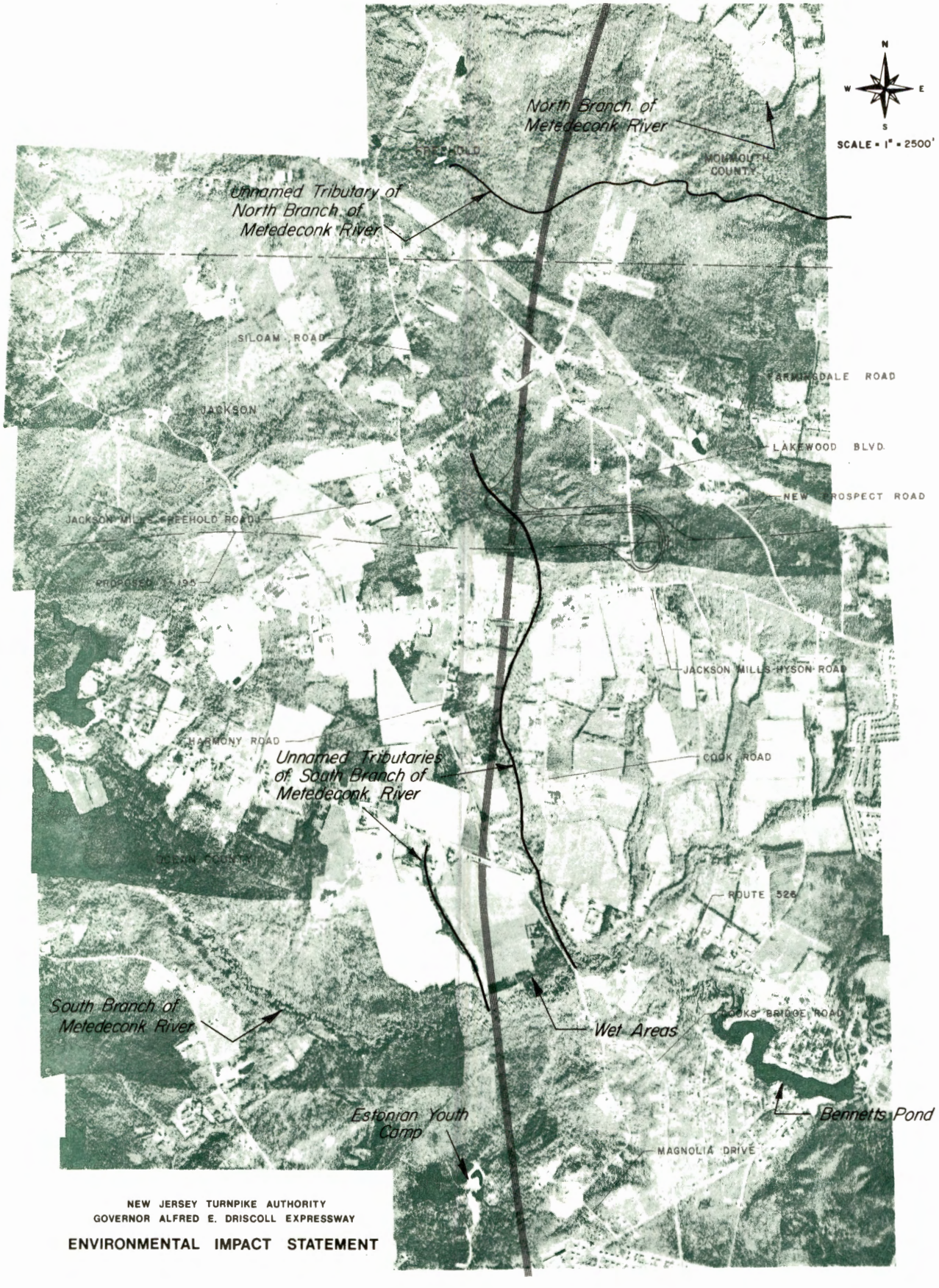

FIGURE 13. WATER RESOURCES: SHEET 5 OF 10

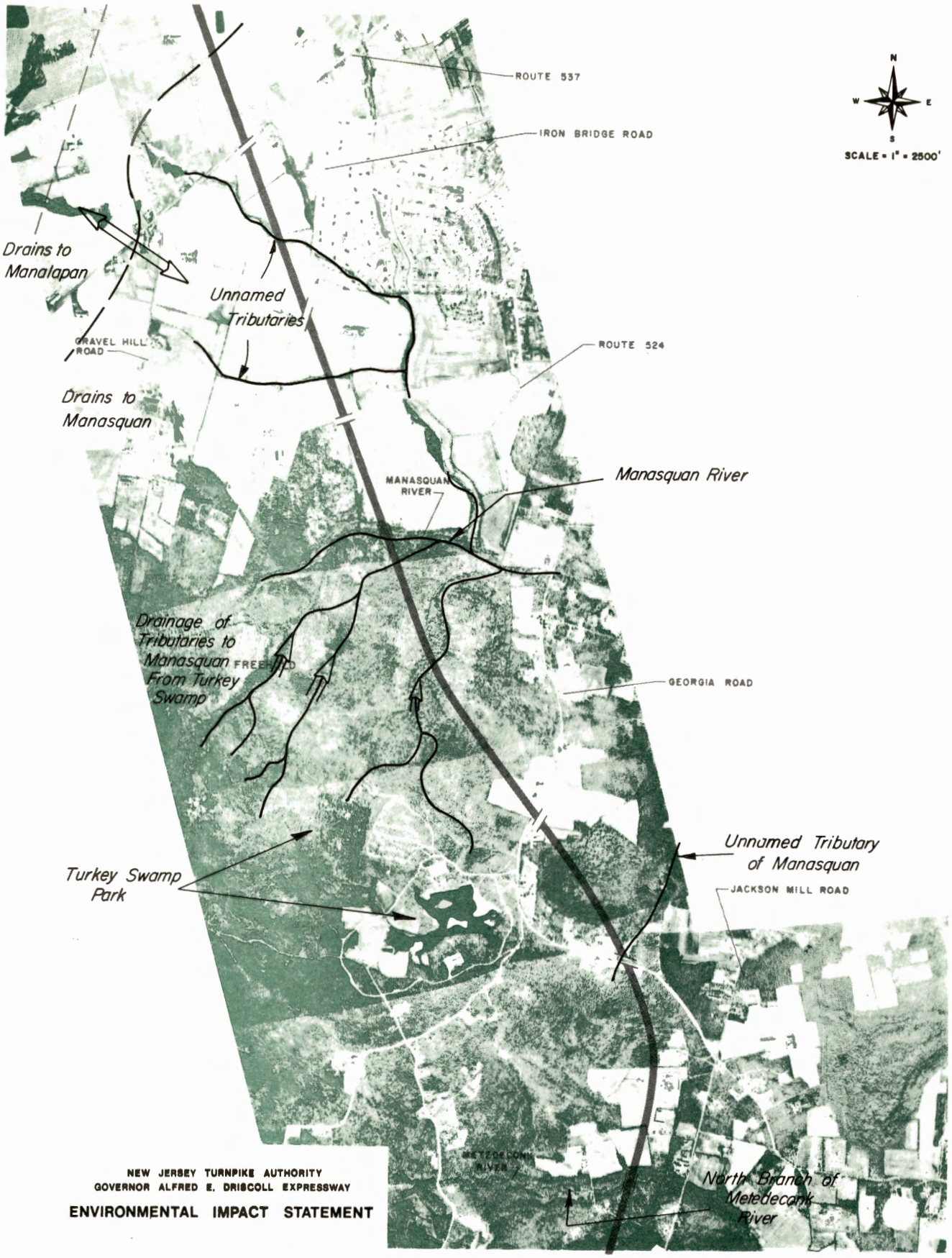

FIGURE 13. WATER RESOURCES: SHEET 6 OF 10



FIGURE 13. WATER RESOURCES: SHEET 7 OF 10



FIGURE 13. WATER RESOURCES: SHEET 8 OF 10



FIGURE 13. WATER RESOURCES: SHEET 9 OF 10



FIGURE 13. WATER RESOURCES: SHEET 10 OF 10

GENERAL DESCRIPTION OF THE STUDY AREA AND A SURVEY OF AVAILABLE DATA

Surface Water

The majority of the surface water observed in the area of influence of the Governor Alfred E. Driscoll Expressway is found in the basins of several coastal rivers. The streams in the study area, indicated in Figure 13, sheets 1 through 10, originate in the central part of the state on the eastern side of the ridge which separates coastal rivers from those which drain to the Delaware River. From this point, the coastal rivers flow north to the Raritan River which drains into the Atlantic Ocean or south and east directly to the ocean. Surface water is in abundance and generally of good to high quality; i.e., the quality is sufficient to permit all water uses, including water supply where water treatment is performed. While most of the drainage basins in the area are of small to moderate size, they are subject to severe but infrequent flooding which usually results from the intrusion of a hurricane into the coastal plain.

Toms River - The headwaters of the Main Branch of the Toms River are located in Sheet 4 to the west of the proposed highway. From this point, the stream flows south and east to its confluence with the Ridgeway Branch and eventually to the Garden State Parkway (Sheet 1) where it turns east and drains to the ocean. The river is parallel to the west of the alignment and at times is fairly close (800 feet) to the banks. As the general drainage pattern is from east to west, all drainage from the east will have to pass through the highway, as it now passes through the Garden State Parkway, to reach the stream.

The Toms River Basin is of medium size with a drainage area of 124 square miles. As indicated by United States Geological Survey (USGS, 1961-1970), the mean flow from 42 years of record is 210 cubic feet per second (cfs) at a point just north of Toms River. These reports also indicate that the river is subject to flooding due to the variability of the river's discharge. The maximum discharge recorded in 1938 was 2000 cfs, or about 10 times the mean flow. This is substantiated by the New Jersey Department of Conservation and Economic Development report (DCED, 1966).

Data gathered by the USGS (1969, 1970) indicates that the water of the Toms River upstream of the Garden State Parkway is of high quality. This was also the finding of the New Jersey Department of Environmental Protection (DEP) from their sample taken in 1969-1971.

Metedeconk River - To the north, the Toms River Basin gradually gives way to the basin of the Metedeconk River (Sheets 5 and 6). Unlike the Toms River which parallels the proposed alignment for several miles, the Metedeconk flows generally due east to the ocean. Thus, drainage directions have now changed from the generally westerly flow in the Toms basin to flows from the west to the east. Since the study area includes mostly the headwaters of the Metedeconk, there are several minor crossings. Major crossings include the South Branch of the Metedeconk (Sheet 5) and the North Branch of the Metedeconk (Sheet 6).

The USGS does not have gaging stations on the Metedeconk which is a relatively minor stream, so that flow data on the river is unavailable. Water quality samples taken in the headwaters of the stream from 1969 to 1972 (DEP) indicate that the water is of generally high quality. However, measurements taken from 1968 to 1970 at a point just upstream of the stream's discharge into the bay (USGS-WQ, 1969-70) indicate a deterioration of quality levels. Salinity levels indicate intrusion of sea water into the estuary.

Manasquan River - To the north of the Metedeconk River is the Manasquan River Basin (Sheet 6). The Manasquan also flows from the west directly to the ocean in the east. Thus, the general drainage patterns observed in the Metedeconk Basin are not altered. Two branches of the Manasquan are crossed by the proposed alignment.

The Manasquan is a rather small basin with a drainage area of 43.4 square miles and a mean discharge from 39 years of record of 71.6 cfs (USGS, 1961-1971) at a point 5 miles downstream of the proposed highway. The maximum discharge over the record period was 2940 cfs in 1938. This data and that from DCED (1966) indicate the possibility of infrequent, severe flooding in the area.

The data from USGS-WQ (1969, 1970) and DEP (1969-1971) indicate that the waters of the Manasquan are also of high quality.

The Raritan Basin: Manalapan and Matchaponix Brooks - Moving further north, one leaves the Manasquan Basin and enters the area of influence of Manalapan Brook (Sheet 7). At this point, the proposed alignment crosses the eastern tip of the headwaters that form the Manalapan. From its origins out to the west of the highway, the river meanders west and north before it bends back toward the east to join with Matchaponix Brook to form the South River which eventually flows into the Raritan River. At the present location in the headwaters of Manalapan Brook, the surrounding area drains to the river. The general drainage pattern, therefore, is one of a northern and western flow.

The flow data available for Manalapan Brook are more applicable to the next appearance of the river (Sheet 10). It can be estimated that the flow in this small section of the headwaters is very small (a few cfs) and of good quality.

The same general drainage pattern is maintained as we move north and enter the headwaters of Matchaponix Brook (Sheets 7 and 8). The proposed alignment crosses several small streams which flow to the west to join and form Matchaponix Brook. The named tributaries which are crossed include McGellairds Brook (Sheet 7), Milford Brook (Sheet 7) and Pine Brook (Sheet 8). The flows in these streams are estimated to be small and of high quality.

Matchaponix Brook flows north as the proposed alignment turns west. Their intersection occurs north of Madison Township where the small tributary of Barclays Brook flows into the Matchaponix (Sheet 9).

The surrounding land area drains to the Matchaponix so that drainage is generally in a northerly direction.

The available data show that Matchaponix Brook has a drainage area of 43.9 square miles with a mean flow from 10 years of record of 62.5 cfs (USGS, 1960-1967). These measurements were taken at a point approximately 3 miles downstream from the stream's crossing by the proposed alignment, and one mile upstream from its confluence with Manalapan Brook. The Matchaponix has also exhibited wide variation in its discharge during its 10 years of record with a maximum recorded discharge of 2050 cfs in 1960, and a minimum recorded discharge of 1.2 cfs in 1963. Water quality samples taken at the same point in 1970 indicate that quality levels are good to high with a possible tendency to be saline and hard.

To the west and north is Manalapan Brook which flows northeast to its confluence with Matchaponix Brook (Sheet 10). The proposed alignment crosses the Manalapan at the southerly portion of the borough of Helmetta. Here, again, drainage patterns indicate a northerly flow of water as the surrounding area drains to Manalapan Brook.

USGS (1961-1971) reported that the mean flow in the stream for 13 years of record was 61.3 cfs from a drainage area of 40.7 square miles. The measurements were taken at Devoe Lake Dam, two miles downstream of the stream's crossing by the alignment. The maximum recorded discharge for this same period was 1650 cfs in 1968. It should be mentioned that these flows are controlled to some extent by the dam at Devoe Lake. Water quality measurements also taken at this site (USGS-WQ, 1970) indicate high quality water.

The final stream to be accounted for is Ireland Brook, a small tributary of Farrington Lake to the west of the South River. Ireland Brook is crossed by a proposed ramp where this proposed alignment meets the existing New Jersey Turnpike.

Ground Water

The ground water resources of the tri-county region, made up of Ocean, Monmouth and Middlesex counties, are extensive and represent the area's primary source of municipal and industrial water supplies. Below, the major ground water aquifers are inventoried for each of the three counties.

Ocean County - The proposed alignment begins north of Toms River and travels northward to Monmouth County. Thus, only the northern part of Ocean County represented by the Toms River area is considered here.

Anderson and Appel (1969) indicate that the ground water supply for the Toms River area is contained primarily in a large water table aquifer and secondarily in aquifers of the Kirkwood Formation, both located in northern Ocean County. Approximately 7 million gallons per

day (mgd) are pumped from the water table aquifer. The water tends to be acidic and may contain high iron concentration. Odors in the pumped water due to the presence of hydrogen sulfide have also been noticed.

The major recharge source for the aquifer is precipitation. In addition, some water enters the ground water from local streams, principally the Toms River.

Monmouth County - As reported by Jablonski (1968), of the 44 mgd of water used in Monmouth in 1958, approximately half was taken from ground water sources. The major aquifers in the study area are those of the Raritan and Magothy Formations and the Englishtown Formation. The quality of the water is generally high, with tendencies toward acidity and high iron concentrations.

Middlesex County - The major aquifer of interest in Middlesex County is that found in the Old Bridge Sand Member located in the eastern part of the county south of Raritan Bay. The quality of the water withdrawn from this ground water deposit is generally good. However, development of the aquifer has been limited by the fear of salinity intrusion from Raritan Bay (Appel, 1962).

Water Uses

Municipal and industrial water supply are the principal uses to which water is applied in the area traversed by the proposed alignment. Most of this water supply is derived from the large aquifers in Ocean, Monmouth and Middlesex counties. Public water supply within the study area at this time is entirely from ground water. The primary uses of surface water in the area are for recreation such as boating, fishing and swimming and a small amount of irrigation. A major recreational area in the headwaters of the Manasquan River is Turkey Swamp Park (Sheet 6). There are other small existing sites and some proposed parks situated in the study area. These are specifically located in a later section. The irrigation carried out is primarily in a few cranberry bogs found along the routes such as the one shown in Sheet 4.

Both ground and surface water are used for the assimilation of wastes. A majority of residential waste disposal is through individual discharge to the ground water through septic tank systems. The extent to which the ground water is polluted by such activity is unknown, but most water quality indicators show little pollution except for cesspool and septic tank problems in the Borough of Helmetta. Here the only treatment plant in the area is operated by the Helme Company for its wastes and for 40 houses nearby. The plant is a secondary plant with an estimated 90% BOD removal and discharge to FW-2 class waters. The sewering of Helmetta has been considered because of possible pollution interference with the Old Bridge Sands aquifer which serves as the source for individual wells. This waste would be transported out of the area to a regional plant.

Thus for the most part, waste disposal in the area is now by individual systems to the ground and there is little direct discharge to surface

waters. The highway alignment will not interfere in a significant manner with any present use of water for waste disposal. Further, existing water quality in the streams of the area indicates relatively small pollution loads from all sources.

GENERAL IMPACTS RESULTING FROM A HIGHWAY

The purpose of this impact study is twofold. First, the extent of the potential changes must be delineated. Then the potential impact of these changes on present and future water used in the area must be evaluated. The differentiation between changes and impacts is an extremely important one and must be clearly made here.

1. New construction of any sort will cause certain changes in the physical environment. In most cases, these changes can be identified ahead of time.

2. Changes, however, are not necessarily impacts. Impacts of a particular project are defined as the interference (positive or negative) with present and future uses of the water resource system.

3. With awareness of changes and their potential impacts, appropriate preventive measures including engineering design, management and operational procedures can be implemented to help minimize these impacts.

This section will outline the possible problems that can occur in the construction of any highway and the remedial actions necessary to mitigate the potential impacts. Throughout this discussion, the type of procedure, that the New Jersey Turnpike Authority (NJTA) employs is also noted. In many cases, the NJTA's procedures are better than those accepted as normal standards.

Roads and their appurtenances may affect water resource systems in several ways depending on design characteristics, route location and the nature of the water resource system. In general, however, highways may change the topography of the land, surface and soil characteristics and the composition and quality of wastes in water. The degree to which these changes affect the water resource system and the importance of their impacts depend on the ways in which water is used, as well as the water system itself.

If any of the general highway changes mentioned above do occur, they would be manifested in different ways depending on the life of the highway. The problems associated with the construction phase are different from those observed during the operation and use of a highway.

The potential effects of highways on water resource systems are discussed in more detail below. Impacts are separated into the phases listed above in which they occur: construction, route location and highway use. In each instance the immediate potential effect of a highway is identified and its impacts traced through an interconnected water resource system.

Construction

Sediment Control - The building of highways through natural terrain requires the stripping of natural cover from the land surface, cutting and filling with earth to make satisfactory road grades, the stabilization of side slopes and the introduction of pavement. During this construction process, there is an increased potential for erosion and sediment. The types of activities that create sediment are clearing, grubbing, cutting and filling, unstabilized side slopes and stream fording.

The impacts from increased sediment reaching streams are many. First, the sediment can fill reservoir capacity, change stream profiles and thus greatly increase flooding potential. Also the sediment blocks light and covers habitat for biota. There is also danger that sediment can block ground water recharge areas.

In order to minimize sediment production, sediment control must be applied in a temporary manner during construction and with permanent methods after completion. The types of sediment control are those methods that attempt to prevent erosion from happening and those that control it when it occurs. With good planning, education and careful monitoring of construction, the cheaper alternative of prevention can be accomplished with little recourse to the more expensive sediment traps and settling basins. Construction practices can be most pertinent and should be directly required to consider sediment reduction. Temporary methods include limiting the amount of land cleared at any time, establishment of final grades quickly, and use of temporary methods to protect slopes until permanent grass or other materials can be installed. Also, the use of dikes, dams and other control structures to slow water flows through the project are all helpful. It should be noted that the Federal Government, many state agencies and the NJTA routinely require in contracts for road building that sediment control measures be included in the design and that the contractor follow guidelines such as outlined above to keep sediment production to a minimum.

Problems from Construction Wastes and Materials - Great care must be taken to insure that construction wastes and materials do not cause water resource problems. This means that foreign materials introduced at the site should be carefully controlled, and fill material moved and placed with care; asphalts can cause considerable water quality problems. All stream crossings and temporary dams should be monitored to prevent water quality problems. Debris from construction can cause changes in stream channels and should be cleared. Provisions must be made for sanitary wastes created during the construction process. Materials for construction should not be stored in recharge areas and should be kept out of surrounding water. Again, NJTA includes such stipulations in its specifications and supervisory procedures for highway construction.

Effects of Route Location and Highway Use

Changes in Topography and Land Surface Characteristics - Water that is observed in lakes and streams and found in ground water deposits is derived from many sources. Surface water results from precipitation

falling directly onto a water body, from precipitation which falls on surrounding land and enters the water body as runoff, and from surface discharges from ground water. In regards to quantity, only drainage basin runoff can be appreciably affected by highways.

Runoff to streams results from precipitation that falls within a certain area of the stream and flows to a river. The land area in which this process occurs is the stream's drainage basin. Drainage basins are defined by purely topographical considerations. A typical drainage basin is narrow near the mouth of a stream and gradually widens as it moves upstream to a river's origins or headwaters. The outer edges of the drainage basin are areas of highest elevation, while the stream itself represents the low point. Thus, water falling within the basin flows "downhill" to the stream. Typically, small creeks and tributaries which flow from high points in the basin to the river will form to collect overland flow. This accounts for the tree-like shape of many rivers in the area of their headwaters. The actual configuration of a stream will depend on local topographical features.

The location of a highway in a drainage basin may change natural drainage patterns. However, impacts from such drainage changes can be minimized or eliminated by good engineering design. Since highways are designed to be a local high point, adequate provision is necessary to prevent ponding and flooding. Given the advances in hydrologic analysis and careful highway design practices, such problems have been adequately handled in recent major highway construction. The NJTA design criteria and procedures reflect these advances; thus adverse flooding and ponding of local drainage due to the Expressway will not occur.

The potential impacts discussed above result from changes in the topography of the drainage basin. Highways also change the characteristics of the land surface of the drainage basin. These alterations usually result in higher streamflows and faster travel time of water from affected areas of the drainage basin to the stream.

Wooded and vegetated areas of a drainage basin offer natural storage for precipitation in the basin. When a rainstorm occurs, the first precipitation which falls is stored in surface depressions, the top layers of the soil (if it is not already saturated) and on the leaves of trees and other vegetation. Water will not appear as runoff in the basin until these storage zones are filled. The stored water which is not lost through evapotranspiration or kept in the soil will enter the stream after some delay through the ground water system. Thus, the effect of natural surfaces is to decrease and delay the amount of runoff which enters the stream.

Highway surfaces which replace the natural tree canopy and soil surface do not offer comparable storage capacity. The effect of a highway, therefore, is to increase and accelerate the runoff to the stream, increasing flood peaks resulting from large storms. In most cases, however, the amount of land area covered by the highway is small in comparison to the size of the drainage area, so that these effects are usually minimal. These changes may be more pronounced in areas

where more paved surfaces are constructed, e.g., at toll barriers, service areas and maintenance facilities. The impact of changing surface characteristics is much more extensive where major urbanization occurs. Increases in streamflows and the acceleration of runoff due to such alterations in surface characteristics may induce flooding downstream, and the impact of the change may be felt far downstream of the original land surface change.

Remedial action for such changes is in engineering design. The case of highways is simple since they cover such a small area. Such action includes: storm water storage and small dams and weirs to control the time of runoff and should be included in the highway design and maintenance schedule. This is a routine practice of the NJTA.

Filling of Wet Areas - Wet areas are low-lying, wet, marshy lands which may be valuable ecologically and for water uses such as recreation and water supply from ground water. Highway route locations which cross wet areas require filling or bridging of these areas to maintain the structural integrity of the roadway. In such situations, the changes in the wet area can be expected.

The consequences of filling wet areas on the ecology of the surroundings are discussed in other sections of this report. It is mentioned here because adverse changes in the ecological character of wet areas significantly reduce water-related recreational uses.

The filling of wet areas may also affect water supply from ground water aquifers. The appearance of low-lying marshy areas usually indicates a high water table in the area. This implies that there is hydraulic contact between the surface water and an underground aquifer. It can also be expected that the wet areas serve as a recharge area for the aquifer, i.e., water enters the aquifer from the land surface at this point. The draining of portions of a wet area and the implacement of fill materials may retard or prevent the entrance of surface water into the soil and its percolation down to an aquifer.

The character of recharge areas and their connection with aquifers is typically uncertain, so that even the use of pervious fill materials or the filling of only a portion of the area may not prevent the destruction of a portion of the recharge area. The seriousness of the impact will depend to a large extent on the sizes of the recharge area and the filled area. Limited filling should not cause any significant impact. The interstitial flow of water through the soil pores as it percolates to the aquifer is very much dependent on the specific characteristics of the local soil at the surface and at greater depths. Any changes in the existing soil or surface characteristics may greatly reduce the effectiveness of the recharge area by altering its hydraulic properties.

The problem of the filling of wet areas and its impact on ground water supplies are best solved by minimizing areas which are to be filled. Thus, the best alternative is to fill or alter as little of the wet areas as possible, decreasing the possibility of impacts on the ground water system. The specific areas where wet areas are potentially affected by the Expressway are detailed in the next section.

Road Salts and Other Wastes - In addition to changes in water quantities discussed above, highways may also change water qualities by the introduction of wastes into water resource systems. Some deterioration in water quality will occur simply because new highways bring more people and vehicles and their associated wastes into contact with water resource systems. The degree to which affected water bodies are polluted will depend on the measures taken to minimize these impacts.

Highway wastes include materials such as salt used in operation and maintenance of the roadway, litter from vehicles, and petroleum-based materials resulting from normal highway use, accidents and unintentional spills. Wastes enter the water system when they are carried off the roadway by runoff into the drainage system and eventually into a stream or ground water aquifer.

Salts used during the winter months for snow and ice control can flow directly into streams or percolate to the ground water in the nearby area through the runoff from the highway. The entrance of salt into ground water is not only a local problem. More distant aquifers can be affected through its hydraulic contact with streams which have borne highway salts from a point far upstream.

Salinity concentrations in highway runoff are the most difficult highway wastes to handle. This is due primarily to the non-existence of a practical salinity removal process. Should salt concentrations in municipal water supplies exceed certain levels, the water is no longer fit for drinking and there is no economically feasible way to make it drinkable. It should be mentioned that, although salt concentrations in highway runoff may be high, the dilution to be expected when the runoff enters a stream will result in relatively low salinity levels in the water body itself. Another factor is the apparent tradeoff between highway safety and possible deterioration of water quality. The NJTA is sensitive to these issues and is striving for ways of maintaining both objectives.

Litter (including car parts, discarded tires and other debris) is a waste created by normal highway usage. Litter will frequently be carried off the roadway by highway runoff into nearby streams. Besides the unsightliness of litter flowing in a stream, another possible problem is that it may clog drainage structures causing local ponding and flooding. This can be prevented by periodic cleaning and inspection of drainage pipes and culverts. Periodic and emergency cleaning of the highway is performed by the NJTA to collect as much litter as possible before it can enter the drainage and water systems for safety reasons as well as to protect water resources.

Petroleum based wastes are usually found on highways as they result from normal usage, spills and accidents. Gasoline and oil can be very detrimental to water and its uses. These wastes are toxic to microorganisms found in water, decreasing dissolved oxygen concentrations of the water and threatening fish, wildlife and vegetation. Furthermore, many water uses such as water supply, recreation and irrigation may suffer severe impacts.

Much of the petroleum wastes generated on highways can be prevented from entering the water system. The oil film which builds up on the roadway from normal usage and is washed away by precipitation probably cannot be controlled. However, these quantities are usually small and have little impact on stream quality. Wastes which result from spills by oil and gasoline trucks and which represent a more serious threat to water quality can be controlled. The NJTA procedure is to sand and sweep rather than flush accidental spills which prevents contamination of water bodies.

Location of Service Facilities - The major potential impacts from highway service areas are the effects of large paved surfaces and the high volume of sanitary sewage flows generated at the areas. The effect of paved surfaces was previously discussed in the section of changes of land surface area. Briefly, large paved areas, such as service area parking lots, make the runoff process "faster", resulting in higher peak flood flows in nearby streams. This is easily remedied by sound engineering practice.

Sanitary sewage flows from service areas can be expected to be large due to the thousands of people daily using rest room facilities. If sewer systems are not available for discharge of these wastes, treatment before it is discharged to streams should be performed. Recommended treatment would be at least secondary treatment with land spraying of the effluent or tertiary treatment. The provision of this type of treatment at service areas is the policy of NJTA and will prevent impacts from sanitary wastes to the surrounding surface waters.

Gasoline and oil storage at fuel stations in service areas are subject to the same NJTA procedures mentioned in the previous section.

Maintenance Areas and Storage of Materials - The major potential problems to be expected from maintenance areas are from the accidental introduction of wastes and stored materials into water systems. The NJTA has instituted provisions to keep waste oils and solutions of washing compounds out of drainage facilities. Salt, fill materials, fuels and oils are routinely stored carefully to prevent contamination of nearby water bodies. These precautionary procedures are reinforced by training and supervision of employees.

GENERATED DEVELOPMENT

While this report in another section shows there will be little generated development due to the Expressway, development due simply to population increases are to be expected for the future. Such development has two types of impacts on water resources: it changes topographic patterns and thus can increase flood risk, and it can seriously affect the quantity and quality of water available for water supply, waste disposal, recreation and other water uses. Whether the highway is built or not, orderly plans for dealing with such development in order to protect water resources must be provided by the governmental units involved.

The Effect of Urbanization on Hydrology -As noted, natural topography has built in storage for rain water falling on it in the perviousness of the soil and the retentive ability of vegetation. This slowing of the collection of runoff is valuable in flood reduction. An increase in population means that parts of the pervious surface are lost to pavement, roof tops and other surfaces that keep water out of storage and force it to collect faster. Thus with loss of storage, there will be higher flood peaks for given storms and flooding will occur more often.

In most metropolitan areas, because of increased imperviousness, this syndrome of increased incidence of flooding has been readily observed. What is more, with more people living in the area, the damage caused by flooding becomes even greater.

There are several ways to deal with such a problem. One impractical method is to try and keep people and development out. In our society, this does not currently seem to be a viable alternative. Another alternative that is very expensive is to build extensive flood control works and stream channelization which will essentially concrete over all the river beds. A much better alternative, as in so many cases in water resources, is careful planning and zoning so that population and development can be spread over the land to limit impacts. Flood plains could be zoned for non-structural use or structures built in flood plains could be "flood proofed" so that water would not cause serious damage (i.e., first floor parking areas rather than expensive shops). The drainage area could be zoned to insure that as much ground as possible is left pervious. Additional upstream storage in terms of small aesthetically pleasing ponds also could slow flooding problems. Only carefully planned development can avoid major water resource impacts.

Water Quantity and Quality - Usually urban storm water runoff has been thought of as being relatively clean and thus it is not necessary to treat it as waste water. However, due to increasing pollution of all forms, investigators such as Weibel (1966) have found urban storm water runoff to be as contaminated in some respects as sanitary sewage. This provides a new pollution source. In addition, more people mean more waste water from municipal and industrial use. It is important to note that the environment has only a finite assimilative capacity which will be harder and harder to keep from violating as such pressures increase. Expensive treatment for municipal and storm flows will become more and more common.

Urbanization as mentioned above also has profound affects on water supply. With more impervious surface on the ground, water is kept out of the ground and moved swiftly along the surface out of the region. Thus it is no longer available for use in the region. Ground water recharge becomes more difficult and the water recharging may be contaminated.

Since all water supply in the area under study is now from ground water, increased urbanization may cause problems in quantity and quality of recharge to aquifers. Major changes in waste disposal will become necessary with increased population as present individual systems which work well in rural environments will be replaced by sewers and central waste treatment facilities. Careful study of the implications of development on flooding, water supply and waste water disposal problems in the future must be made. It is clear that uncontrolled, unmanaged growth can have direct water resources impacts. It is also clear in many cases that careful preparation now can limit major impacts later.

Again, it must be emphasized, the above potential problems are to be expected with the urbanization and development of the area whether the highway is built or not. Only successful land use planning, facility construction and resource evaluation ahead of time will help in easing the problems of increased resource requirements and topographical changes caused by such development. Responsible governmental agencies must plan for this transition as soon as possible to insure that it can take place with a minimum impact to the water resource system.

IDENTIFICATION AND ANALYSIS OF POTENTIAL IMPACTS

Potential Impacts Which Are Not Site Specific

Certain potential impacts to water resources of highway building are associated with the physical act of placing an engineered structure into a natural landscape and they are relatively independent of where the highway is located within a region. For this reason, such impacts will be discussed here first before addressing the issue of site specific impacts. In most cases, the character and force of the potential impacts can be greatly moderated by recognizing the potential ahead of time and establishing design and operational procedures to handle them.

Water Quality Problems During Construction - One major cause of water quality problems during construction is erosion and excess sediment to streams. The nature of the impacts and means for limiting them have been previously noted. The New Jersey Turnpike Authority's (NJTA) present procedure of requiring contractors to provide for temporary control measures and to take care of exposed surfaces is to be greatly commended. It is recommended that such procedures be part of any contract let for this new road portion as it normally does. In addition, the NJTA is currently evaluating the Federal Department of Transportation's requirements for federally financed roads which are somewhat more stringent, particularly with respect to the maximum amount of land to be cleared at any time.

Crossing of streams by equipment should be avoided if at all possible and kept to an absolute minimum. Temporary dams created to allow construction should be approved ahead of time by the NJTA and completely removed as soon as possible. Debris of any form should be kept out of streams. Adequate provision for sanitary wastes during the construction period is routinely made.

Water Quality Problems During Operation - In order to keep fuels and other petroleum derivatives out of storm water drainage, several strategies are employed. First, routine maintenance of vehicles should be done only in designated areas where special waste traps are available and used. Personnel must be told that a storm sewer is not an appropriate place to get rid of waste oil. Procedures for dealing with accidental spills should also be developed to keep foreign material out of water resources. New oil gathering materials might be used instead of flushing the spill into the water resource system. In actual critical areas, special settling tanks can be built. These recommendations are already established procedures for existing NJTA facilities.

Water Quality Problems at Maintenance and Service Areas - Adequate and careful sewage treatment of sanitary wastes at service areas must be accomplished. Water from routine repair and maintenance work should be adequately treated. These procedures are discussed in more detail in the previous section on general highway impacts; the existing NJTA policy includes many of these procedures.

Adequacy of Storm Drainage - The highway design will provide for adequate passage of local drainage to insure that adverse local ponding of a long-term nature will not occur and that flooding potential in surrounding areas is not increased. Design criteria and procedures and review of drainage plans by state administrative agencies will insure adequate drainage design.

Route Specific Potential Impacts

In this section, potential impacts that are directly reflected to the chosen preliminary route location on water resources are indicated. All discussion is referenced to the ten sheets (Figure 13) which define the route on airphoto maps with Sheet 1 starting at the southernmost end near Toms River and with Sheet 10 terminating at the northernmost end at the joining of the proposed route with the New Jersey Turnpike near Exit 8A. Data sources used in preparation of this critique were:

1. Airphoto maps of the route -- approximate scale: 1" = 2000'
2. Topographic maps derived from the United States Geologic Survey (USGS) maps -- scale: 1" = 2000'
3. Reports on surface water quantities and quality published by the USGS
4. Data on surface water quality collected by the Department of Environmental Protection, State of New Jersey
5. Ground water quantity reports published by the Department of Conservation and Economic Development, Division of Water Policy and Supply with cooperation of USGS
6. Ground water quality from USGS and State agencies
7. Data on proposed alignment, cutting, filling, drainage and location of facilities from Howard, Needles, Tammen, and Bergendoff, Consulting Engineers
8. Flood Plain Definition report by the Department of Environmental Protection in cooperation with the U. S. Army Corp of Engineers
9. Field Observations and Personal Interviews

Although the formal study area is only a narrow corridor, it must be continuously stressed that the nature of water resource systems is such that impacts may be felt well beyond these boundaries. It is necessary to consider areas outside as well as inside the corridor. It should also be noted that certain types of water resource changes are inevitable from highway construction which requires that maximum effort be made to moderate such changes through corrective measures, careful planning and established operational procedures.

As discussed previously, there is a difference between changes and impacts. In the next section, changes will be outlined and evaluated as to potential impact by addressing the following questions:

1. Is the change profound in its potential consequences in that it interferes with other water uses or increases the danger of flooding?

2. Will all that is feasible be done to ameliorate any external effect through design change, treatment, operation, etc.?

In the case of the Expressway, reasonable answers to both of these questions are evident and the direct impact of the highway on water resources is minimal. There are some sensitive areas, however, where future development, whether or not the highway is built, will cause water resource impacts which can be minimized by successful planning and anticipation. In these situations, the magnitude of the highway impact in the total problem is uncertain.

Also, many times there are changes in water resource related objects such as vegetation, wildlife and ecologic systems, while the water resources themselves are usually not hurt. These are considered in appropriate sections in this report. This section is limited to impacts on particular water uses such as recreation, water supply, etc. and to physical problems such as flooding. Only in the case where vegetation, etc. are encompassed in recreation are such impacts specifically noted.

Sheet 1: Main Branch of Toms River Crossing to North of Oak Ridge Parkway - The Toms River crossing will be built with the existing Garden State Parkway. The river crossing will be over an existing bridge which will require structural modification. There is potential temporary water pollution during construction from construction materials entering the Toms River. This will probably not be serious, but every precaution as mentioned in the sections on construction practices above should be followed. Experience at the existing crossing has been that no flooding problems due to the bridge structure have been encountered and no new problems are anticipated.

Moving north from the bridge to the end of the joint roadway, the highway continues to share the alignment with the Garden State Parkway. Expansion of this segment of the highway is not expected to create any problems.

North of the river crossing the proposed alignment runs east of and parallel to the Toms River. The highway is generally 1000 to 2000 feet from the river. Drainage in the area is from the east across the highway to the Toms River. Since the highway in this area is in fill (from 1 to 6 feet) it serves as a natural barrier for runoff from the residential areas to the east. Drainage structures are provided to allow passage of this water through the alignment and appear adequate. The location of the alignment relatively close to the Toms is sufficiently high so that flooding in the Toms is not affected. Furthermore, as indicated by Anderson and Appel (1969), the flows in this reach of the main branch of the Toms are appreciably less than those observed downstream of the confluence of the main branch with the Ridgeway Branch. Here the measured mean flow is only 210 cubic feet per second, 70 percent of which is base flow from ground water sources.

Since the Toms has significant hydraulic contact with the water table aquifer used as municipal water supply for Toms River, great care should be exercised to keep salts, petroleum based wastes and other road wastes in the highway drainage at minimum levels. Existing water quality in the Toms below this point is generally very good. Anderson and Appel (1969) indicate that the general relationship between the aquifer and the Toms River is that ground water flows to the surface water; and this is rarely reversed, but this can occur in times of extremely high river flow.

Sheet 2: North of Oak Ridge Parkway to Grass Hollow Branch of Toms River - The alignment continues to parallel the Toms River on its eastern bank and to be a barrier to drainage from the east. The closest contact between the highway and the river, 200 feet, is observed here with the highway and original ground level at an elevation of 43 feet and the stream at an approximate elevation of 20.5 feet. Again, drainage through the alignment appears adequate and the road will not create any increased flooding potential for the Toms. Care should be taken in limiting water quality impacts of storm drainage from the highway to the Toms.

The Albocondo camp grounds are to the east of the Toms and to the west of the highway. Drainage from the highway is routed through a small, unnamed tributary which flows to the ponds located in the camp grounds. Care should be taken to preserve quality levels in these water bodies. Just north of Albocondo camp grounds is the "K.O.A." campgrounds. This area, however, is located to the west of the Main Branch of the Toms River so that no impact to its water will occur.

The alignment crosses several branches and unnamed tributaries of the Toms including the Grass Hollow Branch and the Slab Branch with drainage provided under the roadway. Care should be taken in construction to minimize excessive erosion and other water quality impacts. A small pond of about one-half acre surface area is to be filled by a ramp at Route 571. Riverwood Park is located at Hyers Road and lies between the alignment and the Toms. Some drainage from the highway will go through a small stream at the lower end of the park

and via the Slab Branch at the upper end. All drainage from the highway in this three-quarter mile stretch is routed through the southern end of the park. At the Slab Branch, there are major cut sections on either side of the structure carrying the stream under the highway and wet areas directly downstream of the highway crossing. Runoff from the road will enter this system. A toll plaza is planned between the Route 70 crossing and the Grass Hollow Branch. Special consideration will be given to any additional runoff contaminants and sanitary facilities at the plaza. At the Grass Hollow Branch crossing, a three-quarter acre surface area pond is filled.

Sheet 3: Grass Hollow Branch to West of Route 547 - The alignment continues to parallel the Toms River to the east of the River. There is little water resource activity in the lower area. Southeast of the intersection with the Central Railroad tracks, a very large working gravel pit is found. There is a sanitary landfill for the City of Lakewood in one of the abandoned pits. No water resource impact from the highway will be seen in these facilities.

A small unnamed branch of the Toms River is crossed just south of Whites Road and adequate drainage is provided through the alignment.

Sheet 4: West of Route 547 to VanHiseville-Bennetts Mills Road - Just west of Hope Chapel Road another small tributary of the Toms is crossed which runs to a five acre surface area pond 500 feet west of the alignment. This stream and pond will receive runoff from the highway and impacts are possible if any impurities enter the highway drainage.

At Route 527 another stream crossing occurs. In this case, the stream is an unnamed tributary of the Dove Mill Branch of the Toms River and it drains several gravel pits and a small pond to the east of the roadway with little impact caused by the highway. Further north, cranberry bogs are located directly west of the roadway, and the highway drainage is established to send storm runoff directly to these bogs at several points (sketched on Sheet 4). This means that any highway contaminants in storm water drainage will enter the bogs. In addition, cranberry bogs require strict control of inflows and this drainage change will disrupt traditional patterns. Thus, there will be highway impacts on the usefulness of the bogs unless engineering measures are made to prevent them.

Butterfly camp grounds will not be affected by the highway. Drainage from a large housing development at Bennetts Mills and Fish Roads to the east crosses the highway and drains to a small one-quarter acre pond which will also receive highway drainage. Little impact is anticipated.

Sheet 5: From VanHiseville-Bennetts Mills Road to the North Branch of the Metedeconk River - At Bennetts Mills Road, the division of drainage between the Toms and the Metedeconk River occurs. Now water flow is generally from west to east whereas previously it was the opposite. The Estonian Youth Camp on the west is not affected as its drainage is towards the highway.

The South branch of the Metedeconk River is crossed with a bridge. East of the highway a major wet area is located which does receive drainage from the highway. The highway construction practices will be difficult as a major cut is planned in this area. The wetness is attributed to two unnamed tributaries of the Metedeconk which flow from north to south with the highway alignment in between them. Some channelization will be required for the streams which will increase flood peaks somewhat. Further, construction is taking place in wet areas with its attendant difficulties, particularly in destruction of habitat. Also, highway storm drainage will find its way to the wet areas and bring any contaminants from the highway. At Interstate 195, one of the small streams is directly at a proposed intersection and interchange between the two roads. It will have to be channelized and routed through this area. This means a major change in natural stream embankments and a faster potential flow. In addition, storm drainage from the highway will enter, but flooding problems are not significant.

The entire area from the South Branch of the Metedeconk north to Interstate 195 is characterized by wet areas and river tributaries. Extensive channelization and changes in topography are to be carried out.

Just north of the Ocean County-Monmouth County line, a tributary to the North Branch of the Metedeconk is crossed with a design flow of approximately 115 cubic feet per second; little flooding problems are anticipated.

Sheet 6:North Branch of Metedeconk River to Route 537 - The highway is bridged across the North Branch of the Metedeconk and the stream is channelized. There will be no flooding problems. At the intersection with Georgia Road, a small stream which flows from west to east to the Manasquan River is crossed with no effect.

To the west, a major recreational and wildlife area, Turkey Swamp Park, is located. It is higher than the highway and hence no highway drainage will reach the swamp and there will be no impact on the Park. Low wet areas to the west of the roadway, between the roadway and the park, drain through the roadway with no effect.

The roadway is bridged across the Manasquan River. Again, the usual caveat about construction practices and the quality of highway storm drainage must be made. No major changes are foreseen if correct procedures as previously outlined are followed.

Just north of Route 524 a small tributary of the Manasquan, which flows from west to east, is crossed; and just north of Iron Bridge Road, another small tributary of the Manasquan is crossed. In both cases little change is foreseen.

Sheet 7:Route 537 to Taylors Mills Road - North of Route 537, the drainage area crossed by the alignment changes from the Manasquan to the Manalapan Brook with water changing direction to flow towards the northeast.

A small pond to the east of the roadway is part of the headwaters of the Manalapan and receives drainage from the highway through 42" and 36" drainage structures. The orchard in this area is being bisected by the highway with the water resources to the west of the highway being unaffected as drainage is away from it.

North of Gulley and Kinney Roads, a pond which is in the headwaters of the Manalapan is completely filled; an upstream pond to the east is drained through the roadway by a 5 x 10 foot box culvert. The impact here is in the destruction of a pond and the potential contamination of downstream wet areas by highway runoff. The pond filled offered some degree of storage and control for downstream flow in the Manalapan, which is now lost. This change is minor because of the small area of the pond in relation to the entire Manalapan headwaters, and because of the relatively low flows observed in that area.

North of Route 33 and east of the alignment, the Monmouth Battlefield and its main water resources feature, Wemrock Pond and Weamaconk Creek, are passed. There is no impact of the highway on these features as they drain away from the highway at this point. Another small stream flowing to the Manalapan is crossed for which a drainage structure should be provided.

Where service areas are proposed adequate sewage treatment, control of maintenance wastes and runoff from the large impervious areas will be provided to protect against impacts. At the point where the Pennsylvania Railroad tracks cross the alignment, the highway bridges over the tracks and the Weamaconk Creek. The usual construction precautions are necessary and flooding problems are not likely. Any maintenance area should be carefully designed to keep oils and salt as well as maintenance materials out of the water resource system.

Sheet 8: Taylors Mills Road to Barclays Brook - The highway now has considerable residential development on both sides with drainage going through the highway with little impact. Pine Brook, a tributary of the Matchaponix, is bridged and channelized with little impact on the water resource. From this point to the Raceway, there are no water resource problems. The Raceway which is west of the alignment has a 13-acre surface area pond and associated wet areas which are very close to the highway and drainage from the highway will enter it. There will be changes only if excessive contamination of highway storm water occurs.

Now an area rich in water resources is entered with several small streams and private fishing grounds in the immediate proximity. Tributaries of Barclays Brook, which flows to the Matchaponix, will be channelized and rerouted and will receive storm drainage from the highway. In particular, the ramp for Route 520 will require a 40' channel to reroute Barclays Brook around the proposed interchange. Impacts on natural topography, land surface and habitat are expected, as well as some water quality deterioration.

Sheet 9: Barclays Brook to West of Spotswood-Gravel Hill Road - Barclays Brook continues to flow along the southern edge of the highway which is now moving east and west. This means channelization and continued storm water impacts. The highway bridges the Matchaponix near its confluence with Barclays Brook and a small unknown tributary. Again, the extensive channelization of both streams in this area has possible aesthetic and water quality potential impact. A small pond of one-half acre surface is filled to the west as well. A sanitary landfill is found south of the alignment and east of Spotswood Gravel Hill Road; there will be little impact on it.

Sheet 10: West of Spotswood-Gravel Hill Road to the New Jersey Turnpike - Just east of the Borough of Helmetta, a bridge over the Manalapan Brook is provided and the stream is channelized. The Manalapan flows to the northeast to its confluence with Matchaponix Brook. Together, the two streams form the South River which flows to the Raritan River and eventually to Raritan Bay. This channelization of the Manalapan -- along with the crossing and minor filling in the headwaters of Manalapan Brook (Sheet 7) and the extensive channelization and crossings of Matchaponix Brook and its named tributaries: Barclays Brook, Pine Brook, Milford Brook and McGellairds Brook, as well as other unnamed tributaries (Sheets 7 and 8) -- indicate that the flow regime in these streams and in the South River may be changed.

Historically, salinity intrusion in the South River and the resulting encroachment of salt into the Old Bridge Sands has retarded development of this large aquifer (Appel, 1962). The pumping of groundwater that has occurred in this area has resulted in a gradual inland movement of salinity into the aquifer. Future development including flood protection, increased water supply and extensive urbanization in the area will result in increased groundwater pumping and further pronounced changes in local drainage patterns. These factors may result in further inland migration of salinity in the aquifer. Changes in flow regime in Manalapan and Matchaponix Brooks resulting from the highway will be minor in comparison to the effects of this future development.

Although the highway impact may be small, relative to the effects of development, changes in flow regime may add to the problem of salinity intrusion. However, existing storage capacity at Devoe Lake Dam on the Manalapan two miles downstream of the highway crossing and at Duhernal Lake Dam on the South River and the proposed tidal dam on the South River would all tend to decrease and possibly negate any changes in flow regime induced by the highway.

Directly to the west of Helmetta and the Manalapan is a potentially important ground water recharge area and wet area for which proposed Jamesburg Park is planned. The highway alignment crosses wet areas and then climbs a very steep wooded hill. This is accomplished by filling in the wet areas to 15 to 20 feet and followed by 15 to 20 foot cuts.

It is most probable that the area provides recharge for the groundwater aquifers of the Old Bridge Sands from which Helmetta, Jamesburg and other communities in the area derive water supply. Furthermore, the full water supply potential of this aquifer has not been attained in part due to the uncertainty of the effect of development on salinity intrusion into the aquifer. It is difficult to predict the effect of taking a relatively small area of this recharge area by the highway, particularly when the highway divides the area with considerable barriers in the form of cuts. Extremely careful construction practices must be followed with full boring tests to define where the water table is. It may become necessary to change the deepness of cuts if groundwater is found in abundance. The NJTA will carefully supervise construction in this area, and if necessary, change the alignment or depth of cut if it is apparent there are groundwater problems.

The Borough of Helmetta should carefully consider whether further industrial development in this area it has proposed will impact on water resource problems. The current controversy in Helmetta over the effect of the previous draining of Helmetta Pond by the Helme Company on groundwater levels and quality should be studied by the Borough to see if there is a major cause and effect relationship. It should also be mentioned that even if filling or cutting does not take place in the recharge areas, highway drainage will still reach them with possible water quality problems unless appropriate safeguards as outlined previously are applied.

At the intersection with the New Jersey Turnpike, one ramp will be located in the flood plain of Ireland Brook, a tributary of Farrington Lake, in a proposed park and flood plain management zone. No significant water resource impact is anticipated.

Summary of Water Resources Impacts

The impacts which are pertinent to the Expressway are summarized below and have been previously listed in the text. Seven local and largely avoidable impacts have been identified; the first six are not route specific:

1. Sediment effects on streams and recharge areas.

2. Petroleum based materials from vehicle operation and other materials from accidental spills entering highway storm drainage systems.

3. Snow and ice control chemicals which enter local water bodies.

4. Sewage treatment and waste control at service and maintenance facilities.

5. Minor flooding and ponding due to changes in natural drainage, including changes in flow patterns at cranberry bogs to which they are sensitive.

6. Construction procedures in terms of erosion control, disposal of waste materials, management of cuts and fills and provision for sanitary wastes.

7. The crossing of the South Branch of the Metedeconk River and the area north to I-195. The channelization and filling of wet areas should be carried out with care to avoid local and downstream changes in hydrologic and quality conditions.

In addition, there are two areas which are very sensitive in water resource aspects to general development expected in the future of which the Expressway is only a part. These areas are:

1. Proposed Jamesburg Park area - here plans for industrial development and a large highway cut through an identified but undelineated recharge area which could have impacts on groundwater availability and quality. The precise contribution of the highway cut is not currently measureable but may contribute to any future problems that may occur. Extremely careful construction practices and supervision will be employed to guard against highway impacts.

2. Manalapan and Matchaponix Brooks - development in terms of residential and commercial land use, increased groundwater pumping and stream channelization can lead in the future to changes in flow regime in the South River and hence increased salinity intrusion in the South River and the Old Bridge Sands aquifer. The contribution of the highway to this extensive potential future impact will be minimal compared to that caused by other development in the area.

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IMPACT OF THE GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY ON NATURAL RESOURCES

INTRODUCTION

The impact of the Governor Alfred E. Driscoll Expressway on Natural Resources is divided into seven sections according to the subject areas investigated:

Topography
Geology
Soils
Cranberry Bogs
Vegetation
Wildlife Populations
Aquatic Life

Each section describes the inventory methods and assumptions, the data sources (including published literature) and field surveys conducted specifically for this study. The impacts are discussed and conclusions and recommendations are made. The inventories for geology, soils and vegetation are graphically displayed for the entire alignment.

A final section presents the Conclusions and Recommendations for the natural resources part of the study.

Several potentially adverse environmental impacts have been identified from the analyses of cranberry bogs and vegetation. The Beauty Bogs, Iron Bog, and Bunker Hill Bogs in Jackson may be adversely impacted by sedimentation, water pollution, and alteration of water flow as a result of the construction of the proposed alignment. Several steps can be taken to minimize the effects. The possibility of damage from accelerated sedimentation virtually can be eliminated by the use of careful construction practices in this area of low relief. The potential for adverse impact from an alteration in water flow in Sandy Hollow can be minimized by good drainage design.

Many areas of low land forest and bog, and one sensitive upland forest, will be impacted severely by the proposed alignment. These types occur primarily in areas in which the alignment parallels streams or passes through extensive lowlands in headwater regions. Consideration should be given to the use of special design and construction techniques in these areas. Many less extensive areas of sensitive vegetation along the alignment could be damaged or destroyed. A variety of special design and construction techniques can be utilized to minimize these impacts.

The analyses of topography, geology, soils, and aquatic life did not identify any specific adverse impacts. Recommendations are made, however, as to sensitive conditions which may warrant special design considerations as a part of the detailed engineering design studies. It is anticipated that there will be certain adverse impacts on wildlife populations along the proposed alignment.

TOPOGRAPHY

Information on the topography of the proposed Expressway route was drawn largely from maps provided by the firm of Howard, Needles, Tammen, and Bergendoff. The terms "valley-feet" and "divide-feet" refer to distances measured along the axis of a valley or divide. Lengths of stream channels were not measured. Because most of the streams have many meanders, stream channels usually are considerably longer than their valleys. All other measurements of distance are straight-line map measurements.

The descriptions give the location and elevation of the highest point on each drainage divide, as well as the directional trend of the divide. The gradient of a part of the divide axis also is given. Descriptions of watersheds contain the gradient of the major valley. In most cases the gradients of two watershed slopes (one from each side of the major valley) are given. These figures are intended to convey a general notion of local topographic patterns but are not statistically descriptive of slopes in the vicinity of the proposed alignment.

The proposed Expressway route lies in the eastern section of the New Jersey Coastal Plain. The surface of this region is essentially flat, and has a gentle slope to the southeast, normally from 5 to 6 feet per mile. The surface of the Coastal Plain is nowhere more than 400 feet, and generally is less than 200 feet, above mean sea level (Kummel, 1940).

Local topography in the vicinity of the alignment primarily is a function of drainage patterns. Major channels generally trend in the direction of the regional slope (southeast). Tributary channels show little evidence of structural control so that, taken together, major and tributary channels form a dendritic (treelike) drainage pattern. Consequently, major drainage divides generally trend from southeast to northwest, and numerous small divides branch from the major divides.

The present degree of local relief and land surface slope in the eastern section of the Coastal Plain is primarily a function of post and present interactions among factors of (1) regional relief, (2) geology, (3) climate, and (4) vegetation. The small regional relief severely limits the amount of hydraulic energy available for erosive work. Neither the strata of soft clay nor the strata of poorly consolidated sand normally support steep slopes. In addition, these strata apparently do not erode differentially to any significant degree. The sand strata commonly are permeable; large amounts of water infiltrate into some of these strata and consequently cannot contribute to the erosive work done by flowing surface water. The climate of the region is temperate, humid and regular over large areas; consequently, mechanisms of weathering and earth movement tend to produce rounded landforms. Extensive vegetation stabilizes slopes and otherwise minimizes the erosive impact of precipitation and flowing surface water. All of these factors combine to give a landscape of little relief and gentle slopes. Both stream valleys and divides tend to be relatively wide and flat.

DETAILS OF LOCAL TOPOGRAPHY

The proposed Expressway route crosses sections of five large watersheds. The northernmost part of the route crosses a part of a sixth, smaller watershed. Some of the topographic characters of each of these watersheds and the five divides which separate them are described below. The descriptions apply only to those portions of the watersheds and divides which are covered by aerial photographs supplied by the firm of Howard, Needles, Tammen and Bergendoff. The descriptions are sequential from north to south.

The watershed of Ireland Brook occupies a small area at the northernmost end of the proposed route. Ireland Brook is a tributary of Lawrence Brook, which is in turn a tributary of the Raritan River. The stream flows predominantly west. At a point just west of Beth Abraham Cemetery, the elevation of Ireland Brook is between 80 and 90 feet above sea level. At the intersection of the brook and the New Jersey Turnpike, 6,400 valley feet away, the elevation of the brook is between 70 and 80 feet. The valley gradient between these points, therefore, is about 8 feet per mile.

A high point at the southern margin of the watershed, just east of the intersection of Cranbury and Dunhams Corner Roads, has an elevation of more than 150 feet. The distance between this point and the point at which Ireland Brook is crossed by the Turnpike is about 6,100 feet; the gradient between these points is about 61 feet per mile.

The Ireland-Manalapan Divide separates the watersheds of Ireland Brook and Manalapan Brook. The divide generally trends from northeast to southwest. About 2,000 feet north of Gillandtown on Fern Road, the divide is more than 150 feet above sea level. Just east of the intersection of Cranbury and Dunhams Corner Roads, the divide begins to slope downward; 10,500 divide-feet away, near the intersection of the New Jersey Turnpike and Brown's Corner Road, the elevation of the divide is between 90 and 100 feet. The divide gradient between these points, therefore, is about 30 feet per mile.

The watershed of Manalapan Brook occupies a relatively large area between the towns of Jamesburg and Spotswood. Manalapan Brook is tributary to South River, which is in turn tributary to the Raritan River. Manalapan Brook flows predominantly northeast. At a point about 2,000 feet southeast of St. James Cemetery, the elevation of the brook is about 40 feet above sea level. Near the upstream end of De Voe Lake, 20,300 valley-feet away, the elevation of the brook is 20 feet. The valley gradient between these points, therefore, is about 5 feet per mile.

In the northern half of the watershed, at a point near the intersection of Helmetta Boulevard and Cranbury Road, the elevation is over 150 feet. Near Helmetta pond, 3,000 feet away, the elevation is about 50 feet. The gradient between these points is about 176 feet per mile.

In the southern half of the watershed, at a point about 8,500 feet east of Jamesburg on Pergola Avenue, the elevation is over 100 feet. At a point just south of Manalapan Brook near Helmetta, 8,000 feet away, the elevation is about 40 feet. The gradient between these points is about 40 feet per mile.

The Manalapan-Matchaponix Divide separates the watersheds of Manalapan Brook and Matchaponix Brook. The divide generally trends from northeast to southwest. About 2,000 feet west of the State Home for Boys, the divide is more than 120 feet above sea level. Approximately 18,000 divide-feet away, in the southwestern section of the town of Spotswood, the elevation of the divide is about 30 feet. The divide gradient between these points, therefore, is about 26 feet per mile.

The watershed of Matchaponix Brook occupies a large area north, east and south of Englishtown. Matchaponix Brook is tributary to South River, which is in turn tributary to the Raritan River. Matchaponix Brook flows predominantly northwardly. Wemrock Brook, a secondary tributary of Matchaponix Brook, has an elevation of about 140 feet at a point just south of Wemrock Pond west of Freehold. About 50,000 valley-feet away, at a point just east of the town of Texas, the elevation of Matchaponix Brook is less than 40 feet. The valley gradient between these points is about 11 feet per mile.

In the western half of the watershed, at a point about 8,500 feet east of Jamesburg on Pergola Avenue, the elevation is more than 100 feet. About 14,000 feet away, at a point just east of the town of Texas, the elevation is less than 40 feet (about 23 feet per mile).

In the southern part of the watershed, at a point just south of Wemrock Pond, the elevation is about 140 feet above sea level. About 2,500 feet to the southeast, the elevation is over 200 feet. The gradient between these points, therefore, is about 127 feet per mile.

The South River-Manasquan River Divide, which separates the watersheds of tributaries to the South River (Manalapan and Matchaponix Brooks) from the watershed of the Manasquan River, is the division between basins which slope to Raritan Bay and those which grade directly to the Atlantic Ocean. The divide generally trends from southwest to northeast. West of the town of West Freehold, at a point 2,500 feet northwest of Route 537, the divide is more than 210 feet above sea level. This is the highest point in the vicinity of the proposed Expressway route. Approximately 2,500 divide-feet away, at a point about 0.4 mile southwest of West Freehold on Route 527, the elevation of the divide is 170 feet. The divide gradient between these points is about 84 feet per mile.

The watershed of the Manasquan River occupies a relatively large area southeast of Freehold. The river flows predominantly to the east. East of Smithburg, at a point about 0.7 mile south of Route 524, the elevation of the Manasquan River is 100 feet above sea level. About 9,600 valley-feet away, the channel is situated at an elevation of 90 feet. The valley gradient between these points is about 6 feet per mile.

In the northern half of the watershed, at a point west of West Freehold and 0.47 mile northwest of Route 537, the elevation is more than 210 feet. Approximately 10,600 feet away, at a point east of Smithburg and 0.7 mile south of Route 524, the elevation is 100 feet. The gradient between these points is, therefore, about 55 feet per mile.

In the southern half of the watershed the elevation is more than 140 feet at a point about 1.1 miles west of the town of Georgia. About 7,500 feet away, at a point on the Manasquan River 0.6 mile south of Route 524, the elevation is less than 100 feet. The gradient between these points is about 28 feet per mile.

The Manasquan River-Metedeconk River Divide generally trends from northwest to southeast. At a point 1.1 miles west of the town of Georgia, the elevation of the divide is more than 140 feet. Approximately 9,100 divide-feet away, at a point about 0.3 mile southeast of Georgia, the divide is situated at an elevation of 120 feet above sea level. The divide gradient between these points is about 12 feet per mile.

The watershed of the Metedeconk River occupies a large area around the village of Harmony. The flow of the river predominantly is to the southeast, and it ultimately drains into the northernmost section of Barnegat Bay. At a point 0.19 mile southeast of Jackson's Mills, the South Branch of the Metedeconk River has an elevation of 90 feet. About 13,200 valley-feet away, at a point about 0.38 mile northwest of Bennetts Mills, the Metedeconk channel is at elevation 60 feet (about 12 feet per mile).

In the northern half of the watershed, at a point 1.1 miles west of the town of Georgia, the elevation is more than 140 feet. At a point 2,800 feet due south the elevation of the North Branch of the Metedeconk is about 110 feet. The gradient between these points is about 57 feet per mile.

In the southern half of the watershed, at a point about 0.38 mile southwest of Bennetts Pond, the elevation is more than 160 feet. Approximately 1,000 feet away, at the southwestern edge of Bennetts Pond, the elevation is less than 70 feet. The gradient between these points is about 475 feet per mile.

The Metedeconk River-Toms River Divide trends from northwest to southeast. At a point about 0.38 mile southwest of Bennetts Pond, the elevation of the divide is more than 160 feet above sea level. Approximately 6,400 divide-feet to the southeast, the divide is slightly more than 140 feet above sea level. The divide gradient between these points is about 17 feet per mile.

The watershed of Toms River occupies a very large area, from near the village of Holmansville to beyond the town of Toms River. Toms River flows predominantly to the southeast, and also drains into Barne-

gat Bay. At a point about 0.95 mile southeast of Holmansville, the Dove Mill Branch of Toms River is at an elevation of 70 feet. About 60,000 valley-feet away, at a point about 0.38 mile east of the town of Toms River, the channel of the Toms River has an elevation of less than 10 feet. The valley gradient between these points is about 5 feet per mile.

In the eastern half of the watershed, at a point near the town of South Lakewood, the elevation is more than 120 feet. Approximately 7,400 feet away, at the point where the Toms River is crossed by the Central Railroad of New Jersey, the elevation is slightly more than 50 feet. The gradient between these points is about 50 feet per mile.

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GEOLOGY

This report on the geology of the proposed Expressway route is divided into eight parts, including the introduction. A set of geologic maps (Figure 14) and stratigraphic section (Table 13) are included.

The second part, "Methods", discusses the sources of information, the means by which the information was assembled, and the limits of accuracy of some of the information.

In the third part, "General Geology", a number of general aspects of the history, lithology, structure, and distribution of rocks along the proposed route are discussed briefly.

The fourth part, "Descriptions of Formations", gives short descriptions of individual formations and formation members.

The fifth part, "Resources", describes economically valuable rock units. Hydrogeologic resources are described elsewhere in this impact assessment.

The sixth part, "Other Features", deals with some important features which are not discussed under "Resources."

The seventh part, "Discussion", is an evaluation of the environmental impact of the proposed route.

METHODS

Data for the geologic maps of the proposed Expressway route were obtained from geologic overlays for New Jersey Topographic Atlas Sheets 28, 29, and 30 (New Jersey Department of Environmental Protection, Bureau of Geology and Topography. Unpublished maps.) These data were transferred to Expressway topographic maps provided by the firm of Howard, Needles, Tammen, and Bergendoff. The data were then transferred from the Expressway maps to mylar overlays.

Two conditions complicated the transfer of data: (1) the transfer involved a change in scale, and (2) the topographic and drainage patterns shown on the Atlas Sheets differed in some particulars from the topographic and drainage patterns shown on the Expressway maps. The change in scale was initially accomplished using a combination of grid overlays and prominent reference points (bench marks, roads, bridges, municipal boundaries, lines of longitude and latitude, ridge tops) as controls for the data points. The resulting locations of geologic features were adjusted to conform to topographic and drainage patterns shown on the Expressway maps. Most of these adjustments involved small displacements of contact lines along narrow stream valleys.

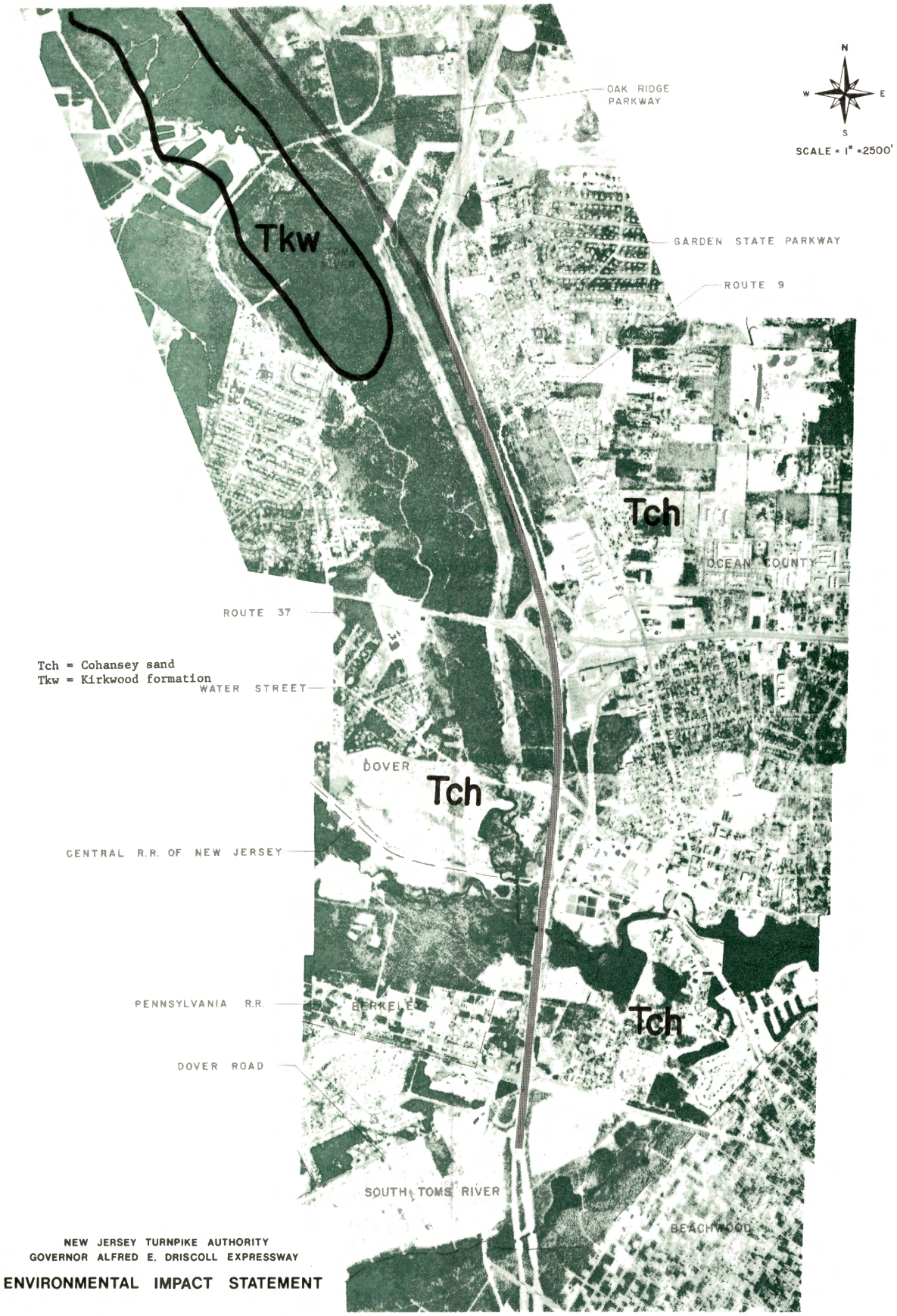

FIGURE 14. GEOLOGY: SHEET 1 OF 10

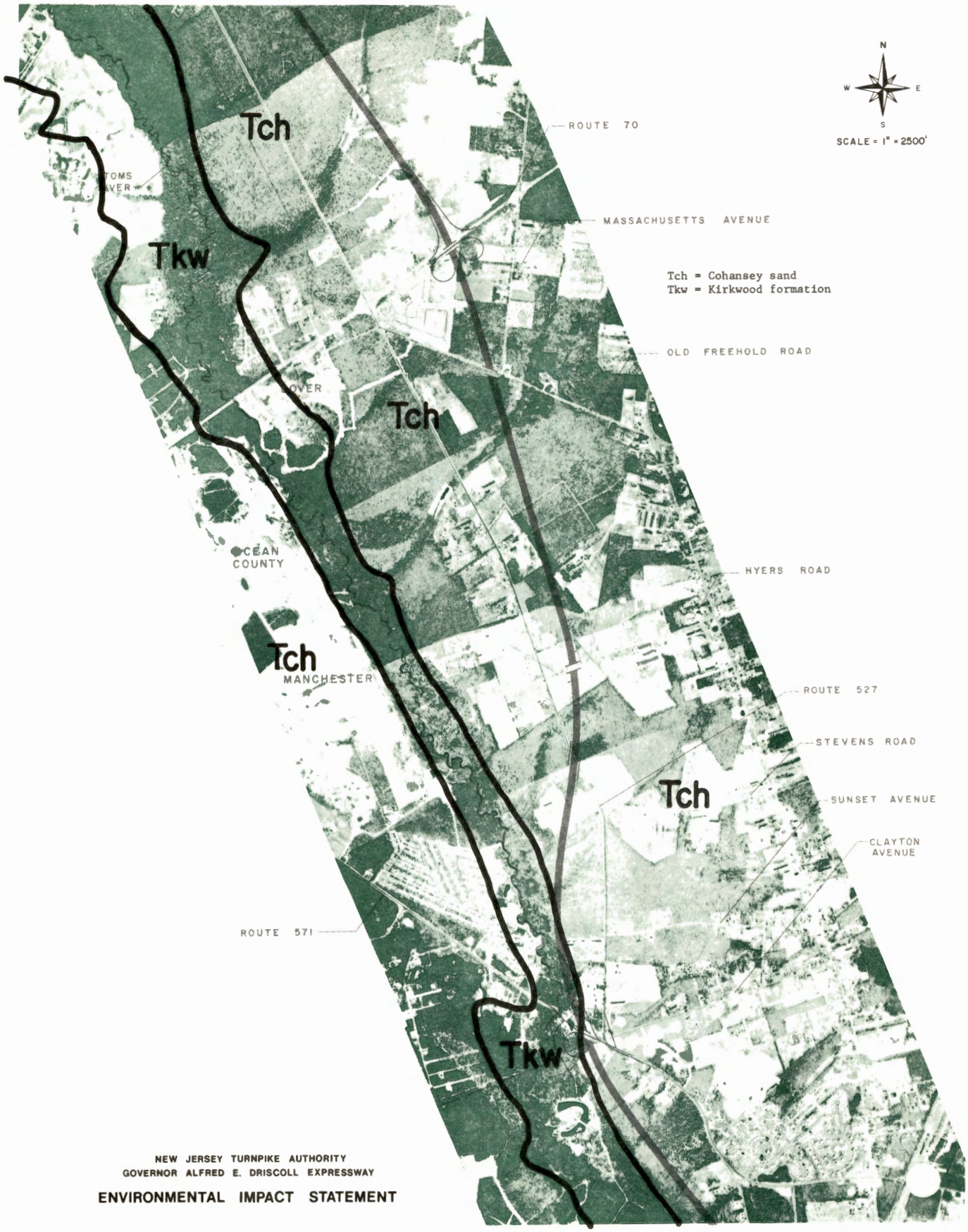

FIGURE 14. GEOLOGY: SHEET 2 OF 10



FIGURE 14. GEOLOGY: SHEET 3 OF 10

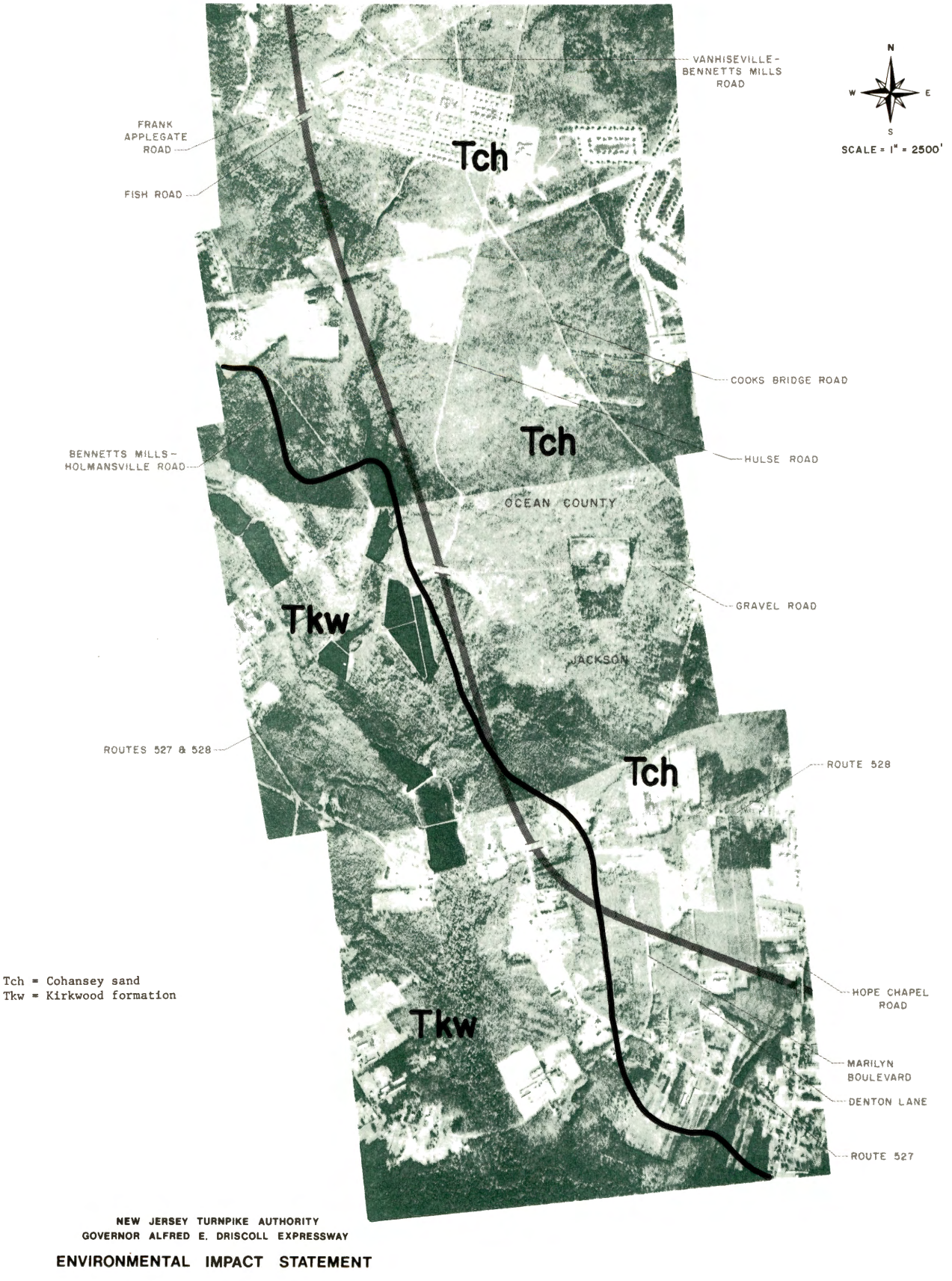

FIGURE 14. GEOLOGY: SHEET 4 OF 10

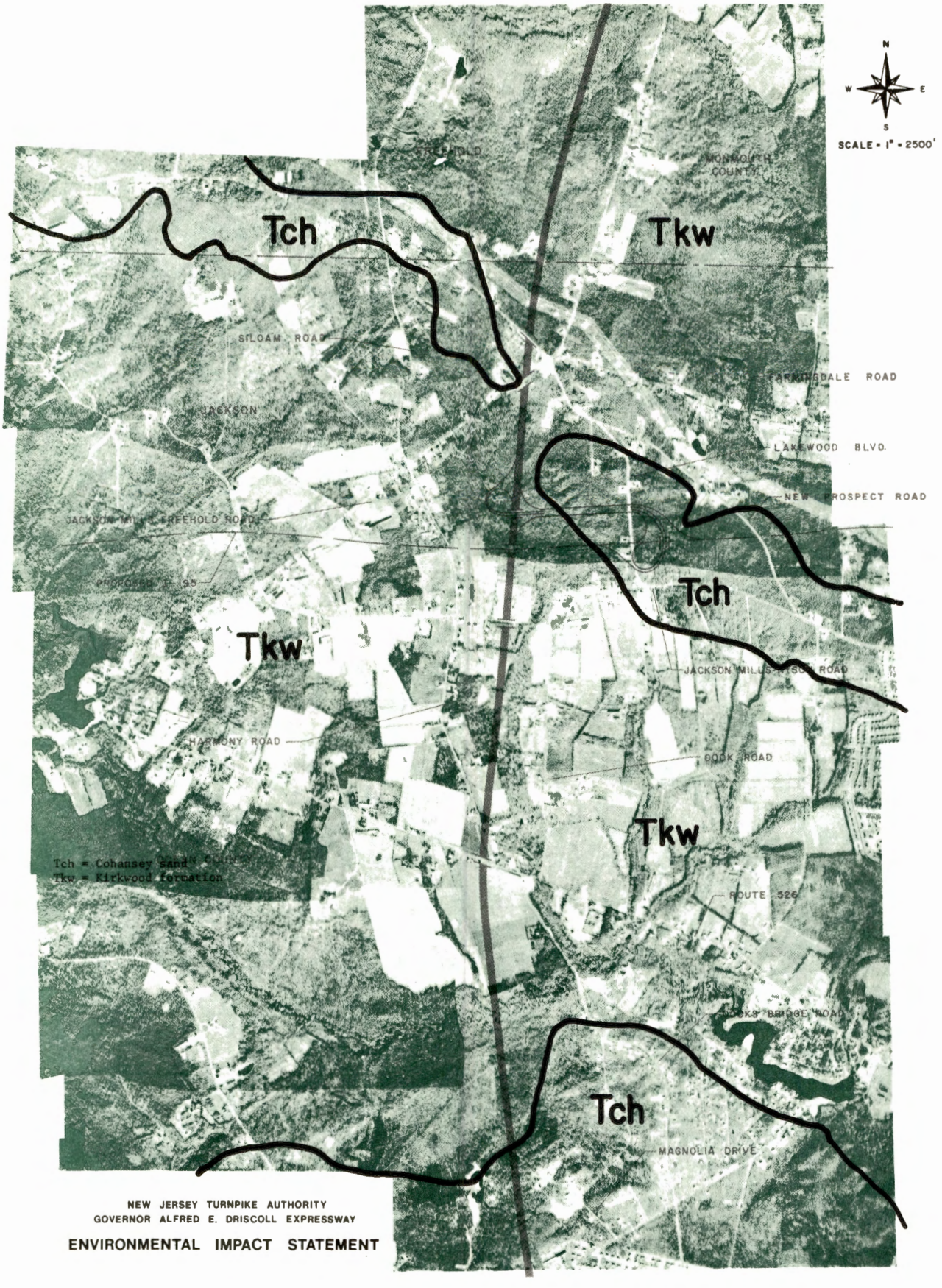

FIGURE 14. GEOLOGY: SHEET 5 OF 10

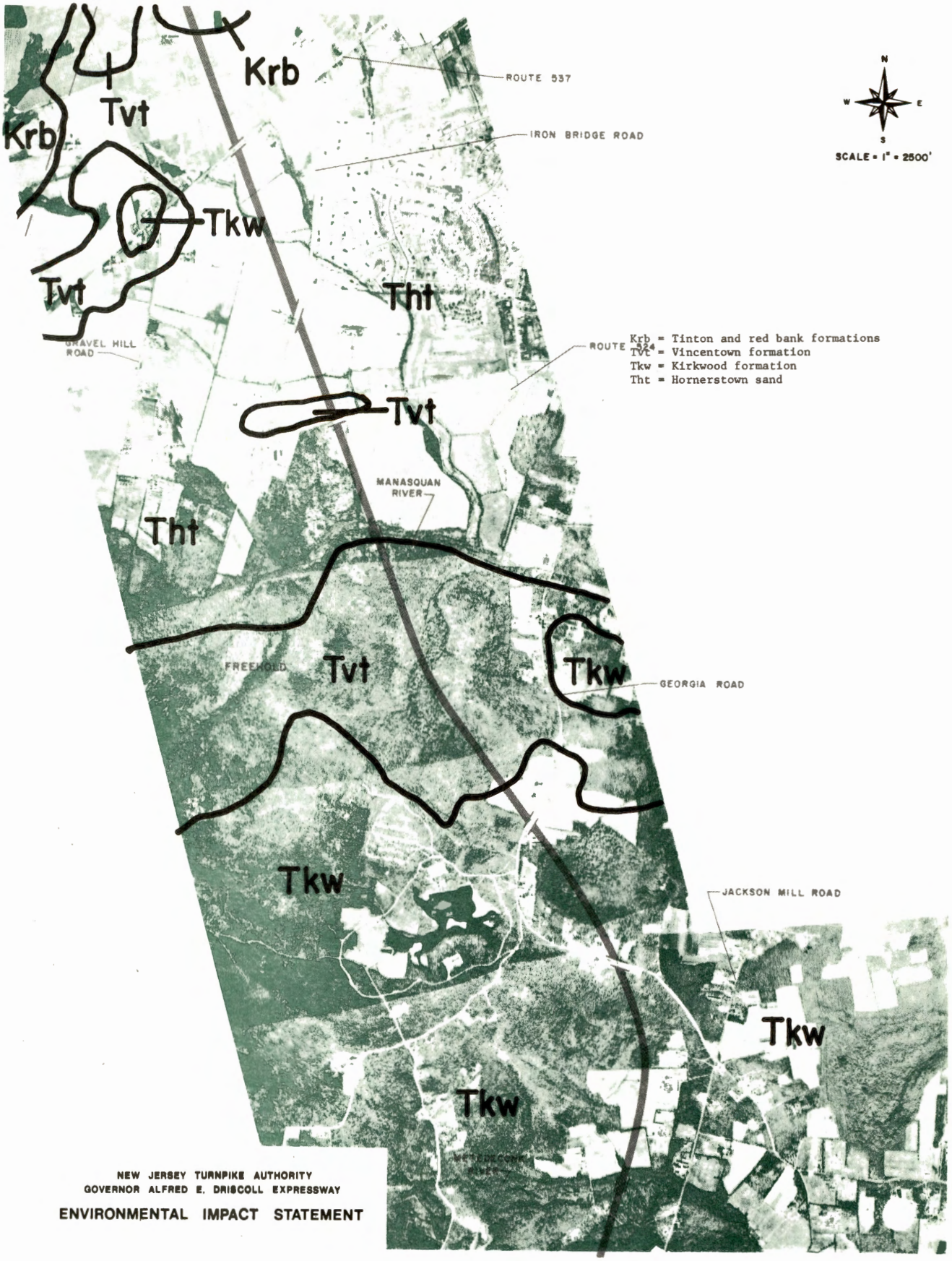

FIGURE 14. GEOLOGY: SHEET 6 OF 10

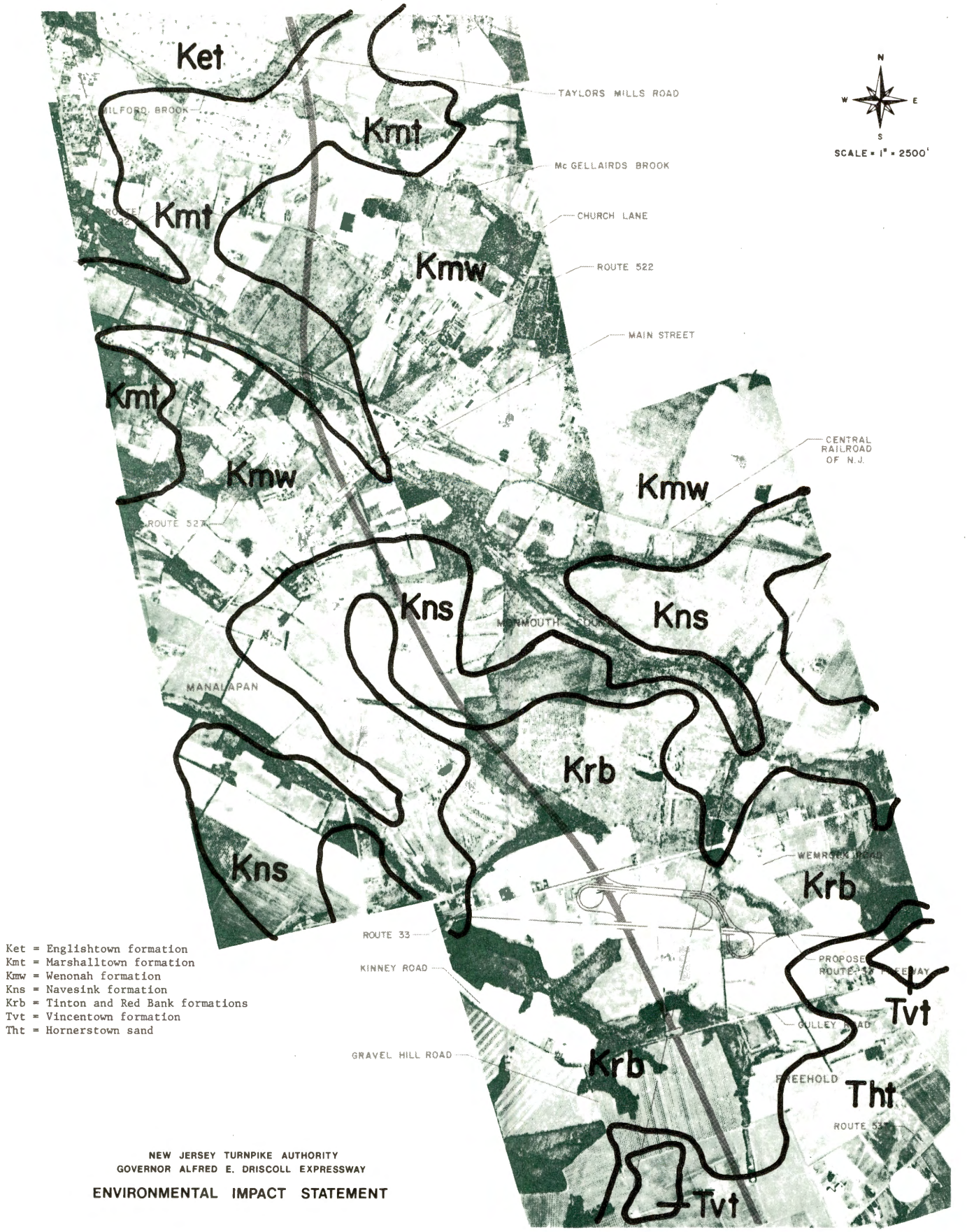

FIGURE 14. GEOLOGY: SHEET 7 OF 10

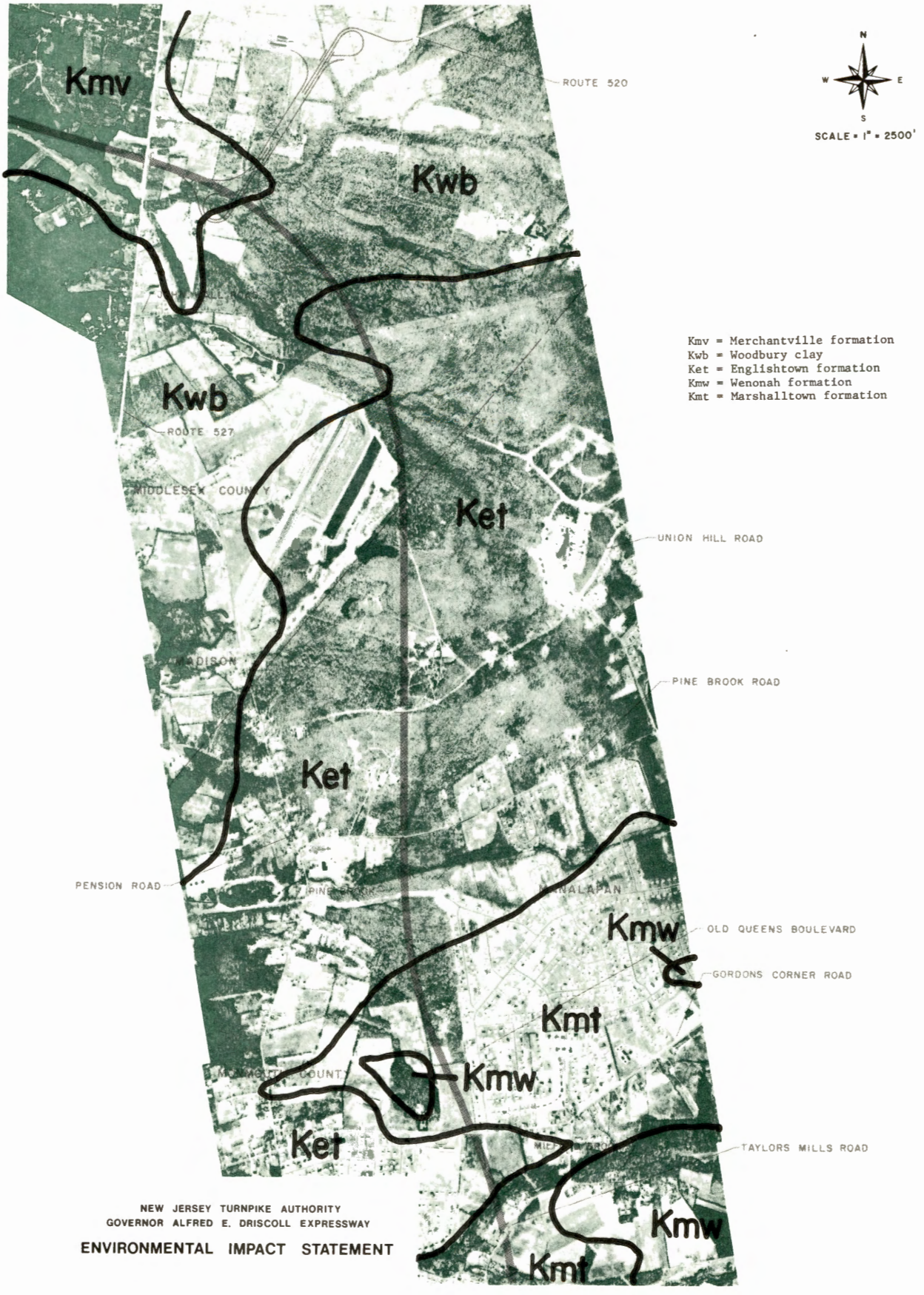

FIGURE 14. GEOLOGY: SHEET 8 OF 10



FIGURE 14. GEOLOGY: SHEET 9 OF 10

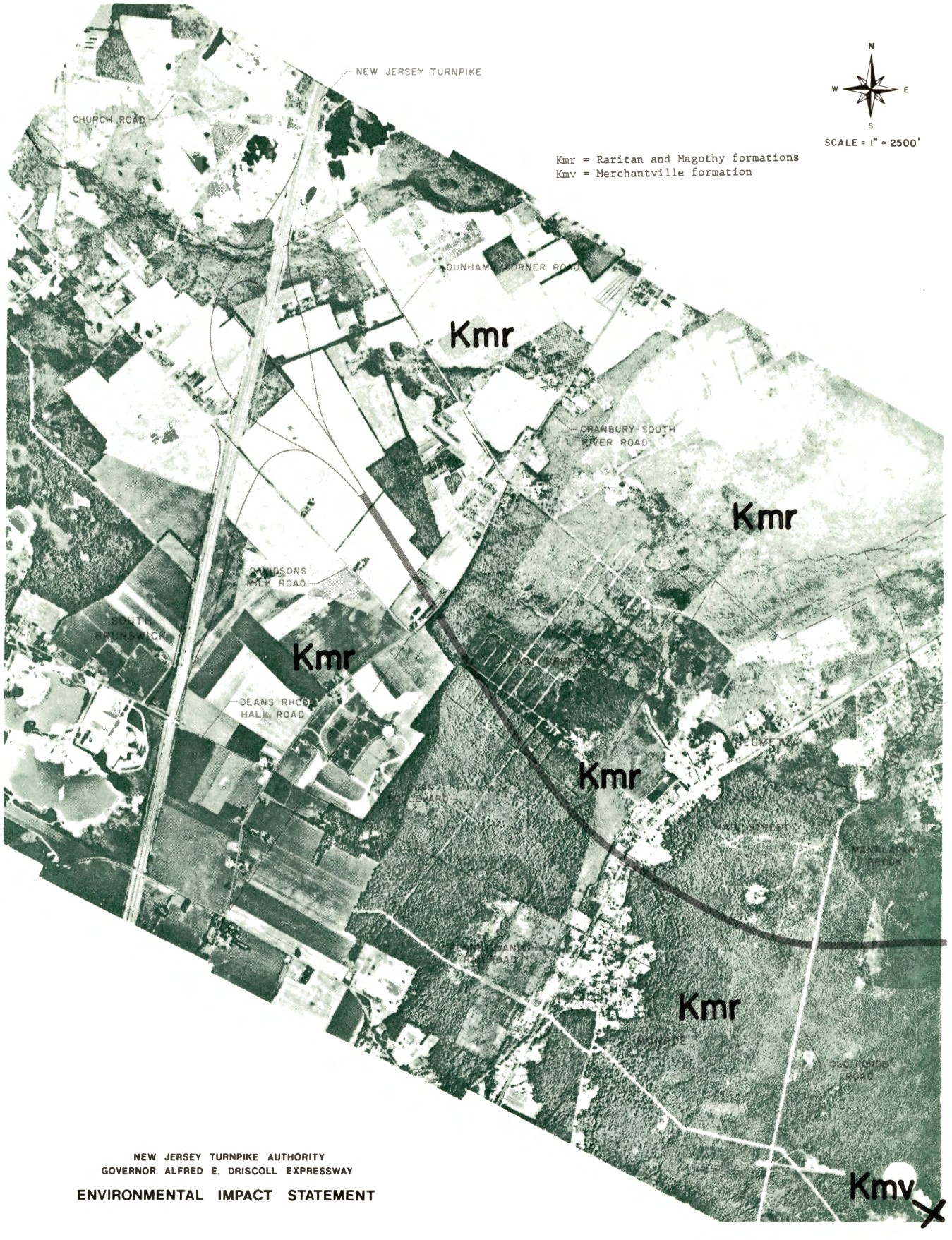

FIGURE 14. GEOLOGY: SHEET 10 OF 10

Point locations on the New Jersey Atlas Sheet Geologic Overlays are at best accurate within about 300 feet (Kemble Widmer, verbal communication, 1972). Because neither the source maps nor the Expressway maps were printed on base-stable material, the margin of error for point locations of geologic features on the geologic maps of the proposed Expressway route is assumed to be slightly more than 300 feet.

General geologic information was taken largely from published sources. Information used to describe individual formations was taken entirely from published sources. The literature generally does not include precise descriptions of each formation at the point where the formation intersects the proposed Expressway route. Because most New Jersey Coastal Plain formations show pronounced areal variations in lithology, they generally are described in the literature as showing a range of lithologies between precisely described locations. Given information from locations on either side of the route, it was possible to predict only the general nature of the lithologic trend between the locations. In addition, some formation members have an irregular areal distribution. For these reasons, it was impossible to give a precise rendering of the geology of the route. Most of the formation descriptions included in this report are accurate in their particulars only within a range of more than two or three miles.

A number of formations and formation members which are described in this report have not been shown individually on the geologic map. Quaternary and recent formations, which are really extensive at the surface in the vicinity of the proposed route, are not described in this report.

GENERAL GEOLOGY

The geology of the proposed Expressway route is complex. The route is aligned in such a way that it encounters most of the rock units found in the New Jersey Coastal Plain. All of the Coastal Plain rock units that were formed in Cretaceous time are represented along the route; and all but three of the units formed in Tertiary time are represented. The proposed route also encounters a number of rock units of Quaternary and Recent ages.

All of the rocks present along the proposed route are of sedimentary origin. The particles which compose the rocks largely were derived from older rocks which once outcropped to the west and north. The particles generally were deposited in or near extensive bodies of water, which at various past times covered much (if not all) of the area which is now New Jersey. The character and arrangement of these particles (lithology) indicate that the rocks along the route were formed in estuarine, beach, deltaic, and deep ocean environments.

Rock units formed during an easily distinguished unit of time are called formations; subdivisions of formations are called members. All of the formations and many of the formation members found along the proposed route occur throughout the New Jersey Coastal Plain. The lithology characteristic of a formation at one location, however, generally is not characteristic of the same formation at another location. Such an areal change in lithology in a single formation or member is called a facies change, and is indicative of a change in the environment in which the particles composing the formation were deposited. Many Coastal Plain formations exhibit regular (and, therefore, somewhat predictable) facies changes.

The lithologic character of Coastal Plain formations probably has remained relatively unchanged since the time the formations were deposited. The formations are composed of poorly consolidated material, which means that the material is neither hard rock nor loose sediment, but something in between.

At the end of the time period in which it was formed, each Coastal Plain formation consisted of a blanket of unconsolidated sediment covering a large area. Some formations may have covered all of the area which is now New Jersey. The orientation of each formation at the time of its deposition was essentially horizontal, although each dipped very gently to the southeast.

Successively younger formations or members generally were deposited on the upper surface of the preceding formation or member. (The plane along which two formations join one another is called a contact. The intersection of the plane of contact with the earth's surface is also called a contact, or contact line, as is the mapped line representing the intersection.) In many instances, the environments in which successive formations were deposited were radically different; so that, even where two formations are immediately adjacent to one another, the lithology of one may differ radically from the lithology of the other.

In some cases, the time interval between the deposition of successive formations was marked by a period of erosion. At particular locations where erosion was extensive, formations were significantly reduced in thickness or completely removed. Formations which were deposited after such periods of erosion are commonly now in contact with several older formations. (Formations which contact other formations along an erosional surface are said to have an unconformable or disconformable contact with the adjacent formations.)

The areal distribution, thickness, and lithology of some formations were strongly influenced by the topographic pattern of the surface upon which the formations were deposited. The Sayreville sand, for example, probably was deposited only in valleys. Consequently, the present areal distribution of this member is highly irregular.

The present outcrop pattern of the formations encountered along the proposed route is a function of (1) the present orientations and thicknesses of the individual formations and (2) the present topography of the land surface of the Coastal Plain. In very general terms, the formations presently compose a thick succession of parallel layers (a section), the whole of which has a gentle dip to the southeast. As a result, the layers of rock intersect the land surface of the Coastal Plain and form a banded outcrop pattern; the outcrop bands trend across the land surface from northeast to southwest. (The direction of this trend is called the strike of the formation.) Contact lines show numerous local departures from this trend as a result of local variations in surface topography, formation orientation, and formation thickness. In a number of places, small remnant patches of younger formations are present in the higher parts of the outcrop areas of older formations.

The thickness of a formation normally is taken as the shortest distance from the bottom of the formation to its top. Since Coastal Plain formations intersect the land surface at a small angle, the outcrop width of a formation is always much greater than its thickness. A formation 100 feet thick may have an outcrop width of over a mile. Different formations usually have different thicknesses. Because all Coastal Plain formations intersect the land surface at approximately the same angle, formations of different thicknesses normally have different outcrop widths.

The proposed Expressway route trends from southeast to northwest. Consequently, the route crosses successive outcrop bands. The successive outcrops are the outcrops of temporally successive formations. The proposed route therefore crosses younger and younger formations as it proceeds from north to south.

DESCRIPTIONS OF FORMATIONS

The proposed Expressway route crosses eleven formations of Cretaceous age and four formations of Tertiary age. Each of these formations is described below. Map symbols are included after each formation name. Beginning with the oldest formation, the order of description follows the order of stratigraphic succession.

The Raritan Formation (Kmr) is of Cretaceous age. It rests unconformably on pre-Cretaceous basement rocks and is unconformably overlain by younger Cretaceous rocks. The outcrop thickness of the formation ranges from 150 to 300 feet (Kümmel, 1940). The basal beds dip to the southeast at about 60 feet per mile (Barksdale and others, 1958), while the uppermost beds dip to the southeast at about 40 feet per mile (Kümmel, 1940); consequently, the thickness of the formation increases down dip to the southeast.

The composition of the Raritan varies widely from place to place. In general, the formation consists of alternating beds of clay and sand; the beds show considerable variation in composition along their outcrop. The sand beds are primarily clean, light-colored, well-sorted quartz, with some clay, mica, limonite, and feldspar admixed. Lignite is a relatively common constituent. Some of the sand beds are important aquifers, and some have been mined for various purposes. The clay beds range in color from dark gray to red to white. Sand, silt, and lignite are common minor constituents; nodules of pyrite or marcasite often are found. Certain sections of the clay beds are composed of very tough, plastic, and/or highly refractory clay. Some of the clay beds are important aquicludes, and some are sources of clay suitable for use in the ceramics industry and in the manufacture of fine china.

Owens and Sohl (1969) distinguished six members of the Raritan Formation; it is not known if the Expressway crosses all of them. The Raritan fire clay (Krr) is the oldest of these members. It rests unconformably on pre-Cretaceous basement rocks. It ranges in thickness from 0 to 35 feet at its outcrop (Barksdale and others, 1943) and thickens down dip to the southeast. The clay is blue, brown, or gray in color throughout most of its thickness, but it is frequently red at its base. It occasionally is mixed with sand and gravel. At some locations, this clay is economically valuable.

The Farrington sand member (Krf) overlies the Raritan fire clay. It averages 80 feet in thickness at its outcrop but varies from 44 to 104 feet in thickness (Barksdale and others, 1943). It dips to the southeast at about 55 feet per mile (Barksdale and others, 1943) and thickens down dip. The lower 10 to 20 feet of this member are composed of light-colored, coarse, arkosic sand (Barksdale and others, 1943). The sand contains lenses of quartz gravel; some flint and pieces of the Raritan fire clay are mixed with the gravel. Lenses and lentils of clay also are found in this basal sand. The upper section of the Farrington sand is composed of medium to fine-grained sand. The Farrington sand member has been mined in various places. It is an excellent aquifer.

The Woodbridge clay member (Krw) overlies the Farrington sand. It ranges in thickness from 50 to 90 feet where it has not been eroded (Barksdale and others, 1943). The basal section of the Woodbridge consists of tough, refractory fire-clay, which ranges in color from white to light gray to red. The middle section consists of gray clay with admixtures of sandy clay or clayey sand. The upper section consists of well-stratified, black, micaceous silts and clays containing some fine sand, many woody fragments, pyrite, and impure siderite concretions. Material from all sections of the Woodbridge clay is economically valuable. The entire Woodbridge clay member is important hydrologically, as it serves as a confining layer for the Farrington sand.

The areal distribution of the Sayreville sand member (Krs) is highly irregular; the sand may or may not be present beneath the proposed Expressway route. If present, the Sayreville probably lies unconformably upon the Woodbridge clay. The thickness and composition of the Sayreville also are highly irregular. Thickness ranges from 0 to 40 feet, with an average between 35 and 40 feet in areas where the Sayreville is present (Barksdale and others, 1943). The Sayreville is generally composed of light-colored, fine to medium-grained, micaceous sand, with occasional beds of light to dark-colored clayey silts and white clay. The sands are extensively cross-bedded. Occasional small beds of gravel and lenses of arkosic sand are also present. In some places, the Sayreville is economically valuable.

The areal distribution of the South Amboy fire clay (Kra) is irregular; the clay may or may not be present beneath the proposed Expressway route. If present, the South Amboy probably lies unconformably upon the Sayreville sand or the Woodbridge clay. The thickness of the South Amboy ranges from 0 to 25 feet along its outcrop (Barksdale and others, 1943) and increases down dip to the southeast. The South Amboy generally is composed of light-colored, tough, refractory clay, which is mixed with sand or lignite in a few places; siderite concretions are not present. In some places the South Amboy is economically valuable.

The Old Bridge sand member (Kro) lies unconformably upon the South Amboy fire clay. It ranges in thickness from 80 to 110 feet and dips to the southeast at from 40 to 45 feet per mile (Barksdale and others, 1943). It is usually a light-colored, clean, slightly micaceous, fine to medium-grained, cross-bedded sand. Coarse, cross-bedded sand beds are abundant. Small beds of light to dark-colored clayey silts are found in some places. Pyrite and lignite are common minor constituents where they have not been removed by weathering. The Old Bridge is an important aquifer. In some places, sand has been mined from the Old Bridge.

The Magothy Formation (Kmr) is of Cretaceous age. The thickness of the Magothy ranges from about 90 to about 120 feet (Barksdale and others, 1943; Owens and Sohl, 1969). Its average strike is 40 degrees northeast (Jablonski, 1968), and its upper surface dips southeast at between 40 and 45 feet per mile (Barksdale and others, 1958). The basal section of the Magothy is a dark, carbonaceous clay bed of variable thickness. This is overlain by a middle section of alternating beds of dark clay and white sand. The uppermost section is a thick bed of white sand.

Owens and Sohl (1969) distinguished three members of the Magothy in the Raritan Bay area of New Jersey. The oldest of these is the Amboy stoneware clay (Kma). It rests unconformably upon the Old Bridge sand member of the Raritan Formation. The Amboy ranges in

thickness from 0 to 35 feet (Barksdale and others, 1943). It is a light to nearly black-colored, micaceous, carbonaceous silt. It is rarely a mottled red color. Lignite is a common minor constituent. Parts of the Amboy are economically valuable.

The Morgan beds (Kmm) of the Magothy Formation rest conformably on the Amboy stoneware clay. These beds reach a maximum thickness of about 100 feet in the Raritan Bay area of New Jersey (Owens and Sohl, 1969); their thickness in the vicinity of the proposed Expressway route is unknown, but is somewhat less than 100 feet. The Morgan beds are composed of thin layers of dark, lignitic clays and silts alternating with thin layers of fine, white, sericitic sand. The clay beds contain small, rounded particles of amber. The composition of the Morgan beds changes along the strike; they grade into light-colored, cross-bedded sands containing lenses of coarse carbonaceous material.

The Cliffwood beds (Kmc) of the Magothy Formation rest upon the Morgan beds; it is not known if the contact between the two is conformable. The Cliffwood beds reach a maximum thickness of about 40 feet in the Raritan Bay area (Owens and Sohl, 1969); their thickness in the vicinity of the proposed Expressway route is unknown, but is somewhat less than 40 feet. The basal section of the Cliffwood is composed of a relatively thin bed of light-colored silt and fine-grained sand containing small, rounded siderite concretions. This basal bed is overlaid by a relatively thick, conspicuous sequence of white, fine-grained, sericitic, cross-bedded sands interbedded with thin, dark-colored layers of fine to coarse-grained carbonaceous material containing chunks of hard sandstone. The Cliffwood beds commonly are capped by a layer of ironstone.

The Merchantville Formation (Kmv) is of Cretaceous age. It rests unconformably on the Magothy Formation, and ranges in thickness from 50 to 60 feet (Barksdale et al, 1943). Its average strike is 45 degrees northeast, and it dips southeast at about 42 feet per mile (Jablonski, 1968). It is composed of dark-colored, glauconitic, micaceous clay and clayey silt. In some places, the clay beds are indurated. There are abundant lenses and beds of glauconite sand which contain lignite fragments and some siderite concretions. The Merchantville contains many fossils. Together with the overlying Woodbury clay, it is an important aquiclude. Some portions of the Merchantville are economically valuable.

The Woodbury Clay (Kwb), which is of Cretaceous age, rests conformably on the Merchantville Formation. The thickness of the Woodbury is about 50 feet (Barksdale and others, 1943). Its average strike is 45 degrees northeast, and it dips southeast at

about 41 feet per mile (Jablonski, 1968). The basal section of the Woodbury is composed of massive, tough, blocky, dark-gray to black, micaceous clayey silt. The upper section is composed of alternating lentils and laminae of fine white sand and brown, blocky clay. Together with the underlying Merchantville Formation, the Woodbury is an important aquiclude. Some portions of the Woodbury are economically valuable.

The Englishtown Formation (Ket) is of Cretaceous age and rests conformably on the Woodbury Clay. The thickness of the Englishtown is about 100 feet (Barksdale and others, 1943). Its average strike is 45 degrees northeast, and it dips southeast at about 39 feet per mile (Jablonski, 1968). In outcrop, the Englishtown is chiefly a yellow, white, or brown, fine-grained to pebbly quartz sand. The sand shows both horizontal and cross-bedding and is locally interbedded with lenses and lentils of dark-colored clay. Mica, glauconite, lignite, pyrite, and feldspar are minor constituents. Siderite concretions are found at the base of the Englishtown in some locations. Ironstone cement is present in some of the coarser sand beds and locally at the top of the formation. The Englishtown is an important aquifer.

The Cretaceous Marshalltown Formation (Kmt) rests disconformably on the Englishtown Formation. The thickness of the Marshalltown is about 30 feet (Jablonski, 1968). Its average strike is 45 degrees northeast, and it dips southeast at about 37 feet per mile (Jablonski, 1968). It is primarily composed of poorly sorted, greenish-black, micaceous, glauconitic, very clayey sand and silt. The basal section of the formation contains lignite, pyrite, and siderite concretions. Fossils and fossil borings are locally abundant. Together with a portion of the overlying Wenonah Formation, the Marshalltown functions as an aquiclude. Portions of the Marshalltown are potentially economically valuable.

The Wenonah Formation (Kmw) is of Cretaceous age. It rests conformably on the Marshalltown Formation. The thickness of the Wenonah is probably between 20 and 30 feet (Barksdale and others, 1943; Minard, 1969). Its average strike is 50 degrees northeast, and it dips to the southeast at 35 feet per mile (Jablonski, 1968). It is composed of dark-gray, massive, poorly sorted, lignitic, micaceous, sandy quartz silt. Glauconite is common at the base of the formation. In some places, fossils are abundant. Together with a portion of the overlying Mount Laurel Sand, part of the Wenonah Formation is an important aquifer.

The Cretaceous Mount Laurel Sand (Kmw) rests conformably on the Wenonah Formation. The thickness of the Mount Laurel is

probably between 25 and 35 feet (Barksdale and others, 1943; Minard, 1969). Its average strike is 50 degrees northeast, and it dips to the southeast at 35 feet per mile (Jablonski, 1968). It is composed of thin horizontal and cross-bedded layers of salt and pepper-colored, fine to medium-grained, lignitic quartz sand interbedded with abundant thin layers of dark, micaceous, carbonaceous clay. Glauconite is a common minor constituent of the sand. The upper few feet of the Mount Laurel are massive, medium- to coarse-grained, highly glauconitic quartz sands. Fossils are abundant in the upper section of the formation. Together with a portion of the underlying Wenonah Formation, part of the Mount Laurel is an important aquifer.

The Navesink Formation (Kns) is of Cretaceous age and rests conformably on the Mount Laurel Sand. The thickness of the Navesink is about 25 feet (Jablonski, 1968). Its average strike is 50 degrees northeast, and it dips southeast at 35 feet per mile (Jablonski, 1968). It is composed of massive, dark greenish-gray, fine to medium-grained, poorly sorted, clayey glauconitic sand. Minor constituents are mica and lignite. The entire formation is locally highly fossiliferous, and the basal section of the formation is commonly marked by a shell zone. Together with the Sandy Hook member of the overlying Red Bank Sand, most of the Navesink functions as an aquiclude. Portions of the Navesink have potential economic value.

The Red Bank Sand (Krb) is of Cretaceous age. It rests conformably on the Navesink Formation. The thickness of the Red Bank ranges from 30 to 120 feet (Jablonski, 1968; Minard, 1969). Its average strike is 50 degrees northeast, and it dips southeast at about 33 feet per mile (Jablonski, 1968).

Minard (1969) distinguished two members of the Red Bank. The oldest of these is the Sandy Hook member (Krsh). It ranges from 20 to 70 feet in thickness (Jablonski, 1968). It is fossiliferous, and is composed of dark-colored, massive, fine to medium-grained, very micaceous, clayey and silty glauconite sand. Together with most of the underlying Navesink Formation, the Sandy Hook member functions as an aquiclude.

The Shrewsbury member (Krbs), which rests conformably on the Sandy Hook member, ranges in thickness from 0 to 70 feet (Jablonski, 1968). It is composed of reddish-brown to gray, massive, medium to coarse-grained, slightly clayey, feldspathic quartz sand. Mica, glauconite, and fragments of shale, sandstone, and schist are minor constituents. In some places, portions of the Shrewsbury are cemented by iron oxide. Together with some overlying formations, the Shrewsbury member functions as a minor aquifer.

The Tinton Sand (Krb) is of Cretaceous age. It rests conformably on the Red Bank Sand, and ranges in thickness from 10 to 20 feet (Jablonski, 1968). Its average strike is 50 degrees northeast, and the dip is southeast at about 33 feet per mile (Jablonski, 1968). It is composed of light-colored, massive, poorly sorted, medium to coarse-grained, clayey, glauconitic, indurated quartz sand. Together with the underlying Shrewsbury member of the Red Bank Sand, the Tinton functions as a minor aquifer.

The Hornerstown Sand (Tht), which is of Tertiary age, rests unconformably on the Red Bank Sand. The thickness of the Hornerstown is about 25 feet (Jablonski, 1968). Its average strike is 55 degrees northeast, and it dips southeast at about 50 feet per mile (Jablonski, 1968). It is composed of dark grayish-green, massive, glauconitic clayey sand. The clay fraction is predominantly glauconite, and the sand is composed of both glauconite and quartz. The Hornerstown functions as an aquiclude. Portions of the Hornerstown have potential economic value.

The Tertiary Vincentown Formation (Tvt) rests unconformably on the Hornerstown Sand. The thickness of the Vincentown ranges from "several feet" to 130 feet (Anderson and Appel, 1969). Its average strike is 55 degrees northeast, and it dips southeast at about 27 feet per mile (Jablonski, 1968). The basal section of the Vincentown is composed of dark-colored, fine to medium-grained, slightly micaceous, clayey, quartzitic glauconite sand in which calcareous fossils are abundant. The upper section is composed of light-colored, fine to medium-grained calcareous quartz and lime sand. In some localities, portions of the upper section are indurated into limestone lenses. Fossils are abundant. The Vincentown functions as a minor aquifer.

The Kirkwood Formation (Tkw) is of Tertiary age. It rests unconformably on the Vincentown Formation. The thickness of the Kirkwood is at least 100 feet (Markewicz and others, 1958; Owens and Sohl, 1969). Its average strike is 70 degrees northeast (Jablonski, 1968); its basal beds dip southeast at about 25 feet per mile, while its upper beds sip southeast at about 10 feet per mile (Barksdale and others, 1958). The basal section of the Kirkwood is composed of massive, dark-colored, lignitic, micaceous clay, which contains pyritized diatoms in some places. The upper section, which is as much as 40 feet thick (Markewicz and others, 1958), is composed of light-colored, massive to thick-bedded, micaceous, floury, ilmenitic quartz sand. Fossil borings are locally abundant. Portions of the upper section of the Kirkwood are economically valuable and the formation is an excellent aquifer.

The Tertiary Cohansey Sand (Tch) rests unconformably upon the Kirkwood Formation, and ranges in thickness from 100 to 250 feet (Markewicz and others, 1958). Its average strike is 70 degrees northeast, and it dips southeast at about 10 feet per mile (Jablonski, 1968). It is composed of light-colored, fine to coarse-grained, extensively cross-bedded, ilmenitic quartz sands, which contain lenses of gravel and thin seams of lignitic clay in some places. The Cohansey is locally indurated by ironstone cement. Some portions of the Cohansey are economically valuable, and the formation generally is considered to be the largest relatively unexploited aquifer in New Jersey.

RESOURCES

Parts of a number of the formations encountered along the proposed Expressway route have been or are presently economically valuable. The valuable parts of the formations sometimes have irregular distribution. Given the limitations mentioned in "Methods", therefore, it is not always possible to say whether or not a particular valuable rock unit is present along the proposed route.

Clay has been mined from a number of the Coastal Plain formations which intersect the proposed route. Of these formations, the Raritan (Kmr), which outcrops at the northern end of the route, is the most important source of clay.

(1) Clay from some parts of the Raritan fire clay (Krr) is tough, dense, plastic, highly refractory, and free of contaminating constituents. It is suitable for use in the ceramics industry. (2) Clay from the Woodbridge clay member (Krw) has been used for a variety of purposes. The basal section of the Woodbridge consists of tough, refractory clay which has been used for fire-clay. The middle section of the Woodbridge consists of a slightly sandy clay which has been used in the manufacture of hollow tile. (3) Clay from some parts of the South Amboy fire clay (Kra) is tough, refractory, and relatively free of contaminating constituents. It has been mined in some places for fire-clay. (4) Brick and terra-cotta clays have been mined from all of these members of the Raritan Formation.

The Amboy stoneware clay (Kma) of the Magothy Formation (Kmr) outcrops at the northern end of the proposed route. In some places, the Amboy has been mined for stoneware and terra-cotta clays.

Some portions of the Merchantville (Kmv) and Woodbury (Kwb) Formations have been mined for brick clay.

Some portions of the Cohansey Sand (Tch) contain brick and terra-cotta clay.

Some of the sand found in members of the Raritan Formation is economically valuable. The upper section of the Farrington sand member (Krf) consists of relatively clean, medium to fine-grained sand. It has been mined for fire sand in various places. The Old Bridge sand member (Kro) usually consists of clean, fine to medium-grained sand. In some places, sand has been mined from the Old Bridge for use in foundries, concrete work, stucco, sand-lime brick, blast sand, and asphalt filler.

Parts of the Cohansey Sand (Tch) are significant sources of clean, white sand suitable for use in the glass industry.

The glauconitic (greensand) portions of the Marshalltown (Kmt), Navesink (Kns), and Hornerstown (Tht) Formations contain as much as 6.6 percent potash in some places (Kümmel, 1940). The potash could be a significant source of fertilizer.

The Kirkwood (Tkw) and Cohansey (Tch) Formations, which outcrop at the southern end of the proposed route, are significant potential and actual sources of titanium-bearing sands over a large part of their outcrop in northern Ocean County. The titanium from these sands is suitable for use as a white pigment in paints. At one location just west of the proposed route, the sands have been mined successfully since 1961. At another location west of the route, mining operations are scheduled to begin in 1973 (Markewicz, Frank, verbal communication, 1972). One of the Quaternary formations (Cape May) not discussed in this report has been identified as a potential source of titanium sand.

OTHER FEATURES

The rocks of the proposed Expressway route generally are poorly consolidated, particularly where they are sandy. They do not normally support steep slopes. It is partly for this reason that areas of high topographic relief are not present along the proposed route. In some places, layers of ironstone or calcareous material form ledges of hard rock. Ironstone ledges may underlie and support some of the higher regions in the outcrop areas of the Magothy (Kmr), Englishtown (Ket), Red Bank (Krb), and Cohansey (Tch) Formations.

The geomorphology of the proposed route, as determined from topographic maps, does not present any evidence of naturally unstable conditions in any of the formations outcropping along the route. The literature cited in this report, furthermore, does not note the occurrence of any unusual geologic or paleontological conditions at any point along the proposed route.

DISCUSSION

Construction on the proposed Expressway route will require (1) removal of rock material from some locations, (2) deposition of rock material in other locations, and (3) construction of pavement and associated structures upon rock material everywhere along the route. These features of the construction of the route will

have a number of impacts. Material from road cuts will closely balance the need for fill material, thereby minimizing the need for borrow pits and the creation of excess materials.

Any economically valuable rock units located near or beneath the proposed route will be unavailable for exploitation after construction of the route. As noted in "Resources", this report does not include precise descriptions of the locations, extent, and values of the various valuable rock units. Consequently, it is impossible to give any detailed estimate of the kinds, amounts, and values of the materials which will be rendered unavailable by the route. "Resources" details the kinds and general locations of valuable material which may be covered by the route.

As noted in "Other Features", most of the rock materials found along the proposed route do not support steep slopes. In order to minimize erosion of these materials, road cut and landscape slopes will be graded to approximate the relief of stable, natural slopes which occur in the area.

The proposed route may encounter resistant ironstone capstones at some higher elevations. If these capstones are removed, the underlying loose materials will be unable to support the slopes inherited from the capstones. As a result, the loose materials will be eroded at an accelerated rate.

No unusual geologic or paleontologic features are known that will be impacted by the proposed route.

TABLE 13. STRATIGRAPHIC SECTION

Unit Symbol Age	Thickness Attitude	Composition	Other Characteristics
Cohansey Tch Tertiary	100-250' Strike 70°NE Dip 10'/mile SE	Quartz sand: light-colored, fine to coarse-grained.	Source of titanium sand, glass sand, brick and terra-cotta clay. Potentially important aquifer.
Kirkwood Tkw Tertiary	At least 100' Strike 70°NE Dip 17'/mile SE	Quartz sand: light-colored, floury. Clay: dark-colored, massive.	Potential source of titanium sand.
Vincentown Tvt Tertiary	Several to 130' Strike 55°NE Dip 27'/mile SE	Quartz and lime sand: light-colored, fine to medium-grained. Glauconite sand: dark-colored, fine to medium-grained.	Minor aquifer.
Hornerstown Twt Tertiary	About 25' Strike 55°NE Dip 50'/mile SE	Clayey sand: dark-colored, massive.	Potential source of potash. Aquiclude.
Tinton Krb Cretaceous	10-20' Strike 50°NE Dip 33'/mile SE	Quartz sand: light-colored, massive.	Minor aquifer.
Red Bank, Shrewsbury Krb/Krbs Cretaceous	0-70' Strike 50°NE Dip 33'/mile SE	Quartz sand: reddish to gray-colored, massive, medium to coarse-grained.	Minor aquifer.
Red Bank, Sandy Hook Krb/Krsh Cretaceous	20-70' Strike 50°NE Dip 33'/mile SE	Glauconite sand: dark-colored, massive.	Aquiclude.
Navesink Kns Cretaceous	About 25' Strike 50°NE Dip 35'/mile SE	Glauconitic sand: dark-colored, massive, fine to medium-grained.	Potential source of potash. Aquiclude.
Mount Laurel Kmw Cretaceous	25-35' Strike 50°NE Dip 35'/mile SE	Quartz sand: salt and pepper-colored, fine to medium-grained. Interbedded with clay: dark-colored, thin-bedded.	Basal portion is important aquifer.
Wenonah Kmw Cretaceous	20-30' Strike 50°NE Dip 35'/mile SE	Quartz silt: dark-gray, massive.	Upper portion is important aquifer. Lower portion is aquiclude.
Marshalltown Kmt Cretaceous	30' Strike 45°NE Dip 37'/mile SE	Sand and silt: greenish-black.	Potential source of potash. Aquiclude.
Englishtown Ket Cretaceous	About 100' Strike 45°NE Dip 39'/mile SE	Quartz sand: light-colored, fine-grained to pebbly.	Important aquifer.
Woodbury Kwb Cretaceous	About 50' Strike 45°NE Dip 41'/mile SE	Sand and clay: white and brown, alternating lentils. Clayey silt: dark-colored, massive, blocky.	Source of brick clay. Important aquiclude.
Merchantville Kmv Cretaceous	50-60' Strike 45°NE Dip 42'/mile SE	Clay and silt: dark-colored.	Source of brick clay. Important aquiclude.
Magothy, Cliffwood Kmr/Kmc Cretaceous	Less than 40' Strike 40°NE Dip 40-45'/mile SE	Sand: white, fine-grained.	
Magothy, Morgan Kmr/Kmm Cretaceous	Less than 100' Strike 40°NE	Clay, silt, and sand: alternating white and dark, thin beds.	
Magothy, Amboy Kmr/Kma Cretaceous	0-35' Strike 40°NE	Silt: light to dark-colored.	Source of stoneware and terra-cotta clays.
Raritan, Old Bridge Kmr/Kro Cretaceous	80-110' Dip 40-45'/mile SE	Sand: light-colored, fine to medium-grained.	Source of sand for many purposes. Important aquifer.
Raritan, South Amboy Kmr/Kra Cretaceous	0-25'	Clay: light-colored.	Source of fire, brick, and terra-cotta clays.
Raritan, Sayreville Kmr/Krs Cretaceous	0-40'	Sand: light-colored, fine to medium-grained.	
Raritan, Woodbridge Kmr/Krw Cretaceous	50-90'	Clay: dark to light-colored.	Source of clay for many purposes. Aquiclude.
Raritan, Farrington Kmr/Krf	44-104' Dip 55'/mile SE	Sand: light-colored, coarse to fine-grained.	Source of fire sand. Important aquifer.
Raritan, Raritan Fire Clay Kmr/Krr Cretaceous	0-35'	Clay: blue, brown, or gray.	Source of ceramic clay.

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SOILS

Soil is formed from biotic and abiotic elements interacting under the influence of parent materials, local climate (with attendant modification by wind and water erosion), vegetation, ground water, and animal activity. Individual soil types thus usually are indicators of certain past and present environmental conditions. More commonly, soil mapping allows a determination of economic values of land areas and provides information on land use capabilities and limitations that can be used in resource-based planning.

METHODS

Soils in and adjacent to the 35.5 mile proposed Expressway alignment have been surveyed at various times by the United States Soil Conservation Service in collaboration with the New Jersey Agricultural Experiment Station. No field examinations were undertaken by Jack McCormick & Associates for this report, but the most recent soil survey information available, including unpublished field sheets, was compiled in the soils maps (Figure 16) which accompany the report. Source data for each section of the proposed Expressway are indicated in Figure 15. Current data are lacking for several small areas (indicated as ID or "insufficient data"). Although less detailed, older surveys (Lee, 1923; Lee, 1926; Lee, 1933) do cover these areas, the combination of their typing with information in the more recent, more detailed surveys (Cox and others, 1948; Markley, 1971; Jablonski, 1972) would result in inconsistencies in the interpretation of soil series. For example, between 1936 and 1953 the original definition of the Sassafras series was narrowed and new series, including the modified Sassafras, were proposed to cover the same range of soil variations (Lyford and Quakenbush, 1956). Engineering soil surveys, in which the criteria for soil classification are based on structural soil characteristics, cannot easily be combined with Soil Conservation Service Surveys, the criteria for which are based on genetic-textural relationships.

For the present report, soil series have been lumped into seven categories (Table 14). This consolidation of series is based largely on the predominant texture of the subsoil plus the presence or absence of glauconite. Soil series within these groupings generally are uniform in regard to the classificatory criteria.

Soil series are groupings of similar soils which have developed from the same underlying parent material but differ in the texture of the surface layer; thus soil series descriptions vary little from county to county. Because there are no modern soil surveys for Middlesex County or Ocean County, and the Monmouth County survey (Cox and others, 1948) was the earliest study in the revised series, series descriptions in this report are based largely upon recent surveys for counties near the proposed alignment. Data relating to

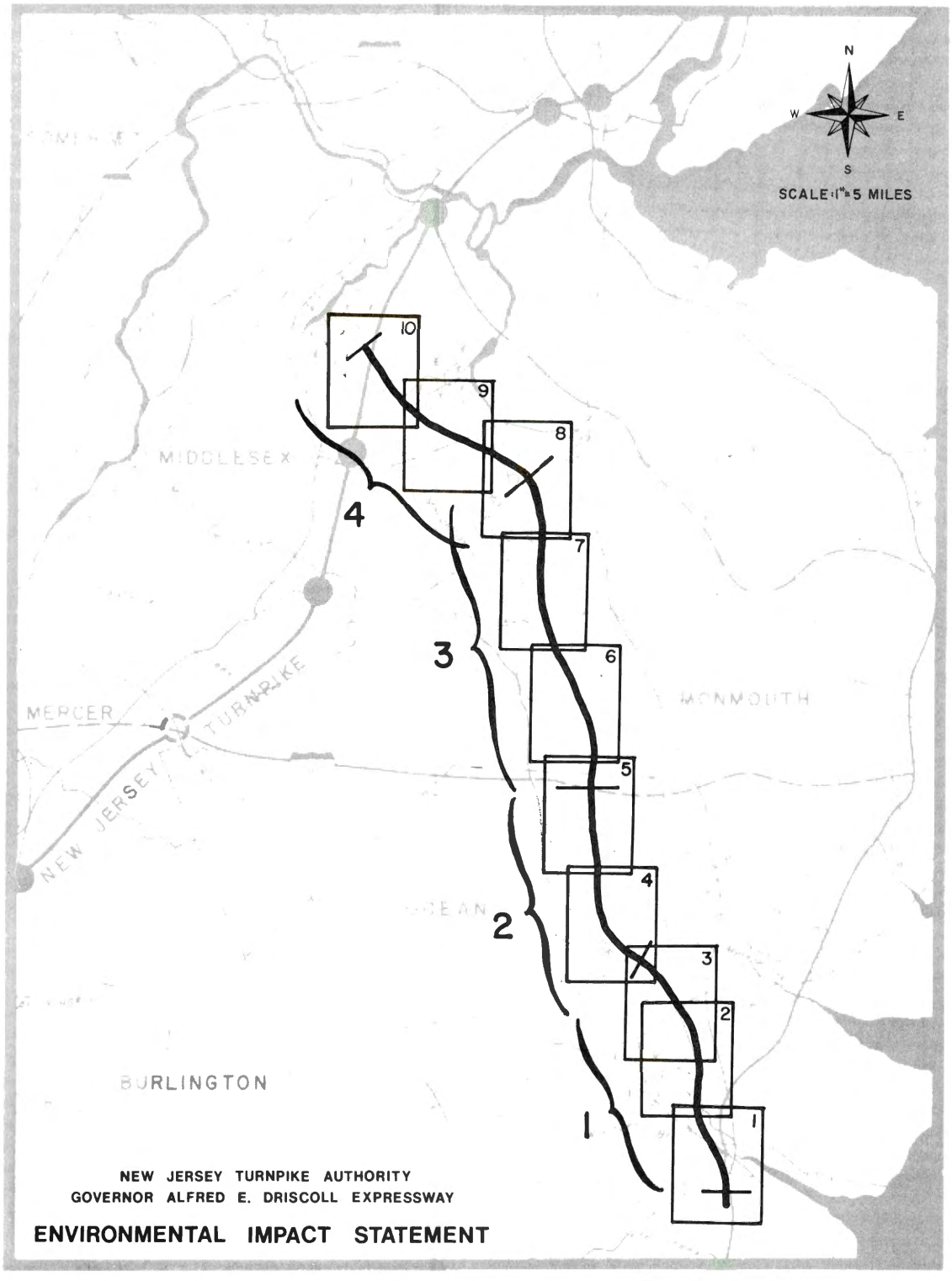

FIGURE 15. SOILS DATA SOURCES

Figure 15. Key: Soils data source map

Map No.	Source of Information	Sheet or Photo No.
1	Markley, M. L., U.S.D.A. Soil Conservation Service. Ocean County, New Jersey Atlas Sheets - Scale 1:20,000. "Advance sheets subject to change."	Atlas Sheets No. 13, 19,25
2	Markley, M. L., U.S.D.A. Soil Conservation Service. Ocean County, New Jersey. "Advance sheets subject to change."	
3	Cox, H. R., et al. 1948. Monmouth County soils, their nature, conservation, and use. New Jersey Agri. Exp. Sta. Bull. 738:1-40 and 33 map sheets. Scale map-1:15,840.	Sheets No. 7,15,16, 29
4	Markley, M. L., U.S.D.A. Soil Conservation Service. Middlesex County, New Jersey aerial photo field sheets. Scale of original - 1" = 1,320'. "Advance sheets subject to change."	CNA-12-107 CNA-12-106 CNA-16-58 CNA-16-57 CNA-16-56 CNA-7R-170 CNA-15R-147

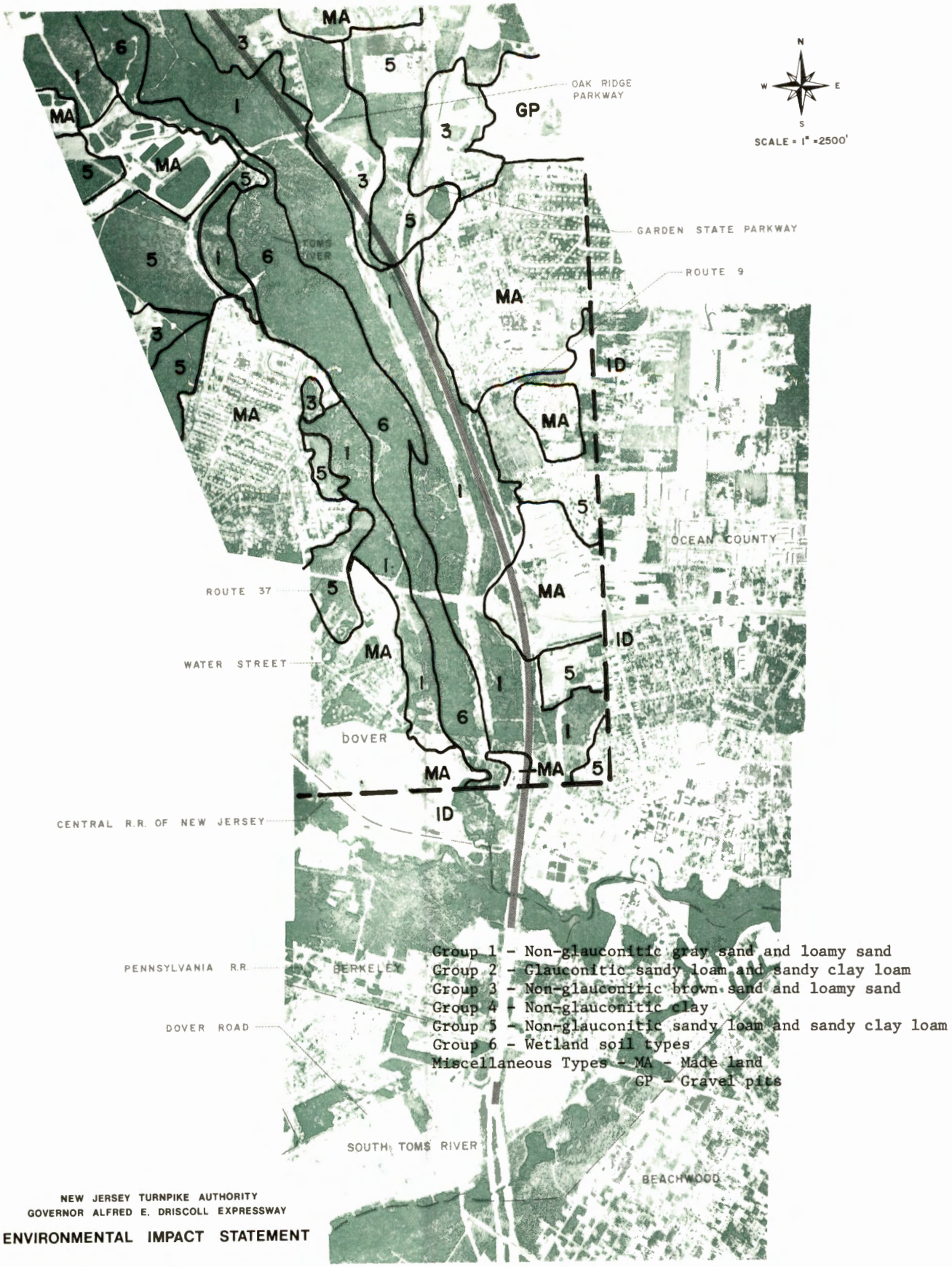

FIGURE 16. SOILS: SHEET 1 OF 10



FIGURE 16. SOILS: SHEET 2 OF 10



FIGURE 16. SOILS: SHEET 3 OF 10



FIGURE 16. SOILS: SHEET 4 OF 10



FIGURE 16. SOILS: SHEET 5 OF 10

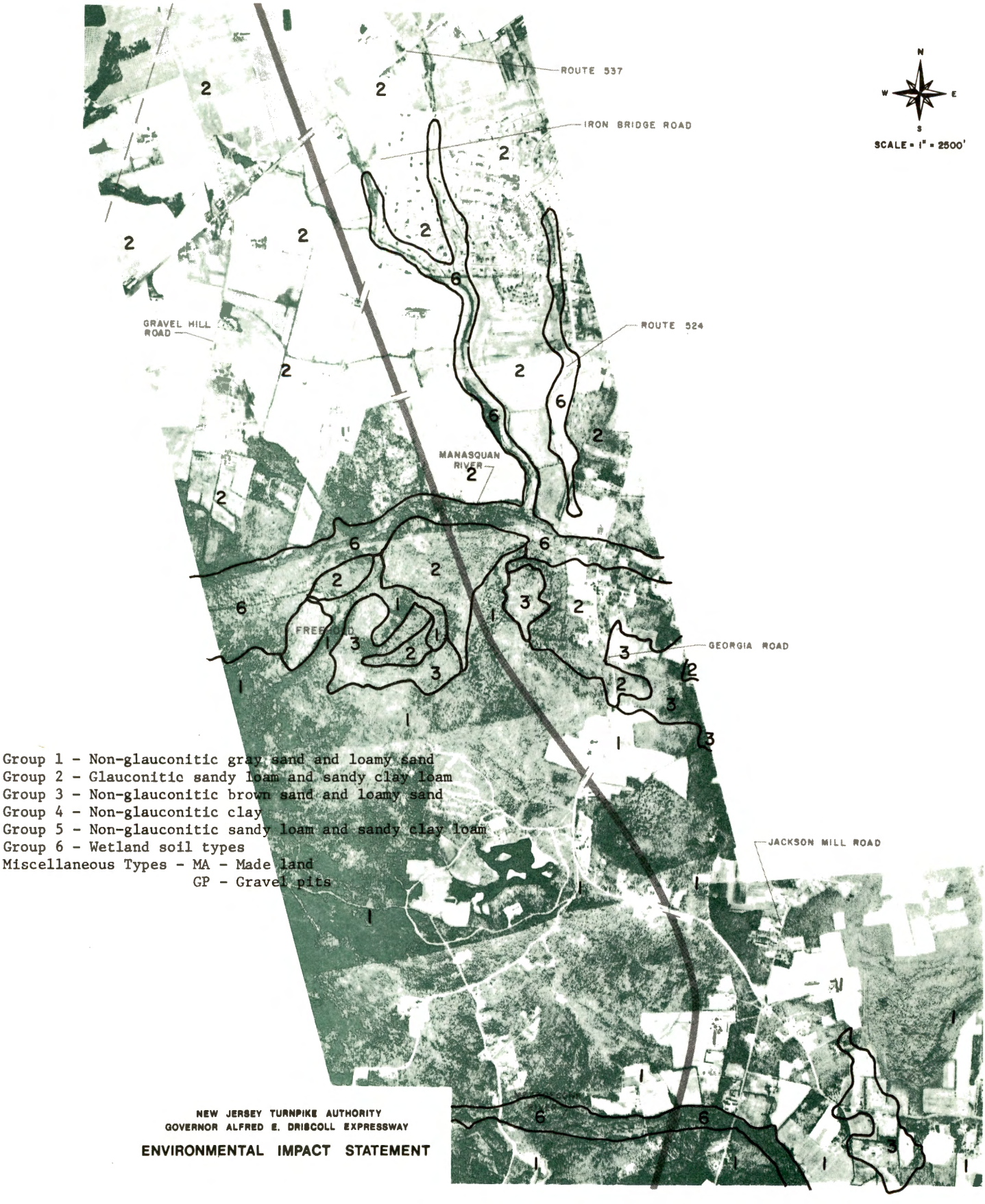

FIGURE 16. SOILS: SHEET 6 OF 10



NEW JERSEY TURNPIKE AUTHORITY
GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY

ENVIRONMENTAL IMPACT STATEMENT

Group 1 - Non-glauconitic gray sand and loamy sand
Group 2 - Glauconitic sandy loam and sandy clay loam
Group 3 - Non-glauconitic brown sand and loamy sand
Group 4 - Non-glauconitic clay
Group 5 - Non-glauconitic sandy loam and sandy clay loam
Group 6 - Wetland soil types
Miscellaneous Types - MA - Made land
GP - Gravel pits

FIGURE 16. SOILS: SHEET 7 OF 10

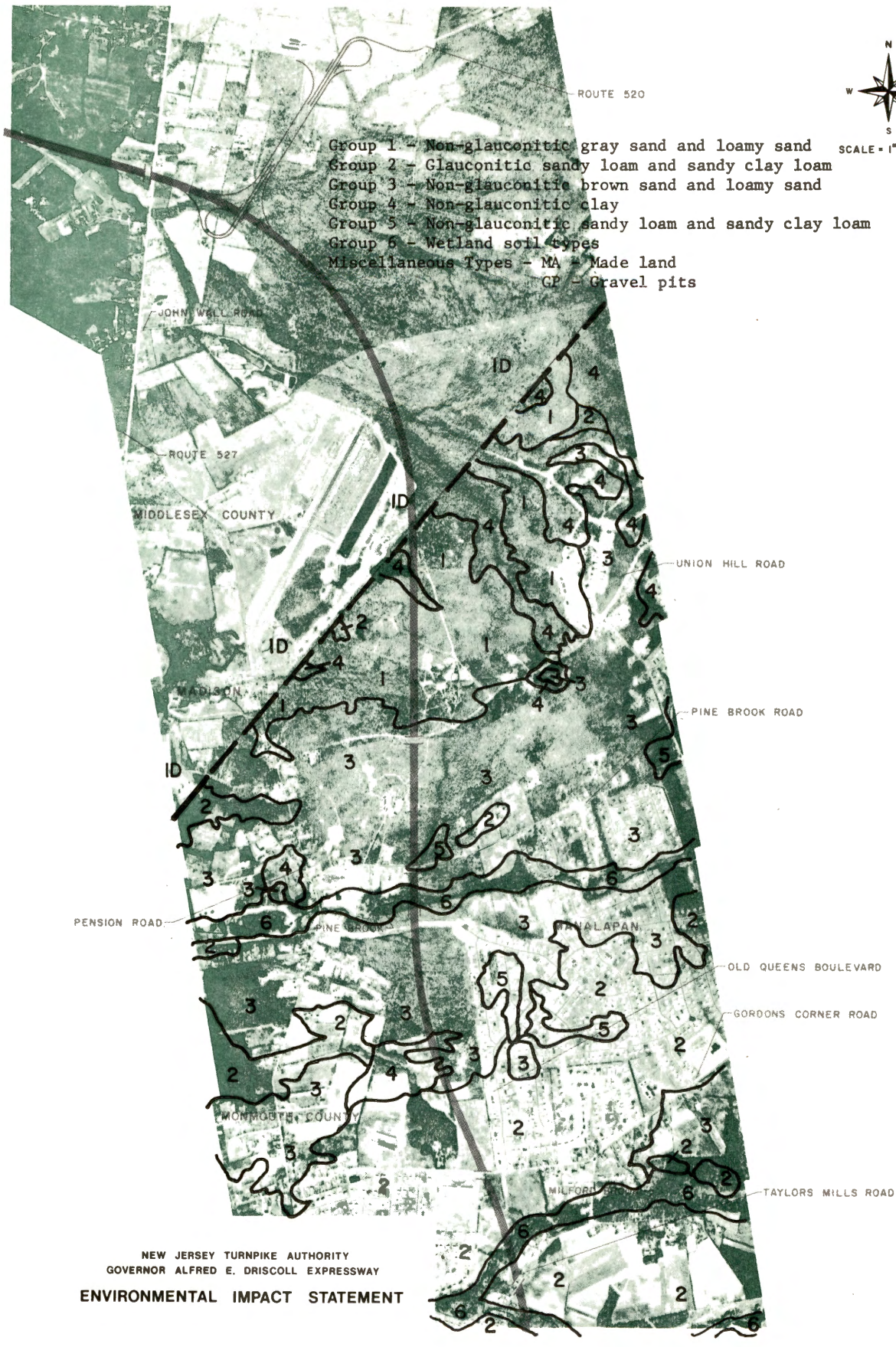

FIGURE 16. SOILS: SHEET 8 OF 10



FIGURE 16. SOILS: SHEET 9 OF 10



FIGURE 16. SOILS: SHEET 10 OF 10

TABLE 14. SOIL GROUPINGS

Group Number	Numeric or Letter Symbol	Series Name
1	970	Lakewood
	972	Lakehurst
	973	Leon-Atsion
	974	St. Johns-Berryland
	901	Munion-Woodmansie
2	Subgroup A	
	811	Monmouth
	821	Collington
	822	Adelphia
	823	Shrewsbury
	824	Keansburg
	841	Lincroft
	861-871	Freehold
	862	Holmdel
	890	Colt's Neck
	8C1	Fort Mott
	8J1	Howell
	9F1	Westphalia
	9F2	Nixonton
	9F3	Pasquotank
	9F4	Weeksville
	9K0	Eatontown
	C01	Tinton-Galestown
	C02	Delanco
	Subgroup B	
	801	Marlton
	802	Kresson
	803	Colemantown
	814	Matlock
3	930-931	Evesboro-Lakeland
	932	Klej
	933	Plummer
4	982	Keyport-Howell
	983	Elkton
	984	Bayboro-Alloway
	9B1	Matawan
5	9H1	Aura
	941	Sassafras
	9J1	Downer
	942	Woodstown
	943	Fallsington
	944	Pokomoke
6	C23	Loamy alluvial land
	C24	Alluvial land
	C54	Sandy alluvial land
	C75	Freshwater marsh
	CW5	Swamp
	M64-M74	Muck
Miscellaneous	MA	Made land
	GP	Gravel pits
	ID	Insufficient data

Note: Soil groupings used in this report based on texture of subsoil and presence or absence of glauconite.

natural vegetation types and agricultural land uses were utilized from newer soil surveys (Markley, 1971; Jablonski, 1972) and do not necessarily reflect local site conditions.

SOIL GROUPINGS

The following seven categories of soils as used in this report were based mainly on the predominant texture of the subsoil plus the presence or absence of glauconite, a dark-green mineral commonly found in greensand. These groupings are wholly artificial because each series includes soil types that differ widely in regard to drainage, erodibility, and surface texture.

Table 15 gives the breakdown of soils categories for each township or borough within the proposed Expressway right-of-way.

Group One

Group One includes soils of the Lakewood, Lakehurst, Leon-Atsion, St. Johns-Berryland, and Munion-Woodmansie series. These soils generally have a gray sand or loamy sand subsoil and are non-glauconitic. They generally are not suited to agriculture except under intensive management. Lakewood, Lakehurst, and Munion-Woodmansie series are somewhat poorly to excessively drained, infertile soils which, owing to their lack of agricultural utility, are covered largely by forests of pitch pine, black oak, white oak, black gum, and hickory. On areas that have been burned frequently by severe fires, the forests are composed principally of pitch pine, black oak, post oak, blackjack oak, and scrub oak. The Leon-Atsion and St. Johns-Berryland series are composed of poorly to very poorly drained soils near borders of swamps and adjacent to some streams. These acid, infertile soils generally support lowland forests of pitch pine with dense undergrowth of scrub oak, sheep laurel, leatherleaf, and other shrubs.

Group Two

Group Two includes all of the glauconitic soils except for a few alluvial soils in Group Six. Subgroup A of Group Two is composed of soils with sandy loam or sandy clay loam subsoils; Subgroup B includes soils with large amounts of clay in the subsoil. No distinction was made between these subgroups on the soils maps included with this report.

Subgroup A consists of the very strongly acid Collington, Adelphia, Shrewsbury, Keansburg, Lincroft, Freehold, Holmdel, Colt's Neck, Westphalia, Nixonton, Pasquotank, Weeksville, Eatontown, Tinton-Galestown, Delanco, Monmouth, and Fort Mott series. The Collington, Lincroft, Freehold, Colt's Neck, Westphalia, and Monmouth series are well-drained soils of moderate to moderately high fertility and include some of the best all around agricultural soils. The natural vegetation on these soils is a hardwood forest of mixed oaks, hickory, ash, beech, and tulip poplar. The Catonville, Tinton-Galestown, and Fort Mott series are well to excessively well-drained soils of low fertility and thus are of marginal agricultural value. Moderately well to somewhat poorly drained soils in this subgroup include the Adelphia, Holmdel, Nixonton, and

TABLE 15. IMPACT ON SOILS BY LISTED TOWNSHIP

Township or Borough	Base-map Sheet No.	Soil Categories (Length in Feet)								
		1	2	3	4	5	6	MA	GP	ID
Berkeley (T.)	1									3,750
Dover (T.)	1,2,3	9,875		15,375		18,375	1,750	2,250	2,000	1,500
Lakewood (T.)	3					1,250				
Jackson (T.)	3,4,5	13,500	2,000	4,000		10,375	2,749			9,935
Freehold (T.)	5,6,7	15,687	15,750				500			
Manalapan (T.)	7,8	2,875	21,875	5,375	1,000	250	1,750			
Madison (T.)										11,625
Monroe (T.)	8,9	312	1,375	3,250	1,000		1,625			9,500
Helmetta (B.)	10					500				1,500
East Brunswick (T.)	10					4,500				
South Brunswick (T.)	10					5,750				
Totals:										
Feet		42,249	41,000	28,000	2,000	41,000	8,374	2,250	2,000	37,810
Miles	38.8	8.0	7.8	5.3	0.4	7.8	1.6	0.4	0.4	7.2

Note: Distances measured by ruler along center line of proposed right-of-way on photographic base maps (scale 1" = 2,000 feet).

Delanco series. Fertility of these soils is moderate to moderately high, and they are rated as fair to good agricultural lands depending on the extent of drainage required. The native vegetation is a mixed hardwood forest of oaks, hickory, beech, ash, tulip poplar, and sweetgum. The Shrewsbury, Keansburg, Pasquotank, and Weeksville series are composed of poorly to very poorly drained soils of moderate fertility and generally are utilized for pasture and hay. Their natural vegetation is a lowland hardwood forest of mixed oaks, ash, beech, hickory, holly, sweetgum, and red maple with a dense undergrowth.

The soils of Subgroup B include the Marlton, Kresson, Colemantown, Matlock, and Howell series. The Marlton and Howell series are strongly acid soils, moderately well to well-drained, and of moderate to high fertility, but agricultural uses are limited to hay and pasture owing to drainage problems related to the clay subsoil. Such soils may be relatively wet one day and relatively dry a few days later. The Kresson, Colemantown, and Matlock soils are somewhat poorly to very poorly drained. While they generally are fertile, these are poor agricultural soils and best adapted to forest cover.

Group Three

Group Three soils include the Evesboro-Lakeland, Klej, and Plummer series. They typically have a brown, loamy sand subsoil and are non-glauconitic. Evesboro-Lakeland and Klej soils are moderately well to somewhat poorly drained, have a low natural fertility, and are highly acid. Fertilizers leach readily from such soils. Native vegetation on Evesboro-Lakeland soils is composed largely of pitch pine and various oaks. Klej soils, which form on river terraces, often have hardwood forests of black oak, white oak, and hickory. Soils of the Plummer series, which are strongly acid, poorly drained, and have moderate to high organic matter contents, form in topographically low areas and generally are covered by forests.

Group Four

The Keyport, Elkton, Bayboro-Alloway, and Matawan soil series compose Group Four. These are clay or sandy clay soils without greensand (glauconite). These soils typically are moderately well-drained (Keyport and Matawan) to poorly drained (Bayboro-Alloway, Elkton) owing to the clay subsoil. They are strongly acid and of moderate fertility generally suited to intensive agriculture because of wetness. Natural vegetation on such soils is a hardwood forest composed of tulip poplar, red oak, white oak, ash, beech, and hickory.

Group Five

The soils comprising Group Five are the Aura, Sassafras, Downer, Woodstown, Fallsington and Pokomoke series. These are non-glauconitic and have a sandy loam or sandy clay loam subsoil. Aura, Sassafras, Downer, and Woodstown soils are well to moderately well-drained, acid, and of moderate fertility. They can be productive agricultural lands with proper management and forests have been cleared from most of their areas. The native vegetation is a hardwood forest of mixed oaks, beech, tulip poplar, hickory, and pitch pine. The Fallsington and Pokomoke series are poorly to very poorly drained, low-lying soils which are moderately fertile and very strongly acid unless they have been limed.

Drainage is necessary for intensive farming; thus hay and pasture are recommended uses. The native vegetation cover is a lowland hardwood forest of various oaks, black gum, red maple, and pitch pine with a dense undergrowth of shrubs.

Group Six

This category includes loamy and sandy alluvial soils, freshwater marsh, swamps, and muck which generally form adjacent to perennial streams and in other topographically low areas. They are acid and have a dark gray or black subsurface layer, but the subsoil texture varies widely according to topographic position and the source of the parent material. Glauconite is present in some of the soils, but not in others. They vary from moderately well-drained to very poorly drained. Alluvial land is most often associated with the Leon-Atsion and St. Johns-Berryland soils of Group One and with muck. The native vegetation on alluvial land varies from Atlantic white cedar in the muck areas to pitch pine, red maple, black gum, and magnolia in sandy areas, but some sites have been cleared for blueberry or cranberry production. Freshwater marshes and swamps have a natural vegetation of rose mallow, buttonbush, and other water-adapted species. These soils of Group Six are best suited for wildlife habitats and limited lowland agriculture.

Miscellaneous Types

This category includes made land and gravel pits. In older soil surveys, before residential and industrial expansion, soils were mapped in detail around and within settled areas. There were few areas called "made land." In recent surveys, however, extensive urban and suburban areas are mapped as made land or as urban land and not differentiated into soil types. Made land is not a soil, but generally is earth material thrown up or spread out during excavations, river dredgings, or other man-related changes. Textures and drainage conditions vary widely and these areas are generally unsuited for crops. Pits are also man caused perturbations in the earth's surface. These are mainly sand and gravel pits which differ from made land in that they are areas from which all of the soil and much of the underlying material has been removed. In the pits fertility is low, acidity is high, and large areas are subject to wind erosion. Where the water table is high, the pits often fill with water and have some recreational or wildlife value.

On the soils maps included in this report (Figure 16), sand pits and gravel pits both are designated by the symbol, GP.

AGRICULTURAL POTENTIAL

The agricultural potential of soil types within the several general groups employed in this analysis differ widely. National Agricultural Land Capability Groupings and the state Agricultural Land Value Soil Groups are specific for each soil type and variant and are determined by such factors as slope, and topsoil texture. A detailed evaluation by soil type is not possible here, although a general assessment can be made concerning the average agricultural potential of each soil group.

The soils of Group One generally are poor agricultural soils owing to intrinsic low fertility and poor moisture relationships. Lakewood, Lakehurst, and Munion-Woodmansie series are well-drained to the point of droughtiness whereas the lower lying Leon-Atsion and St. Johnsberryland soils are poorly drained and are covered by water during several weeks of each year.

Group Two soils are more difficult to characterize because twenty-two soil series are included. Subgroup A, however, includes some of the best agricultural soils. Most are highly fertile and the principal agricultural limitation is drainage. Poorly drained soils of this subgroup, thus, are better adapted to hay and pasture. Subgroup B, in contrast, includes series with clayey subsoils which retain or retard downward water movement, and result in severe agricultural limitations. Because the groups were not divided on the basis of land use capabilities, it is not possible to determine on the enclosed maps which soils of Group Two are good agricultural lands and which are poor.

Group Three soils are infertile and generally have poor natural drainage. Thus, they have severe limitations for agricultural purposes unless intensively managed.

Group Four includes moderately well-drained to poorly drained soils of moderate fertility. These soils generally are not suited to intensive agriculture because of their wetness.

Group Five is a mixed group insofar as agricultural potential is concerned. The soils of this group are moderately fertile, and are well to poorly drained. Except for the poorly drained series (Fallsington and Pokomoke), they can be good agricultural lands with proper management.

The soils of Group Six and those of the Miscellaneous types are not adapted to general agricultural utilization owing to poor drainage and/or disturbance.

LIMITATIONS AND IMPACT

Engineering limitations vary widely depending on the proposed use of a soil body. Soils with severe engineering limitations may be difficult to modify, may require extensive reclamation, special design, and/or intensive maintenance. Their alteration and use may result in undesirable environmental changes. Moderate limitations generally can be overcome by minor modifications, special designs, and/or continual maintenance, and generally would not result in unacceptable environmental changes. Slight limitations necessitate few modifications and would not result in serious environmental impact.

AGRICULTURE

Generally, soils to be impacted along the proposed Expressway alignment have at least moderate limitations for agricultural purposes owing to low inherent fertility, strong acidity, and drainage problems. Productive farming along the proposed alignment often requires exces-

sive fertilization, liming, and drainage control. The best agricultural soils, those within Group Two and Group Five, lie within Freehold, Manalapan, and South Brunswick Townships. Approximately 8.2 miles (21.1% of total Expressway length) of these more valuable agricultural soils would be impacted.

SUSCEPTIBILITY TO WIND EROSION

Because most of the soils along the proposed alignment contain large proportions of fine sand, they are susceptible to wind erosion if the vegetation cover is removed. Special care will be required during the construction and maintenance phases to minimize blowing sand which often results in inconvenience, discomfort, and economic loss. Limiting the size of the area to be disturbed at any given time, and planting rapidly growing cover plants soon after the construction phase is completed should reduce the impact of this erosion. Permanent windbreaks will be built along especially susceptible open areas soon after completion of sections of the road.

Alluvial soils, freshwater marshes, and swamps normally are not affected by wind erosion except when extremely dry.

DRAINAGE

Several areas along the proposed Expressway can be expected to have severe soil limitations owing to poor drainage. These are areas of alluvial soils (Group Six) and of poorly drained soils in all other categories. Where the proposed alignment follows Toms River in Dover Township, and where it crosses drainage channels of smaller tributaries in Jackson, Freehold, Manalapan, and Monroe Townships, dredge and fill operations to remove unstable alluvial soil may result in stream siltation, wildlife habitat destruction or degradation, and altered drainage patterns. Such impact will be reduced by special practices during the construction stage to limit siltation. No large areas along a particular drainage should be altered simultaneously, and vegetation should be reestablished as soon as the work in a given area is completed. Suitable bridges, culverts, and other structures may be required to minimize drainage pattern alterations.

WATER EROSION

Steep slopes located mainly along the banks of streams may erode excessively if they are not stabilized rapidly with vegetation or structures. Water erosion of piled topsoil during the construction phase may result in sedimentation of local streams. It is recommended that such piles be grassed over until used to minimize this erosion problem in sensitive areas near streams. Ring dikes should be used around more permanent storage areas.

GRAVEL PITS, MADE LAND

The proposed right-of-way may include gravel pits and made land in Dover Township and other small areas. The effect on existing pits is not as important as the impact on areas where new borrow pits will

be opened to obtain fill for highway construction. These excavations will destroy existing soils, but such impact cannot be assessed until the proposed source areas for fill are designated. However, pits created by the construction of the Expressway will be graded and landscaped to minimize aesthetic impact.

The impact on made land is not considered important from a soils viewpoint owing to previous extensive alterations, but there may be severe engineering limitations in areas of made land. The extent of impact on made land in Dover Township is minimal (0.4 mile or 0.01% of total length of the proposed alignment).

TRAFFICABILITY

Trafficability of soils, or the way a soil responds to continued surface compaction, may be a factor to consider in service areas adjacent to the Expressway. Heavy foot traffic in grassed areas such as picnic sites may result in deterioration of the vegetation and increased wind and water erosion hazard if the topsoil is fine sand. This can be alleviated by paving foot trails, placing picnic tables on paved pads, and keeping grass in a healthy state by watering and periodic fertilization.

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CRANBERRY BOGS

An active cranberry bog complex, owned by Edward Lipman, will be affected by the proposed alignment of the Governor Alfred E. Driscoll Expressway. This complex is located east of Holmansville on Dove Mill Branch of Toms River and Sandy Hollow -- a tributary that flows into Dove Mill Branch midway between the Butterfly Road bridge and the Route 527-528 bridge (see Figure 17).

The complex is divided into three bogs (Figure 17):

1. **Beauty Bogs:**
   Total bog area approximately 20 acres; three bogs are located east of Sandy Hollow, approximately 1500 feet above Dove Mill Branch; two reservoirs are located on Sandy Hollow above Gravel Road, adjacent to Butterfly Road.
2. **Iron Bog:**
   Total bog area approximately 6 acres; one bog is located on Sandy Hollow, directly above Dove Mill Branch; the reservoir is located on Sandy Hollow directly above the bog.
3. **Bunker Hill Bog:**
   Total bog area approximately 24 acres; two bogs located on Dove Mill Branch directly above Route 527-528; one reservoir located on Dove Mill Branch directly above the bogs.

Three bogs (formerly owned by David Showell) on Dove Mill Branch between Butterfly Road and Sandy Hollow, also owned by Mr. Lipman, have been fallow for a number of years and are overgrown by shrubs and young trees.

WATER FLOW PATTERN

Water flowing down Sandy Hollow is impounded in the two Beauty Bog reservoirs north of Gravel Road. It then is diverted by a ditch to the northern end of the Beauty Bogs, where it can either be diverted into the northwestern bog (Figure 17, B-NW) or into the northern end of the eastern bog (B-E). Water normally leaves the bogs at their western edges and flows to the Iron Bog reservoir, but it can also be released from the eastern bog into the adjacent swamp.

Water from the reservoir passes through a gate into the Iron Bog. It is released through a gate in the middle of the southwest side of the bog into Dove Mill Branch. After flowing through Dove Mill Branch for approximately 1000 feet, the water enters the Bunker Hill reservoir. Then flow from the reservoir passes through the northern and southern Bunker Hill bogs, and then exits under Route 527-528 as Dove Mill Branch.

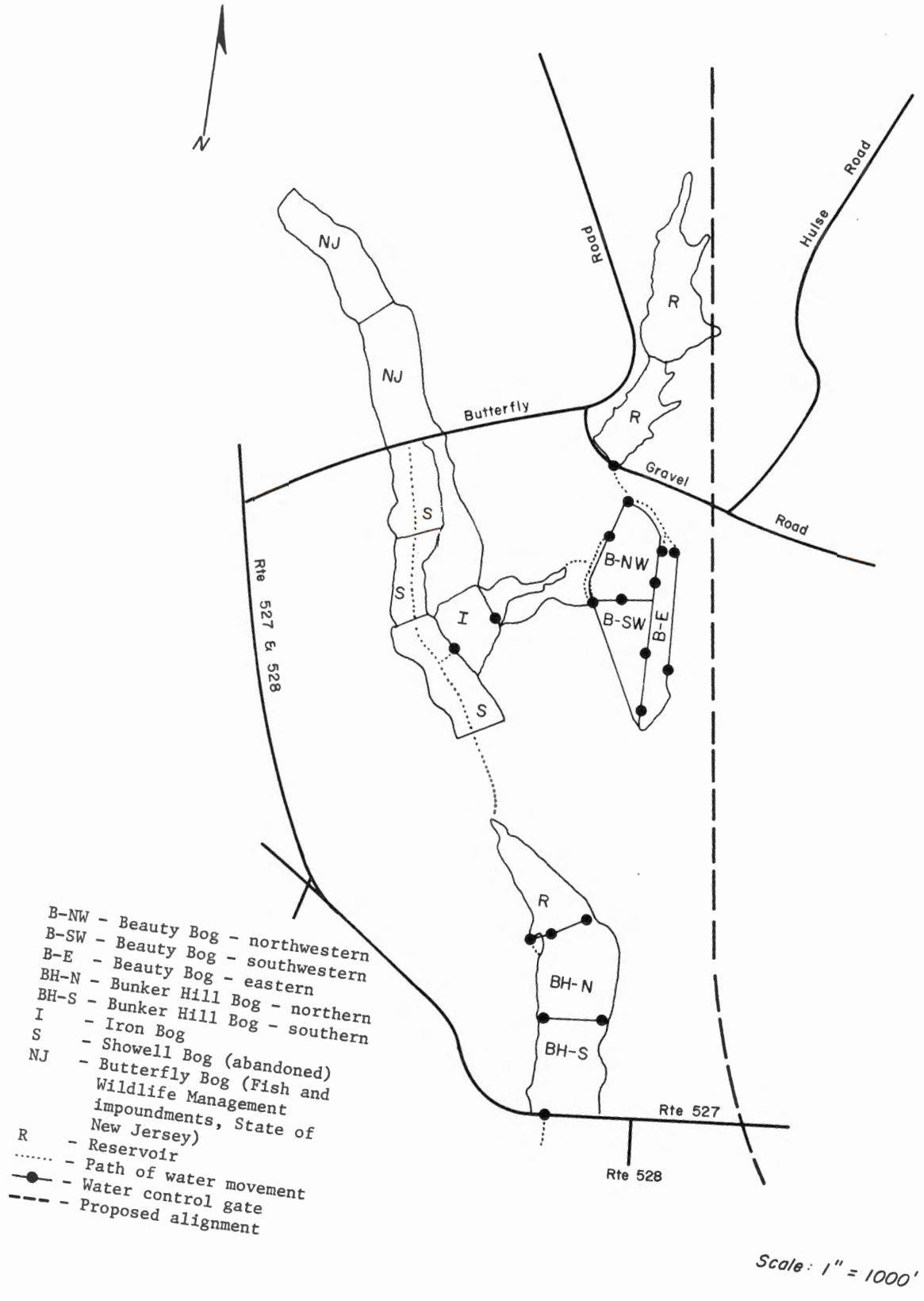

FIGURE 17. LIPMAN CRANBERRY BOG COMPLEX

PRODUCTION

The 1971 production for the three bogs was: Beauty Bogs --1820 barrels, Iron Bog -- 400 barrels, and Bunker Hill Bogs -- 500 barrels (E. Lipman, personal communication, 1972). The average per acre production was: Beauty Bogs -- 91.1 barrels, Iron Bog --66.6 barrels, and Bunker Hill Bogs -- 20.8 barrels. Thus, the Beauty Bogs are the major producers and the most productive per acre in the complex. This is because the Beauty Bogs have been more intensively managed and maintained than the other two bogs (E. Lipman, personal communication, 1972). The productivity of the Beauty Bogs, furthermore, is responsible for the economic feasibility of the operation of this complex. The Bunker Hill Bogs, however, have been increasingly productive because of improvements in water control.

According to P. Marucci of the Rutgers Agricultural Extension Service, Cranberry and Blueberry Research Station, New Lisbon, New Jersey, the Beauty Bogs were severely defoliated by gypsy moths during June of 1972 and production may be reduced by 50 per cent. The Iron Bog was defoliated slightly. This should have no long term impact on bog productivity.

CRANBERRY INDUSTRY

Although the acreage of active cranberry bogs in New Jersey has fluctuated little during the last decade, the production and crop value has varied greatly (Table 16). Total acreage has ranged from a low of 2,600 acres in 1963 to a high of 3,300 acres in 1968. Production was lowest in 1963 (25.3 barrels per acre) and highest in 1971 (76.5 barrels per acre). The 1971 crop set a new harvest record for the State.

The output from the Lipman bogs constututed 1.2% of the total New Jersey crop in 1971. As compared with the average yield of 76.5 barrels per acre for the State, the Beauty Bogs were above average by 19.1%. The Iron Bog, however, was below average by approximately 12.9%, and the Bunker Hill Bogs by 72.8%.

IMPACT

The proposed alignment is situated to the east of the cranberry bogs. The west right-of-way line of the roadway crosses Route 528 at the intersection of Route 527 (approximately 1050 feet from the southeastern corner of the southern Bunker Hill Bog). The right-of-way line then proceeds northward parallel to the Bunker Hill Bogs at a distance of not less than 500 feet. The line then closely parallels the edge of the eastern Beauty Bog at a distance of from 60 to 10 feet.

TABLE 16. CRANBERRY PRODUCTION IN NEW JERSEY

YEAR	ACRES HARVESTED	AVERAGE YIELD PER ACRE	TOTAL PRODUCTION	VALUE PER BARREL	TOTAL CROP VALUE
1962	3000	34.3	103,000	$10.00	$1,020,000.
1963	2600	25.3	65,800	12.20	803,000.
1964	3100	49.4	153,000	14.50	2,218,000.
1965	3000	51.0	153,000	15.70	2,402,000.
1966	3000	45.0	135,000	15.60	2,106,000.
1967	3200	49.1	157,000	14.70	2,308,000.
1968	3300	47.0	155,000	16.70	2,588,000.
1969	3000	53.3	160,000	16.50	2,640,000.
1970	3100	57.7	179,000	11.80	2,112,000.
1971	3100	76.5	237,000	11.70	2,773,000.

Note: Cranberry production (barrels and dollar value) in New Jersey, 1962 to 1971 (N.J. Crop Reporting Service, 1969; 1971 data not yet published).

North of Gravel Road, the line passes to the east of the southern Beauty Bog reservoir at a distance of 550 to 50 feet. The alignment would take the eastern third of the northern Beauty Bog reservoir for approximately 1050 feet, and the roadbed of the southbound lanes would cross this reservoir at two points for a total distance of approximately 160 feet. The center of the roadway will cross Sandy Hollow approximately 1000 feet above the northern Beauty Bog reservoir and pass through the western portion of the headwaters of Sandy Hollow.

There are three ways in which the proposed roadway can affect the cranberry culture in these bogs: heavy sedimentation; water pollution by salt, oils, and other toxic materials; and alteration of water flow. Sedimentation will be a concern primarily during the construction of the highway. Erosion of materials from spoil piles and denuded land could fill in the reservoirs, block ditches, and bury vines. This is not expected to be a serious problem owing to the low relief of the area. If suitable erosion control measures were instituted during and following construction activities, the impact could be minimized. Sedimentation damage also can be corrected without permanent loss of bog productivity.

Water pollution by salt and other deicing chemicals, crankcase oil, fuel oil, gasoline, and spills of toxic chemicals resulting from highway accidents could permanently destroy bog productivity by killing or stunting the cranberry vines or contaminating the soil. Severe short-term pollution also could destroy or reduce the crop during a particular season by imparting undesirable characteristics (such as taste, odor, or appearance) to the fruit. The Beauty Bogs would be most susceptible to such damage because of their proximity to the alignment, but the Iron Bog and Bunker Hill Bogs also could be affected because they receive water from Sandy Hollow. No assessment can be made now of the potential impact because of the lack of data concerning the types and concentrations of possible pollutants and their effects upon cranberries.

Alteration of water flow is the most probable impact of the roadway (P. Marucci, personal communication, 1972). Water control is a very critical aspect of cranberry culture and alteration of the flow characteristics of the watershed could make an extensive revision of the existing water control system necessary, or make cranberry culture impossible. Because the roadway will pass through the northern Beauty Bog reservoir and a substantial area of swamp associated with Sandy Hollow, it will reduce the water retaining characteristics of the swamp. The channeling of runoff waters from the paved and grassed areas of the roadway into the Sandy Hollow watershed also will increase flooding and the intensity of flow variation in the watershed. The Beauty Bogs would be most affected because of their proximity to the roadway.

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VEGETATION

An assessment of the probable impact of the proposed Governor Alfred E. Driscoll Expressway on vegetation of the selected alignment was prepared in June and July of 1972. The vegetation maps (Figure 18, scale 1 inch = 2,000 feet) were prepared from aerial photographs (scale approximately 1 inch = 1,000 feet) taken in April and August of 1971. Field investigations were conducted to determine the nature of the vegetation types and to improve the accuracy of the mapping.

VEGETATION TYPES

Twenty-four vegetation types were identified in the field investigations. These types were combined into nine general vegetation types for the purposes of this report.

UPLAND FOREST TYPE (UF)

The upland forest type includes four subtypes: oak, oak-pine, pine-oak, and pine-oak scrub. The oak subtype occurs primarily along the northern half of the alignment and contains red oak, white oak, black oak, pin oak, and pignut hickory. Sprouts of American chestnut are common in some areas. Lowbush blueberry frequently forms an undergrowth.

The remaining three subtypes that form the upland forest type are found primarily along the southern half of the alignment and are representative of the New Jersey Pine Barrens biotic region. The oak-pine subtype consists principally of pitch pine and shortleaf pine, although tree-sized oaks (primarily black, white, post, and chestnut oak) occur in small numbers. Lowbush blueberry, shrubby oaks (scrub, blackjack, and dwarf chestnut oak), and bracken fern are common in the undergrowth. In the pine-oak subtype oaks are more common than pines. Mountain laurel is occasional in the undergrowth, along with lowbush blueberry, shrubby oaks, and bracken fern. The pine-oak scrub subtype represents forests that have been disturbed recently by fire or logging. The pines generally are the tallest living trees, but are widely spaced so that their crowns do not form a closed canopy. Shrubby oaks form a dense undergrowth with sweetfern, staggerbush, bracken fern, and lowbush blueberry.

LOWLAND FOREST TYPE (LF)

The lowland forest type consists of six subtypes: hardwood swamp, hardwood swamp mixed with other species, gum-poplar, pine lowland, oak lowland, and white cedar. The hardwood swamp subtype is common along the entire alignment.

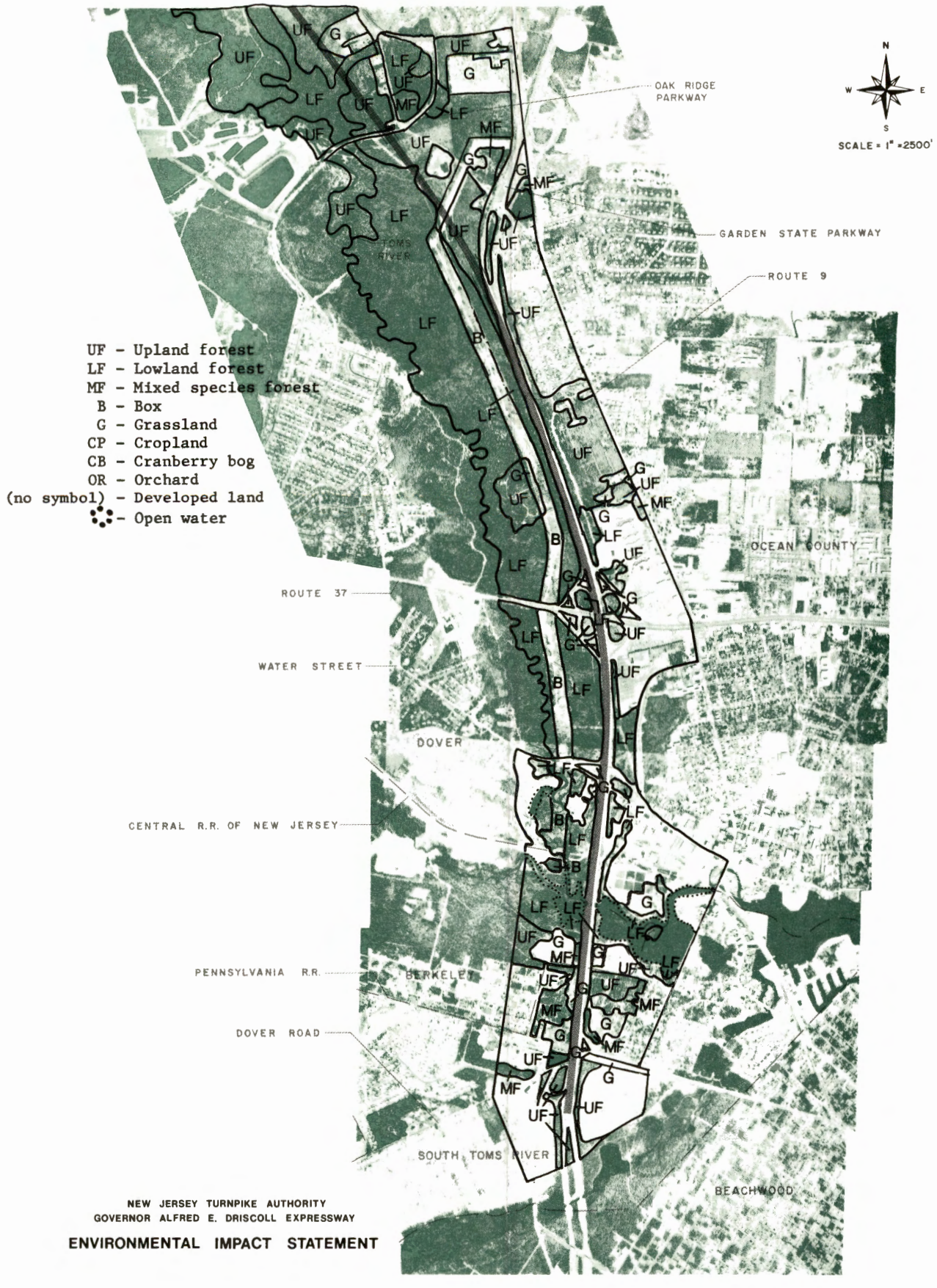

FIGURE 18. VEGETATION: SHEET 1 OF 10



FIGURE 18. VEGETATION: SHEET 2 OF 10



FIGURE 18. VEGETATION: SHEET 3 OF 10



FIGURE 18. VEGETATION: SHEET 4 OF 10

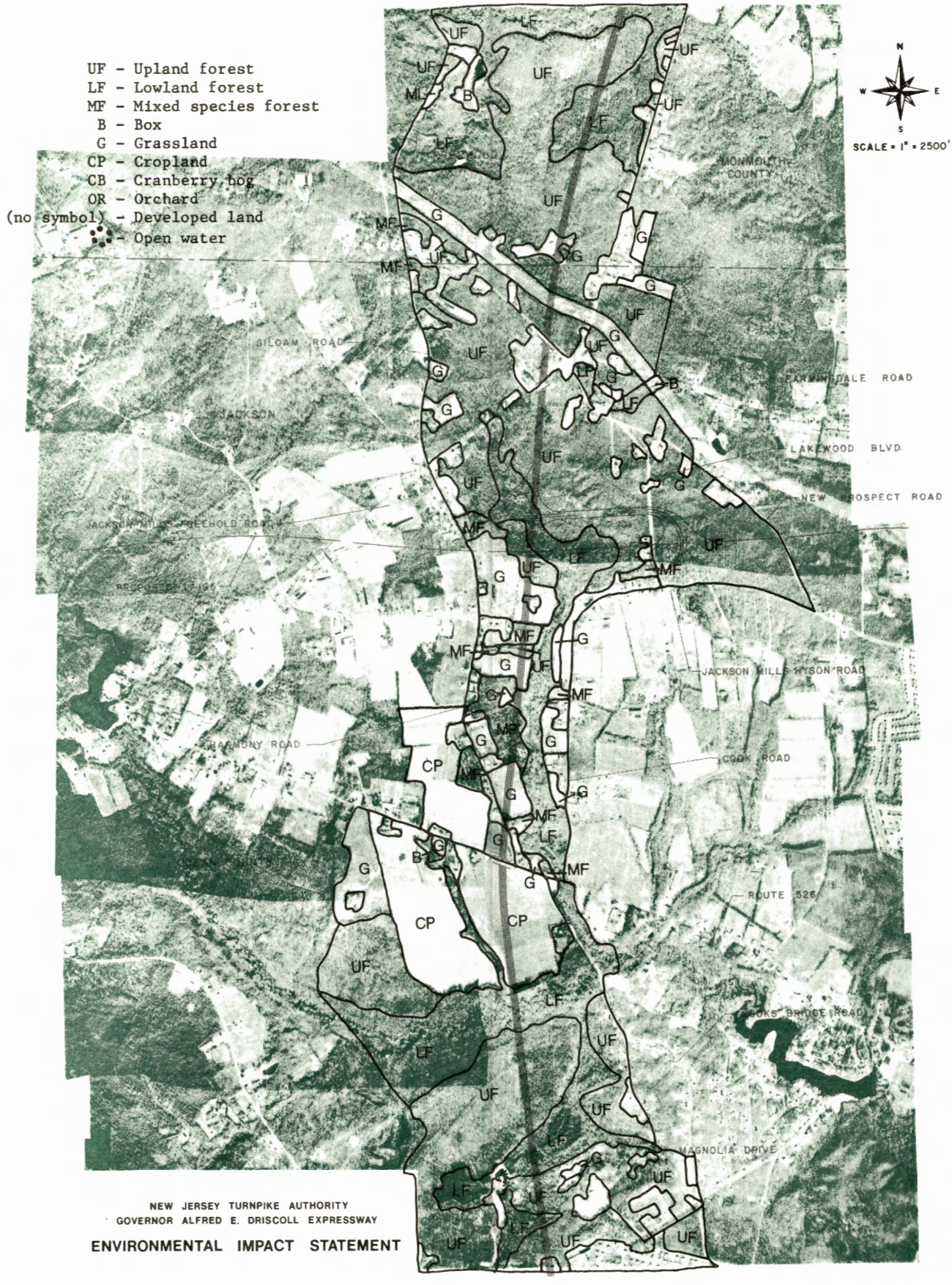

FIGURE 18. VEGETATION: SHEET 5 OF 10

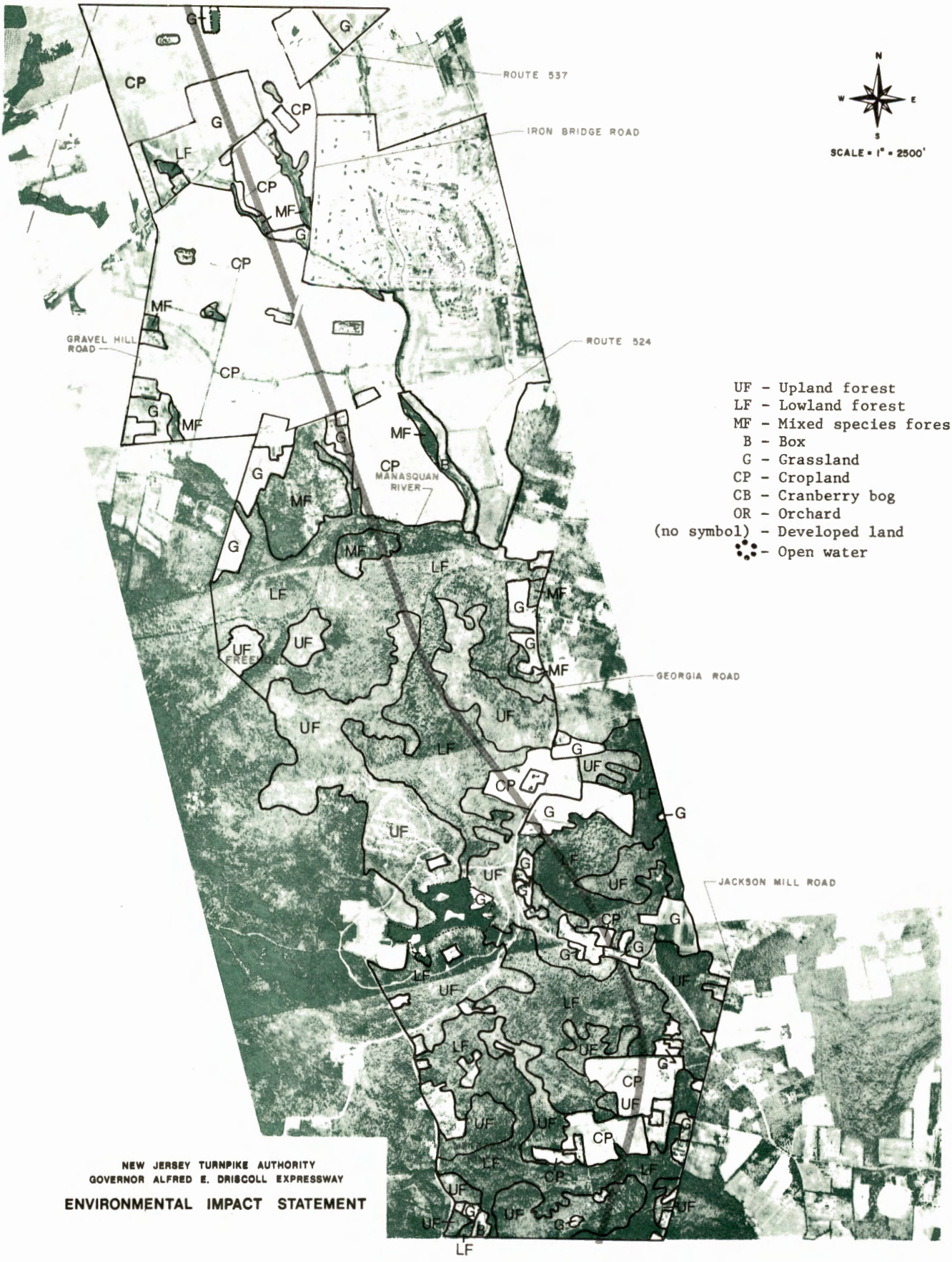

FIGURE 18. VEGETATION: SHEET 6 OF 10

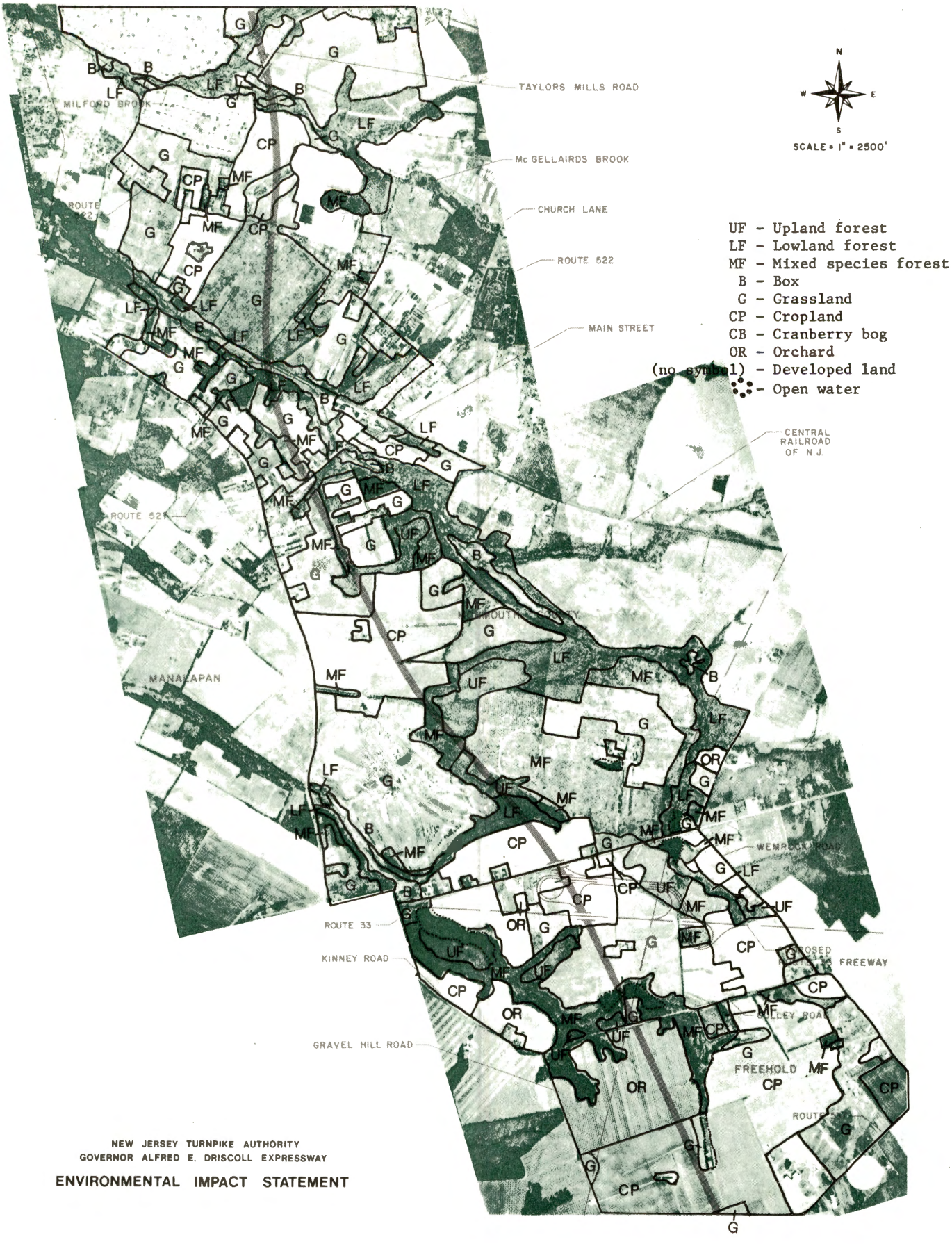

FIGURE 18. VEGETATION: SHEET 7 OF 10

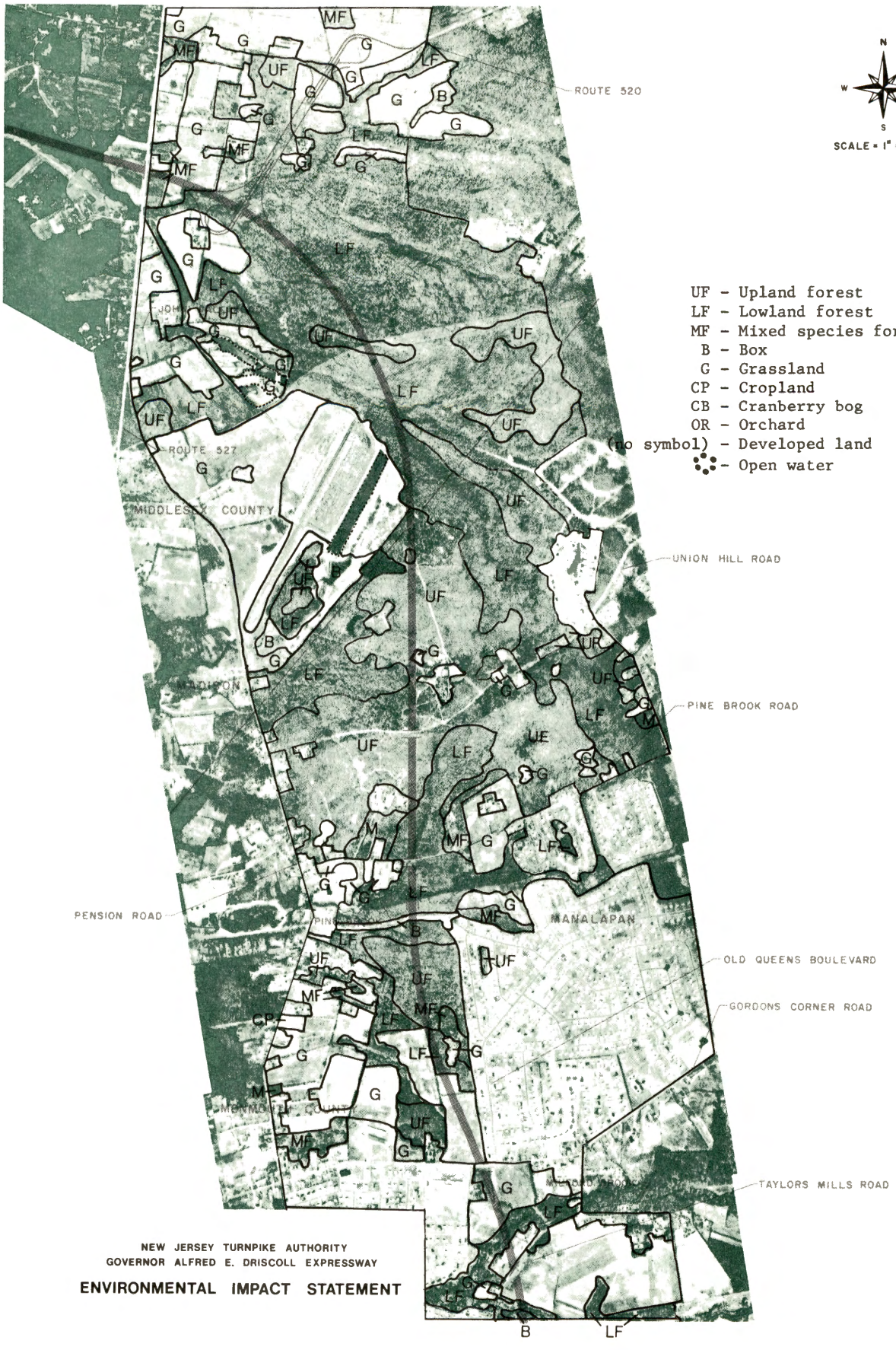

FIGURE 18. VEGETATION: SHEET 8 OF 10



FIGURE 18. VEGETATION: SHEET 9 OF 10



FIGURE 18. VEGETATION: SHEET 10 OF 10

Red maple, sweetgum, and blackgum are the most characteristic trees, and highbush blueberry, cinnamon fern, sweetbay, and swamp azalea are frequent in the undergrowth. Most stands of the hardwood swamp mixed species subtype occupy fallow fields in or near lowland areas. Hardwood swamp trees are mixed in these stands with species that are more characteristic of abandoned fields (such as winged sumac, redcedar, black locust, and sassafras). The gum-poplar subtype is infrequent along the northern half of the alignment. Represented by pure stands of tulip poplar or sweetgum, it occupies areas that generally are moist but not wet, such as the slopes of valleys. The pine lowland subtype occurs primarily in the southern half of the alignment in moist areas adjacent to hardwood and white cedar swamp forests. Pitch pine is the predominant species, although red maple and blackgum may be present in variable proportions. Sheep laurel frequently forms a dense undergrowth in which sweet pepperbush, inkberry, and bracken fern are associates. The oak lowland subtype grows in a few moist areas along the northern third of the alignment. Willow oak and pin oak are common trees, white oak is occasional, and other lowland species are variably abundant. The white cedar subtype occurs only in a few small areas along the alignment. Atlantic white cedar is the principal tree, but hardwood swamp species are usually present in small numbers. Sphagnum moss is common in the ground layer, and cinnamon fern, highbush blueberry, and swamp azalea occasionally form a sparse undergrowth.

MIXED SPECIES FOREST TYPE (MF)

The mixed species forest type, which occupies areas that have been cleared for agriculture or otherwise disturbed in the past, is composed of five subtypes: mixed species, mixed species-pine dominant, mixed species-red cedar dominant, abandoned orchards, and mixed species-lowland forest. Sassafras, black cherry, winged sumac, black locust, and red cedar are common woody species. Small, irregular clearings in which asters, goldenrods, thoroughworts, broomsedge and other herbaceous plants grow are frequent in mixed forest stands. Wild grapes, greenbriers, blackberries, and dewberries are occasional.

Shortleaf pine, pitch pine, or red cedar is the predominant tree in some mixed species forests. Plantations of introduced pines (Scotch and white pine) also were mapped as the mixed species forest-pine dominant subtype. Mixed species forests near lowland areas frequently contain a few trees characteristic of the hardwood swamp subtype.

BOG TYPE (B)

The bog type includes three subtypes of non-forest wetland vegetation: bog, lowland shrub, and meadow. These subtypes occur in wetland areas along the entire alignment, although few of them were large enough to be delineated on the map.

The bog subtype contains low woody vegetation, including leatherleaf and cranberries, and occurs primarily along the southern half of the alignment. Most of the inactive commercial cranberry bogs which were classified as bogs, occur at the southwest corner of Helmetta and southwest of Turkey Swamp on Schreibers Lane. Southern arrowwood is the principal component of the lowland shrub subtype, but lowland tree saplings are in most stands. This subtype is most common in the northern half of the alignment. The meadow subtype, which is predominantly an herbaceous vegetation, occurs along the entire alignment, but the stands vary widely in composition. Some meadows are composed of low grasses, sedges, and rushes, whereas others are formed by broad-leaved cattail or common reed. Some meadows in the southernmost part of the alignment are representative of the diverse Pine Barrens "open bogs" and contain such species as bog clubmoss, sphagnum moss, marsh fern, rose pogonia, orange milkwort, bladderworts, and meadow beauty.

GRASSLAND TYPE (G)

The grassland type includes two subtypes of non-lowland herbaceous vegetation: grassland and oldfield. The grassland subtype is composed of grasses, sedges, and other herbaceous species that are kept at a low height by periodic grazing or mowing. Lawns, golf course greens, pastures, and mowed rights-of-way are classed as this subtype, although few could be shown on the map because of their small size and proximity to developed land and roads. The oldfield subtype, which forms the bulk of the grassland type shown on the map, contains a variety of herbaceous species, including various grasses and sedges, broomsedge, thoroughworts, Queen Anne's lace, St. John's wort, goldenrods, and asters. Winged sumac, sassafras, greenbriers, grapes, blackberries, dewberries, and sapling red cedar, black locust, and black cherry are occasional minor components.

AGRICULTURAL TYPES (CP, CB, OR)

Three vegetation types represent agricultural and horticultural activity. Croplands (CP) are areas currently utilized for annual crops -- primarily corn and wheat. They are most common in the areas between Turkey Swamp and Englishtown, and northwest of Helmetta. Because of poor growing conditions in 1972, many croplands resembled oldfields at the time of this survey. Some croplands had not been planted because of extreme wetness, and others had been fallowed subsequent to planting owing to crop failure. Cranberry bogs (CB) are active at only one location -- east of Holmansville. They are described fully in a section regarding the impact of the proposed Expressway on cranberry agriculture. Active orchards (OR) are located principally between Routes 537 and 33 near the midpoint of the alignment.

Apple orchards are most common, but peaches also are grown. A tree-shrub nursery, which was mapped as an orchard, is located west of Helmetta on the Cranbury-South River Road between Davidsons Mill Road and Dunhams Corner Road.

DEVELOPED LAND

Developed land (no symbol used on the map) includes buildings and barren land associated with residences, farms, businesses, and public institutions. Small lawns and gardens in these areas are included as developed land.

LAKES AND PONDS

The borders of lakes and large ponds are denoted on the map by dotted lines.

IMPACT ASSESSMENT

A general assessment of impact of the proposed alignment can be made by considering the vegetation types and, in some cases, the subtypes that are included within the proposed alignment. In this approach the evaluation of probable impact is based upon the apparent uniqueness or value of vegetation types observed during field investigations. It is likely that certain areas of vegetation may be either more or less valuable than the general vegetation groups in which they have been categorized. The reconaissance level intensity of this investigation however does not warrant an assessment of site-specific impact, particularly in regard to any unique floristic communities.

On the vegetation maps utilized as overlays for a set of ten serial photograph base maps, the Expressway was assumed generally to require a right-of-way 450 feet wide. At interchanges the take line was assumed to be 100 feet from the edge of the outermost roadway. Seven interchanges are planned along the proposed alignment, including the Garden State Parkway in Toms River (Ocean County), Interstate I-195 (proposed roadway) in Jackson Township (Ocean County), Route 33 in Manalapan Township (Monmouth County), Route 520 in Madison Township (Middlesex County), and New Jersey Turnpike in South Brunswick Township (Middlesex County). The impact areas for a toll building and parking area 1,900 feet above the Route 70 interchange and west of the alignment were determined from a set of 43 plan sheets prepared by Howard, Needles, Tammen and Bergendoff (scale 1 inch = 200 feet).

VALUE OF VEGETATION TYPES

The evaluation of the different vegetation types and subtypes is the result of a subjective analysis of their uniqueness in relation to the areas in which they are found and the possibility that rare, unusual, or

scientifically valuable floristic communities may occur within them. On this basis, the following vegetation types and subtypes are considered to be of greater than average value and, therefore, to be most sensitive to impact by the proposed roadway: oak subtype, lowland forest type, and bog type.

The oak subtype is found on upland sites along the northern half of the alignment. This is a non-Pine Barrens forest type representative of the vegetation that once covered the Inner Coastal Plain Region of New Jersey. The Inner Coastal Plain is an area of fertile soils that occurs as a band along the Delaware River and across the neck of central New Jersey. This region has been subject to extensive farming and development since it was first settled, and much of the original upland forest cover has been destroyed. The small, scattered stands of oak are remnants of the once widespread natural vegetation.

The lowland forest type is represented along the entire alignment by a number of highly variable subtypes. Areas mapped as this type generally are floristically and structurally diverse - i.e., there is frequent variation in canopy and undergrowth height and density that favors floristic diversity. These stands, thus, include a variety of unusual, rare, scientifically valuable, and often aesthetically pleasing plant communities. The gum-poplar and white cedar subtypes frequently are represented by dense, single-species stands in which the floristic diversity of the undergrowth and ground layers is limited. Because they are so rare along the alignment, the gum-poplar and white cedar subtypes are considered to be of great intrinsic value. Cedar forests, in particular, represent a once-common regional vegetation type that now has become relatively scarce throughout southern New Jersey.

The lowland forest type also is of value as an indicator of environmentally sensitive areas from two non-vegetative viewpoints: wildlife and water-quality protection. The occurrence of a number of different plant communities in close proximity favors diversity of wildlife populations because it provides a variety of habitats and extensive edges between the various subtypes, as well as between lowland and upland types.

Lowland forests grow in moist to wet areas near streams. Development in these areas can adversely affect water quality and hydrology. Placement of fill, for example, may restrict normal and flood flows. Flood frequency and intensity may be increased by the channeling of runoff from extensive impervious land surfaces into existing stream channels. Water quality also may be affected by accelerated erosion after forest cover is removed from slopes.

The bog type is a floristically rich lowland vegetation which also indicates sensitive watershed areas. Bogs of the meadow subtype, in particular, may contain extremely unique, rare, aesthetically desirable, and scientifically valuable plant species. Orchids (such as the rose pogonia), insectivorous plants (including bladderworts, pitcher plant, and sundews), bog clubmoss, sphagnum moss, and ferns (including the rare curly grass-fern) are components of these communities.

IMPACT ON VEGETATION

Berkeley and Dover Townships - Ocean County

Garden State Parkway (distance along the centerline approximately 14,500 feet)[1] -- The construction of the Expressway will require widening and remodeling of the Garden State Parkway from Route 530 in Berkeley Township to a point in Dover Township at which Whitesville Road formerly crossed the Parkway alignment.

The chief impact will be upon lowland forest and bog areas west of the Garden State Parkway, between the Route 37-Parkway intersection and the point at which the Expressway will diverge from the Parkway (12,500 feet), where new southbound lanes for the Expressway will be constructed 300 to 400 feet west of the existing roadway. The impact area includes lowland forests and bogs previously created by the clearing of forests for a power line right-of-way 250 feet wide and crossed by the ROW.

Garden State Parkway to Route 571 (8,250 feet) -- After diverging from the Parkway, the Expressway will parallel the Toms River close to Route 571. Lowland forests along Toms River will be destroyed chiefly by the roadway from the Garden State Parkway to Oak Ridge Parkway (1,000 feet). Lowland forest of a small tributary 1,000 feet north of the Oak Ridge Parkway will be removed for 200 feet.

Route 571 Interchange -- The interchange to be constructed at Route 571 largely will displace lowland forests along Toms River. The Expressway will require relocation of an access road to the Albocondo Campground (private family camping) south of the interchange. The access road is to be relocated midway between the interchange and Toms River and also will destroy lowland forest.

Route 571 to Route 70 (14,500 feet) -- There will be little impact upon sensitive vegetation areas between Route 571 and Route 70. The first 2,000 feet of the Expressway, however, will destroy lowland forests and the roadbed will be within 150 feet of the Toms River. The roadway also will destroy lowland forest at the head of a small tributary to the Toms River for 200 feet (near the intersection of Route 527 with the alignment), and lowland forest on Slab Branch for 200 feet.

Route 70 Interchange -- The Route 70 Interchange will not impact any sensitive vegetation types.

Route 70 to the Dover Township Boundary (7,750 feet) -- This portion of the roadway will cross Grass Hollow Branch, a small tributary to Toms River approximately 3,000 feet north of Route 70. This valley, however, has been extensively altered by earthmoving activities at the crossing point and contains

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1/Distance determined by measurement on photo base maps at scale 1 inch = 2,000 feet (Table 17).

TABLE 17. IMPACT ON VEGETATION LISTED BY TOWNSHIP

	Vegetation to be destroyed			Road Length
	LF	B	UF	
Ocean County				
Berkeley	500			2,500
Dover	3,600			42,500
Lakewood				1,250
Jackson	11,250	200		43,750
Total - feet	15,350	200		90,000
- miles	2.90	0.03		17.0
Monmouth County				
Freehold	12,250			25,000
Manalapan	5,300	400	2,000	37,000
Total - feet	17,550	400	2,000	62,000
- miles	3.32	0.07	0.37	11.3
Middlesex County				
Madison	9,250	200		11,750
Monroe	6,300	100		18,500
Helmetta	1,500			2,000
East Brunswick*	500		4,000	4,500
South Brunswick*				3,500
Total - feet	18,550	300	4,000	40,250
- miles	3.51	0.05	0.75	7.22
Total - miles	9.73	0.15	1.12	35.5

* Distances do not include ramps to and from New Jersey Turnpike.

Note: Distances along the centerline of the Expressway by township, county, and vegetation type impacted (in feet, unless otherwise noted).

no significant lowland forests. A toll building and parking area, which are to be located approximately 2,000 feet north of Route 70, will not impact any sensitive vegetation.

Lakewood and Jackson Townships - Ocean County

Lakewood Township Boundary to Hope Chapel Road (6,500 feet) -- This section of the roadway will not impact any sensitive vegetation.

Hope Chapel Road to Route 528 (5,500 feet) -- This section of the roadway will destroy lowland forests where it crosses two small streams. The roadway passes through a tributary to Toms River at Hope Chapel Road for a distance of approximately 500 feet. A tributary to Dove Mill Branch of Toms River near Route 528 will be impacted at three locations, each area being affected by approximately 250 feet of roadway (measured in terms of distance along the centerline of proposed ROW).

Route 528 to Van Hiseville-Bennetts Mills Road (14,000 feet) -- Approximately half of this section of the roadway (4,750 feet) will destroy lowland forest and a bog (in a power line right-of-way) associated with Sandy Hollow, a tributary that flows into Dove Mill Branch approximately 2,000 feet below Butterfly Road.

Van Hiseville-Bennetts Mills Road to Route 526 (7,500 feet) -- This section of road will destroy lowland forests along the South Branch of the Metedeconk River for approximately 750 feet, and along a southern tributary to the River for 1,000 feet. A small area of the white cedar subtype (approximately 200 feet in diameter) is located in the center of the alignment where it crosses the tributary.

Route 526 to the Jackson Township-Ocean County Boundary (10,750 feet) -- This section closely parallels a tributary to the South Branch of the Metedeconk River between Route 526 and the Jackson Mills-Freehold Road, but will destroy only 1,600 feet of lowland forest. The western part of the proposed interchange with Interstate Route 195 (proposed) at this crossing point will destroy all of the lowland forest, as well as the channel of the tributary, within its area.

Freehold Township - Monmouth County

Freehold Township Boundary to Georgia Road south of Turkey Swamp (8,750 feet) -- This section of the alignment will destroy lowland forests associated with the North Branch of the Metedeconk River at three points. A southern tributary will be impacted for 1,250 feet, the mainstem of the River for 1,000 feet, and a northern tributary for 1,750 feet.

Georgia Road to Route 524 (11,000 feet) -- This segment will destroy lowland forests of the Manasquan River in four areas. The headwaters of one tributary will be impacted for 2,000 feet between the two intersections of Georgia Road with the alignment. North of Georgia

Road and Turkey Swamp the roadway will impact lowland forests on another tributary for approximately 3,250 feet, on the mainstem of the River for 1,500 feet, and on another small tributary for 1,500 feet.

Route 524 to Freehold Township Boundary (5,250 feet) -- This section of the Expressway will not impact sensitive vegetation.

Manalapan Township - Monmouth County

Manalapan Township Boundary to the Central Railroad of New Jersey (18,250 feet) -- This segment of the Expressway will destroy sensitive vegetation in several small areas. North of Gulley Road the roadway will pass through 300 feet of forest of the oak subtype, and then through a mixed forest (lowland species present) for 200 feet before crossing the twin ponds at the head of Manalapan Brook. After crossing Route 33, the right-of-way is in a lowland forest associated with a tributary of Manalapan Brook for 750 feet and in an oak forest for 1,200 feet near Monmouth Battlefield State Park. Parklands will be taken in a 700 foot strip through an oak forest. Between the Park and the Railroad, 500 feet of oak forest and 700 feet of lowland forest will be destroyed. A bog adjoining the Railroad also will be disrupted for 200 feet. The lowland forest and bog are associated with Weamaconk Creek.

The interchange with proposed Route 33 will destroy an oak forest for a short distance southwest of the existing Route 33-Wemrock Road intersection.

Central Railroad of New Jersey to Taylors Mills Road (5,750 feet) -- This segment will destroy 200 feet of lowland forest and 100 feet of bog where it crosses McGellairds Brook at Taylors Mills.

Taylors Mills Road to Manalapan Township Boundary (13,000 feet) -- Between Taylors Mills Road and Gordons Corner Road the Expressway will destroy lowland forest associated with Milford Brook (a tributary to McGellairds Brook) for 400 feet. Between Gordons Corner Road and Union Hill Road, 3,250 feet of lowland forest and 100 feet of bog associated with Pine Brook will be destroyed. The Expressway will infringe slightly upon the edges of lowland forest for short distances at two locations between Union Hill Road and the Manalapan Township Boundary.

Madison and Monroe Townships - Middlesex County

Middlesex County Boundary to Route 527 (8,250 feet) -- This section of the Expressway will destroy lowland forest on the headwaters of Barclay Brook (a tributary to Matchaponix Brook) for nearly its entire length. The southwestern half of the proposed interchange with Route 520 also is located in lowland forest on this watershed.

Route 527 to Spotswood-Gravel Hill Road (14,250 feet) -- Between Route 527 and the Matchaponix Brook (the boundary between Madison and Monroe Townships) the Expressway will closely parallel Barclay Brook and will destroy lowland forest (2,500 feet) and bog (200 feet; created by the clearing of lowland forest for a power line right-of-way) for most of its length. West of Matchaponix Brook the roadway will destroy 3,600 feet of lowland forest associated with Matchaponix Brook and its tributaries. At the Spotswood-Gravel Hill Road intersection 500 feet of lowland forest associated with the Manalapan watershed also will be destroyed.

Spotswood-Gravel Hill Road to Monroe Township Boundary-Manalapan Brook (7,750 feet) -- This segment of the Expressway will destroy lowland forest for 200 feet where the right-of-way crosses the head of a small tributary of Malapan Brook 1,000 feet west of the Spotswood-Gravel Hill Road. Approximately one-fifth of the site for the service area south of the alignment and west of the Spotswood-Gravel Hill Road. The roadway will also destroy a bog for 100 feet where the alignment passes through the middle of a private bird sanctuary and family campground 1,000 feet east of Old Forge Road. An additional 2,000 feet of lowland forest will be destroyed before the roadway crosses Manalapan Brook.

Helmetta Borough - Middlesex County (2,000 feet)

Lowland forest will be destroyed for 1,500 feet within Helmetta Borough. Along 500 feet, this forest adjoins Manalapan Brook east of Main Street. The remaining 1,000 feet, situated west of the Penn Central Railroad, is associated with a tributary to Manalapan Brook.

East Brunswick Township - Middlesex County (4,500 feet)

The Expressway will pass through approximately 500 feet of lowland forest and 4,000 feet of upland forest within the Township. The upland forest contains oak, oak-pine, and pine-oak forest subtypes (no exact boundary of the oak subtype could be delineated during the cursory field investigations). The oak-pine and pine-oak subtypes, however, occur chiefly north of Washington Avenue to Helmetta Road. The entire upland forest area should be considered as unusual because of the diversity of forest subtypes present and because it spans the border between Pine Barrens and Inner Coastal Plain biotic regions.

South Brunswick Township - Middlesex County (3,500 feet)[1]

The impact in South Brunswick will be confined to lowland forests and some oak forest associated with Ireland Brook (the boundary between South Brunswick and East Brunswick Townships). The ramp from the Expressway to the northbound lanes of the existing New Jersey Turnpike will destroy lowland forests east of the Turnpike for 500 feet. West of the Turnpike the ramp from the Expressway to the southbound lanes will destroy oak forest for 1,000 feet, and the ramp from the southbound lanes to the Expressway will destroy 500 feet of oak forest and 300 feet of lowland forest (roughly half of this is north of Ireland Brook and, therefore, in East Brunswick Township).

DISCUSSION

The impact of the Expressway on the sensitive vegetation types along the proposed alignment can be minimized by utilizing special design and/or construction techniques. The proposed alignment is known to impact several extensive areas of lowland forest and an oak forest in the proposed Jamesburg Park which are considered to be highly sensitive vegetation types.

Special design and construction techniques will be used to minimize damage in less extensive areas of sensitive vegetation that will be crossed by the roadway. In lowland forests and bogs associated with small drainages, through the generally limited areas of oak forests, and where the edges of sensitive vegetation types are skirted, all construction activities -- including vehicle and material storage areas -- will be restricted to the proposed roadbed and to areas of cut and fill. The remainder of the right-of-way will be left in native vegetation cover and undisturbed. Any land that is denuded of vegetation, particularly on the slopes of cuts and fills, will be revegetated as soon as construction acitivities have been completed. This will prevent the erosion of soil and fill material onto adjoining vegetation. Combination desilting-retention basins will be utilized during the construction phase and incorporated in the final highway design to further lessen offsite sedimentation. These basins also would minimize the destruction of vegetation along established streams by storm surges that may result from the channeling of runoff from extensive impervious areas (such as roadbeds, shoulders, toll plazas and service area parking lots).

1/Distance is only for the Expressway and not for connector roads and ramps to the New Jersey Turnpike.

SPECIES LIST

Common and scientific names of plant species cited in the text. Nomenclature follows Gray's Manual of Botany, Eighth Edition.

Arrowwood, Southern	*Viburnum dentatum*
Asters	*Aster* spp.
Azalea, Swamp	*Rhododendron viscosum*
Blackberry	*Rubus* sp.
Bladderworts	*Utricularia* spp.
Blueberry, Highbush	*Vaccinium corymbosum*
Blueberry, Lowbush	*Vaccinium vacillans*
Broomsedge	*Andropogon virginicus*
Cattail, Broad-leaved	*Typha latifolia*
Cedar, Atlantic White	*Chamaecyparis thyoides*
Cherry, Black	*Prunus serotina*
Chestnut, American	*Castanea dentata*
Clubmoss, Bog	*Lycopodium inundatum*
Cranberries	*Vaccinium* spp.
Dewberry	*Rubus* sp.
Fern, Bracken	*Pteridium aquilinum*
Fern, Cinnamon	*Osmunda cinnamomea*
Fern, Curly-grass	*Schizaea pusilla*
Fern, Marsh	*Dryopteris thelypteris*
Goldenrod	*Solidago* spp.
Grapes	*Vitis* spp.
Grasses	Family Gramineae
Greenbriers	*Smilax* spp.
Gum, Black	*Nyssa sylvatica*
Hickory, Pignut	*Carya glabra*
Inkberry	*Ilex glabra*
Laurel, Mountain	*Kalmia latifolia*
Laurel, Sheep	*Kalmia angustifolia*
Leather leaf	*Chamaedaphne calyculata*
Locust, Black	*Robinia pseudo-acacia*
Maple, Red	*Acer rubrum*
Meadow-beauty	*Rhexia* sp.
Milkwort, Orange	*Polygala lutea*
Moss, Sphagnum	*Sphagnum* spp.
Oak, Black	*Quercus velutina*
Oak, Blackjack	*Quercus marilandica*
Oak, Chestnut	*Quercus prinus*
Oak, Dwarf Chestnut	*Quercus prinoides*
Oak, Pin	*Quercus palustris*
Oak, Post	*Quercus stellata*
Oak, Red	*Quercus rubra*
Oak, Scrub	*Quercus ilicifolia*
Oak, White	*Quercus alba*

Pepperbush, Sweet	*Clethra alnifolia*
Pine, Pitch	*Pinus alba*
Pine, Scotch	*Pinus sylvestris*
Pine, Shortleaf	*Pinus echinata*
Pine, White	*Pinus strobus*
Pogonia, Rose	*Pogonia ophioglossoides*
Poplar, Tulip	*Liriodendron tulipifera*
Queen Anne's-lace	*Daucus carota*
Redcedar	*Juniperus virginiana*
Reed, Common	*Phragmites communis*
Rushes	Family Juncaceae
Sassafras	*Sassafras albidum*
Sedges	Family Cyperaceae
Staggerbush	*Lyonia mariana*
St. John's-wort	*Hypericum* sp.
Sumac, Winged	*Rhus copallira*
Sundew, Round-leaved	*Drosera rotundifolia*
Sundew, Spoon-leaved	*Drosera intermedia*
Sundew, Thread-leaved	*Drosera filiformis*
Sweetbay	*Magnolia virginiana*
Sweet Fern	*Comptonia peregrina*
Sweetgum	*Liquidambar styraciflua*
Thoroughworts	*Eupatorium* spp.

LITERATURE CITED

McCormick, J. 1970. The Pine Barrens: a preliminary ecological inventory. New Jersey State Museum Research Report 2:1-103.

WILDLIFE POPULATIONS

Bird, mammal, amphibian, and reptile populations representative of the area were surveyed from 5 to 12 July 1972 along the proposed Expressway route. Information concerning mammals of the area was obtained from Dr. Leonard Spiegel, Monmouth College, and information concerning amphibians and reptiles likely to occur along the proposed route was obtained from Raymond J. Cummins. Both Dr. Spiegel and Mr. Cummins conducted field surveys of the route as subcontractors to Jack McCormick and Associates.

Habitats discussed in this report are described more fully in the chapter on vegetation.

BIRD POPULATIONS

Previous Studies in East-Central and Southern New Jersey

The most intensive study of breeding bird populations of the northeastern Pine Barrens region was conducted by Fables (1950, 1962) from 1938 to 1960. The study site which was located about 3 miles north-northwest of Toms River and less than one mile west of the proposed Expressway route, contained 71 acres of pitch pine forest and 4 acres of white cedar swamp forest. Fables found at least 43 species breeding on this site. The most intensive study of winter bird populations of the northeastern Pine Barrens region is the Lakehurst, New Jersey, National Audubon Society Christmas Count, which has been conducted annually since 1932. This count includes the section of the proposed Expressway route from South Toms River to Whitesville. At least 114 species have been recorded in these counts. Approximately 42 of these species are unlikely to occur on the present route because they are associated with more coastal habitats. McCormick (1970) listed 144 species known to occur in the Pine Barrens. Twelve of these species are extremely rare or have a more southerly or more coastal distribution and probably do not occur in the study area.

Contemporary Avifauna of the Proposed Expressway Route

The avifauna of this area consists of approximately 159 species (Table 18). Eighty-five species are known to occur on the route (Fables, 1950). The remaining 74 species are reported in the literature to occur infrequently to abundantly in inland habitats in east-central and southeastern New Jersey.

The nesting birds of the proposed Expressway route include 100 species (Table 18). Sixteen species were observed

TABLE 18. BIRDS OF THE PROPOSED EXPRESSWAY ROUTE

	Bogs, Ponds	Cropland, Grassland	Developed Land	Forested Lowland and Associated Streams	Forested Upland	Mixed Species Forest	Totals for all Habitats
Number of known inhabiting species	21	38	39	59	62	59	85
Number of suspected inhabiting species	19	80	80	72	60	64	74
Total number of inhabiting species	40	118	119	131	122	123	159
Number of known nesting species	8	5	10	19	39	9	60
Number of suspected nesting species	11	22	39	49	29	55	40
Total number of nesting species	19	27	49	68	68	64	100

Compiled from Fables (1950, 1962), Heintzelman (1970), Jacobson (1965), Lakehurst, New Jersey National Audubon Society Christmas Counts (1949-1950, 1967-1972), McCormick (1970), Peterson (1947), and Robbins, Brunn, and Zim (1966); supplemented with field observations by Jack McCormick & Associates, 5, 6, 7, and 12 July, 1972. Species known to occur or to nest in a habitant were observed either by Jack McCormick & Associates or referred to by Fables (1950, 1962). Habitats are described in the chapter on vegetation.

on nests or with recently fledged young during field investigations, and 44 additional species are known to nest in this area (Fables, 1950, 1962). Forty other species reported in the literature as occasional to common nesters in inland habitats in east-central and southeastern New Jersey are believed to breed in this area.

One hundred thirty-one kinds of birds utilize forested lowland and associated streams. Fifty-nine species are known to occur in this habitat, and 72 species probably occur there. Of 68 species that nest in forested lowland, 19 species are known to nest on the proposed route and 49 are believed to nest there. The Cooper's hawk, red-shouldered hawk, osprey, eastern bluebird, and orchard oriole, all of which are listed by Heintzelman (1971) as possibly or definitely rare or endangered species in New Jersey, probably occur in forested lowlands on the proposed route. The Cooper's hawk and the red-shouldered hawk may nest in this habitat (Heintzelman, 1970).

One hundred twenty-three species occur in mixed species forest. Fifty-nine species are known to frequent this habitat in the study area, and 64 species probably occur there. Of 64 species that nest in mixed species forest, 9 kinds of birds are known to nest and 55 are believed to nest in this area. In a mixed species forest 0.5 mile south of the proposed Route 33 By-pass interchange, 43 species were observed in four hours on 7 July. Unusual observations included one yellow-billed cuckoo and two black-billed cuckoos, and one Acadian flycatcher and five least flycatchers, one of which was a fledgling, all apparently nesting in the same forest. Both species of flycatchers are at the extreme edge of their respective breeding ranges in this section of New Jersey (Bull, 1964). The ruby-throated hummingbird, Acadian and least flycatchers, yellow-throated vireo, American redstart, and rose-breasted grosbeak were observed only in this forest along the proposed Expressway Route. The rose-breasted grosbeak is reported to be a rare breeder in eastern Monmouth County; most individuals breed farther north (Bull, 1964). Species listed as possibly or definitely rare or endangered in New Jersey (Heintzelman, 1971) that probably occur in mixed species forest in this area include the Cooper's hawk, red-shouldered hawk, pigeon hawk, eastern bluebird, and orchard oriole. The orchard oriole may nest on the route in this habitat.

Forested upland is utilized by 122 kinds of birds. Sixty-two species are known to occur and sixty are believed to occur on the proposed route in this habitat. Of 68 species that nest in forested upland, 39 species are known to nest in the area of the proposed route and 29 are suspected nesters. The relatively large number of known nesting species may be attributed to the intensive breeding

bird study conducted primarily in pitch pine forests by Fables (1950). A hermit thrush was heard in full song in an extensive oak forest about 1.5 miles east of Holmansville on 12 July. Bull (1964) reported the hermit thrush to be a fairly common breeder of localized distribution in pine barren areas on eastern Long Island, but gave no nesting records from the northeastern Pine Barrens in New Jersey. McCormick (1970) considered the species to be a common spring and fall migrant through the New Jersey Pine Barrens, but gave no indication that it nests in the region. An eastern bluebird was observed in the same oak woods where the hermit thrush was singing on 12 July. Heintzelman (1971) listed this species as rare in New Jersey, its numbers having declined markedly during recent years. The eastern bluebird is known to breed in upland forest habitat along the proposed Expressway route (Fables, 1950). A red-shouldered hawk was observed in an extensive oak-pine forest 0.5 mile north of the main entrance to Turkey Swamp Park on 7 July. According to Heintzelman (1971), this species may be rare or endangered in New Jersey. The only pine and prairie warblers seen during field investigations were observed in open pitch pine woods in a private bird sanctuary and family campground one mile southeast of Helmetta on 6 July. The only solitary vireo and parula warbler noted during field investigations were observed in an oak forest on the northern edge of the proposed Jamesburg Park on 6 July. Both of these species are very rare breeders in the New York City area; most individuals breed farther north or west (Bull, 1964). The Cooper's hawk, pigeon hawk, and orchard oriole, denoted as possible or definite rare or endangered species in New Jersey by Heintzelman (1971), probably occur in upland forest along the proposed Expressway route. The orchard oriole may nest in this habitat.

One hundred nineteen species occur on developed land. Thirty-nine species are known to frequent this habitat and eighty species probably occur there. Of 49 species that nest on developed land, 10 species are known to nest on the proposed route and 39 probably nest there. An eastern bluebird was observed in a residential area surrounded by oak forests one mile west of Bennetts Mills on 12 July. According to Heintzelman (1971), this species is rare in New Jersey; McCormick (1970) considered the species to be occasional near settlements. Other species listed as possibly or definitely rare or endangered in New Jersey by Heintzelman (1971) that probably occur on developed land in the study area include the Cooper's hawk, red-shouldered hawk, and orchard oriole, with the orchard oriole a possible nester.

Croplands and grasslands are utilized by 118 kinds of birds. Thirty-eight species are known to occur in the area of the proposed Expressway route in this habitat, and 80 others are believed to occur there. Many species of migrating songbirds listed under this habitat classification primarily are associated with active orchards. Of 27 species that nest in cropland and grassland, 5 species are known and 22 are suspected to nest in this area.

A vesper sparrow was observed in extensive corn fields 1.5 miles south of the proposed Route 33 By-pass interchange on 7 July. This species is an uncommon and local breeder which has suffered greatly from the rapid decline in agriculture in the New York area (Bull, 1964). The marsh hawk, pigeon hawk, eastern bluebird, orchard oriole, and Henslow's sparrow, all of which are listed by Heintzelman (1971) as possible or definite rare or endangered species in New Jersey, probably occur in cropland, grassland, or active orchards in the area of the proposed route. The Henslow's sparrow may next in grassland areas and the orchard oriole may nest in active orchards along the route.

Forty species occur in bogs and on ponds. Twenty-one species are known to frequent these habitats along the proposed Expressway route, and 19 species probably utilize them. Of 19 species that nest in or on the edge of bogs and ponds, eight species are known to nest and eleven species are believed to nest there. A great blue heron and a wood duck were observed along the edge of a cranberry bog reservoir 1.5 miles east of Holmansville on 12 July. Fifteen Canada geese were observed in a pond 0.5 mile south of the proposed interchange with the Route 33 By-pass on 7 July. Species listed possibly or definitely as rare or endangered in New Jersey by Heintzelman (1971) that probably utilize bogs and ponds include the osprey and Henslow's sparrow, with the latter a possible nester along bog edges.

MAMMAL POPULATIONS

The mammal fauna of the proposed Expressway route consists of 43 species (Table 19). Eight species were observed during field investigations, and 21 other species are known to occur on the route from published references to collected specimens and from the personal knowledge and past field experience of Dr. Leonard Spiegel, Monmouth College. According to Dr. Spiegel, 14 additional species reported in the literature as occasional to common in inland habitats in east-central and southeastern New Jersey are also likely to occur in the area of the proposed route.

Thirty-one kinds of mammals utilize forested lowland and associated streams. Twenty species are known to occur in this habitat, and 11 species are believed to occur there. A longtailed weasel was observed along a small stream in a lowland maple forest 0.5 mile south of Redshaw Corner on 6 July. The masked brown bat and northern brown bat, both of which are listed by Heintzelman (1971) as rare in New Jersey, may occur in forested lowlands in the area of the proposed route. Active colonies of river otters have been reported during 1972 from the Assunpink area of Monmouth County, and other colonies may be present along streams within the proposed Expressway route. Heintzelman (1971) listed the river otter as extremely rare and endangered in New Jersey.

TABLE 19. MAMMALS OF THE PROPOSED EXPRESSWAY ROUTE

	Bogs, Ponds	Cropland, Grassland	Developed Land	Forested Lowland and Associated Streams	Forested Upland	Mixed Species Forest	Totals for all Habitats
Number of known inhabiting species	13	17	19	20	18	17	29
Number of suspected inhabiting species	4	4	10	11	12	11	14
Total number of inhabiting species	17	21	29	31	30	28	43

Compiled from Blair, Blair, Brodkorb, Cagle, and Moore (1968), Burt and Grossenheider (1964), Hamilton (1943), Heintzelman (1971), and McCormick (1970); supplemented with field observations by Dr. Leonard Spiegel, Monmouth College, and Jack McCormick & Associates, 5 to 12 July, 1972. Species known to occur in a habitat were either observed by Jack McCormick & Associates or referred to from Dr. Spiegel's personal knowledge and past field experience on the proposed route. Habitats are described in the chapter on vegetation.

Thirty species occur in forested uplands. Eighteen species are known to frequent this habitat on the proposed route, and 12 species probably occur there. An adult gray fox was observed at the point where the proposed alignment intersects Grass Hollow Brook on 5 July. Species listed as rare in New Jersey by Heintzelman (1971) that are likely to occur in forested upland on the proposed route include the smoky shrew, masked brown bat, northern brown bat, and Allegheny cottontail.

Developed land is utilized by 29 kinds of mammals. Nineteen species are known to occur in this habitat along the proposed route, and 10 are believed to occur there. The masked brown bat, northern brown bat, and Allegheny cottontail, all indicated by Heintzlman (1971) as rare in New Jersey, probably occur on developed land in the study area.

Twenty-eight species occur in mixed species forests. Seventeen species are known to utilize this habitat on the proposed alignment, and 11 are likely to occur there. Species listed as rare in New Jersey that may occur in mixed species forest along the proposed route include the masked brown bat, northern brown bat, and Allegheny cottontail (Heintzelman, 1971).

Twenty-one kinds of mammals utilize cropland and grassland. Seventeen species are known to utilize this habitat along the proposed Expressway route, and 4 species are believed to occur there. The Allegheny cottontail, listed as rare in New Jersey by Heintzelman (1971), may occur in these croplands and grasslands.

Bogs and ponds are utilized by 17 species. Thirteen species are known to occur in these habitats on the proposed route, and 4 species are suspected to occur in them. Species listed as rare or endangered in New Jersey that may frequent bogs and ponds along the route include the rice rat and southern bog lemming (Heintzelman, 1971).

AMPHIBIAN AND REPTILE POPULATIONS

The herpetofauna of the proposed Expressway route consists of 38 species, including 3 salamanders, 13 frogs and toads, 7 turtles, 1 lizard, and 14 snakes (Table 20). One species of frog and 2 species of turtles were observed during field investigations. Recent records from Ocean, Monmouth, and Middlesex Counties indicate that the remaining 35 species probably occur in the area.

Thirty-two species of amphibians and reptiles utilize forested lowlands and associated streams. An eastern box turtle was observed along a small stream in a lowland maple forest 0.5 mile south of Redshaw Corner on 6 July. The corn snake, listed as possibly rare or endangered in New Jersey by Heintzelman (1971), probably occurs in this habitat along the proposed alignment.

TABLE 20. AMPHIBIANS AND REPTILES OF THE PROPOSED EXPRESSWAY ROUTE

	Bogs, Ponds	Cropland, Grassland	Developed Land	Forested Lowland and Associated Streams	Forested Upland	Mixed Species Forest	Totals for all Habitats
Number of known inhabiting species	1	0	1	1	1	0	3
Number of suspected inhabiting species	28	19	23	31	26	27	35
Total number of inhabiting species	29	19	24	32	27	27	38

Compiled from Black (no date), Cochran and Goin (1970), Conant (1958), Gosner (1962), Grant (1959, 1966), Heintzelman (1971), McCormick (1970), Reimer (1963), Rossman and Gosner (1959); supplemented with field observations by Raymond Cummins and Jack McCormick & Associates, 6 to 12 July, 1972. Species known to occur in a habitat were observed by either Raymond Cummins or Jack McCormick & Associates. Habitats are described in the chapter on vegetation.

Twenty-nine kinds of herptiles occur in bogs and ponds. A bullfrog was heard calling in a pond 0.5 mile south of the proposed Route 33 interchange on 7 and 9 July. The Pine Barrens treefrog and carpenter frog are probably common in bogs and ponds on the proposed route. McCormick (1970) indicates that both species are rare or seldom found outside the New Jersey Pine Barrens.

Forested upland is utilized by 27 species, and 27 also occur in mixed species forest. An eastern painted turtle was observed entering an upland oak forest near a cranberry bog 1.5 miles east of Holmansville on 12 July. The corn snake probably occurs in both habitats along the proposed alignment (Heintzelman, 1971).

Twenty species of amphibians and reptiles frequent forested uplands. The only species listed as possibly rare or endangered in New Jersey that probably occurs on developed land on the proposed route is the corn snake (Heintzelman, 1971).

At least 19 species of herptiles occur in cropland and grassland. The corn snake probably frequents these habitats in the study area.

VALUE OF WILDLIFE HABITATS

The proposed Governor Alfred E. Driscoll Expressway alignment intersects numerous habitats of considerable value to wildlife. Comparisons of the number of vertebrate species occurring in different habitats is one criterion that may be utilized to measure the relative importance of those habitats to wildlife. Two hundred forty species of vertebrates other than fish are known to occur on or near the route, including 16 species listed as possibly or definitely rare or endangered in New Jersey (Heintzelman, 1971).

Forested lowlands support 194 species of birds, mammals, and herptiles, and are the most important wildlife habitat. The areas of lowland forest between the Toms River and the proposed alignment from South Toms River to Riverwood Park retain substantial aesthetic and wildlife value. The mixed white cedar-hardwood swamps that surround the cranberry bogs and reservoirs east and southeast of Holmansville comprise especially good haitat for herons and ducks. Nine species of vertebrates denoted by Heintzelman (1971) as possibly or definitely rare or endangered in New Jersey are likely to occur in forested lowlands along the proposed route.

Mixed species forests are utilized by 178 kinds of vertebrates, and this type is the second most important wildlife habitat. The area of mixed species forest and forest edge ecotone 0.5 mile south of the proposed Route 33 By-pass interchange comprises an unusually rich and varied bird habitat. An area of mixed species forest, shrubland, and lowland forest extending west and northwest from the corner of Old Texas Road and De Voe Lake Road contains excellent habitat for many species of birds. Mixed species forest and fencerows southeast and northwest of the proposed inter-

change with the New Jersey Turnpike comprise valuable habitat for birds, deer, and other mammals. Nine species of vertebrates listed by Heintzelman (1971) as possibly or definitely rare or endangered in New Jersey are believed to frequent mixed species forest in the area of the proposed Expressway route.

Forested uplands are of approximately equal importance to mixed species forest as wildlife habitat, with 179 inhabiting species. An extensive oak, oak-pine, and mixed species forest north and northwest of the main entrance to Turkey Swamp Park contains good habitat for several species of hawks, many kinds of songbirds typical of Pine Barrens fringe areas, and deer. The private bird sanctuary and family campground 1 mile southeast of Helmetta is of considerable interest as a northern island of pitch pine barrens where attempts have been made to improve wildlife habitats. Numerous bird boxes have been placed in the pines for hole-nesting species, and brush piles have been gathered from cleared campsites to serve as protective cover for birds and small mammals. At least 16 species of birds typical of the main Pine Barrens appeared to be breeding uncommonly to abundantly in this area on 6 July. The upland oak forest in the northern section of the proposed Jamesburg Park comprises particularly good songbird habitat. Eight species of vertebrates listed by Heintzelman (1971) as possibly or definitely rare or endangered in New Jersey are expected to occur in forested uplands in the study area.

Developed land is of lesser importance to wildlife than the three forest habitats. Although 172 species of birds, mammals, amphibians, and reptiles occur here, many species are associated primarily with nearby forest habitats and are of only marginal occurrence in developed areas. Heintzelman (1971) listed 8 species as possibly or definitely rare or endangered in New Jersey that are likely to utilize developed land in the area of the proposed Expressway route.

One hundred fifty-eight species of vertebrates occur in cropland and grasslands. Agricultural areas provide important feeding areas for many species of birds and mammals that breed in other habitats. Seven species of vertebrates listed by Heintzelman (1971) as possibly or definitely rare or endangered in New Jersey are believed to occur in grassland and active orchards in the area of the proposed route.

Bogs and ponds support 86 species of vertebrates. Numerous species of waterbirds, mammals, amphibians, and reptiles are associated primarily or exclusively with these habitats. Bogs and ponds comprise the second most important habitat for herptiles. The cranberry bogs and reservoirs east and southeast of Holmansville are excellent habitats for several kinds of waterbirds, amphibians, and reptiles. Twin ponds located 1 mile south of the proposed Route 33 by-pass interchange enhance the ecological diversity of the surrounding woods and fields, which support an unusually varied fauna. Heintzelman (1971) listed 4 species as possibly or definitely rare or endangered in New Jersey that are expected to utilize bogs and ponds on the proposed route. Two additional species that are likely to occur in bogs and ponds along the route are noted by McCormick (1970) as rare or seldom found outside the New Jersey Pine Barrens.

IMPACT OF THE PROPOSED ALIGNMENT

The proposed Expressway alignment would destroy or alter extensive areas of wildlife habitat within the ROW along its entire length. The elimination of habitat will reduce slightly the regional populations of many species that breed on the proposed route. Migrating and wintering birds will be forced to utilize other nearby areas. Several species of birds and mammals prefer extensive forested areas away from developed land (e.g., the goshawk, sharp-shinned hawk, Cooper's hawk, long-tailed weasel, and mink). Populations of these more sensitive vertebrates might be reduced considerably within 0.25 to 0.5 mile of the alignment. Several other species of birds and mammals are more numerous in disturbed areas than in forested areas (e.g., the sparrow hawk, rock dove, mourning dove, starling, house sparrow, song sparrow, masked shrew, least shrew, eastern cottontail, Norway rat, and woodchuck). Populations of these species, might be increased considerably along the alignment. Although road construction will reduce roosting sites for bats by eliminating numerous hollow trees and abandoned buildings, populations may be concentrated along the proposed Expressway route. This is because lights from vehicle headlights, toll booths, interchanges, and service areas concentrate positively phototropic insects, which comprise the food supply of nearly all species of bats.

Construction of the proposed Expressway would result in noise, light, and motion impact on wildlife that utilize roadside areas. Populations of many vertebrate species would be subjected to continual mortality from roadkills; species with nocturnal habits would be especially vulnerable (e.g., the American woodcock, common opossum, the 8 species of bats, the eastern cottontail, raccoon, common striped skunk, and whitetail deer). Accidents involving whitetail deer are of particular danger to motorists because of the size and weight of the deer. Occasional collisions with deer can be expected, as deer are common along the entire route.

Of the 16 species listed by Heintzelman (1971) as possibly or definitely rare or endangered in New Jersey that are likely to occur in this area, none is known to be immediately threatened with extinction by construction of the Expressway. The probability of longterm survival of each of these species in the state of New Jersey, however, would be reduced slightly.

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AQUATIC LIFE

In order to assess the potential impact of the proposed Alfred E. Driscoll Expressway of the New Jersey Turnpike on aquatic life in the area, nine stations between Jamesburg and Toms River, New Jersey, were visited in June, 1972. These stations were located where representative streams cross the proposed alignment (Figure 19 and Table 21).

Water chemistry was not studied intensively but elementary water quality factors were measured (Table 22) as an indication of the suitability of these streams for the support of aquatic life (Warren, 1971). Collections of benthic invertebrates living in close association with the banks and bottoms of streams were made to provide information about water conditions (Patrick, 1950; Beck, 1954). These collections were made at each station (Table 23) employing methods appropriate to local conditions.

METHODS

Flying aquatic insects such as dragonflies, damselflies, and mosquitoes, and surface forms including water striders, water beetles, and water boatmen were observed and recorded. Stream banks and bottoms were worked with an aquatic sweep net. Accumulations of leaves and trash were collected, placed in white pans and carefully examined for benthic invertebrates. Submerged rocks and wood were systematically searched. In riffles, a Surber bottom sampler was staked down and stones and pebbles to a depth of 2 inches were carefully brushed in front of the opening. In larger streams a Peterson grab was used to obtain bottom samples which were seived for bottom life. A qualitative plankton net was streamed at most stations.

Water temperature and dissolved oxygen were determined with a Yellow Springs Instrument Company Model 51A meter. The pH was measured with a Heath electronic digital pH meter. Specific conductance as an indicator of dissolved solids was calculated and corrected to terms of 25°C after null balancing with a cycle bridge having a decade resistance and employing a cathode ray oscilloscope for readout.

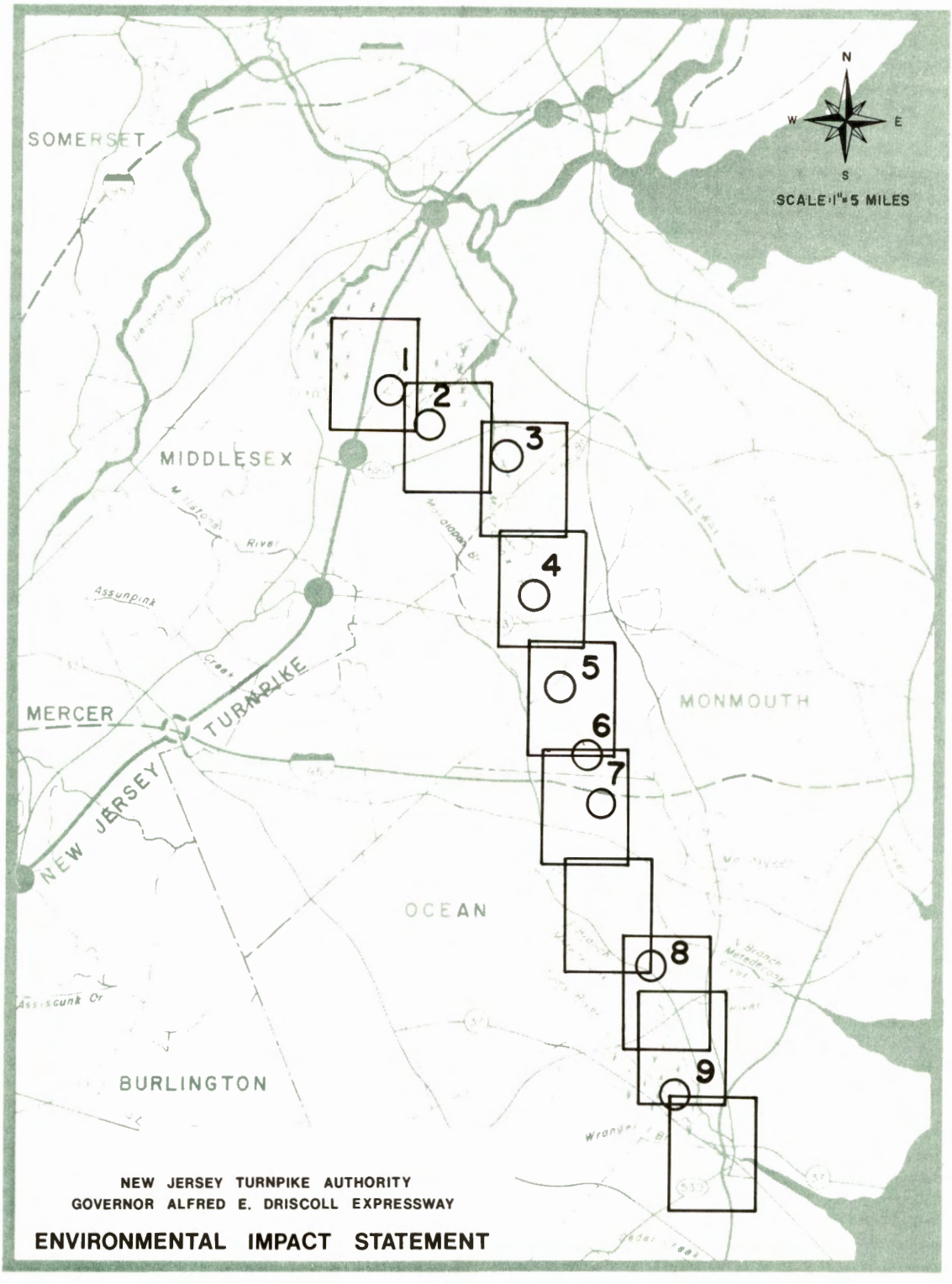

FIGURE 19. SAMPLING STATIONS FOR ANALYSIS OF AQUATIC LIFE

TABLE 21. LIST OF SURVEYED STREAM STATIONS

1. Cedar Brook (sampled 1200 daylight saving time, 6/24/72) 0.15 mile north of Helmetta on Helmetta Boulevard in or near the site of the proposed Jamesburg Park. The brook is 2 to 3 feet wide and 3 to 12 inches deep. There was a good flow and the water was brownish straw color. Tufts of green algae were waving in the current. There was some duckweed on the surface. Water striders and springtails were observed. Mosquitoes were abundant at this location.

2. Manalapan Brook (1015 DST, 6/26/72) in Helmetta near the Roman Catholic Church. The brook is about 16 to 20 feet wide, but was swollen and muddy from recent rains so that few specimens could be found. Water striders, springtails and mosquitoes were observed.

3. Matchaponix Brook (1100 DST, 6/26/72) 0.15 mile east of Texas on the Old Texas Road (State Route 520). The brook is about 15 feet wide and up to 30 feet in some places. It has a mud bottom and is bordered by swamps where many frogs were observed. Water striders and dragonflies also were seen.

4. Weamaconk Creek (1315 DST, 6/26/72) 0.4 mile southwest of Tennent. The creek is about 10 to 12 feet wide and 1 to 2 feet deep. It is swift-flowing with a pebble bottom and some larger stones. In some places it has a mud bottom. Water striders were observed.

5. Small Tributary of Manasquan River (1600 DST, 6/26/72) on side road 0.15 mile north of State Route 524. Small swiftly flowing stream, 2 to 4 feet wide, 6 to 12 inches deep. Mud bottom west of road, pebble bottom east of road. Water striders and frogs observed.

6. North Branch of Metedeconk River (1040 DST, 6/28/72) 0.45 mile south-southwest of Georgia on road from Route 9 to Jacksons Mills. Slow flowing "cedar colored" water, 15 feet wide, 2 feet deep in middle, 6 inches deep at edges. No green plants in water at this place. Plant detritus on bottom. Swampy areas along stream. Water striders and water beetles observed.

7. South Branch of Metedeconk River (1125 DST, 6/28/72) at State Route 526 and Cook Road, 2.1 miles west-northwest of Bennetts Mills. Stream swift-flowing with sand bottom, 3 to 5 feet wide, 0.5 to 1.5 feet deep. Moss on banks but no aquatic vegetation in the water at this place. Damselflies and water beetles observed.

Table 21. continued.

8. Grass Hollow Brook (1340 DST, 6/28/72) tributary of Toms River, at State Route 527, 0.4 mile north-northwest of Route 70. Small stream 2 to 3 feet wide, 0.3 to 1 foot deep. Wooded swamp around borders of this area. Mosquitoes very abundant. Frogs, water striders, water beetles, dragonflies and damselflies observed.

9. Toms River (1523 DST, 6/28/72) at State Route 571, 0.2 mile northwest of State Route 527. River is 20 feet wide and up to 4 feet deep. Bottom is stony with large pebbles in some places and small pebbles and sand at others. Some plant detritus on bottom but not much plant life in water. Moderate current, and mosquito larvae observed.

TABLE 22. ELEMENTARY WATER FACTORS

Station	Location	Dissolved Oxygen ppm	Temp. Degrees C	pH Units	Specific Conductance micromhos/cm
1.	Cedar Brook	7.2	15.5	5.72	139.8
2.	Manalapan Brook	7.6	24.0	6.36	102.0
3.	Matchaponix Brook	7.8	17.5	5.85	131.1
4.	Weamaconk Creek	8.8	17.2	6.86	161.7
5.	Manasquan River (Tributary of)	8.4	17.5	6.56	247.3
6.	Metedeconk River (North Branch)	7.6	17.1	5.74	158.9
7.	Metedeconk River (South Branch)	8.5	16.8	6.35	184.1
8.	Grass Hollow Brook	8.2	22.6	5.07	142.9
9.	Toms River	8.8	18.2	5.72	157.0

TABLE 23. AQUATIC INVERTEBRATES

Station	Location	Insects	Crustacea	Mollusks	Worms	Totals
1.	Cedar Brook	7	3	0	1	11
2.	Manalapan Brook	3	-	-	-	3
3.	Matchaponix Brook	9	1	0	1	11
4.	Weamaconk Creek	4	2	1	1	8
5.	Manasquan River (Tributary of)	2	0	1	1	4
6.	Metedeconk River (North Branch)	6	1	1	1	9
7.	Metedeconk River (South Branch)	9	1	0	0	10
8.	Grass Hollow Brook	8	1	0	2	11
9.	Toms River	9	0	1	1	11

RESULTS AND COMMENTS

The water quality data indicate that these streams are suitable for fish (Table 22; Warren, 1971). Dissolved oxygen levels are adequate. Specific conductance values are often multiplied by a factor ranging from 0.5 to 0.9 in order to give an indication of total dissolved solids. If this were done with the conductances measured in the streams during this survey, a mean value on the order of 100 ppm as $CaCO_3$ would be obtained. This is low but certainly compatible with fish and insect life. The relatively acid pH values together with the presumed low solids content of the water renders them unfavorable for mollusks and this is borne out by the relative scarcity of these forms.

The assemblage of invertebrate animals is in no sense a complete inventory of the forms which may be present in these waters (Table 23). The scope of the present study did not encompass an investigation of that magnitude. The variety does indicate, however, that these are healthy, natural streams (Beck, 1954; Wilhm and Dorris, 1968). Among the insects were forms such as springtails, mosquitoes, dragonflies, damselflies, water beetles, water striders and water boatmen. Nymphs and immature stages of fishflies, stoneflies, and mayflies were taken. Chironomid larvae were common. The crustaceans included isopods, amphipods, and ostracods. Copepods were taken from the Toms River. The Phylum Mollusca was represented only by the gastropod Physa and the pelecypod Pisidium, both relatively resistant to acid waters. Larger annelid worms were taken from bottom mud at stations 4 and 8. Small tube-building worms were found at all stations except 2 and 4. As noted above, the taking of this variety of aquatic invertebrates in a relatively cursory survey confirms these streams as healthy, natural watercourses. Every effort should be made to preserve them as part of New Jersey's natural resources.

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CONCLUSIONS AND RECOMMENDATIONS

TOPOGRAPHY

The slopes in the vicinity of the proposed Expressway route for the most part are regular and gentle. The topography of the route will not pose major obstacles to construction, nor are any significant adverse impacts anticipated due to construction.

GEOLOGY

Construction of the route may require road cuts through valuable material in some places. The present and potential values of these materials should, therefore, be estimated. The possibility of selling this cut material to interested industries should be investigated. For example, the industries involved in the mining of titanium sands in Ocean County are located close to the proposed route. These industries might purchase valuable cut material taken from the Kirkwood and Cohansey Formations. Any cut material sold to industry, however, would be unavailable for use as fill. Consequently, the selling of cut material might necessitate the use of fill from other sources in construction of the proposed route. Waste material from titanium operations might be available.

The location of ironstone capstones along the proposed route should be determined during design. If any of these capstones are destroyed during construction of the route, steps should be taken to insure the stability of slopes in the material underlying the capstones.

The proposed Expressway route encounters, in a relatively short distance, a large proportion of the Cretaceous and Tertiary formations found in the New Jersey Coastal Plain. It is likely that construction of the route will expose unweathered parts of many of these formations to view. In effect, the route may constitute a section through a large part of the geology of the Coastal Plain. In addition, construction of the route will require the collection of engineering information at many points along the route. For these reasons, construction of the route may present an unusual opportunity to study coastal plain geology, and to gather correlated geologic and engineering information which might be of use in many other parts of the Coastal Plain.

SOILS

The majority of the soils along the proposed Expressway are infertile and of low agricultural value. Most of the areas not mapped (ID on maps) are covered by old fields, forests, and residential developments and are probably poor agricultural sites. Consideration should be given, however, to minimization of impact on productive soils. Since comparatively large areas within and near the proposed alignment have insufficient data on soils by current soil mapping techniques and criteria, detailed soil-type mapping and a full evaluation of local conditions, such as slope, drainage, and erosion hazard should be made during design.

Soils susceptible to wind erosion when vegetation is removed are common. The impact on these soils can be reduced by controlling the size of area exposed at any one time and by immediate revegetation, among other techniques. Soils along streams and in swampy areas, if disturbed, may result in erosion, siltation, drainage impediment, and ponding. Such sites must be carefully protected to minimize deleterious environmental impact.

CRANBERRY BOGS

The Beauty Bogs, Iron Bog, and Bunker Hill Bogs may be adversely impacted by sedimentation, water pollution, and alteration of water flow as a result of the construction of the proposed alignment. The alteration of water flow within the Sandy Hollow watershed, with particular regard to increased flooding and reduced water storage capacity, is the most probable impact. The Beauty Bogs are most likely to be adversely impacted because of their proximity to the proposed alignment. Because the Iron Bog and Bunker Hill Bogs utilize water from Sandy Hollow, they also are subject to adverse impact resulting from changes in that watershed.

The Beauty Bogs are the major producers in this complex, and their destruction or degradation could make the operation of the complex economically unfeasible. During the 1971 season, this operation contributed 1.2% of the total cranberry harvest in New Jersey and the Beauty Bogs exhibited outstanding production ability. Gypsy moths have heavily defoliated the Beauty Bogs this year and the 1972 yield may be reduced by half. No permanent reduction in bog productivity, however, is expected to result from the defoliation.

The possibility of damage from accelerated sedimentation virtually can be eliminated by the use of careful construction practices in this area of low relief. Large acreages should not be denuded of vegetation for construction sites or storage areas in or near the channels and lowland forests on the Sandy Hollow watershed. Erosion from construction sites in the watershed should be controlled through the use of desilting basins and the establishment of a vegetation cover through seeding, sodding, and/or planting immediately following the completion of construction activities.

The effect of water pollution cannot be predicted at this time, but this potential source of impact should be considered as part of any long-term studies of the effects of the highway upon water quality.

The potential for adverse impact from an alteration in water flow in Sandy Hollow can be minimized by the use of special engineering features as appropriate.

VEGETATION

Primary Impact Areas

Many areas of lowland forest and bog, and one sensitive upland forest, will be impacted severely by the proposed alignment. These types occur primarily in areas in which the alignment parallels streams or passes through extensive lowlands in headwater regions. Consideration should be given to the use of special design and construction techniques in these areas. The following areas are considered to be subject to adverse impact by the alignment:

1. Lowland forest and bog associated with the Toms River between Route 37 and the Oak Ridge Parkway.

2. Lowland forest associated with the Toms River at the Route 571 interchange, and north of the interchange along the Expressway for 2,000 feet.

3. Lowland forest associated with Sandy Hollow between Route 528 and the Van Hiseville-Bennetts Mills Road.

4. Lowland forest associated with the headwaters of a northern tributary to the South Branch of the Metedeconk River in the vicinity of the interchange with proposed I-195.

5. Lowland forest associated with the North Branch of the Metedeconk River.

6. Lowland forest associated with the Manasquan River between Georgia Road (intersection south of Turkey Swamp) and the River.

7. Lowland forest associated with Pine Brook between Gordons Corner Road and Union Hill Road.

8. Lowland forest associated with Barclay Brook from the Madison Township Boundary to Matchaponix Brook.

9. Lowland and oak forests in Helmetta Borough and East Brunswick Township.

Secondary Impact Areas

Many less extensive areas of sensitive vegetation along the alignment could be damaged or destroyed. A variety of special design and construction techniques can be utilized to minimize these impacts. Such techniques can be considered in final design for the Expressway, particularly in the following locations:

1. Lowland forest on a small tributary to the Toms River 1,000 feet north of the Oak Ridge Parkway.

2. Lowland forest along a tributary to the Toms River near Route 527.

3. Lowland forest on Slab Branch, a tributary to the Toms River.

4. Lowland forest on a tributary to the Toms River, west of Hope Chapel Road.

5. Lowland forest on a tributary to Dove Mill Branch south of Route 528.

6. Lowland forest on the South Branch of the Metedeconk River and one of its southern tributaries between Van Hiseville-Bennetts Mills Road and Route 526.

7. Oak forest north of Gulley Road on the alignment.

8. Oak forest southwest of the existing Route 33-Wemrock Road intersection in the vicinity of the eastern boundary of the proposed Route 33 interchange.

9. Lowland forest at the head of a tributary to Manalapan Brook adjacent to Monmouth Battlefield State Park.

10. Oak forest in and adjoining Monmouth Battlefield State Park.

11. Oak forest east of the alignment and north of Monmouth Battlefield State Park.

12. Lowland forests and bog associated with Weamaconk Creek near Main Street and the Central Railroad of New Jersey in Tennent.

13. Lowland forest and bog on McGellairds Brook.

14. Lowland forest on Milford Brook.

15. Lowland forest at the head of a small tributary to Matchaponix Brook north of Union Hill Road.

16. Lowland forest between Matchaponix Brook and Spotswood-Gravel Hill Road.

17. Lowland forests of the Manalapan watershed 1,000 feet west of the Spotswood-Gravel Hill Road intersection.

18. Bog in a private bird sanctuary and family camping area 1,000 feet east of Old Forge Road.

19. Lowland forest on Ireland Brook at the New Jersey Turnpike crossing.

20. Oak forest south of Ireland Brook and west of the New Jersey Turnpike.

Additional Recommendations

The Expressway will pass through extensive areas of upland forest subtypes that are representative of the Pine Barrens (Figure 20). These oak-pine, pine-oak, and pine-oak scrub forests occur along the alignment as far north as the Manasquan River and also between Pine Brook and Jamesburg Park. The latter section is the southwestern part of an isolated Pine Barrens area known as the "Spotswood outlier." The size and quality of this outlier have been reduced substantially during the past two decades by suburban development. Although the three upland forest subtypes are not rare or unique in southern New Jersey, they are disjunct remnants in this more northern area and should be avoided if at all possible.

Recommendations on Naturalistic Landscaping

Where the alignment must be routed through forest lands, forests on the median strip and outside of the roadway area will be protected from disturbance. This will reduce land areas exposed to erosion and will minimize the need to reestablish vegetation cover. Insofar as possible, areas that must be cleared temporarily will be allowed to revert to a native forest cover after construction is completed. Planting with suitable native tree and shrub species may be desirable to expedite reforestation, particularly on larger areas.

A low-growing vegetation on areas beyond the road shoulders will provide visibility, emergency stopping spaces, and will allow snow and ice to melt more rapidly. These extra-shoulder areas can be formed and maintained in ways that will add visual diversity and seasonal variability, and also will provide a cover that requires only minimal maintenance. On many sections of the Expressway, it will be possible to retain existing native forests on the outer portions of the right-of-way as well as on the median. The edge of this fringing forest nearest the roadway can be formed into a gently undulating border. At irregular distances, deep cutbacks into areas now covered by cultivated crops, open marshes, old-fields or other non-forest vegetation types, can be maintained. In a few selected places, new vistas might be opened.

Native species will be utilized to form the low-growing vegetation. These species are adapted to local soil and climatic conditions and will require little or no fertilization or pest control. To afford a rich variety of herbaceous flowering plants and to prohibit their overgrowth by shrubs and trees, these herbaceous stands should be mowed in late October, November, or December of each year. This will also minimize fire danger by placing the dead stems and leaves on the soil surface where they will retain moisture and decompose more rapidly. Late autumn-winter scheduling also should permit better utilization of mowing crews and equipment that may be committed to traditional grass-strip maintenance on older roadway sections and in rest areas during the summer.

Because the Expressway alignment crosses diverse soil and geologic types, a diversity of floristic arrays also will be encountered. In this study it was not possible to assess this diversity adequately enough to provide detailed recommendations for naturalistic landscaping.

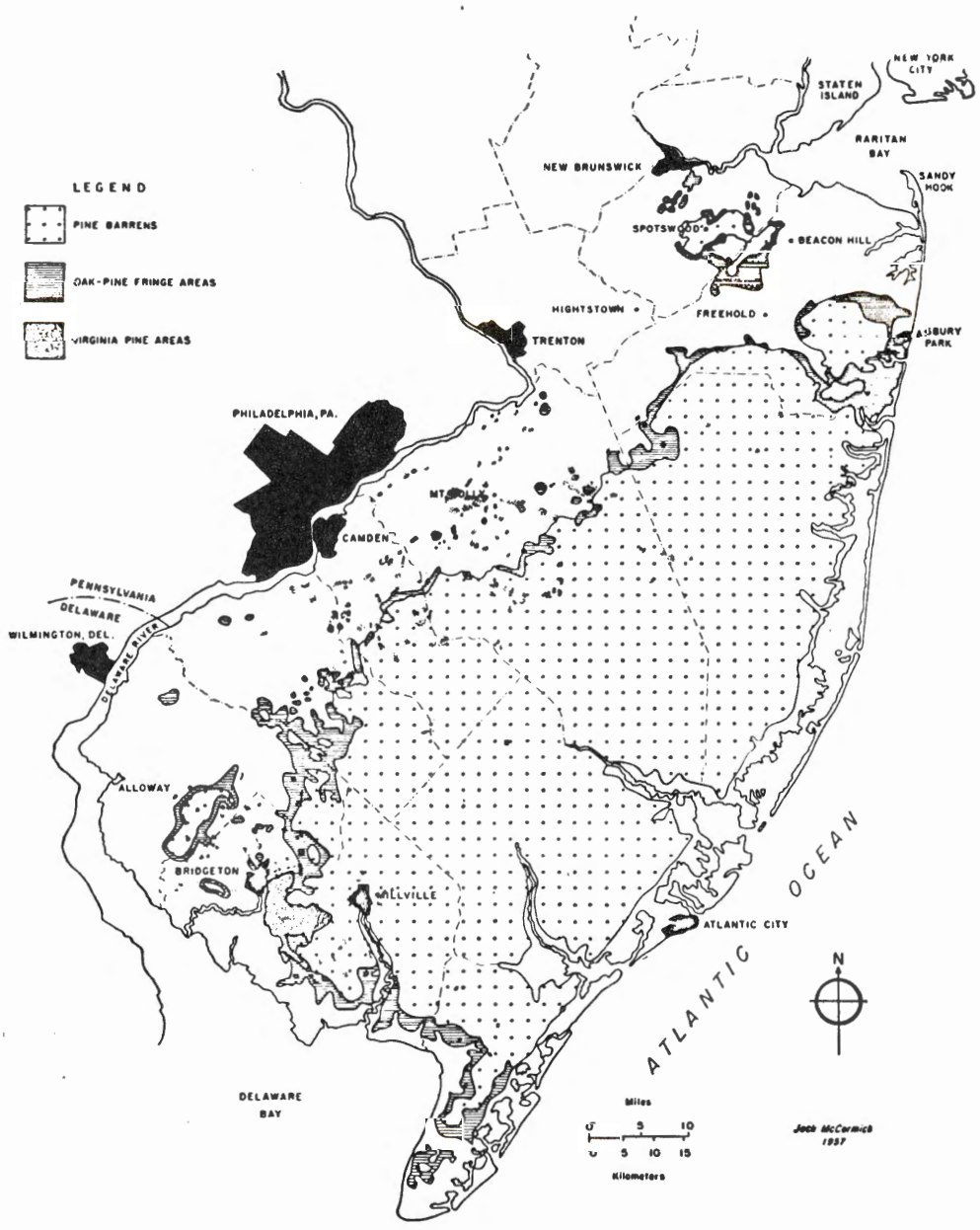

FIGURE 20. EXTENT OF THE PINE BARRENS

The alignment is principally through Pine Barrens habitats from Toms River to the Manasquan River and again around Jamesburg Park. Between the Manasquan River and Pine Brook, the routing is through a deciduous forest region. Although different groupings of plants will be involved in different sections, the general technique of dormant-season mowing management will be appropriate.

In the deciduous forest region the Expressway is routed largely through grasslands and crop fields. Reestablishment of forests on the right-of-way will add a visual amenity in this region and also will provide visual and acoustical barriers between the Expressway and nearby residential areas. Insofar as possible, trees and shrubs should be established from local seed sources or by transplanting specimens from nearby areas that are to be cleared for other construction. This practice will serve further to preserve the intrinsic genetic variability that has been depleted by widespread clearing.

WILDLIFE POPULATIONS

Care should be taken during construction to minimize the disturbance of existing forest and wetland habitats and to avoid unnecessary clearing of other disturbance. It is recommended that native shrubs and trees valuable to wildlife as food sources, nest sites, and cover be considered for roadside plantings. However, these plantings should be utilized only in areas at least 100 feet from the roadside in order to reduce roadkills, especially those involving deer.

If during construction of the Expressway an active beaver or river otter colony is encountered, the animals will be live-trapped and relocated to a suitable site by persons experienced in trapping these mammals and familiar with their habitat requirements.

AQUATIC LIFE

Heavy silting would have a detrimental effect on the aquatic life in the small natural watercourses. Every effort should be made to keep direct runoff from fresh cuts or fills to a minimum. Netting or mulch should be employed to minimize erosion until grass or other vegetation can gain a foothold. In the course of earth-moving operations, complete blockage of small tributary streams should be avoided. Cement trucks should not be washed directly into these waters. Waste water from cement mixing operations should be allowed to settle before entering these streams. Similarly, petroleum products, such as crankcase oil from vehicles and heavy equipment, must not be allowed to enter the streams.

Lake De Voe, a scenic recreation area at Spotswood, is just downstream from Helmetta on Manalapan Brook. Excessive silting here would have a particularly detrimental effect. It is anticipated that proper precautions will prevent such silting.

There are cranberry bogs downstream from the proposed roadway in the Toms River watershed and these should be protected from silting and

from altered stream flow. The salt marshes on the lower reaches of the Toms River likewise represent an area sensitive to silting or pollution.

GENERAL DESIGN CONSIDERATIONS

In a number of cases it has been pointed out that special design and construction practices may be required to minimize potential adverse impacts. It is the intent of the Turnpike Authority to investigate each of the locations and conditions identified by this study during engineering design so as to minimize the impact on natural resources. It is anticipated that most potential impacts can be minimized through careful engineering design and standard design practices. In any instances where this does not prove to be the case, adequate consideration will be given to special engineering features, such as elevated structures through lowlands and wet areas and localized realignment, to avoid particularly sensitive areas. Such considerations must weigh the "costs" of producing other adverse impacts, including increased construction cost, against the "benefits" of lessened impact on the affected natural resources.

It is recognized that all of the information desired to perform a complete environmental analysis will rarely be available. In several instances in this study the degree to which assessments of impact could be made was hampered by availability of information. It is anticipated that the additional data that will be forthcoming as a part of the normal engineering design for the Expressway (and is recommended in our study for further analysis) will alleviate much of this problem and will allow potential impacts to be minimized.

IMPACT OF THE GOVERNOR ALFRED E. DRISCOLL EXPRESSWAY ON SOCIAL AND PHYSICAL RESOURCES

INTRODUCTION

This section on the social impacts of the proposed Expressway is divided into six parts according to the subject areas investigated:

Impacts on Open Space and Recreation
Impacts on Historic, Archeological, and Paleontological Sites
Impacts on Community Services
Impacts on Community Institutions
Impacts on Educational Institutions
Impacts on Neighborhood Land Use

Each part describes the sources of data and any impacts identified. Very little published information exists for the areas investigated in this section. Field surveys were undertaken where warranted and feasible; attempts were made to contact interested governmental, civic, and other groups who were thought to have information pertinent to the study.

Open space and recreation areas and areas of social resources were analyzed for impacts. These analyses are graphically presented for the the entire alignment in Figure 21.

Because social impacts are very difficult to quantify and are a function of the perceptions of various interest groups, our study has concentrated on identifying potential problem areas or "sensitive impacts" that may warrant more detailed analysis.

A seventh part presents the Conclusions and Recommendations for the social and physical resources portion of the study.

No major adverse environmental impacts have been found. An adverse impact was identified for a bird sanctuary in Monroe; however, steps can be taken to minimize this impact. Potential secondary impacts warranting detailed analysis during design were found for recreational activities at the Estonian Youth Camp in Jackson and the proposed Jamesbury Park, community social institutions in ~~Manalapan,~~ and compatibility of neighborhood land uses in several areas, particularly Helmetta. In Helmetta continuing efforts are being made to minimize potentially debilitating impacts. In general, good design practices should minimize any potential adverse impacts.

Positive impacts were identified in a number of cases, including enhancement of potential open space uses for the Monmouth Battlefield and redefinition of neighborhood boundaries to community benefit in Freehold and Madison.

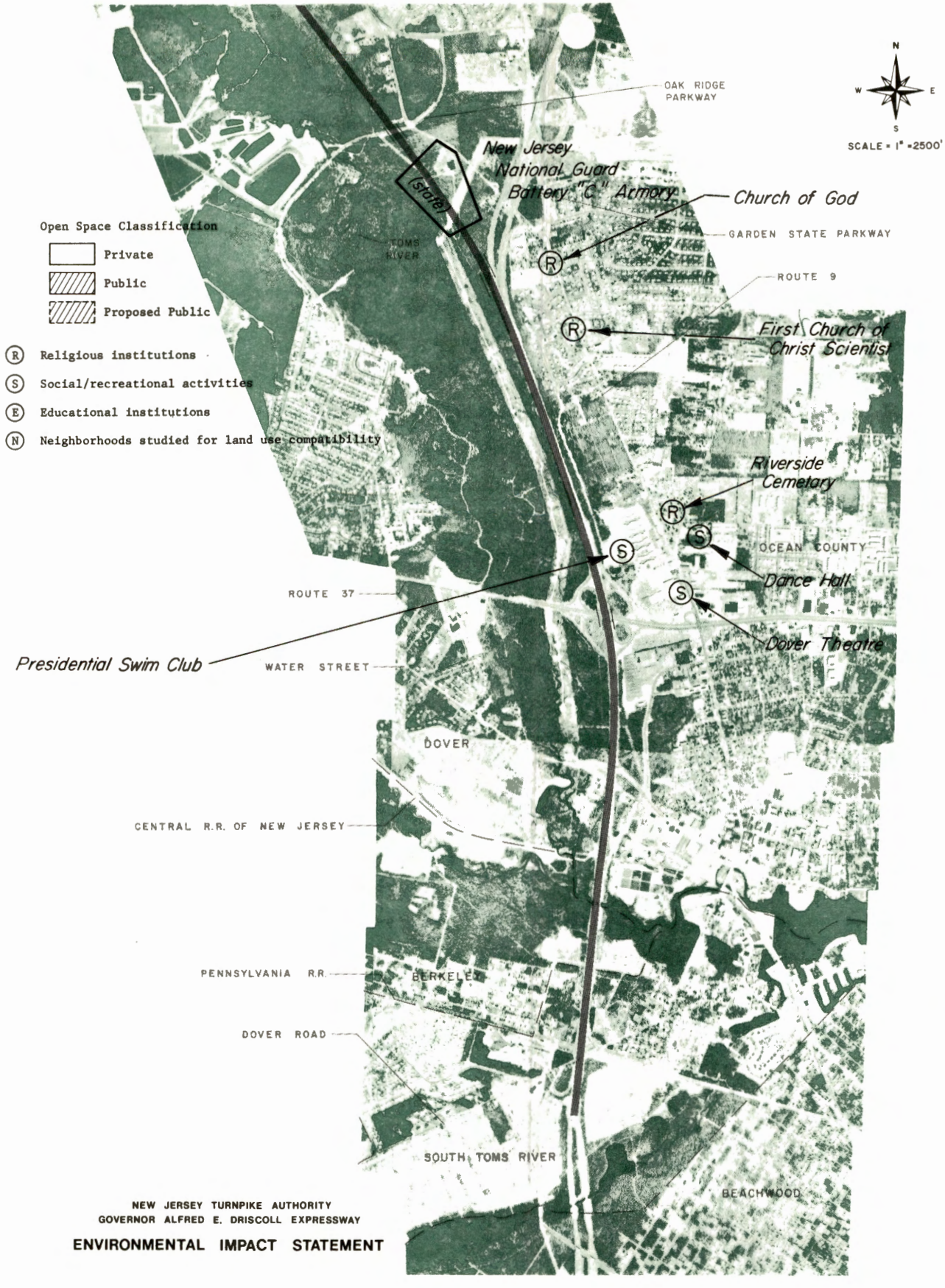

FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 1 OF 10

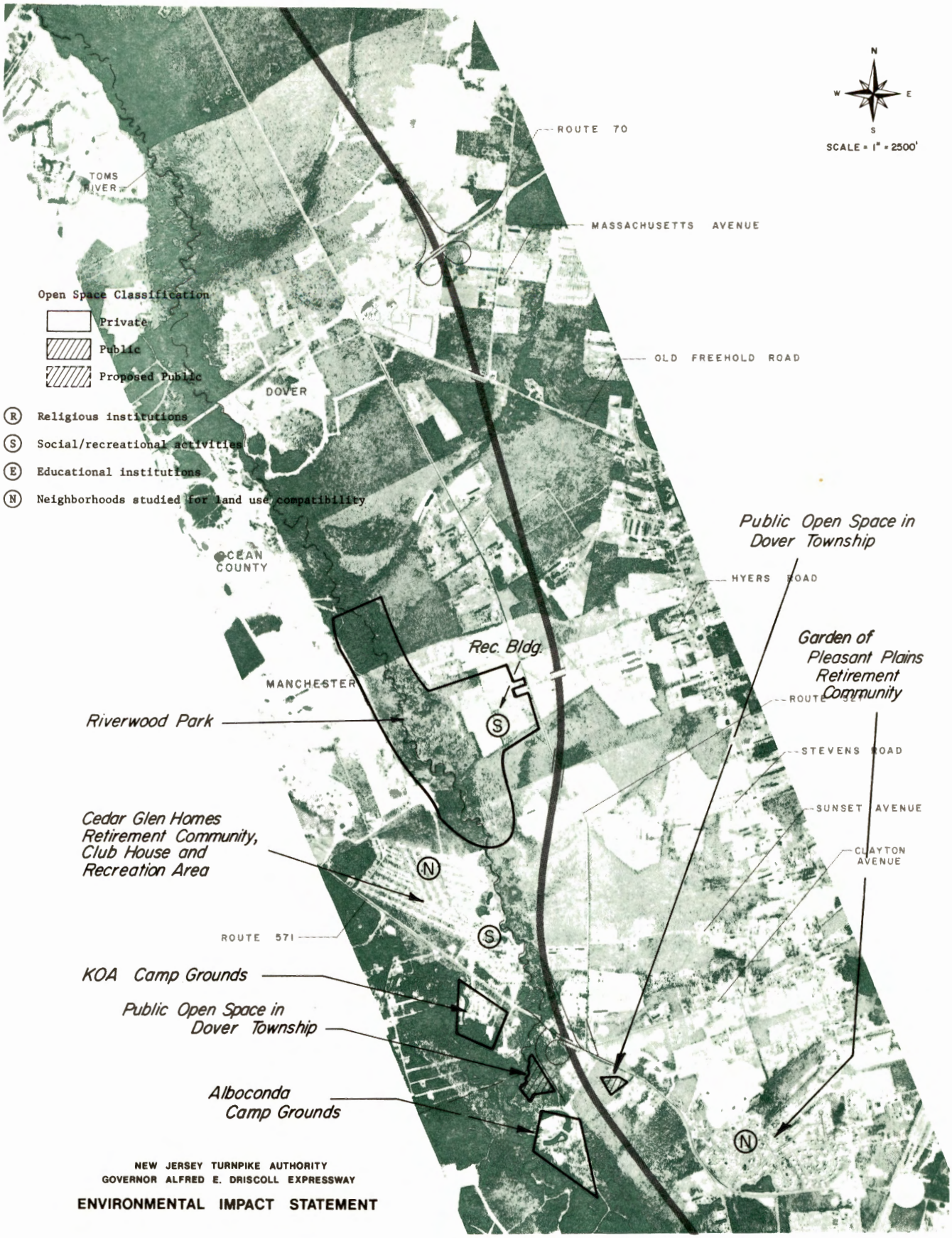

FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 2 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 3 OF 10

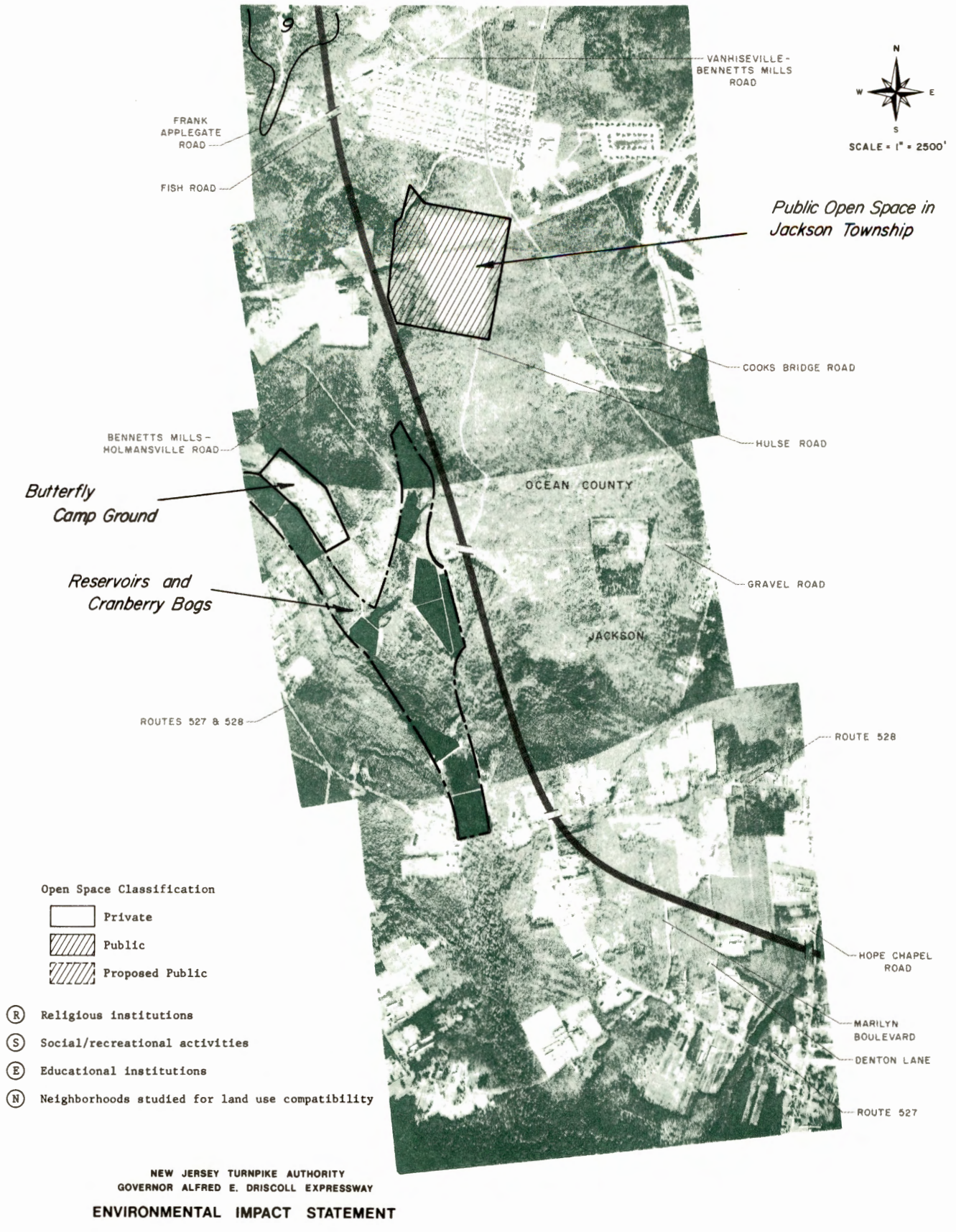

FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 4 OF 10

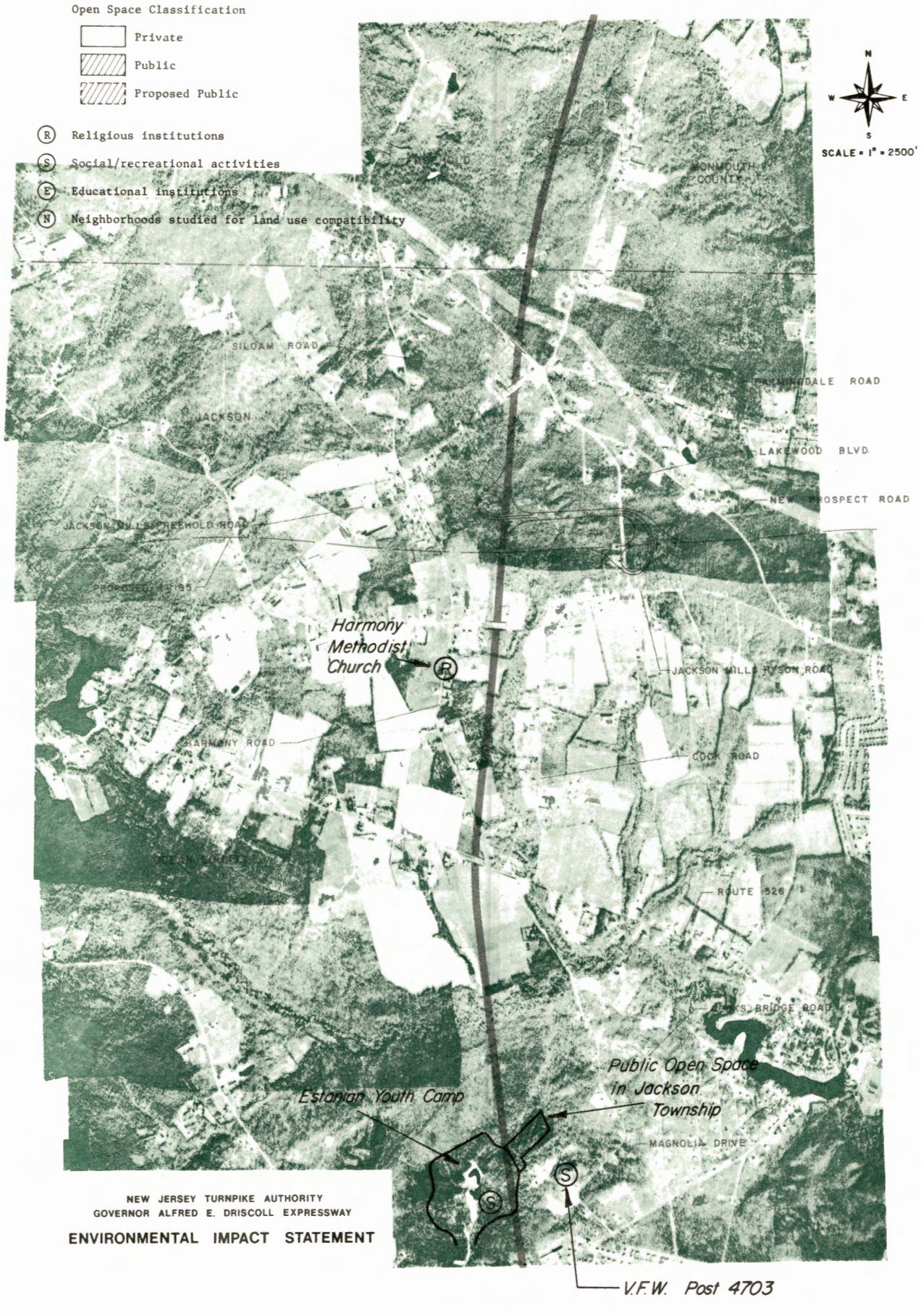

FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 5 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 6 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 7 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 8 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 9 OF 10



FIGURE 21. SOCIAL AND PHYSICAL RESOURCES: SHEET 10 OF 10

IMPACTS ON OPEN SPACE AND RECREATION

DATA SOURCES

An inventory of public and private open space, recreation and related land uses was assembled from available data; it is shown on the accompanying ten sheets. One of the primary sources of data consisted of overlays prepared by Howard, Needles, Tammen, and Bergendoff for 1" = 1000' aerial photographs of the proposed alignment. These overlays showed the location of major buildings and open space areas within 2000 feet of either side of the center line of the road. Howard, Needles had conducted research from tax maps, surveys and memoranda of present town acquisitions. They had also prepared lists of public-owned parcels in the ROW, open space privately owned for public use and the actual acreage that would be taken by the ROW for each parcel. Their information was very complete as to topography, land ownership and acquisition for the entire alignment. Because of the magnitude of information needed to adequately cross-reference all parameters of interest, all of the data desired was not readily available in one informative listing.

Several other sources of information were used, generally to clarify the use or status of parcels already identified. Field surveys conducted for the study of natural resources (Horace Somes of Jack McCormick & Associates) contributed detailed information on cranberry bogs and wildlife refuges, while the field studies concerned with noise impact (Matt Rubin of Bolt, Beranek, and Newman) provided information on public and private open space use. The status of parcels owned by the New Jersey Highway Authority and of the Armory in Dover was ascertained from the Turnpike Authority (Allen Lewis).

The status of the proposed Jamesburg Park in Middlesex County has recently been of significant controversy. In particular, the Middlesex County Conservation Council is strongly opposed to the Expressway passing through the proposed park because of the perceived danger to the environment in the area of the park. We have attempted to examine the proposed park in this section in terms of its open space and recreation functions. In this regard, we talked to members of the staff of the Middlesex County Planning Board on 13 July 1972. Furthermore, questions regarding the impact on water and natural resources for the area of the proposed park are treated in other sections of this report.

IDENTIFICATION OF AREAS IMPACTED

Table 24 lists each of the 22 parcels analyzed in our study together with pertinent inventoried information. Their locations are shown in Figure 21 on Sheets 1 to 10. The following sections describe impacted parcels town by town.

Dover - A total of five parcels were analyzed in the town of Dover. The three public open spaces include two small township parks and undeveloped Riverwood Park; none are adversely impacted. The one private parcel (the Alboconda Campground) is not affected.

TABLE 24. OPEN SPACE AND RECREATION INVENTORY

Aerial Photograph No.	Township	Description	Ownership	Estimated Acreage of Parcel	Estimated Acreage Acquired By Alignment	Notes
1	Dover	Armory	State	26.00	11.00	State of New Jersey National Guard Battery "C"
2	Dover	Township Parcel	Public	3.00	1.00	
2	Dover	Alboconda	Private	23.00	n.a.	Campground; electric and water hookups available
2	Dover	Township Parcel	Public	8.00	6.00	R.O.W. of interchange with Route 571
2	Dover	Riverwood Park	Public	96.00	n.a.	Recreation building and 7000 foot stream frontage
2	Manchester	K.O.A.	Private	19.00	n.a.	Campground; electric and water hookups available
4	Jackson	Butterfly Campgrounds	Private	30.00	n.a.	Fish and wildlife management area = State Campgrounds = Private
4	Jackson	Township Parcel	Public	96.00	.50	
5	Jackson	Township Parcel	Public	10.00	.50	
5	Jackson	Estonian Youth Camp	Private	65.00	7.00	Russian heritage youth camp, recreation grounds & community center
6	Freehold	Camp Namoco	Private	99.00	n.a.	Girl Scout Camp
6	Freehold	Turkey Swamp	Public/State	568.00	n.a.	Camping & Fishing = 168 acres Hunting & Fishing = 400 acres
7	Manalapan	Monmouth Battlefield	Public/State	195.00	13.00	State historical site under renovation
8	Manalapan	New Jersey Highway Authority	*	28.00	11.00	
8	Manalapan	New Jersey Highway Authority	*	83.00	15.00	
8	Manalapan	New Jersey Highway Authority	*	167.00	29.00	
8	Madison	Moulders Farm	Private	40.00	n.a.	Fishing ground
9	Madison	Township Parcel	Public	86.00	9.00	Town dump
10	Monroe	Bird Sanctuary	Private	44.00	4.00	Family camping area
10	Helmetta	Township Parcel	Public	2.00	1.00	Within Jamesburg Park; 5 lots at 25' x 100' as of 7-12-72
10	East Brunswick South Brunswick Helmetta Spotswood	Jamesburg Park	Public	1474.00	45.00	88 lots at 25' x 100' as of 7-12-72
10	East Brunswick	Community Park	Public	46.00	n.a.	Recreation & Swimming area

Notes:

* = Property previously purchased for the then proposed Garden State Thruway

n.a. = No Acreage acquired by alignment or Right-of-Way

The alignment goes through the center of the parcel belonging to the state armory in Dover. However, the armory will be receiving a "swap parcel" which will more than adequately compensate for the area taken by the ROW and the remaining area on the other side of the alignment. There is no loss in tax dollars and the impact is not considered significant.

Manchester - The impact on the private K.O.A. campground in Manchester was analyzed and found to be minimal since the campground itself is not directly impacted.

Jackson - Two township parcels in Jackson are within 2000 feet of the road with a total loss in land of one acre out of 106 acres. The impact is considered to be minimal. The Master Plan for Jackson shows large areas of residential and green belt planned for the area of the road. The provision of a "parkway-like" wide ROW here could serve as a catalyst for such open space preservation.

Two private parcels were analyzed in Jackson. The impact on the Butterfly Campgrounds is considered minimal. However, the impact on the Estonian Youth Camp is sensitive and may warrant more detailed analysis during the design phase. The parcel is severed by the Expressway, 7 of 65 acres are taken, and the existing access road will be cut off. A new access road will be built, but the layout of recreational activities should be carefully assessed in determining the location of this road and the inconvenience caused during construction.

Lakewood - Part of the city dump on foreclosed land in Lakewood will be taken. Any impact here is apt to be of a positive nature, serving as a buffer zone between the dump and future land uses. The area is currently defoliated as a result of the gypsy moth.

Freehold - The Expressway should not have an adverse impact on Turkey Swamp, a major recreation area located in Freehold. The impact on Camp Namoco is considered minimal.

Manalapan - Three parcels of property previously purchased for the then proposed Garden State Thruway are affected by the Expressway. No taxable land is lost and the impact is considered minimal.

Thirteen acres out of an approximate total of 195 acres comprising Monmouth Battlefield State Park will be acquired. They are in a remote area of the park which is not planned for renovation and therefore no adverse impact should result. Because of the better access afforded by the interchange with the Route 33 Bypass (which is in keeping with the planned renovation), the overall impact on the Battlefield Park as an open space area should be positive.

Madison - Part of a township parcel in Madison used as a dump will be taken; the impact is considered minimal or positive since the site will be upgraded. A private parcel - Moulders Farm - which is used for fishing is not impacted.

Monroe - The proposed Expressway goes down the center of a private bird sanctuary and family camping area in Monroe. Because of the nature of the open space use and the location of the ROW in relation to the parcel boundaries, the localized impact is major; adverse environmental impacts are unavoidable.

The entire parcel consists of 44 acres of which 4 are scheduled to be taken. According to the wildlife description in the section on Natural Resources, the bird populations and provisions made for them are such that relocation should be feasible. To minimize the unavoidable adverse environmental impacts, steps should be taken to find a suitable relocation parcel in the vicinity and to compensate the owners for moving or replacing the shelters and other facilities necessary for the maintenance of the bird sanctuary and ancillary activities. If such steps are carried out successfully, the environmental impact will be minimal.

East Brunswick - No adverse impact was found for the community park in East Brunswick within 2000 feet of the alignment.

Helmetta, Spotswood, East Brunswick, and South Brunswick - Portions of proposed Jamesburg Park are contained in each of these four townships (one acre is contained in Jamesburg). Of approximately 1474 acres proposed for the park, the ROW would take 45 acres, including one acre of an existing 2-acre township parcel in Helmetta. It would divide the open space area into two nearly equal halves but would not impact any existing recreation and open space activities.

Because of the controversial nature of the proposed Jamesburg Park and the possible impact of the Expressway, we made our analysis in two parts: first, we have used the same objective criteria employed with the other 21 parcels analyzed; secondly, we have examined some of the public statements made about the proposed park and the impact of the Expressway on the use of the area for open space and recreation.

No plans have been made, according to the Middlesex County Planning Board, for particular recreational or open space uses at specific locations in the proposed park. Therefore, the proposed alignment does not interfere with potential uses at this time. If a greater amount of land were taken or if the alignment were to sever a small section of the park area from the main body, the impact would be more severe. If the Expressway traverses the park in as short a distance as possible and allows for ready access between the two parts of the park, the impact can be minimized. This could be accomplished in part by planning the future recreation and other open space areas such that activites that would be adversly affected by a road are removed from the area of the alignment. As the Expressway and Jamesburg Park are currently proposed, there would not appear to be an adverse environmental impact on the open space and recreational uses (or potential uses) according to the criteria we have used throughout this study.

The issues discussed in various newspaper articles and other published accounts can be categorized into four different areas of interest:

1. Open space and recreation
2. Wildlife and ecology
3. Water supply
4. Taxable land

The greatest concern of the environmental groups is not with the potential impact on recreation and open space use.

The items considered by the Middlesex County Planning Board to be of importance in assessing the impact of the road are:

> "For open space and recreation, that it does not prevent the park from functioning as a resource protection area or produce excessive noise or air pollution within the proposed park, or harm aesthetically pleasing characteristics of the existing terrain, tree cover or other natural characteristics of the terrain.
>
> For wildlife and ecology, that it does not prevent the park from functioning as a wildlife preserve, nor harm or prove detrimental to indigenous animal and plant life presently found in the park area.
>
> For water supply, that it does not intrude on water recharge areas or existing or potential bog areas, nor disrupt natural drainage characteristics of the area.
>
> For design, that it meets optimum geometric design standards, provides for maximum motorist safety and is itself an aesthetically pleasing facility."

The questions of wildlife and ecology, water supply, and design are discussed elsewhere in this report. In general, no adverse environmental impacts were identified for these considerations although further study would be warranted to make definitive statements, particularly in regard to the impact on water supply.

It would appear that the proposed Expressway would create a sensitive impact on the potential recreational and open space uses of the park. The impact should not constitute an adverse environmental impact. Furthermore, steps can be taken during design and construction to minimize the impact, to make the open space areas adjacent to the roadway as attractive as possible and to meet criteria such as those put forth by the Middlesex County Planning Board.

IMPACTS ON HISTORIC, ARCHEOLOGICAL AND PALEONTOLOGICAL SITES

DATA SOURCES AND FINDINGS

Our primary source of information was the State of New Jersey, Department of Environmental Protection, Division of Parks and Forestry, Historic Sites Section. Under the direction of David N. Poinsett, Supervisor, Historic Sites, an examination of their files was made at our request. They did not find any historic or architectural sites in the inventory that would be impacted, nor were they aware of any archeological or paleontological areas along the right of way.

We also contacted the Monmouth County Historic Association in Freehold (Mrs. Feltus) and the Monmouth Battlefield State Park (Frank Enders) to assess the impact on Monmouth Battlefield which is a state historic site currently under renovation. The right of way will take some 13 of 195 acres in a remote undeveloped section of the park, well removed from the Battlefield monument itself. Neither of the people contacted were aware of the alignment, nor did they feel that it would adversely affect their activities. Monmouth Battlefield State Park is currently being upgraded to emphasize its historic value and to attract visitors. It appears that improved access to the park, as provided by Interchange 5 at Route 33 Bypass, would complement the renovation plans currently underway. Access provided by an interchange in the park itself would probably be overly distractive and not in keeping with the intended use of the site. In general, the impact of the proposed Expressway on the state historic site is positive by providing necessary access without opening up this natural resource to greater exploitation.

We also examined all appropriate Federal Registers for the listings of historic sites and found none in the area of potential impact of the Expressway.

River beds in this region are known to have scattered archeological and paleontological items of interest, but no inventory exists. Furthermore, such items will probably not be discovered until construction actually takes place (if any exist along the proposed alignment).

IMPACTS ON COMMUNITY SERVICES

DATA SOURCES

Using cartographic materials and data obtained by Howard, Needles, Tammen, and Bergendoff during field observation, we have identified all locations at which the Governor Driscoll Expressway will require roadway and utility reroutings. The charts (Table 25) on the following pages describe 44 such sites and array the utility alterations deemed necessary at each. Four categories have been used: water/sewer, gas, power, and telephone, with fire alarm and other communications systems accounted for under this last item. To facilitate site identification, each entry is given its appropriate aerial photograph, USGS quadrange (7.5 minute series), and station number.

Because impact assessment inevitably carries with it the question of what is "important," we have avoided making any explicit statements of an evaluative nature. Rather, each entry carries with it the only comparative element across sites which presently exists; namely, an order of magnitude cost estimate divided into three ranges: less than $50,000, $50,000 to $100,000, and greater than $100,000 total cost. Readers are cautioned not to confuse magnitude with significance.

SUMMARY OF PROBLEMS IDENTIFIED, BY SERVICE TYPE

Sewer and Water

Very few municipal water and sewer systems are affected, because the rural nature of much of the landscape has made such supply and disposal systems uneconomical. Generally, private wells and septic systems are the rule. It is unlikely that any dewatering will occur as a result of highway construction. In this event, however, it is the policy of the Turnpike Authority to make restitution for any damages done.

Police and Fire

Data for local police precincts and fire district lines were not readily available. Because individual approaches to every jurisdiction affected would have been prohibitively expensive and because such information - even if it were collectable - would have had extremely limited utility, we discontinued our efforts.

Fire response times may be affected where permanent road reroutings are implemented (e.g., entry #4, Route 527). However, this is not to say that the effects will necessarily be negative, simply that more information is required during design. Individual fire companies should be presented the facts of access changes and encouraged to evaluate their effects on what they know to be their own needs. Coordination with a county fire plan is recommended.

With respect to emergency preparedness, the Turnpike Authority's practice of making contributions to first aid squads and fire departments serving the present Turnpike will be continued.

State Police protection will be provided by Troop D of the New Jersey State Police. Local police forces will not be involved.

Fire alarm systems encountered have been identified by Howard, Needles, Tammen, and Bergendoff. These systems will be maintained and replaced as required, and provisions for future needs in developing areas have been made in the highway designs.

Power

All service connections, transmission lines, towers, etc., will be replaced or rebuilt as necessary. New connections for toll plazas and service areas will be required, though firm determinations of footage and connection sites await final siting decisions. The entries in Table 25 reveal no particular difficulties. One exceptional situation worthy of note occurs at site #41, Pennsylvania Railroad crossing and Main Street. Here, the structure proposed is long and high, making it feasible to construct pole line under the structure rather than go underground. Catenary railroad cable will be unaffected.

Telephone

Relocation and replacement of all affected facilities is anticipated.

Gas

Relocation and replacement of all affected facilities is anticipated.

Postal Facilities

No loss of facilities, parking areas, or diminished access is anticipated. Only one post office (Manalapan) is within 1000 feet of the Expressway.

TABLE 25. IMPACT ON PUBLIC UTILITIES

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
SECTION I 1. Garden State Parkway Tie-On A.P. 1 USGS Toms River Quadrangle **Cost Range:** **>$100K**			Sta. 27-54 • Relocate 2600 L.F. 34.5 KV (transmission) pole line • Reconstruct high tension towers #70 & 71 to provide 30' clearance of roadway Sta. 65-99 • Relocate 4500 L.F. 34.5 KV (transmission) pole line	
2. Oak Ridge Parkway A.P. 1 USGS Toms River Quadrangle **Cost Range:** **$50K-$100K**		Sta. 98 Provide 300 L.F. 16" steel sleeve for existing 8" gas line (250#)	Sta. 95-100 • Construct 300 L.F. ug 34.5 KV (transmission) Cable and ducts • 2 M.H. • 2 riser poles • Construct 300 L.F. ug BKV cable and ducts	• Construct 300 L.F. ug 100 pr. cable and ducts • 2 M.H. • 2 riser poles
3. State Route 571 A.P. 2 USGS Lakewood Quad **Cost Range:** **>$100K**	Through Structure Sta. 150 • Construct 300 L.F. 6" water main • 300 L.F. 12" steel sleeve • 2 hydrants	Through Structure Sta. 150 • Construct 300 L.F. 6" (distrib.) gas main • 300 L.F. 12" steel sleeve	Through Structure Sta. 150 • Construct 300 L.F. ug 4 KV Cable and duct • 2 M.H. • 2 riser poles	Through Structure Sta. 150 • Construct 300 L.F. ug 200 pr cable • 2 M.H. • 2 riser poles
	Toms River Crossing • Construct 1300 L.F. 6" water main	Toms River Crossing • Construct 1300 L.F. 6" gas main (250#)	Toms River Crossing • Construct 1300 L.F. 4 KV pole line	Toms River Crossing • Construct 1300 L.F. 200 pr cable pole line
			• Remove 1600 L.F. existing cable	• Remove 1600 2F existing cable • Install fire alarm system Sta. 155 • Lower 650 L.F. 900 pr cable • 2 M.H.
4. State Route 527/Clayton Avenue; Sta. 150 A.P. 2 USGS Lakewood Quad **Cost Range:** **>$100K**	• Construct 1200 L.F. 12" water main 1 Hydrant • Construct 1200 L.F. 8" sanitary sewer 4 M.H.	• Construct 1200 L.F. 8" (250#) transmission line • Construct 1200 L.F. 4" main (distrib.)	• Construct 1200 L.F. 34.5 KV (transmission) pole line • Construct 1200 L.F. 13 KV (transmission) pole line • Construct 1200 L.F. service pole line • Construct 500 L.F. 4 KV pole line • Remove 1200 L.F. existing line	• Construct 1200 L.F. pole line 200 pr cable • Remove 1200 L.F. existing line

A.P. = aerial photograph number
USGS = quadrangle map title
Sta. = approximate station number
ug = underground
M.H. = manhole

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
5. State Route 527 (Whitesville Rd.) Sta. 200 A.P. 2 USGS Lakewood **Cost Range: $50K-$100K**	• Existing sanitary sewer remains	• Install 300 L.F. 16" steel sleeve for existing 8" gas line	Under structure: • Construct 300 L.F. ug 34.5 KV Cable and ducts • Construct 300 L.F. ug 13 KV cable and ducts • Construct 300 L.F. ug service cable and ducts • 2 M.H. (extra large) • 2 riser poles	Under structure: • Construct 300 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
6. Hyers Road; Sta. 220 A.P. 2 USGS Lakewood Quad **Cost Range: $50-$100K**			Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • Construct 250 L.F. ug service cable and ducts • 2 M.H. • 2 riser poles Approaches: • Construct 1,100 L.F. 4KV and service pole line • Construct temporary 2 cable power line, 4 house connections • Remove 1400 L.F. existing line	Through structure: • Construct 250 L.F. ug 400 pr cable and ducts • 2 M.H. • 2 riser poles Approaches: • Construct 1,100 L.F. 400 pr. pole line • Construct temporary phone line, 4 house connections • Remove 1400 L.F. existing line
7. Cox Cro Road (Old Freehold Rd.); Sta. 275 A.P. 2 USGS Lakewood Quad **Cost Range: < $50K**			N.B. DATA UNAVAILABLE FOR THIS CROSSING. PRESENCE OF UTILITIES IS ASSUMED. • Construct 1200 L.F. 4 KV pole line • Remove 1800 L.F. existing line • Deadend existing line	• Construct 1200 L.F. 200 pr cable pole line • Remove 1800 L.F. existing line • Deadend existing line
8. Route 70 (Rockefeller Highway; Sta. 300 **Cost Range: > $100K**	• Construct 2500 L.F. 8" steel water main • Construct 250 L.F. 16" steel sleeve • 2 Hydrants • Construct 2500 L.F. 8" sanitary sewer • Construct 250 L.F. 16" steel sleeve • 5 M.H.		Through structure: • Construct 1050 L.F. ug 13 KV cable and ducts • 4 M.H. • 2 riser poles Approaches: • Construct 1600 L.F. 13 KV pole line • Remove 2700 L.F. existing line • Install temporary power line	Through structure: • Construct 1050 L.F. ug 600 pr cable and ducts • 4 M.H. • 2 riser poles Approaches: • Construct 1600 L.F. 600 pr cable pole line • Remove 2700 L.F. existing line • Install temporary phone service and fire alarm system
	Access and all utility connections from Route 70:			
8a. Toll Building; Sta. 320 A.P. 2 USGS Lakewood Quad.	• Construct 2050 L.F. 6" water main • 1 Hydrant • Construct 2050 L.F. 6" sanitary sewer • 5 M.H.	• Construct 2050 L.F. 2" gas line	• Construct 2050 L.F. 4 KV service line (buried cable)	• Construct 2050 L.F. 50 pr telephone cable

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
SECTION II:				
9. Central RR of New Jersey; Sta. 396 A.P. 3 USGS Lakehurst Quad. **Cost Range: < $50K**			Under Structure: • Construct 250 L.F. 34.5 KV cable and ducts • 2 riser poles Sta. 398 • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 250 L.F. telegraph and communications wire and ducts • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • riser poles
10. Whites Road; Sta. 438 A.P. 3 USGS Lakehurst Quad. **Cost Range: $50K-$100K**			• Construct 1500 L.F. 4 KV pole lines • Install temporary 1 cable power line • Remove 1750 L.F. existing line • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1500 L.F. 100 pr pole line • Install temporary 1 cable line • Remove 1750 L.F. existing line • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles • Install fire alarm system
11. State Route 547 (Hope Chapel Rd.); Sta. 458 **Cost Range: $50K-$100K**			• Construct 1000 L.F. 4 KV (service) pole line • Install temporary 2 cable power line • Remove 1300 L.F. existing line • Construct 300 L.F. ug 4 KV cable and ducts • Construct 300 L.F. ug service and ducts • 2 M.H. • 2 riser poles	• Construct 1000 L.F. 100 pr pole line • Install temporary service line • Remove 1300 L.F. existing line • Construct 300 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
12. Denton Lane; Sta. 480 A.P. 3 USGS Lakehurst Quad. **Cost Range: < $50K**			• Remove 400 L.F. 4 KV pole line • Remove 400 L.F. service line	• Remove 400 L.F. 50 pr pole line • Install fire alarm system
13. Marilyn Boulevard; Sta. 490-495 A.P. 3 USGS Lakehurst Quad. **Cost Range: < $50K**			• Construct 900 L.F. 4 KV pole line and service pole line • Remove 1100 L.F. existing line	• Construct 400 L.F. 50 pr pole line • Remove 1100 L.F. existing line

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
14. State Rts. 527-528 (Bowman Rd.); Sta. 518 A.P. 4 USGS Lakehurst Quad. **Cost Range: $50K-$100K**			• Construct 1000 L.F. 4 KV pole line • Install temporary 1 cable line • Remove 1300 L.F. existing line Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1000 L.F. 100 pr pole line • Install temporary 1 cable line • Remove 1300 L.F. existing line Through structure: • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
15. High Tension Cable Crossing; Sta. 624 A.P. 4 USGS Lakehurst Quad. **Cost Range <$50K**			• Reconstruct 1 high tension tower • Construct 1000 L.F. 34.5KV aerial cable • 2 extra high poles (50') • 2 high-rise poles (40') • Remove 1000 L.F. existing line	
16. Bennetts Mills Road; Sta. 654 A.P. 4 USGS Lakehurst Quad. **Cost Range: >$100K**			• Construct 1700 L.F. aerial 4 KV and service line (same poles) • Install 2200 L.F. temporary 2 cable line • Remove 1700 L.F. existing line Through structure • Construct 300 L.F. ug 4 KV and 300 L.F. service cable in ducts • 2 M.H. • 2 riser poles	• Construct 1700 L.F. 300 pr cable pole line • Install temporary 2 cable line • Remove 2200 L.F. existing line • Construct 300 L.F. ug 300 pr cable and ducts • 4 M.H. • 2 riser poles • Construct 900 L.F. ug 900 pr cable and ducts • Install fire alarm system
17. State Route 526 (Jacksons Mills - Lakewood Road); Sta. 1835 A.P. 5 USGS Adelphia Quad.			• Construct 500 L.F. aerial 4 KV and service line • Install 900 L.F. temporary 2 cable service • Remove 800 L.F. existing line Through Structure: • Construct 300 L.F. ug 4 KV cable and ducts • Construct 300 L.F. ug service cable and ducts • 2 M.H. • 2 riser poles	• Construct 500 L.F. aerial 300 pr cable • Install 900 L.F. temporary 1 cable service • Remove 800 L.F. existing line Through Structure: • Construct 300 L.F. ug 300 pr cable and ducts • 2 M.H. • 2 riser poles • Fire alarm system

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
18. Jackson Mills Hyson Road; Sta. 1879 A.P. 5 USGS Adelphia Quad. **Cost Range: $50-$100K**			• Construct 1000 L.F. aerial 4 KV line • Install 1500 L.F. temporary 1 cable service • Remove 1300 L.F. existing line Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • riser poles	• Construct 1000 L.F. 100 pr aerial line • Install temporary 1 cable service • Remove 1300 L.F. existing line Through structure: • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
18a. Route I-195 Interchange; Sta. 1890-1910	• Proposed toll plaza, north bound side, would be provided utility connections from Lakewood Blvd. or New Prospect Road. Separate septic system probable. Present utilities at Lakewood Blvd. to be deadended and new connections provided as necessary. Approximately 1400 L.F. pole line to be removed.			
19. Jackson Mills Freehold Rd.; Sta. 921 A.P. 5 USGS Adelphia Quad. **Cost Range: $50-$100K**			Through structure: • Construct 300 L.F. ug 4 KV cable and ducts • Construct 300 L.F. ug service cable and ducts • 2 M.H. • 2 riser poles • Install temporary 4 KV cable • No aerial installation required.	Through structure: • Construct 300 L.F. ug 50 pr cable and ducts • 2 M.H. • 2 riser poles • Install temporary 50 pr cable • Install fire alarm system
20. Siloam Road; Sta. 1930 A.P. 5 USGS Adelphia Quad. **Cost Range: $50K-$100K**			• Construct 700 L.F. 4 KV pole line • Install temporary 4 KV cable • Remove 1100 L.F. existing 4 KV cable Through structure: • Construct 300 L.F. ug 4 KV cable and ducts • Construct 300 L.F. ug service cable and ducts • 2 M.H. • 2 riser poles	• Construct 700 L.F. 50 pr cable pole line • Install temporary 50 pr cable • Remove 1100 L.F. existing 50 pair cable Through structure: • Construct 300 L.F. ug 50 pr cable and ducts • 2 M.H. • 2 riser poles
SECTION III 21. High Tension Crossing; Sta. 1938 A.P. 5 USGS Adelphia Quad. **Cost Range: $50K-$100K**			• Construct steel tower • Construct 2400 L.F. 64 KV aerial cable • Construct 8 extra high poles (50') • Remove existing tower • Remove 2400 L.F. 64 KV cable	
22. Georgia Road; Sta. 2032 A.P. 5 USGS Adelphia Quad. **Cost Range: $50K-$100K**	• Construct 1800 L.F. 8" steel water main • Construct 200 L.F. 18" steel sleeve • 1 Hydrant		• Construct 1600 L.F. 4 KV pole line • Install temporary 4 KV cable • Remove 1800 L.F. existing 4 KV cable Through structure: • Construct 200 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1600 L.F. 200 pr cable pole line • Install temporary 200 pr cable • Removal 1800 L.F. existing 200 pr cable Through structure: • Construct 200 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
23. Georgia Road; Sta. 2060 A.P. 6 USGS Adelphia Quad. **Cost Range: $50K-$100K**	• Construct 1800 L.F. 8" steel water main • Construct 200 L.F. 18" steel sleeve • 1 Hydrant		• Construct 1600 L.F. 4 KV cable pole line • Install temporary 4 KV cable • Remove 1800 L.F. existing 4 KV cable Through structure: • Construct 200 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1600 L.F. 200 pr cable pole line • Install temporary 200 pr cable • Remove 1800 L.F. existing 200 pr cable Through structure: • Construct 200 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles • Install fire alarm system
24. Adelphia Road **Cost Range: $50K-$100K**			• Construct 900 L.F. 13 KV cable pole line • Construct 900 L.F. 4 KV cable pole line • Install temporary 13 KV and 4 KV cable • Remove 1000 L.F. existing cable Through structure: • Construct 200 L.F. ug 13 KV cable and ducts • Construct 200 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 900 L.F. 100 pr cable pole line • Install temporary 100 pr cable • Remove 1000 L.F. existing cable Through structure: • Construct 200 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
25. Iron Bridge Road; Sta. 2163 A.P. 6 USGS Adelphia Quad. **Cost Range: $50K-$100K**			• Construct 1200 L.F. 4 KV and 13 KV cable pole line • Install temporary 13 KV cable • Remove 1400 L.F. existing cable Through structure: • Construct 250 L.F. ug 13 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1200 L.F. 100 pr cable pole line • Install temporary 100 pr cable • Remove 1400 L.F. existing cable Through structure: • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles • Fire alarm system
26. State Route 537 (Smithburg Road); Sta. 2195 A.P. 6 USGS Adelphia Quad. **Cost Range: $50K-$100K**			• Construct 1000 L.F. 4 KV cable pole line • Install temporary 4 KV cable • Remove 1200 L.F. existing cable Through structure: • Construct 200 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1000 L.F. 600 pr cable pole line • Install temporary 600 pr cable • Remove 1200 L.F. existing cable Through structure: • Construct 200 L.F. ug 600 pr cables and ducts • 2 M.H. • 2 riser poles

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
27. Gulley Road; Sta. 2247 A.P. 7 USGS Adelphia Quad.		• Install 925 L.F. 12" steel pipe (high pressure, 700#) • Install 300 L.F. 36" steel sleeve • Install 2 valves	• Construct 1600 L.F. service line	• Construct 1600 L.F. service line
28. Route 33; Sta. 2287 A.P. 7 USGS Freehold Quad. **Cost Range: >$100K**			• Construct 1300 L.F. 34.5 KV cable pole line • Construct 1300 L.F. 13 KV cable pole line • Construct 1300 L.F. 4 KV cable pole line • Install temporary 34.5, 13 and 4 KV cables • Remove existing 1700 L.F. cable Through structure: • Construct 350 L.F. ug each of 34.5, 13, and 4 KV cable and ducts • 2 large M.H. • 2 riser poles	• Construct 1300 L.F. 200 pr cable pole line • Install temporary 200 pr cable • Remove 1700 L.F. existing cable Through structure: • Construct 350 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles • Fire alarm system
28a. Proposed Toll Plaza	• No data available			
SECTION IV 29. Woodward Rd.; Sta. 2368 A.P. 7 USGS Freehold Quad. **Cost Range: $50K-$100K**			• Construct 1500 L.F. 4 KV pole line • Install temporary 4 KV cable • Remove 1700 L.F. existing 4 KV pole line Through structure: • Construct 300 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1500 L.F. 100 pr cable pole line • Install temporary 100 pr line • Remove 1700 L.F. existing 100 pr cable Through structure: • Construct 300 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles • Install fire alarm system
30. Pennsylvania RR Crossing; Sta. 2390 A.P. 7 USGS Freehold Quad.	• Proposed adjacent maintenance area will require 2200 L.F. duct burial power cable and telephone line, a well and sanitary sewering. Specific data unavailable.		• Construct 200 L.F. Telepone and Telegraph communications cable and duct	

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
31. State Route 522 (Englishtown Road); Sta. 2414 A.P. 7 USGS Freehold Quad. **Cost Range: $50K-$100K**	• Construct 1400 L.F. 8" steel pipe main • Construct 200 L.F. 18" steel sleeve • 1 Hydrant		• Construct 1200 L.F. 4 KV cable pole line • Install temporary 4 KV line • Remove 1400 L.F. existing pole line Through structure: • Construct 200 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1200 L.F. 400 pr cable pole line • Install temporary 400 pr cable • Remove 1400 L.F. existing 400 pr cable Through structure: • Construct 200 L.F. ug 400 pr cable and ducts • 2 M.H. • 2 riser poles • Fire alarm system
32. Taylors Mills Road; Sta. 2447 A.P. 7 USGS Freehold Quad. **Cost Range: $50K-$100K**			• Construct 700 L.F. 4 KV cable pole line • Install temporary 4 KV cable line • Remove 900 L.F. existing 4 KV cable Through structure: • Construct 300 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 700 L.F. 200 pr cable pole line • Install temporary 200 pr cable pole line • Remove 900 L.F. existing 200 pr cable Through structure: • Construct 300 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles
33. Gordons Corner Road; Sta. 2465 A.P. 8 USGS Freehold Quad. **Cost Range: >$100K**	• Construct 1850 L.F. 8" steel pipe (main) • Construct 250 L.F. 18" steel sleeve • 1 Hydrant	• Construct 1000 L.F. 10" H.P. main • Construct 300 L.F. 36" steel sleeve • 2 valves	• Construct 1600 L.F. 4 KV cable pole line • Install temporary 4 KV line • Remove 1850 L.F. existing 4 KV cable Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1600 LF. 900 pr cable pole line • Install temporary 900 pr cable • Remove 1850 L.F. existing 900 pr cable Through structure: • Construct 250 L.F. ug 900 pr. cable and ducts • 2 M.H. • 2 riser poles
34. Sanitary Sewer Crossing; Sta. 2508 A.P. 8 USGS Freehold Quad. **Cost Range: <$50K**	• Construct 350 L.F. cast iron pipe sanitary sewer • Construct 300 L.F. 36" steel sleeve • 2 M.H.			
35. Pine Brook Road; Sta. 2519 A.P. 8 USGS Freehold Quad.			• Construct 1400 L.F. 4 KV cable pole line • Install temporary 4 KV line • Remove 1650 L.F. existing 4 KV cable	• Construct 1400 L.F. 200 pr cable pole line • Install temporary 200 pr cable • Remove 1650 L.F. existing 200 pr cable

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	TELEPHONE
35. Pine Brook Road (Cont.) **Cost Range:** $50K-$100K			Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	Through structure: • Construct 250 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles • Fire alarm system
36. Union Hill Road; Sta. 2540 A.P. 8 USGS Freehold Quad. **Cost Range:** $50K-$100K			• Construct 1800 L.F. 13 KV cable pole line • Install temporary 13 KV line • Remove 2050 L.F. existing 13 KV cable Through structure: • Construct 250 L.F. ug 13 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1800 L.F. 100 pr cable pole line • Install temporary 100 pr cable • Remove 2050 L.F. existing 100 pr cable Through structure: • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
37. State Route 527; Sta. 5257 A.P. 8 USGS James-burg Quad. **Cost Range:** $50K-$100K	• Proposed toll plaza will require utility connections (e.g., 2300 L.F. pole line) and septic system. Detailed data unavailable.		• Construct 1100 L.F. 4 KV cable pole line • Install temporary 4 KV line • Remove 1350 L.F. existing 4 KV line Through structure: • Construct 250 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 1100 L.F. 100 pr cable pole line • Install temporary 100 pr line cable • Remove 1350 L.F. existing 100 pr cable Through structure: • Construct 250 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles • Install fire alarm system
SECTION V 38. High Tension Crossings; Sta. 2692 A.P. 9 USGS James-burg Quad. (2 115 KV aerial cables) (1 34.5 KV aerial cables) **Cost Range:** >$100K			• Construct 4 H-frame extra high poles (60') • Construct 1200 L.F. 34.5 KV pole line • 2 steel towers on piles	
39. Spotswood Englishtown Road; Sta. 2748 A.P. 9 USGS James-burg Quad. **Cost Range:** <$50K	• Construct 300 L.F. 8" steel pipe water main • Construct 300 L.F. 18" steel sleeve	• Construct 300 L.F. 6" gas main • Construct 300 L.F. 12" steel sleeve	• Relocate 300 L.F. 4 KV cable pole line • Relocate 300 L.F. service line • 2 extra high poles	• Construct 300 L.F. 200 pr cable pole line • Fire alarm system

TABLE 25. CONTINUED

LOCATION	WATER/SEWER	G GAS TRANSMISSION/DISTRIBUTION	POWER TRANSMISSION/DISTRIBUTION	T TELEPHONE
39a. Proposed Service Area; Sta. 2800-2830	Well and septic system		• Construct 250 L.F. ug 4 KV cable • Construct 3400 L.F. 4 KV pole line • 1 M.H.	• Construct 250 L.F. ug 50 pr cable • Construct 3400 L.F. 50 pr pole line • 1 M.H.
40. Old Forge Road; Sta. 2842 A.P. 9 USGS Jamesburg Quad. **Cost Range:** <$50K				• 2 extra heavy (3"-4") ug cables to be avoided • 2 manhole chambers to be extended vertically
41 Main Street; Sta. 2879 A.P. 10 USGS Jamesburg Quad. Pennsylvania RR Crossing; Sta. 2881 **Cost Range:** >$100K	• Replace 1 fire hydrant		Under structure: • Construct 300 L.F. 34.5, 13, and 4 KV cable and ducts • Construct 300 L.F. service cable and ducts Above structure: • Construct 2 H-frame high tension towers for 120 KV cable	Under structure: • Construct 300 L.F. 200 pr cable pole line • Fire alarm system • Construct 300 L.F. aerial communications cable
42. Subdivision Road (Logan Blvd.); Sta. 2912 A.P. 10 USGS Jamesburg Quad. **Cost Range:** <$50K			• Construct 400 L.F. ug 4 KV cable and ducts • 2 M.H. • 2 riser poles	• Construct 400 L.F. ug 100 pr cable and ducts • 2 M.H. • 2 riser poles
43. Cranberry Rd.; Sta. 2940 A.P. 10 USGS New Brunswick Quad. **Cost Range:** $50K-$100K			• Construct 800 L.F. 13 KV cable pole line • Construct 800 L.F. service cable pole line • Install temporary 13 KV and service cable • Remove 1050 L.F. existing 13 KV and service cable Through structure: • Construct 250 L.F. ug 13 KV cable and ducts • Construct 250 L.F. ug service cable and duct • 2 M.H. • 2 riser poles	• Construct 800 L.F. 200 pr cable pole line • Install temporary 200 pr cable • Remove 1050 L.F. 200 pr cable Through structure: • Construct 250 L.F. ug 200 pr cable and ducts • 2 M.H. • 2 riser poles
44. N.J. Turnpike Crossing; Sta. 3000 A.P. 10 USGS New Brunswick Quad. **Cost Range:** <$50K		• Construct 100 L.F. 42" steel sleeve • 2 valves	• Relocate 200 L.F. pole line	• Relocate 200 L.F. pole line

IMPACTS ON COMMUNITY INSTITUTIONS

Principal data sources for our identification of community institutions located in the zone affected by the proposed Governor Alfred E. Driscoll Expressway were aerial photographs, municipal and county master plans, and interviews with highway engineers and local officials and planners. Using these, we then evaluated the impacts on churches, clubs and social/recreational activities in terms of the expected disruptions to their normal operations. Criteria for the extent of disruption included destruction of church or club facilities, dispersion of members, loss of parking space, and altered access to facilities. Our investigation covered those community institutions situated in the designated "affected zone" extending 1000 feet to either side of the proposed alignment.

RELIGIOUS INSTITUTIONS

Data

The following churches or religious institutions, listed by township, were identified in the analysis zone:

Dover Township:	Riverside Cemetry First Church of Christ Scientist Church of God
Jackson Township:	Whitesville United Methodist Church Harmony Methodist Church
Freehold Township:	First Assembly of God Church
Helmetta Borough:	Holy Trinity Church
East Brunswick Township:	Holy Cross Burial Park
South Brunswick Township:	Fresh Ponds Chapel

Problems Identified

In Helmetta Borough (10)* the Expressway will pass approximately 100 feet west of Holy Trinity Church property, the exact distance depending on the ultimate width of the elevated right of way. The Expressway's removal of five to ten houses in the immediate area may disperse or reduce church membership somewhat. It was not possible within the scope of our study, however, to determine how many of the potentially dislocated residents are Holy Trinity parishioners. One other potential problem for the church is an increase in maintenance costs because of additional soiling caused by vehicles using the Expressway.

*Reference numbers in the text correspond to Sheets 1-10 of the aerial photographs (Figure 21).

SOCIAL/RECREATIONAL ACTIVITIES

Data

We identified very few clubs or indoor recreation sites in the analysis zone. This is in part explained by the generally rural character of the land along the alignment; however, where there are clusters of denser development, it seems reasonable to assume the presence of a greater number of such sites than our data sources disclosed. We were able to identify positively only the following:

Dover Township:	Dover Theater Presidential Swim Club Dance Hall Riverwood Park recreation building
Manchester Township:	Cedar Glen Homes retirement community (clubhouse and recreation area)
Jackson Township:	VFW Post 4703 Estonian Youth camp grounds
Madison Township:	Raceway Park dragstrip

Of these only one will be adversely impacted by the Expressway. The Estonian Youth organization, whose camp grounds are situated slightly north of the Route 528 crossing (4), will lose a portion of its land and two cabins.

In addition to the above, a residential area in Manalapan Township between Route 522 and Pine Branch Road (7,8) will be disrupted by the Expressway which cuts between its two residential developments and close to three schools. Although no formal social institutions were identified, certain types of informal social activities (scout troops, dancing schools, bridge clubs, etc.) are likely to be active. No existing vehicular travel patterns are being changed, but the highway may modify pedestrian travel patterns to social activities, and will impose a psychological barrier to social exchange between residents on either side of it.

IMPACTS ON EDUCATIONAL INSTITUTIONS

Impacts of the proposed Expressway on educational institutions have been evaluated in terms of modifications to attendance boundaries or the actual school environment, including loss of school property, separation of schools from students' residences, changes in access, changes in school district boundaries, highway proximity to playgrounds, and possible danger to children.

Data

The following schools have been identified in the analysis zone:

Manalapan Township:	Manalapan High School (Freehold Regional High School District)
	Taylor Mills School
	Clark Mills School

Problems

The three identified schools are situated close together in the same residential neighborhood of Manalapan Township (7,8) discussed above under Social Institutions. Proceeding north through this area the Expressway crosses six local roads heavily traveled by school buses and commuters to the Route 9 corridor; it closely skirts the Manalapan High School playing fields and cuts through a corner of the Taylor Mills School lawn. The third facility, Clark Mills School, is not as close to the alignment, but is still well inside the analysis zone.

Tests conducted by sound engineers at these schools found noise levels inside the Taylor Mills School and Manalapan High School to be only marginally acceptable on the basis of proposed Federal standards for highway planning. As a result, the Turnpike Authority has agreed to take measures which would limit noise penetration to levels clearly within these standards.*

Attendance boundaries and vehicular access to the schools will not change, as all existing roads will remain open. Although pedestrian travel will be somewhat restricted, this impact will be minor because almost all of the students are bussed to school. As a safety measure, highway engineers are providing fencing along the entire right-of-way and on bridges built over the Expressway.

The one safety concern we noted is the potential effect of carbon monoxide pollution on students using the High School's outdoor athletic facilities. The Expressway will pass within 260 feet of the tennis courts and about 180 feet of a planned ballfield. Studies made for this portion of the Expressway have predicted that the average level of carbon monoxide will be less than 10% of the standards established for this gas. This would appear to be safe, although no specific carbon monoxide standards have been set for locations where there is strenuous athletic activity over a prolonged time period.

*See section on Noise Analysis.

IMPACTS ON NEIGHBORHOOD LAND USE

People's perceptions about a highway operate on two different scales, depending on whether they are users or neighbors of the road. From the user's viewpoint, the Governor Driscoll Expressway is a 35-mile path of travel, whereas on the human scale of the neighborhood, it is a static boundary which serves either to accentuate or redefine preexisting land uses. The highway's latter role is the subject of this analysis.

We based our assessment of land use impacts on the extent to which compatible and conflicting neighborhood land uses will be separated by the Expressway. As applied in this study, the criterion of compatibility refers to land supporting similar functions, such as two residential clusters, or functions which are not at cross-purposes with each other as, for example, a residential area bordered by woodlands. Complementary land uses are also compatible, but are further defined by their interdependency. Conflicting land uses, on the other hand, are characterized by the communication of undesirable stimuli such as noise, dirt, or risk. In making our evaluation we did not consider the highway itself as a land use, but rather as a definer of land use to either side of it.

Data

The objects of our investigation were the clusters of development along the alignment identified as lying wholly or partially inside the analysis zone. We did not address land uses in the predominantly rural areas, nor did we investigate neighborhoods located along the portion of the Expressway south of the juncture with the Garden State Parkway; land uses here will not be affected since construction will involve only the addition of lanes to the existing highway. Areas identified for investigation were:

Manchester Township:	Cedar Glen Homes retirement community
Dover Township:	Garden of Pleasant Plains retirement community Route 70 trailer park complex
Freehold Township:	Levitt residential development
Manalapan Township:	Suburban neighborhood east of Englishtown Borough
Madison Township:	Apartment development north of Englishtown Borough
Helmetta Borough	

In addition, we identified three other sites of light residential development in Jackson Township which did not really constitute "neighborhoods," but where we felt potential land use impacts warranted mention:

Marilyn Boulevard
Harmony Road
Jackson Mills-Freehold Road Intersection

Findings

Slightly north of the Garden State Parkway tie-in, the Expressway will be very close to the Garden of Pleasant Plains retirement community (2) where it may require the taking of an eastern edge currently under construction, depending on the ultimate width of the right of way. Across Whitesville Road from this community the Expressway traverses a parcel of land currently slated for residential development. The highway will prevent development to the extent now planned, and may inhibit it altogether because of the proximity to the Expressway. Thus, compatible uses are separated here, both as they exist and are proposed, and the Expressway effectively replaces Toms River as the Western boundary of Dover Township here.

In contrast, land use boundaries affecting Cedar Glen Homes retirement community nearby in Manchester Township (2) will not be influenced by the Expressway since the section of the development facing the highway is already hemmed by a natural division, the Toms River.

The immediate vicinity of the Route 70 interchange in Dover Township (2) currently supports a mobile home sales establishment and three trailer parks, at least one of which is a retirement community. The proposed right of way would take the corner of one development, displacing several homes, and separating this large settlement from the other two and from the sales office. Although travel on Route 70 and Cox Cro Road will not be interrupted, the Expressway imposes a psychological and visual boundary through what is at present an integrated complex of residential and complementary commercial land use.

North of Turkey Swamp Park in Freehold Township (6) the Expressway skirts the edge of a large Levitt suburban-type residential development. The Expressway poses a barrier to this development's westward expansion, which has been occurring at a rapid rate. However, the opportunity remains open for development to take place on the other side of the alignment since connecting local roads are not disturbed. This is a clear case of compatible land use separation, but here such division could work to the area's long-term advantage. In terms of neighborhood impact, the boundary formed by the Expressway here has more potential for good than harm. Curtailing the unconstrained growth of the Levitt development and requiring that future development occur separately, the Expressway provides a chance for individual settlements to retain a neighborhood identity instead of merging into an anonymous suburban "sprawl". Furthermore, if appreciably wide strips of land are allotted within the ROW for open space, the Expressway will provide the area with a permanent green belt linking Turkey Swamp Park to the south with Monmouth Battlefield to the north.

The Expressway separates compatible land uses where it cuts between two abutting suburban developments east of Englishtown Borough in Manalapan Township (7,8). Several houses will be taken as well as a piece of school property. In contrast to the situation in Freehold described above, here two distinct developments coexist as neighbors and share the services of three local schools. The Expressway will divide the neighborhood, imposing constraints on some neighborhood activities which make for the attractiveness of suburban residence. The Turnpike Authority has made an effort, however, to minimize the potentially divisive impact; all local

streets will remain open in this area, and the Expressway will be depressed to prevent obstruction of views across the right of way.

Slightly north of Englishtown Borough in Madison Township (8), the Expressway serves to separate presently conflicting land uses where an expanding apartment development is encroaching on the Raceway Park dragstrip. This protective barrier will be particularly beneficial to apartment residents since the nearby Route 520 interchange will likely increase traffic inflow to Raceway Park.

The most notable instance of adverse land use impact is the Expressway's proposed alignment through part of Helmetta Borough (10), a small company town of some 1125 residents on three-quarters of one square mile. Necessary elevation of the right of way here contributes to the divisive effect, interposing what certain town spokesmen contend is a visual and psychological barrier between several houses on its western extremity and the body of the town. In response to this local opposition, the Turnpike Authority is investigating (among other alternatives) the feasibility of relocating the residents affected to town sites on the other side of the alignment. While this measure would remove the most serious social impact to Helmetta, it would at the same time reduce the effective size of this already very small town. It should be noted, however, that the right of way in Helmetta, because it is elevated, will not require the usual recommended 450-foot width. The bridge could conceivably be as narrow as 120 feet according to the Turnpike Authority. Construction as now contemplated would remove five to ten dwellings, depending on the selected width of the bridge and on the decision of several adjacent homeowners who would be given the option of selling their houses to the Turnpike Authority.

To the north, the Expressway spans the proposed Jamesburg Park land. Helmetta residents have been eyeing this land as a site for much-needed utilities, recreation, school facilities, and industrial development. On the other hand, environmentalists in surrounding municipalities wish to see it preserved as a permanent conservation area. In either case, the Expressway will take acreage from the parcel and cut off visual communication between the two sides except at a point where provision has been made for a bridge to accommodate a connecting road.

In addition to the neighborhood impacts described above, we identified three residential clusters in Jackson Township where anticipated land-use impacts warrant mention.

Just south of the Route 528 crossing the Expressway cuts off the "elbow" of Marilyn Boulevard, a small right-angle street containing some six houses. Two homes will be taken here, and a new stretch of road will be constructed to connect the dwellings remaining on either end. Although the cluster thereby remains an entity, the Expressway will interpose a boundary between it and the wooded setting.

Along with Marilyn Boulevard, Harmony Road is one of the few instances where existing roads are being altered by the Expressway. The junction of Harmony Road and Route 526 will be shifted slightly west of its present

location; several houses on Harmony Road will be lost to the Expressway, and one to the revised stretch of Harmony Road.

One of the highway's positive effects in terms of land use impact is the removal of an unsightly junkyard from a small community flanking the Jackson Mills-Freehold Road crossing. The Turnpike Authority plans to clear away all of this eyesore with the right of way.

CONCLUSIONS AND RECOMMENDATIONS

OPEN SPACE AND RECREATION

No adverse environmental impacts on open space and recreation uses were found with the exception of the bird sanctuary in Monroe. Steps can be taken to relocate the sanctuary or provide other compensation to minimize this impact.

Secondary impacts warranting detailed analysis during design were found for the Estonian Youth Camp in Jackson and the proposed Jamesburg Park. Furthermore, compensation is necessary in the form of a "swap" parcel in the case of the armory in Dover.

Positive impacts were found for the Monmouth Battlefield State Park and several town dumps.

In general, new open space areas can be provided through careful design in conjunction with water recharge areas, particularly at interchanges. These areas can be permanent uses for borrow pits as well. A well-landscaped right of way with a large setback can serve as a catalyst for open space areas that various town and county planning agencies want to preserve. These can also serve as buffers between incompatible land uses that would grow together due to natural forces whether or not the Expressway is built.

HISTORIC, ARCHEOLOGICAL, AND PALEONTOLOGICAL SITES

Based on the available data, no historic, architectural, archeological or paleontological sites are adversely impacted by the proposed Expressway.

The only state historic site impacted is the Monmouth Battlefield State Park; the impact of the proposed Expressway is positive. Careful coordination should be maintained with the renovation planning efforts underway during the engineering design and construction phases.

Care should be taken during construction to safeguard any archeological or paleontological finds uncovered and to provide research opportunities for the appropriate groups. Appropriate steps can be taken during construction to minimize harm should any archeological or paleontological items of a salvageable nature be found.

COMMUNITY SERVICES

The plans for handling utility disruptions appear to account for all potential problem areas, so far as they are known. No prolonged service disruptions to customers are foreseen. Utilities will provide their own expert labor forces to make new connections and alterations in existing lines with dispatch.

Local police and fire protection will not be significantly affected, except as temporary (construction phase) roads may add several seconds travel time to existing routes. In general, however, travel will in no case be dead-ended without provision of alternate access. Further investigation - both on a township and county basis - will be made to insure that reponse times are not changed.

COMMUNITY INSTITUTIONS

The Expressway's impact on religious institutions is very slight. We noted no changes anywhere with respect to property, parking, or access. The only anticipated impacts on membership and operation are those affecting Holy Trinity Church discussed above.

Except for the area in Manalapan Township noted, impacts on community social institutions are nowhere significant.

EDUCATIONAL INSTITUTIONS

We anticipate no major effects on school operations in the Manalapan area: property loss is slight, and attendance boundaries and vehicular access are unaffected. Traffic levels should also remain generally stable, as no interchange is contemplated for this stretch of the Expressway. Although some local officials favor construction of an interchange in the Manalapan schools area, strenuous opposition has been voiced by the school board. Since provision will be made for sidewalks on bridges and sturdy fencing along the right of way, we foresee no physical danger to students.

NEIGHBORHOOD LAND USE

In the neighborhoods we identified, the "boundary" effect of the Expressway is manifested primarily in the separation of compatible rather than conflicting land uses. This is so because the highway passes through an area which is generally rural, and the scattered sites of relatively thick settlement tend to be recently constructed suburban-type residential developments situated near similar neighborhoods or otherwise undeveloped lands. The effect of the Expressway in these developments, as well as in Helmetta, is that of a barrier separating residents from the adjacent rural scene or from their neighbors. Because local officials have voiced particularly strong opposition to the alignment proposed in Helmetta, we recommend that current efforts to minimize potentially debilitating impacts be continued. We found that impedance of the growth of the Levitt development in Freehold, and separation of the dragstrip from nearby apartment residents in Madison to be the two cases where redefinition of existing neighborhood boundaries will work to community benefit.

SECTION VII

QUALIFICATIONS OF PARTICIPATING CONSULTANTS

A. Howard, Needles, Tammen & Bergendoff

B. Bolt Beranek and Newman, Inc.

C. Coverdale & Colpitts, Inc.

D. Environmental Research & Technology, Inc.

QUALIFICATIONS AND EXPERIENCE

Howard, Needles, Tammen & Bergendoff is a partnership offering a wide range of consulting services to both public and private clients. Established in 1914, the firm has grown in size and capability, currently employing about 1,200 professional, technical and support personnel located in 22 offices in major cities throughout the country. Its leadership and success over these many years has been based on the quality and completeness of the services rendered.

Evolving from basic highway and bridge planning and engineering design activities, HNTB has broadened its professional practice during the past 25 years to include urban and regional planning; transportation systems planning and design (highways, mass transit and airports); architectural services; municipal engineering; pollution abatement services; and, with especial significance to the concerns of our time, environmental impact analyses.

HNTB is fully committed to an interdisciplinary study approach to the complex problems of urban areas, and our staff consists of those with requisite skills to develop solutions to these problems. Where desirable and appropriate, HNTB has allied itself with other consultants in specialized fields of expertise, and has considerable experience in the coordination and management of team efforts.

The firm earned national prominence for its role in designing an innovative study approach and decision-making procedure to resolve a dispute over the environmental impact of the "Everglades Jetport." In South Florida, the procedure involved a formal agreement among the governing bodies setting the general rules and responsibilities for relocating the airport; thorough studies of potential sites by private, neutral consultants; and review and recommendations by representatives of appropriate public agencies. A key element of the study was citizen participation from the commencement to the conclusion of the site selection. The success of this approach is demonstrated by the fact that parties to the original controversy have endorsed the selected site.

The Department of Environmental Quality and Conservation, located in the Alexandria office provides environmental and ecological evaluations for all HNTB offices. Environmental studies and statements recently completed or in progress are listed below.

HNTB ENVIRONMENTAL IMPACT STATEMENTS COMPLETED

South Wilmington Connector to I-95, Wilmington, Delaware
I-205, Portland, Oregon
US 95 Bypass, Sandpoint, Idaho
Winkler Road and Bridge Crossing of Estero Bay, Fort Myers, Florida
Park and Lake Freeways, Milwaukee, Wisconsin
Willow Springs Road, Bridge Replacement, Chicago Sanitary and Ship Canal
Route 2, Acton, Concord, Lincoln and Lexington, Massachusetts
Replacement of Matanzas Pass and Hurricane Bay Bridges, Lee County, Florida
Cape May-Lewes Ferry Channel, Delaware

HNTB ENVIRONMENTAL IMPACT STATEMENTS IN PROGRESS

Highways

I-394, Minneapolis, Minnesota
I-287, northern New Jersey
I-66, northern Virginia
Delaware Turnpike Dual Laning Project
Crosstown Expressway, Chicago
T.H. 212, 41 and 169, Minnesota
Governor Alfred E. Driscoll Expressway, southern New Jersey

Airports

South Florida Regional Airport Site Selection
Buffalo Regional Airport Site Selection
Miami International Airport Runway Extension

Other

14 projects, North Central District, U.S. Corps of Engineers, Chicago area
Recreational Housing Development, Wisconsin Dells
West Beach Development, National Park Service, Indiana Dunes

HNTB ENVIRONMENTAL STUDIES IN PROGRESS OR COMPLETED

Miami International Airport Master Plan
Bangor, Maine, International Airport Master Plan
Central Nebraska Regional Airport Study
Manchester, New Hampshire, Airport Master Plan
Fairmont, Worthington and Albert Lea, Minnesota, Airport Master Plans
Burlington, Vermont, Airport Master Plan
Knik Arm Crossing, Anchorage, Alaska
East-West Expressway, Orlando, Florida
Expansion of I-95, Old Saybrook-Old Lyme, Connecticut
Wisconsin State Airport Systems Study
Virginia State Airport Systems Study
Nashua Water Quality Plan, New Hampshire
Washington, D.C., Heliport Study

CORPORATE QUALIFICATIONS

Bolt Beranek and Newman Inc. has provided consulting, research, and development services in noise and vibration control engineering and architectural acoustics since the firm was organized in 1948. BBN's technical staff consists of approximately 250 engineers and scientists; of these, about two-thirds hold advanced degrees. Regional offices are maintained in the metropolitan areas of Houston, Boston, Chicago, Los Angeles, New York, San Francisco and Washington.

In recent years, solving highway noise problems has become a growing part of BBN's consulting activities. These consulting activities have involved highway noise projects that require the broad range of BBN's technical disciplines, from basic research to engineering applications. Studies of human reaction to noise have received continued support as public interest in the subject has continued to grow. Projects involving research into the many aspects of traffic noise generation, propagation, and attenuation are complimented by projects requiring the application and field verification of the research products. Projects involving new highway design have included assistance in route selection, advice on highway design for noise control, noise impact assessment, and the preparation of environmental impact statements. Lastly, BBN has been called upon to deal with the general public and special study committees, either in conferences or in public hearings, to explain the acoustic implications of the building of a new highway.

In 1957 BBN developed a method for the prediction of traffic noise, based on the statistics of traffic flow associated with superhighways. For the Washington State Highway Commission in 1962, a report was prepared on the noise environment resulting from the proposed Spokane Freeway. In 1965, for the Highway Research Board, BBN developed a simulation method for determining the noise from highway traffic. Again, for the Highway Research Board in 1970, BBN prepared the widely used handbook, "Highway Noise - A Design Guide for Highway Engineers". In 1966, a noise and vibration study was undertaken for the proposed New Orleans Riverfront Expressway. In the last five years, BBN has provided the acoustic studies, and noise impact statements where required, for the Route 105 Freeway in California, Interstate 90 in Seattle, Interstate H-3 in Hawaii, Interstate 75 in Georgia, Long Island Sound Bridge in New York, a Turnpike widening project for the New Jersey Turnpike Authority, Route 38 Freeway in New Jersey, Interstate 185 in Georgia, and others. Special projects in highway noise have included studies for the Automobile Manufacturers Association, Inc., U. S. Department of Housing and Urban Development, and the Highway Research Board.

COVERDALE & COLPITTS, INC.

EXPERIENCE

Coverdale & Colpitts has been providing consulting services to industry and government for over 66 years and continues to do so in a wide variety of fields both at home and abroad. Representative clients are corporations, public bodies, bankers and lawyers. Most of the firm's work has economic aspects and frequently is directed toward public and private financing of projects. All forms of transportation — highway, railroad, mass transit, air, water and other forms — are the subject of studies by the firm.

Types of services rendered are traffic studies for determining the economic feasibility of toll facilities, expert testimony before courts and government regulatory bodies, market surveys, valuations for various purposes, studies of reorganizations or acquisitions of properties and companies, management appraisals, transportation rates and product pricing, plant location or expansion, and operating studies.

The following are some of the socioeconomic studies done by Coverdale & Colpitts:

- A study on the economic impact of an area-wide rapid transit system in Los Angeles in connection with a report prepared for the Southern California Rapid Transit District.

- A compilation and review of studies and data on the historical and projected environment of the Southeastern Pennsylvania metropolitan region as a part of a study of the commuter railroad system in the area.

- A study for the New York City Transit Authority on the proposed expansion of its Rapid Transit System including an examination of the impact on the community of the proposed new routes, based upon historical data drawn from records of the impact of previous similar expansion and extension programs.

- A report on the economic impact on Lewiston, Idaho — Clarkston, Washington and the surrounding area created by a modification to the Camas Prairie Railroad.

Coverdale & Colpitts, Inc., Transportation and Industrial Consultants, was formed in June, 1970 and took over the existing partnership's organization. The partnership continues for the practice of professional engineering.

In November, 1970 Coverdale & Colpitts, Inc. became an affiliate of URS Systems Corporation. URS is a multi-disciplinary corporation dedicated to improving the quality of man's environment, and has brought together within a single professional services organization several of the nation's most distinguished and experienced engineering, research, architectural, planning and construction management firms.

SUMMARY OF CORPORATE QUALIFICATIONS

The study team consisting of Environmental Research & Technology, Inc. (ERT) and three consulting groups, Abt Associates, Inc., David H. Marks, P.E. and Jack McCormick & Associates, are well qualified to assess the impact of the Gov. Driscoll Expressway in the following environmental areas:

1. Air quality
2. Water resources
3. Cultural, historic, open space and other related resources
4. Vegetation and wildlife ecology
5. Natural (depletable) resources
6. Social impacts

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INCORPORATED

At present ERT employs approximately 45 scientists and technicians of which 8 hold Ph.D.'s. Its business is conducted in five areas,

A. Regional Air Pollution Control

This includes:

1. Urban diffusion modeling of atmospheric contaminants
2. Evaluation of land use plans for air pollution potential
3. Emission inventories
4. Meteorological methods for regional control of air quality
5. Implementation planning preparation
6. Evaluation of the impact of transportation systems on air quality
7. Environmental Impact Statments

B. Air Pollution Meteorology

This includes:

1. Air quality monitoring network design
2. Site evaluation
3. Safety analysis for fossil and nuclear power plants
4. Stack height evaluation
5. General meteorological studies as related to air pollution control

C. Pollution Control Engineering

This includes:

1. Stack sampling
2. Analysis of particulate and gaseous emissions
3. Pollution control equipment specifications
4. Laboratory analysis of aerosols and contaminants
5. Design of training equipment for pollution control supervisors and inspectors

D. Remote Sensing

This includes:

1. Atmospheric modeling for radiative transfer problems
2. Microwave spectroscopic standards
3. Earth resources satellite data analysis
4. Microwave experimental programs
5. Satellite meteorological studies

E. Scientific Instruments

ERT has studied, tested and is in the process of developing a group of scientific instruments which will be highly useful in air pollution control and which have broad applications in other fields.These instruments employ infrared, microwave and optical techniques.ERT believes they are more sensitive and more accurate and lower in cost than any other such devices now on the market.They can be employed in the following applications:

1. Monitoring of ambient air quality
2. Monitoring of gaseous stack emissions
3. Process control in chemical and combustion processes
4. Testing the emissions of auto exhausts
5. Monitoring gaseous and particulate emissions in mines
6. Remote detection of natural gas leaks
7. Incipient fire detection
8. Measurement of aerosol and cloud particle size distribution
9. Particle size analysis
10. Velocity measurement in three dimensions
11. Remote sensing for:
    a. Atmospheric stability measurement
    b. Satellite surveillance

c. Weather analysis and prediction

d. Measurement of the earth's radiational characteristics

CLIENTS

The following represents a partial list of the clients for whom ERT has completed work or is now performing work:

1. International Telephone and Telegraph
2. Miles Laboratories
3. General Electric Co.
4. Boston Edison
5. State of Connecticut
6. State of New Jersey
7. State of New Mexico
8. State of Washington, Dept. of Highways
9. New England Electric System
10. New England Gas and Electric Association
11. Central Hudson Gas and Electric Co.
12. Pennsylvania Electric Co.
13. Northeast Utilities Service Co.
14. U.S. Air Force
15. NASA - Goddard Space Flight Center
16. NASA - Marshall Space Flight Center
17. Otis Elevator Co.
18. Washington, D.C., Dept. of Highways
19. Commonwealth of Massachusetts, Dept. of Public Works (Highways)
20. Federal Aviation Administration
21. Department of Transportation
22. Boston Transportation Planning Review
23. Environmental Protection Agency
24. New Jersey Turnpike Authority
25. Many consultants, Architects and Engineering Firms, etc.

The following air quality studies were performed for firms and agencies in the state of New Jersey.

1. Air Quality study for Hackensack Meadowlands, Dept. of Environmental Protection and U.S. E.P.A.

2. Air Quality Analysis Hackensack Sports Complex for Jack McCormick & Associates
3. Air Quality Effects of Widening the New Jersey Turnpike between Exits 9 & 10, Model Results
4. Air Quality Effects of Widening the New Jersey Turnpike between Exits 9 & 10, Air Monitoring Results
5. A preliminary Analysis of Current Air Quality in the Vicinity of the Beckett New Town Site (New Jersey)
6. Atlantic City Electric Co - Air Monitoring Study
7. Diffusion Study and Air Quality Impact Statement for Metropolitan Edison - Pennsylvania

DAVID H. MARKS, P.E.

The water resources aspects of this report were carried out by the firm of Resource Systems Associates, Inc. of Cambridge, Massachusetts through Dr. David H. Marks, Senior Consultant and Jared L. Cohon, Staff Engineer.The firm is a small advanced research and engineering analysis group devoted entirely to water resource and other resource systems problems.Principal past work have included flood plain evaluation and effects of urbanization on flooding problems for sponsors such as the United States Office for Water Resources Research, The Department of Public Works of the Commonwealth of Puerto Rico and other private sources.Dr. Marks, who is also an Associate Professor of Civil Engineering, Water Resources Division, MIT has had considerable water resources experience including 3 years as a commissioned officer in the U.S. Public Health Service working on Water Quality Management for the Delaware Estuary for which the State of New Jersey is a prime party of interest.Other impact related work includes participation in the water quality aspects of the FAA environmental impacts guide for airport construction, studies of the effect of land use planning on flood problems, consideration of regional waste treatment plans for Clear Lake, Galveston Bay Texas (EPA sponsor), and the effects of environmental controls on future energy production (NSF). Dr. Marks is also an official consultant to the Environmental Protection Agency Office of Solid Waste Management.

Jared L. Cohon, staff engineer holds a B.S. in civil engineering from the University of Pennsylvania and S.M. in Water Resources Engineering from MIT.He has worked on large scale water resource planning studies for the Republic of Argentina and the analysis of the supply of Municipal Servicing in Cambridge, Massachusetts. He is familiar with water resource problems in the Pennsylvania and New Jersey area and has practical experience as a construction inspector in Southeastern Pennsylvania and as an engineering aide in the Philadelphia Water Department.

Related studies include:

Federal Highway Administration, Housing Preferences of Highway Relocatees

One of the major impacts that highways have had is on the amount of housing available, especially for low income households.

Abt Associates has recently completed a contract with the FHWA to develop a technique for assessing the residential preferences of potential highway displacees. Highway planning processes were analyzed and the kinds of information that would be more useful to a highway planner were identified.Many of the problems involve access to employment, social services, shopping and recreation.The technique has proved to be effective in eliciting the concerns of relocatees and was applied to the planned Gov. Driscoll Expressway.

Boston Redevelopment Authority, Air Transportation for Boston 1970 to 1990

Abt Associates recently completed a study of air transportation for Boston as part of the City's Community Renewal Program. The purpose of the study was to determine the nature and magnitude of the expected air traffic demand, to identify alternatives for meeting that demand, and to evaluate the impact of those alternatives on other land uses.

This study was relevant to the proposed Expressway project because it dealt explicitly with the problems of unbalanced growth and development. While the airport itself has not stimulated rapid development of commercial services in its immediate vicinity (mainly because of the lack of undeveloped land), it has had some significant negative impacts on traffic congestion and on the quality of the residential environment which might have been avoided with the appropriate controls.Abt Associates staff members have gained an understanding of the difficulty of formulating and implementing equitable controls through this study.

Highway Research Board, Impact of Highways on Environmental Values

Abt Associates participated with Daniel, Mann, Johnson and Mendenhall in a feasibility study for the Highway Research Board. Under this subcontract we analyzed the social and cultural values that are affected by the presence or prospect of a highway, and identified several methodologies which might be applied in a logical way to specify these values more fully.

TRW Corporation, Social and Economic Planning in Fresno

Abt Associates, is currently assisting in the development of the Community Renewal Program plans.It specifically focuses on social and economic development programs needed for Fresno, and on the need for establishing a set of social and economic indicators within the city. Initial investigations of the overall social and economic conditions in the city have already been conducted.

State of Illinois, Bureau of the Budget, South Side: A Study of a Community

Abt conducted work on the Chicago South Side in many service areas including health, welfare, housing, job training and development, legal, recreational, youth and the elderly. The contract was designed to develop a total community profile of an inner city area beset by all the usual problems facing all inner cities across the United States. An intensive field effort collected data describing the needs, conditions, and problems prevalent in the various neighborhoods of the South Side, and the resources which exist in the community.

Office of Economic Research, the Industrialization of Southern Rural Areas

This project provided an in-depth and comprehensive evaluation of rural economic development with special emphasis on the process of industrialization in four rural cities - two growth centers and two smaller satellite towns. The question which this report addresses was whether small towns, five to twenty thousand in population could serve as viable growth points, capable of attracting and maintaining an export base while at the same time serving the consumption needs of their citizens.Topics covered in this study included: the economic characteristics of the growth process - the quality and quantity of resources, their relative prices vis-a-vis other competing areas; the availability of transportation facilities; the location patterns of new economic activities; the role of public services in small towns and especially local subsidization of new industry; and finally, the political and social factors which enter into the development process.

Army Corps of Engineers, Baltimore District Office

Examination of socio-economic, ecologic and aesthetic impacts associated with alternative waste water management schemes in York County, Pennsylvania.Elements of the analysis include technical alternatives embodying sophisticated treatment techniques, baseline evaluations of location conditions and impact evaluation categories.

JACK MCCORMICK AND ASSOCIATES

Jack McCormick and Associates was organized in 1971 and currently has a professional staff in excess of fifteen.

Recent experience in ecological and environmental problems in the New Jersey area have included the following customers or areas:

- New Jersey Central Power and Light
- Fairmount Park
- Tocks Island
- Fire Island National Seashore, New York
- Beckett New Town, Gloucester County, New Jersey
- Pureland Industrial Park, Gloucester County
- Tinicun Marsh
- Stockton State College

- New Jersey Department of Environmental Protection, Environmental Protection Agency, Region III
- Maryland Department of Natural Resources
- New Jersey Sports and Exposition Authority