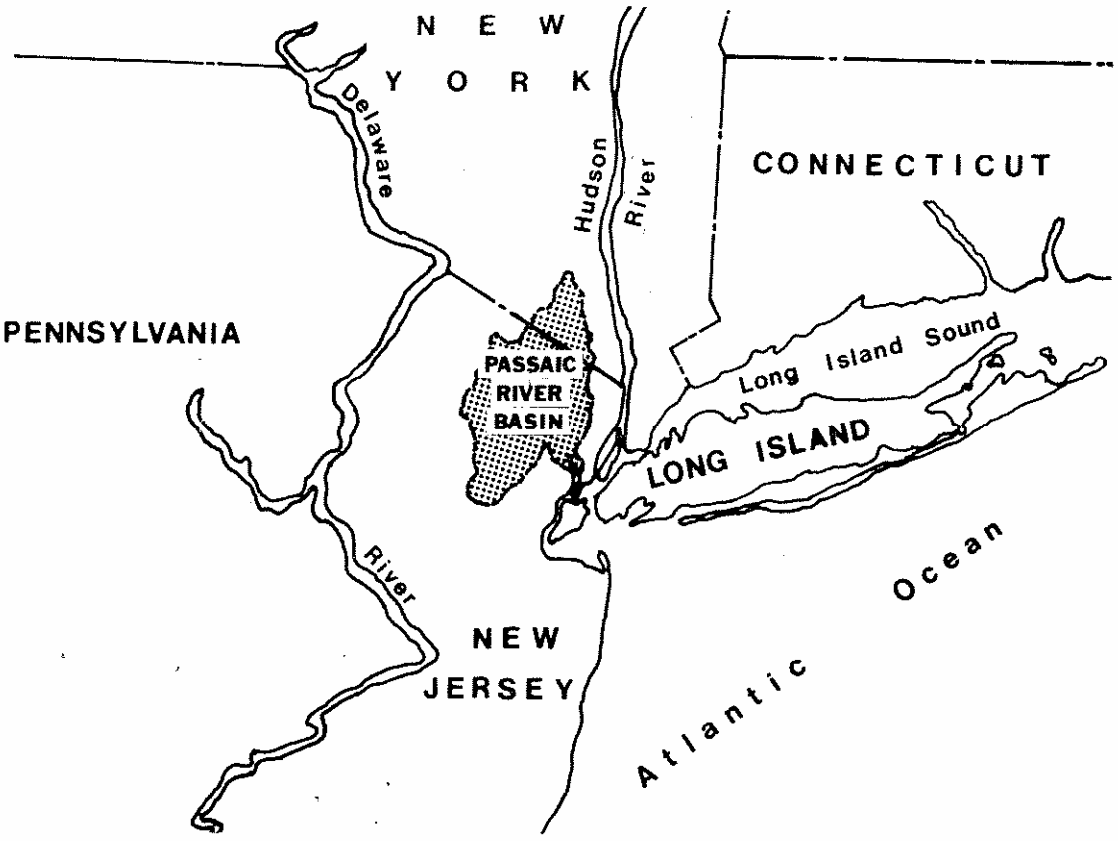
US Army Corps
of Engineers
New York District

PASSAIC RIVER BASIN STUDY

Passaic River Basin, New Jersey and New York
Phase I - General Design Memorandum

Flood Protection Feasibility Main Stem Passaic River

Main Report and Environmental Impact Statement



December 1987 Vol I

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SUBJECT: Flood Protection Feasibility, Mainstem Passaic River - Final Report

Cdr, North Atlantic Division, Corps of Engineers, 90 Church Street, New York, NY 10007-2979 22 February 1988

FOR: Cdr, Board of Engineers for Rivers and Harbors, ATTN: CEBRH, Kingman Bldg, Ft. Belvoir, VA 22060-5576

I concur in the District Commander's conclusions and recommendations.

CHARLES E. WILLIAMS
Brigadier General, USA
Commanding

US Army Corps
of Engineers
New York District

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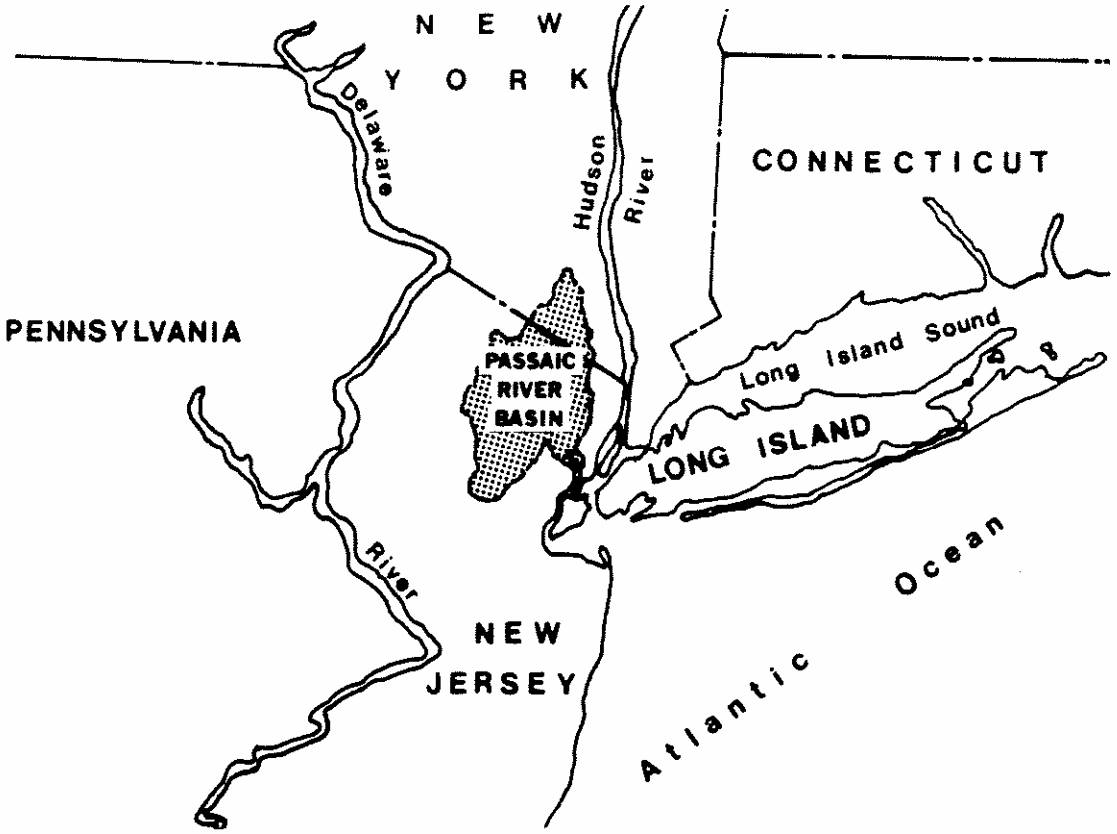


December 1987

Vol. I

SYLLABUS

Flooding, with its resultant property damage, general disruption to a peaceful existence, and devastating potential for injury and death, is a way of life in the Passaic River Basin. This recurrent natural disaster has been virtually unchecked since Colonial times. Urbanization, industrialization and economic development have occurred at an incredible pace, and extensive floodplain development has significantly increased the potential for flood damages. The Passaic Basin represents the most serious flood problem in New Jersey, and localized flood damage areas in New York are major concerns. With average annual equivalent flood damages estimated at about $105 million (October 1986 price level), the Passaic Basin has been characterized as a major East Coast flood problem area.

The 1903 flood is the flood of record over most of the Passaic Basin, while the April 1984 event brought flooding to areas that had not previously experienced it. It is estimated that almost $1.8 billion in damages would be caused if a flood comparable to the 1903 event were to occur today. Portions of the Basin were declared Federal disaster areas in 1968, 1971, 1972, 1973, twice in 1975 and in 1984.

In 1976, Congress recognized the urgent need for flood control in the Passaic River Basin. The Passaic River Basin Study, a Phase I advanced engineering and design study, was authorized in the Water Resources Development Act of 1976 (Public Law 94-587, 22 October 1976). Congressional guidance included in House of Representatives Report 94-1702, directed the reformulation of an existing plan, or in effect, the development of new plans for meeting the flood control needs of the people of the Passaic River Basin. The Congress cited local opposition to the extensive structural remedies proposed in previous plans, in providing specific direction for the Passaic River Basin Study. The Corps of Engineers was directed to study seven specific alternatives, and to consider interim flood protection measures and recommend them to Congress as they are completed, even if prior to the overall Study.

The Passaic River Basin Study was conducted by the Passaic River Basin and Special Studies Branch, an interdisciplinary study team and a major branch of the Planning Division, New York District, U.S. Army Corps of Engineers. Study activities were coordinated with the New Jersey Department of Environmental Protection, the New York State Department of Environmental Conservation, and other Federal, regional and local government agencies, public and private organizations, and interested individuals.

THE RECOMMENDATION

The Pompton/Passaic Dual Inlet Tunnel Diversion Plan is the State of New Jersey-selected plan which combines large diversion tunnels, levees, floodwalls, channel modifications and natural flood storage to provide flood protection to the Basin's major damage areas, totally eliminating flooding from severe events such as the April 1984 flood.

The major elements of this flood control proposal are the two tunnels, with the key being the 13.5-mile long, 39-foot-diameter main tunnel, which will carry floodwaters from an inlet at the upper end of the Pompton River down to an outlet on the Passaic River bank just above its confluence with the Third River. A 1.2-mile-long, 22-foot diameter spur tunnel, will convey Central Basin area floodwaters from an inlet just downstream of Two Bridges on the Passaic River, to an underground connection with the main diversion tunnel. The two inlets will be located in Wayne Township, while the outlet will rise on the west bank of the Passaic River at its confluence with the Third River in Clifton. The diversion tunnels and associated surface works are designed to protect against a 100 year flood event.

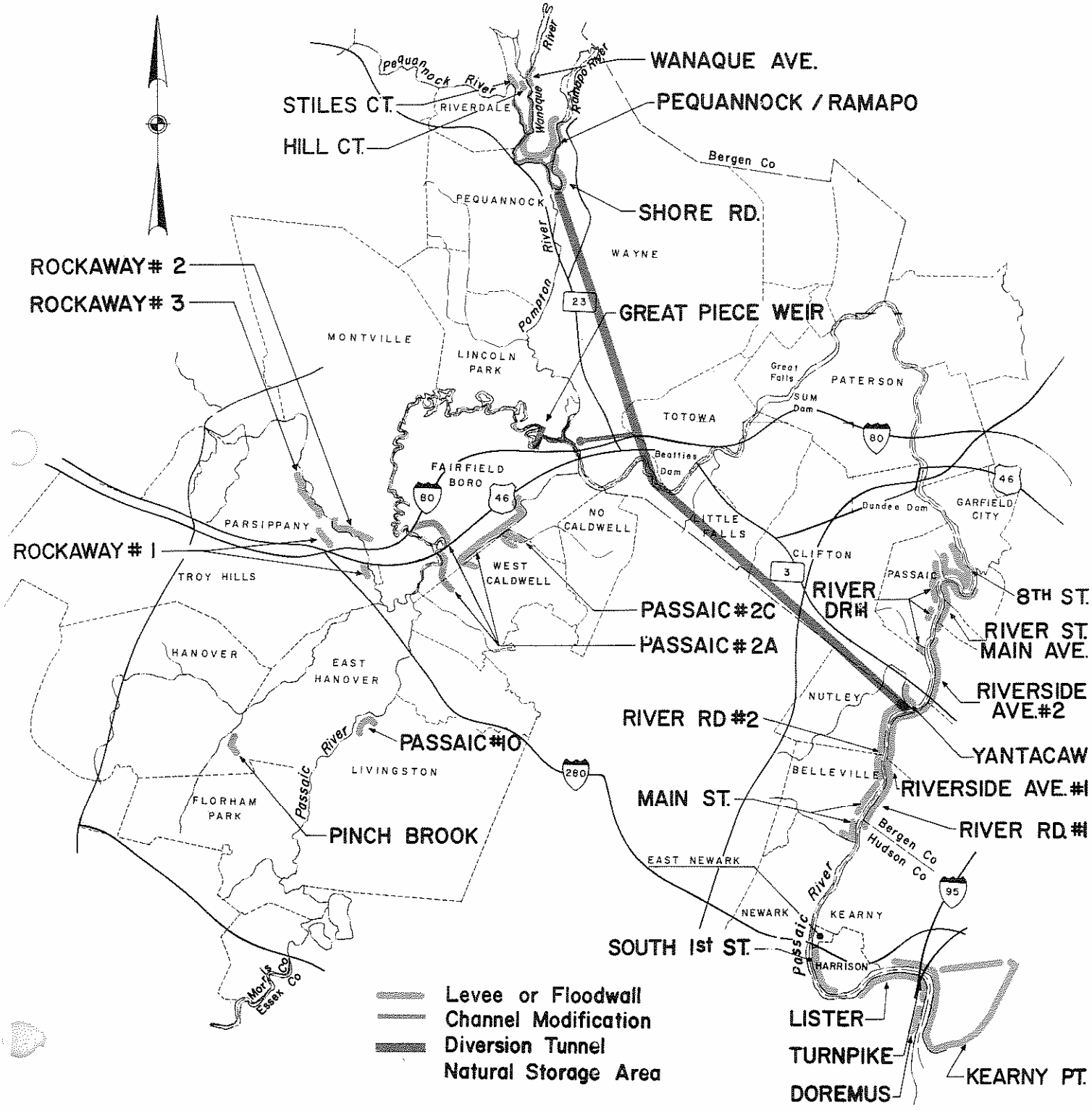
The tunnels will be constructed entirely underground -- some 125 feet below the surface at the Pompton Inlet, about 130 feet below the Passaic Inlet, and approximately 155 feet below the outlet. The intersection of the main and spur tunnels would be about 150 feet below ground level. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the tunnel would be some 450 feet underground.

A total of 5.9 miles of channel modifications would be required to direct the flows into the inlets, and the diversion tunnels will be augmented by some 37.7 miles of levees and floodwalls consisting of some 23.7 miles of levees and 14.0 miles of floodwalls.

Of the total 5.9 miles of channel modifications, 4.8 miles would lie upstream of the Pompton Inlet, along the Ramapo, Pequannock and Wanaque Rivers. The remaining 1.1 miles of channel modifications would consist of 0.8 miles on the Passaic River and 0.3 miles on the Pompton River upstream of the Two Bridges Inlet. No other structural remedies would be needed along the Pompton River or along the Passaic River between the Two Bridges Inlet and Dundee Dam, because the tunnels would divert flood flows away from these areas.

RECOMMENDED PLAN

POMPTON RIVER/PASSAIC RIVER DUAL INLET TUNNEL



Levees and floodwalls along the Pompton River tributaries include 3.5 miles of levees and 0.7 miles of floodwalls which are integral to the design of the Pompton Inlet and would provide a 100 year level of protection.

The 37.7 miles of levees and floodwalls also include flood protection in the Central Basin upstream of Two Bridges along the main stem Passaic and Rockaway Rivers and Deepavaal and Pinch Brooks. Protection against floods, ranging from a 100 year up to a 500 year event, would be provided intermittently where needed by 9.0 miles of setback levees and 0.5 miles of floodwalls.

Protection in the Lower Passaic Valley includes 5.5 miles of levees and 5.0 miles of floodwalls lying downstream of Route 280 to Newark Bay which provide 500 year protection against hurricane and tidal surges. Also included are 5.7 miles of levees and 7.8 miles of floodwalls along the Passaic River from upstream of its confluence with the Saddle River downstream to its confluence with the Second River, which protect against a 100 year event from both tidal flooding and Passaic River fluvial flows including discharges from the tunnel.

Interior runoff generated behind the levees and floodwalls would be safely handled by a series of interior drainage facilities, including ponding areas and pumping stations. The design of the levees and floodwalls include provisions for required river access and accommodations for locally desired recreation features.

In order to minimize the impact of future development within the basin, the acquisition of significant portions of the remaining unprotected natural storage areas within the Central Passaic Basin is included as part of the recommended plan. A total of 5,350 acres would be acquired, of which 5,200 acres are wetlands, all within the following eight major areas: Great Piece Meadows; Bog and Vly Meadows; the lower Pompton Valley; Hatfield Swamp; Hatfield Swamp South; Troy Meadows; Black Meadows; and Canoe Brook.

The total First Cost of the plan is $841,200,000 (October 1986 price levels). The Federal share of the First Cost is $622,500,000, while the non-Federal share is $218,700,000. The non-Federal share consists of $58,300,000 in lands, easements and rights of way, and $160,400,000 as a cash contribution. The total annual cost of the plan is $85,500,000. The average annual equivalent benefits equal $122,500,000, resulting in a benefit to cost ratio of 1.4 to 1.

REPORT ORGANIZATION

The Flood Protection Feasibility Report for the Main Stem Passaic River is organized into a total of nine volumes, including the Main Report, which contains the Environmental Impact Statement. There are also three appendices and five volumes of Supporting Documentation.

Main Report

Volume I - Main Report and Environmental Impact Statement

Appendices
(Available Upon Request)

Volume II - Appendix A - Public Involvement
Volume III - Appendix B - Natural Resources
Volume IV - Appendix C - Plan Formulation

Supporting Documentation
(Available at New York District)

Part I - Hydrology
Part II - Hydraulics
Part III - Foundations
Part IV - Cost Estimates
Part V - Economics

FLOOD PROTECTION FEASIBILITY
MAIN STEM PASSAIC RIVER

MAIN REPORT

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MAIN REPORT ADDENDA

Addendum	
1	404(b)(1) EVALUATION
2	FWCA REPORT AND CORPS RESPONSES

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A	PUBLIC INVOLVEMENT (VOLUME II)
B	NATURAL RESOURCES (VOLUME III)
C	PLAN FORMULATION (VOLUME IV)

SUPPORTING DOCUMENTATION (Available at New York District)

Part	Title
I	HYDROLOGY
II	HYDRAULICS
III	FOUNDATIONS
IV	COST ESTIMATES
V	ECONOMICS

CHAPTER 1. PREVIOUS PLANNING IN THE PASSAIC RIVER BASIN

Flooding in the Passaic River Basin has been studied at both the State and Federal level since before the turn of the century. From 1900 to 1940, the State of New Jersey produced eight major reports containing a variety of recommendations, advancing flood control storage as the key to solving the problem. None of these recommendations were implemented.

U.S. Army Corps of Engineers involvement in Passaic River planning was first authorized in the Flood Control Acts of 1936. Since then, reports recommending plans of action were issued in 1939, 1948, 1962, 1969, 1972 and 1973. None of these plans were implemented because they did not receive widespread public support, with opposition based on the concerns of municipalities and various other interests throughout the Basin.

Planning to solve the water and related land resources problems and needs in the Passaic River Basin has been wrought with controversy and indecision. In the 50 years since the Corps of Engineers was first directed to plan solutions to the Passaic Basin's flood problems, public opposition has prevented the implementation of any of the six plans that were recommended. This strong opposition centered around the use of the upstream floodplain to protect downstream damage areas; extensive structural measures, including dams, levees and floodwalls; and the vast amounts of land required for implementation. Basically, these plans lacked public acceptability; and this opposition, based on environmental, economic and social factors was mounted by various Passaic Basin interests, including government agencies, organizations and individuals. The many levels of political jurisdiction within the basin has further complicated the resolution of the many issues surrounding flood control planning. As a result, the people of the Passaic River continue to be plagued by economic losses, hazards to health and safety, and the threat of injury and loss of life.

HISTORICAL SUMMARY OF PLANNING

1936 AUTHORIZATIONS

In the Flood Control Act of May 6, 1936, and further in the Flood Control Act of December 19, 1936, the Corps of Engineers received its first authorizations for water resources planning in the Passaic River Basin. These laws directed the examination and survey of the control of flooding. The study was initiated with a September 29, 1936 public hearing in Paterson, N.J.

Major views expressed at this meeting included support for a comprehensive flood damage reduction program; for flood protection on a regional, rather than local, basis; channel clearing and improvements; and flood gates in Dundee Dam and the S.U.M. Dam. Individuals spoke for flood damage reduction along the lower Passaic River below the Saddle River, at Lincoln Park, and at Paterson, New Jersey. Concern was expressed regarding the loss of tax rateables, and the destruction of the wildlife sanctuary in the Troy Meadows.

1939 SURVEY REPORT

The New York District prepared a 1939 survey report which considered three alternative plans of improvement, all including dry flood detention reservoirs and channel modifications. The recommended plan located the dry flood detention reservoir on the Passaic and Pompton Rivers at Two Bridges, and included channel modifications from Two Bridges downstream to Little Falls.

The 1939 report was presented at a public meeting on December 18, 1939 at Paterson, N.J. Concerns were expressed regarding the large sums of money that would be required of local interests, citing the financial burden on small municipalities, and opposing sizable local contributions. The potential loss of tax rateables was mentioned. Opposition was expressed to a permanent reservoir in the Central Basin area, and the possibility of gates in Dundee Dam also surfaced. Hope was expressed that conflicts could be resolved, and that a suitable plan could be recommended to Congress.

Project proponents requested time to evaluate the project further, to work toward resolving differences among local interests, and to submit further data to the Board of Engineers for Rivers and Harbors. The Board deferred action on the recommended plan because complete information had not been received from all interested parties. This lack of information and unresolved local conflicts remaining caused delays which resulted in the return of the 1939 report to the New York District on April 23, 1945 for updating probable changed physical conditions.

During this effort, an April 25, 1946 public hearing was held in Paterson, N.J. The purpose of this hearing was to determine if there were changes in public concerns and desires since the 1939 report was issued. The following public inputs resulted from this hearing: support for a comprehensive flood control plan, considering social impacts as well as engineering measures, that would reflect a compromise among conflicting interests; interest in preservation of wildlife sanctuaries;

strong protests against increases in tax rateables, flood protection along Molly Ann's Brook and Weasel Brook; elimination or modification of Dundee Dam; consideration of water supply; and various types of measures including headwater reservoirs, channel improvements, retention basins and permanent lakes with flood control storage.

1948 SURVEY REPORT

Information gained from this public hearing and from many coordination meetings with State and local officials, resulted in a revised survey report in October 1948. This report included three alternative plans of improvement and three local protection projects.

The recommended plan included a reservoir in the Central Basin area, upstream of Two Bridges, for flood control and water supply, and channel modifications in the Passaic River downstream of the proposed reservoir. Local protection projects were recommended for Weasel Brook at Passaic City and Clifton, the Saddle River at Lodi, and at Molly Ann's Brook at Haledon.

The Board of Engineers for River and Harbors conducted a public hearing on this report on January 26, 1950 in Washington, D.C. Concerns expressed at this hearing included the possible loss of present and future tax rateables and other local cost impacts, the provision of water supply, and the possible negative impacts of flood protection on Morris County. As a result of this hearing, the Board returned the report to New York District for further consideration of the divergent views expressed by local interests.

1955 PASSAIC VALLEY FLOOD CONTROL COMMITTEE REPORT

In June 1953, the Governor of New Jersey established the eight-member Passaic Valley Flood Control Committee to develop an equitable plan for the control of floods in the Passaic Basin. The plans developed were to be acceptable to a majority of local interests, provide for a reasonable amount of channel enlargement in the lower Passaic River, provide for a reasonable amount of detention basin storage in the Central Basin, and satisfy the design requirements of the Corps of Engineers.

A July 2, 1956 letter from the Chairman advised the New York District Engineer of the Committee's findings. It concluded that no practical plan they considered had achieved the unanimous acceptance of the entire Passaic Basin. However, the Committee was confident that the active opposition that had prevented the adoption of any plan in the past, would not be experienced again, if future plans incorporated, insofar as

practical, the individual desires of all interests in the Basin. The Committee also stressed that flood control in the Passaic Basin is a single problem which can only be solved by a comprehensive Basinwide program. The letter also expressed the Committee's view that half measures, which would protect limited areas and cause problems at other locations, would create inequities which could not be justified.

1955 SENATE RESOLUTIONS

As a result of the hurricane flood of August 1955 and the flood of October 1955, the Senate Public Works Committee requested a review of reports on streams affected by these floods in resolutions adopted on September 14, 1955 and November 14, 1955. As a result, a flood control investigation was initiated in Upper Passaic Basin areas affected by the 1955 floods. A public hearing was held on February 1, 1956 at Newark, N.J. as part of this investigation.

Four major views expressed at this hearings were: (1) the plans should be comprehensive; (2) plans benefiting the downstream damage areas at the expense of upstream areas were opposed; (3) if possible, flood control should be combined with water supply and recreation; and (4) plans should avoid major losses of tax rateables.

1956 NEW JERSEY ACTION

By letter of December 21, 1956, the Governor of New Jersey referenced the Corps of Engineers 1948 Survey Report and the Passaic Valley Flood Control Committee's 1955 report in requesting that new plans be developed for Basinwide flood control. The Governor cited recent extensive development, economic changes and the desires of the people for a more comprehensive program in requesting that new plans be developed. He recommended the following criteria for development:

- That flood control in the Passaic Valley is a single problem which can only be solved by a comprehensive plan which will prevent or alleviate flood damage and loss of life throughout the entire basin.
- That the plan provide for a reasonable amount of channel improvement in the Lower Valley and a reasonable amount of flood storage in the Central Basin.
- That the plan, insofar as possible, incorporate the individual desires of all portions of the basin.

- That an effort be made to decrease the volume of storage required in the Central Basin by development of detention basins on upland tributaries.

- That including water supply as part of a flood control project is objectionable to the people of the Central Basin and should not be included, except as a possible alternate benefit to be considered separately.

- That greater emphasis than in previous studies be placed on the strategic location of the area in the Nation's most important metropolitan area; on the danger of great loss of life as well as extensive property damage; and on secondary benefits such as recreation, mosquito control and increased land values.

The Corps of Engineers adopted the recommendations in the New Jersey Governor's letter as the criteria and guidelines for further planning.

1962 DRAFT SURVEY REPORT

In consideration of the State of New Jersey's objectives, five alternative plans of improvement were formulated and presented in a 1962 draft survey report. These included a comprehensive reservoir-tunnel plan, a multiple-purpose reservoir plan, a dry detention reservoir plan, a tunnel plan, and a local protection plan.

It was determined that the comprehensive reservoir-tunnel plan was most compatible with the New Jersey objectives. The comprehensive reservoir-tunnel plan included flood detention reservoirs in Oakland and on the lower Whippany River, and a multiple-purpose reservoir on the Passaic River above Millington. It also included channel improvements from these reservoirs to Beatties Dam, and along the lower Passaic River. A 45-foot diameter diversion tunnel from Little Falls in the Central Basin to Nutley on the Lower Valley was a major feature of this economically justified plan of improvement.

1963 NEW JERSEY ACTION

The New Jersey Governor, in an April 27, 1963 letter, cited unjustifiable costs of the tunnel and increased demand for water supplies in urging further investigation of plans which included conservation storage for water supply within a flood detention reservoir.

1969 DRAFT SURVEY REPORT

As a result of this new direction from the State of New Jersey, seven new Basinwide plans were formulated and presented in a 1969 draft survey report. These plans included a reclamation plan, a flood detention plan, an intermediate conservation development plan, a maximum conservation development plan, a comprehensive reservoir-tunnel plan, a tunnel plan, and a local protection plan.

The intermediate conservation development plan was tentatively recommended in the 1969 draft report. It included a multiple-purpose reservoir in the Passaic River above Two Bridges, with a conservation pool for water supply, hydropower production and pollution abatement. It also included diversions of the Pompton River into the reservoir, and levees and floodwalls along the Pompton River and along the proposed diversion channel. The plan also included protection along the lower reaches of major tributaries within the backwater influence of the Passaic River from Two Bridges to the mouth and local protection measures in the tidal reach of the lower Passaic River against the tide of record.

Prior to completion of the 1969 draft survey report, two public meetings were held on December 16 and 19, 1968 at Wayne, N.J., and Madison, N.J. A major view expressed at these meetings was a need for additional data on the plans. Other concerns involved losses of tax rateables, better cooperation and coordination between governments at all levels, and the impact of costs on municipalities.

1972 SURVEY REPORT

The alternatives presented in the 1969 draft report were updated and revised during detailed planning, and five alternative plans of improvement and six local protection projects were presented in a 1972 survey report. The recommended plan, Plan III, included a multipurpose reservoir at Two Bridges, with a conservation pool for water supply and water quality enhancement in the Great Piece Meadows, and a multiple-purpose reservoir with conservation storage for water supply at Myers Road. It also featured channel modifications along the Passaic, Pompton, Pequannock, Wanaque, and Ramapo Rivers. The 1972 report also recommended six local protection projects located on the Saddle River at Lodi, N.J.; on the Ramapo River at Pompton Lakes and Oakland, N.J.; on the Rockaway River at Denville, N.J.; on Nakoma Brook at Sloatsburg, N.Y.; on the Ramapo and Mahwah Rivers at Mahwah, N.J. and Suffern, N.Y.; and on Molly Ann's Brook at Haledon.

Plan II in the 1972 report was to figure prominently in future Corps of Engineers planning. Plan II differed from the recommended plan (Plan III) in that the reservoir at Two Bridges was a dry flood detention reservoir.

Several areas of concern regarding Plan III, the recommended plan, surfaced during the Board of Engineers for Rivers and Harbors (BERH) review of the 1972 report. These included strong public opposition to the plan based on adverse environmental impacts; the absence of current assurances of intent to provide local cooperation as required by law; the basic intent of the authorizing resolution, which stressed flood control; indications that the control of eutrophication in the Two Bridge reservoir conservation pool might be costly; and the requirements of provisions of the newly enacted Federal Water Pollution Control Act Amendments of 1972.

These considerations led the BERH to request that the New York District develop a new alternative plan to provide the maximum degree of flood damage reduction with minimum adverse environmental impacts. The Board directed consideration of the following points in the development of this new alternative: the elimination of storage for water supply and water quality from the proposed Two Bridges Reservoir, making it strictly a flood control impoundment; the elimination of the proposed Myers Road Reservoir; and the necessary reformulation of the proposed channel modifications consistent with the two previous changes.

The result of this reformulation was Plan II-B, which was presented in an April 1973 supplemental report.

1973 SUPPLEMENTAL REPORT

Plan II-B, which was similar to Plan II in the 1972 Report, included a dry flood detention reservoir at Two Bridges for flood control and recreation, channel modifications, including channel diversions, and local protection works along the Passaic and Pompton Rivers. The six local protection projects in the 1972 report were included as independent elements of the plan.

The 1973 Supplemental Report (Plan II-B) was presented for public review at a Board of Engineers for Rivers and Harbors public meeting on April 5, 1973 at Pompton Lakes, N.J. A summary of the public concerns expressed at that meeting follows:

- Plan II-B is an improvement over the previous recommended plan, but is still not environmentally acceptable. It would degrade the quality of life in the Passaic Basin to an unacceptable degree.

- Channel modification can contribute to worsening flood problems at downstream areas, and is not an acceptable alternative.

- Levees and floodwalls are aesthetically unpleasant, and because they are designed to protect against a specific flood they create a false sense of security, as they may be inadequate against a more severe flood. Significant losses of tax rateables is a serious negative impact.

- The environmentally preferred solution, and least expensive alternative, is the relocation of most flood prone structures, the floodproofing of remaining structures, and flood plain management by legislative action.

- Finally, the high cost of the project, expressed in terms of its financial impact on local municipal governments, was also a concern.

Public reaction to Plan II-B and the 1973 Supplemental Report, reflected the divergence of opinion and divisiveness which, throughout the years, lead to an inability to develop any agreement among the municipalities and prevented the implementation of any of the solutions to the Passaic Basin's flood problems. Two camps were in evidence at the public meeting: those who supported Plan II-B and who were advocates of structural flood control measures; and those in opposition to structural works largely out of concern for the environment. Concerns were expressed over the loss of tax rateables, the impact of project costs on local governments, and deep concern for environmental quality. With minor variations, these are basically the same concerns expressed over the years since the Corps of Engineers first plans were formulated in 1939.

The major contributory factor to the lack of public acceptability of plans formulated by the Corps of Engineers and by others in the years before Federal involvement in Passaic Basin planning, was the wide disparity of interests and their divergent views. Despite these differences, Plan II-B had sufficient support and interest to become the first U.S. Army Corps of Engineers recommended flood control plan for the Passaic River Basin to reach the Congress for action. Congressional action on Plan II-B opened another chapter in the history of planning for solutions to the Passaic River Basin's water and related land resources problems and needs.

1976 CONGRESSIONAL HEARING ON PLAN II-B

Plan II-B was the subject of considerable public interest at a September 8, 1976 hearing of the Subcommittee on Water Resources of the House of Representatives Committee on Public Works and Transportation, in Washington, D.C. Once again, the difficulty of developing a plan acceptable to all was illustrated through the variety and diversity of views represented in the testimony or material submitted for the record by Passaic Basin interests. The concerns, issues and problems were basically those stated throughout previous Corps of Engineers planning efforts.

Plan II-B encountered serious and strong opposition, largely because of its massive structural flood protection works, the amount of land required for its implementation, its environmental impacts, and its high costs. Once again, issue was taken regarding the impact on municipalities of the potential losses of tax rateables and the effects of local project costs. Major opposition was expressed to the reservoir feature of the plan. Strong expressions of support were voiced for continuing the planning process into the advanced engineering and design stage, with emphasis on updating the planning process to current conditions, and completely reformulating plans in consideration of the recommendations and considerations of Basin interests.

Although a majority of the testimony was against the authorization of Plan II-B, there was almost unanimous recognition of the urgent need for flood control in the Passaic River Basin. A strong desire was also indicated for the involvement of individuals, organizations and governments from the Passaic Basin in the planning process, and also that the plans developed have demonstrated public acceptability.

NEW JERSEY CONGRESSIONAL TESTIMONY

In testimony before the Congressional Hearing, representatives of the State of New Jersey sought the authorization of further study of the Passaic River Basin, to be conducted under new procedures in the 1974 Water Resources Development Act. This act required the Corps of Engineers, as part of a Phase I study, to conduct post-authorization studies to establish the basic design and scope of a project, and to appraise its justification and public acceptability under current conditions. Such studies would provide for the complete analysis and coordination of all aspects of a project, in order to:

1. Reaffirm the basic planning decisions made in the investigation stage or reformulate the project to respond to changes since authorization.

2. Establish the scope of the project, current criteria, and develop, from a multiobjective standpoint, the optimum plan from the alternative plans studied.

3. Coordinate the project plans to get the views of other government agencies and local interests.

4. Provide a basis for a reliable, up-to-date estimate of project cost.

5. Provide a basis for updating environmental impacts and effects of the proposed action and the environmental statement.

6. Establish the current economic aspects of the project.

7. Provide a basis for cost sharing agreements, the preparation of plans and specifications, the acquisition of lands, and the negotiation of relocation agreements.

8. Establish operating requirements, and determine that the project will meet such requirements.

9. Facilitate the orderly scheduling and programming of funds for detailed design and construction of the project.

10. Provide an analysis of the consequences of possible alternatives, considering engineering feasibility, environmental effects, economic factors including regional and national development, social well-being, and other considerations as applicable.

11. Describe and consider the costs and means of eliminating, minimizing, or ameliorating possible economic, social, and environmental effects that may result from the project.

12. Provide the basis for a statement of findings signed by the District Engineer, fully describing the evaluation and decision process: that the proposed action is based upon consideration of a reasonable set of appropriate alternative courses of action for achieving the stated objectives; that the action is fully consistent with national policy, statutes, and administrative directives; and that the total public interest is best served by its implementation.

A New Jersey representative indicated that such a report could provide Congress with sufficient information for making a decision on authorization for construction. It was also indicated that the Corps of Engineers should include, but not be limited to, study of the tunnel diversion plan and reconsideration of water supply objectives.

The State also urged support for an interim plan to deal with the current and future flood hazard. Citing a 15-to-20 year time frame for design and construction of a recommended plan, the New Jersey representative stressed that positive, responsible steps in the interim would stem the rate of growth of the flood damage potential. Proposed interim measures included the acquisition of unimproved, non-publicly owned land, with reference to the Great Piece Meadows, Troy Meadows, Black Meadows, Long Meadow and Hatfield Swamp. Other suggested interim measures included floodplain mapping, floodproofing and early warning systems.

A NEW STUDY

As a result of the Congressional hearing, the Congress authorized a new Passaic River Basin Study.

Figure 1. Study Authorization
Extract from Public Law 94-587

PUBLIC LAW 94-587—OCT. 22, 1976 90 STAT. 2917

Public Law 94-587
94th Congress

An Act

Authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes.

Oct. 22, 1976
[S. 3823]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Water Resources Development Act of 1976.

SECTION 101. (a) The Secretary of the Army, acting through the Chief of Engineers, is hereby authorized to undertake the phase I design memorandum stage of advanced engineering and design of the following water resources development projects, substantially in accordance with, and subject to the conditions recommended by the Chief of Engineers in, the reports hereinafter designated.

PASSAIC RIVER BASIN

The project for flood control in the Passaic River Basin, New Jersey and New York: Report of the Chief of Engineers dated February 18, 1976, at an estimated cost of $12,000,000.

CHAPTER 2. THE NEW STUDY

The Flood Protection Feasibility Report is an interim report and is submitted in partial compliance with Section 101(a) of the Water resources Development Act of 1976, which authorized the Phase I Advanced Engineering and Design Study for the Passaic River Basin. Figure 1 is an extract of the authorizing legislation.

STUDY OBJECTIVE

The objective of the Passaic River Basin Study was the development of a feasible and publicly acceptable Basin-wide plan for meeting the flood control and other associated water and related land resources needs of the people of the Passaic River Basin. This plan was developed through the consideration of a wide range of alternative nonstructural and structural flood protection and water management measures consistent with current and projected future environmental, economic and social conditions in the Basin. It was conducted in compliance with all applicable water and related land resources laws, regulations and authorities.

CONGRESSIONAL GUIDANCE

The Passaic River Basin Study was also conducted under Congressional guidelines included in U.S. House of Representatives Report No. 94-1702, the House Public Works and Transportation Committee's 27 September 1976 report on the 1976 Water Resources Development Act (Figure 2).

The testimony from the September 1976 Congressional Hearing was translated into some very specific guidelines for conducting the PRB Study. In them, the Congress recognized the controversial nature of the previous plans recommended by the Corps of Engineers, and identified several controversies as the basis for reformulation planning. They include:

- Controversy from many communities in Morris and Essex Counties that stand to lose land to structural solutions.
- Controversy from conservation interests who seek nonstructural solutions.
- Controversy from those who favor alternatives involving a diversion tunnel or a system of tunnels addressing the needs of the basin.

- o Controversy from those who desire meeting water supply objectives along with flood control.

The House Report directed the reformulation of Plan II-B; the consideration of interim flood protection measures; emphasis on coordination with Federal, State and local agencies, particularly the New Jersey Department of Environmental Protection; and mandated the study of seven alternatives, as follows:

> Local opposition to any plan which relies upon extensive use of dikes, dams and levees, such as those proposed in previous survey reports mandates that the following alternatives or any combination thereof shall be the only ones surveyed and considered:
>
> 1. A full range of nonstructural flood control alternatives to include land acquisition, floodplain mapping, floodproofing, developing early warning systems and relocation of buildings.
>
> 2. A tunnel diversion plan.
>
> 3. A system of tunnels addressing the needs of the entire basin.
>
> 4. Plans that combine local protection works where locally acceptable and nonstructural solutions including improvements to stream carrying capacity in accordance with different needs in the Lower Valley and in the Central Basin.
>
> 5. Evaluation of fulfilling water supply objectives together with flood control.
>
> 6. Aquifer recharge and underground storage.
>
> 7. Reservoir management in the headwaters.

The Congressional Guidance further mandated the consideration of interim flood protection measures for recommendation to the Congress as soon as they are formulated, even if prior to completion of the overall study. Potential interim measures were considered under existing water resources laws and authorities and were required Congressional authorization and funding prior to implementation under this guidance. Interim measures are discussed in the section titled SOLVING THE PROBLEMS. The House Report also emphasized that the newly reformulated plans will require new environmental impact statements.

Figure 2

CONGRESSIONAL GUIDANCE
Extract from House Report 94-1702

PASSAIC RIVER BASIN, NEW JERSEY AND NEW YORK

The Phase I study shall include consideration of interim flood protection measures, and recommendations as to such measures are to be made to the Committee as soon as they are formulated, prior to completion of the Phase I study. Implementation of interim measures consistent with Public Law 92-500 and the National Environmental Policy Act, shall begin as soon as authorized and funded, and shall not await completion of the Phase I study.

Controversy revolves around a concern that conclusions reached by the Chief of Engineers Report of February 18, 1976, will be given priority to the exclusion of equal consideration of alternatives, and other objectives, including water management and attainment of water quality goals, pursuant to P.L. 92-500. Controversy over construction of the project emanates from many communities in Morris and Essex Counties that stand to lose substantial portions of their land to structural solutions; from conservation interests who seek non-structural solutions; from those who reject dams, dikes, and levees in their communities; from those who believe other forms of construction such as a diversion tunnel or a system of tunnels addressing the needs of the entire basin should be reevaluated; from those who believe water supply objectives should be met together with flood control.

In the Water Resources Development Act of 1974, the Congress adopted a new two-step authorization procedure for projects such as the Passaic River Basin project. The reasons for this new procedure, and a description of the items to be included in Phase I advanced engineering and design, are set forth in House Report 93-541 which accompanied H.R. 10203, and repeated in the introductory material in this report. These requirements and provisions apply to the Phase I study of the Passaic River Basin project.

The Committee directs the reformulation of the plan for water management and flood control for the entire Passaic River Basin. Said plan shall include a new environmental impact statement which is the subject of public hearings and formulation of a final environmental impact statement to be submitted to the Council on Environmental Quality.

Local opposition to any plan which relies upon extensive use of dikes, dams and levees such as those proposed in previous survey reports mandates that the following alternatives or any combination thereof shall be the only ones surveyed and considered:

1. A full range of non-structural flood control alternatives to include land acquisition, flood plain mapping, flood proofing, developing early warning systems and relocation of buildings.
2. A tunnel diversion plan.
3. A system of tunnels addressing the needs of the entire basin.
4. Plans that combine local protection works where locally acceptable and non-structural solutions including improvements to stream carrying capacity in accordance with difference needs in the Lower Basin and in the Central Basin.
5. Evaluation of fulfilling water supply objectives together with flood control.
6. Aquifer recharge and undergrounds storage.
7. Reservoir management in the headwaters.

Coordination with Federal, State and local agencies particularly the New Jersey Department of Environmental Protection in its efforts on flood control and management of the total water resource cycle including water supply and water quality, shall be carried out by the Corps of Engineers.

FIGURE 2

STUDY MANAGEMENT

The Congress directed the Secretary of the Army, acting through the U.S. Army Chief of Engineers, to undertake the Passaic River Basin Study. Since the Passaic River Basin lies within its Civil Works boundaries, the Corps of Engineers' New York District conducted the Study. The New York District Engineer established the Passaic River Basin Study Group, a separate, multi-disciplined study team, as a major branch of the District's Engineering Division; later transferred to the new Planning Division when it was established in 1980. This group devoted its total energies to the development and coordination of plans for water management and flood control in the Passaic Basin.

COORDINATION

Primary consideration was given to the coordination mandate in the Congressional Guidance, and concerns expressed throughout previous Corps of Engineers planning efforts for the involvement of Basin interests in the planning process and for the formulation of plans with public acceptability. The Passaic River Basin Study was conducted in coordination with other Federal agencies, the States of New Jersey and New York, and regional, County and local agencies, organizations, and individuals. The Corps of Engineers and the Basin States were committed to conducting the Passaic River Study as an open planning process emphasizing public involvement and citizen participation.

The New York Department of Environmental Conservation (NYDEC) and the New Jersey Department of Environmental Protection (NJDEP) are sharing the required non-Federal sponsorship of the Mahwah/Suffern local protection project, which is located in both Basin States. NYDEC is also the non-Federal sponsor of a local protection project for Monroe, NY. The NJDEP is the non-Federal sponsor of three other local protection projects in New Jersey and the enhancement of the basin-wide Flood Emergency Preparedness System. NJDEP has also indicated a willingness to sponsor project recommendations resulting from ongoing studies.

Throughout the planning process, the New Jersey Department of Environmental Protection was the lead State Agency, assuming a non-Federal sponsorship role in 1980, with direct involvement in selecting, shaping and defining main stem Passaic River alternatives. Within NJDEP, coordination was maintained with the Divisions of Parks and Forestry; Green Acres and Recreation; Fish, Game and Wildlife; Coastal Resources; Environmental Quality; Waste Management; Water Resources. Additional

coordination involved NJDEP's Fish, Game and Wildlife; Coastal Resources; Environmental Quality; Waste Management; and the Office of Science and Research. The Study was also coordinated with three other New Jersey State Agencies: the Departments of Commerce, Law and Public Safety, and Transportation.

PUBLIC INVOLVEMENT AND CITIZEN PARTICIPATION

An extensive program to public involvement and citizen participation was developed and implemented in the Passaic River Basin Study.

In the 50 years since the U.S. Army Corps of Engineers was first directed to develop plans to solve the flood control and other water resources problems of the Passaic River Basin, public opposition has prevented the implementation of any of the plans that were formulated and recommended.

In authorizing the new Passaic River Basin Study, the Congress emphasized that the reformulated plan the Study produces must have public acceptability. It was the policy of the New York District, U.S Army Corps of Engineers to conduct the Passaic River Basin Study in an open planning atmosphere, with emphasis placed on the development and implementation of a wide range of activities directed at making every Study action public and achieving a broad-based public involvement and high level of citizen participation.

PI/CP PROGRAM

An active Public Involvement and Citizen Participation (PI/CP) Program was conducted throughout the Passaic River Basin Study as integral part of the planning and decision-making procedures. All available means of communicating with the Passaic Basin's publics and receiving their inputs into the Study effort were utilized. A program was designed as a tool for establishing a continuous, two-way communication process, whereby the public was able to learn about and participate in the planning activities of the Corps of Engineers in the Passaic River Basin, while the planners learned the opinions, perceptions and preferences of the people of the Passaic Basin.

PI/CP OBJECTIVES

The Passaic River Basin Study PI/CP was developed with the following objectives:

1. To build public confidence and trust throughout the Passaic Basin in the Study process, the ability of the planning procedure to meet Study objectives, and in the capability of Passaic River Basin Study Group.

2. To assist in the formulation of alternative solutions to insure that they satisfy the needs and preferences of the people of the Passaic River Basin to the maximum degree possible within the bounds of Federal, State, County and local programs and water resources laws, regulations and authorities.

3. To seek a clear consensus among the people of the Passaic River Basin and their official representatives by facilitating the resolution of controversy and developing measures and plans that have public acceptability.

PROGRAM GUIDELINES

In seeking the achievement of these objectives, the Passaic River Basin Study Group:

1. Presented information to assist the public in defining the Passaic River Basin water resources problems, needs, objectives, and priorities, and in understanding the U.S. Army Corps of Engineers' planning procedure as it relates to this study.

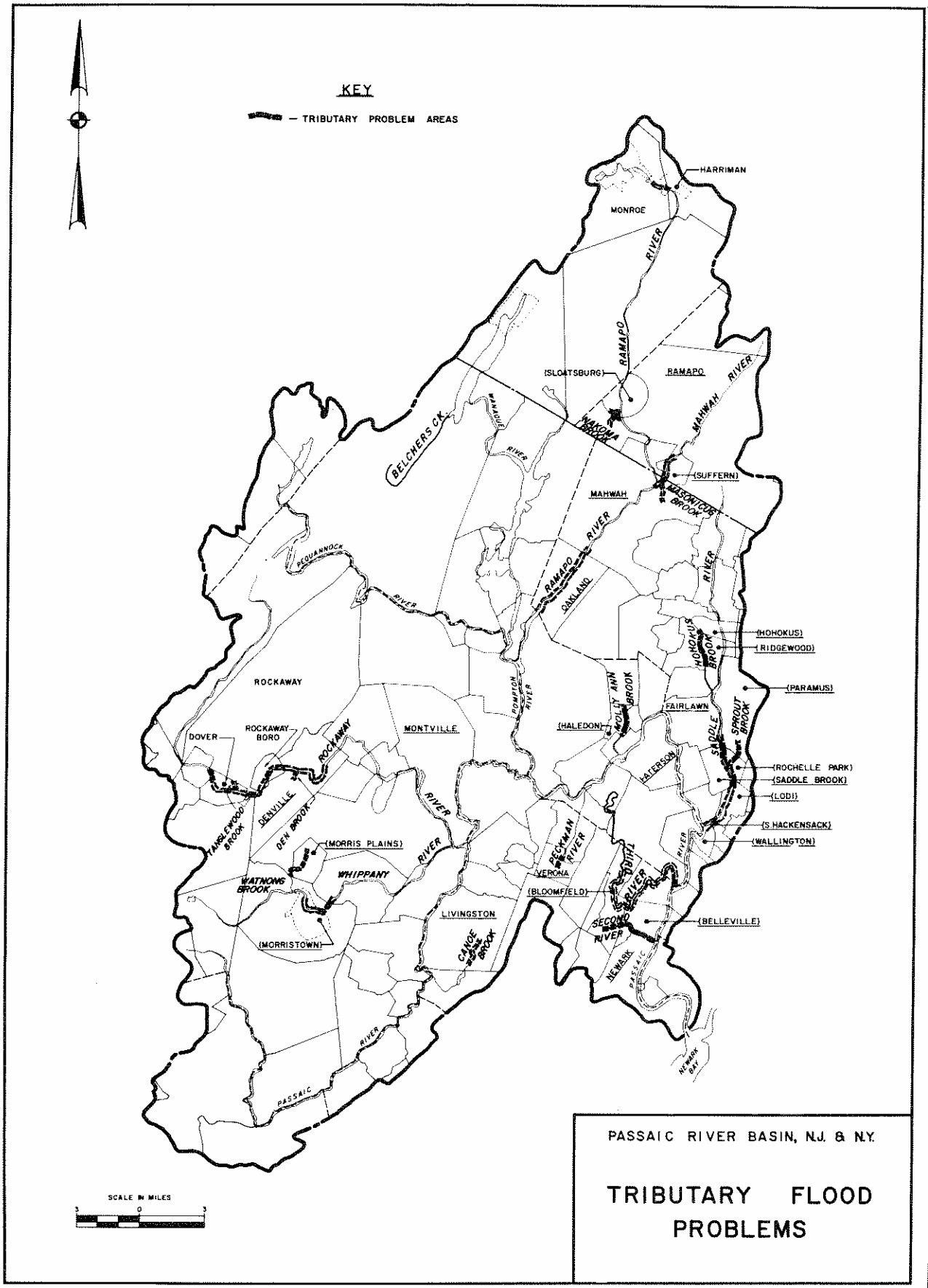
2. Developed an understanding with the Basin's publics as to how they can become involved in the Study process by establishing clear channels for them to express their perceptions of problems, needs, priorities, and preferences regarding the measures and plans to be considered.

3. Provided opportunities for Passaic Basin publics to participate in and influence the development of alternative measures and the formulation of alternative plans, to analyze and resolve conflicts, and to achieve consensus regarding publicly acceptable plans.

4. Actively promoted effective coordination throughout the Basin among Federal, State, County and local planning efforts.

SOLVING THE PROBLEMS

Early in the conduct of the PRB Study, it was determined that the business of developing solutions to the flood problems in the Passaic Basin would best be pursued on two levels. The first was the major objective of solving the Main Stem Passaic River flood problem and the second was the consideration of possible interim flood protection measures, as directed in the Congressional Guidance (HR 94-1702). The Plan of Study for the overall Passaic River Basin Study was completed in July 1979. An Intermediate Stage Report, which documented the full range of flood damage reduction measures for the Main Stem Passaic River, was completed in June 1983.



PASSAIC RIVER BASIN, N.J. & N.Y.

TRIBUTARY FLOOD PROBLEMS

FIGURE N° 3

It was determined that interim measures are those flood control actions which could be implemented prior to an overall Basin flood control project. Interim projects could partially meet the problems and needs in the Basin -- either by providing a partial solution to flood problems throughout the Basin; or a total or partial solution to flood problems in a section of the Basin.

Four criteria were utilized in the consideration of potential interim measures. They were:

1. The measure is effective as a solution to the water resources problems and needs in the Basin and would not cause any significant adverse impacts to other areas in the Basin or impact on an overall Basin plan.

2. The measure is engineeringly, economically, and environmentally sound from the Federal and public viewpoints.

3. There is a local sponsor for the measure, i.e. some non-Federal Government agency is willing to and capable of providing local assurance or items of local cooperation for the measure and the solution has public acceptance.

4. The interim study report and accompanying environmental impact statement can be completed without causing delays in completing the overall Basin study and report.

Early in the planning process, officials from both Basin States requested the consideration of several areas as potential site-specific, long-range interim project areas. The State of New Jersey recommended the following: the Saddle River Subbasin; Molly Ann's Brook; the Ramapo River at Oakland; the Ramapo and Mahwah Rivers at Mahwah; the Third River Subbasin; the Upper Rockaway River; the Peckman River; the Whippany River at Morristown; and Singac Brook at Wayne. New York officials requested consideration of the Ramapo River at Suffern, and Nakoma Brook at Sloatsburg, N.Y. Figure 3 presents the locations of tributary flood problems within the Passaic River Basin.

New Jersey officials also requested the following three items as possible Basin-wide interim projects: 1. a regionalized flood warning system; 2. the acquisition of natural storage areas; and 3. clearing, snagging and/or dredging activities.

Interim reports on flood protection feasibility were completed under the Passaic River Phase 1 authority for four of the tributaries identified for consideration as site-specific project areas. The recommended flood protection plans for these four tributary areas, which consist of the Ramapo and Mahwah Rivers at Mahwah, N.J., and Suffern, N.Y., the Ramapo River at Oakland, N.J., the Lower Saddle River and Molly Ann's Brook, N.J., were authorized for construction in Section 401(a) of the Water Resources Development Act of 1986.

Investigations of two site-specific areas are currently ongoing under the Passaic River Basin authority. These consist of the Upper Rockaway River and the Third River.

Since the flood problem along Singac Brook at Wayne, N.J. is caused primarily by Passaic River backwater flooding, this was treated as part of the main stem study.

It was determined that there was no Federal interest in providing flood damage reduction measures for the remaining tributaries identified as possible site-specific interim project areas. These areas include the Peckman River at Little Falls, West Paterson and Cedar Grove, N.J.; the Whippany River at Morristown, N.J., the Ramapo River at Suffern, N.Y.; and Nakoma Brook at Sloatsburg, N.Y. It should be noted, however, that the Water Resources Development Act of 1986 may impact on the negative finding for Nakoma Brook.

Additional areas which were studied include Ho-Ho-Kus Brook at Waldwick, N.J. for which construction of an emergency streambank erosion control project was completed in December 1981. A Detailed Project Report for the Ramapo River at Monroe, N.J. recommended a clearing and snagging project to reduce flood damages. Plans and specifications for this project were initiated in April 1986 and are expected to be submitted to the Office of the Chief of Engineers by the end of 1987. Other small project areas were studied but it was determined that there was no Federal interest in providing flood damage reduction measure to these areas. These include Belchers Creek at West Milford and Canoe Brook at Livingston, N.J.

The three measures identified as possible Basin-wide interim projects were also studied under the overall Passaic River Basin Phase 1 authority. The Detailed Project Report on the enhancement of the Passaic River's Flood Emergency Preparedness System resulted in a recommendation to improve the timeliness, accuracy and reliability of floodwarnings throughout the Basin. Subsequent to the completion of Plans and Specifications for the recommended plan, the Secretary of the Army approved the project

for construction and signed a Local Cooperation Agreement with the State of New Jersey on 30 October 1986. Implementation of the project is scheduled to begin in 1987 and is to be completed in March 1988.

For the Preservation of Natural Flood Storage study, the recommendation was for no interim action, but for further consideration as an early action measure in conjunction with the overall Main Stem Passaic River Study. The main stem flood protection plan recommended in this report contains the preservation of key natural flood storage areas as a nonstructural project element.

Snagging and clearing measures are being investigated as a potential interim action as part of the Channel Clearing Feasibility Study for the Passaic River and tributaries. Detailed planning studies for channel clearing alternatives are currently ongoing.

The Water Resources Development Act of 1986 (Public Law 99-662) contains several provisions which impact on the Passaic River Basin. Section 103 established cost-sharing requirements which are applicable to the plans developed for this study. The project cost apportionment presented later in this report conforms to these requirements (see Table 28).

PL 99-662 also authorized several projects within the Passaic River Basin, including the previously discussed interim projects at four tributary areas (Ramapo and Mahwah Rivers at Mahwah, N.J. and Suffern, N.Y.; the Ramapo River at Oakland, N.J.; the Lower Saddle River, N.J,; and Molly Ann's Brook, N.J.) which were authorized for construction in Section 401(a) of this act. Flood control planning, engineering and design studies were authorized for the aforementioned Upper Rockaway River, Third River and Nakoma Brook areas (Section 401(c)).

Five other projects were authorized for implementation in PL 99-662, subject to Section 903(a) of this act, including: Section 602-Lakes Program for Greenwood Lake and Belchers Creek, N.J.; Section 603 - Streambank Erosion Control Program for the east bank of the Passaic River, N.J., from Dundee Dam to Kearney Point; Section 607 - Passaic River Basin Channel Clearing, and Beatties Dam Flood Control; and Section 1148 - Acquisition of flood prone residential structures from willing sellers in the Passaic River Basin. Those authorized projects, which are further discussed in Table C-1 of Appendix C - Plan Formulation, and in other pertinent Sections of this report, address water resource needs other than flood damage reduction or are aimed at providing localized or interim flood protection. On the other hand, the plans formulated in this study would provide long-term Passaic River Main Stem flood protection.

TABLE 1

PASSAIC RIVER BASIN MUNICIPALITIES

NEW JERSEY

BERGEN COUNTY

1. Allendale Borough
2. Carlstadt Borough
3. East Rutherford Borough
4. Elmwood Park Borough
5. Fair Lawn Borough
6. Franklin Lakes Borough
7. Garfield City
8. Glen Rock Borough
9. Hasbrouck Heights Borough
10. Hilladale Borough
11. Hohokus Borough
12. Lodi Borough
13. Lyndhurst Township
14. Mahwah Township
15. Maywood Borough
16. Midland Park Borough
17. Montvale Borough
18. North Arlington Borough
19. Oakland Borough
20. Paramus Borough
21. Ramsey Borough
22. Ridgewood Village
23. Rochelle Park Township
24. Rutherford Borough
25. Saddle Brook Township
26. Saddle River Borough
27. South Hackensack Township
28. Upper Saddle River Borough
29. Waldwick Borough
30. Wallington Borough
31. Washington Township
32. Woodcliff Lake Borough
33. Woodridge Borough
34. Wyckoff Township

ESSEX COUNTY

35. Belleville Town
36. Bloomfield Town
37. Caldwell Borough
38. Cedar Grove Township
39. East Orange City
40. Essex Falls Borough
41. Fairfield Borough
42. Glen Ridge Borough
43. Livingston Township
44. Millburn Township
45. Montclair Township
46. Newark City
47. North Caldwell Borough
48. Nutley Town
49. Orange City
50. Roseland Borough
51. Verona Borough
52. West Caldwell Borough
53. West Orange Town

HUDSON COUNTY

54. East Newark Borough
55. Harrison Town
56. Kearny Town

MORRIS COUNTY

57. Boonton Town
58. Boonton Township
59. Butler Borough

MORRIS COUNTY

68. Chatham Borough
69. Chatham Township
70. Denville Township
71. Dover Town
72. East Hanover Township
73. Florham Park Borough
74. Hanover Township
75. Harding Township
76. Jefferson Township
77. Kinnelon Borough
78. Lincoln Park Borough
79. Madison Borough
80. Mendham Borough
81. Mendham Township
82. Mine Hill Township
83. Montville Township
84. Morris Township
85. Morris Plains Borough
86. Morristown Town
87. Mountain Lakes Borough
88. Mount Arlington Borough
89. Parsippany-Troy Hills Township
90. Passaic Township
91. Pequannock Township
92. Randolph Township
93. Riverdale Borough
94. Rockaway Borough
95. Rockaway Township
96. Roxbury Township
97. Victory Gardens Borough
98. Wharton Borough

PASSAIC COUNTY

99. Bloomingdale Borough
100. Clifton City
101. Haledon Borough
102. Hawthorne Borough
103. Little Falls Township
104. North Haledon Borough
105. Passaic City
106. Paterson City
107. Pompton Lakes Borough
108. Prospect Park Borough
109. Ringwood Borough
110. Totowa Borough
111. Wanaque Borough
112. Wayne Township
113. West Milford Town
114. West Paterson Borough

SOMERSET COUNTY

115. Bernards Township
116. Bernardsville Borough
117. Bridgewater Township
118. Far Hills Borough
119. Warren Township

SUSSEX COUNTY

120. Hardyston Township
121. Sparta Township
122. Vernon Township

UNION COUNTY

123. Berkeley Heights Township
124. New Providence Borough
125. Summit City

NEW YORK

ORANGE COUNTY

60. Greenwood Lake Village
61. Harriman Village
62. Monroe Town
63. Monroe Village
64. Tuxedo Town
65. Tuxedo Park Village
66. Warwick Town
67. Woodbury Town

ROCKLAND COUNTY

126. Haverstraw Town
127. Hillburn Village
128. Ramapo Town
129. Sloatsburg Village
130. Spring Valley Village
131. Stony Point
132. Suffern Village

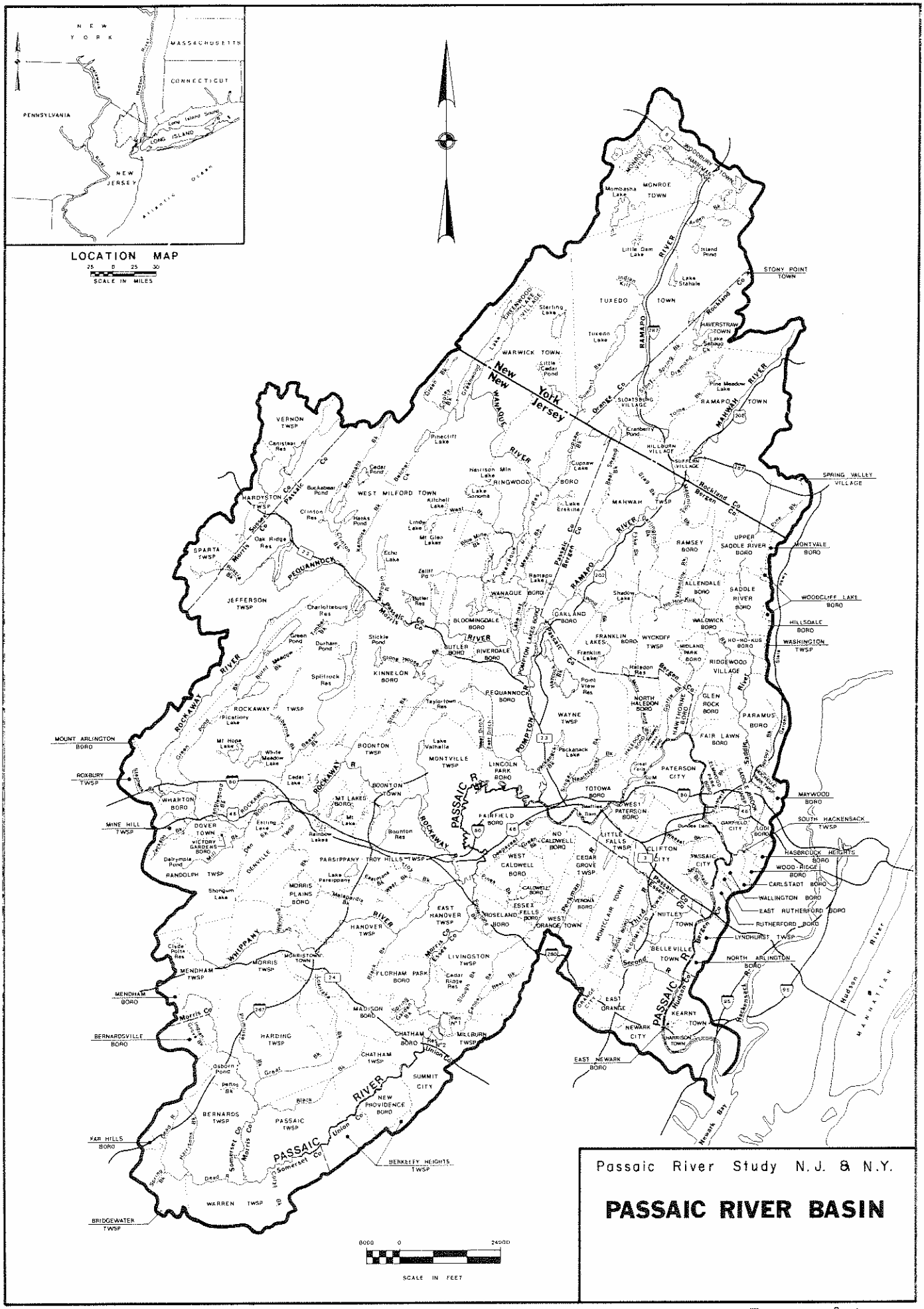

LOCATION MAP
SCALE IN MILES
SCALE IN FEET
New York
New Jersey
PASSAIC RIVER BASIN
Passaic River Study N.J. & N.Y.

FIGURE N° 4

CHAPTER 3. THE PASSAIC BASIN

The Passaic River Basin is a 935-square mile watershed in New Jersey and New York (Figure 4). It is located in the Greater New York City Metropolitan Area within a 35-mile radius of New York City, and includes 787 square miles, 84%, in northeastern New Jersey and 148 square miles, 16%, in southern New York State.

The Passaic Basin is a major center of economic activity in New Jersey. Occupying about 10.5% of the area of the Garden State, the Basin contains all or part of 117 municipalities in portions of eight counties -- Bergen, Essex, Hudson, Morris, Passaic, Somerset, Sussex and Union. In New York State, the Passaic Basin includes some 15 municipalities in Orange and Rockland Counties.

Flood control planning for the Passaic River and tributaries is greatly influenced by the many levels of political jurisdiction in the Basin. It contains portions of two states, ten counties (see EIS Figure 1) and some 132 incorporated municipalities (Figure 5). Table 1 presents a listing of Passaic River Basin municipalities. There are eight U.S. Congressional Districts in New Jersey and one in New York. It also comes under the influence of numerous state legislative Districts in both states.

The Basin has an elliptical shape, with a 56 mile long northeast-southwest axis, and a width of 26 miles. It is bounded on the west and north by the Appalachian Highlands, on the east by the Piedmont Plain and on the south by the First Watchung Mountains. It has a wide diversity of features, ranging from heavily-wooded, mountainous, rural areas to suburban lowlands, relieved by rolling hills, to densely-populated, highly-industrialized urban concentrations.

The Passaic River has seven major tributaries, including the Whippany River, the Rockaway River, the Pompton River, the Pequannock River, the Wanaque River, the Ramapo River, and the Saddle River.

TOPOGRAPHIC AND HYDROLOGIC FEATURES

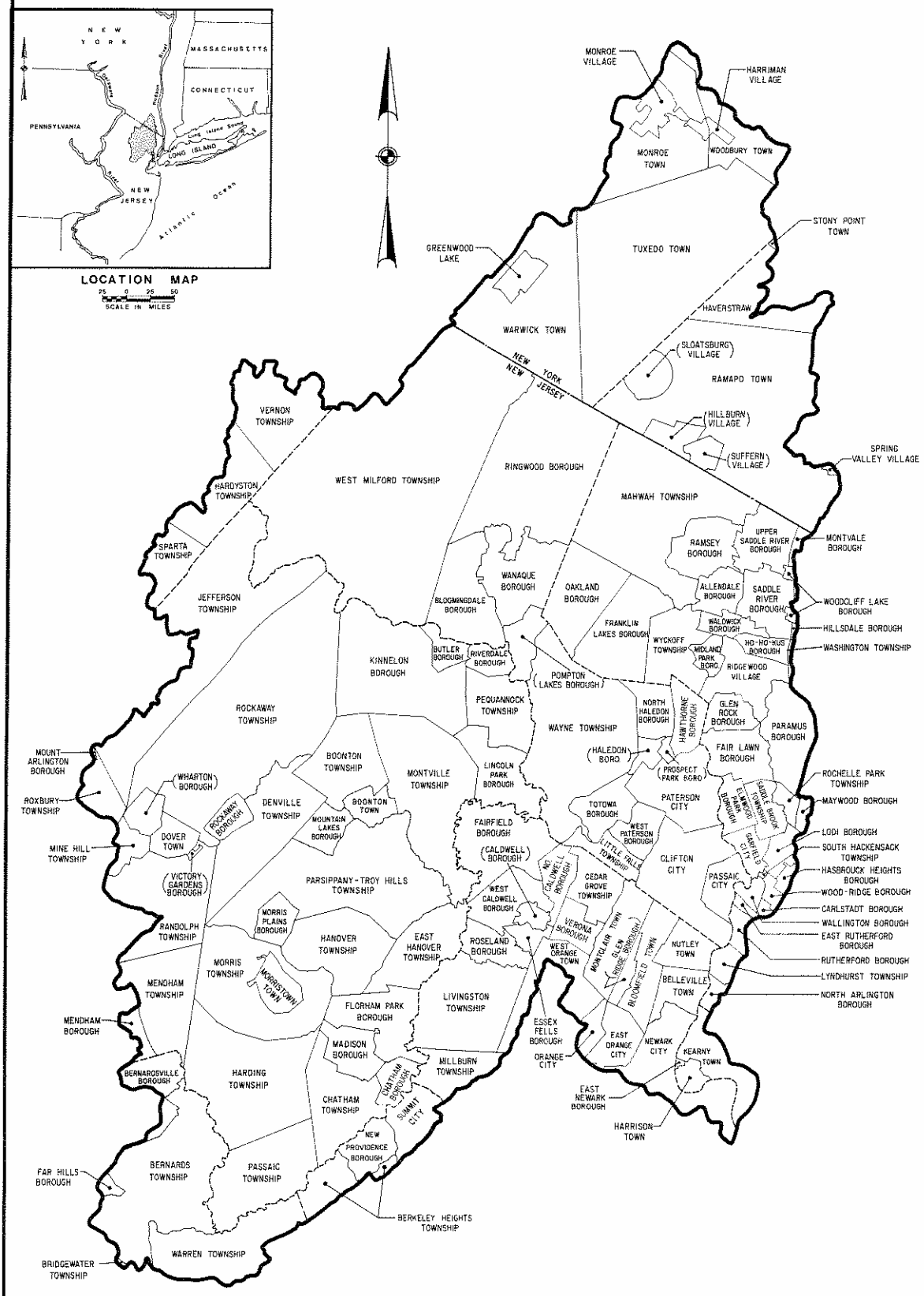
The Passaic River Basin has three distinctly separate areas, distinguishable by widely variant topographic features and hydrologic characteristics (Figure 6). These are the mountainous Highland Area, with diverse stream slopes and

rushing streams; the Central Basin, a large concentration of natural flood detention wetlands; and Lower Valley, the eastern flat urban belt, which features the tidal, saline lower reach of the Passaic River.

The Highland Area, is by far the largest of the three, covering 500 square miles in the western and northern half of the Basin. It is a heavily-wooded, mountainous section of the Appalachian Mountain Province. In Mendham Borough in the Highland Area, the Passaic River begins its irregular, 100-mile course to Newark Bay. This 13-mile-wide by 38-mile-long irregularly-shaped wedge is characterized by steep-sided, narrow valleys carrying the Ramapo, Wanaque and Pequannock Rivers. The three tributaries join almost in the center of the Passaic Basin to form the Pompton River, one of the two major Passaic Basin flood damage areas. The Upper Rockaway River above Boonton Reservoir, is another tributary located in the southern portion of the Highland Area.

The Central Basin, a flat, oval 262 square mile depression, 10 miles wide and 30 miles long, runs from the southernmost point in the Passaic Basin north and east to its center. It contains 24,485 acres of natural flood storage area, including the Great Piece Meadows, Hatfield Swamp, Troy Meadows, Black Meadows, Bog and Vly Meadows and the Great Swamp. The Central Basin is clearly the hydrologic centerpiece of the Passaic Watershed as it also contains the two most significant flood damage areas -- the Pompton River Valley, and the Central Passaic River area west of the Pompton River. The Main Stem Passaic passes through the Central Basin area from the south in a generally northeast direction until it flows through the narrow, rock gorge, natural channel constriction above Little Falls into the Lower Valley area.

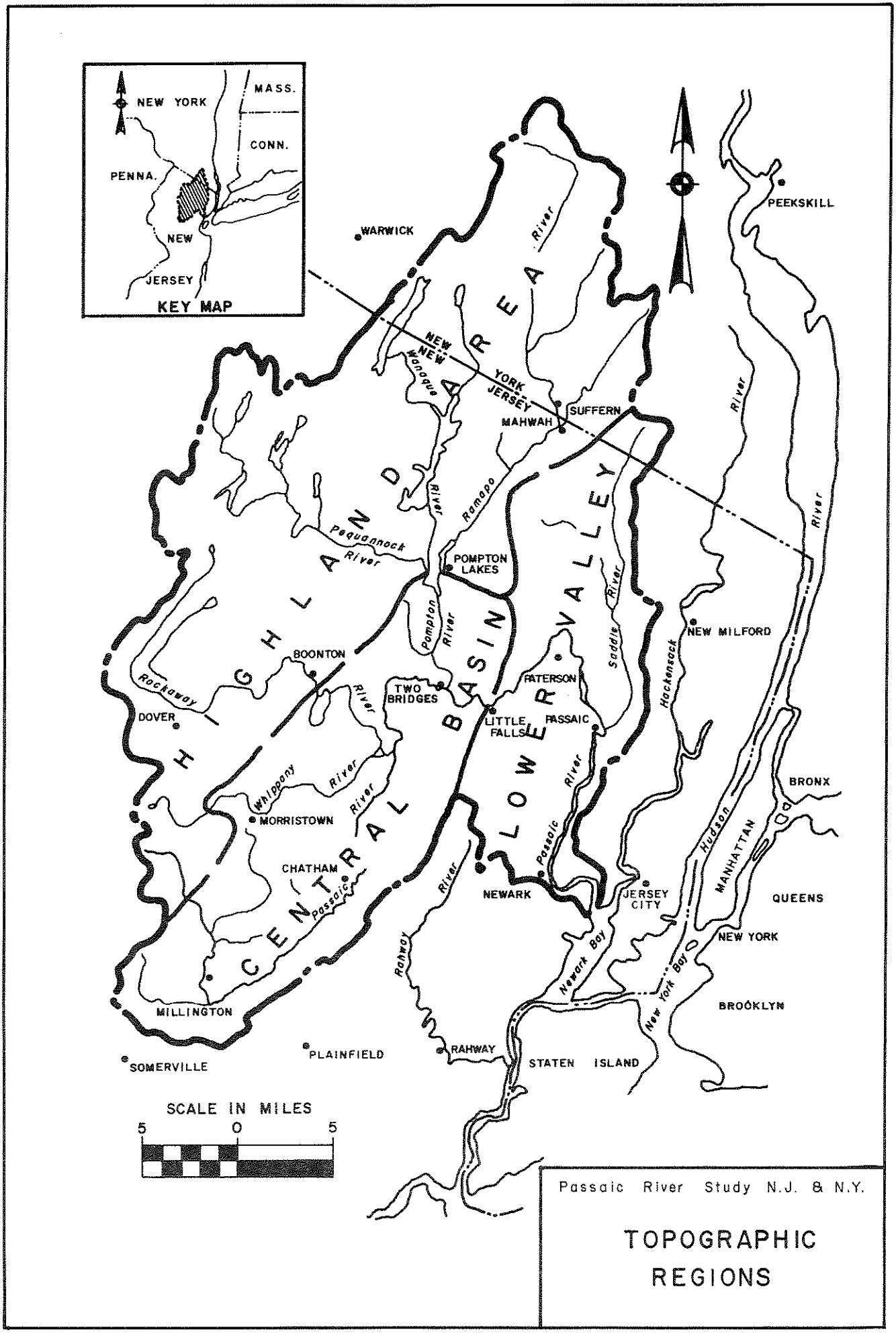
The populous, urban, industrial Lower Valley area covers 173-square miles, and carries the Main Stem Passaic River into Newark Bay through an area eight miles wide and 26-miles-long. Its major tributary is the Saddle River. Within the Lower Valley, the Passaic River falls a vertical distance of 33 feet at Beatties Dam in Little Falls, 63 feet at the Great Falls (S.U.M. Dam) in Paterson and 17 feet at Dundee Dam in Clifton. The lower Passaic River is influenced by the tidal flows for some 17 miles from the Dundee Dam in Garfield downstream to Newark Bay.



Passaic River Study N.J. & N.Y.

BASIN MUNICIPALITIES

FIGURE 5



Passaic River Study N.J. & N.Y.

TOPOGRAPHIC REGIONS

FIGURE 6

PHYSIOGRAPHY AND GEOLOGY OF THE PASSAIC RIVER BASIN

The Passaic River Basin is situated completely within one physiographic province in the State of New Jersey. This province, known as the Appalachian Province, covers the northernmost one third of New Jersey and extends from central Alabama northeastward into Canada. The Appalacian Province can be subdivided into six lesser geologic provinces. The Passaic River Basin lies within two of these lesser provinces, known as the Highlands and the Piedmont Plains. The two provinces are divided by a border fault, known as the Ramapo Fault, which extends from Morristown, in the southwestern part of the Passaic River Basin, northeastward along the Ramapo and Mahwah River Valley, toward Stony Point, New York, just beyond the northeast limit of the basin. The Piedmont Province encompasses a little more than one half of the total watershed southeast of the border fault. The Highlands Province has more rugged terrain than the Piedmont Province and makes up the remaining northwestern part of the Passaic River Basin.

The rock types underlying the Passaic River Basin are diverse and it is therefore convenient to consider the bedrock geology of the Piedmont Province and the Highland Province separately. Bedrock of the Highland Province, for example, consists of metamorphic rocks (granitoid gneisses and associated pegmatite and diabase dikes) of Precambrian age. Infolded with the Precambrian rocks are areas consisting of Devonian and Silurian age conglomerate, sandstone, shale, and limestone. Extensive northeast trending faults, of both normal and reverse type, are present in the Highlands Province.

The Piedmont Province, known geologically as the Newark Basin, is underlain by sedimentary rocks (sandstones, shales, limy shales, and conglomerates), igneous rocks (basalt and diabase) and metomorphic rocks (schists and gneisses). These rocks vary in age from late Triassic to early Jurassic. The structure of the Newark Basin is such that progressively younger rocks are exposed toward the northwest.

Landform is directly influenced by underlying rock type. In the Piedmont Province, for example, sandstone and shale bedrock form a rolling and undulating surface, while the more resistant basalt forms conspicuous, parallel ridges, such as the Watchung Mountains.

Almost the entire Passaic River Basin was subjected to glacial erosion and deposition, producing lasting effects on its topography and drainage. The last stage of the Wisconsinan glacier created the present landscape of the Passaic River Basin as it swept away deposits from previous glaciations. The southernmost limit of the glacial advancement is marked by a

terminal moraine ridge from Dover to Summit. Also, as the glacier retreated, a blanket of ground moraine was deposited on bedrock. The moraine material is generally comprised of an unsorted, heterogenous mixture of material, ranging in size from clay to boulders, and can be 100 feet or more in thickness. Glacial till and stratified drift deposits are present in the Highlands Province and the Piedmont Province. These deposits generally consist of silt, sand, and gravel and can be up to 10 feet or more in thickness. West of the Watchung Mountains, glacial Lake Passaic deposited considerable quantities of impermeable silts and clays. These clay deposits underlie the vast meadowlands of the Central Basin.

TRIBUTARIES

All of the Passaic River's major tributaries rise in the Highland Area and enter the mainstream within the Central Basin,as shown in Figure 6. Table 2 presents pertinent watershed data.

The Whippany River is 21 miles long, with a 72-square-mile drainage area located entirely in Morris County. The short headwater reach of the River in the Highland Area has rapid flows with small pools and eddies. Flowing into the Central Basin, the Whippany River widens, becoming a slow, meandering stream traversing large wetlands. It separates the municipalities of East Hanover and Parsippany-Troy Hills at its mouth on the Rockaway River in the Hatfield Swamp.

The Rockaway River is the Passaic River's largest tributary, draining about 206 square miles, and traveling some 43 miles from its headwaters in Jefferson Township to the Passaic River at East Hanover and Montville. The Rockaway is interrupted by Boonton Reservoir, a large water supply reservoir owned by Jersey City.

The Pompton River is the smallest of the Passaic tributaries, 6.7 miles long with a drainage area of just 17 square miles. It originates with the joining of the Pequannock and Ramapo Rivers at Pequannock and Wayne, and ends at its confluence with the Passaic River in the area known as Two Bridges. Lincoln Park, Wayne, and Fairfield border on the confluence. Despite its small size, the floodplain of the Pompton is very highly developed, and it is the most frequently flood damaged area in the Passaic Basin.

TABLE 2
PERTINENT WATERSHED DATA

Stream	Locality	Distance Above Mouth Passaic River (Miles)	Tributary Length (Miles)	Elevation in Feet m.s.l. Mouth	Source	Vertical Fall (Feet)	Streambed Slope(a) (Ft./Mi.)	Drainage Area (Sq. Mi.)
Passaic River	Mouth, Newark	0	87.6	-40			7.9	935.0
	Above Saddle River	15.5	72.1	0			9.0	815.5
	Dundee Dam, Clifton	17.4	70.2	25.4		17.0	8.9	809.9
	S.U.M. Dam, Paterson	25.2	62.4	114.5		63.0	8.6	785.0
	Beatties Dam, Little Falls	29.7	57.9	157.6		33.0	8.5	762.2
	Two Bridges	33.0	54.6	157.6			9.0	740.8
	Chatham	64.5	23.1	200			19.5	100.0
	Millington	75.8	11.8	210			37.3	55.4
	Source	87.6	-	-	650		0	0
Saddle River	Mouth	15.5	23	0	505		22.0	60.6
	At Lodi (U.S.G.S. Gage)	18.3	-	17	505		24.2	54.6
	Above Hohokus Creek	25.8	-	48	505		36.0	23.3
Hohokus Creek	Mouth	25.8	11.5	48	570		45.4	19.5
Weasel Brook	Mouth	14.2	5.0	-5	590		119.0	7.1
	At Clifton (U.S.G.S. Gage)	16.0	-	65	590		194.0	4.5
Diamond Brook	Mouth	22.2	4.0	24	330		76.5	3.1
Goffle Brook	Mouth	23.3	7.2	24	560		74.4	8.9
Molly Ann's Brook	Mouth	25.8	6.7	108	560		67.5	8.6
Slippery Rock Brook	Mouth	26.1	2.5	115	550		174.0	0.9
Peckman River	Mouth	28.2	7.7	115	660		70.8	9.8
Singac Brook	Mouth	31.8	8.5	150	810		77.6	11.5
Pompton River	Mouth (Two Bridges	33.0	44.8(b)	157.6	1100.0		21.0	378.1
	At Mountain View	34.4	43.4	157.6	1100.0		21.6	377.3
	At Pompton Feeder Dam	40.0	37.7	175.5	1100.0	8.0	24.5	353.3
Pequannock River	Mouth	39.7	30.8	165.0	1250.0		35.2	192.6
	Macopin Intake	50.3	20.0	583.7	1250.0		33.3	63.7
Wanaque River	Mouth	41.8	25.0	175.0	1000.0		33.0	108.1
	Above Wanaque Dam	46.6	20.2	300.3	1000.0	90.0	34.6	90.4
Ramapo River	Pompton Lakes Dam	41.9	35.8	200.9	1100.0	25.0	25.1	160.0
	Mahwah (U.S.G.S. Gage)	53.9	24.3	255.0	1100.0		34.8	118.0
Rockaway River	Mouth	47.0	43.0	160.0	1314.0		26.8	205.7
	Above Boonton	55.2	34.8	305.4	1314.0		29.0	116.0
Whippany River	Mouth	48.2	21.0	160.0	1090.0		44.3	72.0
	Near Morristown (USGS Gage)	60.2	9.0	280.0	1090.0		90.0	29.4
Green Pond Brook	At Picatinny Lake Dam	76.0	6.3	710.0	1260.0		87.2	8.7
Meadow Brook	At Lake Denmark Dam	78.0	3.4	818.0	1222.0		118.9	4.2

FOOTNOTES: (a) Slope from location indicated to source.
(b) Pompton R. source assumed to be Ramapo R.

The Pequannock River, in the northeastern section of the Basin is 31 miles long and drains an area of 193 square miles. The Pequannock is significant in Passaic Basin flooding only along its lower three miles. Its flows contribute to the flooding experienced in the Pompton Valley damage area.

The Wanaque River is 25 miles long from its origin in Greenwood Lake to its mouth on the Pequannock River at the head of the Pompton Valley. The Wanaque drains some 108 square miles.

The Ramapo River drains an area of 160 square miles in New Jersey and New York. Its headwaters are Round Lake above Monroe, N.Y., and it flows 36 miles, picking up the Mahwah River in Suffern, N.Y. down to its confluence with the Pompton River in Wayne, N.J. Pompton Lake, in Pompton Lakes Borough and Wayne Township, is a major source of water supplies for the Passaic Valley Water Supply Commission. Water from Pompton Lake is piped to the Commission's Wanaque Reservoir.

The Saddle River, also lying in both New Jersey and New York, drains 61 square miles, runs 23 miles from its headwaters in Rockland County, N.Y., through several Bergen County, N.J., municipalities to its confluence with the Passaic River at Garfield and Wallington.

SOCIOECONOMIC FACTORS

The patterns of development and land use distribution in the Passaic River basin are products of the post-World War II trend of suburbanization interacting with the area's natural physical characteristics. From the urban center of Newark, at the River's mouth, to the rural western perimeter of the watershed, the Passaic River Basin displays all the degrees and stages of suburban trend development.

Patterns of suburban development radiate from the core central city. In the case of the Passaic River Basin, the urban cores are New York City, and to lesser extents, Hudson County and Newark, which border the Basin. Smaller urban cores, such as Paterson and Passaic, generate their own patterns of development, as do Central Basin towns to the west, such as Morristown, although to lesser degrees.

Before World War II, a vast majority of the Northeast's population was urban-oriented. Industry and commerce, and jobs, were located in the cities. Large-scale commutation from suburbs was limited by a poor highway system. Suburbanization was confined to a few commuter rail corridors, and most of this development was close to urban cores.

After World War II, the baby boom and limited housing in the cities provided the impetus for suburban residential expansion. The growing importance of the automobile and continuing expansion of the highway system opened outlying areas for development.

The impact of this suburbanization in northeastern New Jersey was dramatic. Development moved progressively away from the urban centers. Cities, such as Newark, lost not only population, but parts of their economic and social vitality as well. Many of the older suburbs in close proximity to the core areas underwent extensive redevelopment and were transformed into essentially high-density urban areas. Farther out, development occurred along major highways, with the greater density development occurring closer to the New York City-Hudson-Newark cores, and the secondary urban centers.

Suburban development in the Passaic River Basin is characterized by low-density residential, commercial, and industrial land use, with residential use representing a major portion of the suburban development. This development has been almost exclusively single family homes, ranging from one-eighth acre subdivisions in the older eastern suburbs to one and two acre (and larger) lot zoning in many towns in the Central Basin and Highland area.

Commercial activity is automobile-oriented, occurring in strip development along major highways and clustered around the intersections of major routes.

Industry has been attracted to the suburbs by the availability of cheaper land and the subsequent feasibility of modern low-rise facilities with immediate access to major highways. Another trend has been the growing acceptance and prestige of suburban locations as sites for corporate offices and research facilities. These operations can often locate on land unsuitable for other types of development. The extensive relocation of commerce and industry, and the jobs they provide to the suburbs, have made commutation feasible from new residential suburbs.

POPULATION

The 1950 population of the Passaic River Basin was approximately 1.8 million, with nearly one-quarter of them, some 439,000, residing in Newark, New Jersey's largest city. The average population of each municipality was more than 14,000. Over the next 10 years, the Basin population increased by about 20% to more than 2.1 million (see Table 3). The 1960 Newark population was down nearly 8% to 405,000.

TABLE 3

POPULATION CHARACTERISTICS
PASSAIC RIVER BASIN STUDY AREA COUNTIES

COUNTY	1/ 2/ 1950	1960	1950-1960 % Change	1970	1960-1970 % Change	1980	1970-1980 % Change	1950-1980 %Change
BERGEN	294,455	431,882	47	505,746	17	467,905	-7	59
ESSEX	804,411	824,014	2	828,340	.5	750,144	-9	-7
HUDSON	55,615	51,087	-8	51,318	.4	49,900	-3	-10
MORRIS	155,292	248,537	60	357,676	44	367,292	3	137
PASSAIC	337,123	406,618	21	460,782	13	447,585	-3	33
SOMERSET	15,359	20,621	34	29,329	42	59,292	102	286
SUSSEX	5,848	11,078	89	20,377	84	34,188	68	485
UNION	21,309	42,641	100	50,494	18	46,046	-9	116
ORANGE	26,184	29,664	13	42,269	42	56,446	34	116
ROCKLAND	60,975	60,435	-.8	114,717	90	169,238	48	178
TOTAL	1,776,571	2,126,577	20	2,461,048	16	2,448,036	-.5	38

1/ County population totals are for communities within the Passaic River Basin.

2/ Population data for 1950 is available for 123 of the 132 communities in the Basin.

During the 1960's, the Basin's population grew by some 16% to a 1970 total of 2.5 million. This increase was higher than the National growth rate of 11.7%. New York State's growth over the same period was 8.7%, and New Jersey overall increased its population by more than 18%.

In the 20 years from 1950 to 1970, a gain of almost 700,000 people Basinwide represented a 39% growth rate. The populations of the typical basin municipality increased by about 35%, to an average of 19,000.

During the next 10 years, the Basin's population remained relatively stable. The 1980 Census showed a 0.5% population decrease, a loss of some 13,012 persons. The largest population gains during the period 1950 to 1980, were experienced by rapidly developing municipalities in Morris and Rockland Counties, and in the northern and western sections of Bergen and Passaic Counties.

While suburban areas experienced significant growth during the two decades, most of the older, central cities and built-up suburbs either lost population or remained relatively stable. Of the five largest central cities in the Basin, four experienced population losses and one gained during this period. Newark showed the largest absolute decline, from 439,000 people in 1950 to 329,000 in 1980 (-25%). The precipitous decline of Newark in relation to the growing Basin can be seen from the fact that it had 25% of the Basin's population in 1950 but only 14% in 1980. The City of East Orange also lost population, declining from approximately 79,000 in 1950, to 77,000 in 1980, as did the City of Passaic, whose population decreased from 57,700 to 52,500 (-9%) over the three decades. Paterson, decreased its population 1% from 139,000 to 138,000 while Clifton's population grew by more than 15%, from 64,500 to 74,400.

Based on 1980 population densities, the Basin's municipalities are primarily "suburban" or "suburban/urban" in character. Some 70 municipalities, 53%, are classified as suburban. The man population density among this group is about 1,000 persons per square mile. More than half of the suburban municipalities are found in Morris and Bergen Counties, including Denville and Riverdale in Morris and Woodcliff Lake and Upper Saddle River in Bergen County. A total of 47, or approximately 36% of all the basin's municipalities, fall within the suburban/urban category, exhibiting a mean density of about 5,000 persons per square mile. Bergen County contained nearly 37% of all such communities, including Rochelle Park, Saddle Brook, and Waldwick. A number of communities in Essex and Passaic Counties achieved this density level.

The Basin's 13 urban municipalities account for about 10% of the Basin's communities. They have a mean density of 14,080 persons per square mile. These urban municipalities are generally older communities, such as Newark, Paterson, and Garfield. Only two communities are considered rural.

PERSONAL INCOME

Based on 1980 data, the average per capita income per municipality in the Passaic Basin was approximately $9,735. This is above the $8,127 per capita income of municipalities in New Jersey, $7,498 in New York State, and $7,298 in the entire United States. Table 4 presents 1980 per capita income census data and future projections for the four Standard Metropolitan Statistical Areas (SMSA's) that cover portions of the Passaic River Basin.

1980 figures also show that the median family income average for the 132 Passaic Basin municipalities runs $28,892. Again, this indicator is higher than the median family incomes for New Jersey -- $19,800, New York State -- $16,647, and the entire U.S. -- $16,841.

The Basin's 1980 maximum median family income was $49,484 in Mountain Lakes, a municipality of some 4,150 people. A total of nine Basin municipalities had median family incomes of more than $40,000.

At the other end of the scale, Newark reported the Basin's lowest median family income of $10,118. Several other municipalities had median family incomes under $15,000, including older, urban centers such as Paterson, Passaic, East Orange, and Orange.

HOUSING

The lower Passaic River is the oldest and most densely developed area of the Basin, containing and receiving the primary influence of its older urban centers, Newark, Passaic and Paterson. High density multi-family housing predominates, with low income and minority groups constituting a large proportion of the populations.

The area from Newark up to Paterson is almost completely developed. It contains many other older suburbs that, because of their proximity to the cities, were redeveloped at higher densities. The houses are primarily single family or two family. Near the river and along the major thoroughfares are pockets of high and low-rise apartments and scatterings of urban renewal projects. Most of the housing in the area, except for Clifton, is more than 40 years old.

TABLE 4

Per Capita Income Projections
(in actual dollars)*

SMSA	(Census Data) 1980	1990	2000	2030
5600: New York, New York-New Jersey	7,905	8,109	9,941	16,998
6040: Paterson-Clifton-Passaic, New Jersey	7,214	7,522	9,107	15,624
5640: Newark, New Jersey	8,680	8,632	10,481	18,048
3640: Jersey City, New Jersey	6,476	7,413	9,022	15,567

*Derived from 1980 OBERS population and personal income projections, no-change-in-share series.

The Central Passaic Area may be characterized as almost completely suburban. Densities range from two to four dwelling units per residential acre in the outer suburban eastern rim and older towns, such as Morristown and Boonton, to less than two dwelling units per residential acre in the rural/suburban western section, where zoning ranges from one-half to 10 acres. The single family house is the predominant housing type. However, garden apartments have increasingly appeared along major automobile routes, and the eastern towns of Wayne, Livingston, and others have several large apartment complexes.

LAND USE AND TERRESTRIAL RESOURCES

Land use data for the Passaic River basin is summarized in Table 5 and depicted on Figure 7. Land use for the Central Basin and Lower Valley portions of the study area are discussed in the paragraphs below. Land use in the Central Passaic Basin area is almost completely suburban, with the single family unit the predominant housing type. There are several large apartment complexes in the area, and garden apartment developments have increased along major roads. Much of the Central Basin serves as a large bedroom community to the Newark-Paterson core and to New York City.

The Central Basin reflects a trend in the movement of business and industry to the suburbs. Major highways linking the area to the urban complex are lined with individual businesses and shopping centers in strip development.

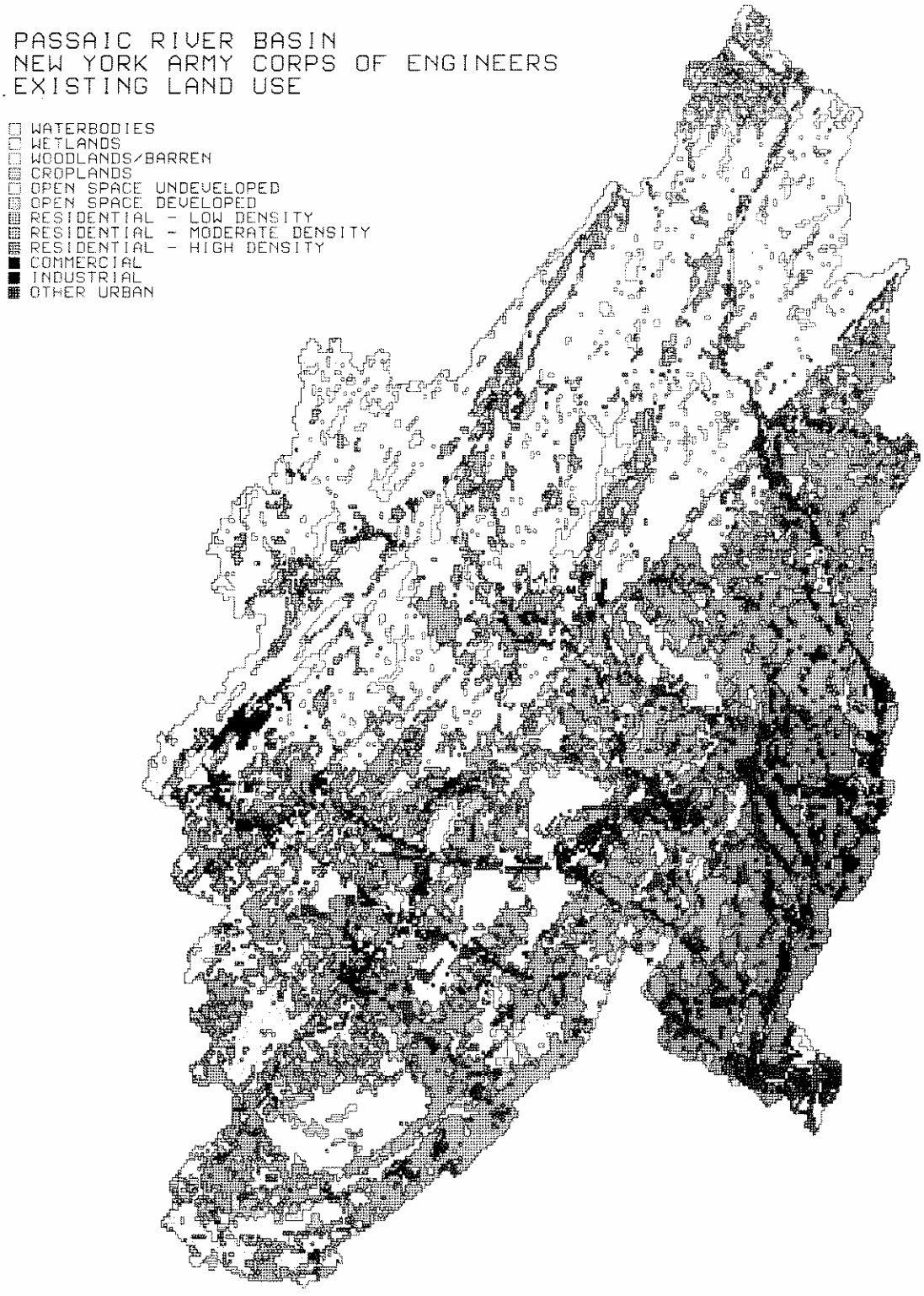
Central Basin municipalities, especially those along the eastern edge, have experienced rapid growth, and development pressure is expected to continue. Large amounts of vacant, developable land exist in this area, even in the established municipalities. Past development has, to a large extent, paralleled transportation corridors, and many areas not adjacent to highways are unused.

Wetlands predominate the Central Basin's open space, although other types of open land are found. Approximately 24,100 acres are wetlands. The major wetlands are: Troy Meadows in Hanover, East Hanover and Parsippany-Troy Hills; Black Meadows in Hanover, East Hanover and Florham Park; Bog and Vly Meadows in Montville and Lincoln Park; Great Piece Meadows in Lincoln Park, Fairfield and Montville; Hatfield Swamp in West Caldwell, Fairfield, Roseland, East Hanover, Montville and Parsippany-Troy Hills; and the Great Swamp in Harding, Chatham Township and Passaic Township (see Figure 61 in Chapter 6). An area of unnamed wetlands is also located along the Passaic River in Florham Park, East Hanover, Livingston, Chatham and Millburn. These wetlands provide valuable habitat for flora and

TABLE 5
EXISTING AND FUTURE CONDITIONS
EXTENT OF DEVELOPMENT
PASSAIC RIVER BASIN COUNTIES

COUNTY	TOTAL ACRES IN BASIN	ACRES DEVELOPED 1/ 1978	1990	2040
BERGEN	74,130	51,821	53,006	55,666
ESSEX	56,729	43,274	45,676	47,728
HUDSON	4,215	3,037	3,422	3,422
MORRIS	201,290	82,610	93,936	96,051
PASSAIC	121,714	51,480	55,205	57,767
SOMERSET	24,214	10,403	13,003	14,252
SUSSEX	14,648	703	3,303	4,214
UNION	7,603	4,916	4,928	5,233
ORANGE	59,863	8,864	17,280	31,326
ROCKLAND	35,741	11,282	15,532	24,985
TOTAL	600,147	268,930	305,291	340,644

1/ DEVELOPED AREAS INCLUDE:
RESIDENTIAL, COMMERCIAL, INDUSTRIAL AND
OTHER URBAN AND INSTITUTIONAL LAND USAGE



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EXISTING LAND USE

FIGURE 7

fauna, and significant natural storage for floodwaters. These wetlands constitute a set of habitats whose plant and animal communities are different from the typical upland areas of northern New Jersey. With the exception of the Great Swamp, which is protected through Federal government ownership, and portions of Tory Meadows protected by Morris County, these wetlands will be subjected to intense development pressure.

Land use in the Lower Passaic River floodplain, the oldest and most densely developed section of the Basin, is dominated by high-density commercial and industrial and commercial development. The area from Paterson down to Newark is almost completely developed with primarily single family or two family houses. In the cities, high-density, multiple-family housing predominates.

Both Newark and Paterson have large central business districts with smaller neighborhood districts centered throughout at major street intersections. Outside of these two types of centers, commerce is in the form of small central business districts in the smaller cities, and strip development along major roads. Large shopping malls have been built along the radiating arteries to the north of Paterson.

Almost all wetlands in the Lower Valley area have been eliminated, with more than 7,500 acres developed since 1940. There are only a few remnant pockets of wetlands to be found along the lower Passaic River.

Despite the preponderant urban and industrial land use in this area, some habitat types still remain to enhance otherwise limited urban wildlife species. The remnant riparian wetland strands, upland habitat areas and linear riverside parks support some urban wildlife, such as raccoon and oppossum. Habitat diversity in the Little Falls ravine, and about one-half mile above and blow the Great Falls also add to habitat and species diversity. Estuarine and riverine wetlands at the mouth of the river provide some habitat for limited numbers of anadromous fish.

WATER QUALITY

The Passaic River Basin is the most urbanized large river basin in New Jersey, and its waters are subject to many competing uses. Although the Main Stem Passaic River and its tributaries are limited recreational and agricultural resources, principal uses are as a major source of public and industrial water, and as a disposal system for municipal and industrial

wastewater. As a result, the quality of water in the Passaic River and its tributaries is generally poorer in their downstream reaches. Average water quality measurements of the Passaic River and its tributaries are presented in EIS Table 12.

The central and lower Passaic River in the affected flood damage area is considered to have serious water quality problems. The water quality is rated very poor in both the freshwater regime above Dundee Dam, and below it in the saline tidal reach.

The poor water quality in the Central Passaic is caused by lower dissolved oxygen and biological oxygen demand, nutrients, ammonia and fecal coliform. While higher quality water from the Pompton River improves the quality of Passaic River water at the confluence, lower Passaic River water is also of very poor quality. The downstream quality is impacted by 89 private discharges, 20 of them industrial. Throughout the project area, the density of industrial development and associated land uses also generates 10 mgd of domestic and process water from 22 sewage and wastewater treatment facilities. These discharges combined with poor upstream water quality and non-point runoff cause severely degraded water in the Lower Passaic.

Federal fishable and swimmable goals set forth in Section 208 of the 1972 Clean Water Act are not met throughout the Passaic Basin. The effluents of some 100 New Jersey permitted point pollution sources enter the area affected by the project. These point sources discharge approximately 122 mgd, which is abut 16% of the Passaic River average flow, and 820% of the low flow. The Peckman River, a minor tributary which enters the Passaic River at West Paterson, is an important contributor to the Main Stem Passaic's poor water quality.

The lower Rockaway River, below Boonton Reservoir, is considered moderately polluted; while the lower Whippany River has a fair to poor water quality rating.

The water quality of the Pompton River Basin and its tributaries is of the highest quality in the Basin, rating from good to fair. Despite effluent discharges from 11 permitted point sources, the Pompton River assimilates these flows and its waters are generally above New Jersey water quality standards. Above the Pompton, the Pequannock River is good to fair, and its tributary Wanaque River is generally above State standards. These ratings are attributable to limited upstream development and minimal point source pollution. These are also the reasons why the Ramapo River has good water quality. The Ramapo's isolated water quality problems are caused by non-point source runoff.

The Saddle River suffers from water pollution problems similar to those in the Lower Passaic, and it contributes poor quality water to the severely degraded Passaic River.

The quality of groundwater resources is good, although limited long-term records shown increases in all levels of contaminants. Increased urbanization in the Basin is the ultimate cause of low level groundwater contamination, evidenced by increases in sulfates, nitrates, total dissolved solids and hardness. The large aquifer underlying the Central Basin area in western Essex and southeastern Morris Counties has been designated as a sole-source aquifer. This designation provides for U.S. Environmental Protection Agency review of any Federally funded project that may impact the aquifer.

AQUATIC RESOURCES

A stressed warmwater fishery regime is found in the Central Passaic River. It supports a pollution-tolerant community. The composition of this fishery is dominated by rough and forage fish and lacking in predatory game fish, and is indicative of a stressed ecosystem. The same is true of the lower Whippany and Rockaway River.

The Pompton River supports a better warmwater fishery, as water quality is better here and in the Pompton tributaries than elsewhere in the study area. The lower Pequannock fishery is unbalanced, while the lower Wanaque has a good warmwater fishery, and there are indications that it has a holdover marginal coldwater fishery. The lower Ramapo supports a relatively limited but balanced fishery. It is characterized as fair. The Pompton Valley is the location of a State of New Jersey trout stocking program.

The aquatic habitat of the lower Passaic River is unobstructed with dams from Newark Bay upstream to Dundee Dam. Within this reach of the river, there are two different types of aquatic habitat. From Newark Bay, the Passaic River is considered estuarine for more than 8 miles up to the Rutgers Street Bridge in Belleville, and riverine (freshwater) from that point up more than 9 miles to Dundee Dam. Upstream of Dundee Dam, for approximately 12 miles to Beatties Dam, the riverine aquatic habitat is punctuated by man-made and natural structures.

In the freshwater portion, the Passaic River is a pollution stressed warmwater fishery. In the tidal reach, there are an abundance of rough pollution tolerant fish. However, a persistence of game fish is an indication that the fishery has not shifted totally to rough fish composition, with some of the species providing a recreational fishery.

Fish sampling in the tidal lower Passaic River and its tributaries has shown the presence of ripe (ready to spawn) anadromous fish species. Juvenile anadromous species have been captured in the Passaic River Main Stem and in lower portions of the major tributaries. EIS Figure 13 presents the locations of anadromous fish sampling sites. These samples indicate successful anadromous fish spawning.

FUTURE WITHOUT PROJECT CONDITIONS

The most probable future conditions, without a flood control project, reflect a strong continuing development trend which would worsen already severe flood conditions and cause large increases in expected annual flood damages. Geographic and socioeconomic factors are favorable toward continuing economic growth trends in most of the Passaic River Basin's service area counties. It is estimated that almost half of the municipalities in this area will develop into suburban-urban areas by 2040. Under a non-action, or without project condition, land development in the drainage area will cause flood events to become more frequent and severe. Increased growth and development will affect the hydrology, hydraulics and water quality of the basin, impacting aquatic and terrestrial resources and increasing flood frequencies and damages.

The future without project conditions have been projected to the year 2040, and are based upon available data and information obtained form various Federal, State and local agencies.

FUTURE POPULATION

Projections of future conditions in the Passaic River Basin give all indications that the future will essentially be an extension of the last three decades. The major trends that developed toward the end of World War II, and were first measured in 1950, are expected to continue.

Population, a most significant indicator of change, will increase substantially by the year 2040, adding some 800,000 people over the period 1980 to 2040. Population declines in some of the older cities,such as Newark and East Orange, are expected to reverse themselves by the year 2000. The overall Basin-wide growth will occur in the same counties that experienced high growth rates in the preceding three decades. Those include Morris, Somerset and Sussex Counties in New Jersey and Rockland and Orange Counties in New York. The older, more populous and urbanized counties such as Union, Essex, Hudson and the central and southern portions of Bergen will remain fairly stable, or grow moderately.

Population density will rise in direct proportion to the total population, both increasing by about 33% over the 60-year period from 1980 to 2040. The overall density in the Basin will increase from 4,000 persons per square mile in 1980, to more than 5,300 in 2040.

FUTURE LAND USE AND TERRESTRIAL RESOURCES

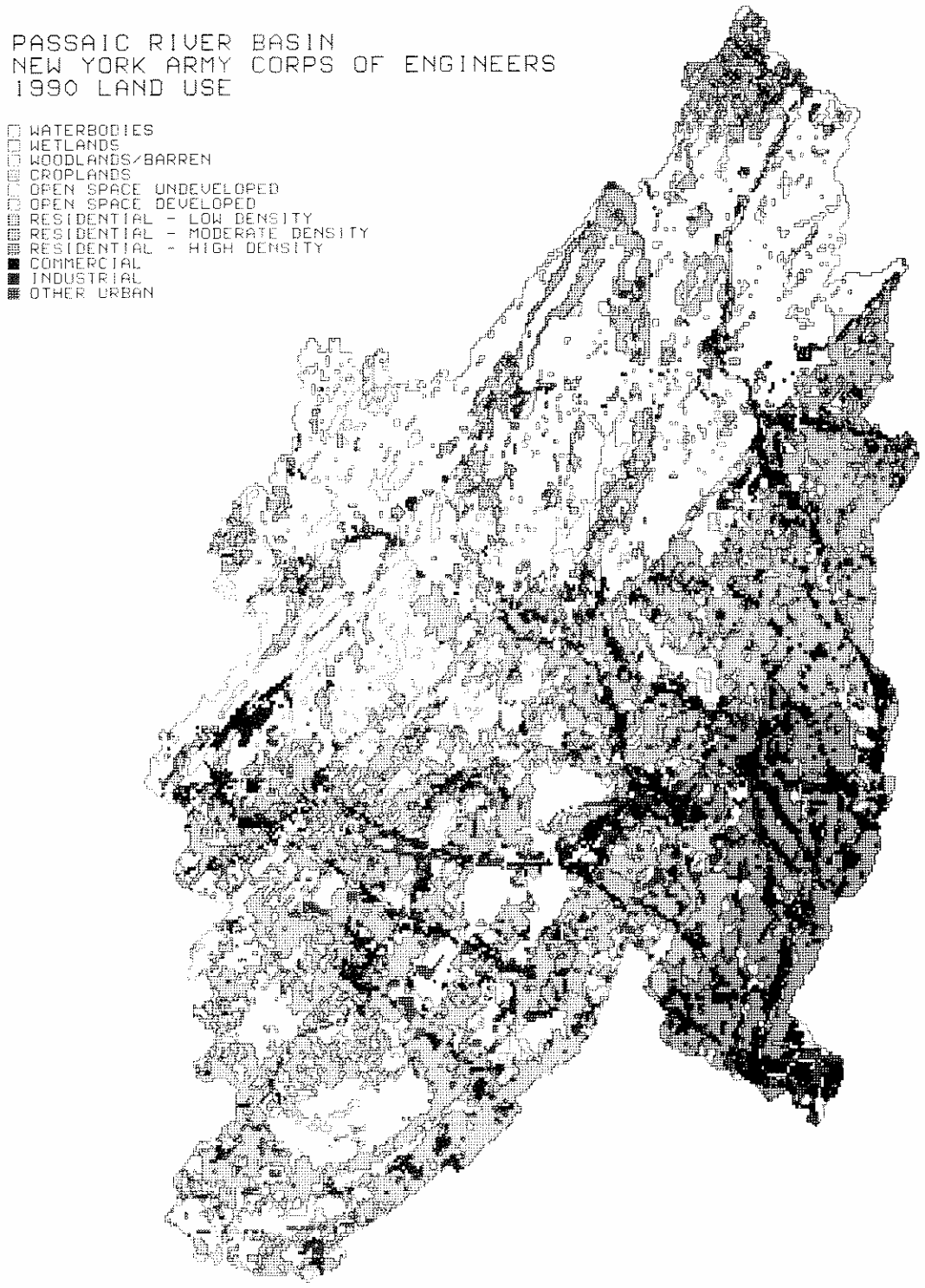
The suburban Central Basin area, with its large, open land areas including three major Passaic Basin wetlands, will suffer the most severe land use change under future without project conditions. The current development pressures for both residential and industrial/commercial uses will continue. It is projected that an additional 8,620 acres of natural storage areas, mostly wetlands, will be at risk for inclusion in development plans by 2040. The extensive development which occurs will severely alter drainage patterns, resulting in decreased infiltration into the groundwater supply, increased runoff, and decreased flood storage. Additional development will also take place upstream in the Highland Area, creating runoff problems that will add to the flooding in the Central Area. This intensification of the Central Basin flood problem will also cause increased downstream flooding because of the flood storage losses in the wetlands.

In the Lower Valley Area, because of its current high-intensity commercial, industrial and residential land use, very little open area remains. No significant land use or drainage changes are anticipated in the foreseeable future.

Figures 8 and 9 depict the watershed's land use for the years 1990 and 2040.

FUTURE WATER QUALITY

In the future, some water quality characteristics, such as dissolved oxygen, biological oxygen demand and nutrient levels, may show localized improvement because of anticipated increased control and treatment, as a result of the Clean Water Act, of municipal wastes being discharged into Passaic River Basin streams. However, expected residential and commercial development will increase the transport of sediments and contaminants into the Passaic River system. Further land development will also increase the magnitude and frequency of floods, increasing the resuspension, transport and deposition of sediments into the floodplain. Increases in non-point pollution from increased development will maintain the general poor quality of Passaic River water.



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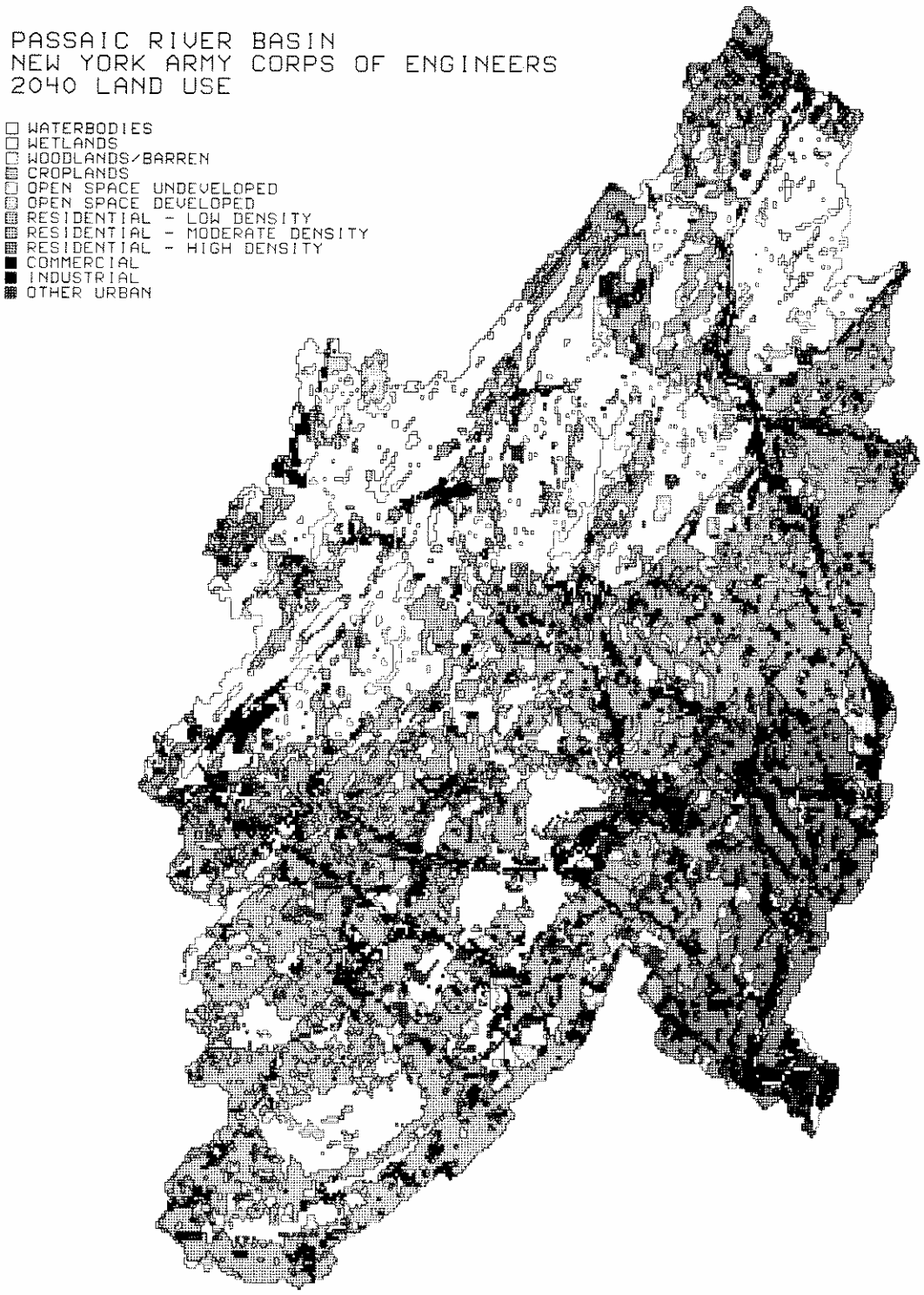
1990 LAND USE

FIGURE 8



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2040 LAND USE

FIGURE 9

FUTURE AQUATIC RESOURCES

The future diminished water quality situation and increased land development pressures will stress aquatic resources. Fisheries will be negatively impacted because of poorer water quality, and the loss of aquatic habitats.

The lower Passaic River is currently inhabited largely by pollution tolerant fish species, and it is anticipated that fish requiring better quality water will continue to be excluded from these lower reaches. The connection of the lower Passaic River and its tributaries to Newark Bay and the Hudson River/New York Bay estuary, and the existence of fresh or nearly freshwater habitats at the upstream end of this reach, is an aquatic system which as potential for supporting the reproduction of anadromous fish. Anadromous fish species are returning to the Passaic River in increasing numbers. Improving water quality and increases in spawning habitat would improve and create the anadromous fishery. However, a lack of extensive habitat and poor water quality will limit this.

In the Upper Passaic River and tributaries, there are a variety of fish species that could extend their ranges back into the Central Passaic River only if mainstream water quality improves. It is anticipated that there will not be sufficient water quality improvement to bring about the spread of these species.

Fisheries in the Whippany and Rockaway Rivers will basically remain the same, because better quality point source problem inputs will be offset by increases in non-point source runoff. The fishery's warmwater characteristics will persist.

The warmwater fisheries of the Pompton River will be maintained if there are no increases in effluents which degrade the waters. This should allow for the maintenance of a moderate range of rough, forage, game and panfish species. Continued development will cause a loss of riverbank forest, increasing water temperatures and decreasing the already marginal suitability of the Pompton River for coldwater species.

The presently rich warmwater fishery of the Pequannock River should not be disturbed by development reducing riverbank shading. However, the river will become less suitable for coldwater species such as trout. The same is true of the Wanaque River.

The Ramapo River will be impacted by little development as most of the land outside the floodway is already developed. Little change is anticipated here.

CHAPTER 4. THE FLOOD PROBLEM

Residential and industrial development and economic growth in the Passaic River Basin have created numerous water and related land resources problems and needs, including a major long-term flood problem, recurring shortages of available potable water supplies, and widespread water quality problems.

A comprehensive list of the problems and needs of the Passaic River Basin is presented in Table EIS-3. These issues were examined in order to establish their relationship with the Corps' traditional purview for water resource problems and the specific Congressional mandate for this study. Based upon this review, problem and opportunity statements for this study area were developed. The final problem and opportunity statements are presented in Table EIS-4. These statements were modified continuously during iterations of the planning process to reflect the availability of more specific data.

This Main Report focuses on the principal problems and need addressed by this study, i.e. the reduction of tidal and fluvial flood damages at areas along the Passaic River mainstream and its tributaries. The remaining problems and needs of the Passaic River Basin which were addressed as part of this study are documented in the Plan Formulation Appendix.

Flooding throughout the Passaic River Basin has been recognized as being among the most serious flood problems on the East Coast. The Passaic Basin includes portions of the most densely developed metropolitan area in the country, and its flooding has often been characterized as politically unsolvable. The Basin contains nearly 2.5 million residents, and its floodplains include some 48,000 residences and places of business.

The Basin's history of severe flooding stems from its location in the East Coast stormbelt, and heavy residential and industrial growth that have led to the development of floodplain lands. While frequent major flooding has occurred along Passaic River tributaries, the last significant flooding throughout the Basin occurred in April 1984.

FLOOD DAMAGES

Flood damages in the Passaic River Basin are caused by both fluvial and tidal flooding. Significant damages are caused by the impact of floodwaters on a wide variety of extensive development -- ranging from large industrial and commercial establishments to single-unit family dwellings on one-half to one acre, and larger, plots. High dollar damages result from

physical damages to buildings and their contents; flood-caused reductions in commercial, industrial and economic activity; limitation placed on the uses of property because of the threat of flooding; impacts of flood-related interruptions in road, rail and air transport on business and interstate commerce; and finally, losses in quality of life caused by the stresses of living and working in a flood prone environment.

Flooding is almost an accepted way of life in much of the Passaic River Basin. Expected annual flood damages in the Basin are estimated at about $84 million (Table 6). The flood damages in Table 6 and the benefits for alternative plans presented later in this report exclude data for the sub-basins considered in interim studies. Flooding occurs annually along the Central Passaic River above the Pompton River confluence, and in the Pompton Valley. Floods of an average 10-year frequency occur along the tidal lower Passaic River.

FLOOD PRODUCING CHARACTERISTICS

There are three regions in the Passaic Basin -- the Highland Area, the Central Basin Area and the Lower Valley, which have distinct topographic features and distinct hydrologic characteristics which produce different types of flooding. Streams in the Highland Area are the Basin's greatest flood producers; however, the flooding occurs downstream in the Central Basin Area. The Highland Area's northern tributaries, the Ramapo, Wanaque and Pequannock Rivers, join to form the Pompton River, the Passaic Basin's greatest producer of extreme floods. Although flood peaks are attenuated somewhat because of lake and reservoir storage in the Highlands and natural storage in the Pompton Valley, the Pompton River flood peak reaches the Passaic River at Two Bridges from 40 to 50 hours earlier than the peak coming down the Passaic. The tributaries in the southern Highlands, the Whippany and Rockaway Rivers, are far removed from the confluence, and the timing of their peaks is such that they do not significantly influence major flooding. The vast natural storage in the Central Basin Area also diminishes their impact on the flood peaks.

Flooding along the Passaic River upstream of the Pompton confluence is caused by the naturally shallow and narrow rock gorge channel from Two Bridges down to Little Falls. This gorge constricts flows down into the Lower Valley and backs Pompton River flows up the Passaic River into the Great Piece Meadows. The combined Pompton and Passaic River flows, which represent the total Passaic Basin drainage above Two Bridges, raises water levels in the Meadows. This natural flood storage retards flood peaks and significantly reduces flooding in the Lower Valley.

TABLE 6

TOTAL EXISTING CONDITIONS EXPECTED ANNUAL DAMAGES[1/]
(OCTOBER 1985 PRICE LEVELS; $1,000'S)

	RES	APT	COM	IND	UTL	RESCON	APTCON	MUN	TOTAL[2/]
LOWER PASSAIC	2,770	200	4,140	16,390	790	1,090	50	4,580	30,010
CENTRAL PASSAIC	4,960	40	9,910	4,550	80	1,870	10	3,430	24,850
UPPER PASSAIC	260	0	150	30	10	90	0	90	630
POMPTON RIVER	9,010	220	6,330	1,760	180	2,930	90	3,280	23,800
PEQUANNOCK RIVER	260	0	4	0	0	100	0	50	410
LOWER RAMAPO RIVER	2,500	0	170	4	1	700	0	510	3,880
WANAQUE RIVER	270	2	70	7	0	90	1	60	500
TOTAL[1/]	20,030	460	20,770	22,740	1,060	6,870	150	12,000	84,080

1/ FIGURES HAVE BEEN ROUNDED AND, THEREFORE, MAY DIFFER FROM THOSE IN ECONOMICS SUPPORTING DOCUMENTATION.

2/ TOTALS MAY NOT MATCH DUE TO ROUNDING.

The Lower Valley is also subjected to fluvial flooding from its short flashy tributary streams, which peak much earlier than the Upper Passaic River. Downstream of Dundee Dam, flood stages are also affected by tidal action.

CLIMATE

The Passaic Basin climate is characteristic of the entire Middle Atlantic Seaboard, where marked changes in weather are frequent, particularly in the spring and fall. Winters are moderate with moderate snowfall. The Basin also experiences moderate summers, with hot-sultry, mid-summer days and frequent thunderstorms. Rainfall is moderate and distributed throughout the year. There are an average of about 121 rainy days per year. Relative humidity is high. Average annual temperatures range from 49 degrees Fahrenheit (F) at Charlotteburg to 54 degrees F at Newark; with extremes from -26 degrees F to +108 degrees F. The growing season averages some 171 days a year. Mean annual relative humidity varies from 67% to 73%. Prevailing winds are from the northwest, with an average annual velocity of about 9.7 miles per hour.

PRECIPITATION

The Passaic Basin's average annual precipitation is approximately 47.3 inches. The observed extreme annual values were 85.99 inches at Paterson in 1882, and 25.26 inches at Morristown in 1930. The monthly extremes were 25.98 inches in September 1882 at Paterson, and .02 inches at Plainfield and Jersey City in June 1949. The distribution of precipitation throughout the year is fairly uniform with higher amounts occurring during the summer months.

SNOWFALL

The Passaic Basin's approximate average annual snowfall of about 34.2 inches is equivalent to about four inches of rainfall. The longest snow season is in the Highland Area, where it runs from October through mid-April.

STORM TYPES

The storms which affect the Passaic River Basin can be characterized as tropical and extratropical events. Tropical storms arise in the tropics, and hurricanes are the most severe, but not the most common, storms of this type. Extratropical storms are generally caused by the interaction of a warm front and a cold front. Thunderstorm activity is the frequent result

of this interaction, which can also cause storms of much greater areal extent, such as Northeasters. The season for tropical storms runs from June through November. Thunderstorms are most likely to occur in the summer, and Northeasters from November to April.

MOST SEVERE STORMS

The storms, which caused the most flooding in the Passaic River Basin, were:

September 1882. The September 20-24 storm was the greatest recorded over the Passaic River Basin, prior to the storm of October 1903. An extratropical event, it resulted in a total maximum rainfall at Paterson, N.J., of 17.9 inches, of which 11.4 inches occurred in 24 hours. The average rainfall over the Passaic River Basin was about 9.2 inches. The storm was preceded by light rainfall during the months of July and August. It was less extensive than that of October 1903, and its destructive effects were generally confined to the Passaic Basin.

February and March 1902. This storm, a typical winter event of low intensity, consisted of over six days of heavy snow and sleet in February, followed in early March by moderate rains and a general rise in temperature. It is estimated that a total of 6.2 inches of rain and snow melt occurred over the Passaic River Basin. The maximum (water equivalent) precipitation recorded in 24 hours was 3.30 inches at Hanover, N.J., and 3.03 inches at Paterson, N.J.

October 1903. This October 7-12 storm, one of the worst in Northern New Jersey, occurred following three months of excessive rainfall which had saturated the ground and raised groundwater levels throughout the Passaic River Basin. This extratropical storm was comparatively widespread but centered over Paterson, N.J., where a total of 15.5 inches of rain was recorded. The greatest intensity occurred during the night of October 8-9, when over 75% of the rain fell. A maximum one day rainfall of 11.4 inches was recorded at Paterson. The total average rainfall over the Passaic River Basin was about 11.4 inches.

March 1936. This March 9-22 extratropical type storm had separate centers over the Ohio River and Connecticut River watersheds. Intense rainfall on 11-12 March fell on a heavy snow cover resulting in damaging floods throughout the northeastern states. The average precipitation over the Passaic Basin was 11.1 inches, of which 6 inches was rainfall and 5.1 inches was the water content of the snow cover. A daily maximum rainfall of 2.6 inches was recorded at Paterson, N.J.

September 1938. These September 16-23 storms comprised a complex series of events ending with a major hurricane. They resulted in heavy rainfall over a widespread area with the center of maximum precipitation over Connecticut and Massachusetts. The average total rainfall over the Passaic watershed was 7 inches. A maximum daily rainfall of 2.3 inches was recorded at Paterson, N.J.

July 1945. This July 15-23 extratropical storm consisted of six days of moderate rainfall followed by about 15 hours of heavy showers on July 22 and 23. The storm was centered over the eastern edge of the Passaic Basin, with a maximum of 14.7 inches at Midland Park, N.J., and 14.6 inches at Suffern, N.Y. The heavy showers were localized and spotty, resulting in flash floods on many small streams in and near the Passaic River Basin. The maximum daily rainfall recorded in the vicinity was 7.6 inches at Little Falls, N.J.; 2.4 inches of rain fell at Wanaque, N.J., in the last three hours of the storm. Some 3.5 inches fell at Spring Valley, N.Y., in five hours after midnight of July 22. An average total of 8.5 inches of rain fell on the Passaic River Basin.

August 1955. The storm of August 11-16 was preceded by hot, dry conditions over New Jersey and New York, which resulted in drought conditions. On August 3, a tropical low which developed into Hurricane Connie was first detected in the Mid-Atlantic Ocean east of the Windward Islands. Moving slowly northwestward, it entered the mainland near Cape Lookout, N.C., on August 12. The storm then moved up the Chesapeake Bay, and northward through central Pennsylvania. The hurricane winds diminished and the storm passed over Central New York on August 14. As a low pressure mass, Connie deposited 4 to 12 inches of rain over eastern Pennsylvania, southeastern New York and northern New Jersey. During this period, rainfall over the Passaic River Basin ranged from 11.5 inches to 5.6 inches with an average of more than 8 inches. These rains filled many small, depleted reservoirs and saturated the soil, resulting in conditions conducive to the disastrous floods following the heavy rains of Hurricane Diane which struck the area only five to six days later.

A second storm on August 17-20, occurred when Hurricane Diane, with greatly diminished winds, passed about 60 miles west of Washington, D.C. on the morning of August 18 and turned northeastward to pass between Harrisburg and Philadelphia that evening. The center moved eastward across New Jersey during the night, and on the morning of the 19th was centered a short distance south of central Long Island. From there it moved east-north-east between Martha's Vineyard and Nantucket. The storm accelerated to produce excessive rains over Pennsylvania,

New York, New Jersey and New England on the 18th and 19th. The maximum daily rainfall was 4.3 inches at Paterson, 4.8 inches at Wanaque Dam, 6.2 inches at Canistear Reservoir, and 4.8 inches at Suffern, N.Y. Average rainfall over the Basin was 5 inches.

October 1955. The storm of October 14-18 was preceded by a cold front which moved into eastern Pennsylvania and southern New York on the morning of October 13 and became stationary, with a coastal wave moving northward accompanied by moderate to heavy rains on October 14 and 15. The center drifted slowly northward bringing abundant rains which continued in the northeast through the 16th. Concurrently, an extratropical cyclone from the Carolinas to New York brought high winds up to 57 m.p.h. on October 14. These winds were accompanied by heavy rainfall extending through October 17. The system finally drifted eastward and the rains ceased on the 19th. Average rainfall over the Passaic River Basin was about 5.5 inches.

September 1960. On September 11 and 12, Hurricane Donna moved northeastward off the Jersey coast and damaging winds, heavy rains and high tides struck the coastal areas of the state. Winds gusting up to 100 miles per hour swept the coast. Average rainfall over the Passaic River Basin was about 4.5 inches.

May 1968. On May 27 and 29, two small low-pressure disturbances formed in the Cape Hatteras area and moved into the Delaware Bay area. The forming of the second low pressure system extended heavy rainfall from north of New York City through the Hudson Valley and into Massachusetts. The storm event extended through May 30 and 31. The maximum recorded precipitation of nearly 8 inches in the Passaic River Basin occurred at Canoe Brook, with an average rainfall over the basin of 6 inches.

August 1971. On August 27, the center of Tropical Storm Doria passed from Delaware Bay and moved northward through the central part of New Jersey on the 28th. From New Brunswick, the storm passed over Newark, then across the Hudson River into southeastern New York State and Connecticut. Excessive rainfall occurred over New Jersey for 24 hours just prior to Doria. The communities hardest hit by Doria were outside of the Passaic Basin, and three deaths by drowning were attributed to the storm. Average rainfall over the Passaic River Basin was approximately 8 inches. The total rainfall at Newark was 8 inches, at Mahwah, 8.3 inches, and at Canoe Brook, 9.2 inches.

November 1977. An extratropical storm travelled into the New Jersey coast on November 6. Strong east winds with speeds of 50 m.p.h. were experienced at the shore on November 7, then decreased on November 8. Rain began on the evening of November 6 and continued into the afternoon of November 8. Heaviest rainfall was in the northeastern part of the State, where 2 inches fell on the 7th followed by 8 inches or more on the 8th. The average total rainfall over the Passaic River Basin was approximately 5.5 inches, with 8.3 inches at Newark, 6 inches at Mahwah, and 4.1 inches at Bernardsville.

March and April 1984. The storm of March 28-30, was of extratropical origin. It brought with it a major tidal surge and significant precipitation in the form of rain, sleet and snow. The maximum known accumulation of such precipitation (water equivalent basis) in the Passaic Basin was 3.9 inches at Little Falls. There was no snow on the ground at the onset of the storm.

The storm of April 4-5, was of an extratropical nature arising out of a large, low-pressure system moving out of the Ohio Valley. It entered New Jersey on the 4th, and it intensified toward the dawn of the 5th with gale force winds and near record rainfalls (there was no snowfall). The two-day rains at the Little Falls, Charlotteburg, and Wanaque gages were, respectively, 5.3 and 6.1 and 4.2 inches.

Total precipitation for the two storms, extending over a 10-day period, and including both rain and the water equivalent of sleet and snow, exceeded 9 inches at Little Falls, 8 inches at Mahwah and 7 inches at Charlotteburg, Oak Ridge and Canistear Reservoirs and at Greenwood Lake. For the Passaic Basin as a whole, the total was probably close to 7 inches.

May 1984. The May 28-31 storm was of extratropical origin and brought substantial rain to the Passaic River and surrounding areas. The four-day totals at the Wanaque and Charlotteburg rain gages in the Pompton subbasin were both about 5.9 inches. Maximum 6-hour accumulations at these stations were, respectively, 1.7 and 1.6 inches.

RUNOFF

The average runoff from the Passaic River Basin is affected considerably by water supply diversions from the Passaic River and from the Rockaway, Pequannock, Wanaque and Ramapo Rivers and Canoe Brook. The average runoff from the 785 square miles of the watershed above Paterson, N.J., is equivalent to 25.7 inches per year, or 53% of the rainfall. Seasonal variations in runoff occur, with over 50% of the annual amount taking place from December to April.

The Basin's flood runoff is affected by the natural storage in the flat swamps and meadows of the Central Basin area. This natural storage has a major impact on the runoff characteristics of the Basin, and on the flood flows down the Passaic River into the Lower Valley Area.

FLOODS

The most significant floods to hit the Passaic River Basin occurred in 1811, 1865, 1882, 1896, 1902, 1903, 1936, 1945, 1968, 1977 and 1984. An absence of early hydraulic and hydrologic data created a situation where little is known about the first four floods, except that the 1811 flood was the second highest, and the 1865 flood the fourth highest, at Little Falls. Some of the later floods were of a Basinwide nature, while others affected localized areas.

Brief descriptions of the most significant Passaic Basin floods in this century follow.

Flood of March 1902. This was a major winter flood in the Passaic River Basin. Heavy rains falling on a deep snow cover, and a rise in temperature caused a sudden increase in streamflow. The estimated peak discharge on the Passaic River at the S.U.M. Dam located just upstream of the Great Falls at Paterson, N.J., was 22,500 c.f.s. on March 2. A runoff volume of 5.2 inches was reported during this flood, equivalent to about 83% of the total rainfall and accumulated snow over the watershed.

Flood of October 1903. This flood was the maximum of record in the Passaic River watershed. The beginning of the sudden flood rise was almost simultaneous on all branches of the Passaic River at about 6:00 P.M. on October 8. The Pompton River reached a maximum at 4:30 P.M on October 9, and continued at a high rate of discharge until Noon on October 10. The peak on the Passaic River reached a maximum at about 12:00 P.M. at Two Bridges, 4:00 P.M. at Little Falls and 9:00 P.M. at Dundee Dam on October 10. The Whippany River at Whippany reached its peak at 5:00 P.M. on October 9. At Midnight on the same day, the upper Passaic River at Chatham reached a maximum. The peak discharges on the Passaic River were 31,700 c.f.s. at Little Falls and 35,800 c.f.s. at Dundee Dam. The total volume of runoff at Dundee Dam was 6.50 inches, approximately 56% of the average rainfall over the Basin.

Flood of March 1936. During this winter flood, the peak discharge recorded at the S.U.M. Dam was 19,700 c.f.s. on March 13. The peak flow on the Pompton River occurred about 24 hours before the peak on the Passaic River. The total runoff volume was 5.99 inches, equivalent to about 67% of the total rainfall and accumulated snow cover.

Flood of September 1938. The storm of September 1938 caused severe flooding throughout the New England States. In the Passaic River Basin, this flood was only moderate, with a peak flow of 8,350 c.f.s on the Passaic River at S.U.M Dam above Paterson on 23 September 1938. The runoff volume was 1.9 inches, equivalent to about 27 percent of the average rainfall over the basin.

Flood of July 1945. This flood hit the Lower Valley, when flash flooding occurred on all small streams tributary to the Passaic River below Two Bridges. The first peak on the Main Stem Passaic, 19,500 c.f.s., was caused primarily by flows from the small tributaries below Two Bridges, and the second peak, 11,600 c.f.s., was caused more than 24 hours later by the flows from the Great Piece Meadows area above Two Bridges. The retardation and reduction of flood peak effected by this natural reservoir was clearly shown during this flood. The peak flow on the Pompton River at Pompton Plains, which has a drainage area equal to about one-half of that just below Two Bridges, was estimated at 9,690 c.f.s. and the peak time was estimated at one hour after the first peak in the Lower Valley of the Passaic River at S.U.M. Dam, and 18 hours before the second peak of 11,600 c.f.s. attributed to the Great Piece Meadows area. The runoff volume was 5 inches, equivalent to 59% of the average rainfall over the Basin.

Flood of August 1955. The storm of August 1955 was not as severe as some of the previous storms described. There was some flooding along the mainstream from Two Bridges to Paterson, but most of the flooding occurred on the tributaries, including the Ramapo, Pompton and Pequannock Rivers and Goffle and Molly Ann's Brooks. A peak flow of 9,850 c.f.s was recorded at S.U.M. Dam above Paterson on 20 August 1955. The runoff volume was 1.2 inches, equivalent to about 36 percent of the average rainfall over the basin.

Flood of October 1955. The storm of October 1955 caused flooding which was most severe on the Pompton, Ramapo and Wanaque Rivers, equalling or exceeding the March 1936 flood. The other tributaries were not as severely affected. Peak flow at Little Falls above Paterson was 11,600 cfs on 18 October 1955. The runoff volume was 3.01 inches, equivalent to about 55 percent of the average rainfall over the basin.

Flood of May 1968. The flooding of May 1968 caused widespread damage over the Passaic River Basin. Flooding occurred on the main stem and all major and most minor tributaries from the headwaters to the City of Passaic, about 12 miles upstream of the mouth. Flooding was most severe on the Pompton, Ramapo, Wanaque and Pequannock Rivers, equalling or exceeding the March 1936 flood. The peak flow at Little Falls was 13,500 c.f.s., on 31 May 1968. The peak flow on the Pompton River at Pompton Plains occurred on 30 May 1968, and was estimated at 13,100 c.f.s.

Flood of August 1971. The storm of August 1971 caused extensive flooding on the tributary system of the Passaic River. There was relatively little flood flow at Little Falls on the Passaic Main Stem in relation to past floods; however, tributaries such as the Pompton River were flooded. The Pompton River at Pompton Plains had a peak discharge of 8,480 c.f.s. The Rockaway River above Boonton Reservoir had a peak flow of 3,086 c.f.s. On the Pompton River at Pompton Plains, the volume was 1.75 inches out of a Basin average rainfall of 7.40 inches, or approximately 24%. This low percentage of runoff is accounted for by the very long, dry period prior to the storm.

Flood of November 1977. The storm of November 1977 caused extensive flooding throughout northeastern New Jersey, particularly in Bergen County. In the Passaic River Basin, the main tributaries of the basin, which included the Saddle, Ramapo and Pompton Rivers, were hardest hit. The peak discharges for various locations include: 11,000 c.f.s on the Ramapo River at Pompton Lakes; 11,000 c.f.s on the Pompton River at Pompton Plains; and 6,000 c.f.s on Ho-ho-kus Brook at Ho-ho-kus.

Flood of April 1984. The most devastating recent flooding which claimed three lives, caused $330 million in damages and brought about a quick decision by New Jersey officials on the type of flood protection they preferred, occurred in April 1984.

This severe flooding occurred when a two-day storm, which brought approximately five inches of rainfall, combined with snowmelt runoff from a 12-inch snowfall which had occurred the week before. The flooding was the worst to occur in 45 years throughout the Passaic River Basin. Nineteen municipalities in four counties along the Pequannock and Pompton Rivers and along the Passaic River from Elmwood Park upstream to Chatham Borough, sustained substantial flood damages. Upper Ramapo River and Saddle River municipalities also experienced flooding. The municipalities most affected were Pompton Lakes, Wayne, West Paterson, Paterson and Little Falls in Passaic County; Riverdale, Pequannock, Lincoln Park and Montville in Morris County; Oakland, Fairlawn and Lodi in Bergen County; and Fairfield in Essex County.

The flood was declared a National Disaster on April 12. Evacuations from the damage areas effected some 9,400 people. The flood relief effort involved many New Jersey State agencies, including the Departments of Health, Community Affairs, Human Services, Labor, and Transportation, as well as the State Police and the Department of Environmental Protection's Bureau of Floodplain Management, and the National Guard, Federal agencies, including the U.S. Army Corps of Engineers, Environmental Protection Agency and Civil Defense also supplied aid as did the American Red Cross and the Salvation Army.

Evacuees took emergency shelter in schools, churches, fire stations, hotels, and the homes of friends and relations. About 2,500 Jersey Central Power and Light Company customers, and 1,200 Public Service Electric and Gas Company customers went without power. Disruptions in electric service of up to three weeks prevented people from returning to their homes, and caused damage to heating systems, and extensive losses of refrigerated foods. Electric and gas meters were completely destroyed by floodwaters. Water seepage into gas meters and broken seals caused explosions in several areas, damaging both the exteriors and interiors of structures. Some 6,400 residential, commercial, utility, and industrial establishments were significantly damaged by floodwaters. Numerous street and bridge closings were reported, creating massive traffic delays throughout the Basin. Major highways were at a standstill for hours and impassible for days. Three lives were lost in the April 1984 flood.

The April 1984 flood was not a significant flood event in the Lower Valley -- it was estimated at an approximate 25-year flood event. Nonetheless, more than 500 Paterson residents were taken by National Guard and Fire Department boats from low-lying areas around President Boulevard to River Street. About 100 stayed in an emergency shelter at John F. Kennedy High School until they could return to their homes. Flooding along the Passaic River forced the closings of the Monroe Street and Wall Street Bridges between Garfield and Passaic. Inundation also caused serious damage to driveways, garages and lawns. Water entering through garage doors, basement windows and foundations caused extremely severe damages to floors, walls, washers, dryers, and heating systems. Photograph 1 shows a scene from the April 1984 flood in Paterson, New Jersey. Photograph 2 depicts a typical example of residential flooding that occurred during this event.



PHOTO 1
April 1984 Flooding in Paterson, N.J.



PHOTO 2
April 1984 Residential Flooding.

In the Central Basin, where flooding was much more severe, approximately 1,700 residential and 300 commercial and industrial structures were inundated during the April 1984 flood. Water heights reached about 12 feet above many main floor elevations. Major highways, including Routes 23 and 46, were closed to traffic for three days. Many inundated roads were closed in Morris County, including sections of Route 10 near Troy-Hills Road in Parsippany; a portion of Blackwell Street, the main thoroughfare in Dover; Salem Street in Randolph; Franklin Road in Denville; and the Hamburg Turnpike from Riverdale to Bloomingdale in Passaic County. Long vehicular traffic delays and detours resulted when roadway retaining walls, shoulders and walkways were washed out by floodwaters. The Ringwood Avenue Bridge in Wanaque was weakened by floodwaters. Willowbrook Mall, Willow Square and West Belt Plaza in Wayne were left inaccessible for approximately three days. Parking lots were inundated with four feet of water, forcing approximately 200 retail outlets and restaurants to close and lose sales. These included major retail stores, such as Sears Roebuck and Company, Ohrbach's, Bamberger's (Macy's), Stern's, Fortunoff and J.C. Penney. Damages to roadways, parking lots, landscaping and walkways were extensive. West Belt Plaza, which includes 13 stores, estimated damages at more than $1 million. Photograph 3 depicts April 1984 flooding on the Passaic River in the Little Falls/Wayne area.

The Pompton River experienced very severe flooding, as the April 1984 storm was estimated at a 50-year flood event. Along the Pompton, an estimated 2,200 residential and 300 commercial and industrial structures were damaged by the flood. Structures were inundated with up to 12 feet of water above main floor elevations. In Wayne, an estimated 1,100 people were sheltered in local high schools for weeks. In Mountain View and Hoffman Grove, low-lying sections of Wayne, some homes were inundated by up to 9 feet of water above main floor elevations. All local streets in these areas were closed for more than two weeks. About 700 homes in both Lincoln Park and Pequannock suffered extensive flood damages. Flood durations lasting up to three weeks weakened and destroyed building foundations. Heating and electrical systems were damaged and had to be replaced. Gas and electric appliances, furniture, household furnishings, personal belongings, clothing, and all possessions were completely destroyed. Damages were as high as $146,000 for a single residential structure. Commercial and industrial merchandise, office furniture and plant equipment were extensively damaged. In Pequannock, Route 23, the Newark and Pompton Turnpike, and Madison, Roosevelt, Pequannock and Greenwood Streets were inundated with up to six feet of water and closed to traffic for four days. Residents could not get to work or move their families out of the flood area. Photographs 4 through 6 depict the April 1984 flood along the Pompton River.



PHOTO 3
Looking south from Wayne Township across Passaic River into Little Falls. Flooding caused by Passaic River.



PHOTO 4
Garden Apartments on Park Ave., Borough of Lincoln Park. Flooding caused by Beaver Dam Brook and Pompton River.



PHOTO 5
Residential Community, Bank Lane, Midwood Road and Woodland Road, Borough of Lincoln Park and Wayne Township, N.J. Flooding caused by the Pompton River.



PHOTO 6
Industry on Pompton Turnpike in Wayne Township, N.J. Flooding caused by the Pompton River.

The lower Pequannock, Wanaque and Ramapo Rivers all overtopped their banks. The Pequannock River reached its highest flow level since 1970 and inundated the lot of a Riverdale camper dealership with an estimated five feet of water causing extensive damages to motor homes and campers. A gas explosion in Pompton Lakes completely destroyed a residential structure and caused extensive damages to neighboring homes. Water heights along the lower Ramapo and Wanaque Rivers reached seven feet above main floor elevations.

CHAPTER 5. THE PLANNING APPROACH

Solutions to Passaic River Basin flood problems were developed in a deliberate and systematic manner that assured the consideration and evaluation of all reasonable potential alternatives. A wide array of water management measures, including both structural and nonstructural measures, were assembled for investigation early in the PRB Study (Table 7). These included those designated by the Congress in House Report 94-1702, and others that could be beneficial in solving Passaic River flood control problems. During the early planning stages, alternatives tended to consist of single measures, with combination plans developing during subsequent planning.

The nonstructural measures included permanent evacuation (removal) of buildings from flood damage areas, floodproofing buildings or raising them above floodwaters, preservation of natural storage areas, flood preparedness and floodwarning and floodplain zoning. The structural measures included channel modifications, dam and bridge modifications, levees and floodwalls, use of existing reservoirs for flood control storage, new flood control reservoirs, aquifer recharge, tunnel diversions, and a tidal barrier.

This Passaic River Basin Study (PRB) plan formulation approach included successive iterations of plan formulation and evaluation, with the level of detail increasing in each step as the number of alternatives decreased. As a result, the large number of measures identified early in the planning process were screened, narrowed down and refined through iterative plan formulation and technical studies. The formulation of alternative plans was accomplished by assembling a variety of nonstructural and structural floodwater management measures in varying scales, extents and combinations.

THE PLAN FORMULATION AREA

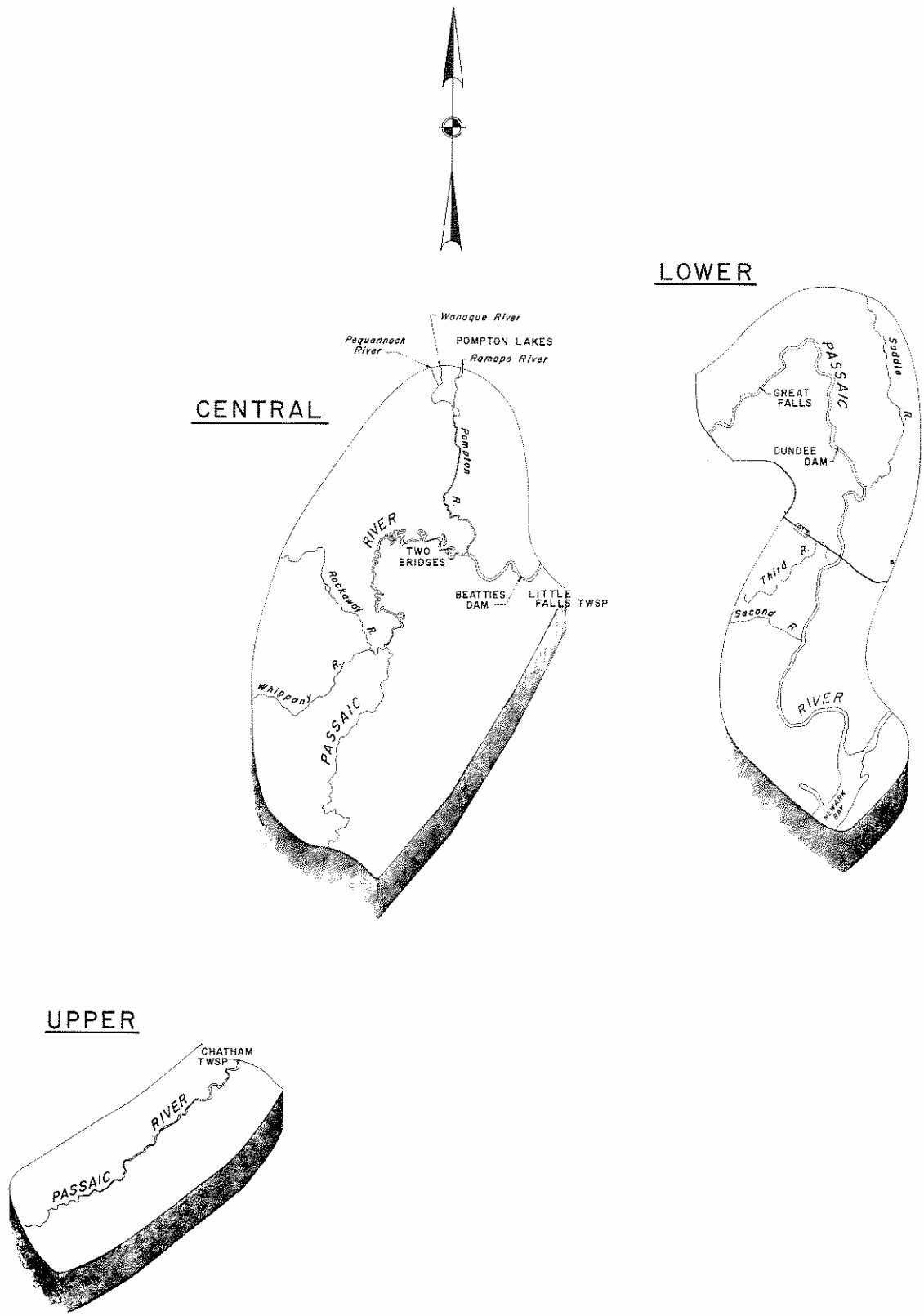
Plan formulation, evaluation and comparison were facilitated by first investigating relevant flood control measures as they impacted on three Passaic River reaches: the Upper Passaic, the Central Basin, and the Lower Valley (Figure 10). Consideration was given to the characteristics of flooding, the location of damage areas, and the significant environmental attributes in each of these areas.

Flooding at the more sparsely populated areas along the Upper Passaic River above Chatham Borough is moderated by natural storage in the Great Swamp. Flooding along the suburban Central Basin reach from Chatham down to Beatties Dam is

TABLE 7 MANAGEMENT MEASURES

MEASURES	DESCRIPTION
Flood Diversions	Rerouting flood flows around or under flood problem areas through either tunnels orchannels.
Channel Modifications	Straightening, widening, deepening or protecting a stream to reduce flooding or prevent erosion.
Levees and Floodwalls	Earthen or concrete wall-type structures used for holding back water.
Tidal Gates	Barrier to keep hurricane tides from flooding estuaries during storms.
Water Conservation Practices	Use of present water supplies more efficiently, thus reducing the need for new water sources.
Drought Contingency	Emergency planning measures implemented during severe droughts.
Interconnection of Water Supplies	Allows surplus water supplies in one area to be transferred to areas of need by connecting the water supply systems.
Stream Diversions for Water Supply	Taking water directly from streams for water supply, or diverting stream water to reservoirs to maintain water supply storage.
Land Treatment of Wastewater	Return of water to system after natural biological, chemical and filtration processes.
Streambank Stabilization	Measures to prevent streambank erosion, including vegetation, walls, and rip-rap.
Sedimentation Basins	Wide and deep areas of streams which reduce flow velocities and allow settling out of sediment.
Energy Dissipators	Structures or devices used to dissipate the energy of flowing waters causing reductions in velocity, which reduce erosive effects.
Create Turning Areas Navigation	Allows vessels to turn around or pass each other increasing the efficiency of transportation and reducing accidant potential.
Water Quality Projects	Measures which upgrade water quality allowing for more use, including recreation and water supply.
Energy Conservation Practices.	Use of energy conservation measures, including car pooling, use of more efficient appliances, apartment living.

MEASURES	DESCRIPTION
Flood Warning and Preparedness Plans	System of warning notices which would allow the public to be notified of an oncoming flood and procedures which could reduce flood damages and threats to health and safety.
Preserve Natural Storage Areas	Preserve those natural storage areas which are presently effective in reducing flood flows so that they will not be developed in the future.
Flood Plain Land Use Controls	Regulations restricting the types, and numbers of structures, and where they may be located in a flood plain.
Floodproofing and Raising Structures	Preventing water from entering a building by making all openings water tight by various methods. This can also be achieved by raising structures.
Permanent Evacuation of the Flood Plain	Removal of structures from flood plain permanently by either purchase or physical relocation.
Stormwater Management	Local stormwater detention areas or other facilities to reduce peak flood flows downstream.
Public Education	Making public aware of needs, problems and the self-help measures available to them.
Bridge and Dam Modification	Modification of bridges and dams to eliminate hindrances to flow.
Debris removal	Removal of debris from stream channel.
Clearing Snagging	Debris removal, and minor channel modifications, realignment and/or restriction removals.
Reregulate or Modify Existing Reservoirs	Changing operating rules or modifying existing reservoirs so that they can also be utilized for flood control.
Dry Detention Reservoir	A dam and detention area which only impounds water during flood periods.
Wet Detention Reservoir	A dam with a capacity for storing additional water during flood periods.
Aquifer Recharge	Method of allowing floodwaters to percolate through the soil to be stored in existing underground storage areas.



Passaic River Study N.J. & N.Y.

PLAN FORMULATION REACHES

FIGURE N° 10

characterized by a reversal of flow from the Pompton River which causes flooding on the Main Stem Passaic River above the confluence. Flooding in the Lower Valley from Beatties Dam down to Newark Bay has two distinctly separate characteristics. From Beatties Dam down to Dundee Dam, floods are fluvial and related to insufficient channel capacity. In the densely urbanized area below Dundee Dam, flooding is caused by upstream fluvial flows and hurricane-related tidal surges from Newark Bay.

The Upper Passaic River reach flows 12 miles from its headwaters in Mendham through a narrow corrider between two ridges which limit the watershed to an average three-mile width. Because of this, and extensive wetlands, flooding along the Upper Passaic is moderate. The 6,700-acre Great Swamp National Wildlife Refuge and a contiguous 800-acre Somerset County park, act as a natural collection basin for headwater tributaries. This is one of the Passaic Basin's largest natural floodwater storage areas.

Moderate flooding which causes low flood damages, in conjunction with significant natural storage, eliminated the Upper Passaic River from further consideration under the PRB Study.

The Central Basin reach includes the Main Stem Passaic from Chatham to Little Falls, and the lower Whippany and Rockaway Rivers, the entire Pompton River, and the lower Pequannock, Wanaque and Ramapo Rivers. This low-lying, flat area includes approximately 21 square miles of environmentally sensitive wetlands.

It could easily be assumed that a flood peak flow on the Passaic River at Little Falls would be comparable to, or larger than, a flood peak produced by the Pompton River. The PRB Study hydrologic studies, however, clearly showed that peak flows for a 100-year flood event in the Pompton River at Pompton Plains, draining an area of 355 square miles, have been estimated to be about 32,500 c.f.s. Peak flows for the 100-year flood in the Passaic River at Beatties Dam, for a 762 square mile drainage area, are about 27,500 c.f.s. The Passaic River drainage area, with more than double the area, produces a flood peak significantly lower than the Pompton River.

This is caused by the narrow, rock gorge Passaic River channel from Two Bridges to Beatties Dam, which severely constricts high flows into the Lower Valley. This constriction produces the backwater effect where the higher Pompton flows are forced back up the Passaic River. This combined flow from the two drainage area backs up into the Central Basin wetlands, and

continues until the water level in the Great Piece Meadows is equal to or greater than the level at Little Falls. Peak flows on the Pompton River at its confluence with the Passaic River occur 40 to 50 hours earlier than the flood peak in the Central Passaic River. Photograph 7 shows the confluence of the Passaic and Pompton Rivers at the Two Bridges area.

A second phase of Main Stem Passaic River flooding is the result of a combination Passaic River flood flow and reversed Pompton River flood flow, which produces higher stages because of the decreasing availability of natural storage in the Great Piece Meadows and high Pompton River coincidental flows. This is also caused by the Two Bridges to Little Falls rock gorge channel constriction.

The densely-populated, highly-developed Lower Valley formulation area, from the Beatties Dam down to Newark Bay has many tributaries. These include the Peckman River, Molly Ann's Brook, Goffle Brook, Weasel Brook, and the Saddle, Third and Second Rivers. High flows at the mouth of these tributaries are influenced by backwater from the Passaic River.

The flooding characteristics in this reach had a significant impact on flood damage reduction solutions considered. Lower Valley flooding can be caused by generalized rainfall over portions of the entire Basin, by localized storms over the lower Passaic area, or by hurricane-related tidal surges from Newark Bay.

Three run-of-the-river dams divide the Lower Valley into three separate hydraulic areas. The dams are Beatties Dam (Photograph 8), the S.U.M. Dam, and Dundee Dam. The Great Falls, depicted in Photograph 9, are located just downstream of the S.U.M. Dam. Dundee Dam is shown in Photograph 10.

A feature unique to the lower Passaic River is its tidal and saline character from Newark Bay up to Dundee Dam. The water has an estuarine quality up to the Rutgers Street Bridge. The Passaic River channel has also been enlarged for navigation up to the Eighth Street Bridge in Passaic City, giving it hydraulic capacity for carrying high flows. This channel can contain a 10-year fluvial flood, although flood damages still occur as the result of tidal surges greater than a 10 year event.

INITIAL PLAN FORMULATION

Initial plan formulation studies resulted in the development of 14 building blocks including 11 single objective measures and three combination measures (Figure 11).

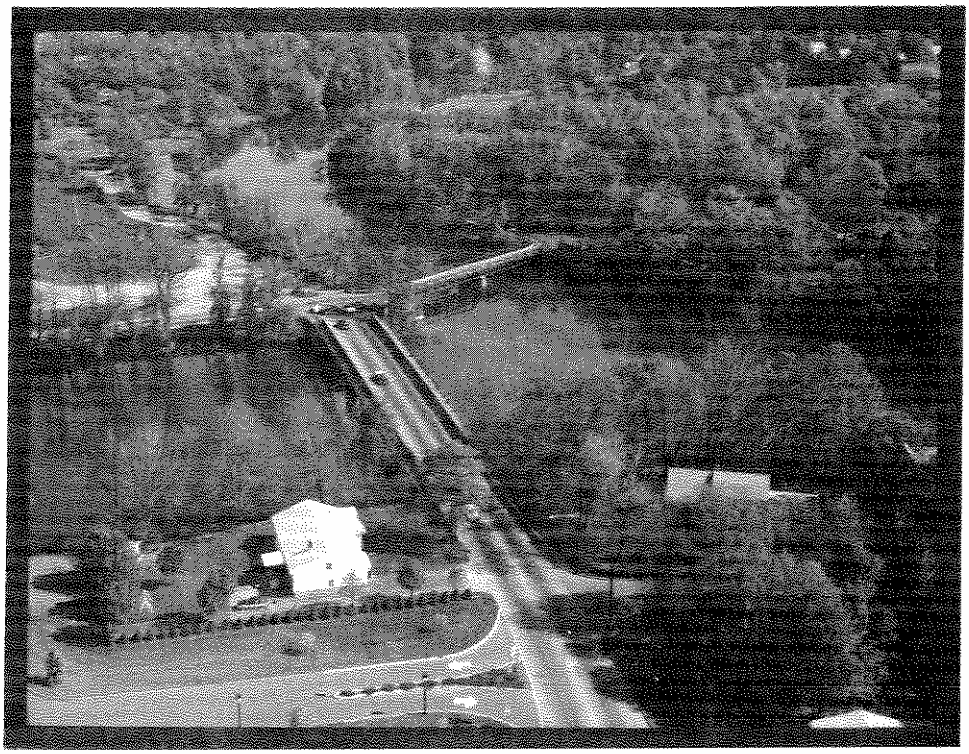


Photo 7
Two Bridges Area, Confluence of Pompton and Passaic Rivers



Photo 8
Beatties Dam, Little Falls, N.J.

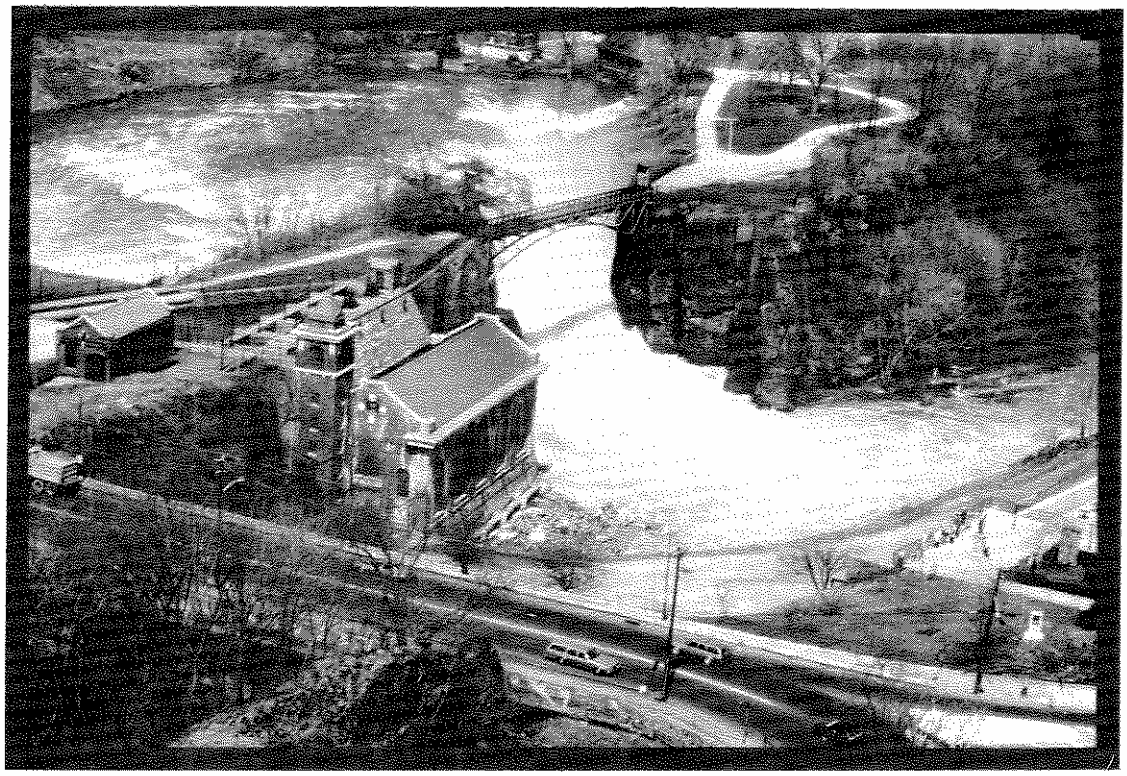


PHOTO 9
Great Falls, Paterson, N.J.

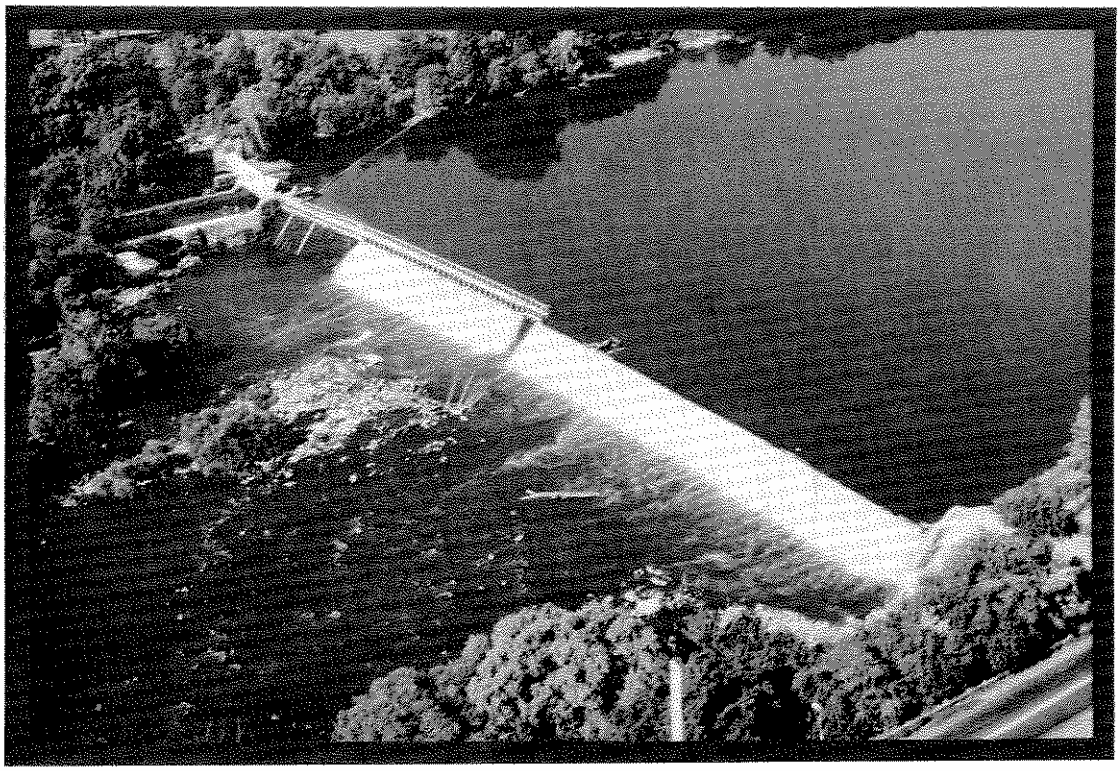


PHOTO 10
Dundee Dam, Garfield, N.J.

DEVELOPMENT OF PLANS – "BUILDING BLOCK" APPROACH

Passaic River Study N.J. & N.Y.

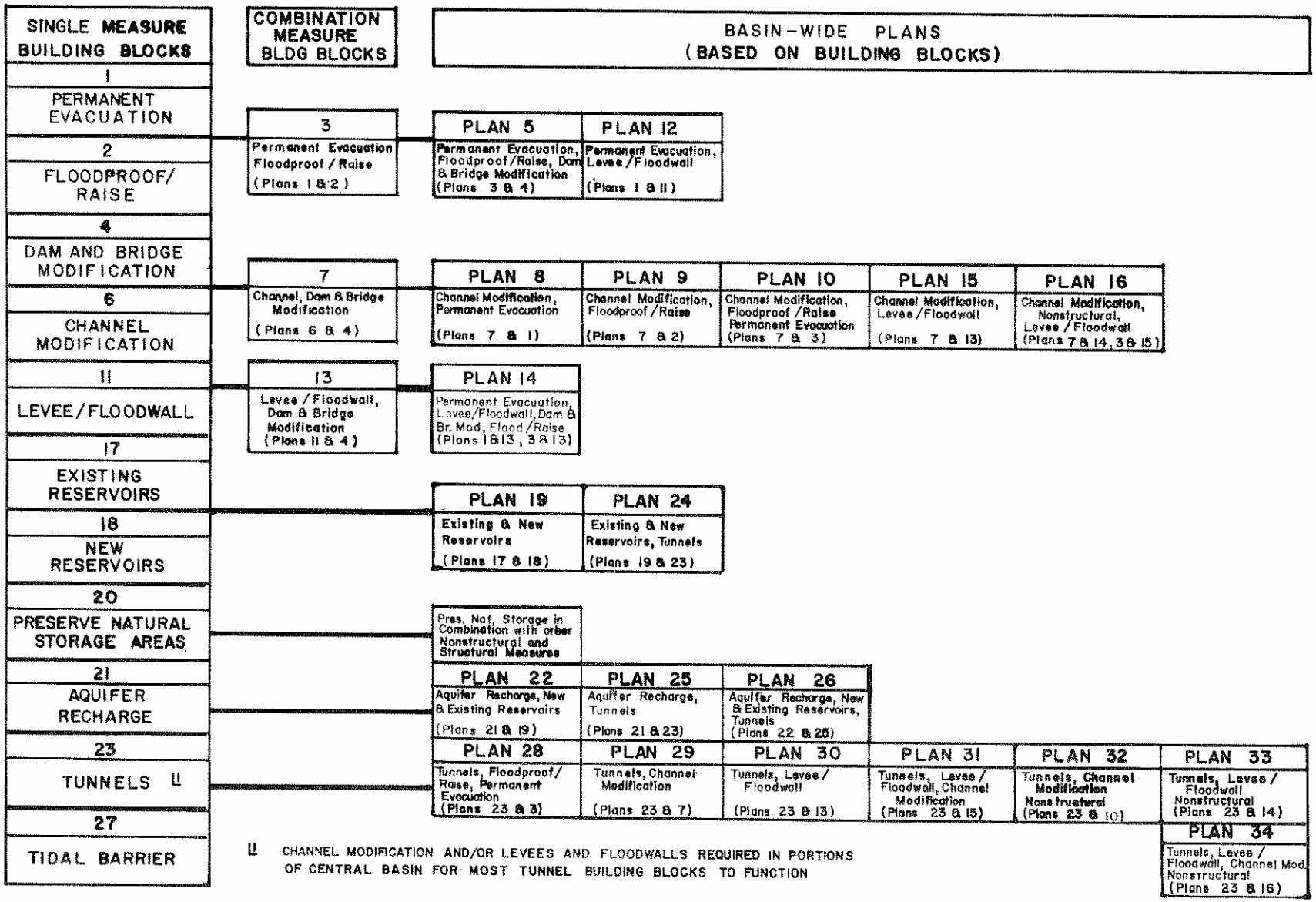


FIGURE 11

The single measures formed the basis for Passaic River plan formulation. They included permanent evacuation, floodproofing and raising, dam and bridge modification, channel modification, levees and floodwalls, existing reservoirs, new reservoirs, preservation of natural storage areas, aquifer recharge, tunnels, and a tidal barrier. The combination measures included permanent evacuation combined with floodproofing/raising; dam and bridge modifications combined with channel modification, and dam and bridge modifications combined with levees and floodwalls.

NONSTRUCTURAL MEASURES

Major emphasis was placed on evaluating the potential of nonstructural remedies consisting of permanent evacuation, floodproofing and raising structures, preservation of natural flood storage areas, and floodwarning.

Consideration was given to the complete elimination of flood damages through permanent evacuation. The evacuation of about 10,300 structures from the area inundated by a 10-year flood event would cost about $2.2 billion. The permanent evacuation of some 16,500 structures from the 100-year floodplain would cost about $3.8 billion. Because of the large numbers of structures vulnerable to damages during floods, basin-wide floodproofing of structures and raising them above floodwaters is also not feasible.

The economic infeasibility of basin-wide flood proofing, raising and permanent evacuation eliminated these measures from further consideration. These nonstructural measures were considered only for isolated, high-development locations in the Basin, and only as a part of a more comprehensive solution. Basin-wide nonstructural measures, which were found economically feasible, included preservation of natural storage and floodwarning and preparedness plans.

The Passaic Basin contains significant undeveloped natural storage areas, which attenuate flood peaks and reduce the stage and duration on both the Passaic and Pompton Rivers. As of 1984, there were some 24,485 acres of natural storage, 24,100 acres of which are wetlands. Of this total, approximately 15,865 acres are protected as parkland or open space in public ownership, or are protected by Federal floodway delineations (see Table 8). Trends indicate that the remaining 8,620 acres are at risk for inclusion in development plans by 2040, subject to further development restrictions resulting from New Jersey's recently enacted Freshwater Wetlands Protection Act. Additional development of natural flood storage areas would cause more frequent and severe flooding and increased flood damages. Early

TABLE 8 - Central Basin Natural Storage Areas of the Passaic River Watershed 1/

Name	Acres	Acres 2/ Protected	Percent Protected
Great Piece Meadows	4125	2405	58%
Troy Meadows	2390	1120	47%
Canoe Brook	1245	885	71%
Upper Passaic River	2200	1605	73%
Hatfield Swamp	1775	1250	70%
Black Meadows	1300	40	3%
Great Swamp	8500	7500	88%
Dead River	850	180	21%
Bog & Vly Meadows	650	205	32%
Hatfield Swamp (South)	605	395	65%
Lower Pompton	845	280	33%
TOTAL	24,485	15,865	65%

1/ Storage areas are not always analogus to wetland designations because of boundary definitions and development patterns.

2/ Acreage consists of FEMA floodways, including those which have been delineated but not yet adopted, and areas expected to remain as park/and or open space.

study indicated the potential economic feasibility of the preservation of natural storage measure. This measure was carried into the subsequent formulation iterations of the intermediate planning stage for hydrologic, hydraulic, economic and environmental analyses.

The feasibility of improving the existing floodwarning systems in the Passaic Basin was also considered. An evaluation of the system revealed that potential warning time is lost because of slow timing and inaccuracies in data collection, inefficient warning release systems, and slow warning dissemination techniques. This investigation resulted in a positive feasibility finding and the development of a wide-ranging combination of floodwarning improvements and response enhancements. This project is currently being implemented under the small project authority of Section 205 of the 1948 Flood Control Act. This project is consistent with comprehensive alternative plans for the Main Stem Passaic River.

STRUCTURAL MEASURES

Early investigations of structural measures resulted in a determination that aquifer recharge, reservoirs, tidal barriers, and dam and bridge modifications would not be appropriate for solving Passaic River flood problems. As a result, they were eliminated from further consideration.

Recharging floodwaters in the buried valley aquifers of the Central Passaic River Basin was considered as a means of reducing flood flows. A conflict between flood control use, which would require the aquifers to be drawn down, and the aquifers' primary function as a major groundwater storage system, was the deciding factor in removing this option from further consideration. There are also other technical problems involved in this determination. These included the possible contamination of the aquifer, and the distance of the severe flood damage areas from access to the aquifers.

Reservoirs were found to be an infeasible alternative after an extensive study of more than 50 potential sites, including both existing reserviors and potential new sites. These analyses were made from a flood damage reduction standpoint, and also in consideration of the potential for fulfilling water supply objectives in conjunction with flood control. Modifications to existing reservoirs to increase flood storage capacities, and trade-offs between existing water supply facilities and potential new flood control reservoirs were analyzed. There are few developable sites in the Passaic Basin with favorable location or sufficient capacity to provide significant flood storage. The potential and existing

reservoirs were evaluated hydrologically, and found to have minimal beneficial effects on reducing flows at downstream damage areas. Regulation of existing reservoirs as part of a water supply/flood control trade-off also produced no significant flood damage reductions. From a multiple-purpose perspective, only the Longwood Valley site in the Upper Rockaway River had potential feasibility for water supply, flood control and pumped storage hydroelectric power generation. This site had no impact on Main Stem Passaic River flooding, and is being considered further under the Upper Rockaway River interim feasibility study.

The feasibility of a tidal barrier to prevent tidal flooding caused by storm surges from Newark Bay was investigated. Several potential sites for a tidal barrier were investigated, and project proposals developed. Upon analysis it was concluded that a tidal barrier was not economically feasible.

The feasibility of reducing backwater flooding through modifications to existing bridges was also considered. Hydraulic studies revealed that modifying or replacing bridges would not bring about significant stage reductions over an area large enough to justify the costs. Bridge modification was considered only as part of channel modification or levee/floodwall plans.

Dam modifications, consisting of lowering dam crests by varying amounts, and total removal of the dams were considered for Beatties Dam, S.U.M. Dam and Dundee Dam.

The Beatties Dam analysis indicated that reductions in upstream water surface elevations would result from either total removal or modification of the dam, in conjunction with minor channel modification. However, only a small number of structures would benefit significantly. The natural, narrow rock-gorge channel constriction above the dam would have to be removed to bring about significant flood flow reductions. Such modifications would eliminate flood storage near Little Falls, and reduce upstream flood storage with a negative impact on the Central Basin wetlands. The loss of this flood storage could also have significant adverse impacts on downstream municipalities. The uncertainty of balancing adverse effects to downstream communities and upstream wetland areas with the beneficial flood damage reduction impacts results in the feasibility and extent of such Beatties Dam modifications being in doubt without detailed hydrologic and hydraulic study of these impacts. In addition, modification of Beatties Dam would impact on the formulation of an overall basin-wide flood control plan.

Removal of the S.U.M. and Dundee Dams would only reduce flooding in areas just upstream of each dam. Channel modifications would be required to effect any significant flood damage reductions. These channel modifications would be essentially the same as those required with the dams in place. Thus, the costs of removing or modifying either dam would not be economically justified.

Based on these studies, dam modifications were eliminated from further consideration as independent solutions to Passaic River Basin flooding. However, this measure was considered further in conjunction with channel modifications.

FEASIBLE STRUCTURAL MEASURES

Structural measures that were found to be economically, environmentally and technically feasible included levees and floodwalls, channel modifications and tunnel diversions.

LEVEES AND FLOODWALLS

Levee/floodwall plans were developed to protect against the 100-year flood throughout the flood damage areas. Riverbank levees and floodwalls were considered along the Pompton River and the lower Passaic River and setback levees were considered in the Central Passaic area.

The initial levee/floodwall strategy was to protect all structures in the 100-year floodplain with continuous levees and floodwalls in flood damage areas. This was infeasible because in many areas only limited numbers of structures would be protected. Continuous levee/floodwall protection was eliminated from further consideration.

As a result, the levee/floodwall alternatives were reduced to intermittent levees and floodwalls to protect most of the structures in the 100-year floodplain. In the Pompton Valley, this protection would not be economically justified, and the extreme heights of the levees and floodwalls would be unacceptable. Levees and floodwalls were not considered further as independent flood control measures along the Pompton River. However, they were considered in combination with other measures, such as channel modifications or tunnel diversion, which reduced their heights. A combination Pompton Valley levee/floodwall channel modification scheme, along with intermittent levee/floodwall systems in the Central Passaic and Lower Passaic areas, was carried forward into subsequent formulation iterations.

A levee/floodwall plan was also developed to protect against the Standard Project Flood (SPF) in the lower Valley and the Central Basin upstream of Two Bridges; however, it is not economically justified.

CHANNEL MODIFICATION

Channel modifications to increase stream carrying capacities were evaluated. Earthen/trapezoidal and concrete/rectangular channels in combination with dam or bridge modifications were investigated for 50 and 100-year flood events. These studies indicated that channel modifications would not be feasible in the Central Basin area or in the tidal Lower Passaic.

It was also found that comprehensive channel modification plans to protect the Pompton Valley, the Passaic River from Two Bridges to Beatties Dam, and the Lower Passaic down to the Route 3 crossing would be uneconomical. Channel modification on the Pompton or the Central Passaic River would significantly increase flows entering the Lower Passaic, necessitating downstream channel modifications.

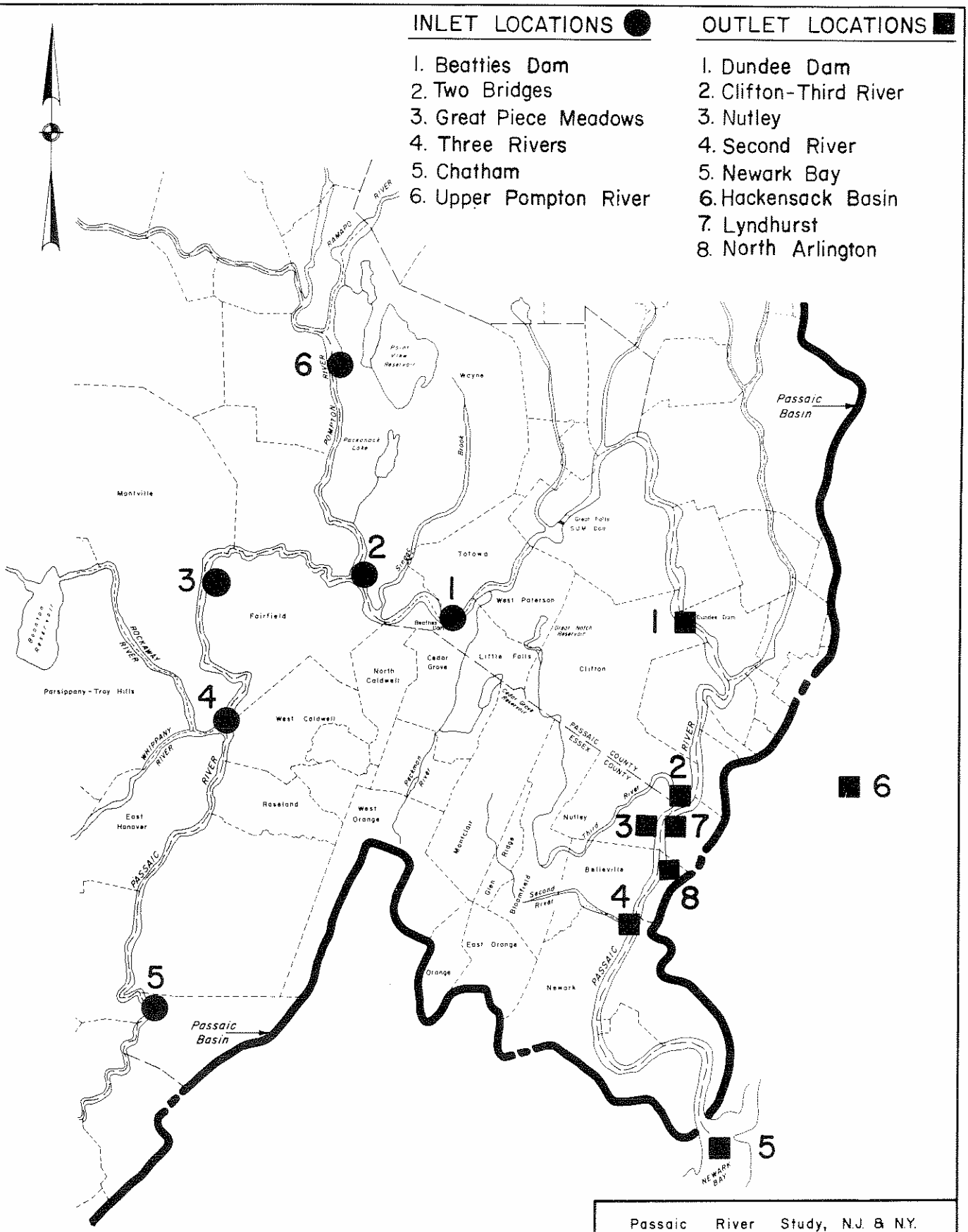
Channel modifications in combination with levees and floodwalls and nonstructural measures on the Passaic River from Beatties Dam to Route 3 were elements of a feasible comprehensive alternative. Channel modifications on the Pompton River and on the Passaic River from Two Bridges to Beatties Dam were also included as elements of feasible tunnel plans.

TUNNEL DIVERSION

Numerous underground tunnel routes were investigated as tunnel diversion plans and or systems of tunnel plans. Tunnels ranging from 13 to 50 feet in diameter, with lengths up to 20 miles were considered. Tunnels were also combined with other flood protection measures in comprehensive flood damage reduction plans, because tunnels by themselves cannot protect all the Basin's flood damage centers.

The evaluations initially focused on the engineering feasibility of tunnel plans from a constructability and cost standpoint. Evaluations were later expanded to include the hydrologic and economic impacts of the inlets and outlet. Cost considerations were focused on specific tunnel designs and construction techniques.

Six inlet locations (see Figure 12) considered in the early planning stage included Little Falls, Two Bridges, the Great Piece Meadows, in the area designated as Three Rivers (i.e., where the Whippany, Rockaway and Passaic Rivers merge), Chatham, and the upper Pompton River. It was found that Little Falls,



Passaic River Study, N.J. & N.Y.

POTENTIAL DIVERSION
INLET & OUTLET LOCATIONS

FIGURE 12

Two Bridges and the Upper Pompton River provided the most significant reductions in flood stages in the damage areas. These three inlet locations were considered in combination with other measures in formulating an intermediate tunnel diversion alternatives.

Eight potential outlet locations were evaluated during initial plan formulation studies, including Dundee Dam, the Third River at Clifton, Nutley, Lyndhurst, North Arlington, the Second River, Newark Bay and the Hackensack River. Many factors were considered in evaluating these locations, but major emphasis was placed on cost. Cost factor evaluations included the length of tunnel required for each outlet versus the fluvial flood protection works required, the geology of each tunnel alignment, and the availability of land for staging, construction and outlet operation facilities. Newark Bay required a long tunnel. Dundee Dam required excessive downstream local protection works. The Hackensack River outlet site had poor geologic conditions along the tunnel route and Nutley had a lack of access and availability of land. The Lyndhurst and North Arlington sites, located in parks adjacent to residential areas, required channel modification and an additional river crossing.

It was determined that the best tunnel outlet location would be in the reach Second River and the Third River. The Third River site would require a significantly shorter tunnel, and has better accessibility and the open space required for construction.

Tunnel diversion plans were developed with inlets at Little Falls, Two Bridges and the upper Pompton River; all with the outlet at the Third River. It was also determined that modifying the Pompton Single Inlet Tunnel with a second inlet on the Passaic River near Little Falls was feasible. The most economical tunnel dimensions included a 35-foot diameter with a Little Falls inlet, and a 40-foot diameter with a Pompton inlet, a Two Bridges inlet or a Pompton/Passaic dual inlet.

INITIAL PLAN FORMULATION FINDINGS

The initial plan formulation findings included the following:

- A comprehensive plan combining several measures would be required to manage Main Stem Passaic River flooding.

- Nonstructural measures would be economically and technically feasible only in localized areas and only in conjunction with structural measures in a comprehensive plan.

- Structural measures that should be considered as potential components of a comprehensive flood control alternative include channel modification, dam and bridge modification, levees and floodwalls and tunnel diversions.

- It was determined that preservation of natural storage areas would be pursued as part of a comprehensive plan recommendation. Analysis clearly showed that this measure could have a major impact on flood damage reduction, and on the successful operation of a flood control project.

- It was determined that the potential for an improved floodwarning/preparedness project would be pursued as an interim project.

INTERMEDIATE PLAN FORMULATION SCREENING

During intermediate plan formulation, the feasible alternatives were combined into more than 150 different combinations. Extensive screening, based on engineering and economic feasibility and environmental concerns reduced the number of alternatives to 80. Further refinement and reformulation reduced them to 36 basic alternatives. These plans were then refined into an array of seven technically sound and economically feasible combination alternatives. They were presented for public review and comment in May and June of 1984.

SEVEN INTERMEDIATE ALTERNATIVES

The seven basic combination alternatives developed during the intermediate planning stage were:

- a levee/floodwall/nonstructural alternative (Plan 14A);

- a levee/floodwall/nonstructural/channel modification alternative (Plan 16A);

- a levee/floodwall/channel modification alternative (Plan 15A);

- a levee/floodwall/channel modification/Passaic River (Beatties Dam) inlet tunnel diversion alternative (Plan 30A);

- a levee/floodwall/channel modification/Passaic River (Two Bridges) inlet tunnel diversion alternative (Plan 30G);

- o a levee/floodwall/channel modification/Pompton River inlet tunnel diversion alternative (Plan 30C); and

- o a levee/floodwall/channel modification/Pompton-Passaic dual inlet tunnel diversion alternative (Plan 30E).

A summary of the plan features categorized by river reaches is presented in Table 9. Figures 13 to 19 present the layout of these alternatives.

Intermediate stage findings also indicated that preservation of natural flood storage areas in the Central Basin would reduce future increases in flood flows and associated flood damages by preventing development in floodplain lowland areas. However, it would have no impact on the existing flood problem, and was not considered as an independent solution to the Basin's flood problem. This measure was considered as an adjunct to any of the seven basic intermediate plans to provide more effective and complete protection.

INTERMEDIATE SCREENING FINDINGS

The intermediate plan formulation screening resulted in the following findings.

- o Approximately 80% of the 36 economically feasible alternatives were centered around tunnel diversions. Four of the final seven intermediate plans included tunnels (30A, 30C, 30E, and 30G).

- o The most economically efficient alternatives were the four plans including tunnel diversions (30A, 30C, 30E and 30G), the channel modification and levee/floodwall plan (15A), the channel modification and levee/floodwall and nonstructural plan (16A), and the levee/floodwall and nonstructural plan (14A).

- o Channel modifications were feasible along the Pompton River and along the Passaic River below Two Bridges. They were not feasible in the Central Passaic River areas.

- o Although channel modifications were economically feasible in the lower Passaic River reach from Beatties Dam to Route 3, they were not incrementally feasible as a last added element to tunnel diversion plans. This ruled out further consideration of channel modification in this reach.

TABLE 9

Summary of Plan Features by Plan Formulation Reach -
Final Array of Intermediate Plans
Passaic River Basin

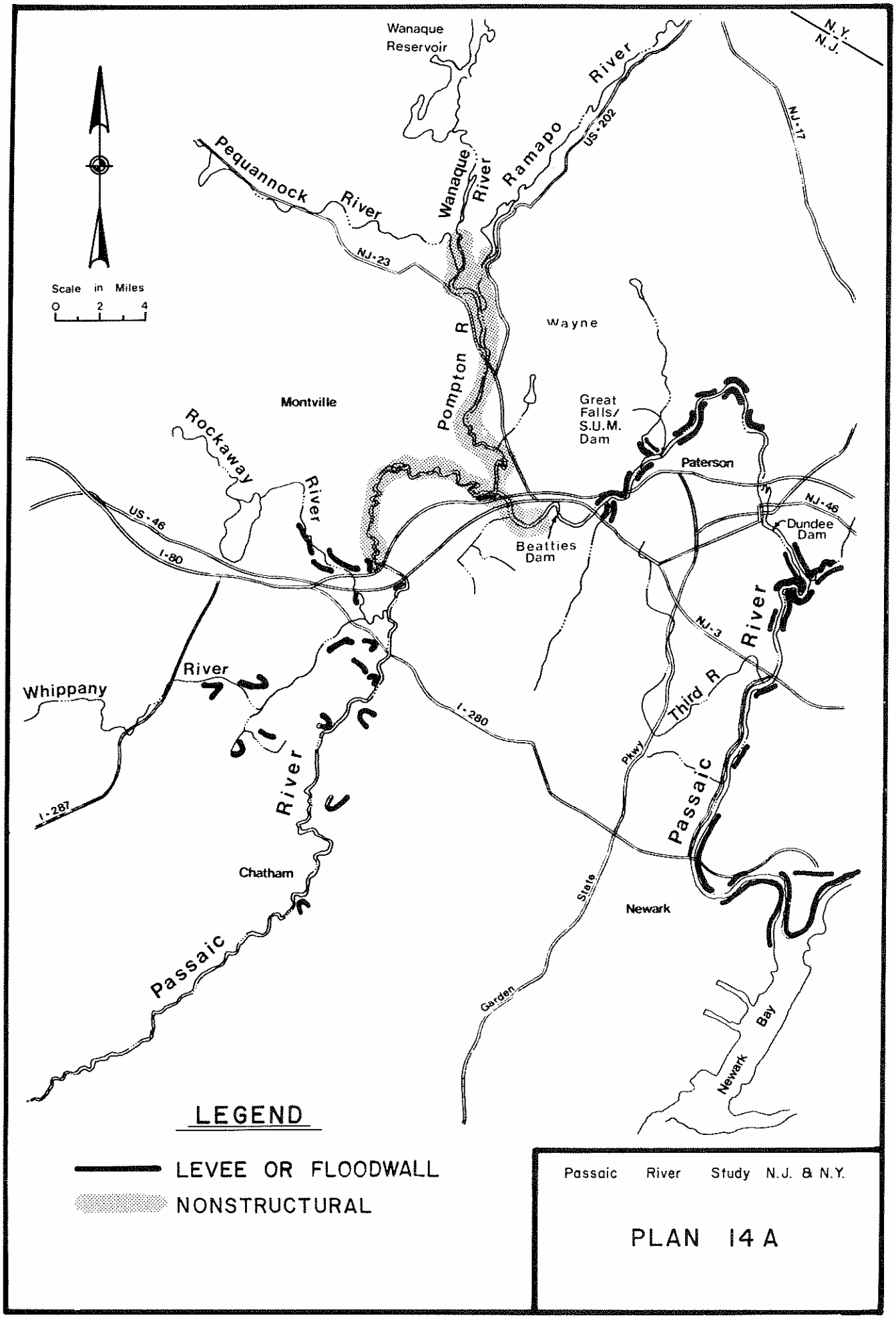
	Reach				
	1	2	3	4	5
Plan	Tidal	Rt 3-Little Falls	Little Falls-Two Bridges	Pompton Valley	Central Basin
14A	LV/FW[1]/	LV/FW	NS	NS	NS/ LV/FW[1,2]/
16A	LV/FW[1]/	CH	NS	NS	NS/ LV/FW[1,2]/
15A	LV/FW[1]/	CH/LV/FW	CH	CH/LV/FW	LV/FW[1,2]/
30A	LV/FW[1]/	TU/LV/FW	BI/CH	CH/LV/FW	TU/LV/FW[1,2]/
30G	LV/FW[1]/	TU/LV/FW	TBI	CH/LV/FW	TU/LV/FW[1,2]/
30C	LV/FW[1]/	TU/LV/FW	CH	PI	TU/LV/FW[1,2]/
30E	LV/FW[1]/	TU/LV/FW	BI/CH	PI	TU/LV/FW[1,2]/

Legend:

LV/FW	-	Intermittent 100 yr Levee/Floodwall Systems
NS	-	10 yr Nonstructural Measures
CH	-	100 yr Channel Modification
CH/LV/FW	-	100 yr combination channel modification, levees and floodwalls
TU/LV/FW	-	Levees and floodwalls necessary to protect against improved 100 yr event in combination with tunnel diversion building block
BI/CH	-	Beatties Inlet Tunnel with channel from Little Falls to Two Bridges
TBI	-	Two Bridges Inlet Tunnel
PI	-	Pompton Inlet Tunnel with associated surface works on Pompton Tributaries

1/ Possible optional substitution of 10 Yr nonstructural at limited locations.

2/ Levees in the Central Basin are setback levees which are located at the outermost limit of the floodplain landward of the riverbank.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Pequannock River
Wanaque River
Ramapo River
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Scale in Miles
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Montville
Great Falls/ S.U.M. Dam
Rockaway River
Paterson
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NJ-46
I-80
Dundee Dam
Beatties Dam
NJ-3
Third R
Whippany River
I-280
Pkwy
I-287
Passaic River
Chatham
State
Newark
Passaic
Garden
Bay
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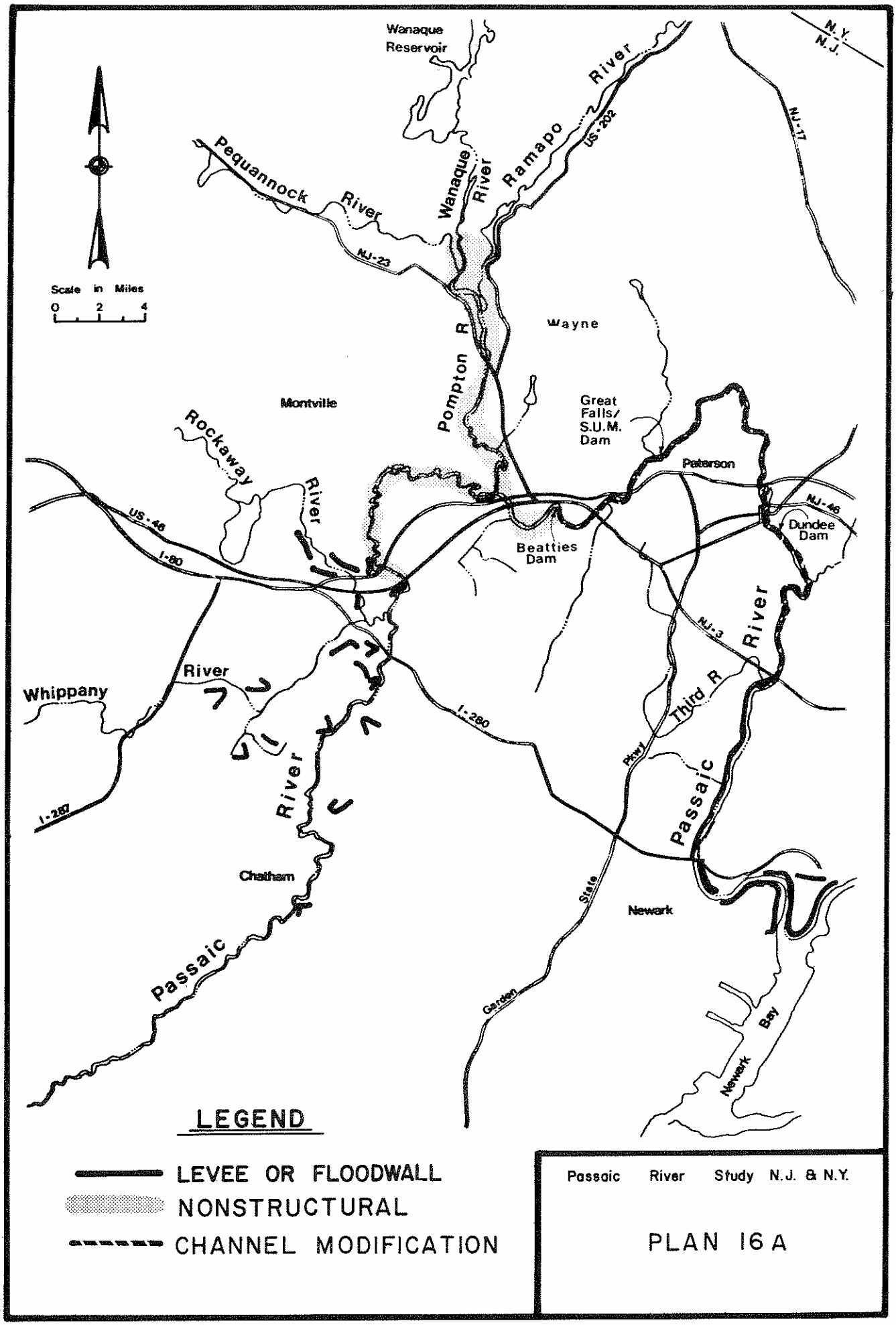
LEGEND
LEVEE OR FLOODWALL
NONSTRUCTURAL
Passaic River Study N.J. & N.Y.
PLAN 14 A

FIGURE 13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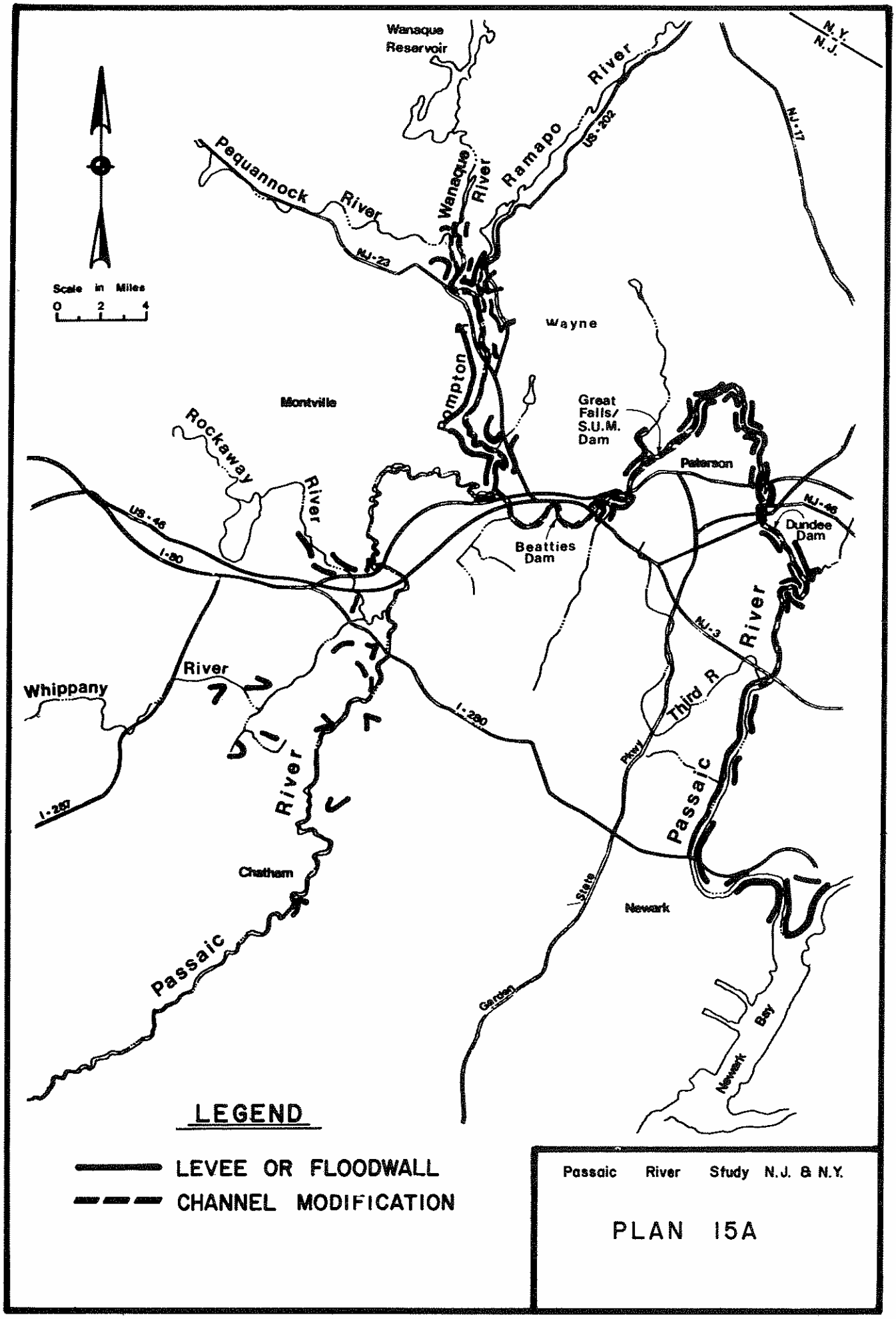
LEGEND
LEVEE OR FLOODWALL
NONSTRUCTURAL
CHANNEL MODIFICATION
Passaic River Study N.J. & N.Y.
PLAN 16A

FIGURE 14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Beatties Dam
NJ-3
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I-287
Passaic River
Chatham
State
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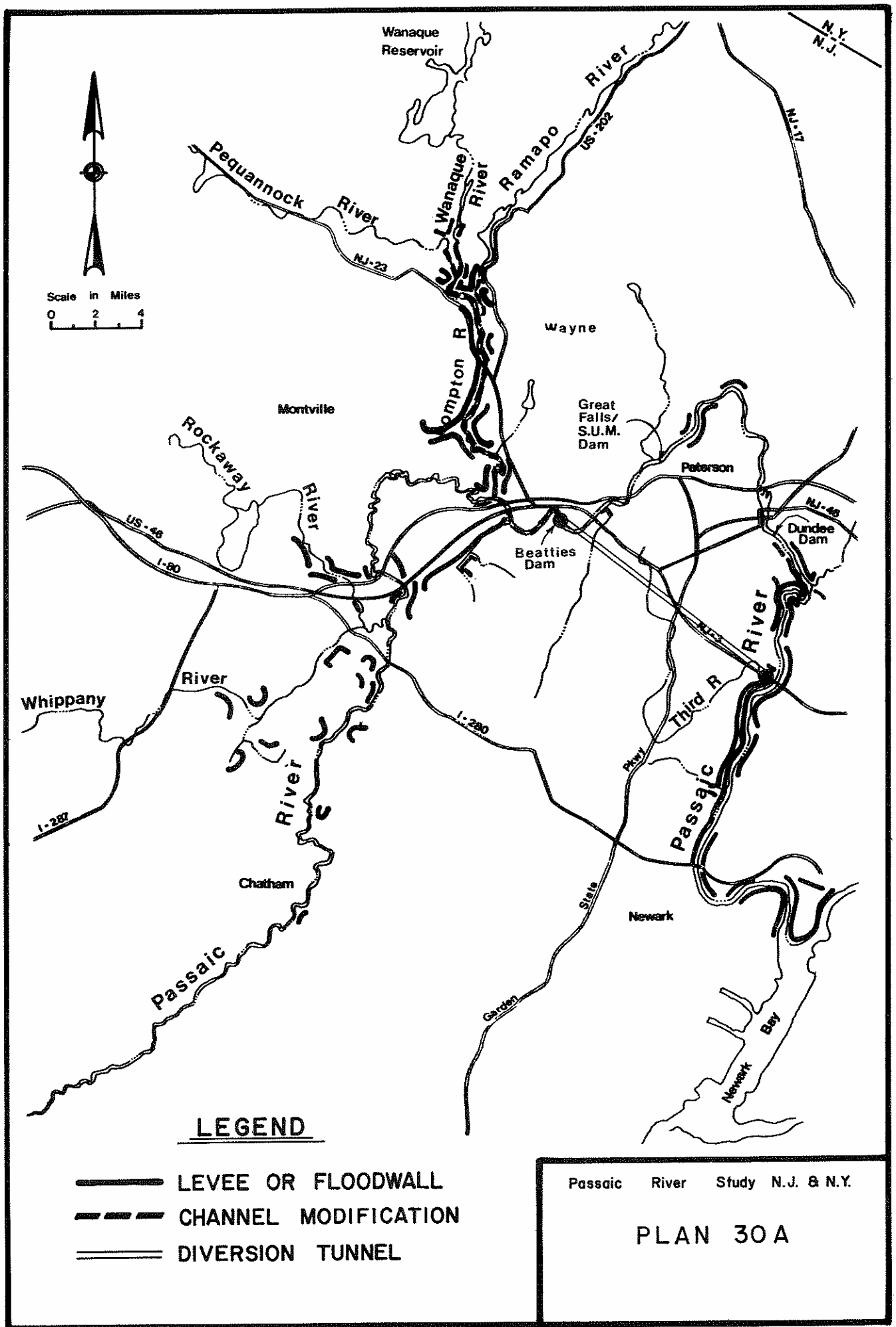
LEGEND
LEVEE OR FLOODWALL
CHANNEL MODIFICATION
Passaic River Study N.J. & N.Y.
PLAN 15A

FIGURE 15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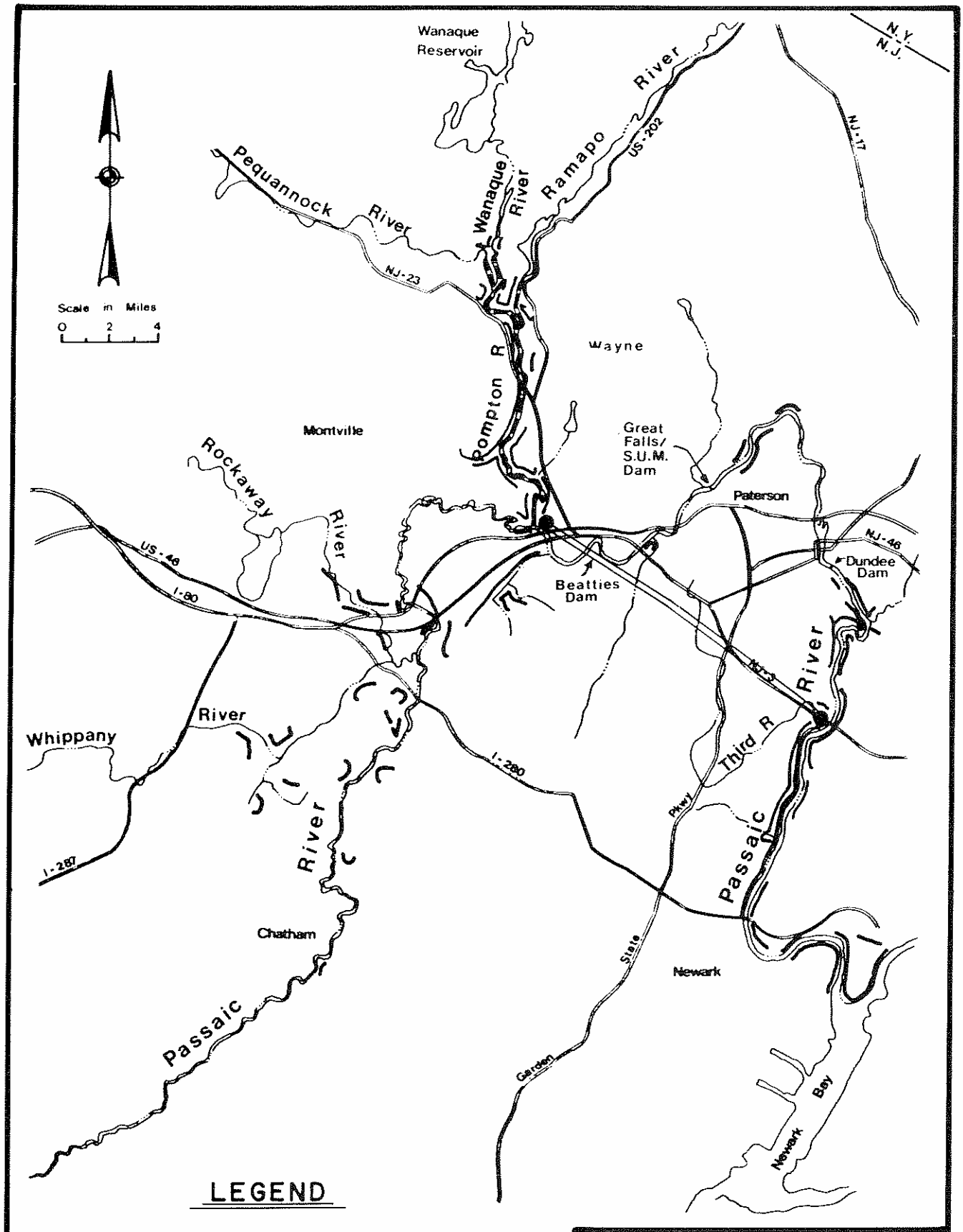
LEGEND
LEVEE OR FLOODWALL
CHANNEL MODIFICATION
DIVERSION TUNNEL
Passaic River Study N.J. & N.Y.
PLAN 30A

FIGURE 16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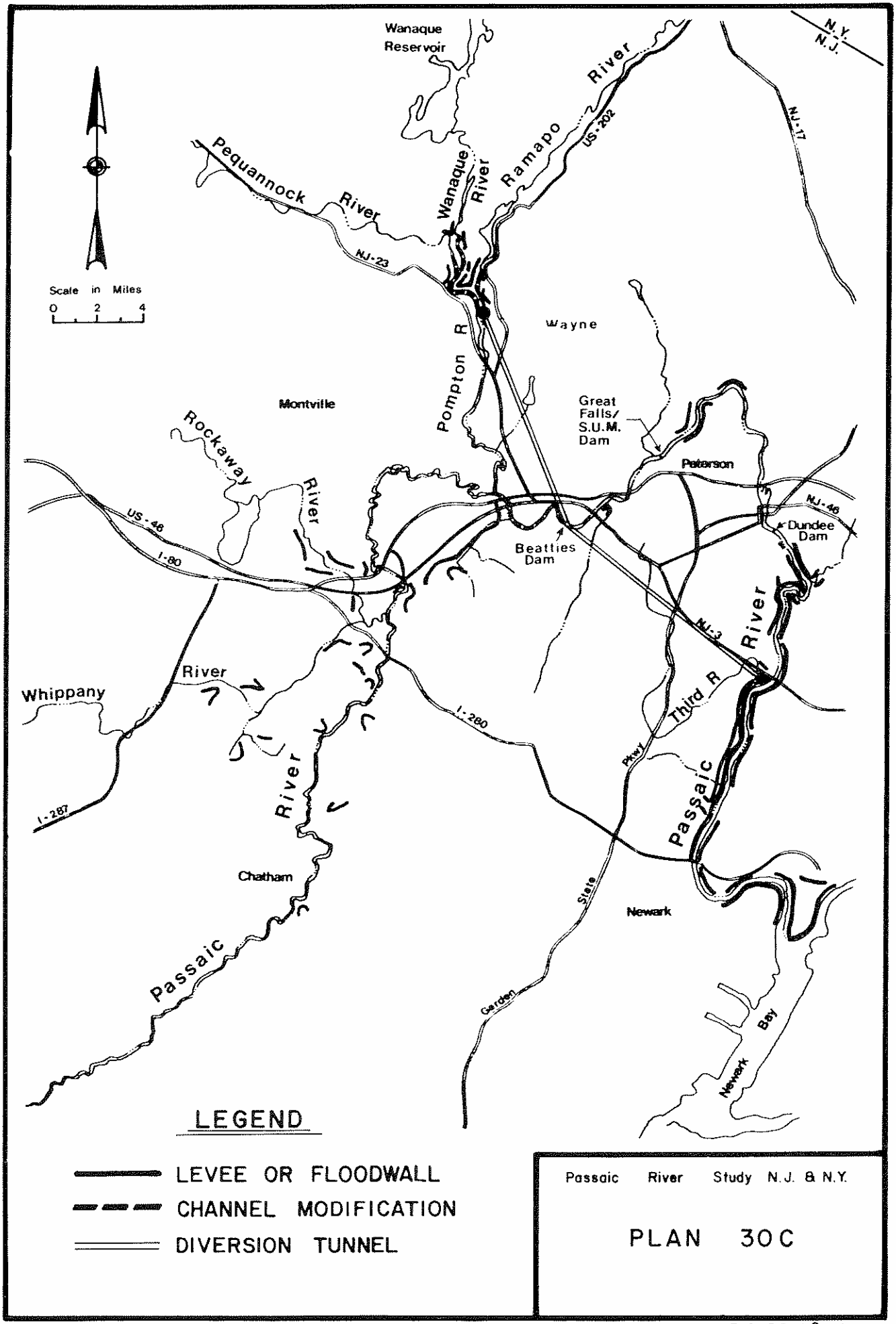
LEGEND
LEVEE OR FLOODWALL
CHANNEL MODIFICATION
DIVERSION TUNNEL
Passaic River Study N.J. & N.Y.
PLAN 30G

FIGURE N° 17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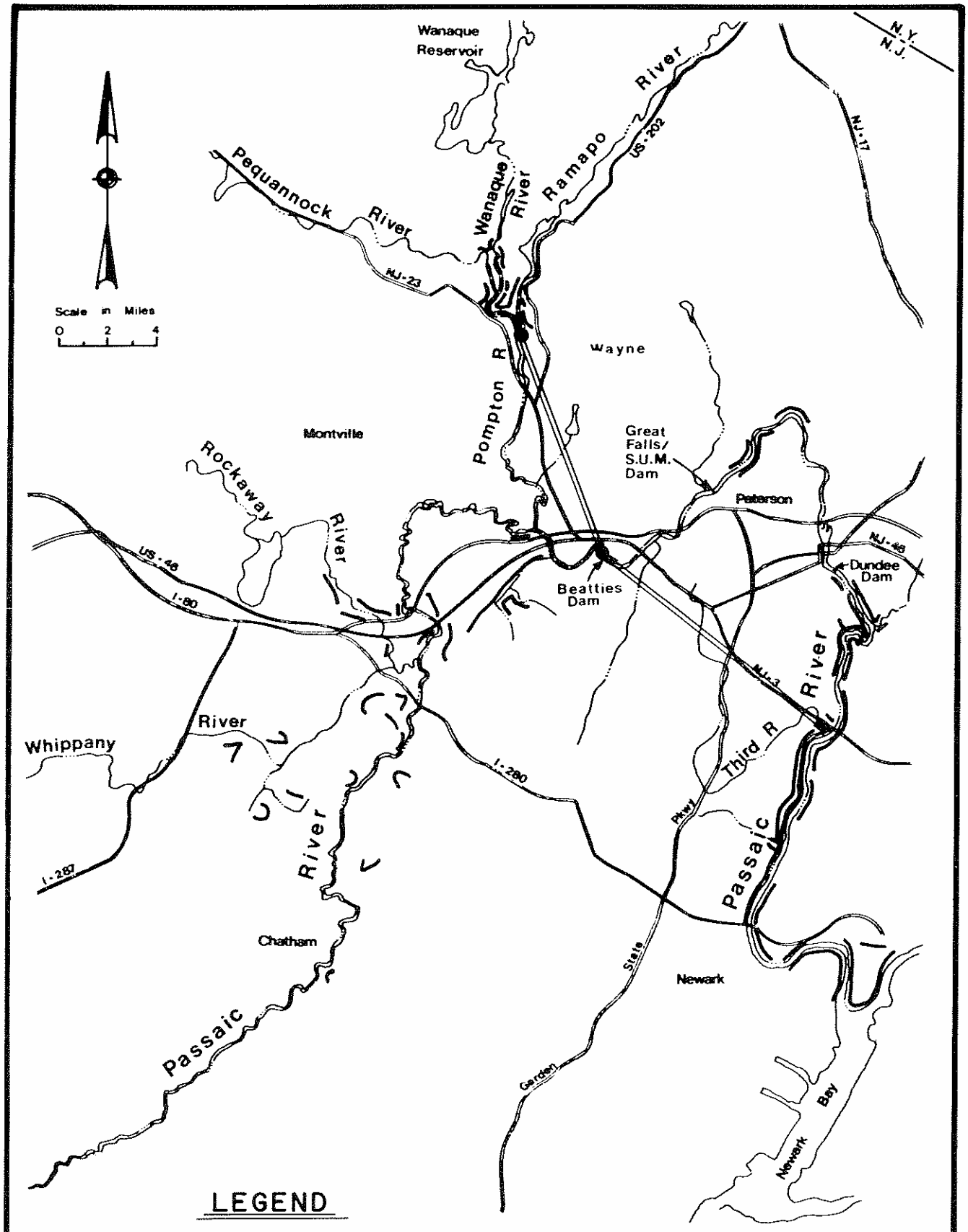
CHANNEL MODIFICATION
DIVERSION TUNNEL
Passaic River Study N.J. & N.Y.
PLAN 30C

FIGURE N° 18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Newark
Garden
Newark Bay
LEGEND
LEVEE OR FLOODWALL
CHANNEL MODIFICATION
DIVERSION TUNNEL
Passaic River Study N.J. & N.Y.
PLAN 30 E

FIGURE Nº 19

- Channel modifications were not feasible in the lower Passaic River tidal reach because they would not reduce tidal flood stages. They were not considered further.

- Verification was made of the earlier conclusion that no Federal flood control action was economically feasible in the Upper Passaic River.

- Existing and new reservoirs, aquifer recharge, tidal barriers, and combinations of these measures were verified as impractical and economically unjustified.

- The addition of nonstructural measures not protected by levees and/or tunnel works contained in the intermediate alternatives is not incrementally feasible. However, the substitution of nonstructural measures for levee systems is feasible at a limited number of locations.

- Preservation of natural storage was found to be a compatible component with any of the seven intermediate stage alternatives.

EVALUATION OF SEVEN INTERMEDIATE PLANS

Intensive evaluation studies were focused on the seven basic intermediate plans, and they were evaluated within a much broader context than the economic criteria that were used for the initial screening. A full range of economic, environmental and other criteria were utilized in this evaluation. The seven alternatives were presented to the public and the non-Federal sponsor. This resulted in much public input into the screening process. The evaluation of the alternatives is summarized in Tables 10 to 12.

Table 10 shows that the alternative with the greatest net economic benefits is the Dual Inlet Tunnel Plan (30E). This table also indicates that the preservation of natural storage measure would be economically justified on a first added basis.

A ranking of the plans, based on assessment of environmental effects, is presented in Table 11. The results of this analysis show that the best plans from an Environmental Quality (EQ) standpoint were Plans 14A and 16A. Plans 15A and 30A had the most severe environmental impacts.

The Water Resources Council's Principles and Guidelines require that one of the alternative plans must optimize National Economic Development (NED), i.e., maximize net benefits. However, the nature and severity of Passaic Basin flooding necessitated the adoption of several additional criteria to

TABLE 10
ECONOMIC SUMMARY OF BASIC INTERMEDIATE PLANS
(OCT. 85 PRICE LEVEL, 8-5/8 %, $1,000'S)

PLAN	TOTAL INVESTMENT COST	ANNUAL COST	ANNUAL O&M	TOTAL ANNUAL COST	ANNUAL BENEFITS	B/C RATIO	NET BENEFITS
14A	395,000	34,200	3,100	37,300	39,700	1.06	2,400
16A	452,000	39,100	2,700	41,800	46,000	1.10	4,200
15A	926,000	79,900	7,100	87,000	87,600	1.01	600
30A	960,000	82,800	5,800	88,600	98,100	1.10	9,500
30G	1,054,000	90,900	5,700	96,600	99,000	1.02	2,400
30C	997,000	86,000	3,900	89,900	98,700	1.10	8,800
30E	1,004,000	86,600	3,900	90,500	100,700	1.10	10,200
PRESERVATION	16,000	1,400	0	1,400	3,700	2.60	2,300

TABLE 11

RELATIVE RANKING OF PLAN EFFECTS ON SIGNIFICANT ENVIRONMENTAL RESOURCES

SIGNIFICANT RESOURCES	LV/FW-NS	LV/FW-CH-NS	LV/FW-CH	TUNNEL PLANS			
				Beatties Plan	Two Bridges	Pompton	Dual
LOWER VALLEY	14A	16A	15A	30A	30G	30C	30E
Wetlands	5	6	7	1	1	1	1
Anadromous Fish	1	6	7	2	2	2	2
Terrestrial Resources	5	1	6	2	2	2	2
Aesthetics	2	1	7	2	2	2	2
Cultural Resources	2	1	7	2	2	2	2
Water Quality	1	2	3	4	4	4	4
Air Quality	5	6	7	1	1	1	1
Noise	5	6	7	1	1	1	1
CENTRAL BASIN							
Wetlands *	2	2	4	4	1	4	4
Aquatic Resources	1	1	4	4	3	4	4
Buried Valley Aquifer	1	1	3	3	7	3	3
Aesthetics	2	2	4	4	1	4	5
Cultural Resources	2	2	4	4	1	4	4
Water Quality	2	2	4	4	1	4	4
Air Quality	2	2	4	4	1	4	4
Noise	2	2	4	4	1	4	4
POMPTON VALLEY							
Wetlands	1	1	5	5	5	3	3
Aquatic Resources	1	1	5	5	5	3	3
Buried Valley Aquifer	1	1	5	5	5	1	1
Aesthetics	1	1	5	5	6	3	3
Cultural Resources	1	1	5	5	6	3	3
Water Quality	1	1	5	5	5	3	3
Air Quality	1	1	5	5	5	3	3
Noise	1	1	5	5	5	3	3
Points	48	51	122	86	73	68	69
Rank	1	2	7	6	5	3	4

LV = Levee
FW = Floodwall
CH = Channel
NS = Non-Structural

NOTE: Lowest point score and ranking has least environmental effect.

* The addition of preservation of natural storage areas, which would have beneficial environmental effects, would not change the ranking of the plans.

TABLE 12 SUMMARY OF INTERMEDIATE PLAN EVALUATION
(Oct. 85 Price Level, 8-5/8% Interest Rate, $1,000's)

EVALUATION CRITERIA	WITHOUT PROJECT	14A	16A	15A	30A	30G	30C	30E
EXCESS ANNUAL BENEFITS ($1,000's)	0	2,400	4,200	600	9,500	2,400	8,800	10,200
AVERAGE ANNUAL EQUIVALENT BENEFITS ($1,000's) 1/	0	39,700	46,000	87,600	98,100	99,000	98,700	100,700
RESIDUAL AVERAGE ANNUAL EQUIVALENT DAMAGES (1,000's) 2/	95,100	58,200	51,900	20,600	13,400	12,700	12,900	11,500
RESIDUAL 500 YR STAGE DAMAGE ($1,000's) 2/	2,371,000	2,371,000	2,267,000	1,526,000	1,224,000	1,115,000	1,196,000	1,021,000
B/C RATIO	N/A	1.06	1.1	1.01	1.1	1.02	1.1	1.1
TOTAL INVESTMENT COST ($1,000's)	0	395,000	452,000	926,000	960,000	1,054,000	997,000	1,004,000
ANNUAL O&M ($1,000's)	0	3,100	2,700	7,100	5,800	5,700	3,900	3,900
TOTAL ANNUAL COST ($1,000's)	0	37,300	41,800	87,000	88,600	96,600	89,900	90,500
PREVENT LOSS OF LIFE	NONE	MODERATE	MODERATE	HIGH	HIGH	HIGH	HIGH	HIGH
PRESERVE TRANSPORTATION FACILITIES	NONE	MODERATE	MODERATE	HIGH	HIGH	HIGH	HIGH	HIGH
LEVEL OF PROTECTION PROVIDED	0	10-100YR	10-100 YR	100YR	100YR	100YR	100YR	100YR
EFFICIENCY	NONE	LOW	LOW	HIGH	VERY HIGH	VERY HIGH	HIGH	VERY HIGH
ACCEPTABILITY								
NON-FEDERAL SPONSOR	NONE	LOW	LOW	MODERATE	HIGH	VERY HIGH	HIGH	VERY HIGH
PUBLIC	NONE	MODERATE	HIGH	LOW	HIGH	HIGH	HIGH	VERY HIGH
COMPLETENESS	NONE	PARTIALLY COMPLETE	PARTIALLY COMPLETE	PARTIALLY COMPLETE	COMPLETE	COMPLETE	COMPLETE	COMPLETE
EFFECTIVENESS	NONE	LOW	LOW	HIGH	HIGH	HIGH	HIGH	HIGH

1/ INCLUDES BENEFITS DUE TO INUNDATION REDUCTION, AFFLUENCE, RESIDENTIAL INTENSIFICATION, TRAFFIC FLOW, INDUSTRIAL CONTENT GROWTH, ADVANCE BRIDGE REPLACEMENT, AND FIA COST REDUCTION WHERE APPLICABLE.

2/ EXCLUDES UPPER PASSAIC BASIN.

facilitate evaluation of plan performance. These criteria placed additional weight on each plan's ability to reduce the flood related economic losses sustained in the Basin. A summary evaluation of Plans 14A, 15A, 16A and 30A, 30C, 30E, and 30G is presented in Table 12.

SCREENING OF SEVEN INTERMEDIATE PLANS

The seven basic intermediate plans were screened through intensive trade-off analyses of their beneficial and adverse effects, and detailed evaluations of their acceptability, efficiency and completeness.

The screening process included assessments of economic data for the seven plans (Table 10), their relationship to significant environmental resources (Table 11), and economic impacts and plan evaluation data for other criteria (Table 12). An in-house planning team approach was used to assess the relative importance of each resource, impact or criteria. This evaluation approach was used in an attempt to develop more insightful results. While the potential for bias existed, this approach was considered to provide the best basis for determining the relative merits of the alternatives.

The results of the evaluations summarized in Tables 10, 11 and 12 were further evaluated. This developed into an overall planning team assessment, which is summarized in Table 13. This table includes criteria which were deemed the most important in evaluating the seven plans.

These criteria included: 1) economic ranking; 2) environmental ranking; 3) acceptability to the non-Federal sponsor; 4) acceptability to the public; and 5) completeness. Table 13 presents a grand summary evaluation based on these criteria, along with a straight raw score and overall ranking. The information included in this series of tables shows the significant trade-offs made between alternatives.

The trade-off analysis indicated that the Dual Inlet Tunnel Plan (30E) ranked the highest, with the lowest raw score. This plan was strongly supported by a portion of the Basin's interests. This plan would provide a 100-year level of protection throughout most of the planning area. It is the NED plan. It would cause moderate adverse environmental effects in the sensitive Central Basin wetlands by minimizing impacts with setback levees and a gated Beatties Dam. This plan would have virtually no surface works in the Pompton Valley. The Dual Inlet Plan was carried into the detailed planning stage for further study.

TABLE 13

SUMMARY RANKING OF INTERMEDIATE PLANS
PASSAIC RIVER BASIN

Plan	SIGNIFICANT CRITERIA RANKING 1/					TOTAL RAW SCORE	OVERALL RANKING
	NED (From Table 10)	EQ (From Table 11)	NON-FED SPONSOR (From Table 12)	PUBLIC ACCEPTABILITY (From Table 12)	COMPLETENESS (From Table 12)		
14A	5	1	7	6	7	26	6
16A	4	2	6	2	6	20	5
15A	7	7	5	7	5	31	7
30A	2	6	4	3	2	17	2
30G	5	5	3	3	2	18	4
30C	3	3	2	5	4	17	2
30E	1	4	1	1	1	8	1

1/
where 1 = most desirable plan .... 7 = least desirable

The Beatties Dam Inlet Tunnel Plan (30A) ranked second, both overall and in NED efficiency. Because it was a potential NED candidate, it was also selected for further study in the detailed planning stage, despite significant adverse environmental impacts in the Pompton Valley.

The Pompton Inlet Tunnel Plan (30C) was tied for second place overall, based on the many favorable impacts it shares with the Dual Inlet Plan. This plan's major trade-off is for marginally less environmental impacts than the Dual Inlet Plan because there would be no construction, or operation, of a second inlet. However, this slight environmental advantage was at the expense of less NED efficiency and completeness. From an NED standpoint, the Pompton Inlet plan ranked third. The flexibility provided by the Dual Inlet Plan's second inlet, results in a more complete plan. This flexibility is highly desirable to Lower Valley interests and is the reason the Pompton Inlet Tunnel Plan is not as acceptable as the Dual Inlet Plan.

The Two Bridges Inlet Plan (30G) ranked fifth in NED efficiency and fourth overall. The major trade-off produced by this alternative is that it precludes the need for 3.6 miles of channel modification from Beatties Dam to Two Bridges, instead directing floodwaters through an additional two miles of tunnel. The adverse environmental impacts of this plan are less than those of the Beatties Dam Inlet Plan.

The levee/floodwall/nonstructural/channel modification plan (16A), which includes 10-year nonstructural measures in the Pompton Valley and from Beatties Dam to the upstream limit of Deepavaal Brook, was ranked fourth from a NED standpoint and a strong second on EQ criteria. The major trade-off is that it achieves its rankings at the sacrifice of completeness. This is because it provides only a 10-year level of protection in the Pompton Valley and portions of the Central Basin. Although this alternative is clearly not acceptable to Pompton Valley/Central Passaic interests, it is supported by environmental groups and some Lower Valley municipalities. The segment of the public which supports "buyout" plans for the Central Basin area, fueled interest in the concept behind this alternative which provides a striking contrast to the tunnel plans in both physical impacts and local support. Since it was the highest ranked no-tunnel plan and was ranked fifth overall, it was selected for additional consideration.

The levee/floodwall/nonstructural plan (14A) ranked sixth overall. It was tied in sixth position from an NED standpoint, but first on EQ criteria. It has the least impacts on fish and wildlife resources. Its relatively low NED standing, and other deficiencies in the completeness and local sponsor criteria, eliminated this plan from further consideration.

The levee/floodwall/channel modification alternative (15A) was ranked last. This low overall ranking was the result of its poor NED rating and extensive environmental impacts. Because it would increase the flood discharges entering the Lower Valley at Little Falls by eliminating the flow reversal up into the Central Passaic, this plan has the most extensive system of surface works of all the plans. It was therefore screened from further study.

PUBLIC INVOLVEMENT AND INPUT

During the intermediate planning stage, study findings were coordinated with the State of New Jersey, with a primary focus on public involvement/citizen participation activities for presenting the intermediate stage alternatives to the public.

The intermediate stage public involvement program was initiated in February 1984. A jointly-sponsored public meeting was held in Lincoln Park on April 3, 1984. Two days later, the Passaic River Basin was hit with the worst flooding in recent history. Devastating rainfall on April 5 and 6, 1984 caused flooding which ranged from a 25-year event on the Passaic River at Little Falls, to a 50-year event on the Pompton River. Runoff far exceeded the rainfall because of snowmelt and thawing ground. Approximately 9,400 residents were evacuated from their homes, with flood damages estimated over $330 million.

This disastrous flooding also caused significant political action. The New Jersey Governor toured the flood area on April 6, made a disaster declaration and issued a call for remedial action. Within a week, NJDEP officials announced that the State of New Jersey would select an alternative for detailed Corps of Engineers study by June 1984.

This intention to select a flood damage reduction plan was announced at an April 19 public meeting at Wayne. The NJDEP sponsored a series of eight workshop meetings, which were held during the following weeks, two each at Pompton Lakes, Totowa, Parsippany-Troy Hills and Nutley. The Corps of Engineers presented intermediate planning stage findings, focusing on the seven basic alternatives and options. An intermediate planning stage report and descriptions of the alternatives were widely distributed, generating significant public interest. This

prompted many questions and requests for additional information. Numerous meetings were scheduled with county and municipal officials and engineers, and with local citizen groups, environmental organizations and business organizations.

At a June 12, 1984 public meeting, also at Wayne, N.J., the NJDEP announced the tentative selection of the Dual Inlet Tunnel Plan as their preferred alternative. A detailed description of this plan was presented, and reaction and input were solicited from the public before the final State decisions was made.

ISSUES AND CONCERNS

Many issues and concerns were expressed at the eight NJDEP workshop meetings, held during April and May 1984. Throughout these meetings, a number of issues surfaced repeatedly. These issues revolved around the quick time frame and basis for the State's plan selection; the time frame for the implementation of a potential project; support for a tunnel diversion solution versus other types of alternatives; concern for the potential impacts and high costs of a tunnel; questions regarding the sharing and financing of the non-Federal costs; and questions regarding various site-specific elements of the alternatives.

Significant concern was expressed over the State's timetable for selecting a plan, and the schedule for completing and implementing a project. Throughout these meetings the planners heard repeated pleas from flood victims and municipal governments in the Pompton Valley and Central Basin for quick action to solve the flood problem. The desire for haste in decision making, future planning and implementation was brought out at all of the meetings. On May 30, 1984, the Basin was hit by more severe flooding, resulting in strong and emotional expressions of support for quick action.

A contrast to these pleas was significant opposition to the State's accelerated decision-making schedule. This concern was voiced primarily by lower Passaic River municipalities and environmental interests. Their concern was that this short period did not allow sufficient time for local review of the plans, and for the development of official positions. A related concern revolved around how New Jersey officials would make their decisions. The State's basis for selecting a plan was often questioned, and requests were made to NJDEP to extend their June decision deadline. While concerns regarding the State's decision-making time frame were divided, the opinion that the schedule was too short was a predominant view.

Concern was also expressed regarding the length of time required to implement a plan. The 15-to-20 year period to implement a major Corps of Engineers project was viewed as unacceptable by most of the Passaic Basin's interests, including many who were critical of the State's short decision-making deadline. Concern for accelerating the implementation of a solution led many interests to support alternatives, such as buyout plans, which were viewed as having a shorter implementation schedule. In addition to acquisition plans, alternatives suggested for immediate implementation included clearing and snagging projects, construction moratoriums, and storm water management measures. Support for acquisition and moratorium alternatives were primarily voiced by Lower Valley interests who wanted these measures applied in the Central Basin area. Support for storm water management was widespread, while Central Basin communities suggested clearing and snagging measures.

The most comprehensive list of alternative suggestions was furnished by the Passaic River Coalition. The Coalition's 21-point program prompted the NJDEP to include provisions for land acquisition, restrictions on floodplain development, snagging and clearing, and storm water management, into their overall flood control program for the Passaic River Basin. However, even where there was agreement to the conceptual merit of specific measures, the degree to which the State sought their implementation remained an issue.

By far, the heaviest support was voiced for the tunnel plans, specifically the dual inlet tunnel plan. The comprehensive, high level of protection it produced, the flexibility of two tunnel inlets, and the minimal amount of surface works and environmental impacts were the factors cited most often in support of the dual inlet plan. Negative factors cited included the high cost of the plan, the long time frame for implementation, the outlet location, and concern about potential induced effects along the lower Passaic River. The most significant issue was the worry that the tunnel would transfer the Central Basin flood problems to the Lower Valley. Many suggested that the tunnel outlet be moved to Newark Bay. Another concern was the potential for reduced recreational opportunities and commercial access to the lower Passaic River.

The outlet location issue was a significant concern among the municipalities downstream of Route 3. The planners conclusively demonstrated that the plans would definitely not result in the protection of one area at the expense of another. It was further pointed out that the Corps of Engineers could not recommend such a plan. The tunnel discharges would be safely contained by modifying the lower Passaic River levee/floodwall

systems that are already necessary to protect against the tidal and fluvial flooding. At the 100-year flood stage, the water level would be 3 to 5 feet below the top of the levee/floodwall systems. The largest impacts on levee/floodwall heights and extents would be at the outlet. The area of expanded protection would run from the Second River upstream to the City of Passaic. Downstream of the Second River, the larger capacity of the Passaic River channel would dissipate discharges and the tunnel would have no effect on levees for this lower reach.

It was also pointed out that diversion tunnels outletting at other downstream locations, including into Newark Bay, were evaluated as part of the Passaic River Basin Study. They were found to be economically infeasible on an incremental basis, with the cost of each mile of underground tunnelling approximately $40-to-$50 million. Six more miles of tunnel would be required to outlet into Newark Bay. Although levees and floodwalls would no longer be required to protect against tunnel discharges, some would still be required to protect against tidal flooding. The Newark Bay outlet option would add approximately $300 million to the investment costs of the tunnel plans and is not incrementally feasibile.

It was explained that access to the river would be addressed during the detailed planning stage. Where access is vital, the planners worked with municipalities to develop levee alignments that were suitable. If that wasn't possible, openings would be included in the line of protection, using closure structures or gates during flood events.

Another issue of major significance involved the State of New Jersey's method of apportioning the non-Federal share of the project cost. The State's position was that this was a complicated issue which could not possibly be fully resolved prior to plan selection. They did not want to cloud the issue of which plan was preferable with questions regarding the many financial arrangement options. During the detailed planning stage, the State studied a variety of options available to them, and developed a formula for apportioning non-Federal costs among local interests.

Finally, there was an overwhelming response for additional information regarding the alternative plans. Many local meetings were held prior to New Jersey's selection of a plan, and many more have been held since to discuss specific plan elements with county and municipal officials.

STATE SELECTION OF A PLAN

On June 12, 1984, the NJDEP announced its tentative selection of the dual inlet tunnel alternative for the Passaic River Basin. This selection was formalized on June 28, 1984 at a meeting in Trenton, N.J. between the New York District Engineer and the New Jersey Environmental Protection Commissioner. The selection was confirmed by letter on that date requesting the Corps of Engineers to proceed with detailed plan formulation on the selected alternative. The Commissioner cited the following as the basis for selecting the Dual Inlet Tunnel Plan:

- It provides basin-wide protection at the 100-year design storm as a minimum.
- It causes minimum surface disruption from the construction of levees and floodwalls;
- It causes the least disruption to the rivers and streams in the Basin through channel modifications;
- It causes the least disruption to transportation and services within the Basin through bridge and highway modifications and relocation of utilities and other services;
- It provides comprehensive protection through flexibility of operation with two inlets;
- It minimizes maintenance costs;
- It incorporates protection of inland wetlands, floodways and floodplains; and
- It minimizes disruption during construction.

The Commissioner also noted that an alternative plan, the Two Bridges Inlet Plan, while not meeting all their criteria, does have the positive effect of not requiring Passaic River channel modification from Two Bridges to Beatties Dam. It was requested that during the detailed planning phase, the Corps of Engineers investigate means of incorporating an inlet at Two Bridges into the dual inlet scheme.

The letter acknowledged that all of the economically feasible plans which provided consistent 100-year protection required expanded levee and floodwall systems in the tidal area to afford protection from increased tunnel discharges. The Commissioner requested that the Corps investigate means to minimize the extent of additional levees and floodwalls during detailed planning.

As an expression of support for the dual inlet tunnel plan, the Commissioner also announced a number of other State measures aimed at providing comprehensive flood control in the Passaic River Basin. These included:

1. New flood hazard area regulations to control construction and filling the floodways and flood fringe areas, effective May 21, 1984.

2. Educational work sessions for municipal and county officials for the implementation and enforcement of the flood hazard area regulations.

3. Development of a formalized method for municipal and county involvement in the implementation of the flood hazard area Regulations.

4. Acceleration of the completion of flood hazard area delineations in the Passaic Basin.

5. Active pursuit of means to make existing storm water management regulations mandatory.

6. Preservation of natural storage areas through the acquisition/regulation of wetland areas.

7. Consideration of the acquisition of frequently flooded properties on a limited scale, as an alternative to protecting those properties.

8. Non-Federal sponsorship of the flood early warning system being developed as a Federal flood control project.

9. To work in conjunction with the Corps of Engineers to design a program for cleaning, desnagging and limited dredging in order to mitigate nuisance flooding.

10. Continue to serve as non-Federal sponsor of Federal flood control projects in the Passaic Basin.

ALTERNATIVES SELECTED FOR DETAILED PLANNING

Based on the letter expressing the desires of the State of New Jersey, the alternatives selected for consideration in the detailed planning stage were the Levee/Floodwall/Nonstructural/ Channel Modification Plan (16A), the Beatties Inlet Tunnel Plan (30A), and the Dual Inlet Tunnel Plan (30E).

Other plan elements identified for Detailed Planning Stage evaluation included preservation of natural storage areas, fish and wildlife mitigation measures, and the acquisition of a limited number of frequently flooded structures. These measures were considered to be potentially compatible with any of the three Basinwide alternatives selected for further analysis, subject to incremental economic justification on a last-added basis.

DETAILED PLANNING STAGE

The detailed planning stage involved refining the design of the three plans carried forward into detailed development. The planners initiated this stage by gathering the most current available information and developing conditions expected at the time of construction and thereafter. A wide range of information was considered, including existing and future hydrologic and hydraulic design conditions, as well as each plan's hydraulic effectiveness, economic efficiency (including incremental justification), public acceptability, and resulting environmental effects. The eight major tasks involved in the detailed planning stage included establishing a base year for design conditions, finalizing the without project conditions, refining the design and cost estimates, screening incremental plan elements for feasibility, determining the most economical level of protection, incorporating preservation of natural storage, determining the feasibility of incorporating other plan elements, and incorporating fish and wildlife mitigation measures.

DETAILED STAGE FINDINGS

The time frame required to complete construction of each three plans, when considered in light of optimistic estimates of the review and authorization process for this type of project, indicated that 2000 would be the most appropriate project base year.

Finalizing the without project conditions included updating hydrologic statistics and models, hydraulic flowlines, economic data, and environmental data and analyses. The results of this update served as the basis for the final evaluation of the detailed plans.

For each of the alternatives, cost estimates and designs were refined by incorporating the final without project conditions data and reviewing previous estimates and assumptions.

Hydraulic studies included the refinement of the design of all project components with extensive sensitivity analyses to determine optimum sizes and configurations of plan elements including tunnels, inlet and outlet structures, and transition channels, as well as operating procedures.

The hydrologic model was utilized extensively for measuring the effects of various sized plan components, particularly the tunnels. The model was also used for determining the most effective operating procedures for achieving flood damage reduction, and to allow for fish and wildlife mitigation and the preservation of wetlands.

An extensive subsurface investigations program was undertaken along the tunnel alignment of the tunnels, channels, levees and floodwalls in order to evaluate subsurface conditions affecting their constructibility. This information was used to develop the cost estimates.

Levees, floodwalls, and other independent features of the plans, were further screened incremental feasibility through a "last added/first added" analysis in order to provide more efficient protection.

Investigations of different scales of development for the independent features of the three detailed alternatives sought to either equal or surpass the economic efficiency of the intermediate plans by identifying the most economical level of protection. This optimum level occurs at the scale of development which meets the National Economic Development (NED) criteria of achieving maximum net benefits, that is, the difference between the benefits and costs is maximized. This NED rating is extremely significant, because it provides a basis for determining the Federal interest in solving a flood problem.

Analyses were made to determine the prime areas for preservation of natural storage and the best timing for the implementation of this element. It was determined that the acquisition of 5,350 acres of natural storage areas should be implemented by 1990.

Preservation of natural storage was determined to be economically feasible, both as a plan in itself and as an element of multi-component plans. Preventing the loss of these storage areas would help maintain the protection level provided by the alternative plans throughout the project life. It was included as an element of all of the three detailed plans.

The inclusion of other elements, such as acquisition of residential structures (buyouts) and recreation, as part of the plan were investigated. It was determined that feasible recreational enhancement would be more appropriately treated under beautification and that buyouts would not be incrementally feasible on a last added basis. Therefore, no buyout element was incorporated into the detailed plans except where needed to implement other plan features, such as channel modifications.

A Fish and Wildlife Service Planning Aid Report for the Passaic River Basin contained many recommendations which influenced the direction and the results of detailed planning. The most significant results were the inclusion of the Great Piece Meadows weir and the development of operating procedures for the tunnels and the weir which would maximize flood damage reduction while maintaining the wetlands and river flushing. A weir would also be included on the Pequannock River as part of the tunnel alternatives in order to maintain upstream water surface elevations and thereby maintain existing wetlands and aquatic habitat. In addition, existing stream meanders would be maintained wherever possible, low flow pilot channels would be included, and cobble substrate placed in the modified channels. A full discussion of environmental design and mitigation measures eventually included in the detailed plans is presented in Section 3 of the EIS. These measures are listed in Chapter 6 of this report.

DETAILED STAGE PLAN REFINEMENT SUMMARY

During the detailed planning stage, Plans 16A, 30A and 30E were refined to be more economically efficient and more responsive to the problem and opportunity statements. The major plan changes and the final iterations of these plans are described in the following paragraphs:

Levee/Floodwall/Nonstructural/Channel Modification Plan - Plan 16A. Plan 16A consists of a combination of levees, floodwalls, channel modification, and nonstructural elements (Figure 20). During the detailed planning stage, many levee/ floodwall systems were eliminated from this plan. The remaining works were optimized, resulting in varying levels of protection between the areas protected by different types of works and even

between individual levee systems. Levee/floodwall systems were optimized individually, with design levels varying from the 100- to the 500-year. The nonstructural elements of the plan, which were optimized to a 10-year design level, included predominantly floodproofing and raising. The channel modification was optimized at a 100-year level.

This plan features the 16.4 mile long channel modification in the Lower Valley from Route 3 in Rutherford up to Beatties Dam. It provides protection against a 100-year flood event.

Plan 16A's channel modification begins just downstream of Route 3 and extends approximately 5.4 miles upstream to a point near Fleishers Brook in Garfield. The bottom width of the modified channel would be 135 feet, and its alignment and top width would remain within the existing channel for almost its entire length. The proposed channel modification would include two sections of semi-trapezoidal channel, two sections of trapezoidal channel, with 2.5:1 side slopes and two sections of transition channel. The channel would be deepened an average of 8 feet.

From Dundee Dam up to the Great Falls, the proposed 7.3 mile-long channel would be a trapezoidal channel with a bottom width ranging from 540 to 95 feet at the upstream limit. The proposed channel would be deepened an average of 10 feet.

From the Great Falls up to Beatties Dam, there would be 3.7 miles of trapezoidal channel with bottom widths ranging from 184 feet at the S.U.M. Dam to 115 feet at Beatties Dam. The channel would be deepened an average of 6 feet. This plan also calls for lowering the crest of the S. U. M. Dam by 1.6 feet, to an elevation of 113.0 feet NGVD.

Plan 16A includes 10.5 miles of levees and 5.0 miles of floodwalls. The five levee/floodwall systems located along the lower Passaic River from Newark Bay up to the I-280 Bridge would protect against a 500-year tidal flood. These systems which are identical to those included in Plans 30E and 30A are summarized in the description of Plan 30E. Six intermittent systems located in the Central Basin along the Passaic and Rockaway Rivers and Pinch Brook would protect against floods ranging from the 100 year event to the 500 year event. Table 14 describes the levees and floodwalls. Ponding areas, pressure interceptors and pumping stations would be provided to protect against interior flooding.

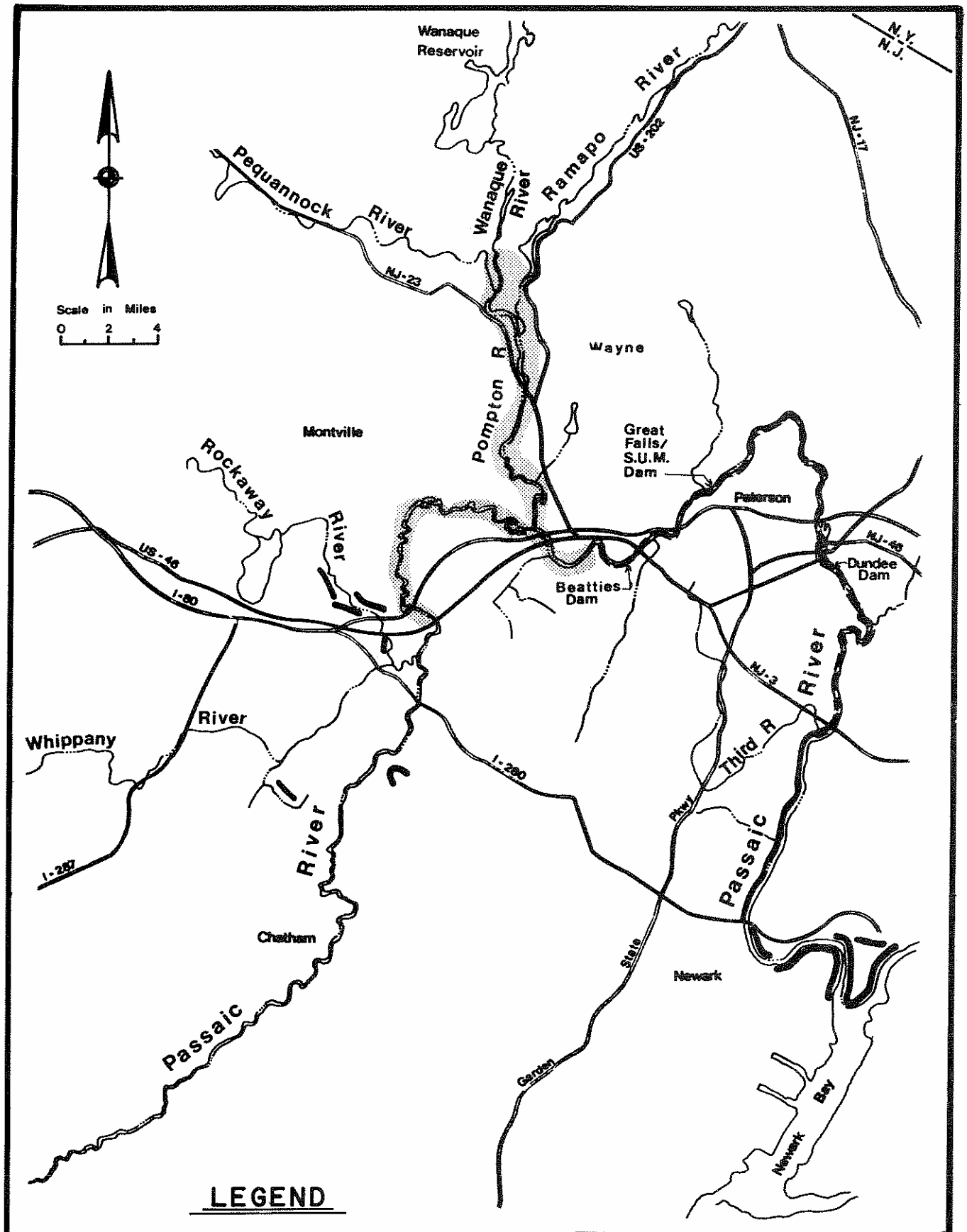

Wanaque Reservoir
Pequannock River
Wanaque River
Ramapo River
N.Y.
N.J.
NJ-17
US-202
NJ-23
Scale in Miles
0 2 4
Wayne
Pompton R
Montville
Rockaway River
Great Falls/ S.U.M. Dam
Paterson
NJ-46
Dundee Dam
US-46
I-80
Beatties Dam
NJ-3
Third R
Whippany River
I-280
Pkwy
Passaic River
I-287
Chatham
State
Newark
Garden
Bay
Newark
Passaic River
LEGEND
LEVEE OR FLOODWALL
CHANNEL MODIFICATION
NONSTRUCTURAL
Passaic River Study N.J. & N.Y.
DETAILED
PLAN 16A
LEVEE/FLOODWALL/NONSTRUCTURAL
CHANNEL MODIFICATION

FIGURE 20

TABLE 14

PLAN 16A
LEVEE/FLOODWALL PHYSICAL FEATURES

				LEVEE			FLOODWALL	
System	Municipality	Bank	River	Avg. Ht. (Ft.)	Avg. Base Width (Ft.)	Length (Ft.)	Avg. Ht. (Ft.)	Length (Ft.)
LOWER VALLEY								
Kearny Point	Kearny	Left Right	Passaic Hackensack	8.8	62.8	16,600	8.0	17,920
Doremus Ave.	Newark	Right	Passaic	8.0	58.0	2,400	10.2	1,910
Turnpike	Newark	Right	Passaic	7.4	54.4	2,030	7.5	590
Lister Ave.	Newark	Right	Passaic	7.4	54.4	4,930	10.5	2,910
South 1st St.	Harrison, E. Newark	Left	Passaic	7.9	57.4	3,130	8.3	2,800
CENTRAL BASIN								
Passaic R. #3B	Fairfield	Right	Passaic	15.5	103.0	3,660	-	-
Passaic R. #10	Livingston	Right	Passaic	10.8	74.8	4,500	-	-
Rockaway R. #1	Parsippany	Right	Rockaway	10.4	72.4	3,640	-	-
Rockaway R. #2	Montville	Left	Rockaway	9.0	64.0	5,340	-	-
Rockaway R. #3	Parsippany	Right	Rockaway	10.9	75.4	5,940	-	-
Pinch Brook	E. Hanover	Right	Pinch	7.1	52.6	3,380	12.5	200

TABLE 15
PLAN 16A - NONSTRUCTURAL MEASURES AND CHANNEL MODIFICATION PHYSICAL FEATURES

NONSTRUCTURAL MEASURES

Subbasin	Total Number of Structures		
	Floodproofing	Raising	Evacuation
CENTRAL BASIN			
Residential	1176	46	12
Non-residential	81	4	6
POMPTON VALLEY			
Residential	3004	516	10
Non-residential	196	12	15

Total 5078 structures involved in non-structural measures.

CHANNEL MODIFICATION PHYSICAL FEATURES

Reach	Length (ft)	Approximate Depth of Cut (ft)	Average Depth, Top of Banks to Invert (ft)	Average Base Width (ft)
Passaic River	2,000	dredged		
Route 3 to	2,600	5	30	135
Dundee Dam	12,850	5	30	135
	1,734	5	30	135
	7,916	15	30	135
	2,000	dredged		
Dundee Dam to				
Great Falls	4,515	5	25	540
	2,450	12	25	340
	3,350	5	25	280
	8,200	5	25	270
	13,200	15	25	210
	3,500	10	25	115
	4,400	10	25	95
Great Falls to	10,460	<5	20	184
Beatties Dam	9,280	10	20	115

The nonstructural measures included in Plan 16A would provide a 10-year level of protection to the Pompton Valley and the Passaic River between Beatties Dam and the upstream limit of Deepavaal Brook. These measures are detailed in Table 15. Plan 16A also includes the preservation of 5,350 acres of natural storage areas.

Beatties Dam Single Inlet Tunnel Diversion Plan - Plan 30A. This alternative, the Beatties Dam Single Inlet Tunnel Diversion Plan, was a candidate NED plan. The initial location of the inlet was at Little Falls, downstream of Beatties Dam. This inlet location was reviewed to ensure the selection of the most economically favorable site. Consideration was given to locating the inlet on Stag Island, a short distance upstream of both Beatties Dam and the rock ledge in the riverbed near the dam. Proper design would allow an inlet at this site to function with or without Beatties Dam. This relocation would eliminate the need for modification of the dam and the subsequent operation and maintenance of the dam. It would also eliminate a flow restrictor structure, and shorten the modified channel upstream of Beatties Dam by almost 2000 feet, including excavation through the rock ledge. The tunnel, however, would be lengthened by almost 3,000 feet, and a large inlet basin with gates would be required. An assessment of these alternatives indicated that the Stag Island inlet would be less costly, although not by a large margin, and easier to operate and maintain because of its simpler design and fewer components.

Another possibility involved an inlet further upstream near the confluence of the Passaic and Pompton Rivers. The obvious trade-off in this instance is the channel length between the inlet on Stag Island and the additional tunnel length to the Two Bridges area. The cost of the almost 9,000 feet of large diameter tunnel was determined to be more expensive than the increment of channel cost. The inlet at Stag Island, upstream of Beatties Dam, is used in the Single Inlet Plan.

The cost of the Passaic River channel modification upstream of the tunnel inlet was revised to reflect a shortening of modification due to the tunnel inlet relocation. The cost for the remaining channel modification was increased as a result of the reassessment of channel construction methods and the constraints imposed by the high development of the area in which the construction would take place. This reassessment was similar to that which was undertaken near the end of the Intermediate Planning Stage for the Pompton River. At that time, several construction methods, including floating dredges and draglines, were evaluated. Limited work and stockpiling areas and the need to move large volumes of excavated material through local streets to distant disposal areas were also

constraints. Possibly only a small portion of this material could be utilized in levee construction. In some areas, concrete floodwalls of considerable size would be required because many residential structures are located along the Pompton Riverbank. In several areas along the lower Pompton, it would be less costly to purchase the first row of structures and construct levees.

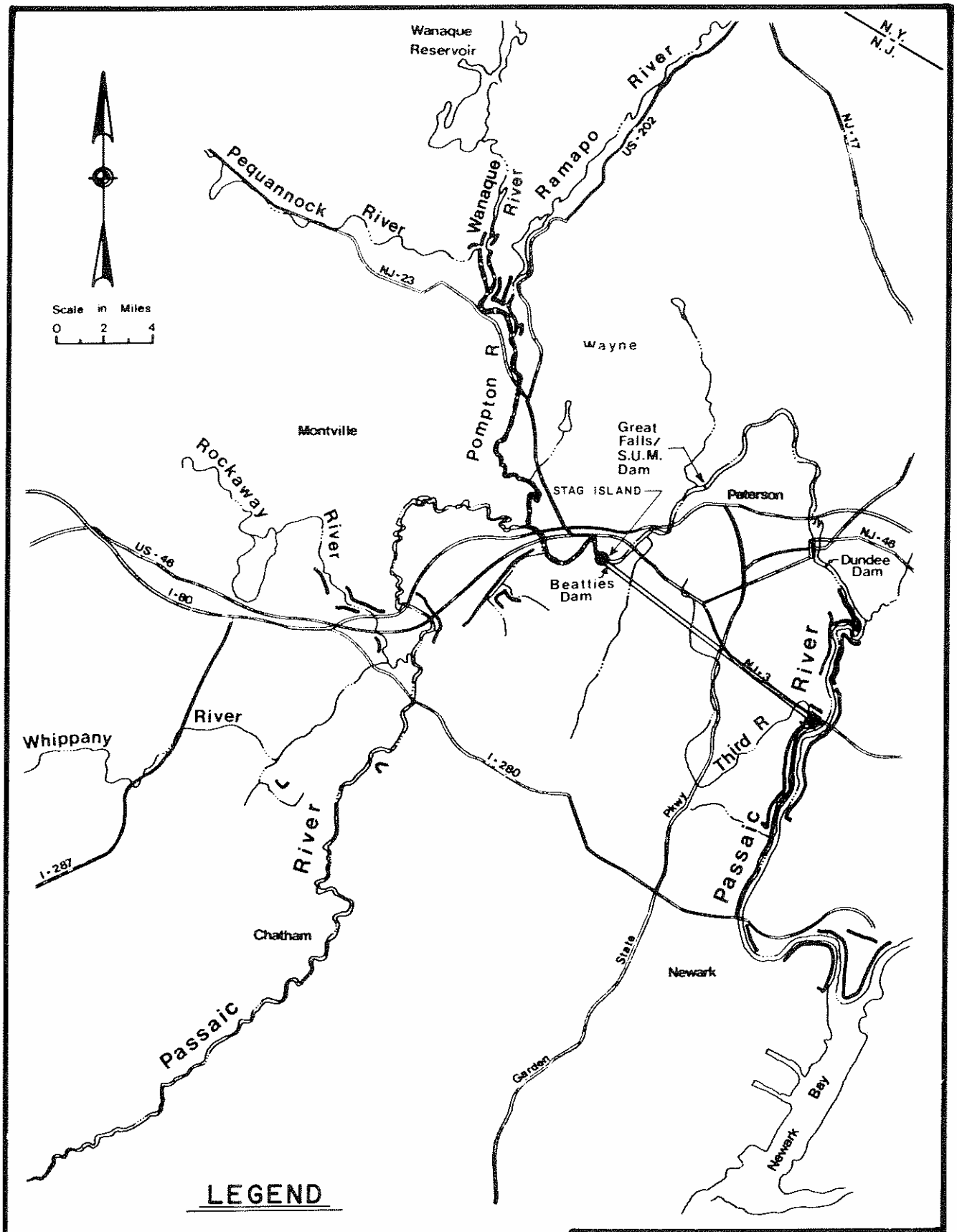
In addition to the refinements discussed above, the features of the plan were optimized, resulting in varying levels of protection in areas protected by different types of works and even in separate levee systems. A 35-foot tunnel diameter was found to be the optimum design size. It was determined that channel modifications upstream of the tunnel inlet would be sufficient to carry the design flow to the tunnel. Therefore, the levees and floodwalls, originally proposed for the Pompton River, were eliminated from the final iteration of Plan 30A. The remaining levee/floodwall systems were optimized individually, with design levels varying from the 100- to the 500-year. A description of the refined version of the Single Inlet Tunnel Plan (Plan 30A) follows:

The refined Plan 30A includes a 7 mile-long, 35-foot-diameter tunnel extending from about 2,000 feet upstream of Beatties Dam down to the Passaic River/Third River confluence. The tunnel inlet and diversion works would be located on Stag Island in the Passaic River at Wayne. The tunnel would divert floodwaters from the central Passaic River area to an outlet located near Clifton-Nutley border. The underground tunnel would be about 90 feet below ground level at the inlet and about 155 feet below the outlet.

The tunnel element would be combined with 14.7 miles of channel modification, 23.7 miles of levees, and 14.0 miles of floodwalls to provide varying levels of protection ranging up to a 100-year event in the Pompton Valley and up to a 500-year event in the Central Basin and Lower Valley. Plan 30A, which would take 145 months to construct, is illustrated in Figure 21. Tables 16 and 17 summarize the physical features of the plan.

The channel modification elements of this plan include deepening the Passaic River an average of 15 feet for 3 miles downstream of Two Bridges to the tunnel inlet to divert flood flows into the tunnel.

The Pompton River channel would be modified to an average 12-foot depth on a 6.8 mile reach upstream of Two Bridges. It would also be necessary to acquire 61 structures located either on islands in the channel or along the river banks.



Passaic River Study N.J. & N.Y.

DETAILED PLAN 30A

BEATTIES DAM SINGLE INLET TUNNEL DIVERSION

FIGURE Nº 21

TABLE 16 - SINGLE INLET TUNNEL PLAN
CHANNEL MODIFICATION PHYSICAL FEATURES

REACH	COMMUNITY	Average Depth of Cut (Ft)	Average Depth Top of Banks to Invert (Ft)	Average Base Width (Ft)	Average Top Width (Ft)
Passaic River					
Stag Island to Two Bridges 3.0 miles	Wayne	15	26	160	290
Pompton River					
Two Bridges to Pompton Plains 6.8 miles	Wayne (61 Structures Required to be Removed)				
	Lincoln Park	12	23	95	190
	Pequannock				
Peguannock River					
Confluence with the Pompton River upstream 2.6 miles	Wayne				
	Pequannock	14	24	75	170
	Pompton Lakes				
	Riverdale				
Ramapo River					
Confluence with the Pompton River upstream 1.3 miles	Wayne				
	Pompton Lakes	6	24	55	150
Wanague River					
Confluence with the Pequannock River upstream 1 mile	Pompton Lakes	6	18	75	150

TABLE 17
PLAN 30A - SINGLE INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)
LOWER VALLEY								
Tidal Systems								
Kearny Point	Kearny	Right Left	Hackensack Passaic	8.8	62.8	16,600	8.0	17,920
Doremus Ave.	Newark	Right	Passaic	8.0	58.0	2,400	10.2	1,910
N.J. Turnpike	Newark	Right	Passaic	7.4	54.4	2,030	7.5	590
Lister Ave.	Newark	Right	Passaic	7.4	54.4	4,930	10.5	2,910
South 1st St.	Harrison, E. Newark	Left	Passaic	7.9	57.4	3,130	8.3	2,800
Systems Integral to Tunnel								
Main St.	Belleville	Left Right	Second Passaic	4.5	37.0	560	7.5	6,580
River Road #1	N. Arlington, Kearny	Left	Passaic	7.3	53.8	4,710	6.0	830
Riverside Ave. #1	Lyndhurst, N. Arlington, Rutherford	Left	Passaic	12.6	85.6	8,570	9.3	2,460
River Road #2	Belleville, Clifton, Nutley	Right	Passaic	8.0	58.0	2,650	9.0	7,720
Yantacaw	Clifton	Left	Third	11.5	79.0	1,540	9.9	1,120
River Drive #1	City of Passaic	Right	Passaic	9.2	65.2	1,920	8.0	3,760
Riverside Ave. #2	Rutherford	Left	Passaic	9.2	65.2	1,570	11.6	4,990
River St.-Main Ave.	Rutherford, Wallington, E. Rutherford	Left	Passaic	8.2	59.2	5,860	10.1	4,160
8th St.	City of Passaic	Right	Passaic	10.0	70.0	2,580	10.8	9,780

TABLE 17 (CONT)
PLAN 30A - SINGLE INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)
CENTRAL BASIN								
Fluvial Systems								
Passaic 2A	Fairfield, West Caldwell	Left Right	Deepavaal Brook Passaic	8.6	61.6	19,430	9.0	1,230
Passaic 2C	West Caldwell	Right	Deepavaal Brook	7.0	52.0	4,860	8.5	950
Passaic 10	Livingston	Rightq	Passaic	8.4	60.4	4,500	-	-
Rockaway 1	Parsippany-Troy Hills	Right	Rockaway	8.7	62.2	3,640	-	-
Rockaway 2	Montville	Left	Rockaway	8.3	59.8	5,340	-	-
Rockaway 3	Parsippany-Troy Hills	Right	Rockaway	10.3	71.8	6,320	-	-
Pinch Brook	East Hanover	Right	Pinch Brook	6.6	49.6	3,380	12.0	200
PEQUANNOCK-WANAQUE-RAMAPO								
Fluvial Systems								
Pequannock-Ramapo	Pompton Lakes	Right	Ramapo	11.9	81.4	9,230	13.3	1,500
Shore Road	Wayne	Left	Ramapo	10.5	73.0	4,500	10.7	1,200
Stiles Court	Pompton Lakes	Left	Pequannock	3.3	29.8	1,760	-	-
Hill Court	Pompton Lakes	Right	Wanaque	8.7	62.2	1,350	8.0	600
Wanaque Avenue	Pompton Lakes	Left	Wanaque	9.9	69.4	1,540	10.5	680

The lower Pequannock, Wanaque and Ramapo Rivers would require a total of 4.9 miles of channel modifications. The average deepening in the three tributaries would be 14, 6, and 6 feet, respectively. Approximately 3.5 miles of levees and 0.7 miles of floodwalls would also be required. The systems along the lower reaches of the three tributaries would average approximately 2.5 feet higher than those in Plan 30E. The levee/floodwall elements in the Central Basin and Lower Valley would be identical to those of the Dual Inlet Tunnel Plan and are summarized in the description of Plan 30E. The preservation of 5,350 acres of natural storage areas would also be implemented as part of this plan.

Pompton River - Passaic River Dual Inlet Tunnel Diversion Plan - Plan 30E. It was also determined that the Passaic River inlet of the duel inlet plan would be more cost effective if located at Stag Island, upstream of Beatties Dam, as in the Beatties Single Inlet Plan. This analysis, described in the previous section on the single inlet plan, led to a relocation of the tunnel alignment which lengthened the lower limb by almost 3,000 feet to the northwest and shifted the lower end of the upper limb almost 1,500 feet further westward. While this move did not alter the overall length of the tunnel significantly, it did result in changes to the plan.

A review was conducted to determine the feasibility of relocating the Passaic River inlet to the vicinity of Two Bridges, as requested by the State of New Jersey. The first approach was to realign the tunnel directly from the Third River outlet to Two Bridges and then to the Pompton Inlet location. A cost analysis indicated that the additional length of tunnel would cost more than the trade-off of channel costs between Two Bridges and Stag Island. Geologic studies revealed a subsurface indentation, possibly a buried valley, that placed competent bedrock well below the alignment of the tunnel. Tunnel construction in this area would require changing from a TBM to soft ground excavation methods, and then back to the TBM to continue rock excavation. This would lower excavation rates and raise unit excavation costs, resulting in higher project costs, and greater uncertainty in the overall estimates. This route was, therefore, eliminated.

When geologic studies confirmed adequate subsurface conditions along the original route, a spur tunnel was considered between the Two Bridges inlet and the main tunnel west of Route 23, along an alignment north of Route I-80. The resulting trade-off is 1.2 miles of tunnel, 22 feet in diameter, versus the modified channel between Stag Island and Two Bridges. The smaller diameter spur tunnel proved to be the more cost effective alternative. The advantages of the spur tunnel

include focusing construction activities at the tunnel workshaft site and avoiding the disruption along the entire Stag Island to Two Bridges reach that occurs with channel construction. The spur tunnel also results in a shortened construction period; and a large reduction in maintenance costs compared with those associated with channel plans and surface features in general. In addition, the smaller volumes of clean tunnel spoil offer easier disposal, and may be marketable. The reduced channel disturbances are also preferred for preservation of the natural fishery habitat.

Another investigation involved the potential relocation of the Pompton Inlet to the north of the old Morris Canal feeder dam on the Pequannock and Ramapo Rivers. While this move would add 2,000 feet to the tunnel length, utilization of this location would be more effective in lowering flood stages in Pompton Plains and the surrounding areas, reducing levee requirements. The cost of the additional tunnel would amount to about $20 million; about the same as the cost of the levee systems. The tunnel would not eliminate the levee systems; it would only reduce their size. As a result, this change was not considered incrementally feasible.

A study was undertaken, at the request of the State of New Jersey, to determine the feasibility of utilizing a channel modification in lieu of levees and floodwalls integral to the tunnel along the lower Passaic River.

The objective of the channel modification was to convey the peak 100-year discharge following tunnel construction through the Second River to Third River study reach at a level no greater than that which exists under present 100-year fluvial flood/ 1-year tide conditions. By doing so, the channel modification would mitigate the effects of the increased peak 100-year discharges resulting from the tunnel and eliminate the need for the proposed mitigation levee/floodwall systems.

The channel modification would not have any effect on tidal stages which are a contributing cause to flooding in the lower Passaic River. The total benefits associated with a channel modification scheme in the lower Passaic River would, therefore, be lower than those associated with levees and floodwalls.

This channel modification would extend from a point located 8,900 feet downstream of the Second River to just upstream of the Third River. It is important to note that, although the effect of the 100-year fluvial flood on the Passaic River under with project conditions would only extend downstream to a point 1,100 feet upstream of the Second River confluence, it would be necessary to begin the channel modifications further downstream.

The proposed channel modifications would consist generally of a 210 foot bottom width trapezoidal channel and a 260 foot-wide flume. The trapezoidal portions of the channel would be unlined with 2 horizontal to 1 vertical bank slopes. To meet space limitations resulting from dense development and to avoid the need for structure removal or relocation, the flume width would narrow to 230 feet for a distance of approximately 1,200 feet in the reach immediately upstream of the Second River confluence. The depth of the channel would make the use of concrete walls extremely expensive and economically infeasible. The flumes, therefore, would have vertical walls constructed from steel sheet piling driven into the subsoil and anchored with tie-backs. In addition, the Conrail, Rutgers Street and Kingsland Avenue Bridges would have to be modified or replaced.

In addition to the high costs of the sheet piling and bridge replacements, there are extensive utility crossings, as well as bedrock, within the proposed excavation area for the channel modification. Preliminary costs for this channel modification plan were estimated at about $150 million compared to about $110 million for the levees and floodwalls. In view of the significantly higher cost as well as the fewer benefits realized with a channel modification in the lower Passaic River, this element was eliminated from further consideration.

The location of the Third River outlet was reviewed in terms of both its immediate location and the possibility of relocating the outlet further downstream to eliminate the effects of the large discharges and the local protection required for these discharges. In the immediate area, consideration was given to extending the tunnel 800 feet to the Passaic River west bank, north of the Third River and east of the McCarter Highway (Route 21). This would result in a simpler project because the Route 21 bridge would no longer require replacement, with the accompanying traffic delays during construction. Also, the Third River channel would not have to be enlarged, and the outlet would be oriented to direct flows more effectively downstream along the Passaic River. While the costs are about the same for both outlet sites, the new location would also provide for a cleaner construction job with fewer uncertainties and annoyances about bridge replacement and traffic delays, and eliminate the need for relocating Passaic Valley Sewerage Commission trunk lines. The Passaic River outlet site was, therefore, selected over the Third River site.

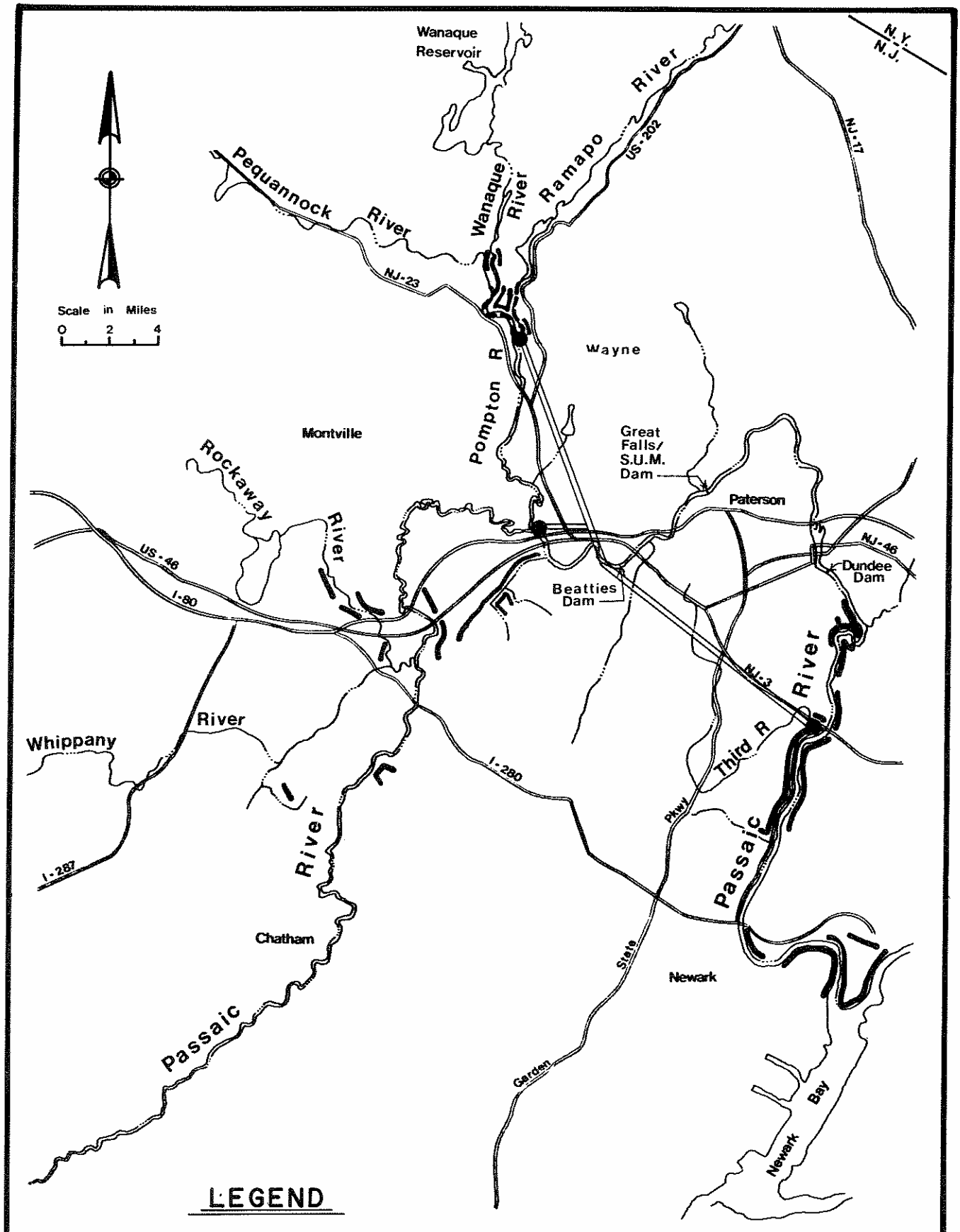
Early in the study, consideration was given to outlets in Newark Bay and near the Second River/Passaic River confluence. The Newark Bay option would not only add about 35,000 feet to the tunnel length, it would also require the tunnel diameter to be increased by one foot to maintain the same level of protection upstream of Dundee Dam. Difficult construction

conditions would be encountered at the outlet location. The outlet would have to be built at an offshore location, adjacent to the navigation channels, and through 100 or more feet of bay sediments before hitting bedrock. The additional tunnel work would extend the construction period by at least 18 months. The cost of this outlet option would add up to $300 million to the investment cost of the Dual Inlet Plan. An outlet in the vicinity of the Second River would be located upstream of the Conrail Bridge in River Bank Park, Kearny. The Second River option would add almost 10,000 feet of tunnel, and extend the period of construction by about one year, while not entirely eliminating increased flood stages upstream. Mitigation levees and floodwalls would still be required although the scale of the protection would be reduced. This location would add about $100 million to the investment cost. Therefore, the outlet location on the Passaic River at the Third River was affirmed.

In addition to the refinements, the plan elements were optimized as discussed in the Plan Formulation Appendix, resulting in varying levels of protection among the areas protected by different types of works and even among individual levee systems. The economically optimum tunnel sizes for the dual inlet plan were a 39-foot diameter main tunnel with a 22-foot diameter spur tunnel (100-year design), while levee/ floodwall systems were optimized individually, with design levels varying from the 100- to the 500-year. At this scale the dual inlet plan was identified as the alternative which best maximizes economic benefits over costs, and, as such, was designated the National Economic Development (NED) Plan.

The revised Plan 30E, the Pompton/Passaic Dual Inlet Tunnel Diversion plan, is the NED plan and the preferred plan of the State of New Jersey. Plan 30E, which would take 90 months to construct, is described below. Figure 22 shows the Iayout of this plan.

The major elements of this flood control proposal are the two tunnels, with the key being the 13.5-mile long, 39-foot-diameter main tunnel, which will carry floodwaters from an inlet at the upper end of the Pompton River down to an outlet on the Passaic River bank just above its confluence with the Third River. A 1.2-mile-long, 22-foot diameter spur tunnel, would convey Central Basin area floodwaters from an inlet just downstream of Two Bridges on the Passaic River, to an underground connection with the main diversion tunnel. The two inlets would be located in Wayne Township while the outlet would rise on the west bank of the Passaic River at its confluence with the Third River in Clifton. The diversion tunnels and associated surface works are designed to protect against a 100 year flood event.



Passaic River Study N.J. & N.Y.

DETAILED PLAN 30 E

POMPTON-PASSAIC RIVERS DUAL INLET TUNNEL DIVERSION

FIGURE 22

The tunnels would be constructed entirely underground -- some 125 feet below the surface at the Pompton Inlet, about 130 feet below the Passaic Inlet, and approximately 155 feet below the outlet. The intersection of the main and spur tunnels would be about 150 feet below ground level. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the tunnel would be some 450 feet underground.

A total of 5.9 miles of channel modifications would be required to direct the flows into the inlets, and the diversion tunnels will be augmented by a total of 37.7 miles of levees and floodwalls consisting of some 23.7 miles of levees and 14.0 miles of floodwalls. Tables 18 and 19 detail the physical features of the channel modification and levees and floodwalls.

Of the total 5.9 miles of channel modification, 4.8 miles would lie upstream of the Pompton Inlet, along the Ramapo, Pequannock and Wanaque Rivers. The remaining 1.1 miles of channel modification would consists of 0.8 miles on the Passaic River and 0.3 miles on the Pompton River upstream of the Two Bridges inlet. No other structural remedies would be needed along the Pompton River or along the Passaic River between the Two Bridges inlet and Dundee Dam, because the tunnels would divert flood flows away from these areas.

Levees and floodwalls along the Pompton River tributaries include 3.5 miles of levee and 0.7 miles of floodwalls which are integral to the design of the Pompton Inlet and provide 100 year flood protection along the Ramapo, Wanaque and Pequannock Rivers.

The 37.7 miles of levees and floodwalls also include flood protection in the Central Basin upstream of Two Bridges along the Main Stem Passaic and Rockaway Rivers and Deepavaal and Pinch Brooks. Protection against floods ranging up to a 500-year event would be provided intermittently where needed by 9.0 miles of setback levees and 0.5 miles of floodwall.

Protection in the Lower Passaic Valley would include 5.5 miles of levees and 5.0 miles of floodwalls lying downstream of Route 280 to Newark Bay to provide 500 year protection against hurricane and tidal surges. In addition there would be 5.7 miles of levees and 7.8 miles of floodwalls along the Passaic River between its confluence with the Second River to upstream of the Saddle River. These systems would provide a 100 year level of protection against both tidal flooding and Passaic River fluvial flows including discharges from the tunnel.

TABLE 18 - DUAL INLET TUNNEL PLAN
CHANNEL MODIFICATION PHYSICAL FEATURES TABLE

REACH	COMMUNITY	Average Depth of Cut (Ft)	Averarge Depth Top of Banks to Invert (Ft)	Average Base Width (Ft)	Average Top Width (Ft)
Passaic River Rt. 46 to Two Bridges 0.8 miles	Wayne	4	15	175	235
Pompton River Two Bridges upstream 0.3 miles	Wayne Lincoln	4	7	150	205
Pequannock River Confluence with the Pompton River upstream 2.6 miles	Wayne Pequannock Pompton Lakes Riverdale	7	15	74-100	135-160
Ramapo River Confluence with the Pompton River upstream 1.2 miles	Wayne Pompton Lakes	4	17	60-100	130-170
Wanague River Confluence with the Pequannock River upstream 1 mile	Pompton Lakes	6	12	74	125

TABLE 19
PLAN 30E - DUAL INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)	Approximate Station Start	Approximate Station End	Level of Protection
LOWER VALLEY											
Tidal Systems											
Kearny Point	Kearny	Right Left	Hackensack Passaic	8.8	62.8	16,600	8.0	17,920	Mouth	150+00	500
Doremus Ave.	Newark	Right	Passaic	8.0	58.0	2,400	10.2	1,910	Mouth	76+00	500
N.J. Turnpike	Newark	Right	Passaic	7.4	54.4	2,030	7.5	590	84+00	114+00	500
Lister Ave.	Newark	Right	Passaic	7.4	54.4	4,930	10.5	2,910	114+00	198+00	500
South 1st. St.	Harrison, E. Newark	Left	Passaic	7.9	57.4	3,130	8.3	2,800	222+00	288+00	500
Systems Integral to Tunnel											
Main St.	Belleville	Left Right	Second Passaic	4.5	37.0	560	7.5	6,580	419+00	490+00	100
River Road #1	N. Arlington, Kearny	Left	Passaic	7.3	53.8	4,710	6.0	830	442+00	496+00	100
Riverside Ave. #1	Lyndhurst, N. Arlington, Rutherford	Left	Passaic	12.6	85.6	8,570	9.3	2,460	496+00	610+00	100
River Road #2	Belleville, Clifton, Nutley	Right	Passaic	8.0	58.0	2,650	9.0	7,720	492+00	587+00	100

TABLE 19 (CONT)
PLAN 30E - DUAL INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)	Approximate Station Start	Approximate Station End	Level of Protection
Yantacaw	Clifton	Left	Third	11.5	79.0	1,540	9.9	1,120	Mouth	30+00	100
River Drive #1	City of Passaic	Right	Passaic	9.2	65.2	1,920	7.8	3,760	655+00	750+00	100
Riverside Ave. #2	Rutherford	Left	Passaic	9.2	65.2	1,570	11.6	4,990	610+00	676+00	100
River St.-Main Ave.	Rutherford, Wallington, E. Rutherford	Left	Passaic	8.2	59.2	5,860	10.1	4,160	685+00	794+00	100
8th St.	City of Passaic	Right	Passaic	10.0	70.0	2,580	10.8	9,780	750+00	854+00	100

SUMMARY OF LOWER VALLEY

	Levee Length	Levee Avg. Ht.	Floodwall Length	Floodwall Avg. Ht.
Tidal	29,090 Ft. (5.51 mi.)	8.3 Ft.	26,130 Ft. (4.95 mi.)	8.5 Ft.
Mitigation	29,960 Ft. (5.67 mi.)	9.7 Ft.	41,400 Ft. (7.84 mi.)	9.6 Ft.
TOTAL	59,050 Ft. (11.18 mi.)	9.0 Ft.	67,530 Ft. (12.79 mi.)	9.2 Ft.

TABLE 19 (CONT)
PLAN 30E - DUAL INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)	Approximate Station Start	Approximate Station End	Level of Protection
CENTRAL BASIN											
Fluvial Systems											
Passaic 2A	Fairfield, West Caldwell	Left Right	Deepavaal Brook Passaic	8.6	61.6	19,430	9.0	1,230	70+00 2,310+00	182+00 2,400+00	100
Passaic 2C	West Caldwell	Right	Deepavaal Brook	7.0	52.0	4,860	8.5	950	130+00	145+00	100
Passaic 10	Livingston	Right	Passaic	8.4	60.4	4,500	-	-	2,590+00	2,635+00	100
Rockaway 1	Parsippany-Troy Hills	Right	Rockaway	8.7	62.2	3,640	-	-	105+00	210+00	100
Rockaway 2	Montville	Left	Rockaway	8.3	59.8	5,340	-	-	140+00	200+00	100
Rockaway 3	Parsippany-Troy Hills	Right	Rockaway	10.3	71.8	6,320	-	-	218+00	282+00	100
Pinch Brook	East Hanover	Right	Pinch Brook	6.6	49.6	3,380	12.0	200	Pinch Brook Trib. to Whippany	500	

SUMMARY OF CENTRAL BASIN

	Levee Length	Levee Avg. Ht.	Floodwall Length	Floodwall Avg. Ht.
TOTAL	47,470 Ft. (8.99 mi.)	8.41 Ft.	2,380 Ft. (0.45 mi.)	9.05 Ft.

TABLE 19 (CONT)
PLAN 30E - DUAL INLET TUNNEL PLAN - LEVEE/FLOODWALL PHYSICAL FEATURES

System	Municipality	Bank	River	LEVEE Avg. Ht. (Ft.)	LEVEE Avg. Base Width (Ft.)	LEVEE Length (Ft.)	FLOODWALL Avg. Ht. (Ft.)	FLOODWALL Length (Ft.)	Approximate Station Start	Approximate Station End	Level of Protection
PEQUANNOCK-WANAQUE-RAMAPO											
Systems Integral to Tunnel											
Pequannock-Ramapo	Pompton Lakes	Right Left	Ramapo Pequannock	9.4	66.4	9,230	10.8	1,500	98+00 on Ramapo	104+00 on Pequannock	100
Shore Road	Wayne	Left	Ramapo	8.0	58.0	4,500	8.2	1,200	Mouth	56+00	100
Stiles Court	Pompton Lakes	Left	Pequannock	3.3	29.8	1,760	-	-	155+00	173+00	100
Hill Court	Pompton Lakes	Right	Wanaque	8.7	62.2	1,350	8.0	600	60+00	73+00	100
Wanaque Avenue	Pompton Lakes	Left	Wanaque	9.9	69.4	1,540	10.5	680	75+00	80+00	100

SUMMARY

	Levee Length	Levee Avg. Ht.	Floodwall Length	Floodwall Avg. Ht.
TOTAL	18,380 Ft. (3.48 mi.)	8.5 Ft.	3,980 Ft. (.75 mi.)	9.5 Ft.

Interior runoff generated behind the levees and walls would be safely handled by a series of interior drainage facilities including ponding areas and pumping stations. The design of the levees and floodwalls include provisions for required river access and locally desired recreational/beautification features.

In order to minimize the impact of future development within the basin, the acquisition of significant portions of the remaining unprotected natural storage areas within the Central Passaic Basin is included as part of this plan. A total of 5,350 acres would be acquired, all within the following eight major wetland areas: Great Piece Meadows; Bog and Vly Meadows; the lower Pompton Valley; Hatfield Swamp; Hatfield Swamp South; Troy Meadows; Black Meadows; and Canoe Brook.

EVALUATION OF DETAILED PLANS

National Economic Development. Economic data for the three detailed plans are presented in Table 20. Plan 30E ranked first in NED efficiency with $35,200,000 in excess benefits; Plan 30A ranked second with $25,800,000; while Plan 16A ranked last with $21,200,000.

Of the three detailed plans, Plan 30E was estimated to be the most expensive to construct, with a first cost of $814,100,000, and annual operation and maintenance (O&M) costs of $2,090,000. Plan 30A was the second most expensive with a $728,200,000 first cost, and $1,990,000 in annual O&M costs. Plan 16A would be the least expensive with a first cost of $385,300,000, and annual O&M costs of $1,050,000.

The average annual equivalent benefits were estimated to be $118,200,000 for Plan 30E, $105,700,000 for Plan 30A, and $59,800,000 for Plan 16A. The residual flood damages associated with the detailed plans were highest for Plan 16A, with residual average annual equivalent damages equal to $56,600,000 and residual damages of $2,219,700,000 for the 500-year event. Plan 30A would have $25,200,000 in residual average annual equivalent damages and $1,409,100,000 residual damages at the 500-year event. Plan 30E has the least residual damages of the three plans, with residual average annual equivalent damages of $17,200,000 and residual damages equal to $1,343,000,000 at the 500-year event. The residual average annual equivalent damages for Plans 30A and 30E include damages associated with the operation of the tunnel.

TABLE 20 SUMMARY OF DETAILED PLAN EVALUATION
(October 1985 price level, 8-5/8% Interest Rate)

EVALUATION CRITERIA	WITHOUT PROJECT	PLAN 30E	PLAN 30A	PLAN 16A
Excess Annual Benefits ($1,000'S)	0	35,200	25,800	21,200
Average Annual Equivalent Benefits ($1,000's) 1/	0	118,200	105,700	59,800
Residual Average Annual Equivalent Damages ($1,000's) 2/	102,600	17,200	25,200	56,600
Residual 500yr Stage Damage ($1,000's)2/	2,700,000	1,343,000	1,409,100	2,219,700
B/C Ratio	N/A	1.4	1.3	1.6
First Cost ($1,000's)	N/A	814,100	728,200	385,300
Construction Duration (Months)	N/A	90	145	72
Investment Cost ($1,000's)	N/A	927,100	892,200	433,800
Annual O&M ($1,000's)	N/A	2,090	1,990	1,050
Total Annual Cost	N/A	83,000	79,900	38,600
Prevent Loss of Life	N/A	VERY HIGH	HIGH	MODERATE
Preserve Transportation Facilities	N/A	VERY HIGH	HIGH	MODERATE
Level of Protection Provided	N/A	100-500	50-500	10-500
Efficiency	N/A	Very High	Moderate	Moderate
Acceptability				
Non-Federal Sponsor	NONE	Very High	High	Low
Public	NONE	High	Moderate	Moderate
Completeness	N/A	Complete	Complete	Complete
Effectiveness	N/A	High	Moderate	Low

1/ Includes benefits due to inundation reduction, affluence, residential intensification, PATH delay, traffic flow, industrial content growth and FIA cost reduction.

2/ Excludes Upper Passaic Basin

Response to Problem and Opportunity Statements. The responses of the three detailed plans to each of the problem and opportunity statements developed for this study are presented in Appendix C, Plan Formulation, Table C-86. The following discussion highlights the responses to the more significant problem and opportunity statements.

The Dual Inlet Tunnel Plan (30E) achieves the flood damage reduction objective of the study by providing levels of protection ranging from the 100-year to the 500-year flood event in the major damage reaches. The optimum operation for Plan 30E during a basin-wide flood event is based on the priority of the Pompton River inlet to divert as much flow as possible into the main tunnel. The Passaic River inlet would operate only when there is capacity in the tunnel beyond that needed for Pompton River flows. The Passaic River inlet also allows for the reduction of flood damages in the event of a storm centered over the Central Basin.

The Single Inlet Tunnel Plan (30A), would provide a 50-year level of protection in the major damage reaches along the Pompton River and up to 100 year level of protection along the Pequannock, Wanaque and Ramapo Rivers. The Lower Valley and Central Basin damage areas would receive protection ranging from a 100 year up to a 500-year event.

Plan 16A would provide levels of protection ranging from the 100 year up to the 500-year event in the Lower Valley and the Central Basin above the upstream limit of Deepavaal Brook. The Pompton Valley and the Central Basin between Beatties Dam and upper Deepavaal Brook, however, would receive only a 10-year level of protection. Because this area contains major damage reaches, this plan was not considered to be fully responsive to the flood damage reduction objective.

The implementation of preservation of natural storage areas in conjunction with any of the three detailed plans would be responsive to the objective of preserving the Basin's remaining wetlands.

Evaluation Criteria. The final array of plans was evaluated against criteria including completeness, effectiveness, efficiency and acceptability. These evaluations are summarized in Table 20.

Each of the three detailed plans were determined to be complete alternatives since each provides and accounts for all investments or actions required to ensure the planned effects.

Plan 30E, was determined to be the most effective because it most fully achieves the primary objective of flood damage reduction. Plan 30A was ranked second in terms of effectiveness since it would provide less protection along the Pompton River. Plan 16A was ranked last in effectiveness because it would provide only a very low level of protection to many of the major damage areas.

Based on NED efficiency, the detailed plans were ranked in descending order as follows: Plan 30E, Plan 30A and Plan 16A.

Plan 30E was selected as the preferred plan by the non-Federal sponsor and is strongly supported by a portion of the Basin's interests. Plan 30A is not acceptable to the Basin's environmental interests because of its extensive channel modifications. Furthermore, because it does not provide a 100-year level of protection along the Pompton River, it is not as acceptable to the non-Federal sponsor and the public as Plan 30E. Plan 16A is supported by environmental groups and some Lower Valley municipalities. However, it is not acceptable to the Pompton Valley/Central Basin because of the low levels of protection provided to these areas.

Environmental Quality. The comparative impacts of the three detailed plans on the Basin's significant environmental resources are detailed in EIS Table 30.

a. Terrestrial Resources. Plan 30E would impact on 905 acres of wetlands, of which 630 acres are compensated for through wetland planting in ponding areas, and 185 acres would be mitigated through wetland reclamation or management measures in the Central Basin project lands. An additional 90 acres of forested wetlands would be converted to scrub-shrub cover type due to tree removal upstream of the Pompton River tunnel inlet.

Plan 30A would impact on 945 acres of wetlands, of which 630 acres are compensated for through wetland planting in ponding areas and 225 acres would be mitigated through wetland reclamation or management measures in the Central Basin project lands. As in Plan 30E, 90 acres of forested wetlands would be converted to scrub-shrub cover type as part of Plan 30A due to tree removal near the confluence of the Ramapo and Pequannock Rivers.

Plan 16A would impact on 250 acres of wetlands, of which 189 acres are compensated for through wetland planting (174 in ponding areas and 15 acres in nonstructural buyout land, and 61 acres would be mitigated through wetland reclamation or management measures in the Central Basin project lands.

b. Aquatic Resources. Plans 30E and 30A would both result in the loss of two acres of anadromous fish habitat in the Lower Valley due to shoreline modifications. Plan 16A would produce the most adverse impacts on anadromous fish habitat. This plan would result in the loss of 84 acres due to the extensive channel modifications in the Lower Valley. Furthermore, Plan 16A would adversely affect 325 acres of aquatic habitat in the Lower Valley between Dundee and Beatties Dams.

However, Plan 16A may result in the maintenance of the fishery in the Central Basin because of maintenance of water quality. The tunnel plans would cause a reduction of aquatic habitat in the Central Basin during construction. Plan 30A would adversely impact three times as much aquatic habitat as Plan 30E. Use of habitat mitigation measures as part of Plans 30E and 30A would help restore the fishery after construction. However, temporary adverse impacts would occur during periodic maintenance of the modified channels.

c. Water Quality. Adverse water quality impacts resulting from the three plans would be of a short-term nature, occurring during construction and later project maintenance. Plan 16A would impact water quality only in the Lower Valley, where the water quality is already severely degraded. Plans 30A and 30E would adversely impact the higher water quality in the Central Basin. Plan 30A would have the most significant water quality impacts of the three plans.

d. Other Significant Resources. The impacts of the three plans would be approximately the same on other significant resources including recreation, hazardous and toxic waste sites, endangered and threatened species, transportation, and cultural resources.

Comparison and Trade-off Summary. Comparison and trade-off analyses were used as a basis for plan selection. The process used to compare the detailed plans consists of a trade-off analysis of the plan characteristics discussed previously, including contributions to the planning objectives, the beneficial and adverse effects of each alternative and the responsiveness to specific evaluation criteria. Table 21 presents the rankings of the plans based on criteria significant to the comparison and trade-off analyses.

Plan 30E ranked first based on NED criteria, because it maximizes benefits over costs, and was designated the NED plan. Plan 30E also provides the highest level of protection. In the Pompton River damage area, Plan 30E provides a 100-year level of protection, while Plans 30A and 16A provide 50-year and 10-year

TABLE 21

SUMMARY EVALUATION OF DETAILED PLANS

SIGNIFICANT CRITERIA RANKING 1/

Plan	NED	EQ	NON-FED SPONSOR	PUBLIC ACCEPTABILITY	COMPLETENESS	TOTAL RAW SCORE	OVERALL RANKING
30E	1	1	1	1	1	5	1
30A	2	3	2	3	1	11	2
16A	3	2	3	2	3	13	3

1/ Most desirable plan = 1 .... least desirable = 3

protection, respectively. Based on environmental quality criteria, Plan 30E ranks first. It was designated the least environmentally damaging plan. Plan 30E, which has the least amount of channel modification, would impact on aquatic resources the least. Plan 30A would have more extensive and deeper channel modifications than Plan 30E, and would have substantially greater adverse impacts on aquatic resources. Plan 16A would have extensive channel modification in the Lower Valley which would adversely impact anadromous fish.

RATIONALE FOR SELECTION

Plan 30E was selected as the recommended plan for the following reasons:

- It is the NED plan, the plan which reasonably maximizes net excess benefits consistent with protecting the Nation's environment.
- It is accepted by the public and is the plan supported by the non-Federal sponsor.
- It efficiently and effectively addresses the problem and opportunity statement of reducing the flood hazard and associated urban flood damages along the Main Stem Passaic River and its major tributaries.
- It reduces average annual equivalent flood damages by 83%.
- It provides the highest level of protection of the detailed planning stage alternatives.
- It is the least environmentally damaging of the detailed planning stage alternatives.

DIFFERENCES FROM PLAN SELECTED BY STATE

The Pompton/Passaic Rivers Dual Inlet Tunnel Diversion Plan, the revised Plan 30E, is detailed in Chapter 6. However, the major differences between this plan and the intermediate stage plan selected by the State of New Jersey are summarized below. The revisions to the plan were made either to improve the economic efficiency of the plan or in response to requests from the State of New Jersey.

- The tunnel inlet on the Passaic River was relocated to the Two Bridges area.
- The tunnel outlet was relocated to the Passaic River upstream of its Third River confluence.

- The main tunnel diameter was reduced to by one foot to 39 feet.

- A 22-foot diameter, 1.2 mile long spur tunnel was incorporated into the plan.

- The preservation of 5,350 acres of Central Basin natural storage areas was incorporated into the plan.

- The channel modification on the Passaic river was reduced in length by 2.8 miles and in depth by 5 feet.

- The channel modifications on the Ramapo, Pequannock and Wanaque Rivers were reduced in depths and widths.

- The tidal levee/floodwall systems were reduced in length by 1.6 miles. The levels of protection of the remaining systems were increased to a 500-year event.

- The Lower Valley levee/floodwall systems integral to the tunnel were increased in length by 1.6 miles.

- The 5.0 miles of Lower Valley fluvial levees and floodwalls were eliminated.

- The Central Basin fluvial levee/floodwall systems were reduced in length by 12.1 miles. The level of protection of one system was increased to a 500 year event.

- The levee/floodwall systems integral to the Pompton River tunnel inlet were reduced in length by 1.9 miles.

- Environmental and fish and wildlife mitigation measures were incorporated into the plan.

- Project planning addressed needs for river access and local recreation plans.

CHAPTER 6. THE RECOMMENDED PLAN

GENERAL

The Pompton/Passaic Dual Inlet Tunnel Diversion Plan combines large underground diversion tunnels with levees, floodwalls, channel modifications and natural flood storage to provide flood protection to major damage areas in the Pompton River Valley, the Central Passaic Basin and the Lower Passaic River. An overview of the plan is depicted on Figure 23. Figures 24 to 60 present a detailed layout of the plan features, along with improved floodplain delineations, hydraulic profiles and typical sections. (All figures contained in this chapter can be found at the end of this chapter.)

The major elements of this flood control proposal are the two tunnels, with the key being the 13.5-mile long, 39-foot diameter main tunnel, which would carry floodwaters from an inlet at the upper Pompton River down to an outlet on the lower Passaic River. A 1.2-mile long, 22-foot diameter spur tunnel, will convey Central Basin area floodwaters from an inlet just downstream of Two Bridges on the Passaic River, to an underground connection with the main diversion tunnel. The two inlets would be located in Wayne Township while the outlet would rise on the west bank of the Passaic River at its confluence with the Third River in Clifton. The diversion tunnels and associated surface works are designed to protect against a 100 year flood event.

The tunnels will be entirely underground -- some 125 feet below the surface at the Pompton Inlet, about 130 feet below the Passaic Inlet, and approximately 155 feet below the outlet. The intersection of the main and spur tunnels would be about 150 feet below ground level. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the main tunnel would be some 450 feet underground.

The Dual Inlet Plan was developed to make more efficient use of the Pompton Tunnel with the expectation that flows could be further reduced by a second inlet at Two Bridges, while operating the tunnel with a priority diversion at the Pompton River inlet. The double inlet takes advantage of the approximate two-day difference in timing of the flood peaks to make more effective use of the tunnel use of the tunnel. The objective is to direct as much flow as possible into the Pompton River inlet and then, if the tunnel flow is less than capacity,

allow additional flow to enter the tunnel by the operation of gates in the Two Bridges diversion spillway. During the design flood, a 100-year event, the main tunnel would have a capacity of 28,700 cfs and the spur tunnel, 13,000 cfs. The Floodwarning and Forecasting System for the Passaic River Basin, which is currently being enhanced by the Corps of Engineers in cooperation with the State of New Jersey, will be an integral element in carrying out the established operating rules for the tunnel.

A total of 5.9 miles of channel modifications would be required to direct the flows into the inlets, and the diversion tunnels will be augmented by 26 levee/floodwall systems, comprising 23.7 miles of levee and 14.0 miles of floodwall. The levees and floodwalls will be situated along the Passaic River and tributaries throughout the damage areas. Except for a transition channel at the Passaic River confluence, no other structural remedies will be needed along the Pompton River, because the tunnel will divert most of the Pompton Valley flood flows.

In the Lower Valley no works are proposed from Beatties Dam downstream to just above the Saddle River because the tunnel would divert most of the damaging flood flows away from this area.

From just above the Saddle River down to Newark Bay, the plan calls for 14 levee/floodwall systems with about 11.2 miles of levee and 12.8 miles of floodwall. The levee/floodwall systems between the Saddle River vicinity and the Second River are required to protect against the combined tidal and fluvial effects, including the tunnel discharges. These systems would provide protection against a 100-year flood. A tunnel diversion plan could not be constructed without the implementation of these flood control measures. From the Second River downstream to Newark Bay, intermittent levees and floodwalls are required to protect against flooding from tidal events. They would provide protection against a 500-year flood.

Upstream of the Pompton Inlet, 3.5 miles of levees, 0.7 miles of floodwalls, and 4.8 miles of channel modifications would be required to direct flood flows into the tunnel, and to protect upstream areas. The lower Pequannock, Wanaque and Ramapo Rivers would be deepened an average of 7, 6, and 4 feet, respectively. The Pompton Valley would be protected against a 100-year flood event. The Passaic River channel would be deepened for a distance of 0.8 miles from upstream of Two Bridges to the Route 46 crossing to divert flood flows into the spur tunnel's Passaic River inlet. A 0.3-mile transition channel would extend up the Pompton River from the confluence.

Along the Passaic River and its tributaries upstream of Two Bridges, levels of protection ranging from 100- to 500-year would be provided at intermittent locations by setback levees and floodwalls. These systems include about 9 miles of levees and 1/2 mile of floodwall.

Channel modification and levee/floodwall plan elements are detailed in Tables 18 and 19.

Each levee/floodwall system includes interior drainage facilities such as ponding areas and pumping stations which would handle the interior runoff generated behind the line of protection.

The planning of levees and floodwalls include provisions for required river access. Recreational/beautification features have been included on the Passaic River east bank between the Saddle and Second Rivers at the request of the non-Federal sponsor. These include hiking/biking paths, overlooks, benches, water fountains, and pocket parks.

The plan requires a total of 810 acres of real estate as permanent easements for structural features and operation and maintenance activities. The surface works of the tunnel element would require 16 acres to be acquired "in fee." Subsurface easements from over 340 parcels of property along the tunnel routes would be required. During construction, an additional 193 acres of property would be required as temporary easements. Table 22 presents a summary of real estate requirements for each affected municipality.

The preservation of 5,350 acres of natural storage areas in the Central Passaic Basin is also a major feature of the plan. The acquisition of these lands would insure the future integrity of the design scale of the project by preventing increases in flood flows which might be caused by the loss of these areas to development. This acquisition, in conjunction with the 15,865 acres already protected under existing Federal and State programs, would preserve the flood storage and environmental characteristics of the Central Basin wetlands.

TUNNEL ELEMENTS

The function of the tunnel elements of the plan is to divert floodflows from the upper Pompton River and from the central Passaic River and reintroduce them into the estuarine portion of the Passiac River, bypassing highly developed areas along the Pompton and lower Passaic Rivers. Figures 56 and 57 present the plan and profile of the tunnel elements.

TABLE 22

DUAL INLET TUNNEL PLAN
REAL ESTATE REQUIREMENTS

LEVEE/FLOODWALL AND CHANNEL ELEMENTS

COMMUNITY	EASEMENTS		
	PERMANENT, UPLAND (ACRE)	PERMANENT, RIVER (ACRE)	TEMPORARY (ACRE)
BERGEN COUNTY:			
E. RUTHERFORD BORO.	3.54	-	1.64
LYNDHURST TWP.	17.71	-	5.57
N. ARLINGTON BORO.	14.37	-	5.92
RUTHERFORD BORO.	10.33	-	5.77
WALLINGTON BORO.	8.77	-	3.47
ESSEX COUNTY:			
BELLEVILLE TOWN	6.42	-	5.71
FAIRFIELD BORO.	82.95	13.77	18.85
LIVINGSTON TWP.	27.41	-	3.11
NEWARK CITY	44.50	-	9.84
NUTLEY TOWN	4.89	-	3.29
W. CALDWELL BORO.	15.51	-	3.44
HUDSON COUNTY:			
HARRISON TOWN	8.09	-	3.60
KEARNY TOWN	94.96	-	21.12

TABLE 22 (CONT)

DUAL INLET TUNNEL PLAN
REAL ESTATE REQUIREMENTS

LEVEE/FLOODWALL AND CHANNEL ELEMENTS

COMMUNITY	EASEMENTS		
	PERMANENT, UPLAND (ACRE)	PERMANENT, RIVER (ACRE)	TEMPORARY (ACRE)
MORRIS COUNTY:			
E. HANOVER TWP.	13.45	-	2.33
LINCOLN PARK BORO.	1.14	10.33	1.65
MONTVILLE TWP.	47.92	-	3.68
PARSIP-TROY HILLS	128.05	-	6.86
PEQUANNOCK TWP.	1.93	15.43	11.47
RIVERDALE BORO.	1.17	9.37	2.18
PASSAIC COUNTY:			
CLIFTON CITY	6.35	-	2.43
PASSAIC CITY	17.00	-	9.99
POMPTON LAKES BORO.	86.25	50.81	30.24
WAYNE TWP.	35.35	32.87	17.91
TOTAL LEVEE/ FLOODWALL AND CHANNEL ELEMENTS	678.06	132.58	180.07

TABLE 22 (CONT)

TUNNEL ELEMENT

COMMUNITY	SURFACE RIGHTS		SUBSURFACE EASEMENTS
	FEE TAKING (ACRE)	TEMPORARY EASEMENT (ACRE)	NUMBER OF PARCELS AFFECTED BY TUNNEL
PASSAIC COUNTY:			
CLIFTON CITY	3.50	3.50	106
LITTLE FALLS TWP.	1.50	2.50	86
TOTOWA BORO.	-	-	5
WAYNE TWP.	11.00	7.00	147
TOTAL TUNNEL	16.00	13.00	344

Pompton River Inlet. The location of the proposed Pompton inlet portal is upstream of the Pompton Plains Cross Road (Jackson Avenue) Bridge in Wayne Township on the east bank of the Pompton River immediately downstream of the Ramapo/ Pequannock Rivers confluence (Figure 58). The site is currently a stockpile area for a sand and gravel mining operation (see Photograph 11). The area surrounding the site is generally undeveloped with lowlying floodplain to the west and north, and agricultural lands to the east. Stream slopes are very flat. The inlet consists of a river flow restrictor, a river diversion spillway, and a morning glory tunnel inlet. The morning glory inlet would stand in the center of an 8-foot-deep, 400-foot diameter concrete basin.

Passaic River Inlet and Spur Tunnel. The proposed Passaic River inlet is located on the Passaic River east bank about 500 feet upstream of the Route 80 bridge, adjacent to Fairfield Road in Wayne (see Figure 59). To access this site, a bridge for Fairfield Road would be built over the inlet structure. The surrounding area consists mostly of undeveloped lowlying wetlands with some light residential development. The inlet structure is similar to the Pompton River inlet, with a gated diversion spillway and morning glory tunnel inlet. The diversion spillway included gates to control the floodwaters entering the inlet basin. The inlet leads to a 22-foot diameter, 1.2 mile long spur tunnel which connects to the main tunnel.

Tunnel Outlet. The proposed outlet is located on the Passaic River west bank above its confluence with the Third River (see Figure 58 and Photograph 12). The diverted flows would exit the tunnel through an upshaft to the surface at sea level (greatly reducing water velocity) and then flow out into the Passaic River. Levees and floodwalls would be constructed on both banks of the Third River to provide protection from increased river stages. These stages are estimated to be 15.4 feet N.G.V.D. as compared to the 11.3 feet that would occur under without-project conditions for the 100-year design flows. Because the tunnel outlet is in the tidal portion of the Passaic River, levees and floodwalls are the only suitable measures for mitigating increased flood stages. To protect against hurricane surges and to mitigate for increased flood stages, 5.7 miles of levees, averaging 9.7 feet in height, and 7.8 miles of floodwalls, averaging 9.6 feet in height, would be required in the 8.2 miles from the Second River up to the Monroe Street Bridge in Passaic City. These additional flows, however, would have negligible effects on river stages downstream of the Rutgers Avenue Bridge in Belleville because of the large capacity of the navigation channel.



Photo 11
Pompton River Tunnel Inlet Site

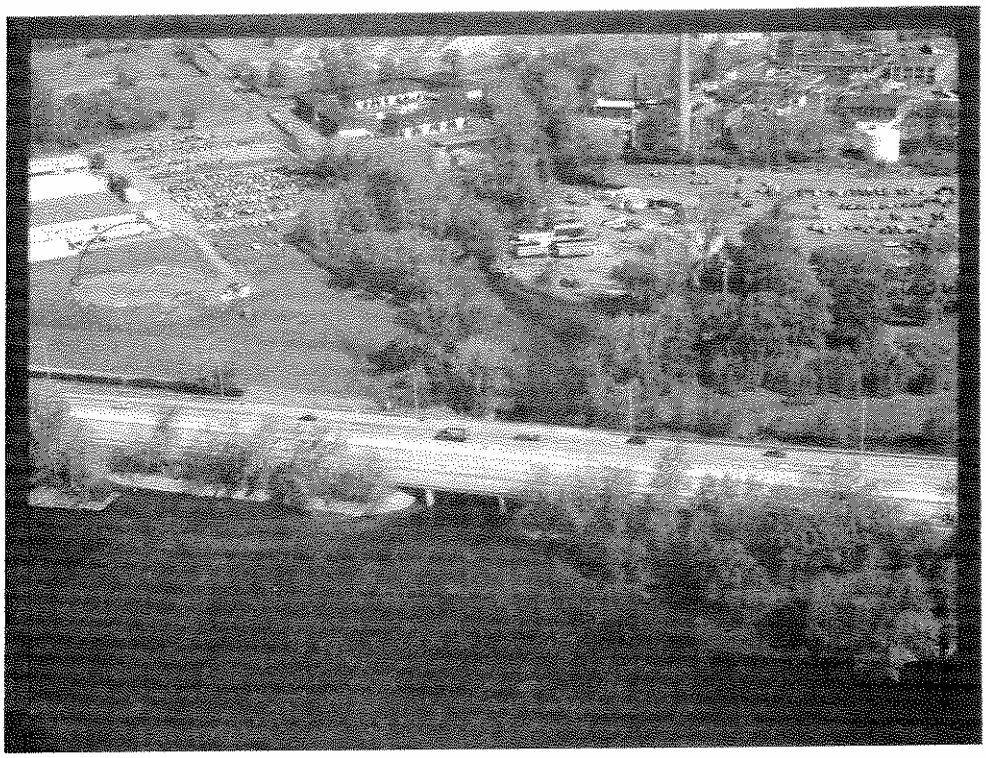


PHOTO 12
Tunnel outlet site on the Passaic River at the Third River confluence.

Alternate Outlet Locations. Relocating the tunnel outlet to Newark Bay would eliminate the need for the nine integral levee/floodwall systems, totalling 13.5 miles, along the Passaic River from the Second River to upstream of the Saddle River. The Newark Bay outlet would require the main tunnel to be 35,000 feet longer and one-foot larger in diameter in order to maintain the same level of protection upstream of Dundee Dam. The additional tunnel work would extend the construction period by at least 18 months. The Newark Bay outlet option would add up to $300 million to the investment cost of the Dual Inlet Tunnel Plan, resulting in a total annual cost of $110,400,000 (October 1986 price level). The average annual equivalent benefits of the plan would be reduced by $5,500,000 to $117,000,000 (October 1986 price level). With a Newark Bay outlet, the Dual Inlet Plan would have a benefit-cost ratio of 1.1.

A tunnel outlet in the vicinity of the Second River would eliminate the need for three integral levee/floodwall systems (Eighth Street, River St.-Main Ave., and River Drive 1 systems), totalling 5.0 miles. The remaining six systems integral to the tunnel outlet would be one to 3.5 feet lower in height than required with the outlet in the Third River vicinity. The Second River outlet would add almost 10,000 feet to the tunnel length and extend the construction period by about one year. The investment cost of the Dual Inlet Tunnel Plan would increase by about $100 million, resulting in a total annual cost of $93,900,000. The benefits of the plan with a Second River outlet would be approximately the same as with the outlet in the Third River vicinity. The benefit-cost ratio of the Dual Inlet Tunnel Plan with a Second River outlet would be 1.3.

CHANNEL MODIFICATIONS INTEGRAL TO THE TUNNEL ELEMENT

Channel modifications included as part of this plan are required to direct floodflows into the tunnel inlets. The channel modifications on the Pequannock, Ramapo and Wanaque Rivers are also required to protect the areas upstream of the Pompton River main tunnel inlet.

Passaic and Pompton Rivers. A modified transition channel in the Passaic River, which would direct flows into the Passaic River spur tunnel inlet, would extend about 0.8 miles from upstream of Two Bridges down to the Route 46 Bridge, and for about 0.3 miles along the lower Pompton River (See Figure 35). This channel would have an average base width of 175 feet and would be deepened an average of 4 to 5 feet. The resulting top width of the channel would be approximately 235 feet. The top width of the existing channel averages approximately 220 feet.

Pequannock River. The Pequannock River channel modification would extend from the Pompton River main tunnel inlet, just upstream of Pompton Plains Cross Road, upstream for 2.6 miles, (Figure 47). The modification includes deepening the existing channel by 7 feet and increasing its bottom width to an average of 74 to 100 feet. The top width of the modified channel would range from 135 to 160 feet. The top width of the existing channel averages approximately 100 feet.

Wanaque River. The Wanaque River channel modification would extend from its mouth upstream about 1 mile to the Paterson-Hamburg Turnpike (Figure 48). The proposed modification includes deepening the existing channel about 6 feet and increasing the channel bottom width to an average of 74 feet. The resulting average top width would be approximately 125 feet. The existing channel top width averages approximately 90 feet.

Ramapo River. The Ramapo River channel modification extends 1.2 miles, from its mouth to the Paterson-Hamburg Turnpike (Figure 49). The modification includes deepening the existing channel by 4 feet and widening the channel bottom to an average of 60 to 100 feet. The average top width of the modified channel would be approximately 150 feet. The top width of the existing channel averages approximately 110 feet.

INTERIOR FLOOD CONTROL FACILITIES

Interior flood control facilities would be required behind levees and floodwalls in order to carry surface runoff from the protected areas to the river. These facilities, which would be designed to minimize maintenance requirements, would include ponding areas, pressure interceptors and pumping stations. The recommended interior flood control facilities are summarized in Table 23.

LEVEE/FLOODWALL SYSTEMS INTEGRAL TO THE TUNNELS

The levee/floodwall systems upstream of the Pompton River tunnel inlet and along the Passaic River from the Second River up to the Saddle River are integral to the operation of the tunnel. There are a total of 14 systems in this category, five above the Pompton Inlet and nine along the Passaic River. Table 19 includes data on the physical features of these levee/ floodwall systems.

TABLE 23

SUMMARY OF INTERIOR FLOOD CONTROL
FACILITY DESIGN SELECTED FOR EACH LEVEE/FLOODWALL SYSTEM

SYSTEM NAME	SUBAREA	INTERIOR FLOOD CONTROL FACILITY
LOWER VALLEY		
TIDAL:		
KEARNY POINT	3	PUMPING 349 cfs pump 335 cfs pump POND AREA DEPTH 4ft. AREA 50.4 acres
DOREMUS AVE.	2	PUMPING 253cfs pump 253cfs pump
N.J. TURNPIKE	1	POND AREA DEPTH 4ft. AREA 23 acres
LISTER AVE.	3	PUMPING 270cfs pump 255cfs pump 349 cfs pump
SOUTH 1ST	2	PUMPING 200cfs pump 257cfs pump
MITIGATION:		
RIVER ROAD #1	2	PUMPING 299cfs pump 319cfs pump

TABLE 23

SYSTEM NAME	SUBAREA	INTERIOR FLOOD CONTROL FACILITY
MAIN STREET	4	PUMPING 228cfs pump 253cfs pump 255cfs pump 337cfs pump
RIVER ROAD #2	4	PUMPING 217cfs pump 237cfs pump 297cfs pump 345cfs pump
RIVERSIDE AVE. #1	5	PUMPING 263cfs pump 311cfs pump 318cfs pump 401cfs pump 429cfs pump
YANTACAW	1	PUMPING 299cfs pump
RIVERSIDE AVE #2	5	PUMPING 222cfs pump 228cfs pump 239cfs pump 239cfs pump 355cfs pump
RIVER ST. - MAIN AVE.	2	PUMPING 325cfs pump 62cfs pump
RIVER DRIVE #1	2	PUMPING 358cfs pump 400cfs pump
8TH STREET	1	PUMPING 211cfs pump

TABLE 23

SYSTEM NAME	SUBAREA	INTERIOR FLOOD CONTROL FACILITY
CENTRAL BASIN		
FLUVIAL:		
PASSAIC 2A	6	POND AREA DEPTH 4ft. AREA 57.62 acres DEPTH 2ft. AREA 100 acres DEPTH 2ft. AREA 133.4 acres DEPTH 4ft. AREA 52.8 acres DEPTH 4ft. AREA 25.0 acres DEPTH 4ft. AREA 20.7 acres
PASSAIC 2C	1	DEPTH 4ft. AREA 6.82 acres
PASSAIC 10	2	POND AREA DEPTH 4ft. AREA 8.55 acres DEPTH 4ft. AREA 10.39 acres
ROCKAWAY 1	6	POND AREA DEPTH 54ft. AREA 3.3 acres DEPTH 5ft. AREA 13.0 acres DEPTH 2ft. AREA 2.4 acres DEPTH 4ft. AREA 28.1 acres DEPTH 6ft. AREA 18.5 acres DEPTH 3.5ft. AREA 18.9 acres

TABLE 23

SYSTEM NAME	SUBAREA	INTERIOR FLOOD CONTROL FACILITY
ROCKAWAY 2	7	POND AREA DEPTH 4ft. AREA 27.5 acres DEPTH 5ft. AREA 10.5 acres PRESSURE INTERCEPTOR DIAMETER 42in. LENGTH 3,400ft. DIAMETER 48in. LENGTH 3,700ft. DIAMETER 42in. LENGTH 3,800ft. DIAMETER 36in. LENGTH 1,800ft. PUMPING 148cfs pump
ROCKAWAY 3	3	PUMPING 188cfs pump PONDING AREA DEPTH 4ft. AREA 26 acres PRESSURE INTERCEPTOR DIAMETER 6ft. LENGTH 2,800ft.
PINCH BROOK	1	POND AREA DEPTH 5.5ft. AREA 7.23 acres

TABLE 23

SYSTEM NAME	SUBAREA	INTERIOR FLOOD CONTROL FACILITY
POMPTON VALLEY		
INTEGRAL TO TUNNEL:		
SHORE ROAD	3	POND AREA DEPTH 5ft. AREA 8.38 acres DEPTH 5ft. AREA 4.88acres DEPTH 4ft. AREA 8.21 acres
PEQUANNOCK-RAMAPO	3	POND AREA DEPTH 4ft. AREA 11.76 acres DEPTH 3ft. AREA 25.82 acres DEPTH 4ft. AREA 7.98 acres
STILES COURT	1	POND AREA DEPTH 4ft. AREA 2.07 acres
HILL COURT	1	POND AREA DEPTH 4.5ft. AREA 1.55 acres
WANAQUE AVENUE	1	PUMPING 217cfs pump

Pequannock/Ramapo System. This system is located on the left bank of the Pequannock River and on the right bank of the Ramapo River in Pompton Lakes (Figures 47 and 49). This system would provide protection to structures within the area bounded on the south and west by the Pequannock River, on the east by the Ramapo River and on the north by Riverview Road. To protect against fluvial flooding, 9,230 feet of levees and 1,500 feet of floodwalls would be required. The levees would have an average height of 9.4 feet and base width of 66.4 feet. The floodwalls would have an average height of 10.8 feet. Portions of Riverview Road and Willow Avenue would be raised to maintain the line of protection. Three ponding areas would collect runoff behind the system.

Shore Road System. This system consists of 4,500 feet of levees and 1,200 feet of floodwalls on the left bank of the Ramapo River in Wayne (Figure 49). Protection against fluvial flooding would be provided to structures within the area bounded by the Ramapo River and Black Oakridge Road. The levees would have an average height of 8 feet, with a base width of 58 feet. The floodwalls would average 8.2 feet in height. Runoff from the drainage area behind the levee/floodwall system would be collected in three ponding areas.

Stiles Court System. This system is a levee located on the left bank of the Pequannock River in Pompton Lakes (Figure 47). It would protect the area bounded by the New York Susquehanna and Western (NYSW) Railroad on the north, Ringwood Avenue to the east and Hamburg Turnpike to the south. The system includes 1,760 feet of levees, with an average height of 3.3 feet and a base width of 29.8 feet. A pond would collect the runoff behind the levee.

Hill Court System. Located on the right bank of the Wanaque River in Pompton Lakes, this system provides protection along Henderson and Hill Courts (Figure 48). It includes 1,350 feet of levee and 600 feet of floodwall. The average height of the levees would be 8.7 feet and the base width about 62.2 feet. The floodwall would have an average height of 8 feet. A pond would be required to collect runoff from behind the system.

Wanaque Avenue System. This system (Figure 48) is located on the left bank of the Wanaque River in Pompton Lakes. It protects an area bounded by the Wanaque River and Wanaque Avenue downstream of the NYSW Railroad to Pompton Avenue, and includes 1,540 feet of levee and 680 feet of floodwall. The average height of the levees would be 9.9 feet and the average base width, 69.4 feet. The floodwall height would average 10.5 feet. Runoff would be collected by a pump station.

River Road 1 System. In North Arlington and in Kearny, commercial and industrial structures along the left bank of the Passaic River within the area bounded by the Passaic River, Baltimore Avenue, and Belleville Turnpike would be protected against tidal and fluvial flooding, including the tunnel discharges, by 4,710 feet of levee with an average height of 7.3 feet and resulting base width of 53.8 feet and 830 feet of floodwall averaging 6.0 feet in height. This system (Figure 27) would also require the raising of 110 feet of Passaic Avenue and a gated structure across the Belleville Turnpike bridge. Recreational/beautification features would include a walking/bike path on the levee and a river overlook near the upstream end. Runoff from the drainage area behind the system would be removed by interior flood control facilities including two pumping stations.

Riverside Avenue 1 System. This system (Figure 27) is located on the left bank of the Passaic River in North Arlington, Lyndhurst, and Rutherford. It consists of 8,570 feet of levee and 2,460 feet of floodwall, and protects residential, commercial, and industrial structures in an area bounded by the Passaic River, Route 3, and Baltimore Avenue from both tidal and fluvial flooding, including the tunnel discharges. The levee in this area would have an average height of 12.6 feet and base width of 85.6 feet. The floodwalls would be 9.3 feet high. Gated structures would facilitate river access and be required across the Kingsland Avenue bridge. Recreational/beautification features include a walking/bike path on the levee; alignment of the levee to form an amphitheater; a public boating facility in Lyndhurst and a strip park at the upstream end of the system. Runoff from the drainage area behind the system would be handled by interior flood control facilities consisting of five pumping stations.

Main Street/River Road 2 Systems. The right bank of the Passaic River, in the communities of Belleville, Nutley and Clifton, would be protected from tidal and fluvial flooding, including the tunnel discharges, from the Second River to the Third River by these two levee/floodwall systems (Figures 26 and 27).

The Main Street System would include 560 feet of levee with an average height of 4.5 feet and base width of 37.0 feet. The system's 6,580 feet of floodwall would average 7.5 feet in height. The River Road 2 System would have 2,650 feet of levee and 7,720 feet of floodwall. The average heights would be 8.0 feet and 9.0 feet, respectively. The levee base width would

average 58.0 feet. Gated structures would be placed at the McCarter Highway, Rutgers Street, Route 21 and Kingsland Avenue bridges. Access would also be provided to the river where necessary. Interior drainage facilities for the Main Street and River Road Systems would consist of pumping stations.

Yantacaw System. Along the left bank of the Third River approximately 1,540 feet of levees and 1,120 feet of floodwall would be required to protect against tidal and fluvial floods, including tunnel discharge backwater. The levees and floodwalls would average 11.5 feet and 9.9 feet, respectively, with the base width of the levee averaging about 79.0 feet. These levees and floodwalls would extend from Route 21 to Route 3 on the Third River, as shown on Figure 27. A 100-foot section of River Road would require raising in order to provide a continuous line of protection. In addition, a Passaic Valley Sewerage Commission pumping station would be replaced. Runoff from behind the system would be handled by a pumping station.

Riverside Avenue 2 System. On the left bank of the Passaic River in the Borough of Rutherford, this system would provide tidal and fluvial flood protection, including protection against backwater from the tunnel discharge, to the area from the Route 3 Bridge upstream almost to the Union Avenue Bridge (Figures 27 and 28). To protect this area, 1,570 feet of 9.2-foot high levees with an average base width of 65.2 feet, and 4,990 feet of floodwalls averaging 11.6 feet in height would be required. Gated structures would allow river access. A walking path on the levee, a strip park, two pocket parks and a public boat launching ramp are included in this system. Runoff from the system would be handled by interior drainage facilities consisting of pumping stations.

River Drive 1 System. Along the right bank of the Passaic River in the City of Passaic, structures within the area bounded by the Passaic River and Route 21 would be protected from tidal and fluvial flooding, including tunnel discharge backwater, by 1,920 feet of levee and 3,760 feet of floodwall (Figure 28). The levees would have an average height of 9.2 feet and a base width of 65.2 feet. The floodwalls would have an average height of 8.0 feet. A gated structure on the Main Avenue bridge would be required in order to ensure a continuous line of protection. Gated structures would also be required for river access. Runoff from the drainage area would be handled by two pumping stations.

River Street/Main Avenue System would be located on the left bank of the Passaic River in Rutherford, East Rutherford and Wallington (Figure 28). It would extend from Washington Avenue in Rutherford upstream to Alden Street in Wallington. The system includes 5,860 feet of levee with an average height 8.2 feet and base width of 59.2 feet; and 4,160 feet of floodwall with an average height of 10.1 feet. Gated structures would be located on the Main Avenue and 8th Street bridges in order to ensure a continuous line of protection. Protection would be provided against tidal and fluvial flooding, including backwater flooding from the tunnel discharge. Access would also be provided to dock facilities on the river. Recreation/ beautification would be provided in the form of a walking/bike path on the levee, a public boat ramp and two parks. A third park would be located further upstream in Garfield below Dundee Dam. Runoff from the drainage area behind the levee/floodwall system would be handled by two pumping stations.

Eighth Street System. On the right bank of the Passaic River, in the City of Passaic, the area bounded by the Passaic River, Weasel Brook, and Monroe Street would be protected by 2,580 feet of levee and 9,780 feet of floodwall (Figures 28 and 29). Protection would be provided against tidal and fluvial flooding, including backwater flooding from the tunnel discharge. The levees would have an average height of 10.0 feet and a resultant base width of 70.0 feet. The floodwalls would have an average height of 10.8 feet. Closure gates would be required across an industrial access road over Weasel Brook and the 8th Street, Wall Street, Conrail Railroad and Monroe Street bridges. Several ponding areas would handle interior runoff.

INCREMENTAL LEVEE/FLOODWALL SYSTEMS

Kearny Point System. This system (Figures 24 and 25) consists of 16,600 feet of earthen levee and 17,920 feet of concrete floodwall protecting an industrial area on the left bank of the Passaic River around Kearny Point, and upstream along the right bank of the Hackensack River in Kearny. Damages in this area are predominately caused by tidal flooding. The levees average 8.8 feet in height and 62.8 feet in base width. The floodwall is approximately 8 feet high. A continuous line of protection will be provided by gated structures across Fish House Road and across three sections of railroad tracks. Access would be provided to dock sites on the river through gated structures. Runoff behind the system would be collected in four ponding areas and two pumping stations.

Doremus Avenue System. Proceeding upstream along the Passaic River, this system (Figure 24) would protect industrial structures against tidal flooding within the area bounded by the Passaic River, the Lincoln Highway and the Central Railroad of New Jersey, in Newark, on the right bank of the Passaic River. This system consists of 2,400 feet of levee with an average height of 8 feet and base width of 58 feet, and 1,910 feet of floodwall with an average height of 10.2 feet. Gated structures will be placed in two openings under the Central Railroad of New Jersey to ensure the line of protection. Access will also be provided to the river through gated structures. Runoff will be removed by two pumping stations.

Turnpike System. The area protected by this system is bounded by the Passaic River, the NJ Turnpike, and Routes 1 and 9 in Newark on the right bank of the Passaic River (Figure 24). This system would protect industrial structures against tidal flooding, and consists of 2,030 feet of levee and 590 feet of floodwall. The levee averages 7.4 feet high, with a 54.4 feet base width. A 500-foot section of road would be realigned. The floodwall is 7.5 feet high. Runoff would be collected by three ponding areas.

Lister Avenue System. This system lies on the right bank of the Passaic River and consists of 4,930 feet of levee and 2,910 feet of floodwall (Figures 24 and 25). The levee averages 7.4 feet high and 54.4 feet wide at the base. The floodwall is 10.5 feet high. This system protects industrial, commercial, and residential structures, within the area bounded by the Passaic River, the NJ Turnpike, Ferry Street and Freeman Street in the City of Newark, against tidal flooding. Access would be provided to dock facilities through gated structures. A park would also be provided at the upstream end of the levee. The runoff from the drainage area behind the system would be discharged by three pumping stations.

South First Street System. This system is situated on the left bank of the Passaic River in East Newark and Harrison (Figures 25 and 26). It would provide protection from tidal floods from the South 4th Street Bridge up to Route 280. A total of 3,130 feet of levee with an average height of 7.9 feet and base width of 57.4 feet and 2,800 feet of floodwall averaging 8.3 feet high would be required. A continuous line of protection would be provided by gated structures on the Harrison Avenue Bridge and across Passaic Avenue. River access would be provided through gated structures. A park would be located at the upstream end of the system. Runoff from the drainage area behind the system would be dispersed through two pumping stations.

Passaic River 2A System. This system consists of 19,430 feet of earthen levee and 1,230 feet of floodwall which protects residential, commercial and industrial development in an area bounded by the right bank Passaic River, I-80, Bloomfield Avenue and the left bank of Deepavaal Brook in Fairfield and West Caldwell. The levees would average 8.6 feet in height with a base width of 61.6 feet. The floodwalls would have average heights of 9 feet. One road raising and the installation of flap valves on eleven culverts are required. Runoff behind the system will be collected in six ponding areas. This large system is shown in Figures 36, 37, 40, 50, and 51.

Passaic River 2C System. This system is located along the right bank of the Deepavaal Brook in Fairfield and West Caldwell (Figure 51). It would protect Fairfield Place, and includes 4,860 feet of levee and 950 feet of floodwall. The levees have an average height of 7 feet, and floodwalls, 8.5 feet. The average base width of the levees is 52 feet. A ponding area would collect interior runoff.

Passaic River 10 System. This system consists of 4,500 feet of levees on the right bank Passaic River in Livingston, (Figure 42). Protection would be provided to structures within the area bounded on the west by the Passaic River and on the east by Eisenhower Parkway. The levees would be set back 800 feet from the river to preserve existing wetlands. The average height of the levees would be 8.4 feet and the base width, 60.4 feet. Runoff behind the levee would be collected by two ponding areas.

Rockaway River 1 System. This system includes 3,640 feet of levees located on the right bank of the Rockaway River in the Parsippany-Troy Hills (Figures 52 and 53). It would protect an area bounded by the Rockaway River, New Road, Edwards Road and Vail Road. Upstream of Route 80, the system would be set back approximately 1,100 feet from the river. Levees downstream of Route 80 would be set back approximately 200 feet, because structures are located closer to the bank in this area. The average height of the levees is 8.7 feet, and the base width, 62.2 feet. Gated structures would be installed on four culverts under I-280 and on two culverts under I-80. Runoff would be collected by six ponding areas.

Rockaway River 2 System. Located on the left bank of the Rockaway River in Montville, this system is designed to protect an area bounded by the Rockaway River, Barnet Road, Walnut Drive, Konner Avenue, Dogwood Circle and Change Bridge Road

(Figures 52 and 53). It includes 5,340 feet of levees aligned along the Rockaway River. The levees would have average heights of 8.3 feet, with base widths of 59.8 feet. A portion of Barnet Road and two areas of Change Bridge Road would be raised. Four pressure interceptors, two ponding areas and one pump station would collect surface runoff from behind the levee.

Rockaway River 3 System. This system would consist of 6,320 feet of levee on the right bank of the Rockaway River in Parsippany-Troy Hills (Figure 53). It would protect an area bounded by the Rockaway River on the east, River Drive, Mohawk Avenue and Sandalwood Drive on the west, Vail Road on the south, and Tioga Avenue on the north. Because of structures located near the bank, it will be necessary to place the levee along the stream and realign a portion of the channel. The average height of the levee would be approximately 10.3 feet, and the average base width, 71.8 feet. Runoff would be collected by a ponding area, a pressure interceptor, and a pump station.

Pinch Brook System. Located on the right bank of Pinch Brook in East Hanover (Figure 55), this system is bounded by Pinch Brook, Great Meadow Lane and Brentwood Drive. Some 3,380 feet of levees would be required to protect against backwater flooding from the Whippany River. The levees, would have an average height of 6.6 feet and a base width of 49.6 feet. There would be 200 feet of floodwall with an average height of 12 feet. A pond would collect runoff from behind the levee/floodwall system.

Information on all the levee/floodwall systems in the Pompton/Passaic Rivers Dual Inlet Tunnel Diversion Plan is included in Table 19.

PRESERVATION OF NATURAL STORAGE

The acquisition of significant portions of the remaining unprotected natural storage areas within the Central Passaic Basin is recommended as part of the selected plan. This measure is included to minimize the impact of future development on the recommended plan. Development pressures throughout the Passaic Basin make this recommendation necessary to maintain the design integrity of the tunnel diversion by preventing the loss of these lands. In consideration of the accelerating rate at which natural storage areas are being lost, Federal preservation is recommended as an "Early Action" element of the overall plan to minimize future increases in flood flows.

In the Draft Feasibility Report, the NJDEP was strongly urged to pursue halting development through available New Jersey State programs and authorities until a Federal "Early Action" project could be implemented. State regulatory procedures were considered more appropriate than Federal procedures for preventing additional filling and development before a Federal preservation project could be implemented. The State of New Jersey's program is aimed specifically at preventing increased flood damages while the Federal Section 404 Program is intended to maintain water quality.

Subsequent to the completion of the Draft Feasibility Report and Draft Environmental Impact Statement, the State of New Jersey passed a moratorium on wetland development and then enacted the Freshwater Wetlands Act. The extent to which this new law will further limit the loss of natural storage cannot be determined until State regulations are developed and implemented. Therefore, it is recognized that the acreage of natural storage areas recommended for acquisition may change during the design phase for this project in order to reflect the interpretation of the State law.

The current preservation recommendation is for a total of 5,350 acres to be acquired, all within the Passaic Basin's eight major wetland areas: Great Piece Meadows, Bog and Vly Meadows, the lower Pompton River subbasin, Hatfield Swamp, Hatfield Swamp South, Troy Meadows, Black Meadows, and the Canoe Brook Subbasin. Tables 24 and 25 identify the areas proposed for acquisition by major wetland and by municipality. Figures 36 to 46, 52, 54 and 55 show the natural storage areas identified for acquisition in relation to the location of the other plan elements, while Figure 61 presents an overall view of these acquisition areas.

Natural storage areas south of I-80 within Great Piece Meadows in Fairfield are proposed for acquisition even though they are behind the Passaic River 2A Levee/Floodwall System. These sites would remain as natural storage prior to construction of the levee/floodwall system. They would then be utilized as ponding areas for the interior runoff behind the levee. This is also the case for the natural storage areas behind the Pinch Brook and the Passaic River #10 levee systems. These areas could also be included with other areas which may possibly be managed by the U.S. Department of the Interior's Fish and Wildlife Service as wildlife habitat.

TABLE 24
PRESERVATION OF NATURAL STORAGE AREAS
BY COMMUNITY

MUNICIPALITY	MAJOR WETLAND AREA	PROPOSED FOR ACQUISITION
E. HANOVER	HATFIELD SWAMP	85
	BLACK MEADOWS	195
	TROY MEADOWS	385
	HATFIELD SOUTH	135
	TOTAL	800
FAIRFIELD	HATFIELD SWAMP	20
	GREAT PIECE MEADOWS	1030
	TOTAL	1050
FLORHAM PARK	CANOE BROOK	0
	BLACK MEADOWS	255
	TOTAL	255
HANOVER	TROY MEADOWS	25
	BLACK MEADOWS	660
	TOTAL	685
LINCOLN PARK	BOG & VLY MEADOWS	360
	LOWER POMPTON	0
	GREAT PIECE MEADOWS	420
	TOTAL	780
LIVINGSTON	CANOE BROOK	175
	HATFIELD SOUTH	55
	TOTAL	780
MONTVILLE	GREAT PIECE MEADOWS	130
	HATFIELD SWAMP	35
	BOG & VLY MEADOWS	45
	TOTAL	210
PAR-TROY	TROY MEADOWS	765
	HATFIELD SWAMP	0
	TOTAL	765
PEQUANNOCK	LOWER POMPTON	120
	TOTAL	120
WAYNE	LOWER POMPTON	165
	TOTAL	165
W. CALDWELL	HATFIELD SWAMP	290
	TOTAL	290

TABLE 25
PRESERVATION OF NATURAL STORAGE AREAS
BY MAJOR WETLAND

MAJOR WETLAND AREA	MUNICIPALITY	PROPOSED FOR ACQUISITION
GREAT PIECE MEADOWS	LINCOLN PARK	420
	MONTVILLE	130
	FAIRFIELD	1030
	TOTAL	1580
BOG & VLY MEADOWS	LINCOLN PARK	360
	MONTVILLE	45
	TOTAL	405
LOWER POMPTON	WAYNE	165
	PEQUANNOCK	120
	LINCOLN PARK	0
	TOTAL	285
HATFIELD SWAMP	FAIRFIELD	20
	MONTVILLE	35
	W. CALDWELL	290
	ROSELAND	0
	PAR-TROY	0
	E. HANOVER	85
	TOTAL	430
TROY MEADOWS	PAR-TROY	765
	E. HANOVER	385
	HANOVER	25
	TOTAL	1175
BLACK MEADOWS	E. HANOVER	195
	HANOVER	660
	FLORHAM PARK	255
	TOTAL	1110
HATFIELD SOUTH	E. HANOVER	135
	ROSELAND	0
	LIVINGSTON	55
	TOTAL	190
CANOE BROOK	LIVINGSTON	175
	FLORHAM PARK	0
	CHATHAM	0
	MILLBURN	0
	TOTAL	175

The preservation of natural storage recommendation proposed in this plan is made with the following conditions: that the State of New Jersey maintains existing approved FIA Floodways at their current limits in the areas of acquisition; floodways, not yet approved, are realistically determined based on current guidelines without attempting to take the effects of this plan into account, and current State regulations concerning fill and storm water management are retained.

ENVIRONMENTAL EFFECTS

The Pompton/Passaic Dual Inlet Tunnel Diversion Plan is the most environmentally sensitive of all of the structural alternatives because the large conveyance tunnel is deep underground, limiting surface works. There are also fish and wildlife mitigation measures included in the plan. As a result, the Dual Inlet Plan would create a minimum of adverse environmental effects. The recommended plan would also provide significant environmental benefits, largely because of its preservation of natural storage areas element.

Aside from the levees and floodwalls and channel modification works above the inlets, the tunnel plan is virtually free of surfaces works, except at seven locations -- the four work shafts, the two inlets and the outlet. The levees and floodwalls in the plan have been greatly reduced in extent compared to the plan selected by NJDEP because of the tunnel's increased capability in handling floodwaters. However, the levees will occupy approximately 75 acres of wetlands. There are only 5.9 miles of channel modifications which, in conjunction with levees and floodwalls, are required to direct floodwaters into the inlets.

The plan also calls for the preservation through acquisition of 5,350 acres of natural storage areas, of which 5,200 acres are wetlands. This will increase the amount of natural storage permanently preserved through government ownership and regulations to 21,215 acres.

In the Lower Valley, minimum adverse environmental effects are expected from the construction and existence of levees and floodwalls. Passaic River waterfront land has, historically, been valuable as the focus of water-related industry and the movement of goods from water to land transportation. As a result, the shoreline has been developed and redeveloped. It is expected that river access will be restricted, but public access points will be provided as mitigation. It is anticipated that currently restricted shoreline use may increase as a result of the project.

The New York District, U.S. Army Corps of Engineers, has determined that construction of the required protective features of the proposed Pompton-Passaic Dual Inlet Tunnel Diversion Plan is consistent, to the maximum extent practicable, with the guidelines of the State of New Jersey's approved Coastal Zone Management Program. A CZM Consistency Determination has been filed with the New Jersey Department of Environmental Protection, Division of Coastal Resources. NJDEP indicated that they must review the final EIS before making their determination of consistency.

The effects of tunnel operation on fisheries is expected to be negligible, with impacts similar to the future conditions without the project, during a storm event. Without the project, many fish which can not find shelter would be washed downstream, with substantial mortality. Additionally, fish finding overbank shelter could be stranded as floodwaters recede, and only a portion of those finding cover would actually survive. With the tunnels in operation, fish not finding shelter or cover could be washed into the tunnel, with little chance of survival. Since floodwaters would not flow overbank, fish that do find cover would be within streambanks and would have a higher rate of survival.

The effects of tunnel-induced increases in velocity or flow are expected to be minimal. The tunnel operation would be for a limited duration, approximately five days for a 100-year flood event.

Water quality would not be negatively impacted by the tunnel operation. In fact, it would be cleaner when discharged into the lower Passaic River because once floodwaters enter the tunnel, they could not accumulate any more sediment or runoff-associated contaminants. The quality of the water remaining in the tunnel after a storm is expected to decline; however, the resultant water quality would be similar to that existing in the lower Passaic River. The diversion of flows through the tunnel could result in less dilution of the water entering the Lower Valley.

The implementation of the dual inlet plan would have a virtually unlimited positive impact on the social well-being of the people who are currently impacted by flooding in the Main Stem Passaic River flood damage areas. The lack of a flood threat would enhance health and safety, improve property values and increase employment and productivity. The vast transportation system affected by flooding would also be greatly improved.

The effects on fish and wildlife would include aquatic and terrestrial changes. Effects on the aquatic biota would be greatest in areas where the physical measures would be placed. The lower reaches of the Pequannock, Wanaque, and Ramapo Rivers, where combinations of levees and channels are proposed, would be affected most. These areas now contain the highest diversities of fish and benthic invertebrate species. This combination of greatest instream and bank manipulation in the area of the greatest diversity would cause the most impact on the aquatic environment.

These impacts would include a reconfiguration of the stream morphology, elimination of substantial tree shade with resultant increases in water temperature, coupled with a decrease in dissolved oxygen, and removal of aquatic flora and fauna during construction. The use of stream habitat restoration techniques, including double wing check dams, would help mitigate for some loss of natural stream habitat. Where trees are present on a south or west bank, efforts would be made to save them in order to limit loss of shaded areas. Reinhabiting of the project area by aquatic flora and fauna should occur naturally with time, through natural immigration and dispersal mechanisms. The occasional need for maintenance of the channel may occur and would adversely affect recolonized organisms.

Anadromous fish are found in limited numbers in the Passaic River. Generally, they spawn in April and May, seeking low salinity or fresh waters. Offspring reside in the river from May until September. Approximately two acres of aquatic habitat utilized by anadromous fish would be affected by the construction of the plan. With the expected low frequency of operation of the tunnel, the high flows during the majority of the time of operation, and the placement of the tunnel outlet on the Main Stem Passaic River as opposed to the original Third River site, and the improvement of four acres of anadromous fish habitat, few long term adverse effects are expected to occur to anadromous fish. In fact, the area of improved habitat is likely to have a beneficial effect.

Impacts on terrestrial resources would be greatest in the Pompton Valley and the Central Passaic Basin, upstream of the proposed Pompton inlet. The recommended plan would impact on 905 acres of wetlands, of which 630 acres would be compensated for through wetland planting in ponding areas and 185 acres are mitigated through wetland reclamation measures in Central Basin project lands. An additional 90 acres of forested wetland would be converted to scrub-shrub cover type due to tree removal upstream of the Pompton River tunnel inlet.

TABLE 26

SIGNIFICANT EQ EFFECTS - DUAL INLET PLAN

Recommended Plan

SIGNIFICANT RESOURCES	ECOLOGICAL	CULTURAL	AESTHETIC
ANADROMOUS FISH, LOWER VALLEY	Loss of 2 acres of habitat due to shoreline modifications. 4 acres created.	No Effect	No Effect
CULTURAL RESOURCES, LOWER VALLEY	No Effect	No Effect	No Effect
WETLANDS BELOW DUNDEE DAM, LOWER VALLEY	Loss of 10 acres, but upgraded in Central Basin project lands.	No Effect	No Effect
WETLANDS ABOVE DUNDEE DAM, LOWER VALLEY	Loss of 5 acres at inlet site; 5 acres scattered loss below Little Falls. 10 acres will be upgraded in Central Basin project lands.	No Effect	No Effect
WATER QUALITY, LOWER VALLEY	No Effect	No Effect	No Effect
ENDANGERED AND THREATENED SPECIES, LOWER VALLEY	No Effect	No Effect	No Effect

TABLE 26 (CONT)

SIGNIFICANT EQ EFFECTS - DUAL INLET PLAN

Recommended Plan

SIGNIFICANT RESOURCES	ECOLOGICAL	CULTURAL	AESTHETIC
ENDANGERED AND THREATENED SPECIES, CENTRAL BASIN	No Federal species involved. Protection of habitat for State listed species.	No Effect	No Effect
WATER QUALITY, CENTRAL BASIN	No increased degradation. Short-term impacts during construction. Possible temperature increase due to riverbank clearing.	No Effect	No Effect
GROUNDWATER RESOURCES	No Effect	No Effect	No Effect
HAZARDOUS SUBSTANCE SITES	Protection of 50 hazardous substance sites in 100-year floodplain. The 8 sites that are near construction areas may require a Health and Safety Plan.	No Effect	No Effect

TABLE 26 (CONT)
SIGNIFICANT EQ EFFECTS - DUAL INLET PLAN

Recommended Plan

SIGNIFICANT RESOURCES	ECOLOGICAL	CULTURAL	AESTHETIC
FISHERIES, CENTRAL BASIN	Reduction of resources during construction; recovery afterwards. Use of habitat restoration techniques would help restore fishery.	Angler use high in some areas, with active NJDEP fish stocking program. Reduced temporarily during construction in the Ramapo, Wanaque and Pequannock Rivers confluence area.	No Effect
CULTURAL RESOURCES, CENTRAL BASIN	No Effect	No known effects. During Phase II, cultural resources will be surveyed. If significant resources are discovered, a mitigation plan will be formulated.	No Effect
WETLANDS, CENTRAL BASIN	Preservation of 5200 acres (4860 acres preserved intact, 340 ac. preserved will be used for ponding areas and replanted as wetland). Loss of 185 acres due to physical and hydrological modifications; these acres would be mitigated by upgrading 185 acres of land acquired for preservation of flood storage. 630 acres of emergent wetlands would be created in ponding areas replacing forested wetlands. Trees would be removed from 90 acres of forested wetlands which will revert to scrub/ shrub wetlands.	No Effect	Wetlands will be maintained as wildlife refuges.

TABLE 26 (CONT)

SIGNIFICANT EQ EFFECTS - DUAL INLET PLAN

Recommended Plan

SIGNIFICANT RESOURCES	ECOLOGICAL	CULTURAL	AESTHETIC
RECREATION (BOATING AND FISHING, HIKING, ETC.)	No Effect	Cleanup of shoreline, but access only at selected points. Fisheries impacted during construction. Preservation of natural storage, along with recreational areas as part of plan components, should help prevent increased deficits.	No Effect
AESTHETICS	No Effect	No Effect	Riverine views improved due to shoreline clean-up would be offset by heights of levees and floodwalls. Wetlands are protected. Some loss of wetlands in the Ramapo, Pequannock and Wanaque Rivers confluence area.

TABLE 26 (CONT)

SIGNIFICANT EQ EFFECTS - DUAL INLET PLAN

Recommended Plan

SIGNIFICANT RESOURCES	ECOLOGICAL	CULTURAL	AESTHETIC
NOISE	No Effect	No Effect	No change. High due to the basin's urban nature, especially near major thorough-fares.
TRANSPORTATION	No Effect	Elimination of most flooding delays. Delays experienced during construction.	No Effect
PUBLIC HEALTH AND SAFETY	No Effect	Flood risk is reduced up to the 500 yr level in many areas.	
DAMAGE AND CLEANUP COSTS	No Effect	No costs associated up to 100 yr event in the protected areas. Property values increase.	No Effect

The environmental effects of the Pompton/Passaic Dual Inlet Tunnel Diversion Plan are fully described in the Environmental Impact Statement, and summarized in Table 26.

MITIGATION MEASURES

Mitigation measures designed to offset the adverse environmental effects of the Dual Inlet Tunnel Plan have been included as part of the project recommended. These recommendations include separable fish and wildlife mitigation measures and standard engineering practice mitigation measures.

i. Separable Fish and Wildlife Mitigation Measures:

- To mitigate for the loss of aquatic habitat, wing-dam habitat structures will be placed in the Pompton River downstream of the flow restrictor. This will provide food and shelter, thus creating a fish holding area to help offset project related adverse effects. This in turn would help support the N.J. State trout stocking program.

- To mitigate for loss of wetland habitat from structural components of the plan (e.g. levees), 185 acres of land would be manipulated to restore or improve the quality of existing degraded wetlands.

- To provide cover for insectivorous birds, nest boxes would be placed in the ponding areas and in other locations where nesting habitat would be lost.

ii. Standard Engineering Practice Mitigation Measures:

- A weir will be placed near the downstream terminus of the Great Piece Meadows (Figure 60) which would allow for the maintenance of existing wetland habitat.

- A weir across the Pequannock River above the Pompton River tunnel inlet would allow for saturation of wetlands, and maintenance of aquatic habitat.

- The existing U.S.G.S. weir downstream of the Pompton inlet will be maintained, thus preserving wetlands by maintaining water surface elevations.

- The diversion structures located at the Pompton and Two Bridges inlets will be operated to allow the bypass of non-flood discharges up to the one year flow after the peak flood has passed, thus maintaining fish habitat.

- Channel modification reaches will provide adequate water depths to maintain passage by fish.

- Channel meanders in modified channel reaches will be maintained where compatible with sound engineering practice and design.

- 630 acres of wetlands, which will be converted to interior flood control ponds, will be planted with perennial flora to maintain wildlife food and cover for game and non-game species. The planting of flora will result in a substantial reduction in operation and maintenance costs compared to the traditional seeding of grass.

- Cobble will be placed in the Passaic River downstream of Dundee Dam and will be used in the modified channels along the Pequannock, Wanaque and Ramapo Rivers upstream of the Pequannock River weir.

- Erosion control methods will be employed during construction, using techniques similar to those utilized by the Soil Conservation Service (SCS).

- Banks susceptible to erosion will be protected by riprap.

- Riparian vegetation will be maintained where compatible with the project.

- Riprap will be used where appropriate for engineering function; this will provide substrate habitat.

- Areas disturbed during construction will have vegetation planted in the first growing season following project completion.

- Topsoil will be replaced to existing depths to allow flora planting.

- Present modal flows will be maintained because only flood flows will be diverted, thus maintaining fish habitat.

- Acquisition of natural storage areas for proper functioning of the plan includes a large amount of wetlands. The preservation of natural storage areas, in concert with the State/Corps' agreement to maintain existing floodways in acquisition areas, would help avoid secondary development impacts as a result of plan implementation.

- Upstream of the Pompton Inlet, scrub/shrub vegetation would be planted to offset the removal of trees.

- Pilot channels would be included along the upstream portions of the affected reaches of the Pequannock and Wanaque Rivers.

- Public access for fishing in the affected reaches of the Ramapo, Pequannock and Wanaque Rivers will be provided.

- Levee designs incorporate walking/biking paths on top of the levees, overlooks, benches, lighting, comfort facilities, river access and planting/beautification measures aimed at providing recreational opportunities.

- Compensation for residual project impacts on parks will include providing equivalent recreational activities on project lands or monetary payments based on fair market value of equivalent public recreation, usefulness, size, quality and location.

- Phase II Engineering and Design Studies:

  - Habitat Evaluation Procedure

  - Plant community sucession modeling

  - Development of Comprehensive Wetlands Management Plan to help refine site-specific mitigation.

  - Organize an Environmental Advisory Board to guide the detailed environmental planning and design.

- Utilize Instream Flow Incremental Methodology to refine site-specific aquatic mitigation.

- Conduct cultural resource surveys; prepare mitigation plans if necessary.

- Coordinate with USEPA and NJDEP regarding the status of hazardous substance sites in the vicinity of the project; develop a Health and Safety Plan if necessary.

- Finalize levee designs in concert with further recreational mitigation refinements in coordination with NJDEP and local recreation planners.

The Fish and Wildlife Service made eighteen recommendations for mitigation in the FWCA report. The ability to accommodate these recommendations is discussed in paragraphs 1.26 through 1.30 of the final EIS. The Corps is able to fully accommodate fourteen recommendations, including plant successional modeling. The plant community succession modeling, has been agreed to by FWS and the Corps as a tool to be used in the Phase II Design effort. Through additional plan modifications and refinements, the Corps was able to partially accommodate three other recommendations, which have been provided to the greatest extent possible.

The remaining FWCA recommendation for mitigation is an unresolved conflict. It is unresolved because it would work in opposition to the goals and purposes of the plan. This FWS recommendation, which calls for eliminating or greatly reducing channel modification upstream of the Pompton inlet, would not allow floodwaters to enter the tunnel efficiently. This would cause extensive backwater flooding and is, therefore, a recommendation which can not be incorporated into the plan.

OPERATIONAL DETAILS OF THE TUNNEL

The operation of the tunnel component of the selected plan, both for flood control and environmental objectives, is reliant upon specific rules which designate when the tunnel would be placed into operation and what flows would bypass the tunnel inlets. Due to the nature of the flooding in the basin, it is possible to define initial bypass flows past the tunnel inlets during the early part of a storm when flood flows are increasing (ascending limb of the storm hydrograph) for flood control

purposes, and a significantly greater bypass flow to produce the 1 year flood event for environmental purposes during the later part of a storm when flood flows are decreasing (descending limb of the storm hydrograph) and the peak flows have passed each of the respective inlets.

The tunnel would not operate for any flow less than or equal to the one year flood event. The tunnel would operate only when a flood greater than the one year flood is predicted to occur. This prediction would be based upon an enhanced Passaic River Basin Floodwarning and Forecasting System with additional streamflow and rain gages to ensure accurate, timely forecasting of expected flood levels.

The recommended Pompton/Passaic Dual Inlet Tunnel Diversion Plans calls for two inlets as follows: the Pompton River Inlet near the upstream limit of the Pompton River, and the Passaic River Inlet downstream of Two Bridges. The purpose of including two inlets in the plan is to make more effective use of the tunnel throughout the duration of the storm while diverting flood flows away from the major damage areas in the Pompton Valley and along the Passaic River. This would be accomplished by taking advantage of the timing difference between flood flows of the Pompton River and those of the Passaic River. The Pompton River flood peaks for the 2 year and the 100 year storms, for example, occur at Pompton Plains at hours 34 and 33, respectively, while for the Passaic River, the corresponding flood peaks occur at Two Bridges at hours 84 and 76. Although the operation of the Pompton Inlet is discussed first, in fact, the operation of the two inlets act in concert.

The Pompton River Inlet consists of three major elements: a river flow restrictor; a gated diversion spillway; and a morning glory diversion spillway. The river flow restrictor lies across the Pompton River and has five gated openings see Figure 58. During non-flood conditions, the center gate of the flow restrictor would remain open to permit normal flows to continue downstream.

In the event that flood flows are predicted to exceed the one year flood, the river flow restrictor would be operated for flood damage reduction purposes so that water starts to pond behind it and a maximum of 500 cubic feet per second (cfs) would bypass the inlet early in the storm. (By comparison, the average daily flow for the Pompton River is approximately 482 cfs.) At the same time the diversion spillway gates would be opened to permit the water that has ponded behind the river flow restrictor to enter the inlet basin and pass into the morning glory inlet, thereby initiating the diversion. The inlet basin

is lower in elevation than the river channel, permitting the diversion of flood flows at non-damaging elevations while maintaining water surface elevations greater than the 1 year stage at upstream wetlands areas for all floods. Should flood flows exceed the capacity of the tunnel, the five gated openings on the river flow restrictor would be opened in order to pass the larger flows while maintaining maximum diversion through the tunnel.

The diversion into the tunnel would continue until several conditions are met. These conditions, which occur in the course of every flood event, are: (1) Rainfall has stopped; (2) Peak flood flows have passed the inlet; and (3) Pompton River stages downstream of the inlet are below the annual flood stage.

At this point, the Pompton River flow restrictor would be opened to permit the bypass of a discharge sufficient to produce the annual flood stage along the Pompton Valley for environmental purposes. Subsequently, as downstream flows continue to recede, the gates to the inlet basin would close, thereby bypassing all flows as discharges return to normal conditions.

The major elements of the Two Bridges inlet consist of a gated diversion spillway and a morning glory diversion spillway (Figure 59). A river flow restrictor is not included for the Two Bridges Inlet since the design pool stage at the diversion spillway is created by the natural rock ledge in the river upstream of Beatties Dam. During non-flood conditions, the gated diversion spillway would be closed so that normal flows would bypass the inlet and continue downstream over Beatties Dam. As with the Pompton Inlet, when it is predicted that flooding greater than the 1 year event is imminent, the gates in the diversion spillway would open. The diversion gates would be operated to divert Passaic River flows into the tunnel and maintain a maximum 100 cfs bypass flow down the Passaic River during the early portion of the flood when the Lower Valley tributaries are peaking. The Central Basin contribution to these Lower Valley tributary flows must be minimized early in the storm to prevent flooding in the Lower Valley.

Since the Pompton River flow would have priority use of the tunnel's capacity, the amount of Passaic River water actually diverted over the course of the event would be a function of how much tunnel capacity is available while the Pompton River is being diverted. For floods between the 50-year and 100-year events, as the flow into the Pompton Inlet increases to its peak, the Two Bridges Inlet diversion would be closed down to permit the maximum diversion of Pompton River water. At this point only Pompton River water would enter the tunnel. There

would no diversion of Passaic River flows at this time; all Passaic River flow would be bypassed downstream. During a 100-year flood event, diversion of Pompton River flows would require the tunnel to carry only Pompton River water for a period of 11 hours, during the middle of the storm, while the Pompton River flows are peaking. During that period no water would enter the Two Bridges Inlet and about 9,000 cfs would be bypassed downstream along the Passaic River. Since this timeframe is well after the peaking of the Lower Valley tributary flooding, these additional flows can be passed downstream of the Two Bridges Inlet without flooding in the Lower Valley. Later in the storm, after the Pompton River flows have receded so that there is excess tunnel capacity, the gates to the Passaic River Inlet would reopen thereby resuming diversion so as to reduce the Passaic River peak flow entering the Lower Valley, which occurs approximately two days after the Pompton peak. (It is noted that for more frequent storms between the 1 year and 50 year floods, the Pompton River flow diversion is not sufficient to fill the tunnel to capacity and the Two Bridges diversion need not completely shut down.)

The Two Bridges Inlet would continue to divert flow in this manner until several conditions are met. As for the Pompton Inlet, these conditions are: (1) Rainfall has stopped; (2) Passaic River peak flows downstream of Little Falls have receded; and (3) Passaic River stages downstream and upstream of the inlet are below damaging elevations.

At this time, the Passaic River spillway diversion gates would be gradually closed. This would permit the bypass of a discharge sufficient to produce the annual flood flow for environmental purposes downstream of the inlet and would result in the annual flood stage upstream to and beyond Two Bridges.

In addition to the diversion works associated with the two tunnel inlets, two gated weir structures, the Great Piece Meadows Weir and the Pequannock River Weir, would be operated in concert with the tunnels for environmental purposes. The Great Piece Meadows Weir would be located in the Passaic River upstream of Two Bridges (Figure 60). The Pequannock River Weir would be located in the modified Pequannock River transition channel (Figure 47).

During periods of normal flow, the gates in the Great Piece Meadows Weir would remain open (lowered) and the flow regime would remain unchanged from current conditions. Under flood conditions the gates in the Great Piece Meadows Weir would remain open (in the lowered position) until the peak flow has passed during a flood event. When the peak flood stage has receded to the one year stage, or, if peak stages have not

reached the one year stage as predicted, the weir gates would be raised to replicate the one year flood stage in the Central Basin wetlands upstream of the weir. The one year flood stage would be maintained for a period of time determined necessary to satisfy fish and wildlife needs in the Great Piece Meadows. Once these needs have been met, the gates would be gradually lowered and would again remain completely open under normal conditions. Since the tunnel would not operate for events up to and including the 1 year flood, there would be no change in the flow regime for these frequent floods. For all floods larger than the 1 year event, the operation of the weir would result in at least the 1 year water surface elevation upstream of the weir in the Great Piece Meadows. For the 100 acres of wetlands downstream of the weir, the 1 year flow bypass rules at the tunnel inlets would insure that these wetlands also receive the 1 year flood stage, although the flooding duration for these 100 acres would be reduced.

The Pequannock River Weir would remain closed (in the raised position) during normal conditions to reproduce the water surface elevations that would occur under without project conditions. This condition would maintain normal river stages and flows over the old Morris Canal Feeder Dams on the Pequannock and Ramapo Rivers. During flood events, the gates in the weir would be opened (lowered) to allow the modified channel to function as designed in conjunction with the levee/floodwall systems to provide a 100-year level of protection to the upstream damage areas. As flood flows recede, the gates would be raised to their normal closed position.

CONSTRUCTION OF THE DUAL INLET TUNNEL PLAN

This plan combines: surface works consisting of channel modifications, levee/floodwall elements, inlet and outlet works and a river flow restrictor; and subsurface works consisting of tunnel excavation. The surface works would be constructed through traditional methods, while the tunnel construction would utilize specialized methods. This plan would have a construction duration of 90 months.

The tunnel would be constructed at an elevation lower than its outlet structure to a depth necessary to reach competent rock which would allow underground construction. In this situation, those occupants located above the route would not be physically aware of the tunnel construction except at the inlet, outlet and construction shaft locations. It has been determined

that the most efficient way to construct the 13.5-mile, 39-foot diameter main tunnel and the 1.2-mile long, 22-foot diameter spur tunnel would be through the use of tunnel boring machines (TBM's). The TBM's would be used throughout except in the excavation of the vertical inlets and outlet, and 4 construction shafts which will utilize conventional excavation methods.

Two TBM's would be used to excavate the main tunnel. They would each be 42.5 feet in diameter. The first machine would begin at Work Shaft #1 near the tunnel outlet and excavate through to Work Shaft #2 in an abandoned quarry near Montclair College. Concurrent with the operation of the first machine, the second would begin at the Montclair work shaft and excavate through to Work Shaft #3 in Preakness Valley Park in Wayne, just above the point where the spur tunnel would join the main tunnel. One smaller TBM, 24.5 feet in diameter, would excavate the spur tunnel beginning at Work Shaft #4, located 700 feet west of where the spur will join the main tunnel. Figures 56 and 57 depict the approximate locations of the work shafts. After the main tunnel excavation has progressed to Work Shaft #3 in Wayne, drill and shoot excavation will be used to connect the main and spur tunnels. The upper leg of the main tunnel would be excavated last. The TBM would begin at the Pompton inlet and excavate through to Work Shaft #3. The concrete lining would be placed in each section of the main and spur tunnels after the TBM's have been removed from these sections.

Whenever the tunnel penetrates groundwater deposits, construction methods will prevent infiltration into the tunnel. The concrete tunnel lining will seal the tunnel against both groundwater infiltration and exfiltration.

It is estimated that approximately 6,506,000 cubic yards of rock would be excavated as part of the main and spur tunnels. There would be no problem in disposing of this material since it is highly marketable and non-contaminated. As part of the surface works, approximately 1,491,000 cubic yards of earth would be excavated. A portion of this material would be marketable. Materials not marketable would be disposed of in suitable disposal areas.

OPERATION AND MAINTENANCE OF THE DUAL INLET TUNNEL PLAN

When completed, the operation and maintenance of the Pompton/Passaic Dual Inlet Tunnel Diversion Project will be performed by the local cooperating agency in accordance with government regulations. The various project features will require either periodic or annual maintenance. Periodic inspections of the tunnel structure, and more frequent testing

of mechanical equipment at gated structures and pump stations will be required. Annual maintenance activities include debris removal at interior drainage facilities, and at tunnel inlets and outlet structures; shoal removal, riprap repair, trash pickup and brush and tree control in the modified channels; the repair and patching of concrete structures; and mowing, trash pickup, and weed control along levees and ponding areas.

ECONOMICS OF THE SELECTED PLAN

Methodology. The tangible economic justification of the proposed plan was determined by comparing the equivalent average annual charges with the estimated equivalent average annual benefits anticipated to accrue over the economic life of the project. A discount rate of 8 and 5/8% was used to obtain comparable equivalent annual costs and benefits. A 100-year project life was used in the economic analysis, in accordance with economic criteria for useful life expectancy. The analysis also reflects detailed refinements to the economic data. It was verified that these refinements, which are only included in the selected plan data, would not have affected previous plan formulation decisions. An economic summary of the recommended plan is contained in Table 27.

The Pompton/Passaic Rivers Dual Inlet Tunnel Diversion Plan of protection is expected to be constructed in 90 months. Interest during construction has been included for the entire construction period. However, it has been determined that the project would begin to accrue flood damage reduction benefits after the first 50 months of construction. Therefore, benefits were claimed on those project elements which would be operating by that time.

Estimate of First Cost. The estimated first cost of the dual inlet tunnel plan is $841,200,000, at October 1986 price levels.

Estimate of Annual Charges. The total estimated annual cost for the selected plan is $85,500,000, including operation, maintenance, replacement charges, the portion of the residual damages associated with the operation of the tunnel, and interest during construction.

Estimate of Annual Benefits. The total equivalent annual benefits over the period of analysis are estimated at $122,500,000. Of this, flood damage reduction benefits, resulting from the tunnels, channels, levees and floodwalls including benefits in advance of the base year, total $103,900,000. Other benefit categories include future affluence

TABLE 27

ECONOMIC SUMMARY OF RECOMMENDED PLAN 1/
(October 1986 Price Levels, 8-5/8%
Interest Rate, 100 Year Project Life
Base Year 2000, $1,000's)

FIRST COST	841,200
INTEREST DURING CONSTRUCTION	114,200
TOTAL INVESTMENT COST	955,400
ANNUAL COSTS:	
INTEREST DURING CONSTRUCTION	9,800
INTEREST AND AMORTIZATION	72,600
OPERATION AND MAINTENANCE	2,100
RESIDUAL INDUCED DAMAGES	1,000
TOTAL ANNUAL COST	85,500
ANNUAL BENEFITS:	
FLOOD DAMAGE REDUCTION	103,900
AFFLUENCE	6,800
PRESERVATION OF NATURAL STORAGE	3,200
TRAFFIC DELAYS	2,500
PATH DELAYS	1,300
FLOOD INSURANCE ADMINISTRATION COST REDUCTION	1,100
RESIDENTIAL INTENSIFICATION	1,100
INDUSTRIAL CONTENT GROWTH	2,600
TOTAL ANNUAL BENEFITS	122,500
B/C RATIO	1.4/1.0

1/ NUMBERS HAVE BEEN ROUNDED AND, THEREFORE, MAY DIFFER FROM THOSE IN THE COST ESTIMATES AND THE ECONOMICS SUPPORTING DOCUMENTATION.

and preservation of natural storage areas, traffic and PATH delay reductions, Federal Flood Insurance Administration cost reduction, residential intensification and industrial content growth. These latter two benefit categories refer to more intense utilization of an existing structure as a result of less frequent flooding. For instance, a resident may intensify the use of his home by finishing the basement if the flood hazard is reduced.

Economic Justification. A comparison of average annual benefits and average annual costs results in a benefit-to-cost ratio of 1.4 to 1 for the Pompton/Passaic River Dual Inlet Tunnel Diversion Plan.

RISK AND UNCERTAINTY

The risk and uncertainty associated with the recommended plan were considered. "Risk" situations are defined as those where potential outcomes can be described in reasonably well-known probability distributions. In situations of "uncertainty," potential outcomes cannot be described in probability distributions.

A determination was made of the probability of certain flood events occurring during the life of the project. This analysis indicated that during the 100-year project life the probability of occurrence would be 63 percent for a 100-year flood event and 18 percent for a 500-year flood. The probability of occurrence of the Standard Project Flood would vary throughout the basin, but would be less than 17 percent.

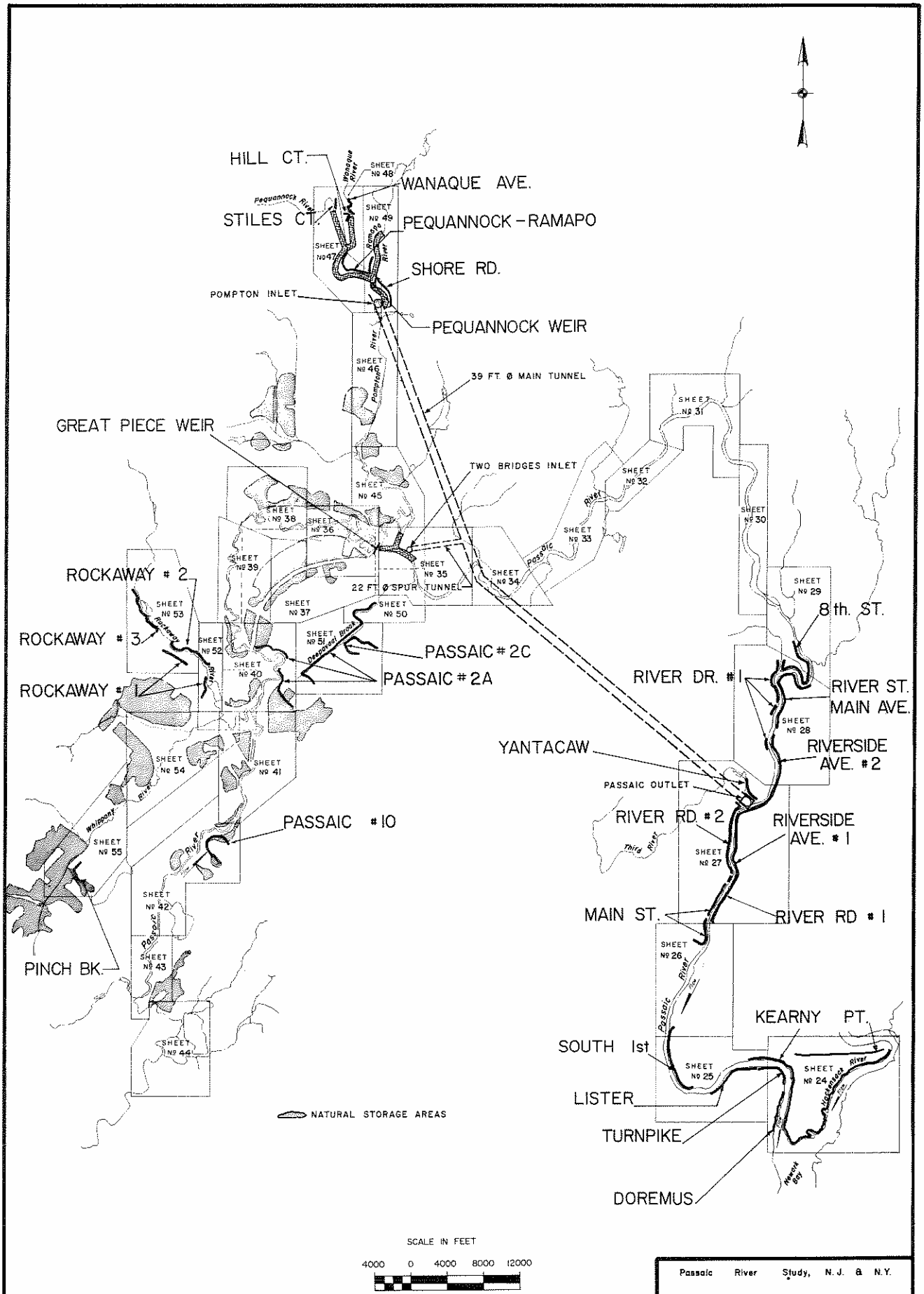
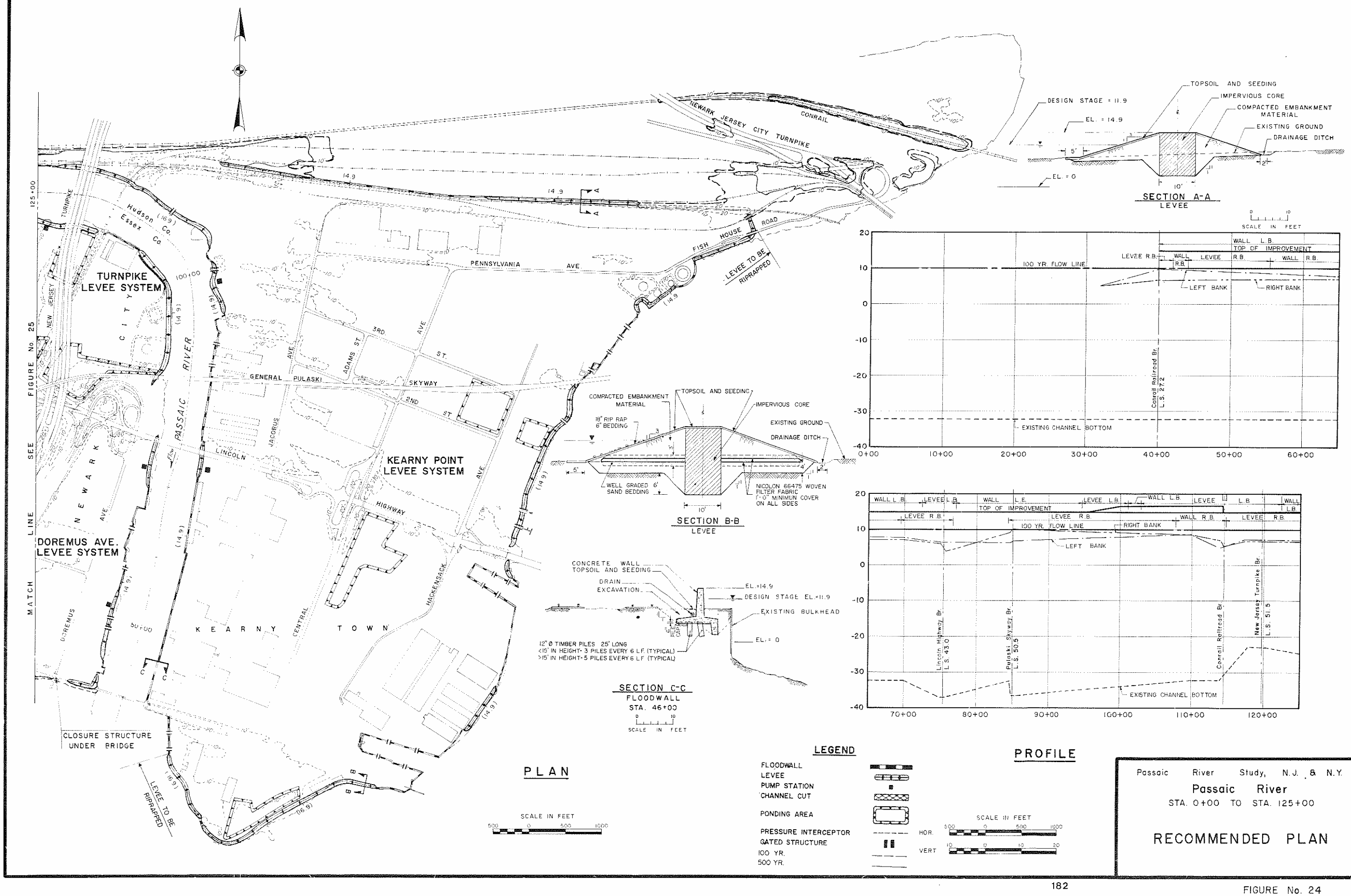

HILL CT.
WANAQUE AVE.
STILES CT.
PEQUANNOCK - RAMAPO
SHORE RD.
POMPTON INLET
PEQUANNOCK WEIR
39 FT. Ø MAIN TUNNEL
GREAT PIECE WEIR
TWO BRIDGES INLET
22 FT. Ø SPUR TUNNEL
ROCKAWAY # 2
ROCKAWAY # 3
ROCKAWAY # 1
PASSAIC # 2C
PASSAIC # 2A
PASSAIC # 10
PINCH BK.
8th. ST.
RIVER DR. # 1
RIVER ST.
MAIN AVE.
YANTACAW
RIVERSIDE AVE. # 2
PASSAIC OUTLET
RIVER RD. # 2
RIVERSIDE AVE. # 1
MAIN ST.
RIVER RD # 1
KEARNY PT.
SOUTH 1st
LISTER
TURNPIKE
DOREMUS
NATURAL STORAGE AREAS
SCALE IN FEET
4000 0 4000 8000 12000
Passaic River Study, N.J. & N.Y.
GENERAL PLAN AND INDEX MAP
RECOMMENDED PLAN

FIGURE 23



Passaic River Study, N.J. & N.Y.

Passaic River

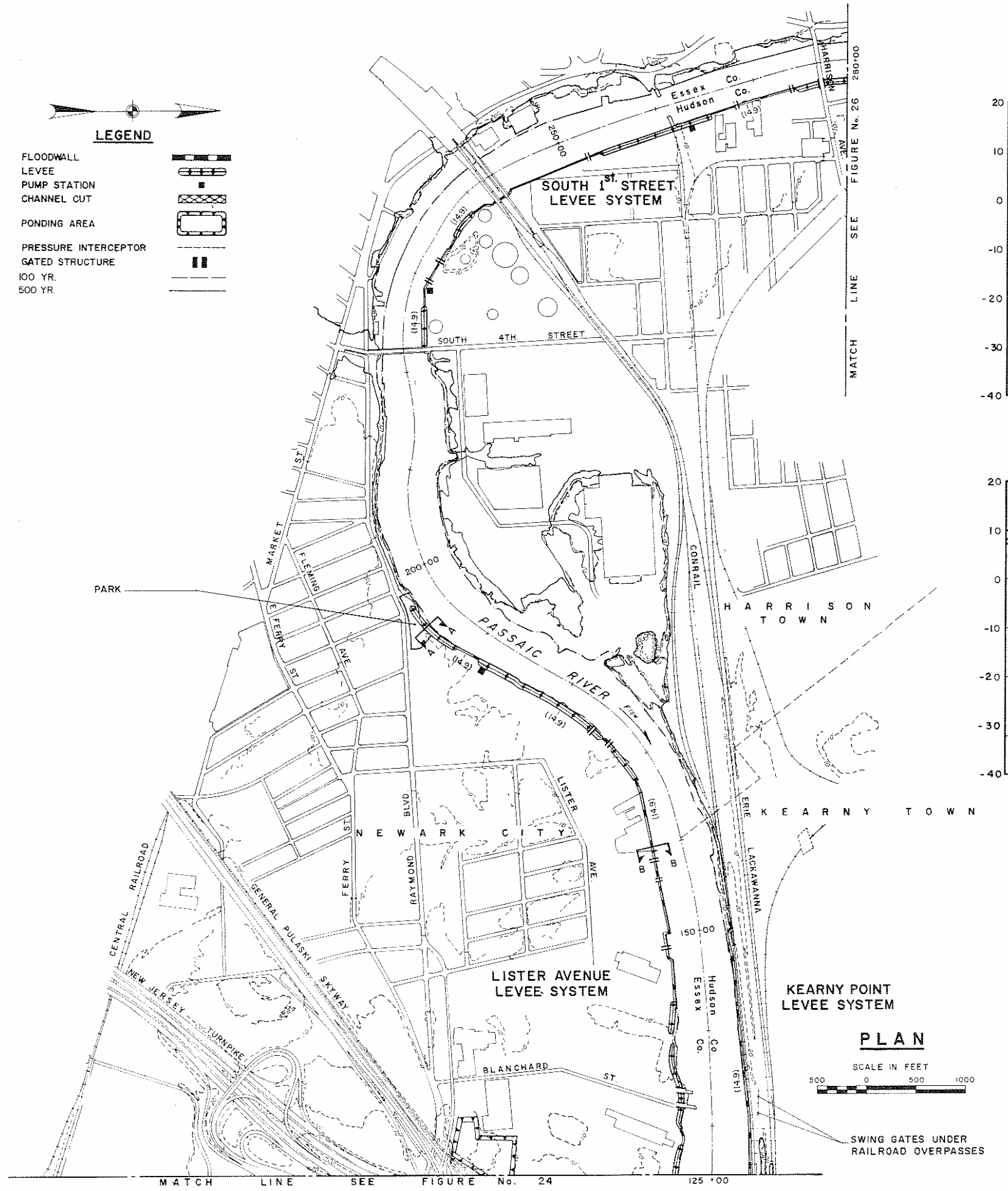
STA. 0+00 TO STA. 125+00

RECOMMENDED PLAN

FIGURE No. 24

LEGEND

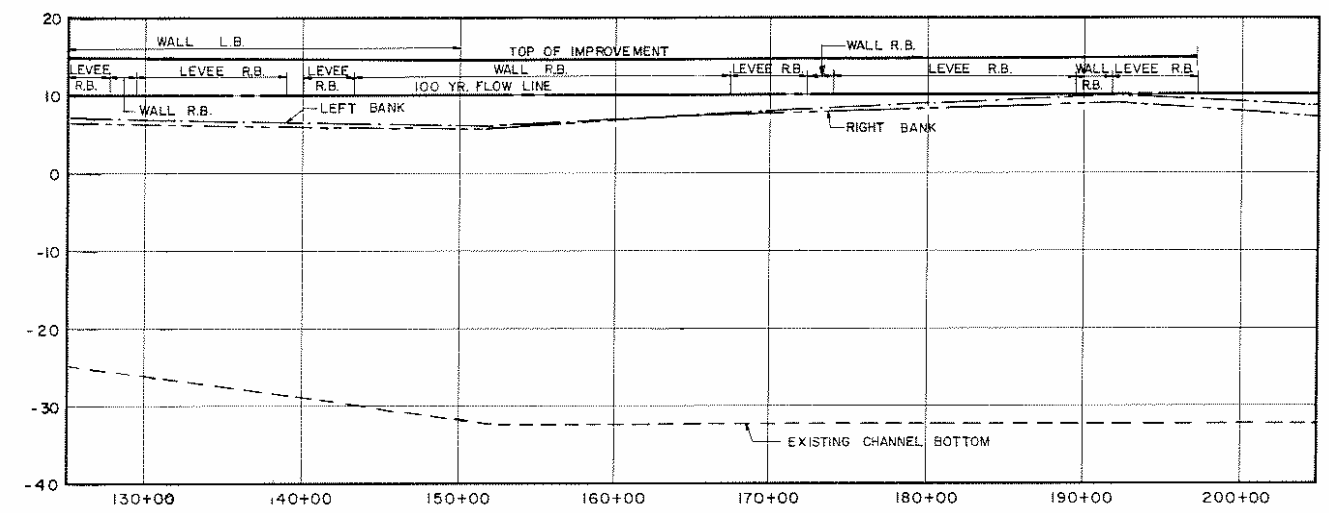
FLOODWALL
LEVEE
PUMP STATION
CHANNEL CUT
PONDING AREA
PRESSURE INTERCEPTOR
GATED STRUCTURE
100 YR.
500 YR.

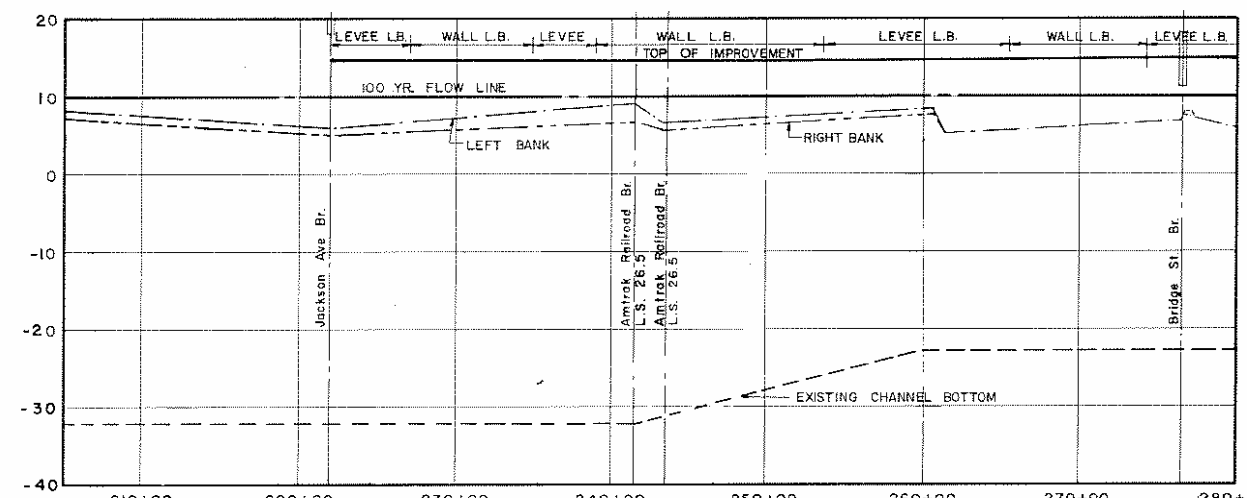


PLAN

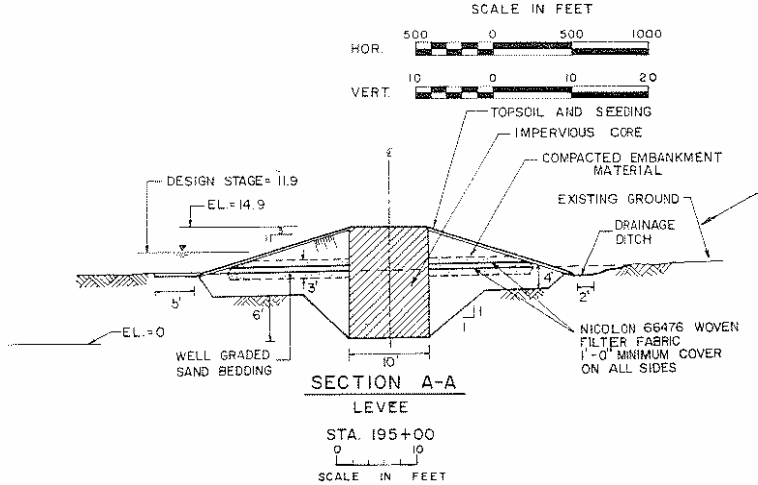
SCALE IN FEET
500 0 500 1000

SWING GATES UNDER RAILROAD OVERPASSES

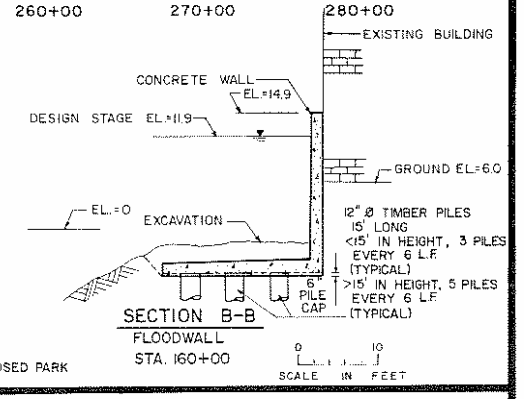




PROFILE



SECTION A-A
LEVEE
STA. 195+00
0 10
SCALE IN FEET



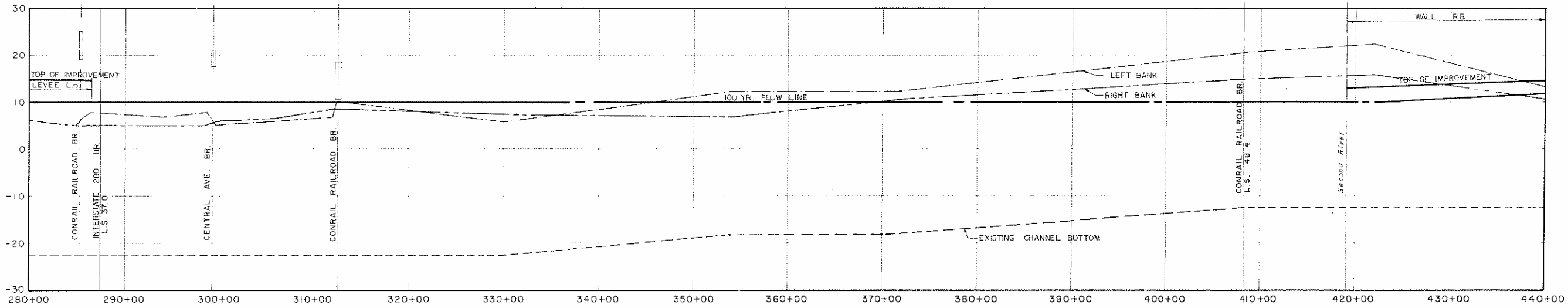
SECTION B-B
FLOODWALL
STA. 160+00

Passaic River Study, N.J. & N.Y.

Passaic. River
STA. 125+00 TO STA. 280+00

RECOMMENDED PLAN

FIGURE No. 25

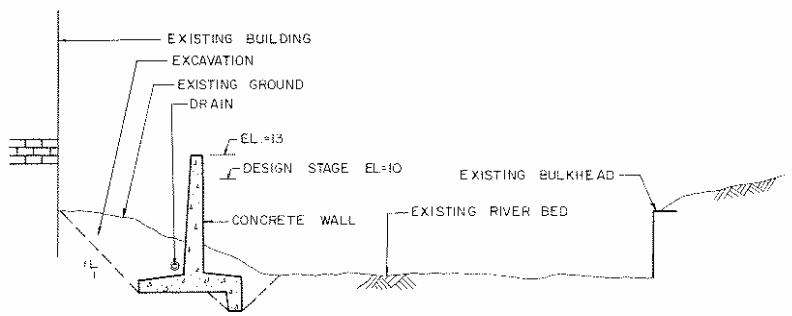


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT 10 0 10 20



SECTION B-B
FLOODWALL
STA. 4+60 (SECOND RIVER)

SCALE IN FEET

PLAN

SECTION A-A
LEVEE
STA. 282+00

SCALE IN FEET

SCALE IN FEET

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

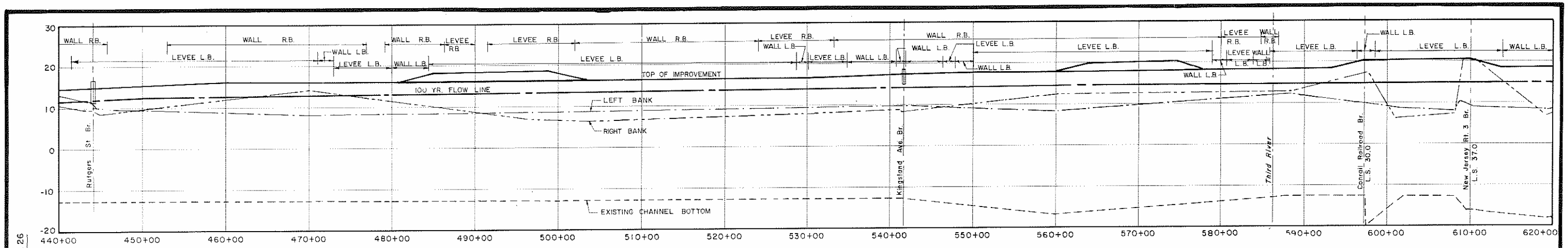
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 280+00 TO STA. 440+00

RECOMMENDED PLAN

FIGURE No. 26

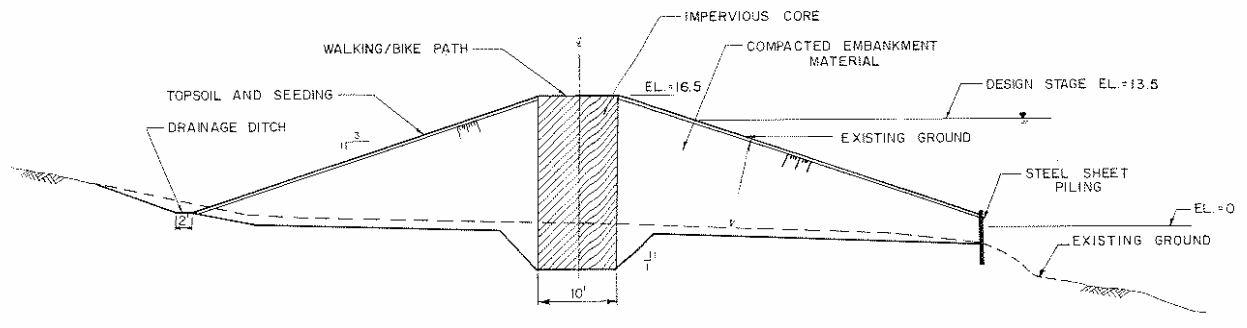


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT 10 0 10 20



SECTION B-B
LEVEE
STA. 504+00
0 10
SCALE IN FEET

SECTION A-A
FLOODWALL
STA. 504+00
0 10
SCALE IN FEET

PLAN

SCALE IN FEET

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

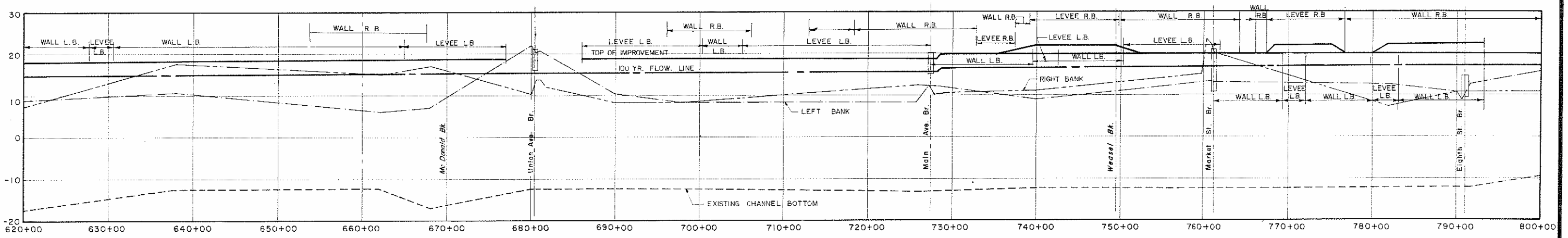
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 440+00 TO STA. 620+00

RECOMMENDED PLAN

FIGURE No. 27

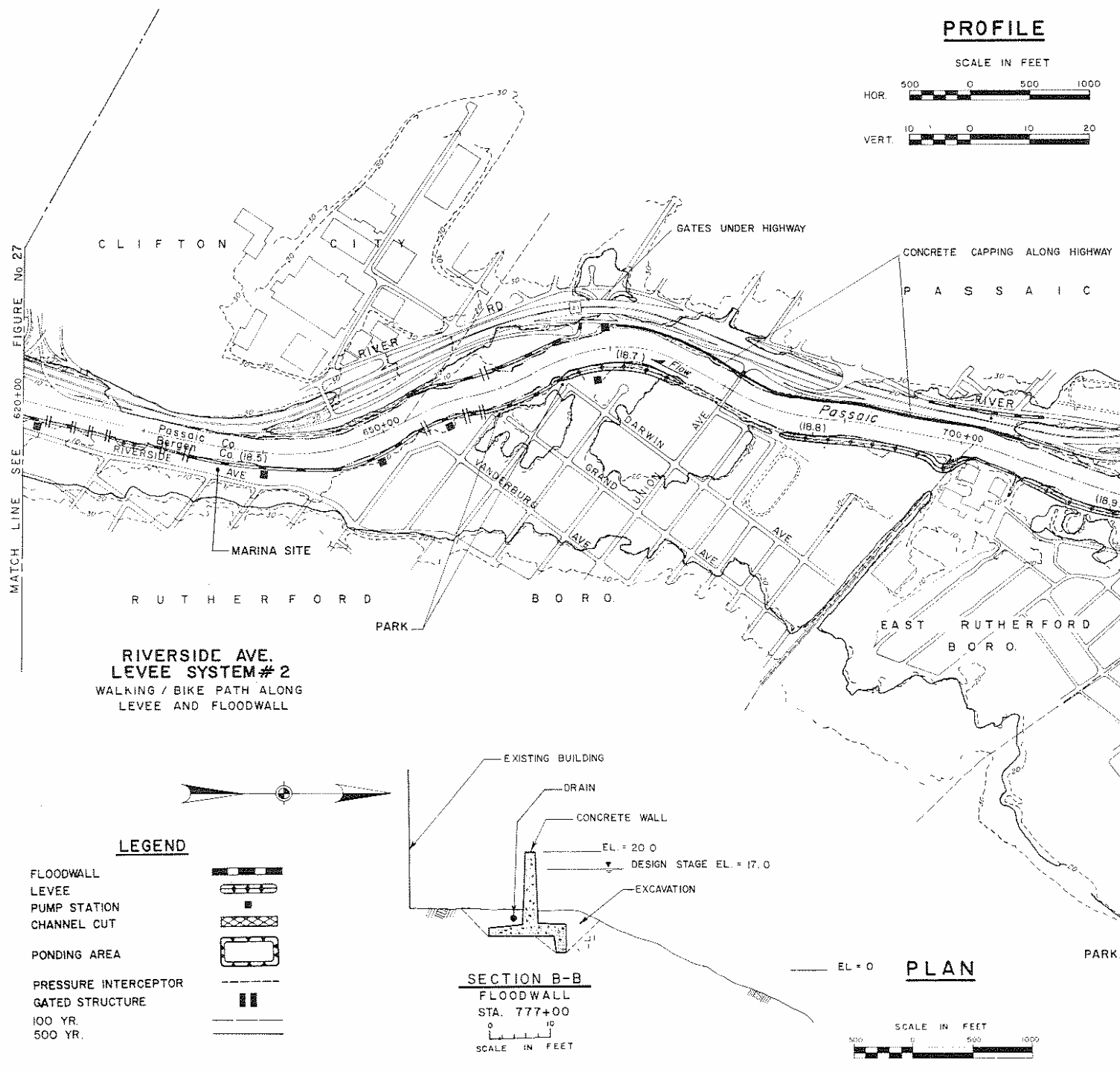


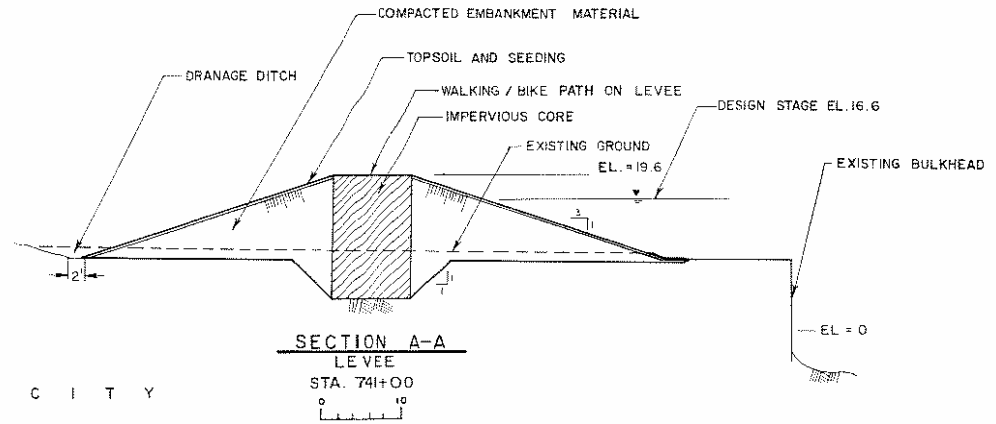
PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20





SECTION A-A

LEVEE

STA. 741+00

0 10

SCALE IN FEET

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

SECTION B-B

FLOODWALL

STA. 777+00

0 10

SCALE IN FEET

EL = 0

PLAN

SCALE IN FEET

500 0 500 1000

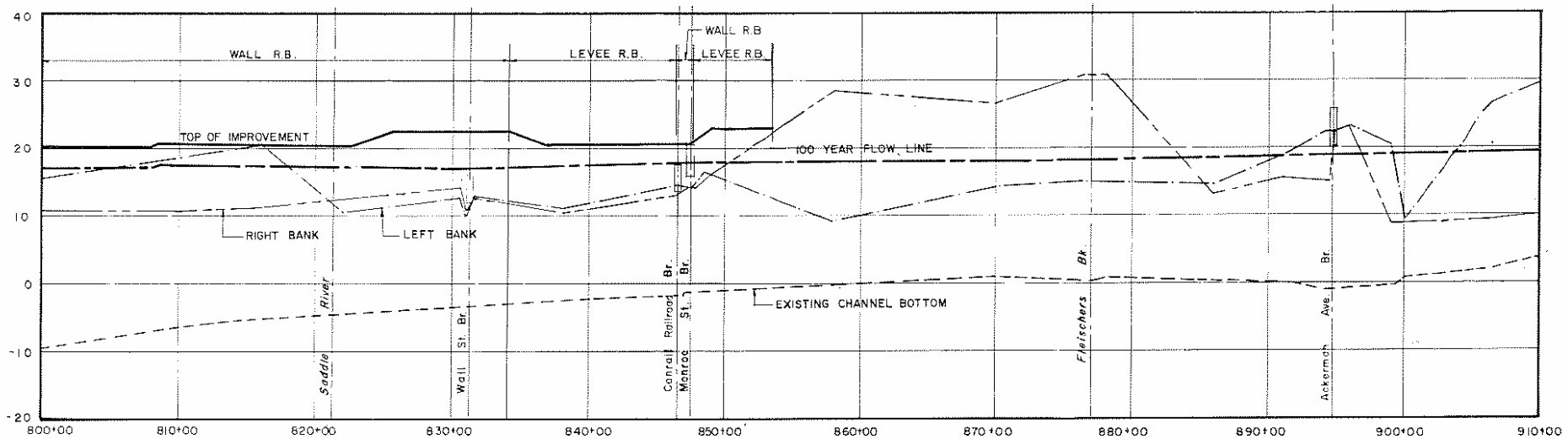
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 620+00 TO STA. 800+00

RECOMMENDED PLAN

FIGURE No. 28

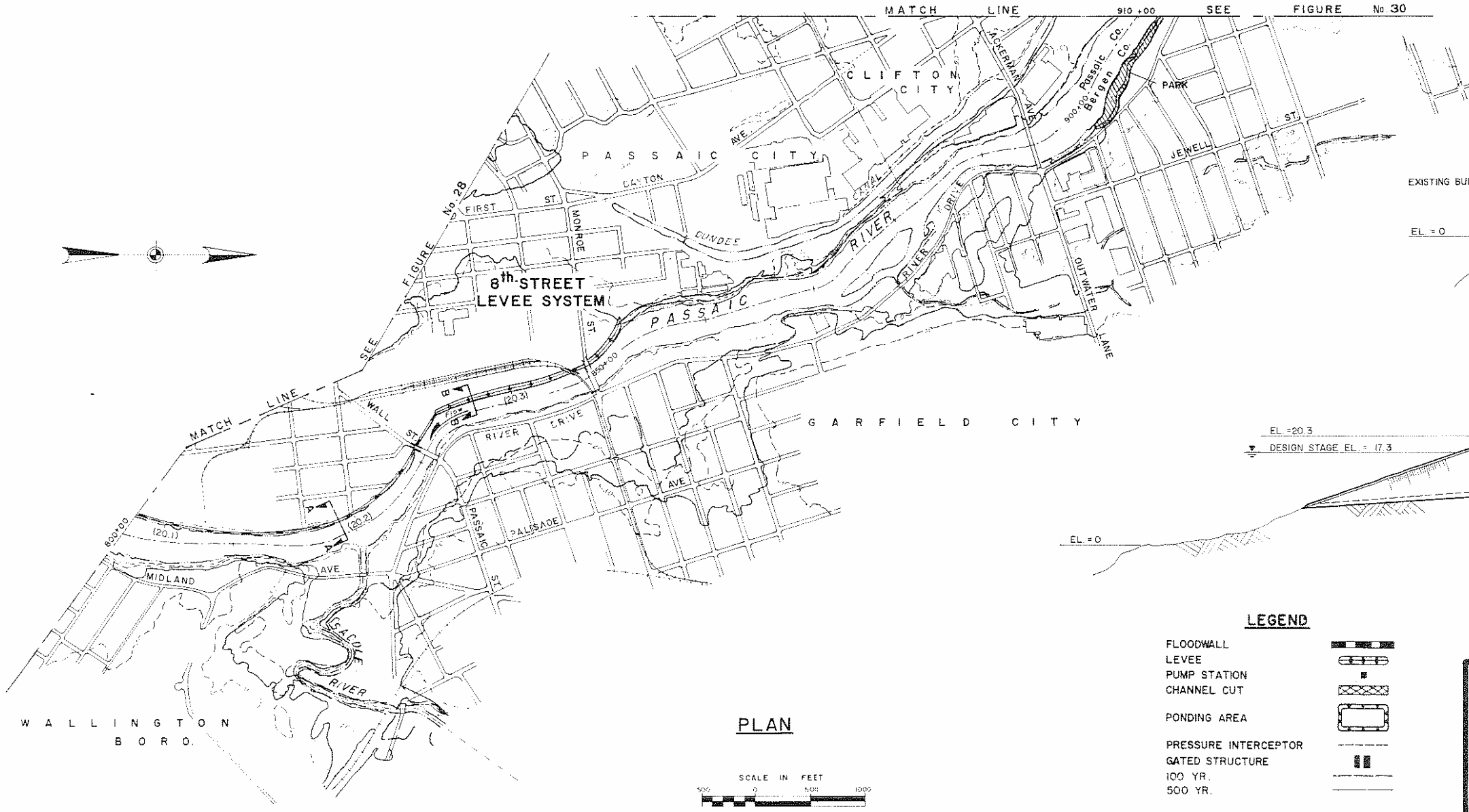


PROFILE

SCALE IN FEET

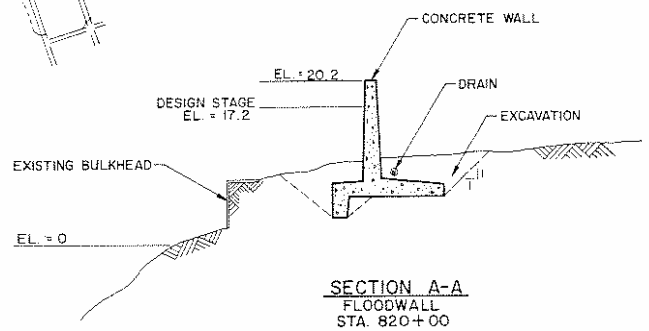
HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET 500 0 500 1000



SECTION A-A

FLOODWALL
STA. 820+00

0 10

SCALE IN FEET

SECTION B-B

LEVEE
STA. 837+00

0 10

SCALE IN FEET

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

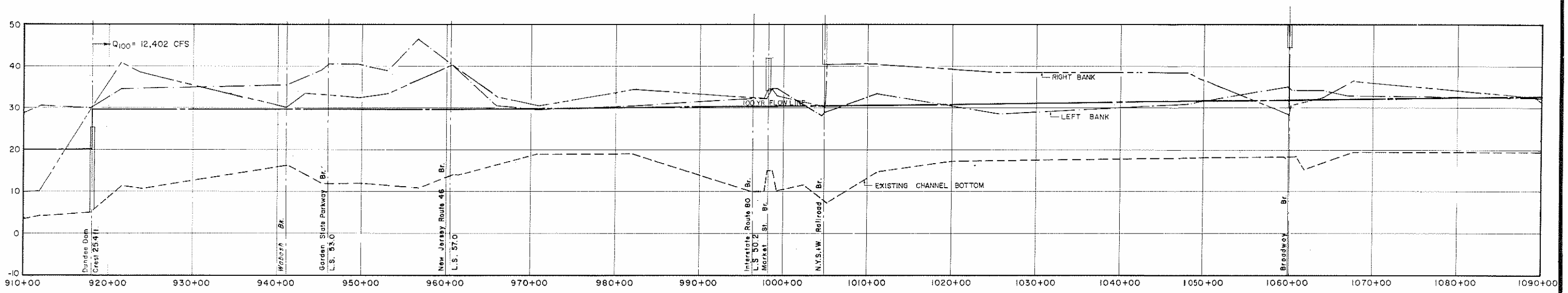
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 800+00 TO STA. 910+00

RECOMMENDED PLAN

FIGURE No. 29

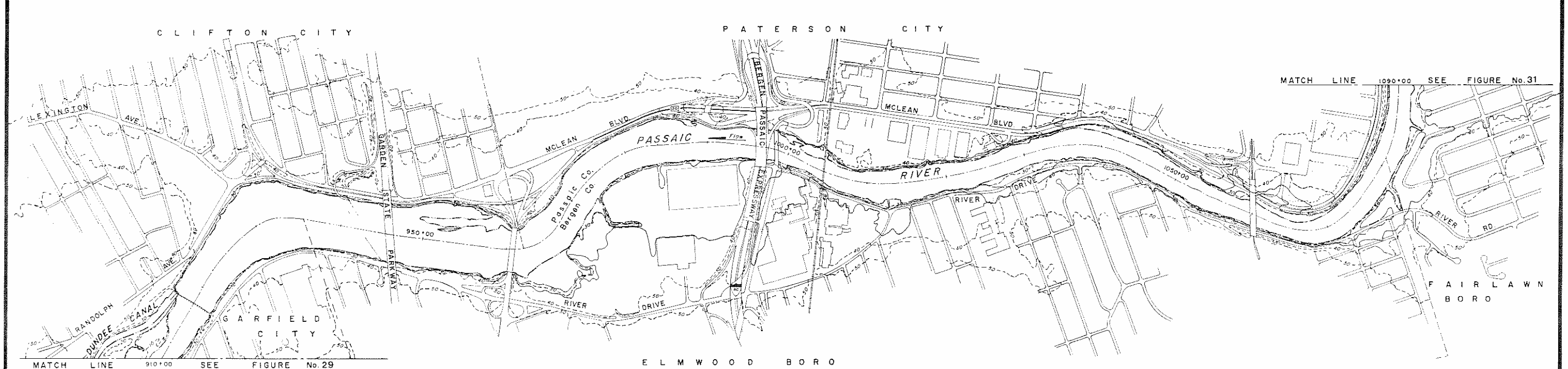


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET 500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

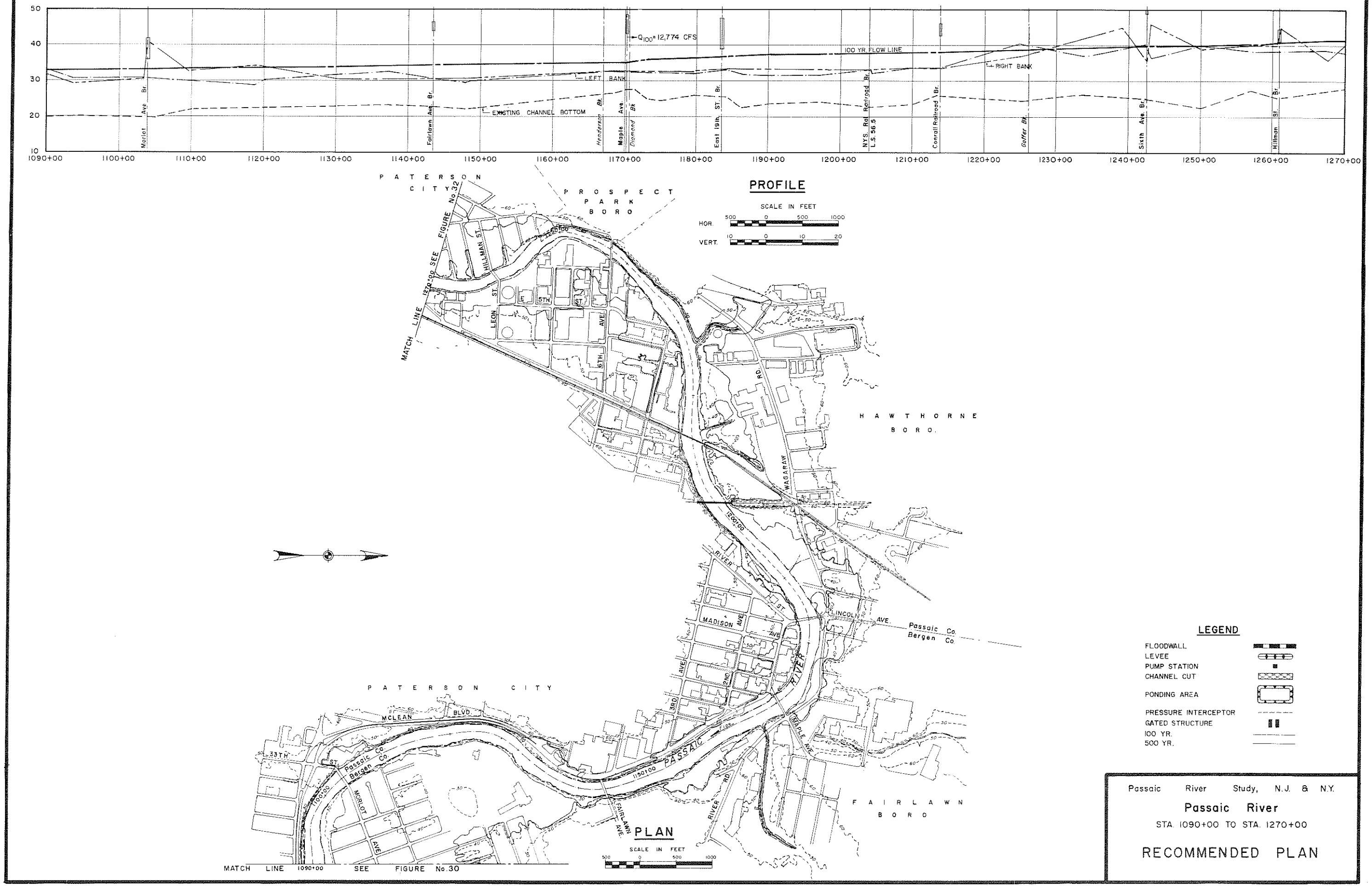
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 910+00 TO STA. 1090+00

RECOMMENDED PLAN

FIGURE No. 30



Passaic River Study, N.J. & N.Y.

Passaic River

STA. 1090+00 TO STA. 1270+00

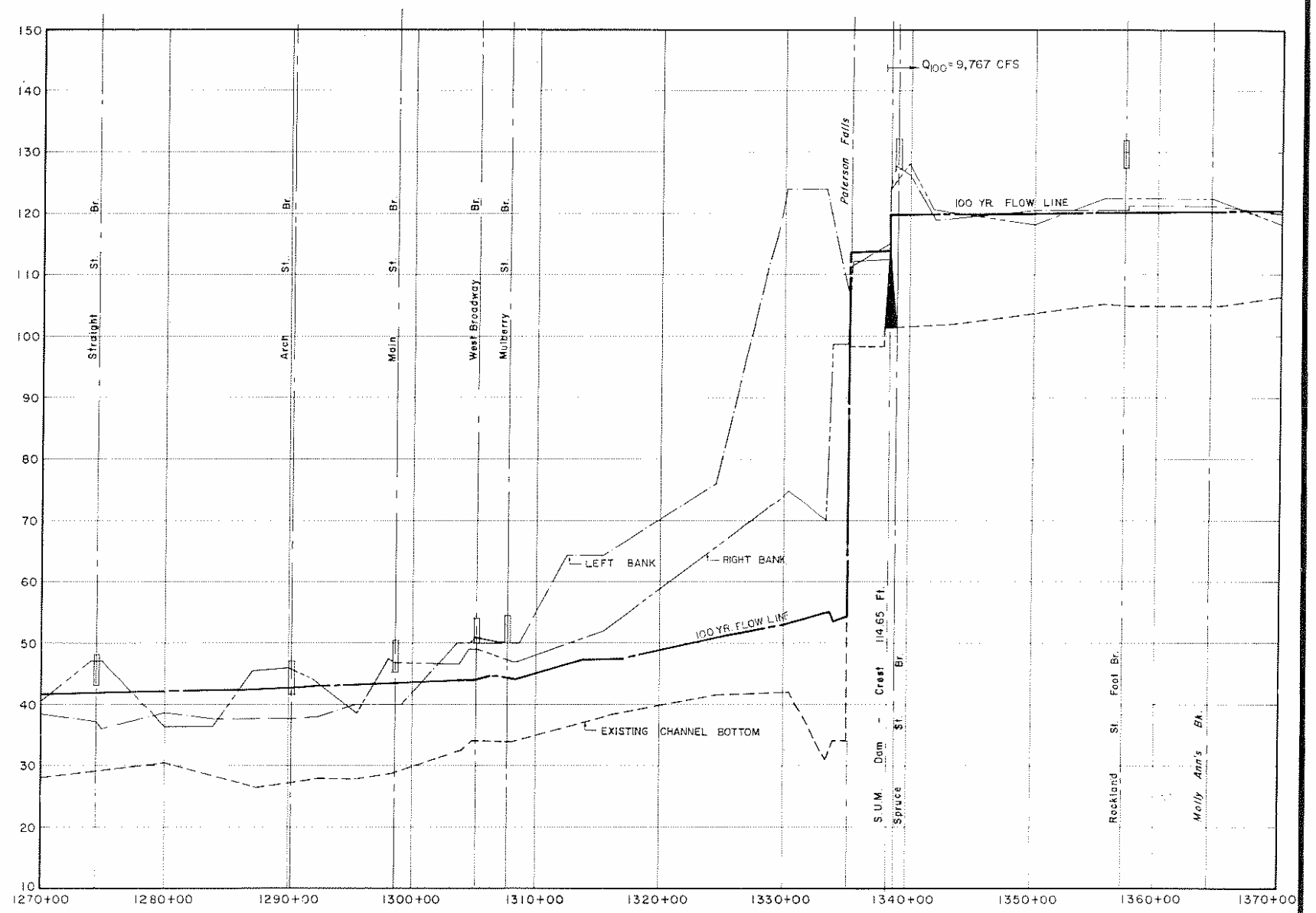
RECOMMENDED PLAN



PLAN

SCALE IN FEET

500 0 500 1000



PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR

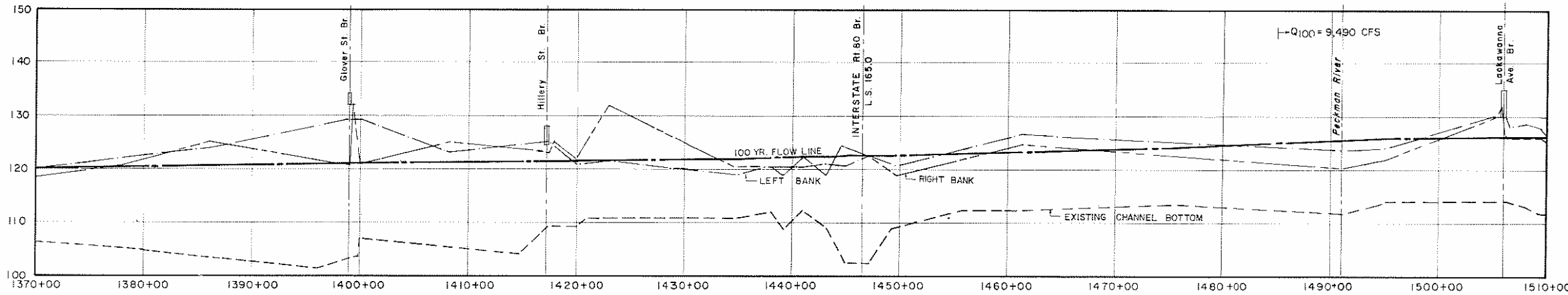
Passaic River Study, N.J. & N.Y.

Passaic River

STA 1270+00 TO STA. 1370+00

RECOMMENDED PLAN

FIGURE No. 32

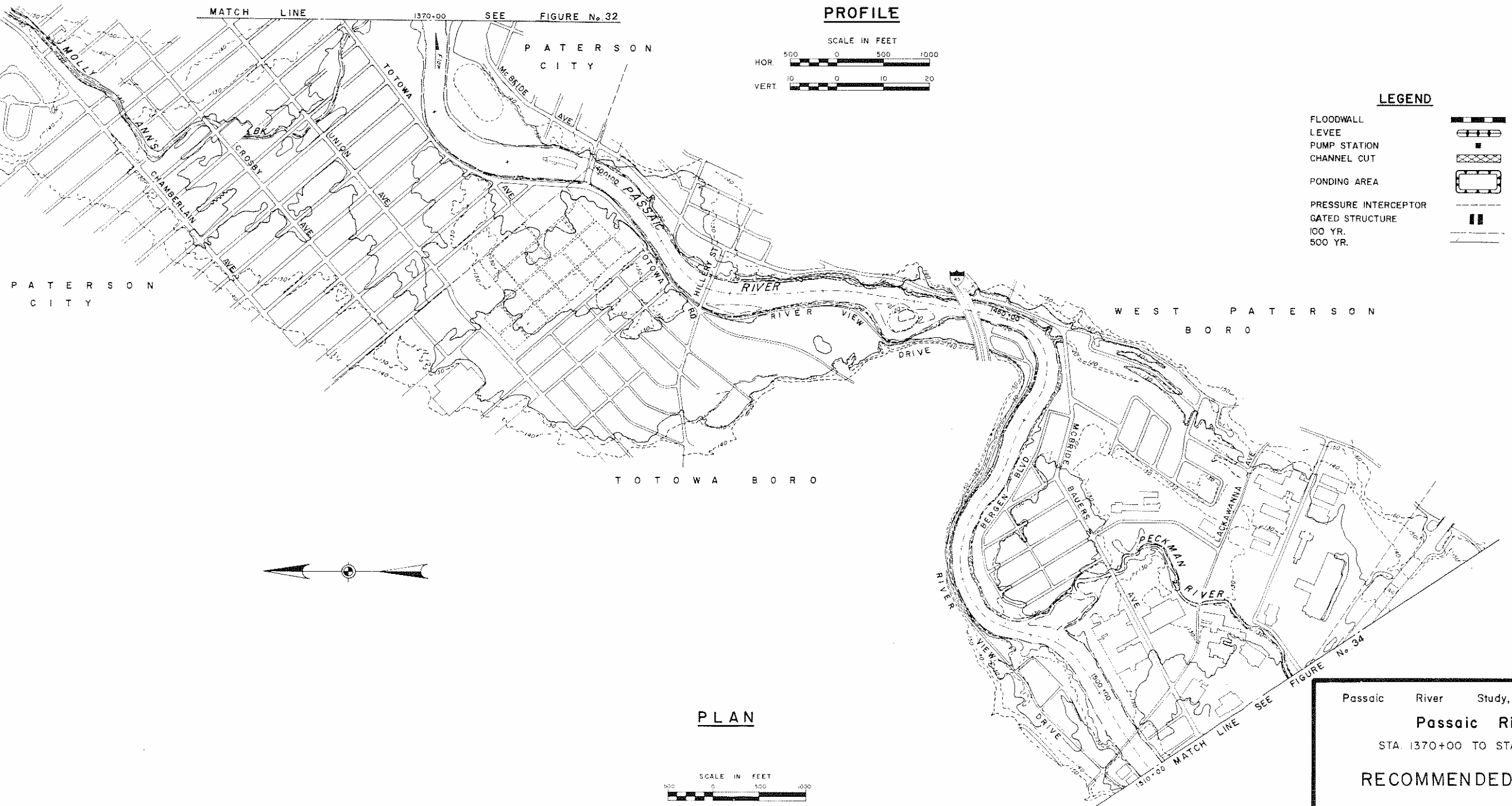


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

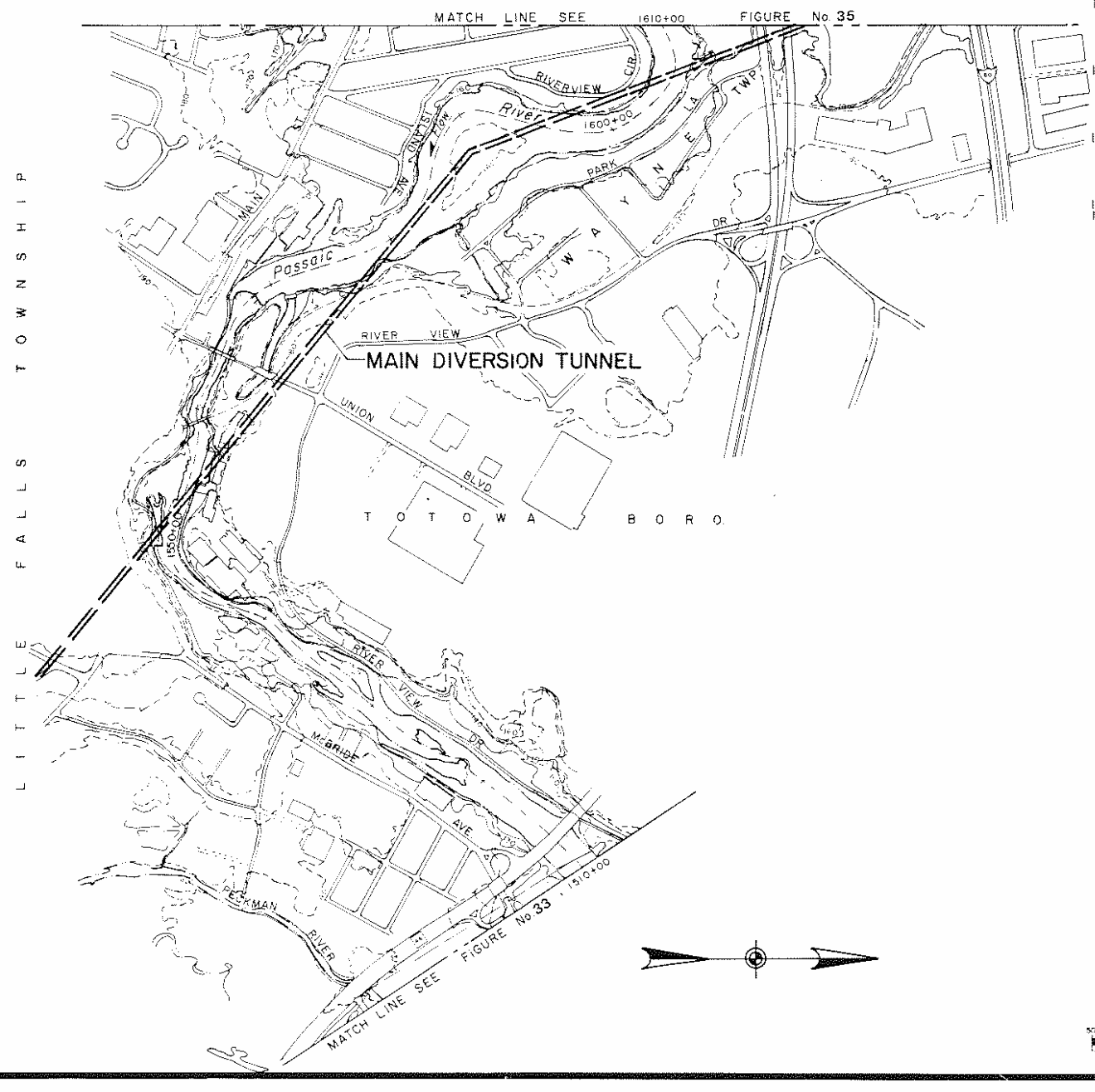
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 1370+00 TO STA. 1510+00

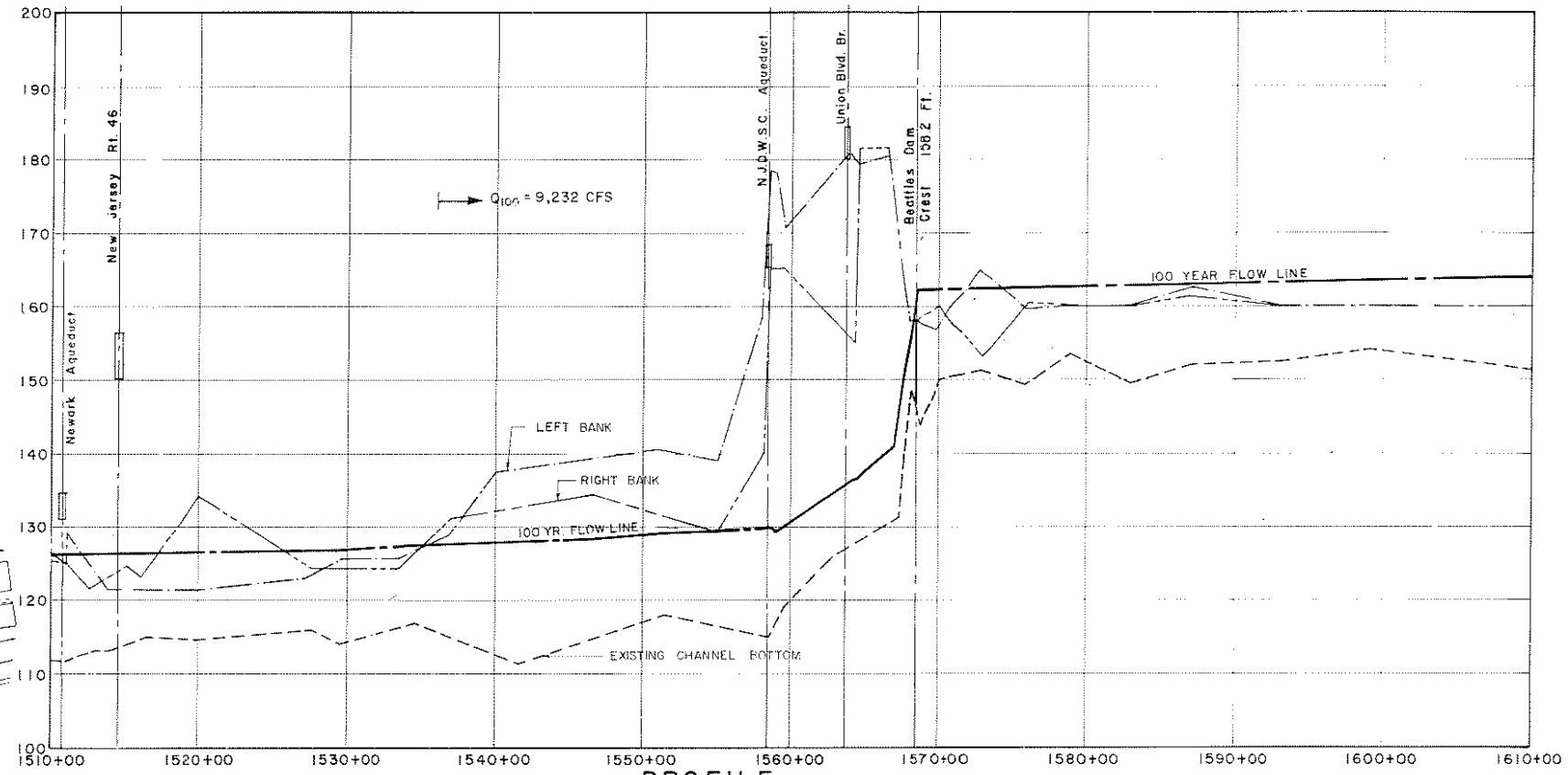
RECOMMENDED PLAN

FIGURE No. 33



PLAN

SCALE IN FEET
500 0 500 1000



PROFILE

HOR. 500 0 500 1000
VERT. 0 5 10 20
SCALE IN FEET

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

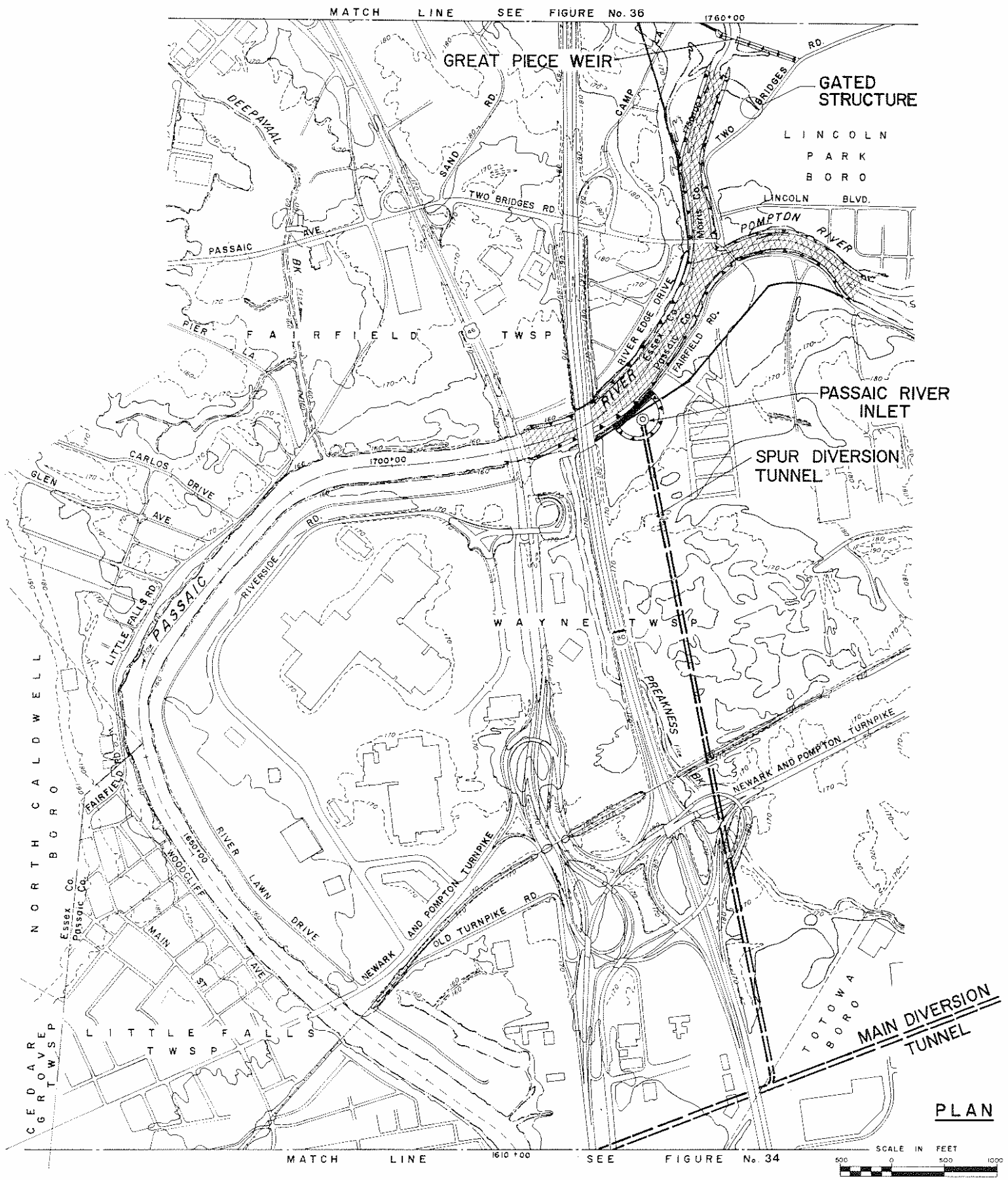
Passaic River Study, N.J. & N.Y.

Passaic River

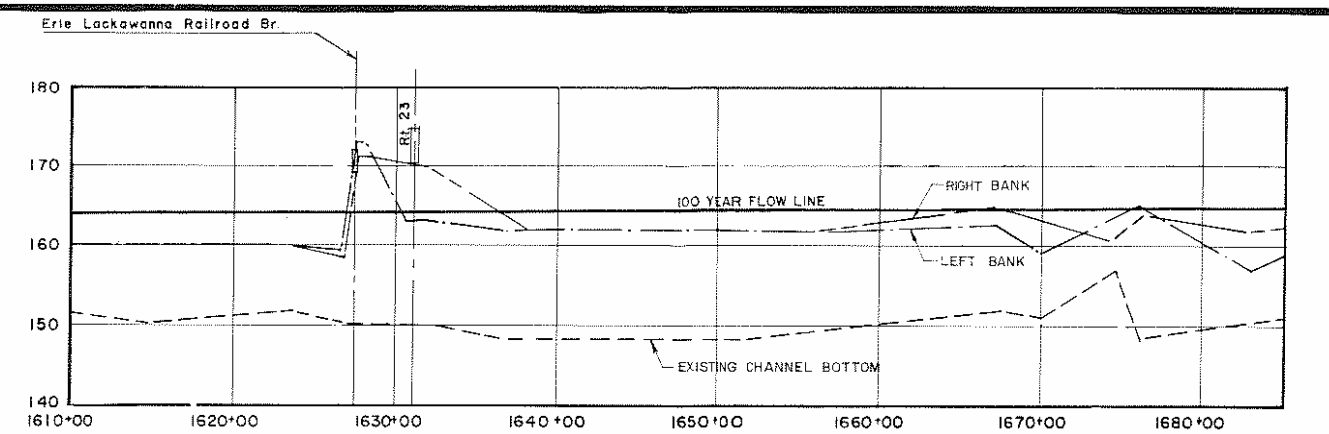
STA. 1510+00 TO STA. 1610+00

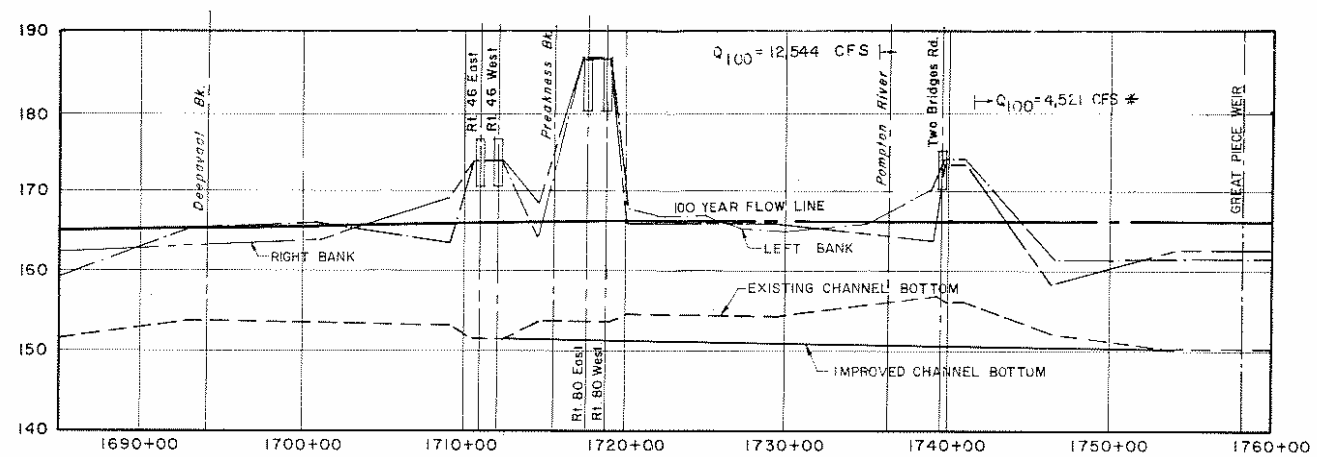
RECOMMENDED PLAN

FIGURE No. 34



PLAN





COINCIDENTAL FLOW *

PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 50 YR.
- STATE DESIGNATED FLOODWAYS

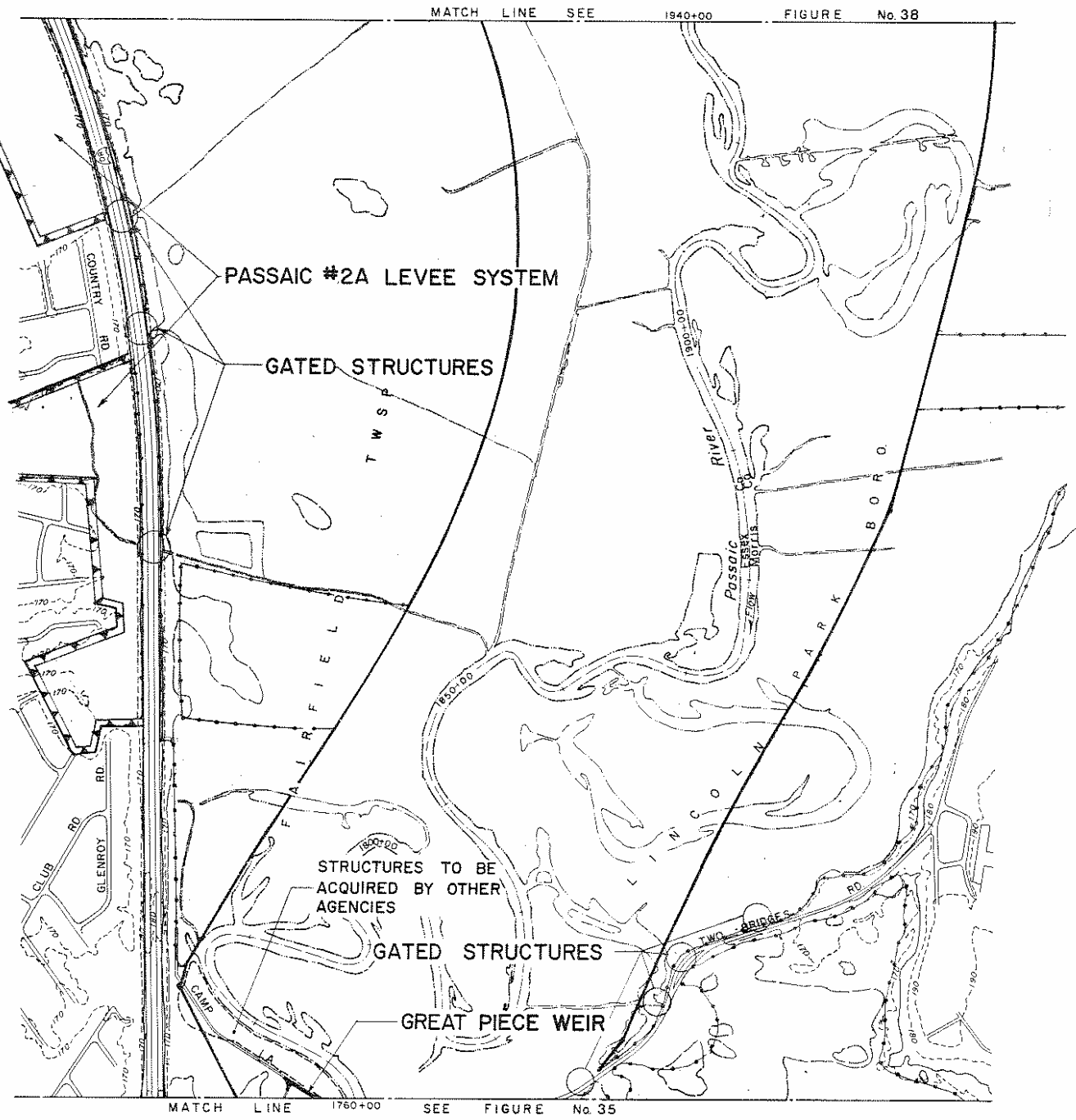
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 1610+00 TO STA. 1760+00

RECOMMENDED PLAN

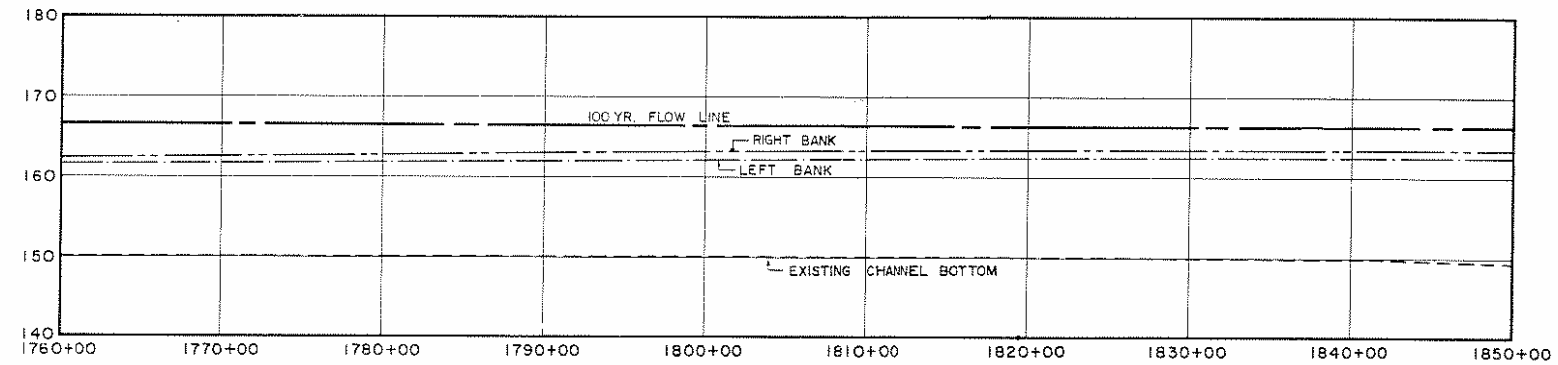
FIGURE No. 35

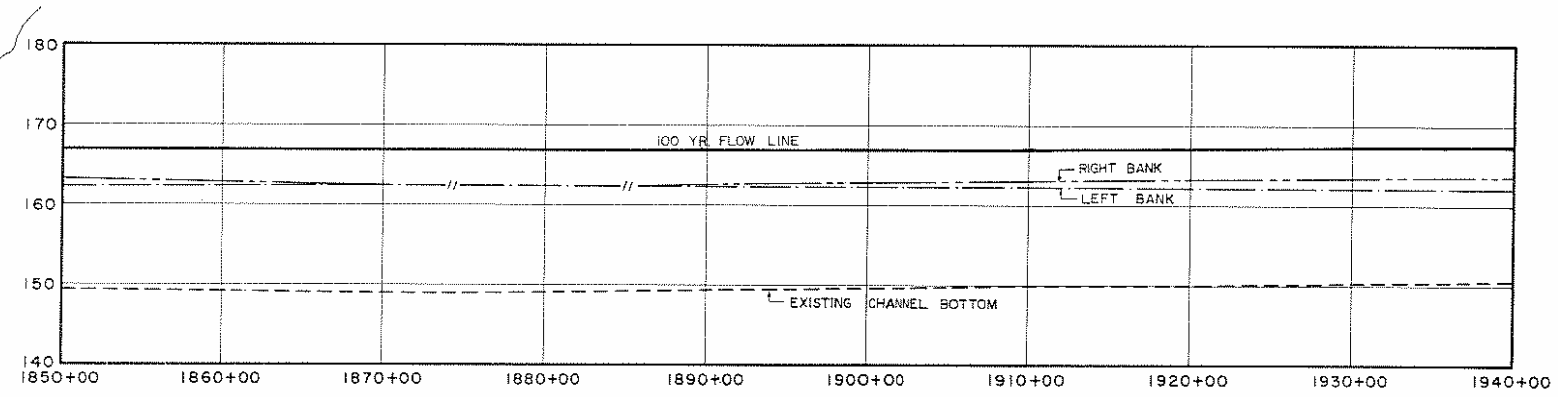


PLAN

SCALE IN FEET

500 0 500 1000





PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

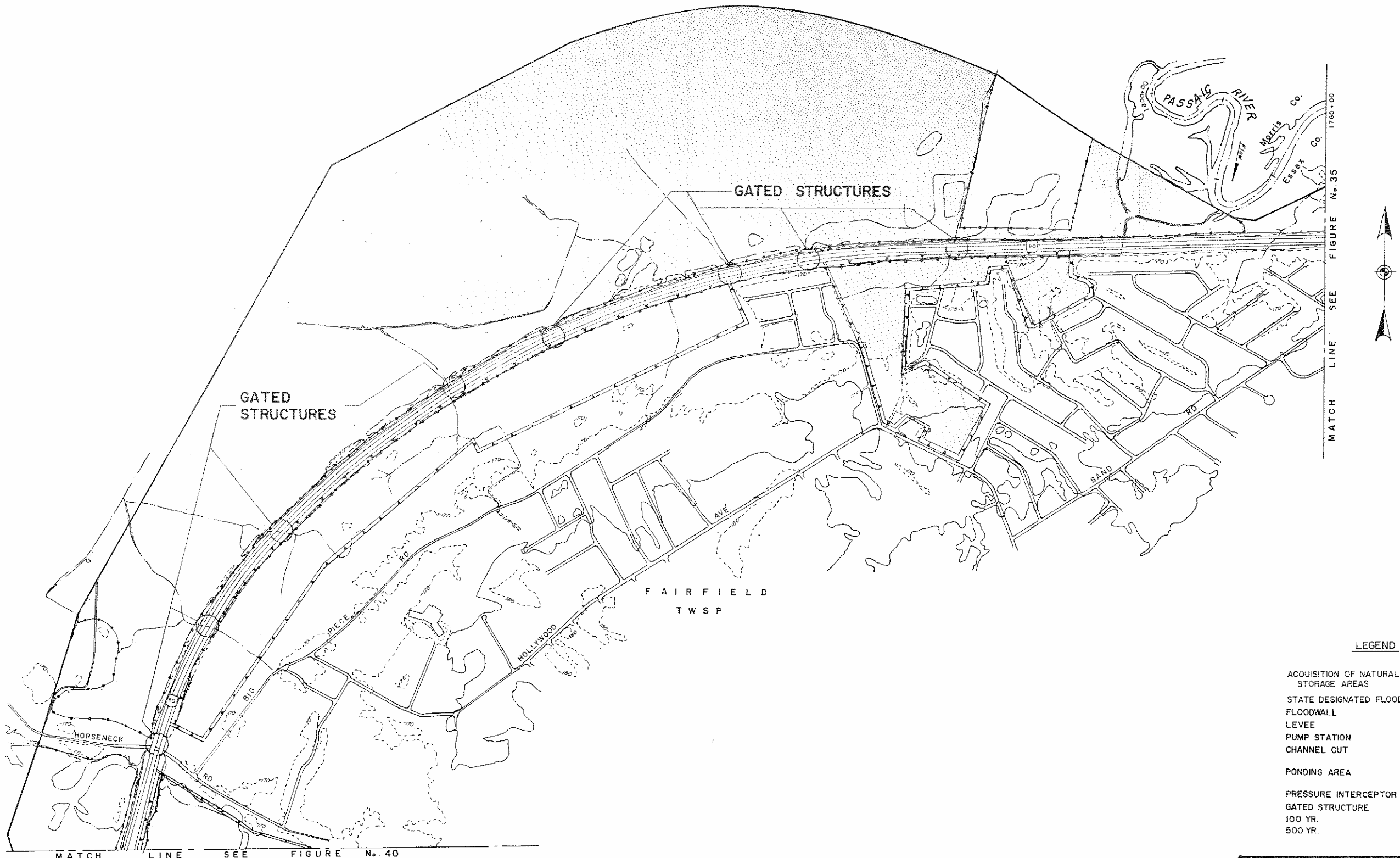
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 1760+00 TO STA. 1940+00

RECOMMENDED PLAN

FIGURE No. 36



LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAY
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

PLAN

SCALE IN FEET

500 0 500 1000

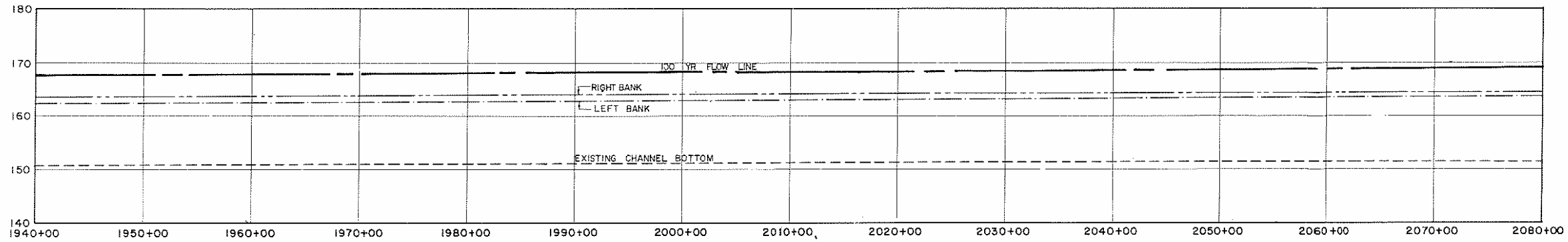
Passaic River Study, N.J. & N.Y.

Passaic River

OVERBANK STA. 1760+00
TO STA. 2240+00

RECOMMENDED PLAN

FIGURE No. 37



PROFILE

SCALE IN FEET

HORZ. 500 0 500 1000

VERT. 10 0 10 20



LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

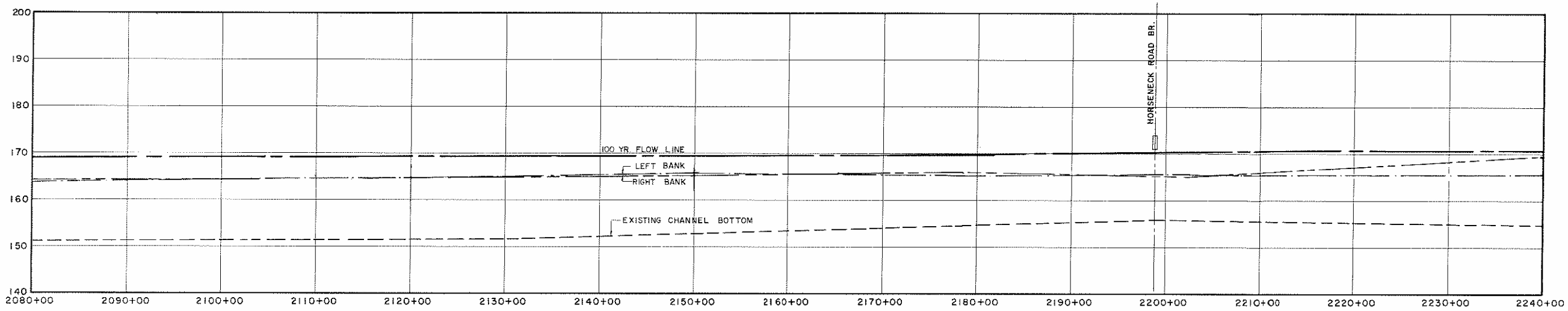
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 1940+00 TO STA. 2080+00

RECOMMENDED PLAN

FIGURE No. 38



PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

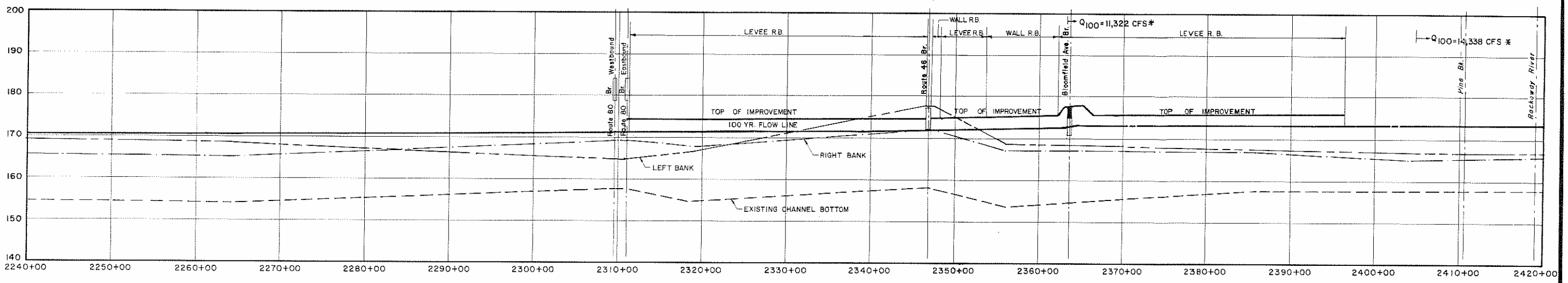
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 2080+00 TO STA. 2240+00

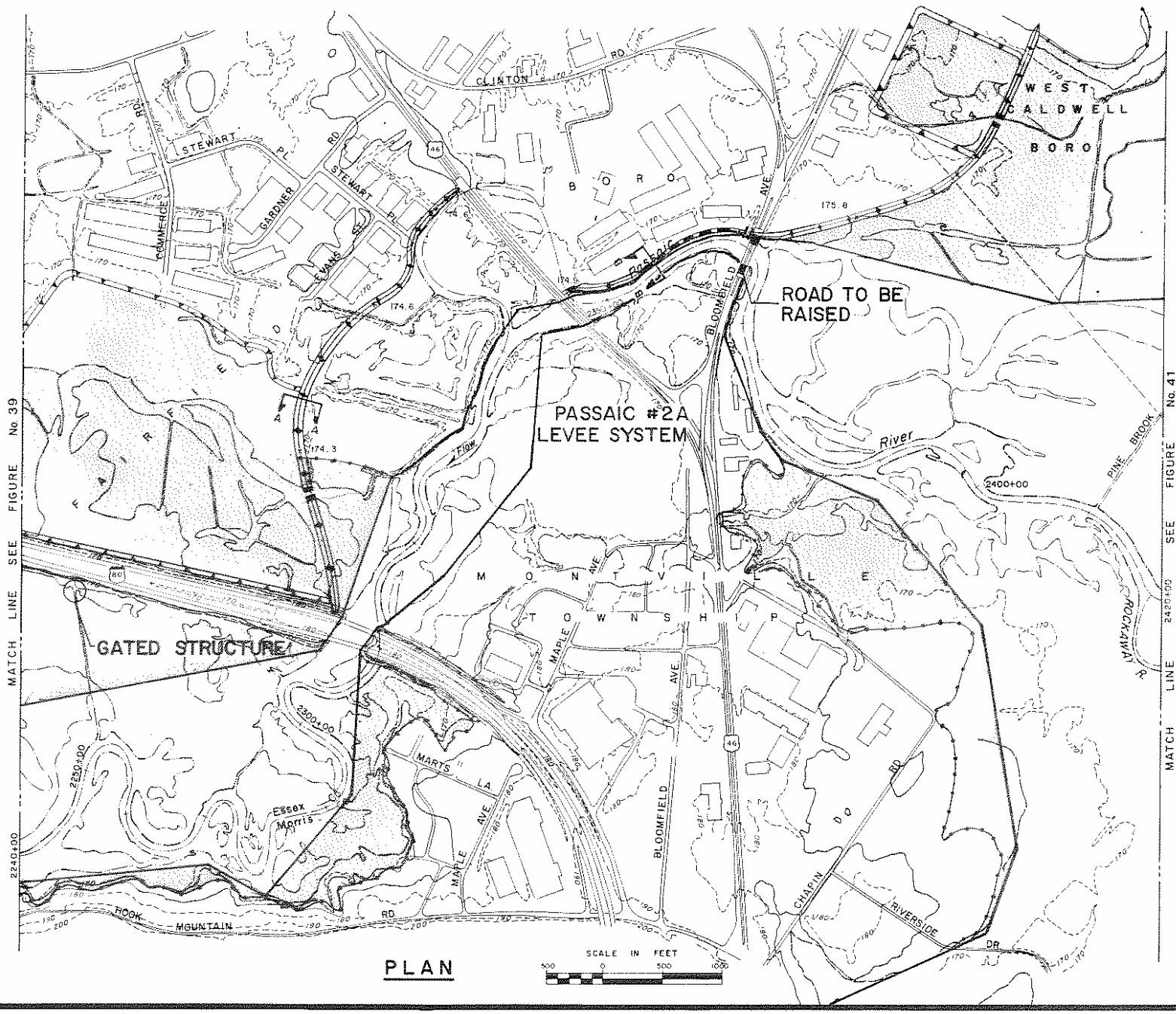
RECOMMENDED PLAN

FIGURE No. 39



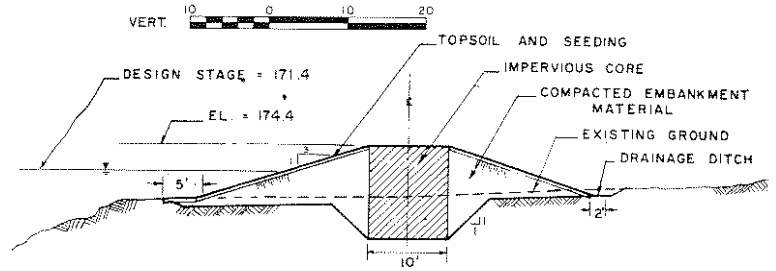
COINCIDENTAL FLOW *

PROFILE



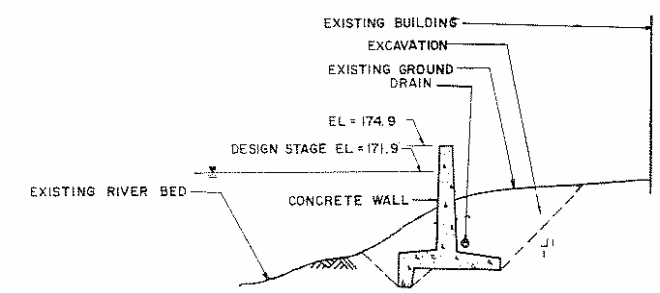
PLAN

SCALE IN FEET
HOR. 500 0 500 1000
VERT. 10 0 10 20



SECTION A-A
LEVEE
STA. 2330+00

0 10
SCALE IN FEET



SECTION B-B
FLOODWALL STA. 2354+00

0 10
SCALE IN FEET

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

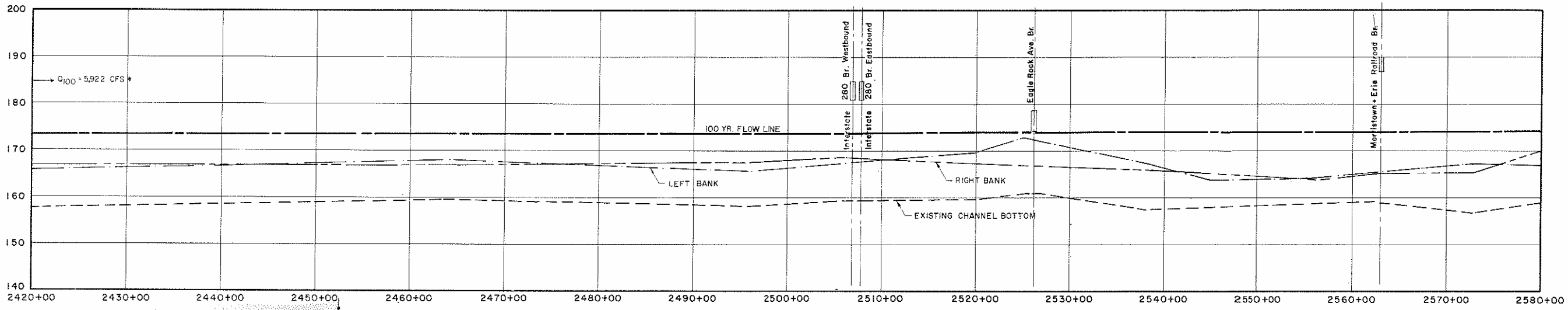
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 2240+00 TO STA. 2420+00

RECOMMENDED PLAN

FIGURE No. 40

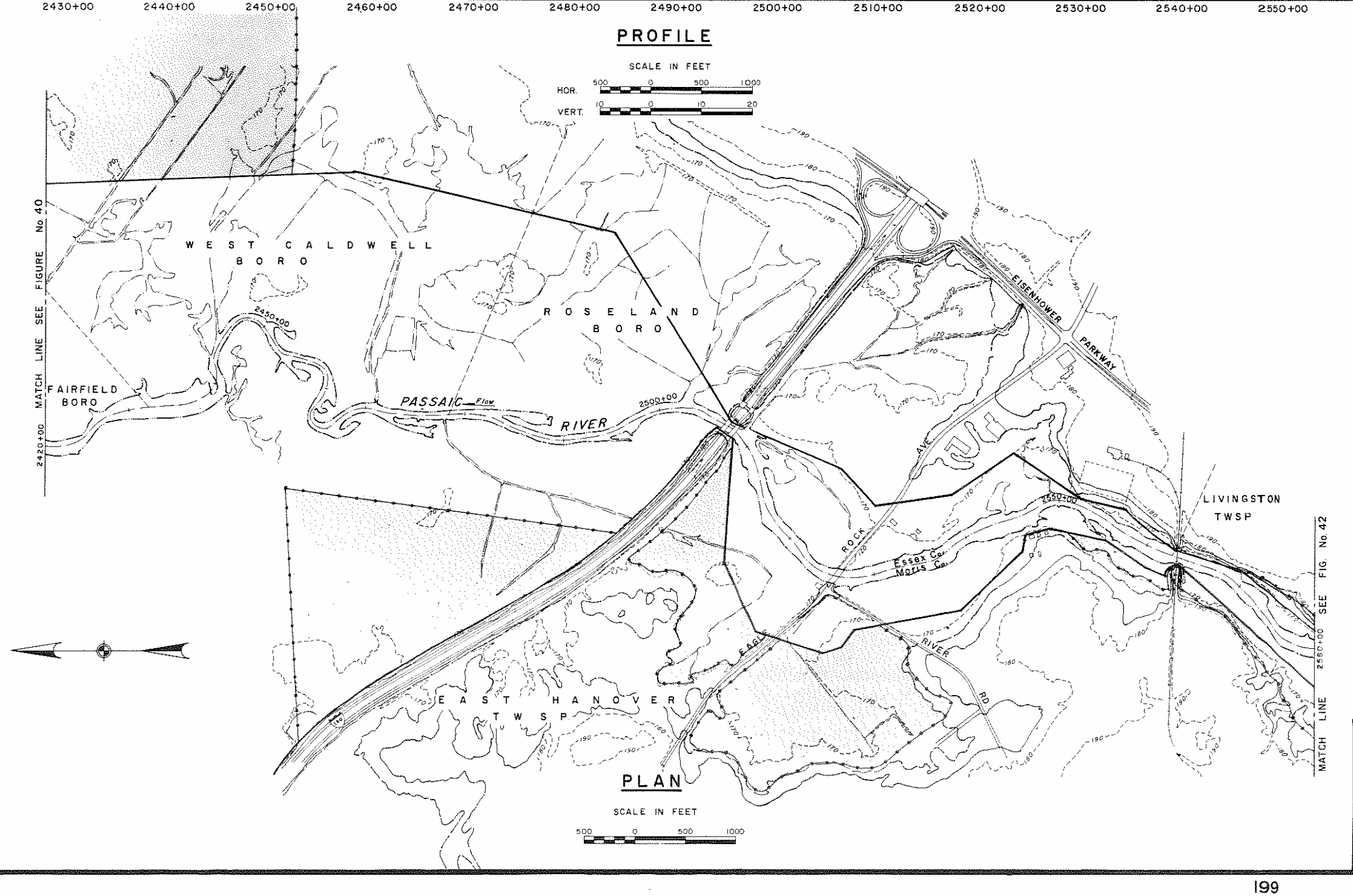


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

Passaic River Study, N.J. & N.Y.

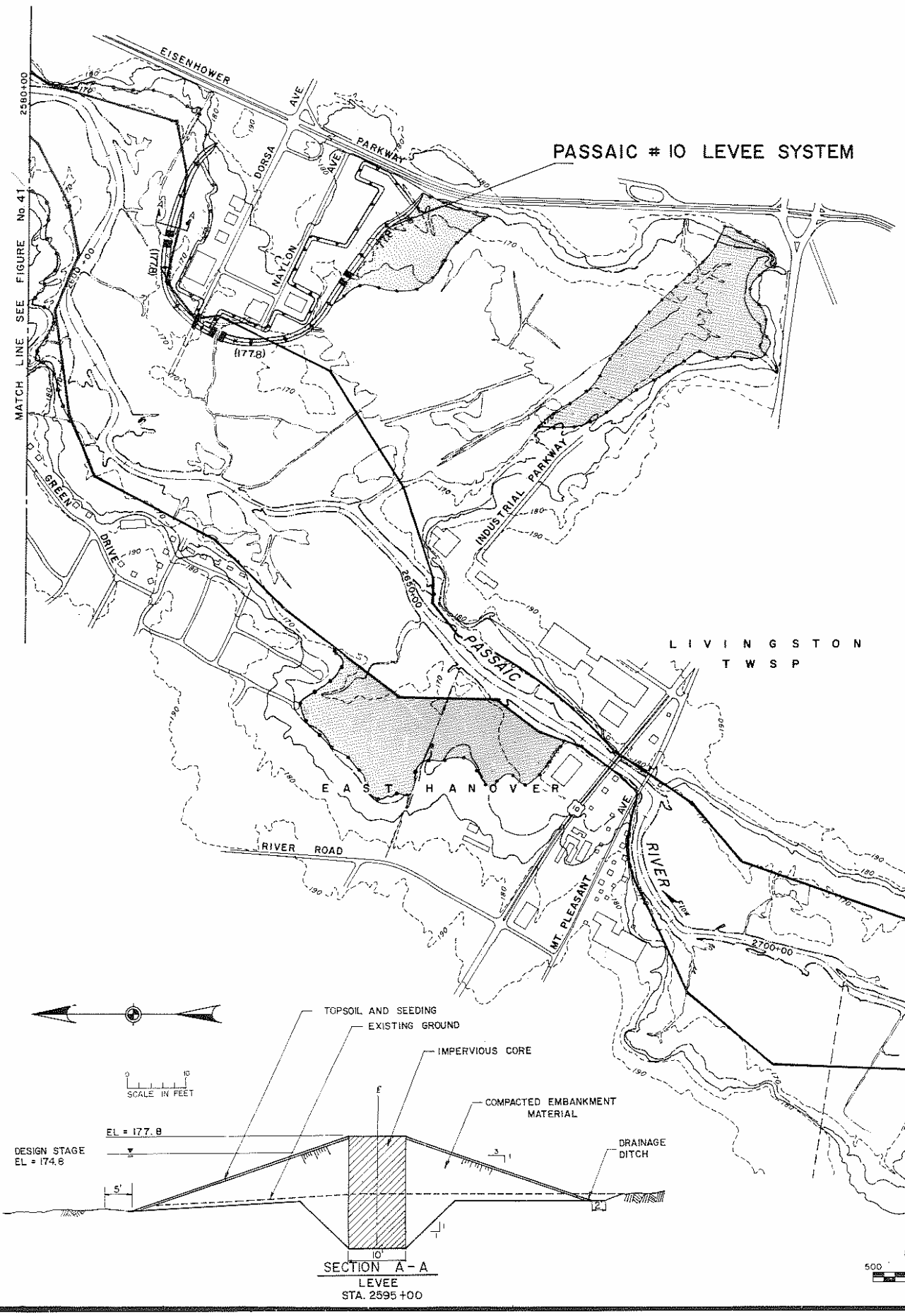
Passaic River

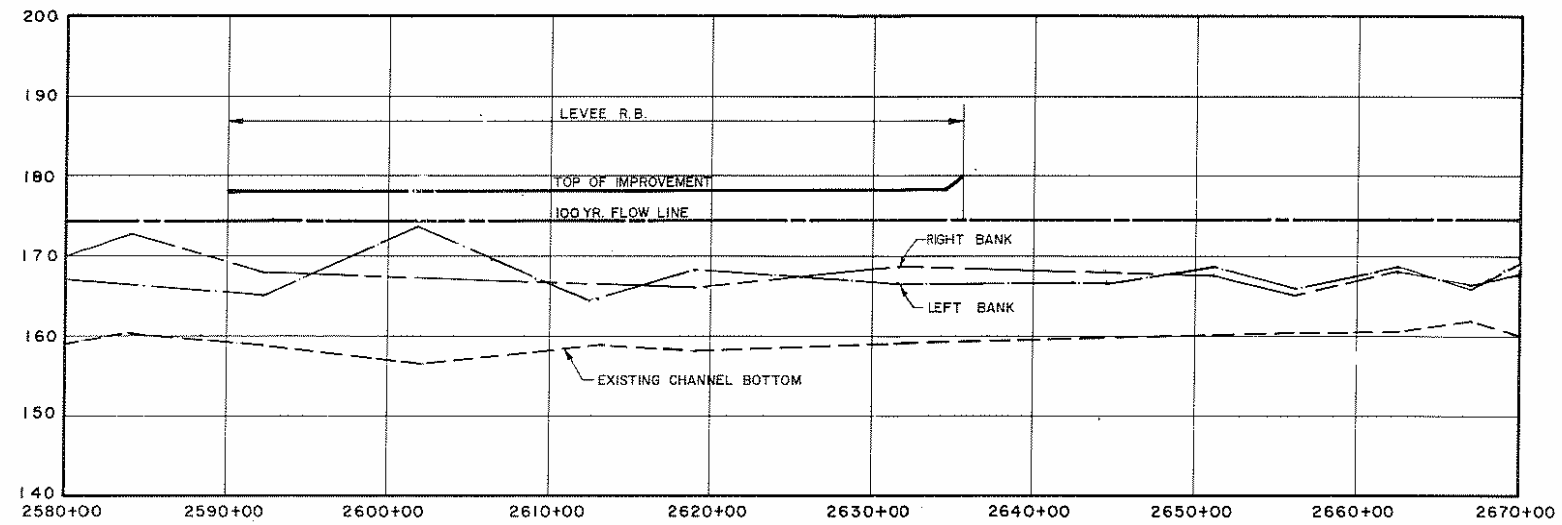
STA. 2420+00 TO STA. 2580+00

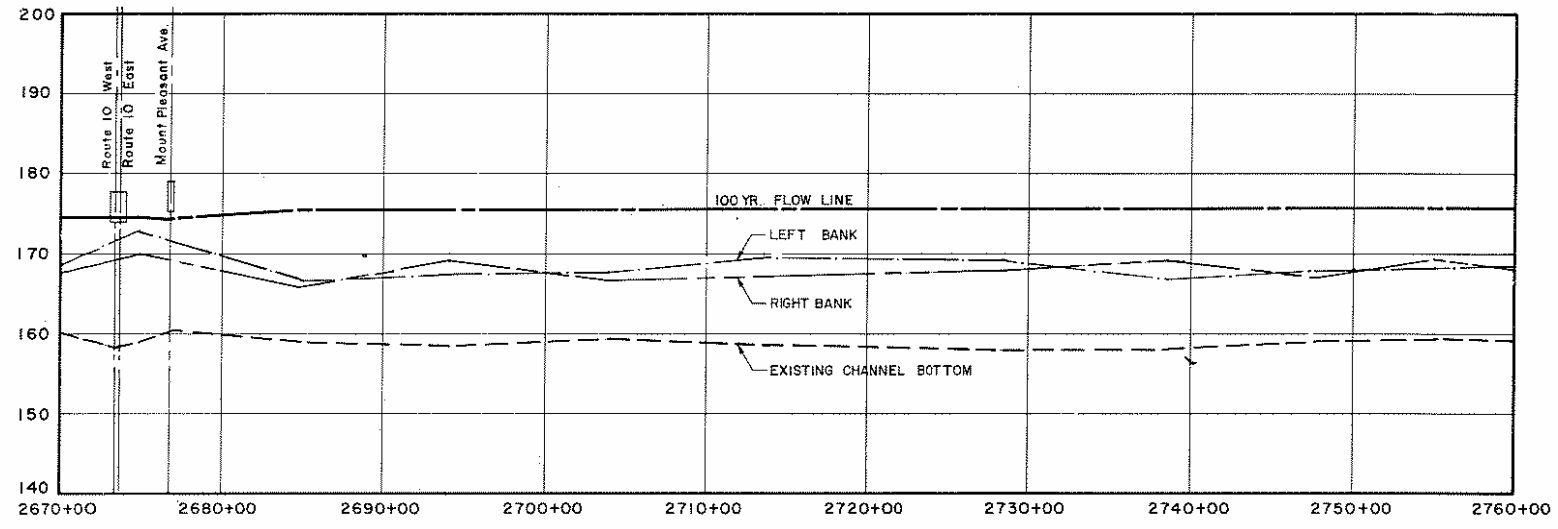
RECOMMENDED PLAN

FIGURE No. 41

PASSAIC # 10 LEVEE SYSTEM







PROFILE

SCALE IN FEET
HOR. 500 0 500 1000
VERT. 10 0 10 20

SECTION A-A
LEVEE
STA. 2595+00

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- ROAD RAISING / RELOCATION
- 100 YR.
- 500 YR.

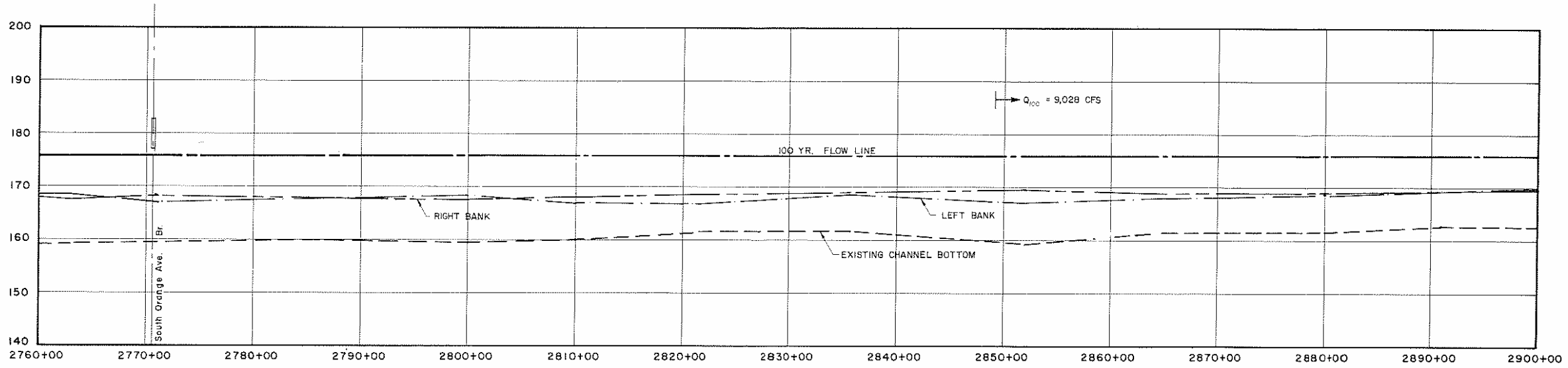
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 2580+00 TO STA. 2760+00

RECOMMENDED PLAN

FIGURE No. 42

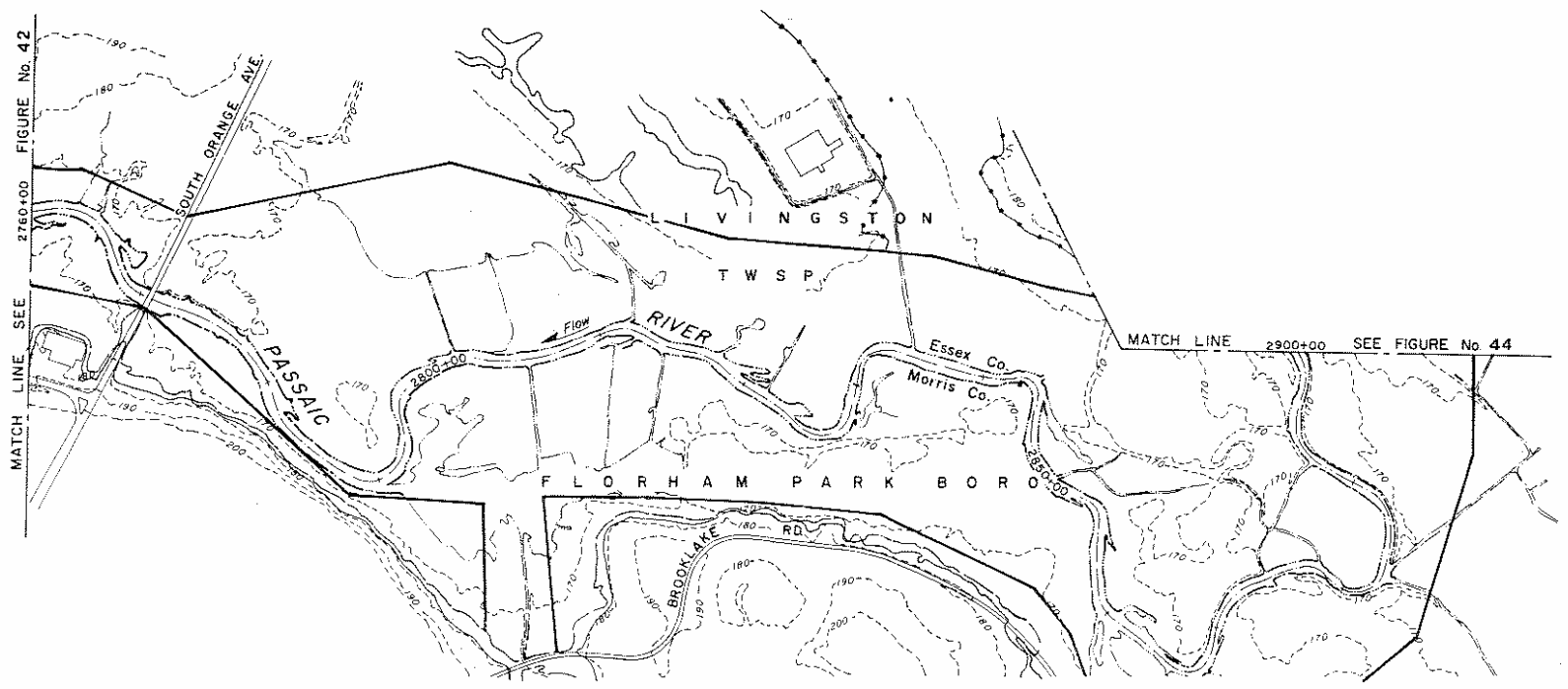


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VER. 10 0 10 20



PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

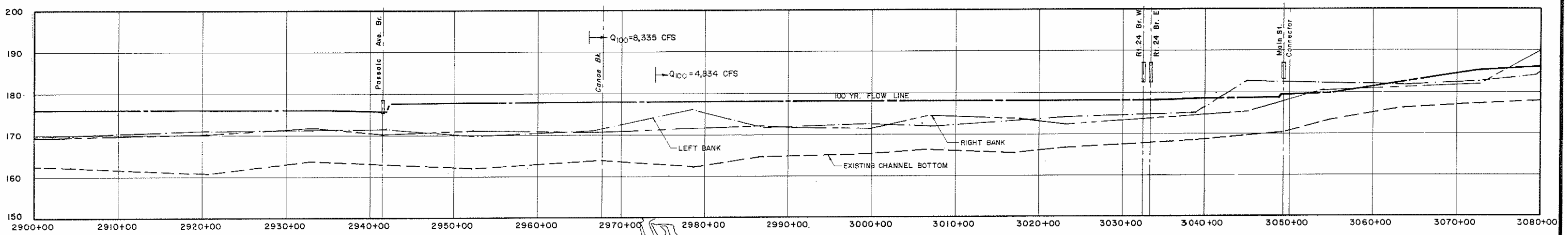
- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAY
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

Passaic River Study, N.J. & N.Y.

Passaic River

STA. 2760+00 TO STA. 2900+00

RECOMMENDED PLAN

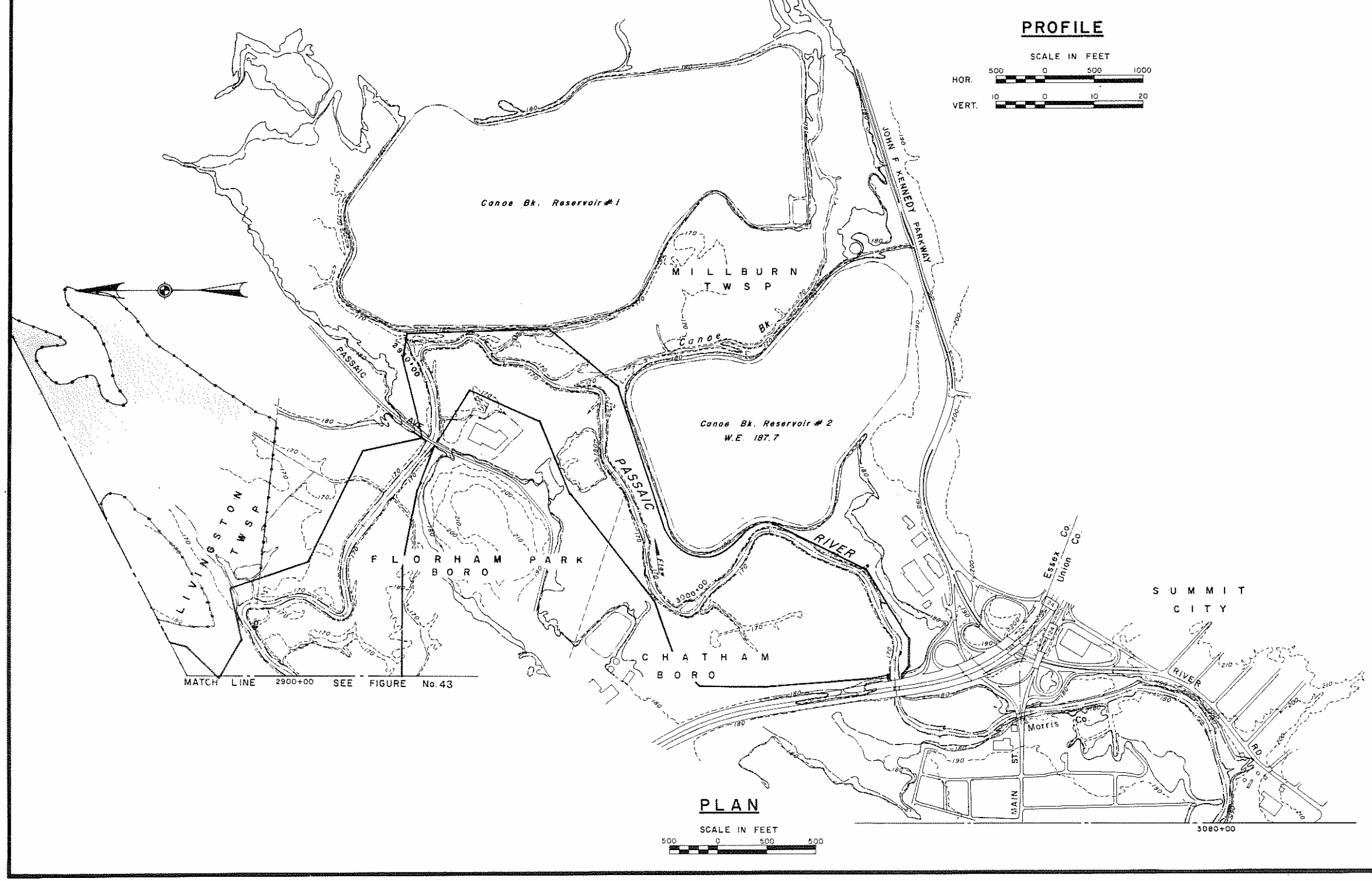


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET

500 0 500 500

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAY
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

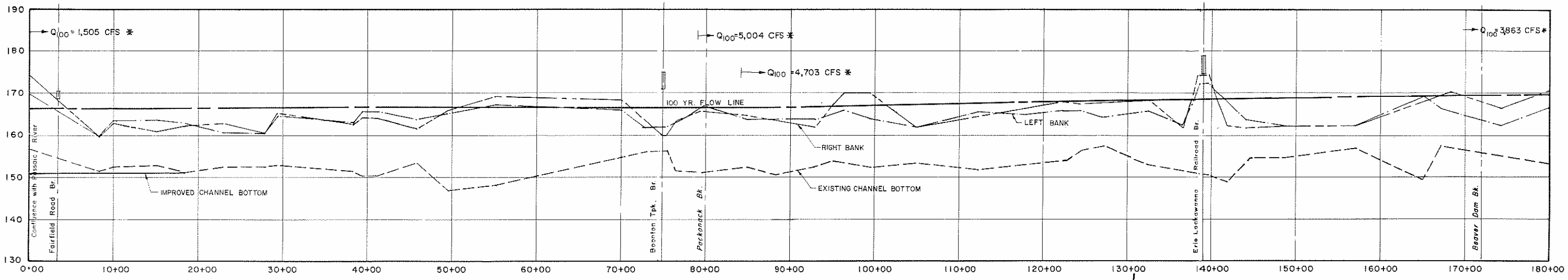
Passaic River Study, N.J. & N.Y.

Passaic River

STA. 2900+00 TO STA. 3080+00

RECOMMENDED PLAN

FIGURE No. 44



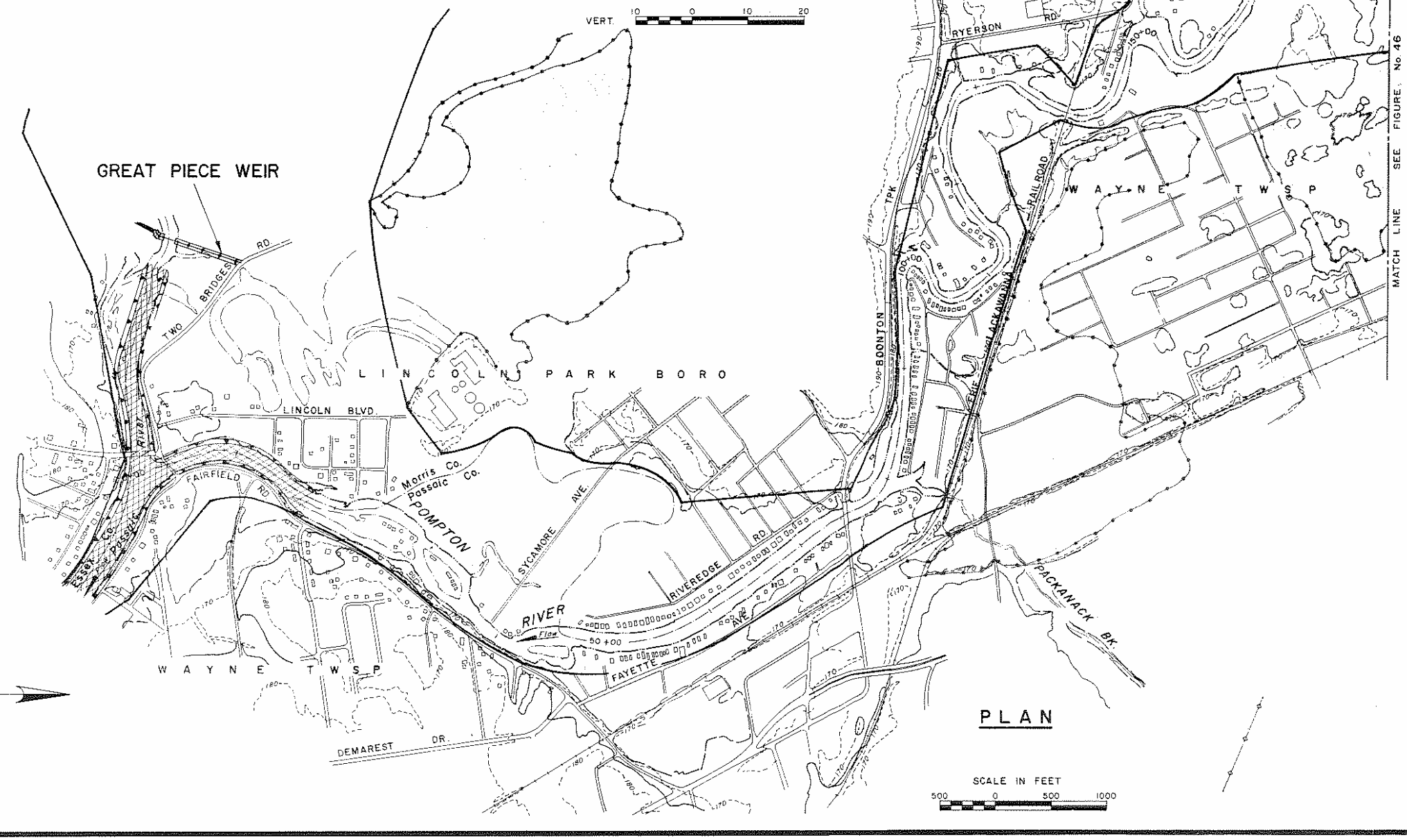
COINCIDENTAL FLOW *

PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN

SCALE IN FEET 500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.
- ACQUISITION OF NATURAL STORAGE AREA
- STATE DESIGNATED FLOODWAY

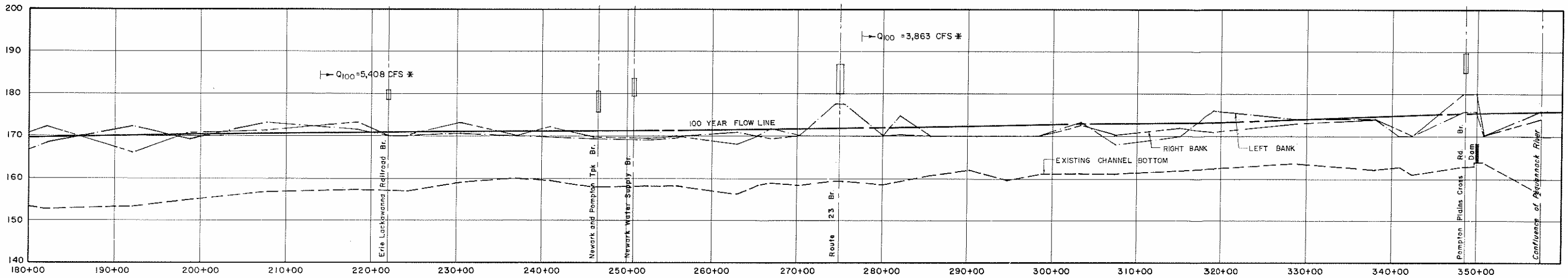
Passaic River Study, N.J & N.Y.

Pompton River

STA. 0+00 TO STA. 180+00

RECOMMENDED PLAN

FIGURE No. 45



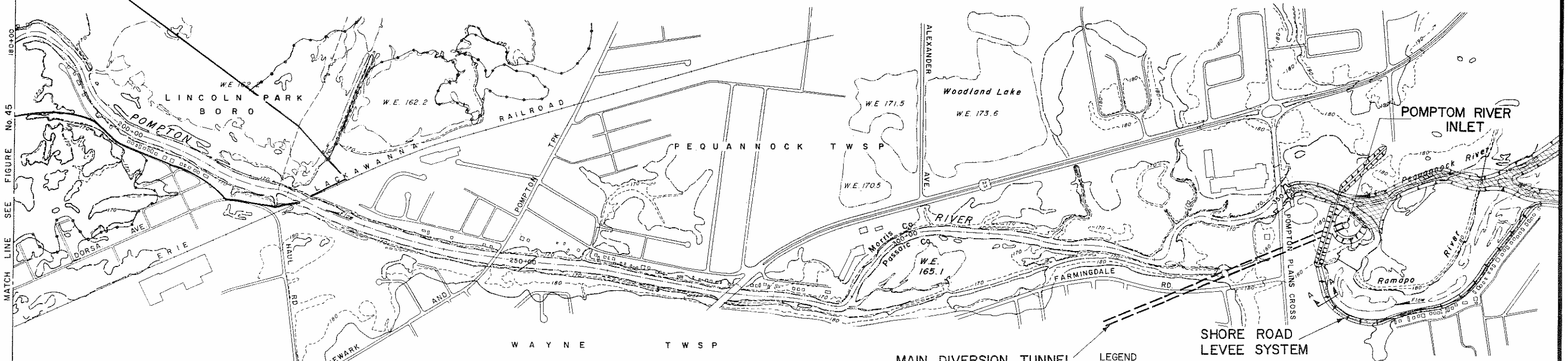
COINCIDENTAL FLOW *

PROFILE

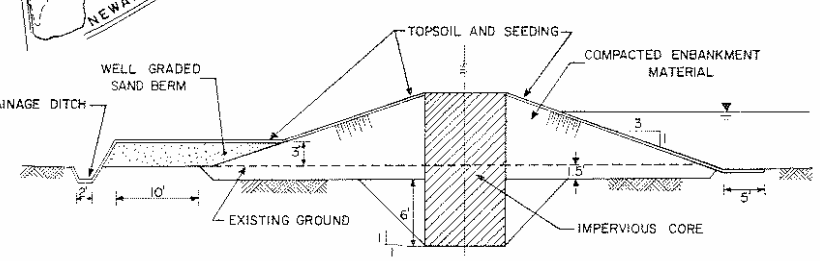
SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



PLAN



SECTION A-A
LEVEE

SCALE IN FEET

500 0 500 1000

LEGEND

- ACQUISITION OF NATURAL STORAGE AREA
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.
- FLOODWAY

Passaic River Study, N.J. & N.Y.

Pompton River

STA. 180+00 TO STA. 357+35

RECOMMENDED PLAN

FIGURE No. 46

Q_{100} = 33,880 CFS

Q_{100} = 17,321 CFS

Q_{100} = 17,584 CFS

Q_{100} = 7,912 CFS

Confluence with Pompton River

Dam

LEVEE L.B.

TOP OF IMPROVEMENT

100 YR. FLOW LINE

RIGHT BANK

LEFT BANK

EXISTING CHANNEL BOTTOM

IMPROVED CHANNEL BOTTOM

EXIST. INV. = 162.5

PROP. INV. = 156.5

EXISTING 72" AQUEDUCT

500' RIPRAP CHANNEL PROTECTION

500' RIPRAP

RIPRAP @ BRIDGE

Riverdale Road

Wanaque River

Paterson Hamburg Tpk. Br.

200' TRANSITION RIPRAP

LEVEE L.B.

TOP OF IMPROVEMENT

LIMIT OF STUDY

240 230 220 210 200 190 180 170 160 150 140 130

0+00 10+00 20+00 30+00 40+00 50+00 60+00 70+00 80+00 90+00 100+00 110+00 120+00 130+00 140+00 150+00 160+00 170+00 180+00

PROFILE

SCALE IN FEET

HOR 500 0 500 1000

VERT. 10 0 10 20

TRAPEZOIDAL CHANNEL
100' BOTTOM WIDTH
2:1 SIDE SLOPES

TRAPEZOIDAL CHANNEL
74' BOTTOM WIDTH
2:1 SIDE SLOPE

PEQUANNOCK TWSP

RIVERDALE BORO

POMPTON LAKES BORO

PEQUANNOCK WEIR

PEQUANNOCK · RAMAPO LEVEE SYSTEM

STILES COURT LEVEE SYSTEM

SEE FIGURE No. 48 FOR WANAQUE RIVER DETAILS

WELL GRADED SAND BERM

TOPSOIL AND SEEDING

COMPACTED EMBANKMENT MATERIAL

DRAINAGE DITCH

EXISTING GROUND

IMPERVIOUS CORE

SECTION A-A

LEVEE
STA. 89+00

PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

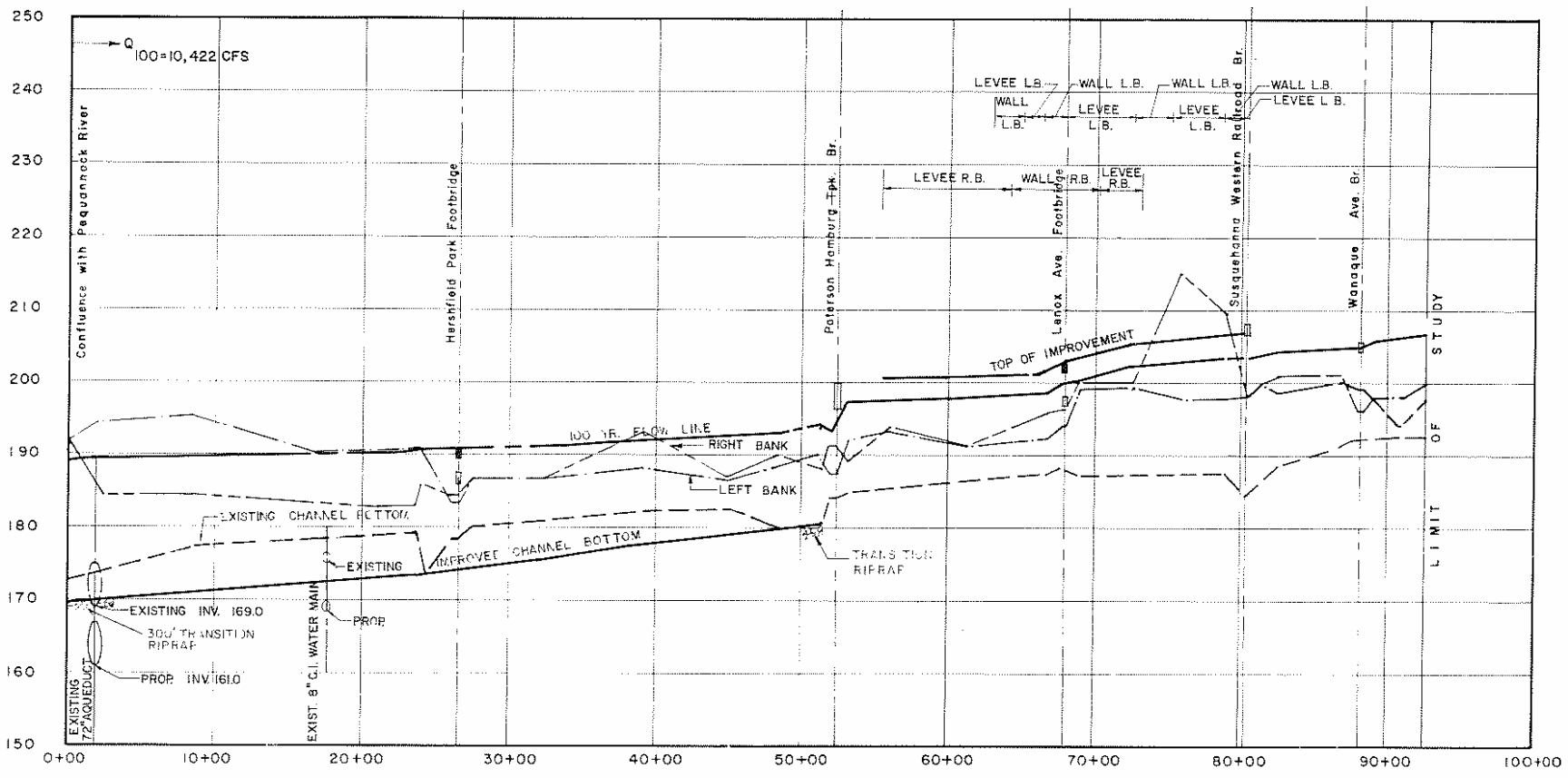
Passaic River Study, N.J. & N.Y.

Pequannock River

STA. 0+00 TO STA 170+55

RECOMMENDED PLAN

FIGURE No. 47

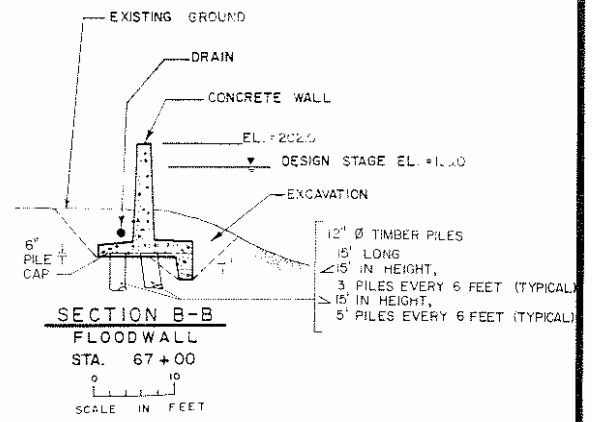


PROFILE

SCALE IN FEET

HOR 500 0 500 1000

VERT 10 0 10 20



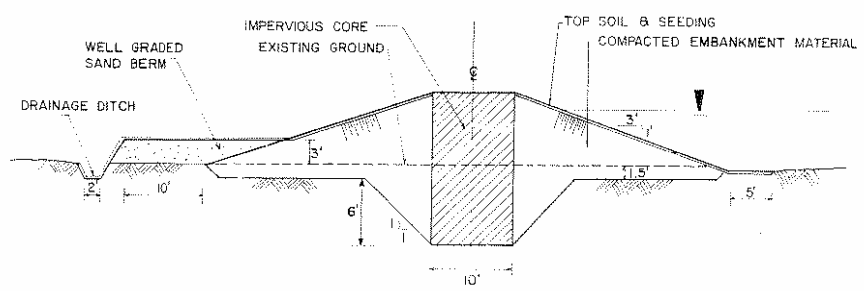
SECTION B-B

FLOODWALL

STA. 67+00

0 10

SCALE IN FEET



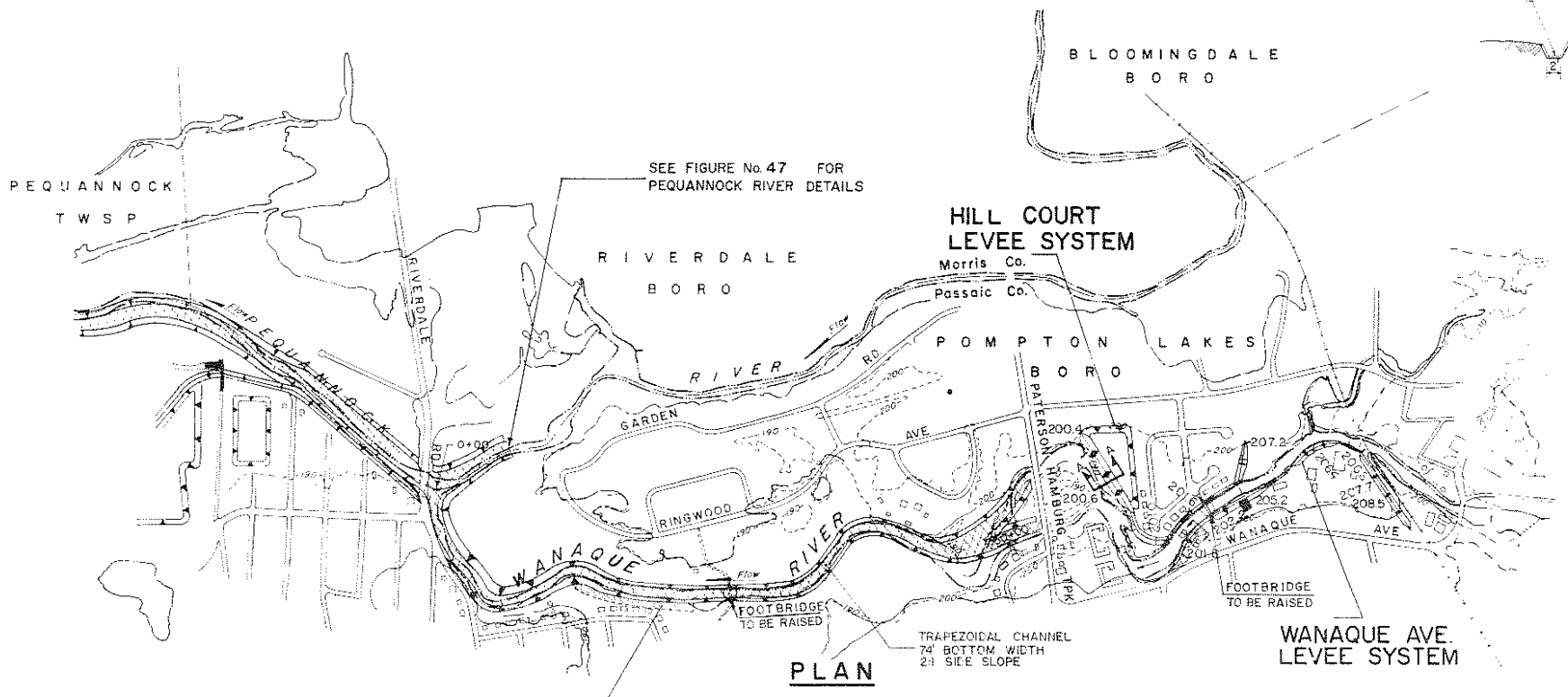
SECTION A-A

LEVEE

STA. 56+00

0 10

SCALE IN FEET



PLAN

SCALE IN FEET

500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

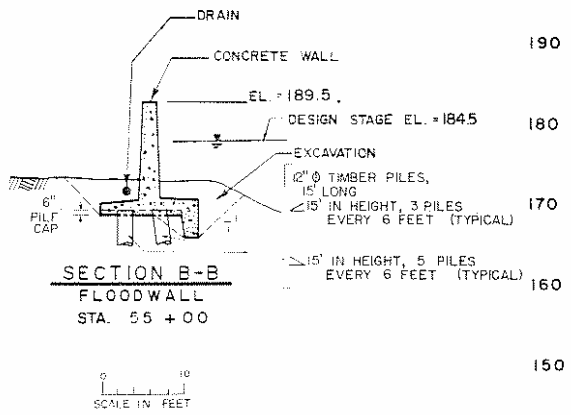
Passaic River Study, N.J. & N.Y.

Wanaque River

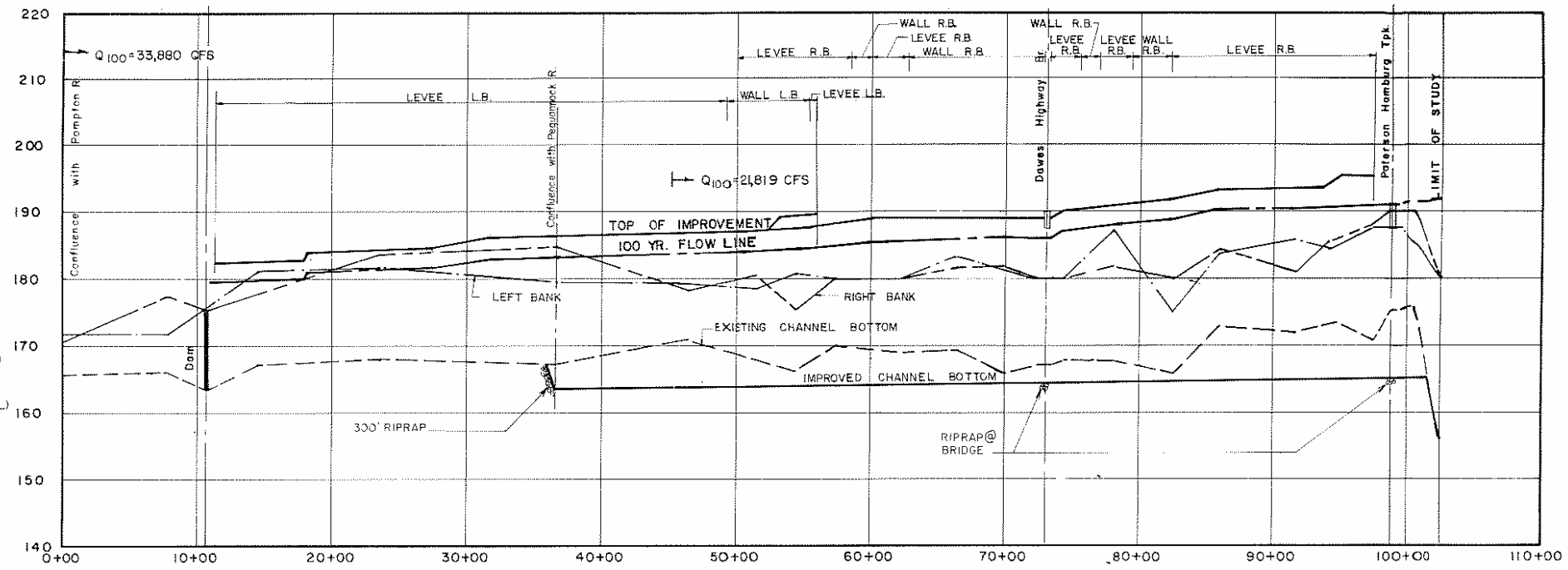
STA. 0+00 TO STA. 92+65

RECOMMENDED PLAN

FIGURE No. 48

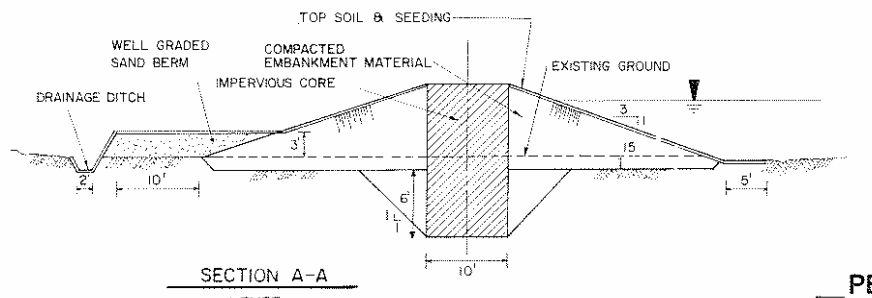


SECTION B-B
FLOODWALL
STA. 55 + 00



PROFILE

SCALE IN FEET
HOR. 500 0 500 1000
VERT. 10 0 10 20



SECTION A-A
LEVEE

PLAN

SCALE IN FEET
500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.
- FLOODWAY

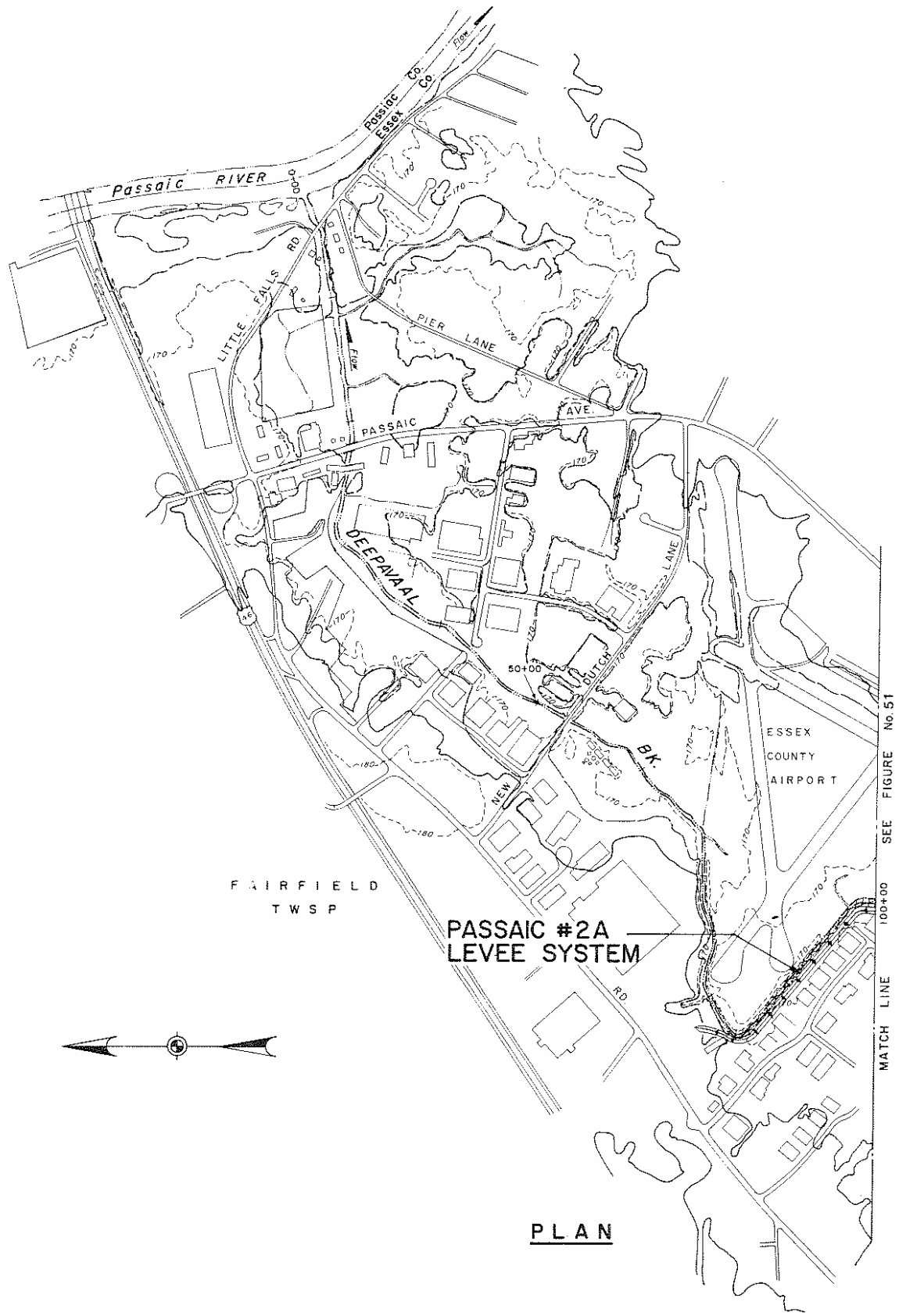
Passaic River Study, N.J. & N.Y.

Ramapo River

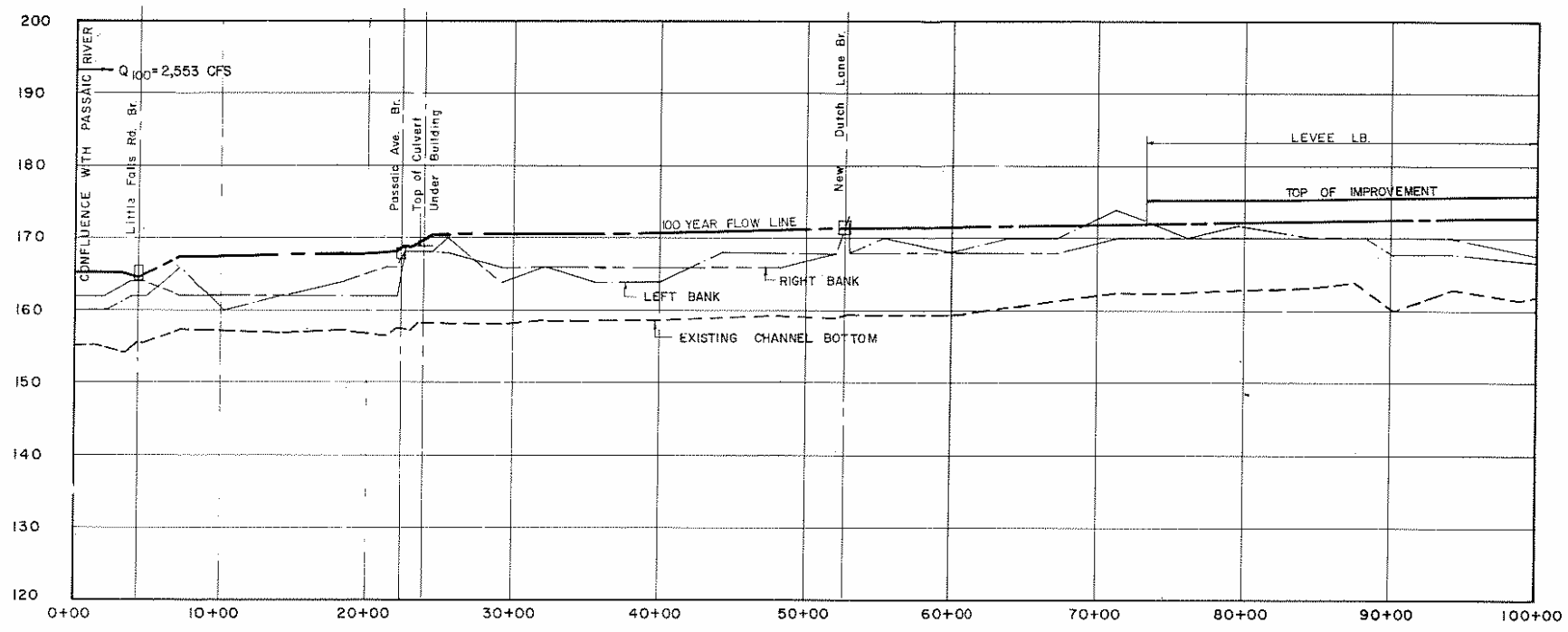
STA. 0+00 TO STA. 102+45

RECOMMENDED PLAN

FIGURE No. 49



PLAN

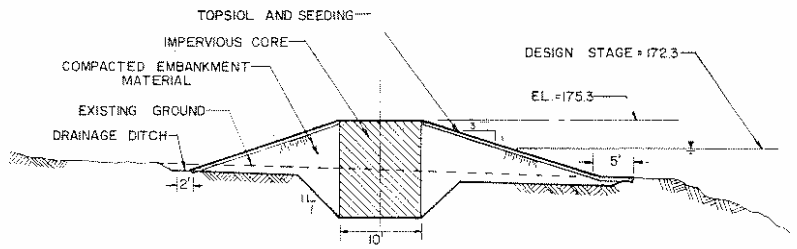


PROFILE

SCALE IN FEET

HOR. 500 0 500 1000

VERT. 10 0 10 20



SECTION A-A

LEVEE

STA. 90+00

0 10

SCALE IN FEET

SCALE IN FEET

500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR

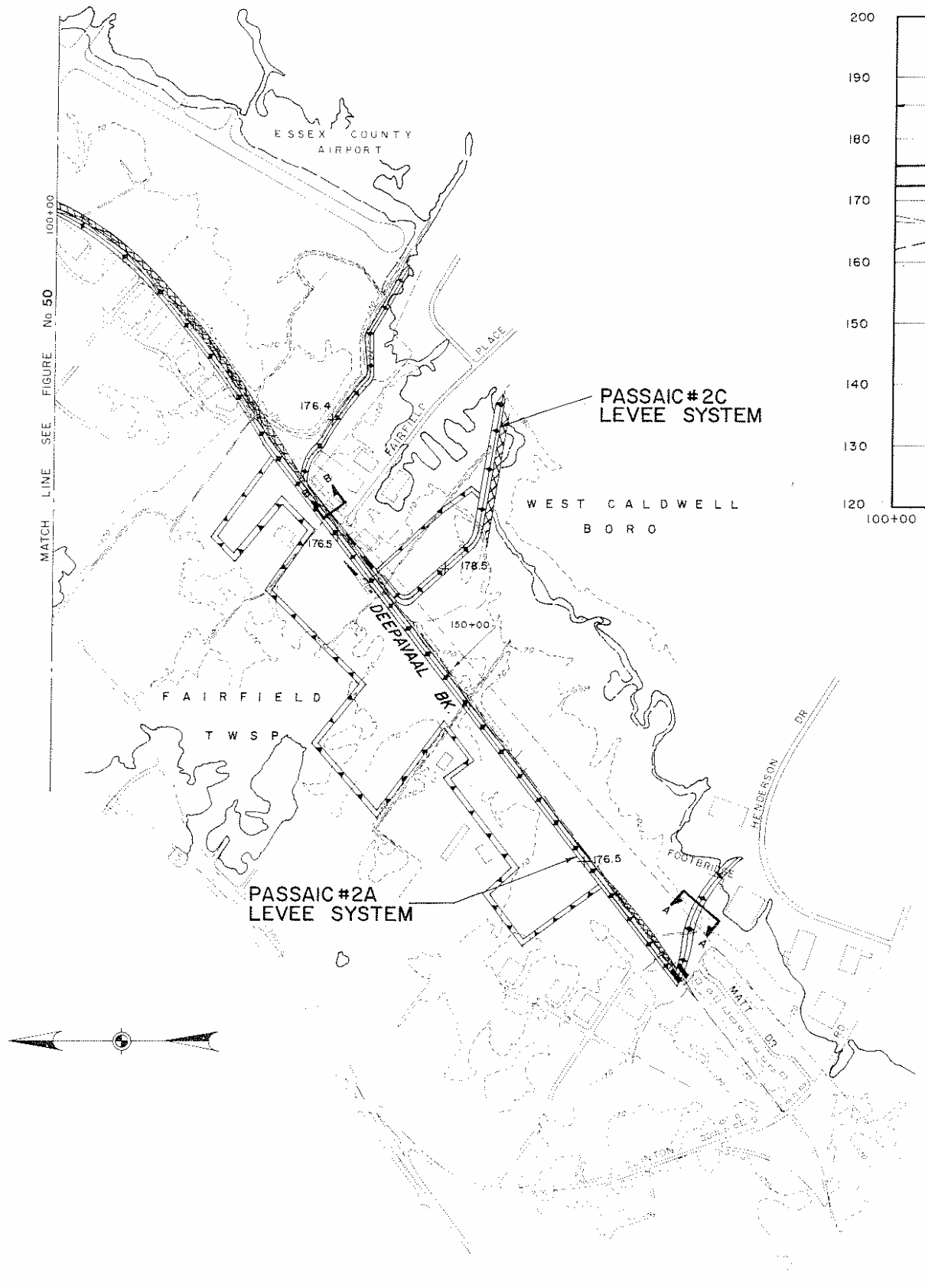
Passaic River Study, N. J. & N. Y.

Deepavaal Brook

STA. 0+00 TO STA. 100+00

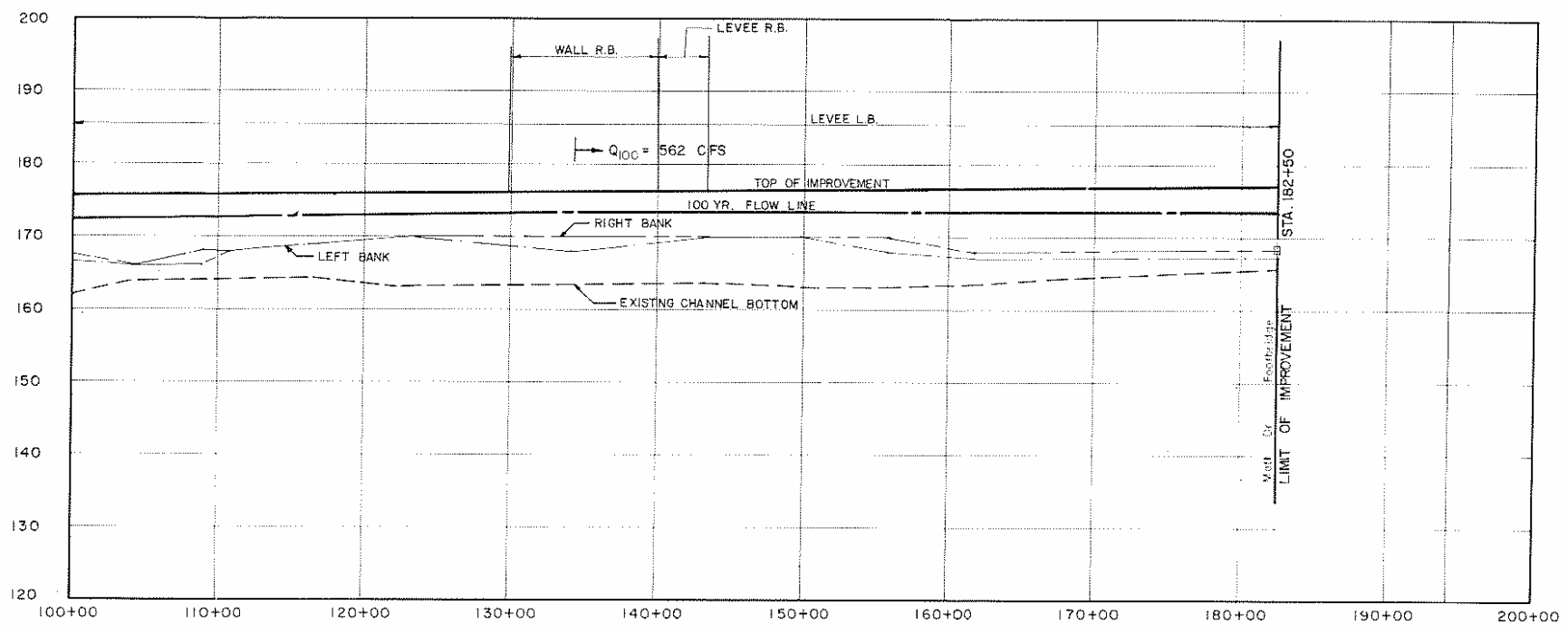
RECOMMENDED PLAN

FIGURE No. 50



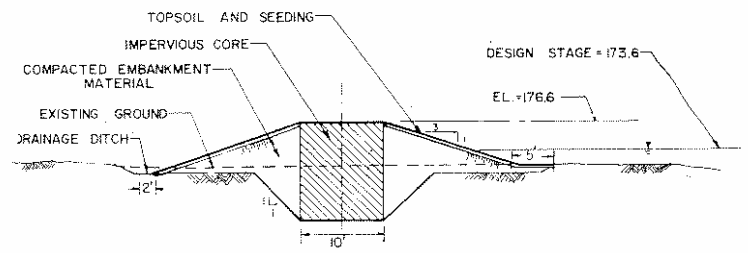
PLAN

SCALE IN FEET
500 0 500 1000



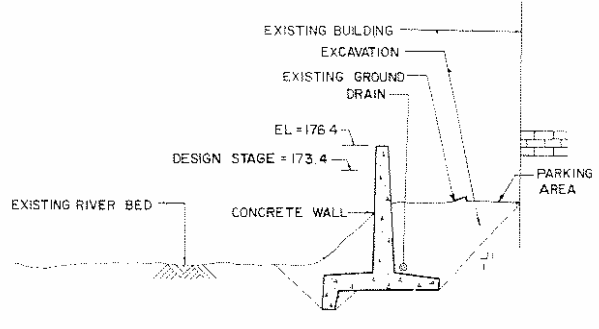
PROFILE

SCALE IN FEET
HOR 500 0 500 1000
VERT 10 5 0 10 20



SECTION A-A
LEVEE

SCALE IN FEET
0 10



SECTION B-B
FLOODWALL
STA. 134+00

SCALE IN FEET
0 10

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

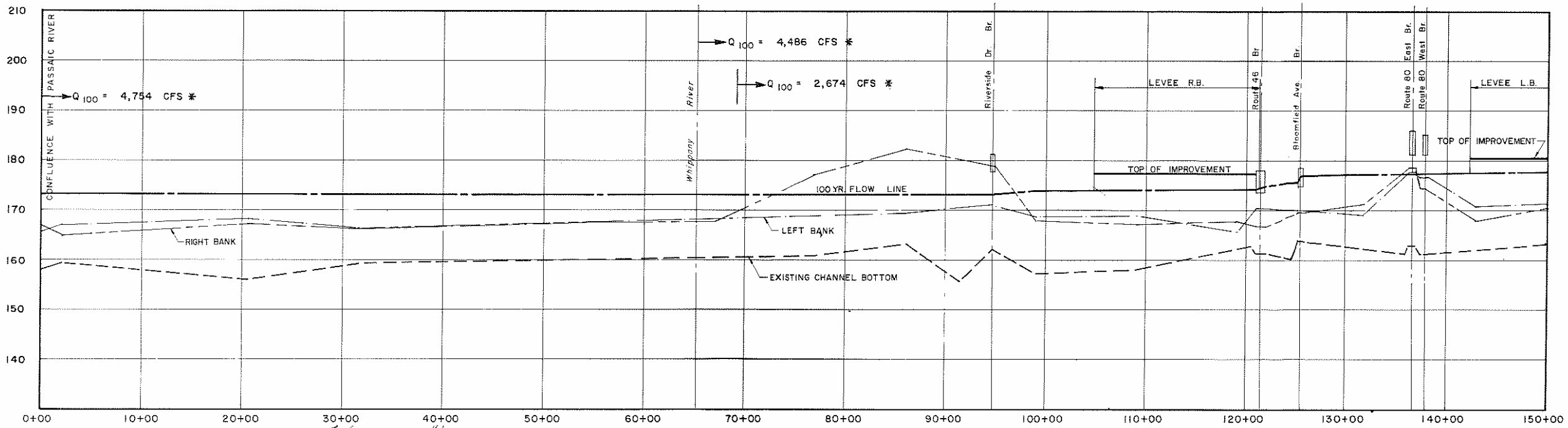
Passaic River Study, N.J. & N.Y.

Deepavaal Brook

STA. 100+00 TO STA. 182+50

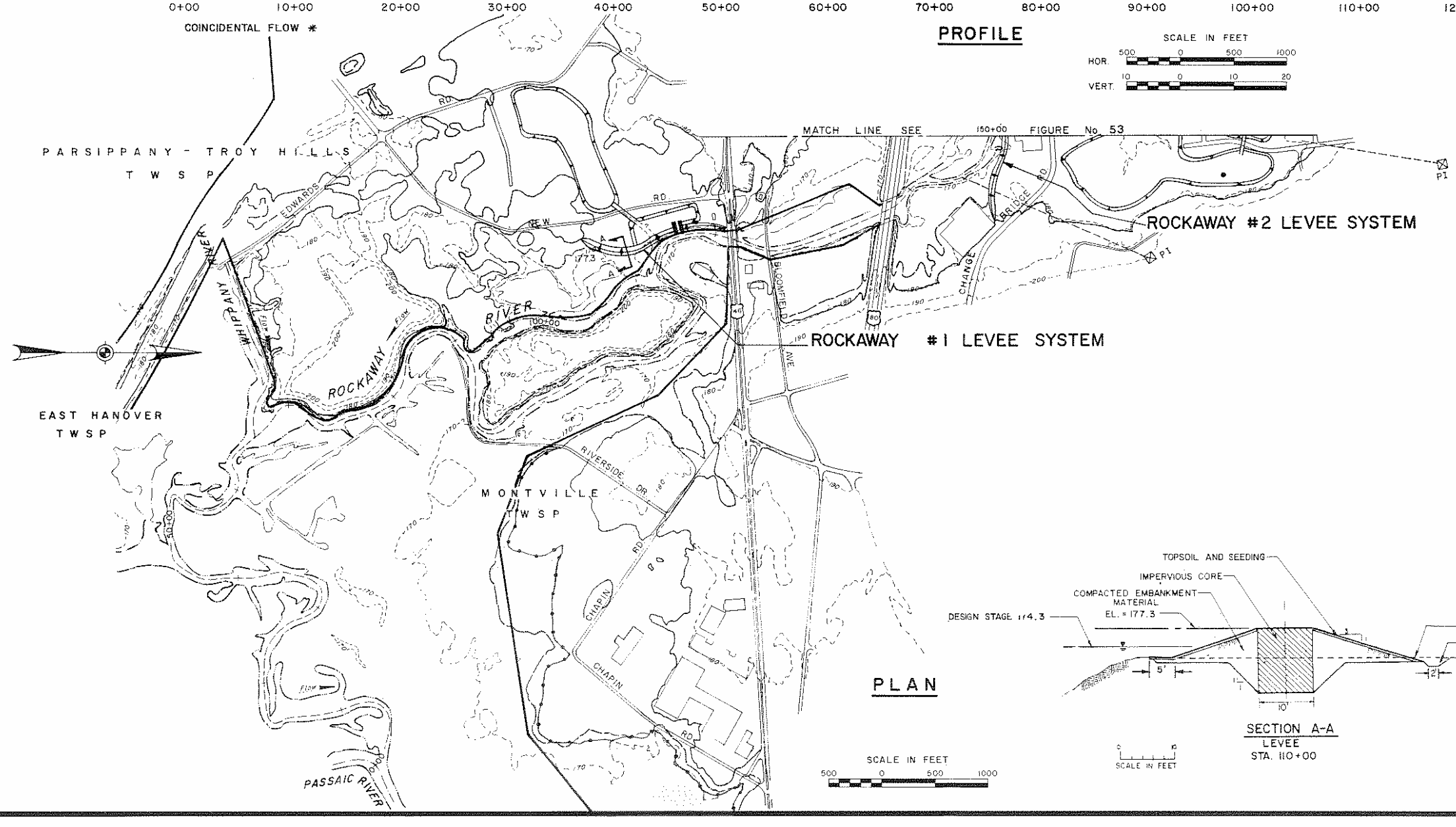
RECOMMENDED PLAN

FIGURE No. 51



PROFILE

SCALE IN FEET
HOR. 500 0 500 1000
VERT. 10 0 10 20



PLAN

SCALE IN FEET
500 0 500 1000

SECTION A-A
LEVEE
STA. 110+00

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAYS
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

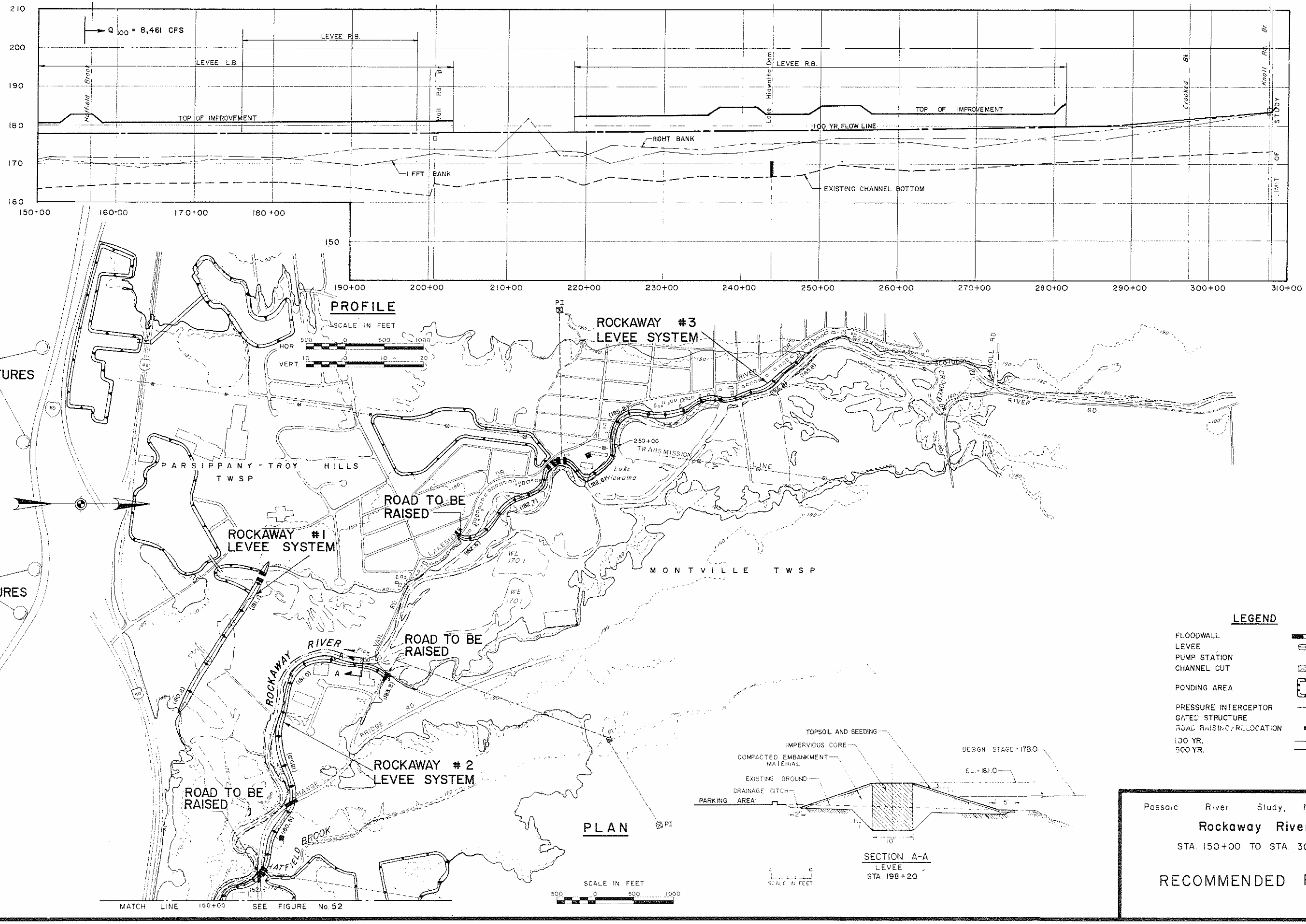
Passaic River Study, N.J. & N.Y.

Rockaway River

STA. 0+00 TO STA. 150+00

RECOMMENDED PLAN

FIGURE No. 52



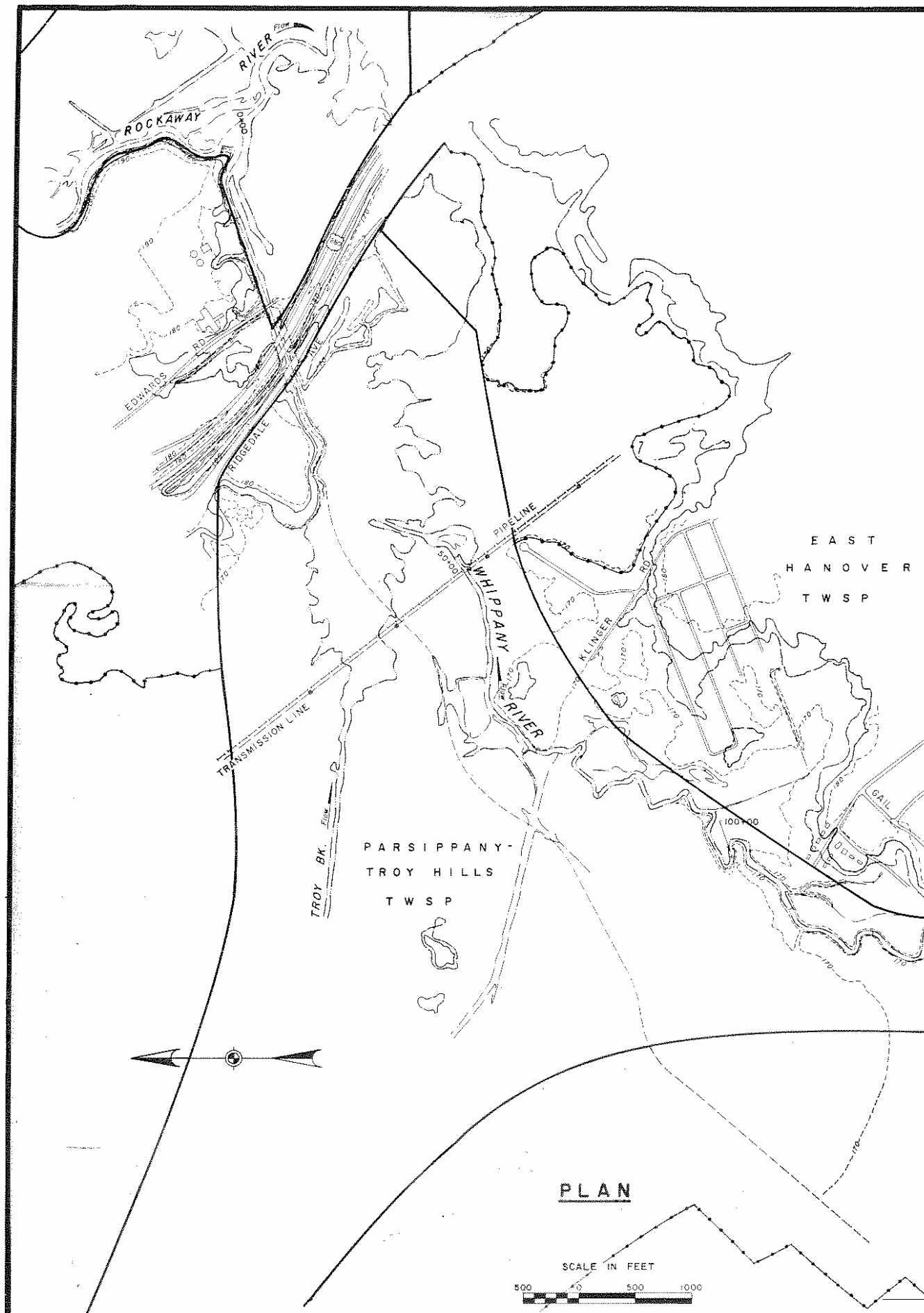
Passaic River Study, N.J. & N.Y.

Rockaway River

STA. 150+00 TO STA. 308+00

RECOMMENDED PLAN

FIGURE No. 53

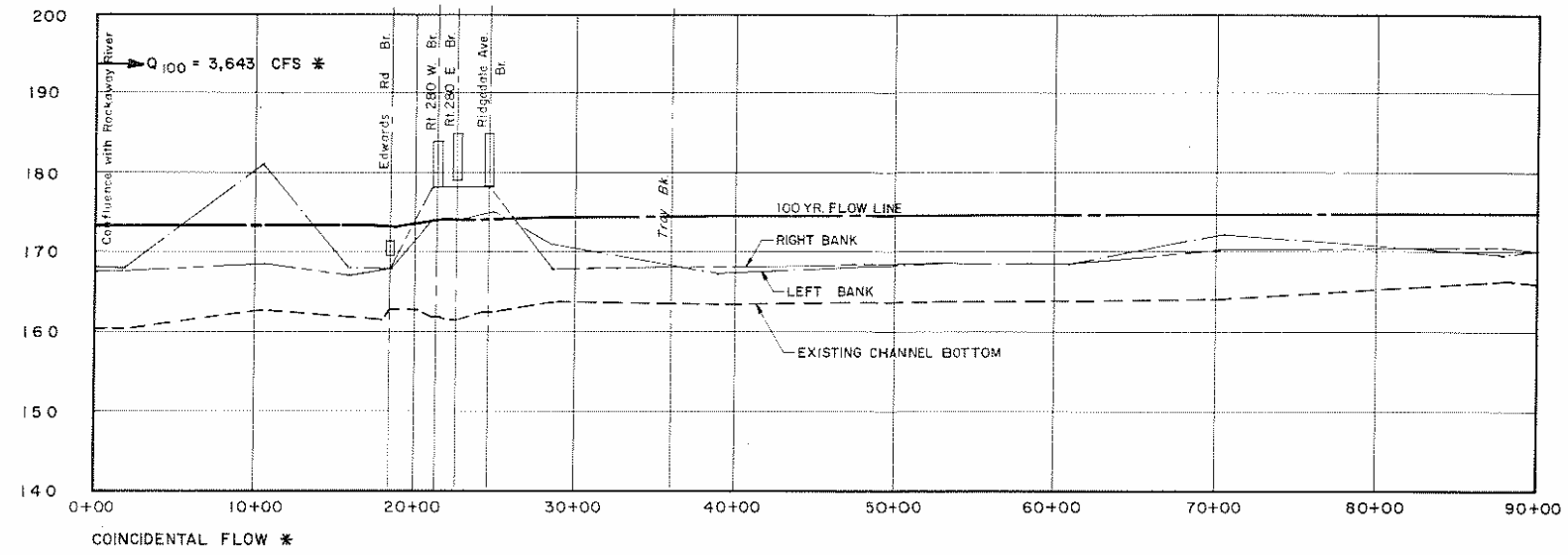


PLAN

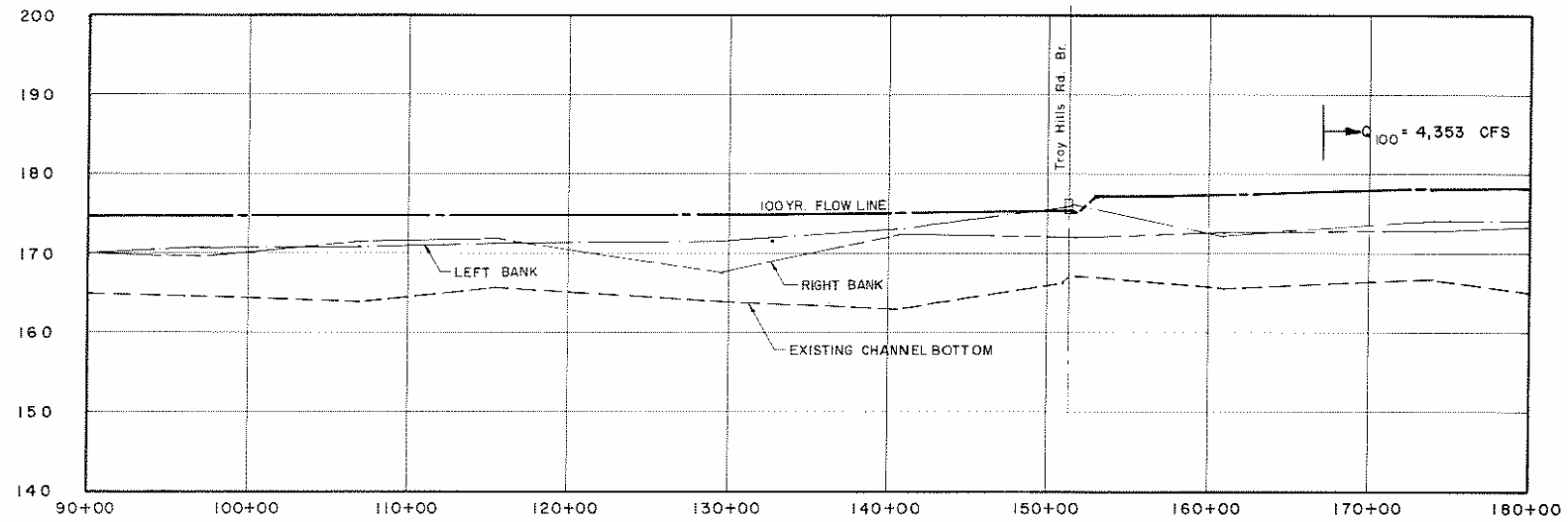
SCALE IN FEET

500 0 500 1000

MATCH LINE SEE 180+00 FIGURE No. 55



COINCIDENTAL FLOW *



PROFILE

SCALE IN FEET

HOR 500 0 500 1000

VERT. 10 0 10 20

LEGEND

- ACQUISITION OF NATURAL STORAGE AREAS
- STATE DESIGNATED FLOODWAY
- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.

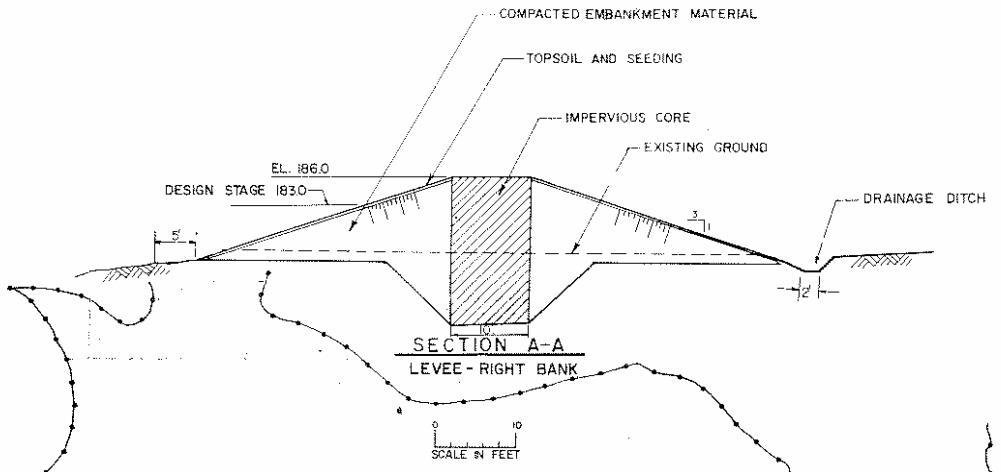
Passaic River Study, N.J. & N.Y.

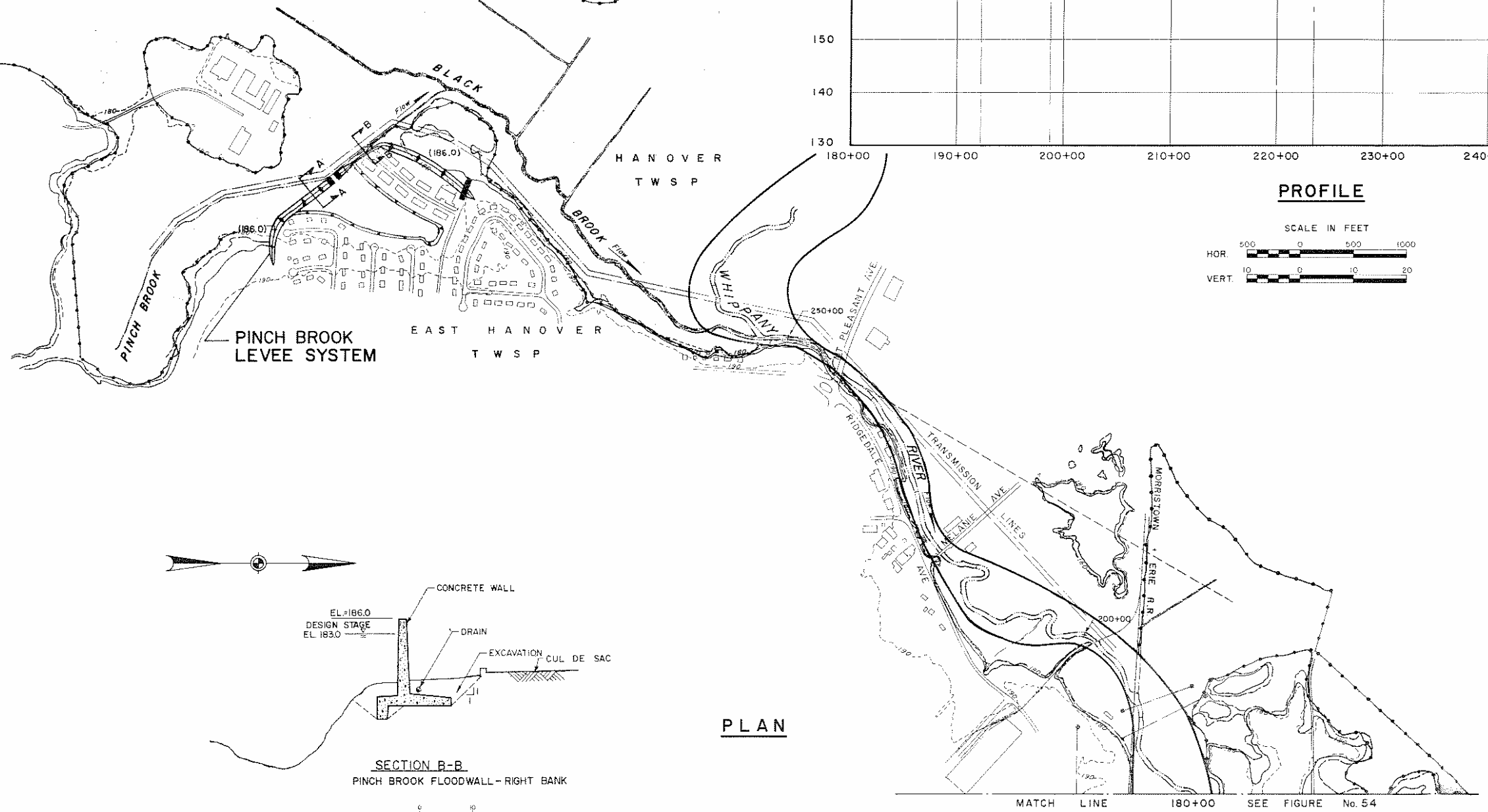
Whippany River

STA. 0+00 TO STA. 180+00

RECOMMENDED PLAN

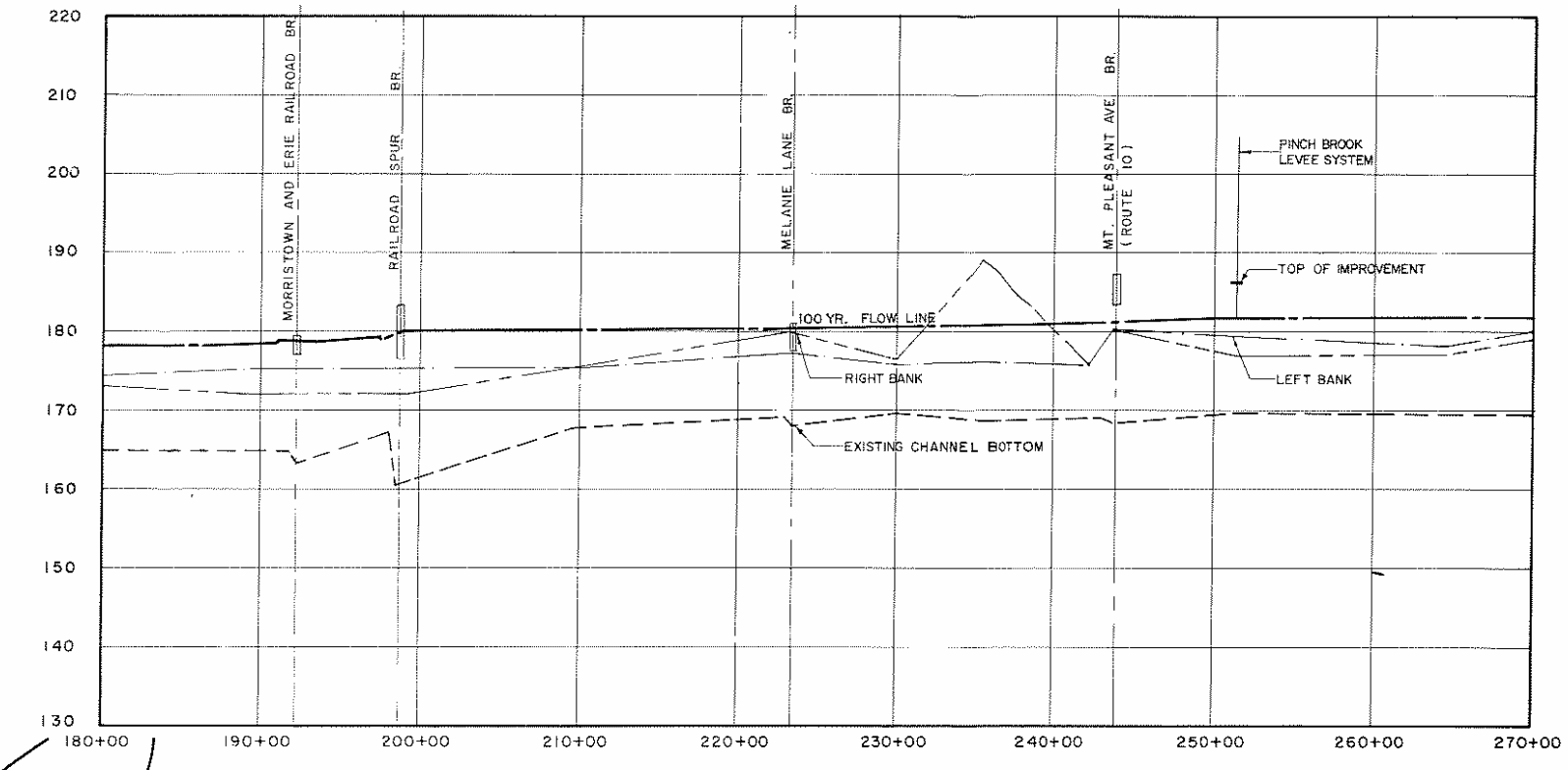
FIGURE No. 54





PLAN

SECTION B-B
PINCH BROOK FLOODWALL - RIGHT BANK
SCALE IN FEET



PROFILE

SCALE IN FEET
HOR. 500 0 500 1000
VERT. 10 0 10 20

SCALE IN FEET
500 0 500 1000

LEGEND

- FLOODWALL
- LEVEE
- PUMP STATION
- CHANNEL CUT
- PONDING AREA
- PRESSURE INTERCEPTOR
- GATED STRUCTURE
- 100 YR.
- 500 YR.
- STATE DESIGNATED FLOODWAYS
- ACQUISITION OF NATURAL NATURAL STORAGE AREAS

Passaic River Study, N.J. & N.Y.

Whippany River

STA. 180+00 TO STA. 270+00

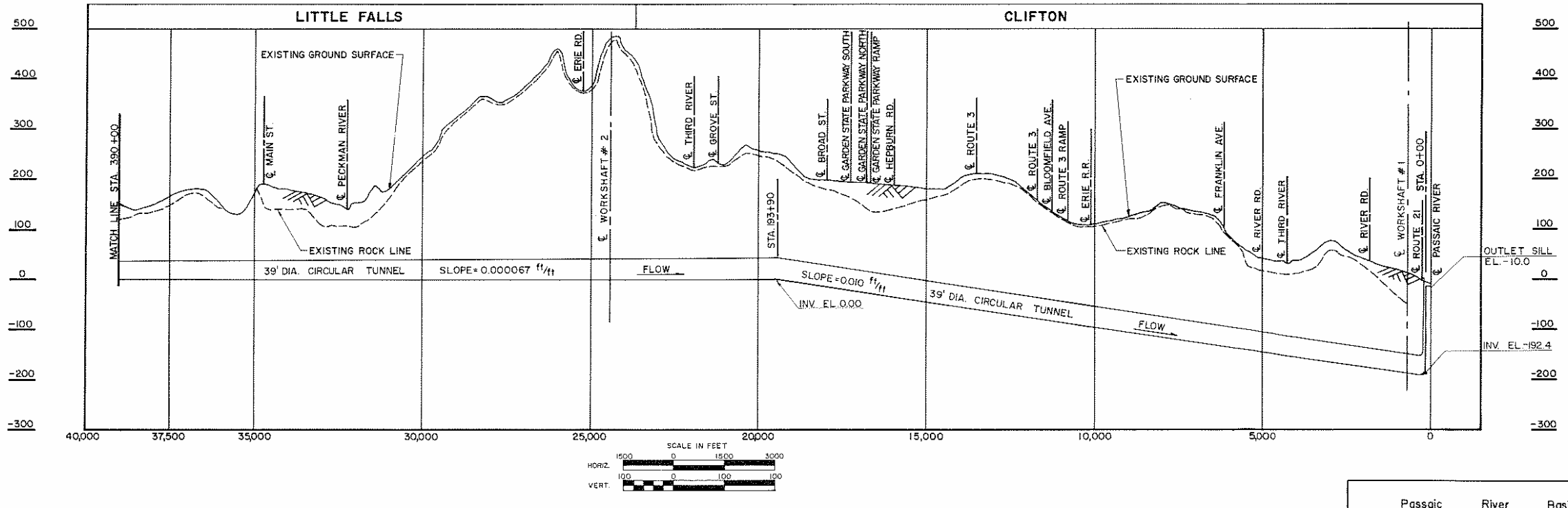
RECOMMENDED PLAN

FIGURE No. 55



PLAN

1500 0 1500 3000
SCALE IN FEET

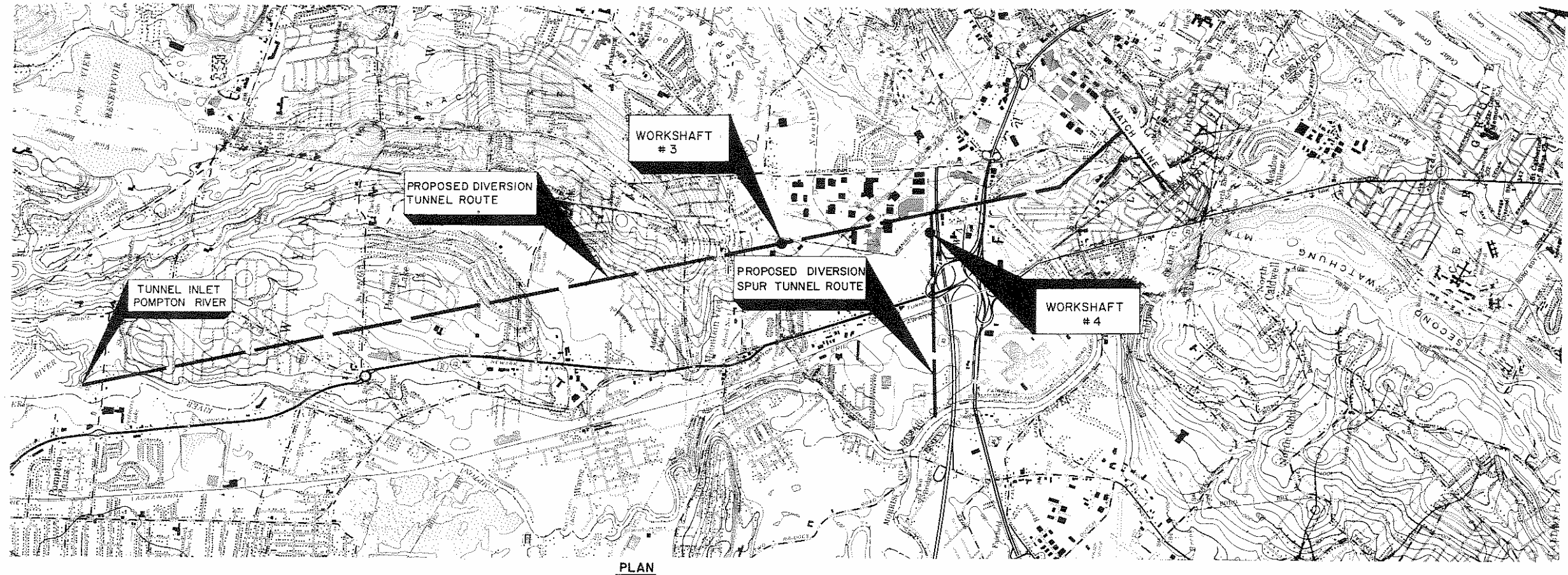


PROFILE OF DIVERSION TUNNEL

Passaic River Basin, N.J. & N.Y.

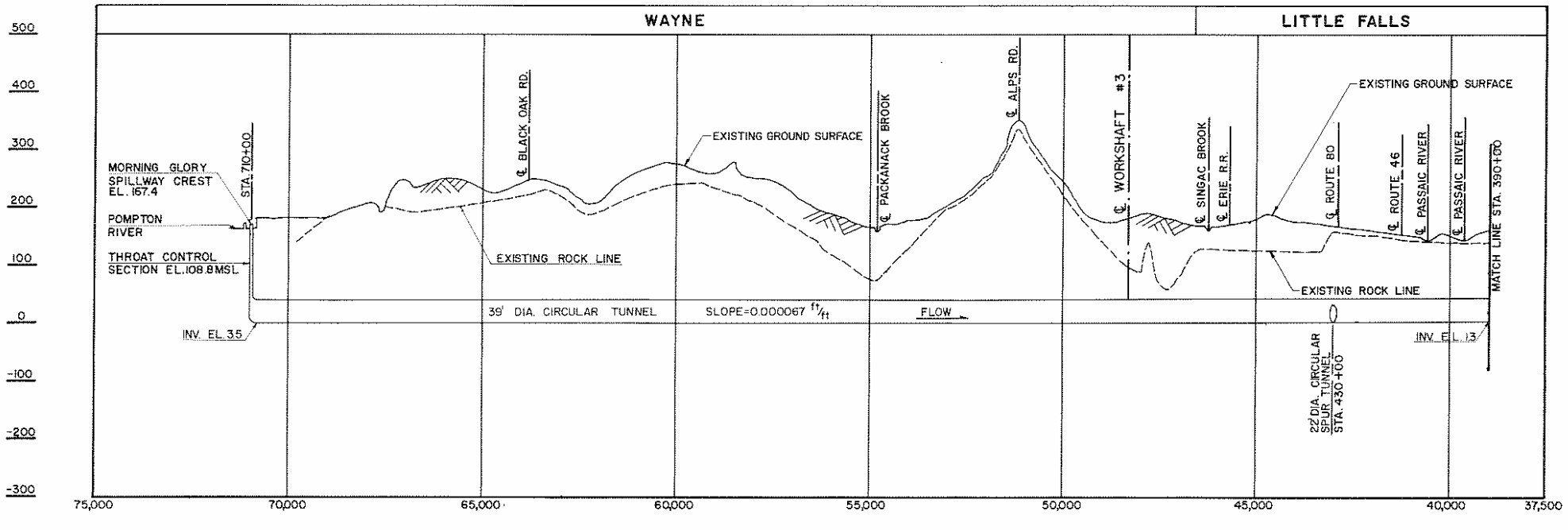
39 FOOT POMPTON RIVER TO PASSAIC RIVER TUNNEL PLAN & PROFILE (1 OF 2)

FIGURE 56



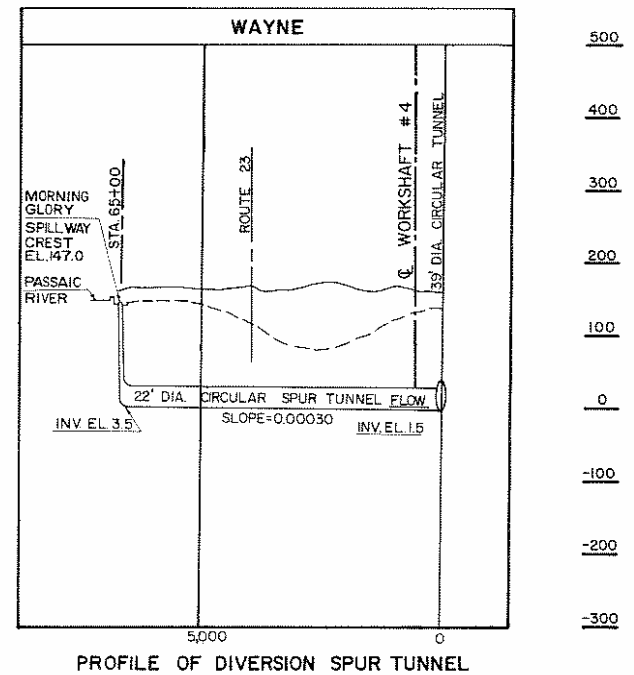
PLAN

1500 0 1500 3000
SCALE IN FEET



SCALE IN FEET
HORIZ. 1500 0 1500 3000
VERT. 100 0 100 200

PROFILE OF DIVERSION TUNNEL

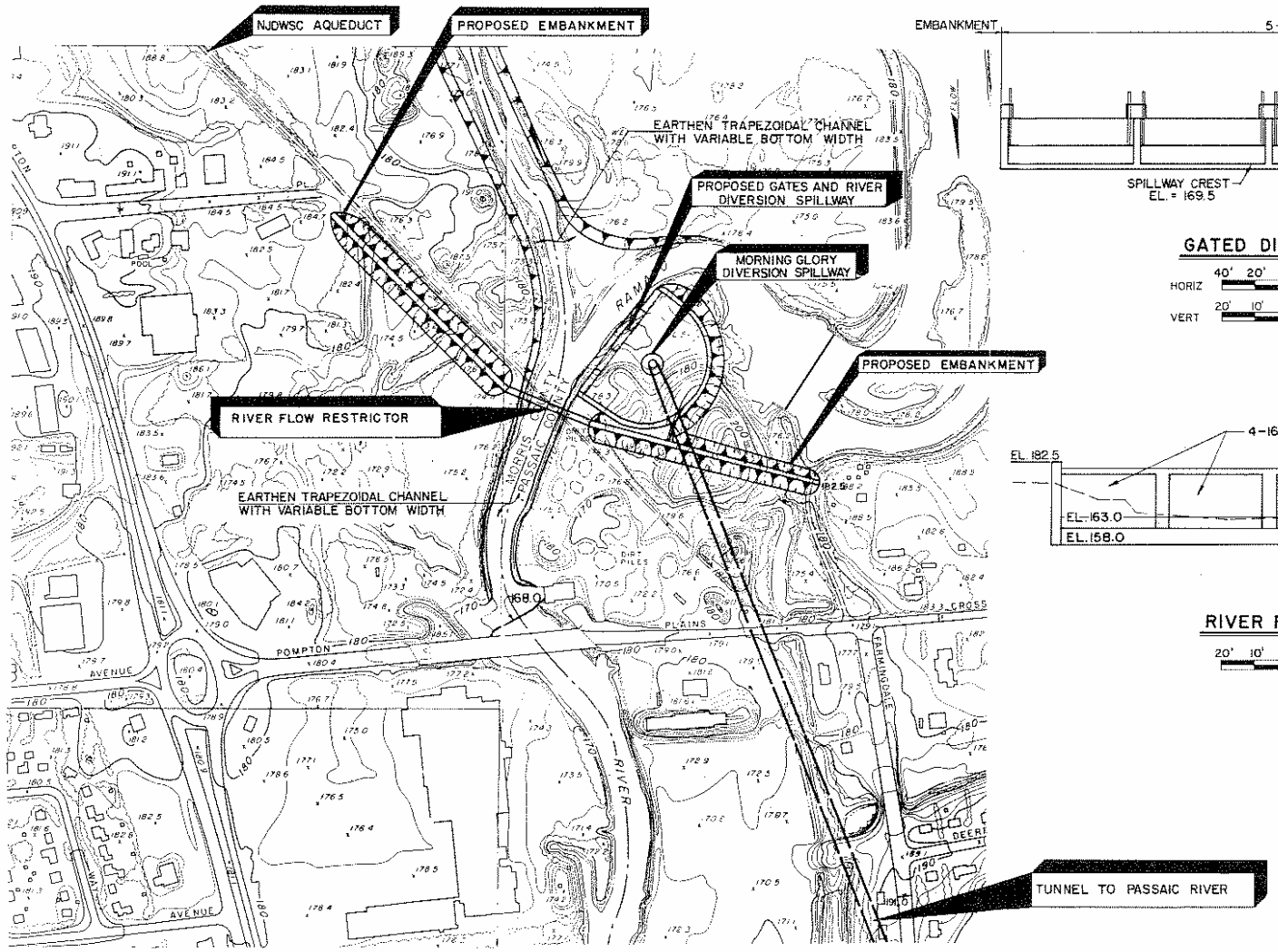


PROFILE OF DIVERSION SPUR TUNNEL

Passaic River Basin, N.J. & N.Y.

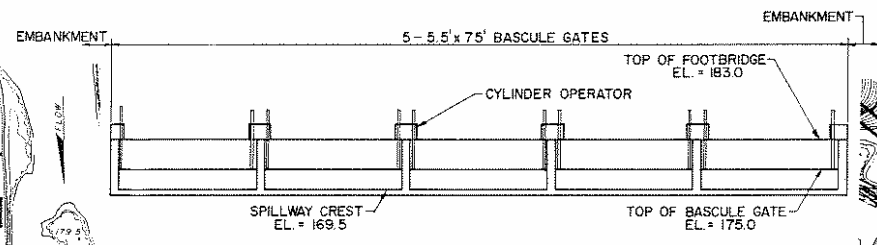
39 FOOT POMPTON RIVER TO PASSAIC RIVER TUNNEL, 22' SPUR TUNNEL PLAN & PROFILE (2 OF 2)

FIGURE 57



INLET LOCATION

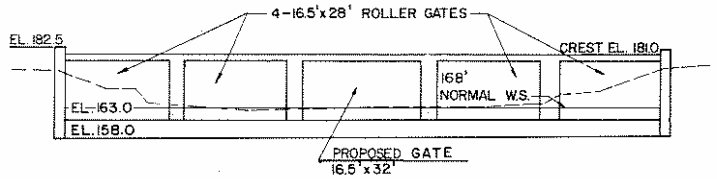
200' 100' 0 200' 400'



GATED DIVERSION SPILLWAY

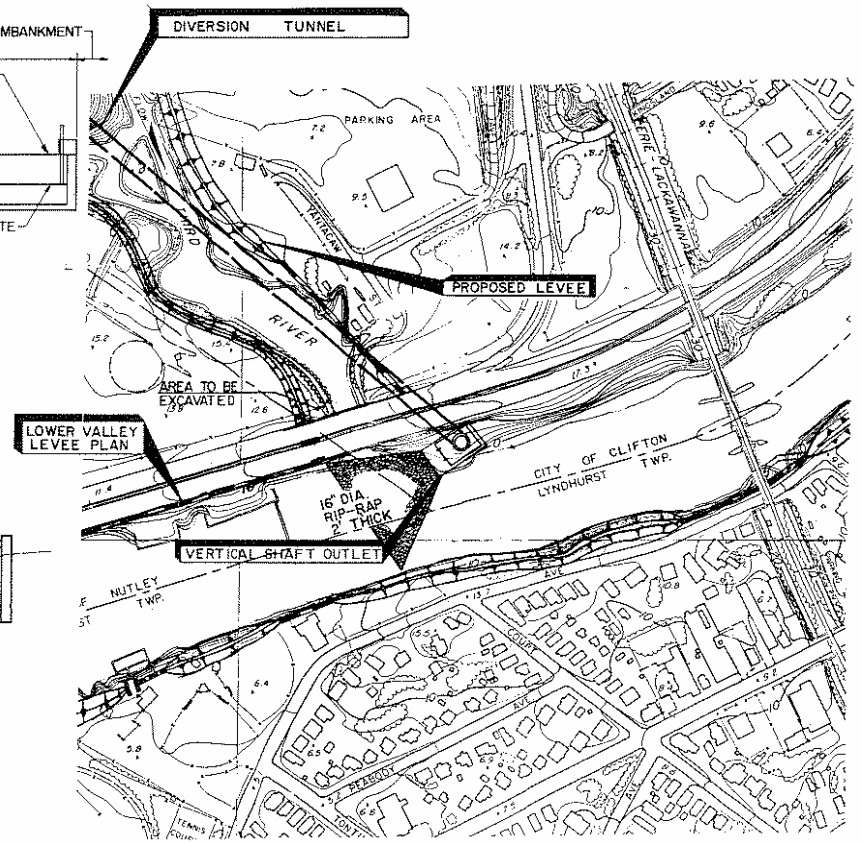
HORIZ 40' 20' 0 40' 80'

VERT 20' 10' 0 20' 40'



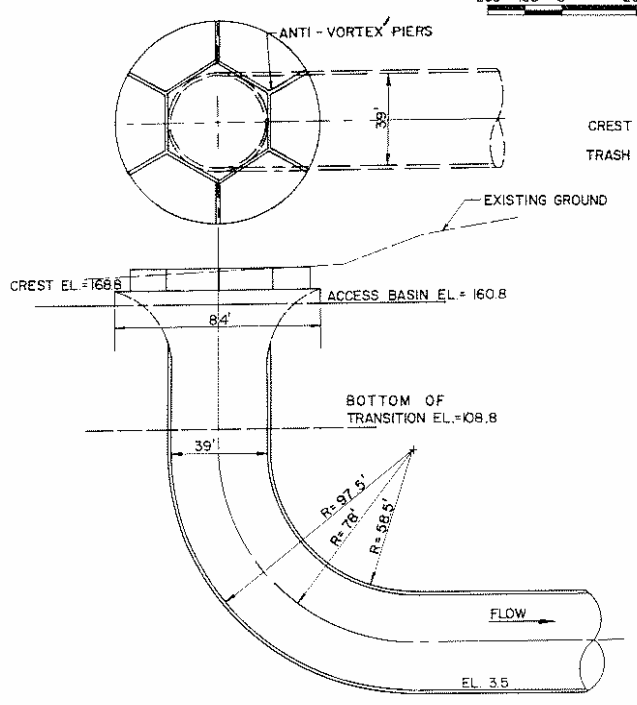
RIVER FLOW RESTRICTOR

20' 10' 0' 20' 40'



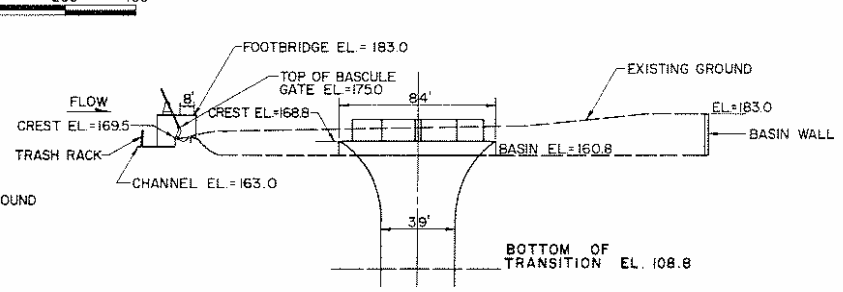
OUTLET LOCATION

200' 100' 0' 200' 400'



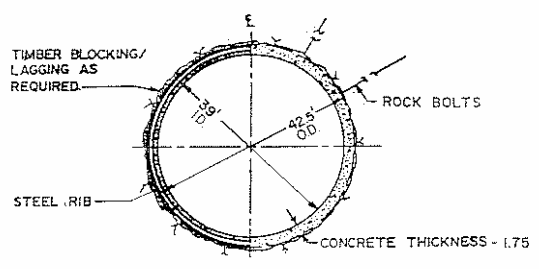
MORNING GLORY SPILLWAY

30' 20' 10' 0 30' 60'



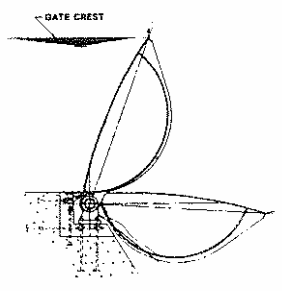
DIVERSION INLET SECTION VIEW

HORIZ. 40' 20' 0 40' 80'



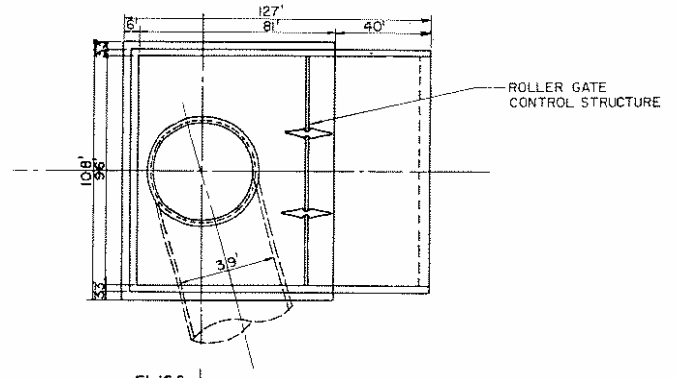
CIRCULAR TUNNEL SECTION

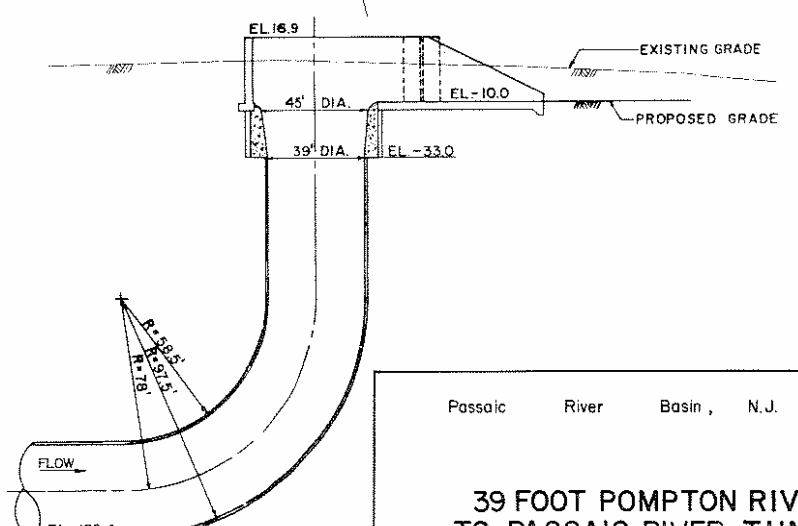
NOT TO SCALE



BASCULE GATE

N.T.S.





VERTICAL SHAFT OUTLET

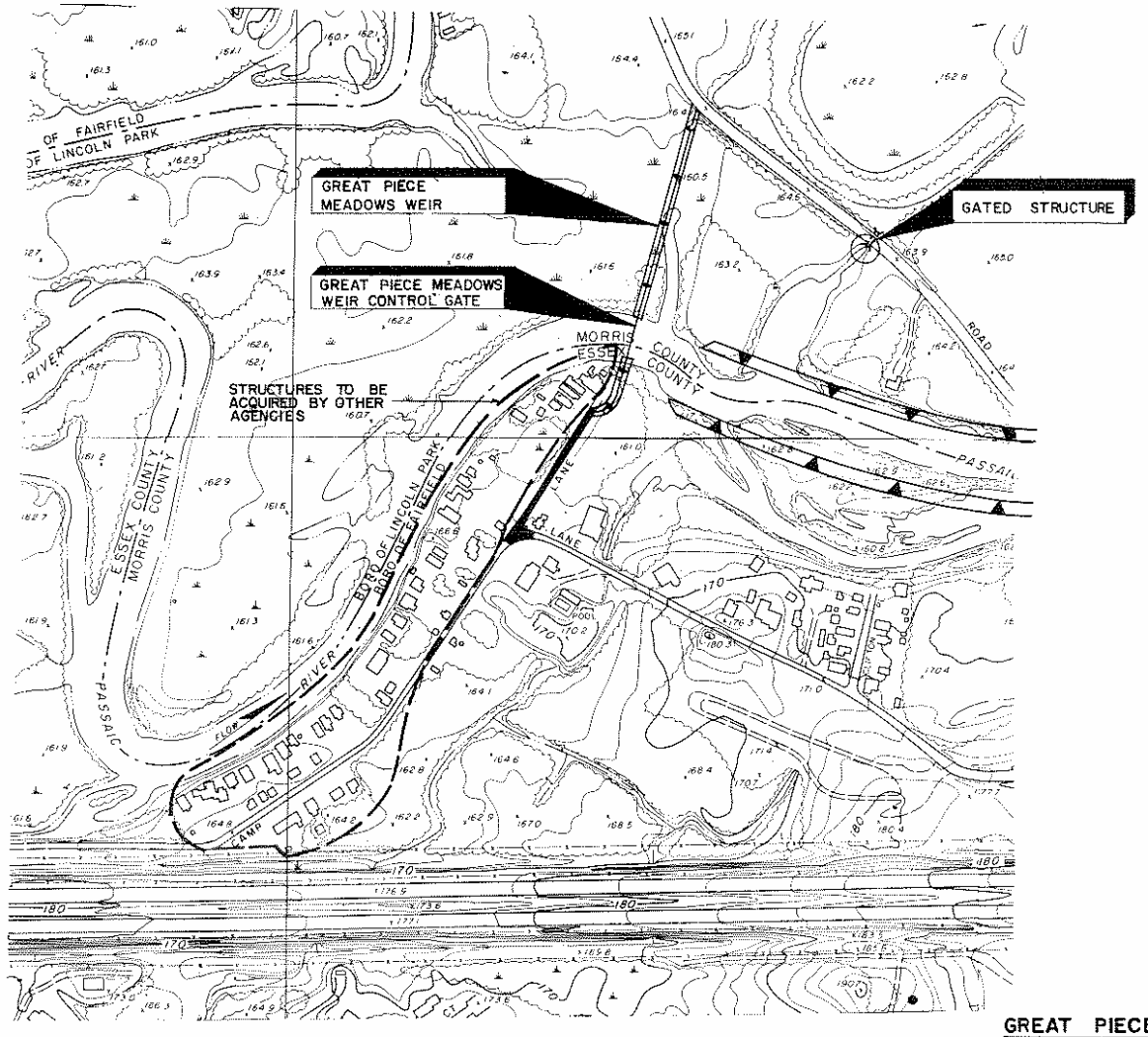
30' 20' 10' 0 30' 60'

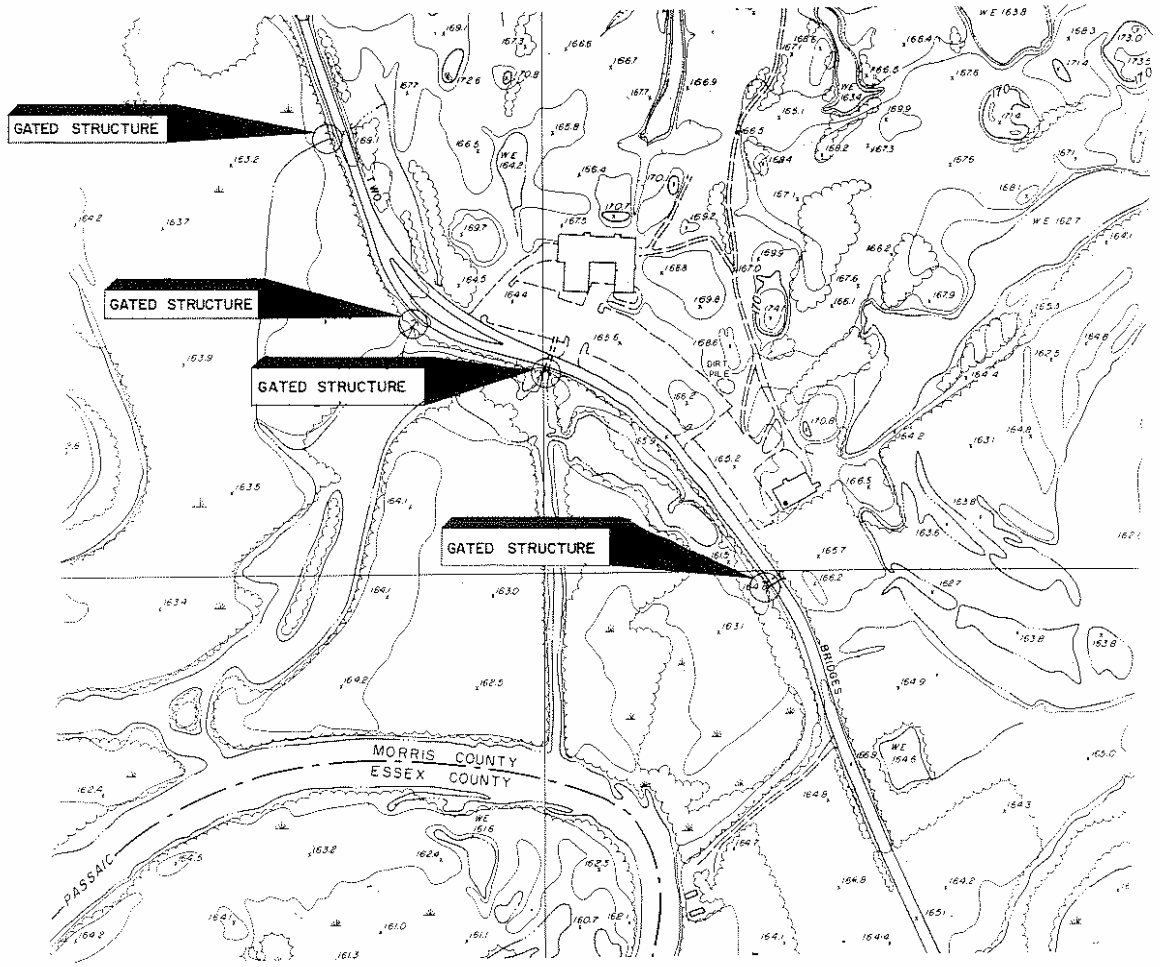
Passaic River Basin, N.J. & N.Y.

39 FOOT POMPTON RIVER TO PASSAIC RIVER TUNNEL

INLET & OUTLET SKETCHES

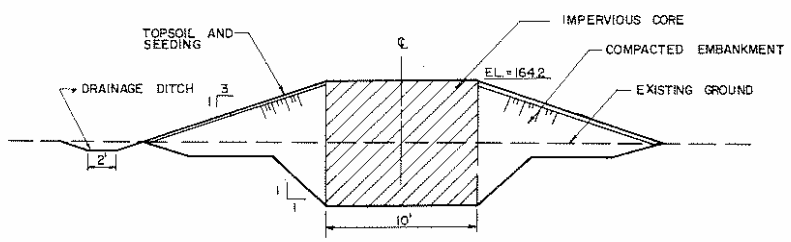
FIGURE 58





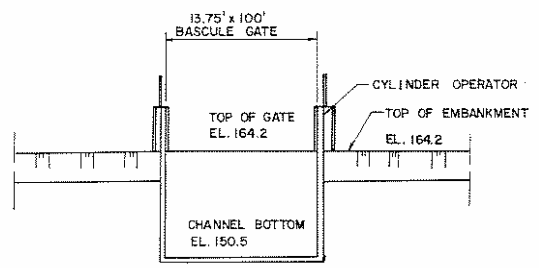
GREAT PIECE MEADOWS WEIR LOCATION

200' 100' 0 200' 400'



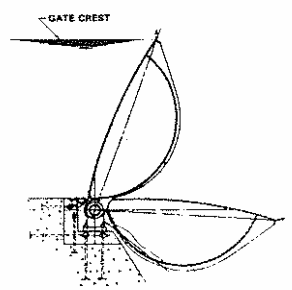
GREAT PIECE MEADOWS WEIR

SCALE = 1"=5'



GREAT PIECE MEADOWS WEIR CONTROL GATE

SCALE: HORZ = 1"=50'
VERT = 1"=10'



BASCULE GATE

NOT TO SCALE

Passaic River Basin, N.J. & N.Y.

GREAT PIECE MEADOWS WEIR DETAILS

FIGURE 60

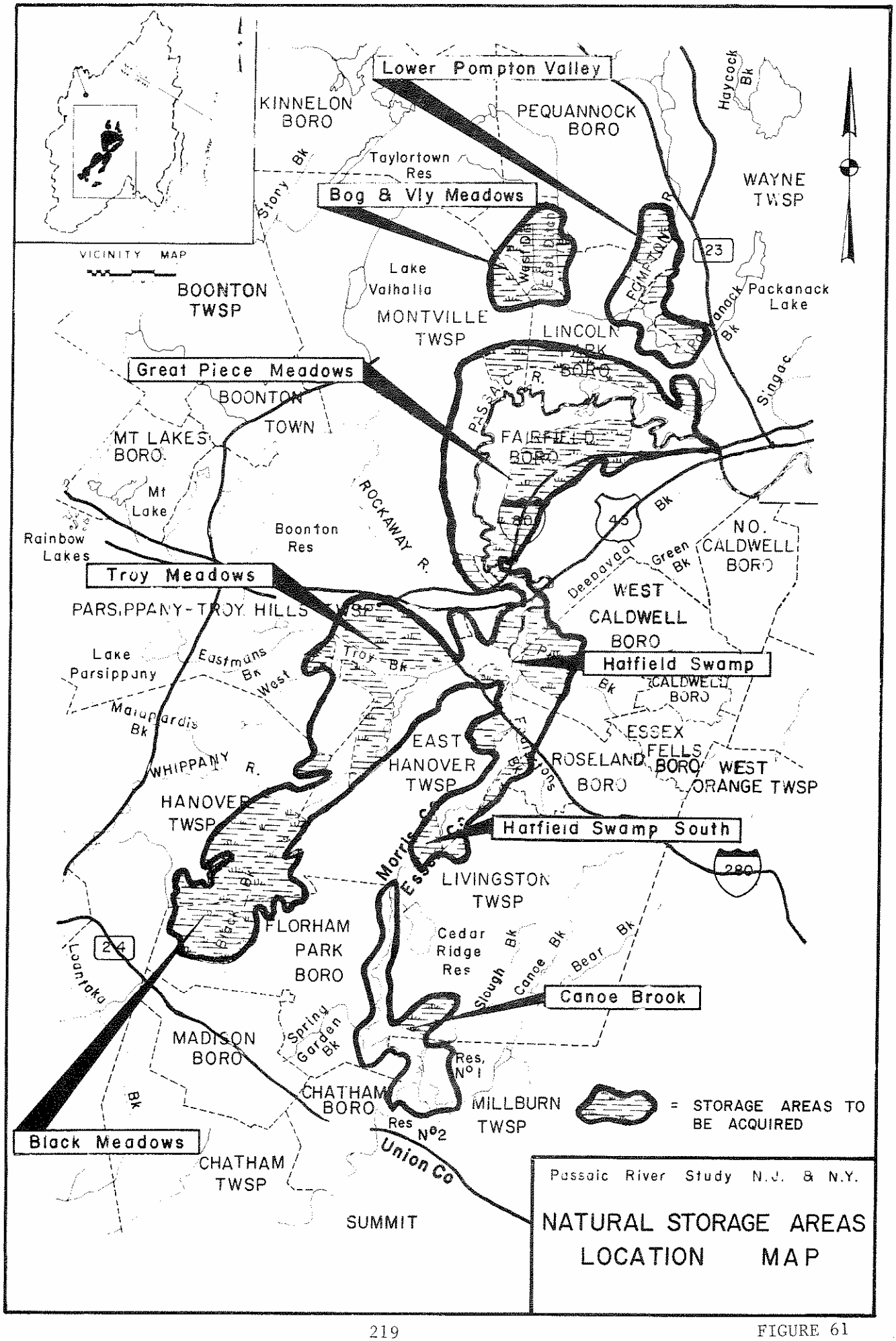

Lower Pompton Valley
KINNELON BORO
PEQUANNOCK BORO
Haycock Bk
Taylortown Res
Stony Bk
Bog & Vly Meadows
WAYNE TWSP
VICINITY MAP
BOONTON TWSP
Lake Valhalla
MONTVILLE TWSP
LINCOLN PARK BORO
Packanack Lake
Packanack Bk
Singac
Great Piece Meadows
BOONTON TOWN
MT LAKES BORO
FAIRFIELD BORO
Mt Lake
Rainbow Lakes
Boonton Res
ROCKAWAY R.
Bk
NO. CALDWELL BORO
Green Bk
Deepavaal
Troy Meadows
PARSIPPANY-TROY HILLS TWSP
WEST CALDWELL BORO
Lake Parsippany
Eastmans Bk
West
Troy Bk
Hatfield Swamp
CALDWELL BORO
Malapardis Bk
ESSEX FELLS BORO
EAST HANOVER TWSP
ROSELAND BORO
WEST ORANGE TWSP
WHIPPANY R.
HANOVER TWSP
Hatfield Swamp South
Morris Co
Essex Co
LIVINGSTON TWSP
FLORHAM PARK BORO
Cedar Ridge Res
Slough Bk
Canoe Bk
Bear Bk
Canoe Brook
Loantaka
Spring Garden Bk
MADISON BORO
Res, No 1
CHATHAM BORO
MILLBURN TWSP
= STORAGE AREAS TO BE ACQUIRED
Black Meadows
Res No 2
Union Co
CHATHAM TWSP
SUMMIT
Passaic River Study N.J. & N.Y.
NATURAL STORAGE AREAS LOCATION MAP

FIGURE 61

CHAPTER 7. PLAN IMPLEMENTATION

The requirements for the Federal and non-Federal sharing of responsibilities in the construction, operation and maintenance of Federal water resources projects are set forth in the Water Resources Development Act of 1986 (PL 99-662). These responsibilities are discussed in the following paragraphs and the Federal and non-Federal shares of the project cost are detailed in Table 28.

FEDERAL RESPONSIBILITIES

The Federal share of the project's total first cost is $622.5 million. The Federal Government will design the project, prepare detailed plans and construct the project, exclusive of those items specifically required of non-Federal interests. These Federal Government responsibilities will commence after Congressional authorization and funding and upon the consummation of an agreement for local cooperation required by Section 221 of the Flood Control Act of 1970, and completion of the items of local cooperation required prior to construction.

NON-FEDERAL RESPONSIBILITIES

The non-Federal share of the estimated total first cost of the proposed project is $218.7 million, which consists of lands, easements, rights-of-way, relocations and disposals totaling $58.3 million, and a cash contribution of $160.4 million. New cost sharing policies for Federal water resources projects were established in the Water Resources Development Act of 1986. Section 103, which sets forth cost sharing for flood control projects, states that non-Federal interests must operate, maintain and rehabilitate the project, and must pay during construction a minimum of 25% of the total cost assigned to flood control, including 5% of costs in cash, and provide lands, easements, rights-of-way and dredged material disposal areas (LERRD). If the 5% cash plus LERRD exceed 30% of the total cost assigned to flood control, non-Federal interests may reimburse the excess over 15 years. The non-Federal share is limited to 50%. For nonstructural components, such as the acquisition of natural flood storage areas, the non-Federal share is limited to 25% of the cost. For hurricane and storm damage reduction measures, such as the Lower Valley tidal levee/floodwall systems, the non-Federal share is 35%. Section 906 of PL 99-662 states that fish and wildlife mitigation costs are to be allocated among the purposes which caused the requirement for mitigation and to be cost-shared to the same extent as project costs allocated to these purposes.

TABLE 28

COST APPORTIONMENT OF THE RECOMMENDED PLAN

(OCTOBER 1986 PRICE LEVEL; 100 YEAR PROJECT LIFE; 8-5/8% INTEREST RATE)

	FEDERAL	NON-FEDERAL	TOTAL
FIRST COSTS:			
Flood Control	566,000,000	188,600,000	754,600,000
(Percent Apportionment)	(75%)	(25%)	-
Hurricane & Storm Damage Reduction	54,700,000	29,500,000	84,200,000
(Percent Apportionment)	(65%)	(35%)	-
Fish and Wildlife Mitigation	1,800,000	600,000	2,400,000
TOTAL	$622,500,000	$218,700,000	$841,200,000
ANNUAL COSTS: 1/			
Interest and Amortization	53,700,000	18,900,000	72,600,000
Operation and Maintenance	-	2,100,000	2,100,000
Residual Induced Flood Damages	-	1,000,000	1,000,000
TOTAL	53,700,000	22,000,000	75,700,000

1/ Interest during construction is not included.

INSTITUTIONAL ANALYSIS

The recommended Pompton/Passaic Dual Inlet Tunnel Diversion Project along the Pompton River and the Main Stem Passaic River is located within the State of New Jersey. The State of New Jersey, through its Commissioner of Environmental Protection, acts as the non-Federal sponsor for all Corps of Engineers flood control projects in the State, by authority of a State Law enacted on November 1, 1982. Confirmation of this intent in regard to the Dual Inlet Tunnel Plan is contained in a June 28, 1984 letter to the District Engineer from the New Jersey Commissioner of Environmental Protection. NJDEP reaffirmed their support for the recommended plan in a May 8, 1987 letter.

PLAN IMPLEMENTATION

Several actions are necessary to bring about the engineering, design and implementation of the recommended plan of improvement.

The North Atlantic Division Commander must review and approve the Final Report and the Final Environmental Impact Statement, and then issue a public notice announcing the study recommendation. He then sends the report to the Board of Engineers for Rivers and Harbors. The Board reviews the report and comments received in response to the public notice and sends its recommendations to the Chief of Engineers who solicits formal review and comments from Governors and interested Federal and State agencies.

Following the state and interagency review and after receipt of comments of the Office of Management and Budget regarding the relationship of the project to the program of the President, the final report of the Chief of Engineers will be forwarded by the Secretary of the Army to the Congress.

If all reviews find the project to be favorable, Congressional authorization of the proposed project will be required and the report will be submitted to the appropriate Congressional committee for consideration. Congressional procedure normally includes review and hearings by the Public Works Committees, and authorization by inclusion in a Water Resources Development Act. Presidential approval of this act concludes the authorizing actions.

When Congress appropriates the necessary funds, detailed engineering and design will begin. Plans, specifications, and detailed estimates will be completed prior to advertising for bids and awarding a construction contract.

As part of the detailed engineering and design phase, local interests will be called upon to satisfy the requirements of local cooperation, including execution of a contract stating the local cooperation requirements and their legal and financial capability to provide them. After necessary lands have been furnished, relocations completed and any necessary cash contributions furnished, a construction contract will be awarded and the project will be carried to completion.

CHAPTER 8. ENVIRONMENTAL IMPACT STATEMENT

FINAL ENVIRONMENTAL IMPACT STATEMENT
Proposed Flood Control Plan for the Main Stem Passaic River which lies in parts of Passaic, Bergen, Morris, Essex, and Hudson Counties in New Jersey. (See Figure 1 in EIS).

Abstract: The New York District has assessed public concerns in the Passaic River Basin relative to the reduction of flood damages and related water resources problems. Recent and recurrent flood related economic losses have sharpened public awareness of the continuing threat to human life and property. In early planning, more than 150 flood damage reduction alternatives were developed consisting of individual management measures and plans consisting of combinations of these measures.

Three plans were selected for detailed study. The recommended flood management plan for the Passaic River Basin, referred to as the Dual Inlet Tunnel Plan, is designed to protect against flooding ranging from 100-to 500-year events, depending on location. This plan involves a 13.5-mile-long, 39-feet-diameter tunnel between Wayne and Clifton, with a 1.2 mile long, 22-feet-diameter spur tunnel with an inlet at Two Bridges. Some 5.9 miles of channel modifications would be required to direct the flows into the tunnel inlet structures, and the diversion tunnels would be augmented by 23.7 miles of levees and 14 miles of floodwalls. The plan includes preservation of 5,350 acres of natural flood storage including 5,200 acres of wetlands. As an item of local cooperation for the project the State of New Jersey has agreed to maintain existing floodways in reaches adjacent to these preservation areas. Two weirs with moveable gates have been included to ensure the project's integrity and functioning during floods while maintaining the viability of wetlands, fish and wildlife resources, a Nationwide River Inventory recreational river reach, water quality, recreation, aesthetics and cultural resources. Fish and wildlife mitigation and environmental design and beautification measures are included in the recommended plan.

In order to implement the requirements of Section 404 of the Clean Water Act, an exemption is being sought under Section 404(r) as part of the authorization process by including the Section 404(b)(1) evaluation in this Phase 1 General Design Memorandum and EIS. The Corps has found that this project is in conformance with the 404(b)(1) guidelines.

Date: _____

Please send your comments to the Office of the Chief of Engineers (OCE) ATTN: DAEN-CWP, Washington, DC 20314 by the date stamped above. If you would like further information concerning this statement, please contact Mr. Robert A. Pietrowsky, U.S. Army Engineer District, New York, 26 Federal Plaza, New York, NY 10278-0090. Commercial Telephone (212) 264-3567; FTS 264-3567.

Information and graphics presented in the Main Report and Appendices are incorporated by reference into this EIS.

FINAL ENVIRONMENTAL IMPACT STATEMENT

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SECTION 1. SUMMARY

MAJOR CONCLUSIONS AND FINDINGS

1.01 National Economic Development Plan. The recommended Pompton/Passaic Dual Inlet Tunnel Diversion Plan has been designated the National Economic Development (NED) Plan because it reasonably maximizes excess benefits when compared to the costs, consistent with protecting the Nation's environment while meeting the study's planning objectives. The Dual Inlet Tunnel Plan combines large diversion tunnels, levees and floodwalls, channel modifications, and natural flood storage to provide flood protection to major damage areas, totally eliminating flooding from severe events such as the April 1984 flood.

1.02 Tunnels. The major elements of this flood control plan are the two tunnels, with the key being the 13.5-mile-long, 39-foot-diameter main tunnel, which will carry floodwaters from the upper Pompton River down to the Passaic River just above the Third River. A 1.2-mile-long, 22-foot diameter spur tunnel will convey floodwaters from an inlet just downstream of the Passaic River-Pompton River confluence at Two Bridges to an underground connection with the main diversion tunnel. The inlets will be located in Wayne Township while the outlet will rise on the west bank of the Passaic River in Clifton. The diversion tunnels and associated surface works are designed to protect against a flood with a one-percent exceedence frequency (100-year flood) based on future conditions expected to prevail over the basin for the year 2040.

1.03 Tunnel Depths. The tunnels would be entirely underground, ranging from 125 to 450 feet under the surface. The main tunnel would be some 125 feet below the surface at the Pompton Inlet, about 130 feet below the Passaic Inlet, and approximately 155 feet below the outlet. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the tunnel would be some 450 feet underground. The intersection of the main and spur tunnels would be about 150 feet below ground level.

1.04 Surface Works Integral to the Tunnels. Some 5.9 miles of channel modifications would be required to direct the flows into the tunnel inlet structures. Of this total, 4.8 miles would lie upstream of the Pompton Inlet, along the Ramapo, Pequannock and Wanaque Rivers. The remaining 1.1 miles would consist of 0.8 miles on the Passaic River and 0.3 miles on the Pompton River upstream of the Two Bridges Inlet.

1.05 Upstream of the Pompton Inlet, 3.5 miles of levees and 0.7 miles of floodwalls would function in conjunction with the channel modifications to direct flood flows into the tunnel and to protect upstream areas.

1.06 At the vicinity of the tunnel outlet, 5.7 miles of levees and 7.8 miles of floodwalls would lie along the Passaic River, between its confluences with the Saddle and Second Rivers which protect against tidal flooding and safely contain flows exiting from the tunnel. The design of the levees and floodwalls include provisions of required river access and accommodations for locally desired recreational features.

1.07 No other structural measures would be needed along the Pompton River or along the Passaic River between the Two Bridges Inlet downstream to just above the Saddle River, because the tunnels would divert flood flows away from these areas.

1.08 Central Basin Levees. At locations throughout the Central Basin damage areas, levees and floodwalls would be provided to protect against flood flows. At the upstream limit of the area, along the Central Passaic River above Two Bridges, protection against flood events ranging from a 100-year up to a 500-year event would be provided intermittently, where needed, by setback levees and floodwalls. These systems would include approximately nine miles of levees, and a half-mile of floodwall.

1.09 Lower Valley Tidal Levees. Protection in the Lower Passaic Valley includes 5.5 miles of levees and 5.0 miles of floodwalls from near Route 280 between Harrison and Newark downstream to Newark Bay. These systems provide 500-year protection against hurricane and tidal surges.

1.10 Interior Drainage. Interior runoff generated from upland areas behind the levees and floodwalls would be safely handled by a series of interior drainage facilities, including ponding areas and pumping stations.

1.11 Acquisition of Natural Flood Storage Areas. In order to minimize the flooding impact of future development within the basin, the acquisition of significant portions of the remaining unprotected natural storage areas within the Central Passaic Basin is included in the recommended plan. A total of 5,350 acres would be acquired, of which 5,200 acres are wetlands. In conjunction with the preservation plan element, the project includes the maintenance of existing NJDEP floodway zoning delineations, as a non-Federal item of local cooperation, for the project. The combined effect of the acquisition of 5,350 acres of natural storage, the 6,380 acres of storage areas

preserved within existing floodways to be maintained, and the 9,485 acres currently protected as public open space and parkland would preserve 21,215 acres of natural flood storage areas in the Passaic River's Central Basin.

1.12 Environmental Design and Mitigation. Two weirs with controllable gates would be installed, one upstream of each tunnel inlet. The weir that would be installed upstream of the Passaic River tunnel inlet would be located near the downstream end of Great Piece Meadows. It would maintain the stability of the modified Passaic River channel leading to the inlet, while simultaneously maintaining the integrity of the upstream wetlands, fish and wildlife habitats and a Nationwide Rivers Inventory recreational river reach. The weir that would be installed upstream of the Pompton River Inlet, in the Pequannock River bypass channel, would maintain the integrity of the historic Morris Canal feeder dams and lessen impacts to upstream wetlands and aquatic habitats.

1.13 Other environmental design features include project operating rules which allow the bypass of flows equivalent to the one-year flood event for inundation of wetlands, flushing of downstream channels, and maintenance of fish habitat; wetland plantings in ponding areas; placement of cobble substrate upstream of the tunnel's outlet as anadromous fish habitat; channel modification designs which include the replacement of existing cobble substrate along with placement of additional cobble; maintaining existing channel meanders where possible; protection of banks susceptible to erosion with riprap; providing adequate water depths for fish by means of pilot channels; use of erosion control methods during construction; maintaining existing riparian vegetation where compatible with the project; replanting of areas disturbed during construction in the first growing season following project completion; replacement of topsoil to existing depths; and a planting and beautification program associated with levee system design including levee topped walkways, benches, lighting, comfort facilities and access to the river for recreational purposes.

1.14 Other project features included as fish and wildlife mitigation measures include the placing of instream wing-dam aquatic habitat structures; the upgrading of wetland values for 185 acres of wetlands within the acquisition areas; and the placing of bird nesting boxes in ponding areas. Additional Phase II studies and the recommendations for a comprehensive wetland management plan by the U.S. Fish and Wildlife Service would be used to formulate possible refinements to project mitigation within the overall confines of the plan. In concert with these activities the Corps will organize an expert interagency Environmental Advisory Board to guide the detailed environmental planning and design and make decisions regarding site specific mitigation.

1.15 Cultural resources surveys during Phase II Design and the mitigation for significant cultural resources affected by the project; groundwater monitoring; hazardous substances site coordination and monitoring; and compensation for project impacts on parkland are also Corps' commitments related to the project. A discussion of environmental design features can be found in paragraphs 3.107 to 3.125 in Section 3 of the EIS.

1.16 Section 404 Compliance. To comply with Section 404 of the Clean Water Act, an exemption is being sought under Section 404(r) as part of the authorization process by including the Section 404(b)(1) evaluation in this Phase 1 General Design Memorandum and EIS. The Section 404(b)(1) evaluation has been prepared for the recommended plan. The evaluation concludes that appropriate measures have been incorporated into the proposed plan to minimize adverse effects, and that the proposed action would not result in any significant environmental impacts relative to the areas of concern under Section 404. The full text of the Section 404(b)(1) evaluation can be found in Addendum 1 to this report.

1.17 NED Plan. The Dual Inlet Tunnel Plan is the National Economic Development (NED) Plan and is the alternative which provides the best balance of minimizing environmental effects while providing comprehensive flood protection for the Main Stem Passaic River. The alternative plans considered in this feasibility study are summarized in Section 3 of this EIS and described in Chapter 5 of the Main Report, and fully explained in Sections 5, 6 and 7 of Appendix C - Plan Formulation.

AREAS OF CONTROVERSY

1.18 Public Views During Early Planning: A number of issues became the subject of controversy among public interest groups during the Passaic River Basin Study. Major issues emerged regarding the formulation of plans during public involvement activities. They include the desire: to minimize impacts to existing development; to preserve natural flood storage areas, including wetlands, which attenuate flood flows; to preserve the natural flushing of river sediments by flood flows; to provide recreational opportunities and to restore the lower Passaic riverside, particularly on the east bank from Kearny to Garfield; and to utilize nonstructural measures wherever possible, rather than modifying the existing rivers. Modifications to the recommended plan during project planning resulted from considering these issues.

1.19 Issue Resolutions During Early Planning. The key elements of the plan are its 13.5-mile-long subsurface diversion tunnel and its 1.2-mile-long spur tunnel, which minimize surface elements and disturbances to existing development. Channel

modifications are limited to 5.9 miles in the reaches upstream of the tunnels' inlets, with virtually no structural features required along the 6.8-mile-long Pompton River downstream of the Pompton inlet, or for 16.3 miles along the Passaic River from the Two Bridges inlet downstream to the Saddle River vicinity.

1.20 A major nonstructural element that has been incorporated into the plan is the preservation of natural flood storage which entails acquisition and preservation of 5,350 Central Basin acres, 5,200 of which are wetlands.

1.21 The tunnel's operating rules were refined. The tunnel would not operate for floods up to and including the one-year event. For larger floods, tunnel operating rules would bypass annual flood flows subsequent to the diversion of flood peaks and would continue to inundate wetlands and flush river channels in conjunction with the operation of the Great Piece Meadows Weir.

1.22 In the Lower Valley, beautification measures and recreational opportunities including walking/bike trails, overlooks, comfort facilities, recreational amenities and access have been included in the levee systems.

1.23 Permanently evacuating the floodplain (the "buyout plan") and relying on a basin-wide nonstructural plan were evaluated several times during the plan formulation process. These plans were found to be either too costly ($3.8 billion for the 100-year evacuation plan, more than four times the cost of the tunnel plan or $2.2 billion for the 10-year acquistion plan). If scaled down to be comparable in cost to the Dual Inlet Plan, would not provide sufficient flood damage reduction benefits for economic justification (preventing damages only in portions of the 10-year floodplain). A No-Tunnel Plan including nonstructural elements along with levees, floodwalls and channel modifications was included in the EIS as the basin-wide plan which uses the most nonstructural measures possible within the constraints of Federal Interest and National Economic Development requirements.

1.24 Notice of Intent, Scoping Meetings and Notice of Availability of DEIS. A Notice of Intent to prepare the EIS was published on October 23, 1985, and scoping meetings for Federal Agencies were held on November 7, 1985 and December 5, 1985; two scoping meetings for New Jersey State Agencies were held on December 16, 1985 in Trenton, NJ, and public scoping meetings were held in the Basin on November 13 and 14, 1985. The notice of availablity for the Draft EIS was published in the Federal Register dated April 17, 1987. A late stage public meeting on the Draft Report and DEIS was held on May 12, 1987 in Little Falls, N.J.

1.25 Issues Raised in Response to the DEIS. The recommended plan modifications presented in paragraphs 1.19-1.23 above were described in the DEIS. However, the modifications were viewed by some as inadequate to resolve their concerns and they remained as areas of controversy. In response to the DEIS, approximately 70 letters were received providing comments on the document (see Appendix A - Public Involvement, Attachments A22 to A85). There were several requests for time extensions, with the result that the comment period was extended from the original 45 day period to 105 days, ending August 1, 1987. Many of the concerns expressed by respondents were interrelated and overlapping. In particular, the issues expressed by the U.S. Department of the Interior (DOI), the U.S. Environmental Protection Agency (EPA) and New Jersey Department of Environmental Protection (NJDEP) were among the most significant and encompassed concerns raised by several other respondents.

1.26 U.S. Department of the Interior. The DOI raised a range of issues in their letter providing comments on the DEIS, (see Appendix A - Public Involvement, Attachment A28). These topics included mineral resources, National Natural Landmarks, Nationwide Rivers Inventory, Federally funded parks, and fish and wildlife resources. The fish and wildlife comments are related to previous recommendations expressed by the U.S. Fish and Wildlife Service (FWS) during interagency coordination prior to the DEIS. The U.S. Fish and Wildlife Service Planning Aid Reports dated June 1983 and March 1984, and a September 1986 Fish and Wildlife Coordination Act (FWCA) Report, presented fish and wildlife recommendations for the Dual Inlet Plan. The FWCA Report is reproduced as Addendum 2 to this volume.

1.27 The FWCA Report presented eighteen fish and wildlife recommendations. In the DEIS the Corps of Engineers was able to fully accommodate twelve of these recommendations and partially accommodate four others, while two recommendations were not incorporated into the project. The partially accommodated recommendations were numbers 2, 5, 6 and 8, while those not included were FWCA recommendations 1 and 10 (see Addendum 2 to this volume which reproduces the FWCA Report along with the Corps' responses to the FWS' recommendations).

1.28 The DOI comments in response to the DEIS included comments from the FWS which reiterated the recommendations articulated in the FWCA Report. Coordination subsequent to the DOI's comments on the DEIS resulted in the FWS and Corps resolving the disagreements associated with FWCA recommendations 2 and 10, and better accommodating, but not fully incorporating, recommendations 5, 6 and 8. Thus, as reflected in this FEIS, the recommended Dual Inlet Plan fully accommodates fourteen FWCA recommendations, partially accommodates three others, while one recommendation remains as an unresolved issue.

1.29 The Corps agreed to refine the wetland impact assessment framework used in the DEIS and to include the Pequannock Weir and additional wetland compensation in the recommended plan to fully address FWCA recommendation 2 regarding impacts to wetlands and areas on the Pompton tributaries (see paragraphs 1.55, 1.56 and 1.59). The Corps and FWS also agreed that the plant community succession model (FWCA recommendation 10) would be developed as part of a package of FWS models to be developed during the Phase II design stage, thus fully resolving this issue (see Attachment A27 of Appendix A - Public Involvement and FEIS paragraphs 1.51-1.54).

1.30 The Corps also refined the provisions for public accessibility to the watercourses in the project area to better address FWCA recommendation 5 (see EIS paragraphs 3.121 and 5.131). The use of setback levees has been reevaluated and found to have been incorporated to the maximum practical extent (FWCA recommendation 6). The incorporation of the Pequannock Weir into the plan, and the clarification in the FEIS of the project's operating rules, including the one-year flow bypass rule, are responsive to FWCA recommendation 8 regarding wetland inundation, channel flushing and adequate flow regimes (see paragraphs 1.56 and 5.162-5.172). The remaining unresolved FWCA recommendation is the request to eliminate or greatly reduce the channel modifications along the Ramapo, Pequannock and Wanaque Rivers (see paragraphs 1.70 - 1.75).

1.31 U.S. Environmental Protection Agency. USEPA raised four issues which were the basis for their EO-3 rating (see Attachment A34 of Appendix A - Public Involvement). The issues are: wetlands and aquatic environments, groundwater, hazardous substances sites and water quality. Based on their review, EPA requested that information regarding these issues be presented for review in a supplemental or revised draft EIS, prior to the preparation of the FEIS for the project.

1.32 Concerning wetlands, EPA found the discounting of direct impacts against the wetlands acquired for preservation of natural flood storage unacceptable mitigation and stated that EPA's Region II policy requires wetlands lost be replaced on a 1:1 value-for-value basis. In general, EPA could not understand the wetland and aquatic habitats' descriptions or impacts to wetlands and aquatic habitats. Likewise, EPA indicated that the DEIS does not adequately describe the groundwater system or hazardous substances sites, and expressed concerns regarding the effects of the project on these features. Concerns were also expressed over potential water quality impacts due to secondary development and operation of the tunnel.

1.33 Subsequent to the circulation of the DEIS and the receipt of the EPA comments, the Corps and EPA agreed to undertake a technical coordination effort aimed at resolving these concerns. This coordination effort took place over a seven month period and involved meetings between management and technical staff, and numerous telephonic and correspondence communications (see Attachment A38, Appendix A - Public Involvement). Significant progress has been made towards resolving this controversy, and final agreement between the Corps and EPA has been reached, regarding the groundwater and hazardous substances sites issues, as documented in the February 2, 1988 Corps of Engineers letter (Attachment A38j) and the February 16, 1988 letter from EPA (Attachment A38k). These letters also document that EPA's remaining water quality concerns are not significant; clarification of the secondary development issue by the Corps addressed much of this concern. Significant progress has also been made in addressing EPA's wetlands and aquatic resources concerns. Specifically, a mutual understanding of the wetlands and aquatic resources impact assessment has been achieved, and a conceptual understanding of the Corps mitigation approach has been reached. However, EPA still has outstanding concerns regarding the Corps proposed wetlands mitigation, as described in paragraph 1.35 and 1.84 (also see Attachments A38j and A38k of Appendix A - Public Involvement). Resolution actions regarding wetlands and aquatic resources are described in paragraphs 1.55-1.61, while steps taken regarding the Sole Source Buried Valley Aquifer and hazardous substances sites are presented in paragraphs 1.38 and 1.65-1.66, respectively. The water quality issue is discussed in paragraph 1.67, and resolution of the secondary development issue, which was a major EPA concern regarding water quality, groundwater and wetlands impacts, is summarized in paragraph 1.48.

1.34 New Jersey Department of Environmental Protection. The NJDEP comments on the DEIS addressed a wide range of issues including: clarification of future development within flood-plains and wetlands, and wetland statistics; mitigation for impacts to wetlands and parkland; the cost of natural storage lands; fish and wildlife impacts due to channel modifications; radioactive minerals; hazardous substances; water and air quality impacts; cultural resources; and coastal resources. These issues were all resolved as discussed in the subsequent paragraphs.

1.35 Issue Resolution. Most of the issues raised in response to the DEIS have been resolved. There are still three unresolved disagreements: (1) the FWS' and other resource agencies' request for additional reductions in the lengths of modified channel reaches; (2) the respondents who objected to the project and/or tunnel outlet's location because of perceived threats of potential increases in Lower Valley flooding,

paralleled by those who objected to the levees and the resulting loss of parkland, riverside access, aesthetics and/or tax ratables; and (3) the level of detail considered necessary for the definition of the wetland mitigation plan, and the issue of whether wetlands mitigation should be approved singularly by the EPA, or jointly between EPA, the Corps and other involved natural resource agencies (FWS and NJDEP), remain unresolved.

1.36 Nonetheless, the overwhelming number of issues raised in response to the DEIS have been resolved. Their descriptions follow. Most of the resolved controversies emerged due to misunderstandings. In some instances the public or agencies didn't understand the organization of the DEIS, or passages in the report, or the operation of the tunnel, the weir, the bypass rules, or the Corps' planning process. The resolved issues presented below are organized to first discuss unaffected resources (paragraphs 1.37-1.40); then misunderstandings (paragraphs 1.41-1.49); wetlands and aquatic habitat related concerns (1.51-1.62) and lastly issues related to coastal resources, parkland, hazardous substances sites, water and air quality, and noise (1.63-1.68).

1.37 Unaffected Resources Not Emphasized in the DEIS. Due to the large size of the basin, the diversity of its resources, and the complexity of the plan, it was necessary to divide the basin into smaller, more manageable units for discussions in the DEIS. Five reaches were used for this purpose. After the affected resources were described in Section 4, the impacts were then described reach-by-reach in Section 5. If a reach did not contain a specific significant resource, or if there were no plan elements or indirect impacts in a specific reach, there was no discussion presented in the DEIS. There was no emphasis on descriptions of direct or indirect impacts that would not occur. This was perceived by natural resource agency reviewers as either ignoring impacts or as being unaware of them. A new reach-by-reach summary of significant resources has been added to the final portion of Section 4 - Affected Environment (paragraphs 4.169-4.201) which is consistent with the systematic reach-by-reach descriptions in Section 5 of the EIS (Environmental Impacts) to help alleviate this confusion.

1.38 Sole Source Buried Valley Aquifer. For instance, the DEIS included information on the Buried Valley aquifer in paragraph 4.15 and Figure 8 (page DEIS-55) and DEIS paragraph 5.123 presented the assessment that the recommended plan is not expected to affect groundwater resources, although supporting documentation was not presented. The EPA and several environmental groups and citizens, commented that the Central Basin's EPA-designated Sole Source Buried Valley Aquifer and the project's effects on this Central Basin resource were inadequately described in the DEIS. This issue has been addressed by explaining in the responses to comments (see EPA

response Attachment A34 paragraphs 15-17, Appendix A - Public Involvement) that since the Buried Valley Aquifer would be unaffected by the project it was not emphasized in the DEIS. In response to these agency concerns, however, the FEIS includes a description of the Sole Source Buried Valley Aquifer (see paragraphs 4.27-4.30), and the Environmental Effects section dealing with Reach 5's' impacts clearly documents that there would be no direct or indirect project effects (see paragraphs 5.178-5.183). The N.J. State Geologist concurred in this conclusion after his independent review (see Attachment A46 in the Public Involvement Appendix), and a sensitivity analysis, including a "worst case" scenario, was performed in coordination with EPA which confirmed the Corps impact assessment (see Attachments A38e-g, A38j, and A38k which document the coordination between the Corps and EPA on this issue).

1.39 Mineral Resources, Federally Funded Parks, National Natural Landmarks. Other resources that would not be impacted and, therefore, were not described, were viewed by the Department of the Interior as oversights in the DEIS. These include mineral resources underlying acquisition areas, parkland, and the Troy Meadows National Natural Landmark. These issues were responded to directly in the Comment/Response portion of the Public Involvement Appendix (see DOI response Attachment A28 paragraphs 2-6 and 12-14, Appendix A - Public Involvement) while the FEIS' description of Troy Meadows now notes its National Natural Landmark status. This status would be enhanced by the recommended plan, by acquiring and preserving significant portions of Troy Meadows as part of the Preservation of Natural Storage project element (see FEIS paragraphs 4.91, 4.92 and 5.196).

1.40 Radioactive Minerals. NJDEP raised a concern regarding "radioactivity in conjunction with tunnel construction and exposure to the excavated material." This issue was resolved by explaining in the response (see NJDEP response Attachment A44, paragraph 8, Appendix A - Public Involvement) that subsurface investigations tested for the presence of radioactive formations and found no detectable radioactive minerals in the rocks that would be penetrated by the Dual Inlet diversion tunnel. Also, see FEIS paragraphs 4.21-4.26 and 5.14.

1.41 Cultural Resources. NJDEP expressed concern over cultural resources, although this topic was addressed in the report. NJDEP called for cultural resources investigations to be conducted and their costs factored into the project. The DEIS stated that cultural resources would be investigated or surveyed in preconstruction site surveys in paragraphs 5.75, 5.96 and 5.108. The assessment of project impacts to cultural resources is based on a Cultural Resources Sensitivity Analysis of the Passaic River Basin and a reconnaissance level study at potential project areas as documented in Appendix B - Natural

Resources, Section 6. The Corps is committed to conducting preconstruction cultural resources surveys at all surface construction sites. The cost of mitigation of any significant sites discovered is limited by Federal law to one percent of the project cost. This amount would be available to accomplish required cultural resources mitigation. Cultural resources impacts are summarized in Section 5 of the FEIS in paragraphs 5.227 and 5.228.

1.42 Acquisition Areas Exclude State, County and Municipal Parkland. Another type of misinterpretation of the DEIS arose from misreading data in the report. Maps in the Plan Formulation Appendix of the draft report displayed the entire Central Basin natural flood storage area. This entire area was misinterpreted as that which would be acquired for the preservation of natural flood storage, so the NJDEP's Office of Green Acres believed that the Corps was planning to buy lands already in public ownership. This opinion was echoed by several other basin environmental interests.

1.43 Coordination with Green Acres indicates that the Corps-designated acquisition areas do not, in fact, overlap onto lands conserved as parkland or owned by Green Acres, counties or municipalities, within the margin of error that exists when transcribing mapped data of varying scales. The final report plan sheets (Main Report Figures 36 through 46, 54 and 55) include the areas that would be acquired for the preservation of natural flood storage. The dynamic nature of the State's parkland acquisition programs prevents this conclusion from being final and conclusive. Close coordination with Green Acres and local entities will continue into the Phase II Design as refinements are made in terms of the precise lot and block location of the lands already owned by public interests, and those that are designated for the acquisition of natural flood storage.

1.44 Planning Process Misunderstandings. Many respondents did not understand the planning process, and because the three detailed plans considered in the EIS did not include a flood-plain buyout plan, they thought acquisition plans were not carefully considered, if at all. Section 3.01 of the DEIS (and paragraph 3.01 of the FEIS) described the iterative nature of the planning process and Section 3.06 in the DEIS (paragraph 3.07 in FEIS) summarized the 100-year buyout plan. This plan, priced at $3.8 billion, was eliminated due to its high cost, more than four times the tunnel plan's price. Some parties, apparently in receipt of misinformation, believed the 100-year buyout plan would cost only $900 million, a price nearly equivalent to the tunnel plan's. Other respondents, learning of the $50 million Congressional authorization (Section 1148, PL 99-662) for buying residential structures from willing sellers in the floodplain, believed that this was "early start" money to begin acquisition for the Dual Inlet Tunnel Plan. Such is not the case.

1.45 Federal Cost-Sharing Rules. Federal cost sharing rules caused confusion. For example, for flood control projects the non-Federal sponsor must contribute approximately 25% of the project's cost to the Federal Government (35% for hurricane protection) in accordance with Section 103 of PL 99-662. For the Dual Inlet Plan this share would take the form of an initial cash contribution of 5% and the lands, easements, and rights-of-way that would be needed for the project, plus additional cash to bring the non-Federal share up to 25% of the project's cost. Several commentors from New Jersey's Department of Environmental Protection (NJDEP) interpreted this rule as requiring the entire cost of the acquisition of natural flood storage areas to be borne by the non-Federal sponsor, in addition to the lands, easements and rights-of-way attached to the flood control project. This is not the case. The preservation of natural flood storage project element is recommended as a nonstructural flood control measure integral to the overall project and is cost shared 75% Federal and 25% non-Federal in accordance with Section 103(b) of PL 99-662. This error manifested itself in exacerbating the unwillingness of NJDEP's natural resources staff to accept many of the initial (DEIS) assumptions. These were concerned with the estimated costs of the acquisition land, future development in the wetlands, and the impact assessment framework of the DEIS mitigation plan, which discounted direct project impacts in the wetlands against the acquisition areas, yielding a net preservation credit. These issues were resolved through subsequent coordination, refine- ments to the mitigation plan, and clarifications in the report. Table 28 of the Main Report presents the Federal/non-Federal cost sharing for the Dual Inlet plan.

1.46 State Cost Sharing. A related State issue was raised concerning the State of New Jersey's ability to provide the non-Federal share of the project cost (approximately 25%) with some commentors calling for assurance of financing. Institutional studies have confirmed the legality and ability of the State to sponsor the project. The State has conducted a study, regarding their options for sharing the non-Federal portion of the project among various levels of local governments, and they have held public hearings soliciting comments regarding the non-Federal financing of the project.

1.47 Cost of Acquisitions of Natural Flood Storage Lands. As discussed above in paragraph 1.45, the misunderstanding regarding the cost-sharing responsibility for the acquisition of the natural flood storage lands was related to concerns expressed by NJDEP's Office of Green Acres regarding the cost of acquiring these lands. Due to concerns over apparent disparities in the estimated costs of the acquisition areas, a second independent estimate was contracted in 1986, which confirmed the original estimate made in 1984, within price level rise adjustments. The Final Report reflects the current cost estimate for these lands.

1.48 Secondary Development. Another germane issue was the environmental community's concern that secondary development would occur on protected lands. This was a concern of EPA regarding potential secondary impacts to water quality, and also wetlands and groundwater. The Corps had recognized prior to issuing the DEIS that redelineation of the State designated floodways could occur with the project, so the Corps developed an Item of Local Cooperation for the project that the floodways adjacent to the acquisition areas will remain in their present configuration. This was reflected in the Draft Report on page 171, item g. The State of New Jersey, in their May 8, 1987 letter of intent for the project, has agreed to this item. (See item g, Chapter 9 of the Final Report; Appendix A - Public Involvement, Attachment A20, page 5, item g; and response to EPA Comment 1, sentence 4, Attachment A36.

1.49 Preservation Areas Maintain Future Levels of Flood Protection. Several respondents were also under the misimpression that the preservation of natural flood storage areas was required for the tunnel to function properly. This is incorrect. If the flood storage areas are not preserved, the tunnel would still function, but its level of protection would diminish over time as development of natural flood storage areas increase future flood levels, durations and frequencies.

1.50 Nationwide Inventory River. The Passaic River reach that flows through Great Piece Meadows has been listed on the Nationwide Rivers Inventory and is eligible for designation as a recreational river noted for the botanical values of its adjacent lands. The National Park Service expressed concern that project impacts could effectively foreclose this reach's designation as a recreational reach. This would not happen. This issue is resolved because the moveable Great Piece Meadows Weir would maintain the viability of these botanically significant wetlands, yet be invisible from the surface, since the gate would be underwater (in the down position) 98% of the time, and only be raised when an annual flood was being created. Camp Lane would be raised to complete the closure across the Meadows. Its side slopes would be landscaped to appear natural and would be planted with indigenous vegetation. The interagency environmental advisory group, which will be established, will include National Park Service representatives who can help ensure that the value of this reach would not degraded (see FEIS paragraphs 4.137-4.139, 5.193 and 5.194).

1.51 FWS Modeling Effort and HEP. A controversy arose during coordination with the Fish and Wildlife Service (FWS) concerning wetland impacts in Great Piece Meadows. Early in the detailed planning stage (1985) the Corps provided FWS with all existing hydrologic and hydraulic data available at that time, including several sets of graphs and maps that were created at the specific request of the Service. These included flood duration

and flood frequency curves and mapping of the annual floodplains with and without the project. The maps, curves, and computer printouts were technical and extremely complex. Later, the FWS indicated in their DEIS comments that the descriptions in the DEIS and the "lack of hydrologic data associated with the weir and site operation...(was) a major concern." This statement recognized the fact that the hydrologic data were not utilized in conjunction with quantitative analytical models such as Habitat Evaluation Procedures (HEP), plant community succession modeling, and the Instream Flow Incremental Methodology (IFIM) in the development of the recommended mitigation plan, as the FWS had requested late in the detailed planning stage. The FWS' comments on the DEIS, therefore, reflected their concern that the measures the Corps included in the recommended plan, which were aimed at avoiding and minimizing wetland losses, could not be properly formulated without the availability of detailed data from environmental modeling studies they had requested.

1.52 Habitat Evaluation Procedure (HEP) studies were planned for with project conditions to supplement the baseline HEP performed by the Corps and FWS in, 1980 and were even included in the original FWS Scopes of Work for Fiscal Year 1985 and Fiscal Year 1986. However, circumstances beyond both the Corps' and FWS' field office's control precluded these studies from being performed during the detailed planning stage.

1.53 These concerns were fully and frankly discussed during coordination with the FWS subsequent to the circulation of the DEIS and the disagreement was resolved. The Corps agreed to revise the impact assessment framework used in the DEIS as discussed in paragraph 1.55, and to refine the project design to include the Pequannock Weir and additional wetland compensation to address project losses within the revised framework. A mutual understanding of project impacts was reached, with an implicit recognition for flexibility in terms of slight refinements of design features (e.g. modifying the Great Piece Meadows Weir design elevation by a few inches or refining its operation time frame) during Phase II design to address site-specific mitigation refinements within the confines of the recommended plan. Central to this understanding was the Corps-FWS agreement that the plant community succession model, HEP and IFIM be developed as part of the Phase II design (see FWS letter dated August 28, 1987, Attachment A27 and DOI response Attachment A28 of Appendix A - Public Involvement).

1.54 The FWS recommended the creation of plant successional and the other model studies. A plant seral successional model will be created during Phase II engineering studies. Its results will be used in conjunction with more detailed engineering data to forecast future vegetative changes in the Meadows for the Habitat Evaluation Procedures (HEP). HEP will be used in conjunction with more detailed engineering data to predict habitat changes with the project in place and mitigation

refinements within the context of the overall recommended plan. The aquatic ecosystems will be evaluated with the Instream Flow Incremental Methodology (IFIM). In conjunction with these studies, the Corps will convene an expert interagency environmental advisory group that will guide the design and site-specific refinements to the mitigation plan that emerge as a result of these detailed studies (see Paragraph 3.116).

1.55 Wetland Impact Assessment Framework: DEIS' Discounting Wetland Losses Against Acquisition Land. Much of the skepticism related to the claim that wetland losses were being replaced through the acquisition of the flood storage land was due to incomplete information in the DEIS that created the impression that all 5,350 acres of natural storage areas recommended for acquisition would be filled and developed in the absence of a flood control plan. Therefore, the entire acreage was presented as a "preservation credit" against which any residual wetland losses could be discounted. The DEIS incorporated material by reference from Sections 2 and 5 of the Plan Formulation Appendix which explained that only 2,410 acres of the Central Basin's natural storage areas would most probably be lost through development, in the absence of acquisition for flood control purposes. The impact assessment framework utilized in the DEIS, however, did not reflect the timing trade-off between with-project wetland losses, which would be expected to take place in a concentrated span of a few years during project construction, versus the without-project loss of wetlands to development, which would take place gradually over the period 1990-2040. The impact assessment framework was revised for the Final Report and no longer discounts direct project impacts against the acquisition acres (see Appendix A - Public Involvement, Attachment A28, comment response 24b and Attachment A39, Response 2C). This issue was resolved by incorporating the resulting revised wetlands mitigation plan in the FEIS as is described in 3.108 to 3.116.

1.56 Wetland and Aquatic Habitat Losses. Two additional areas of controversy regarding wetlands became known during coordination of the DEIS. The first concerns wetland and aquatic habitat losses in the Pompton River's tributaries upstream of the Pompton Tunnel Inlet. The second concerns out-of-kind replacement of wetland losses, particularly by the acquisition of natural flood storage in the Central Basin area as a nonstructural flood control measure. Response to this concern is discussed below in paragraphs 1.57 and 1.58. Responding to the first concern, the recommended Dual Inlet Plan has now been refined to incorporate a controllable weir across the bypass channel adjacent to the Pequannock River (see Figure 47 of the Main Report) as part of the Pompton Inlet works, thereby maintaining existing water surface levels in the upstream channels and the associated wetland groundwater regime

and cultural resources. Although certain residual wetland and aquatic resource impacts remain, this structural modification successfully avoids the substantial losses that the DEIS projected would take place without it. Details pertaining to the modified mitigation plan have been incorporated into this FEIS in paragraphs 3.107 to 3.125 and a description of the Pequannock Weir, and its operation appears in paragraphs 5.112, 5.119 and 5.125-5.128.

1.57 Out-of-Kind Wetlands Replacement. The second area of controversy involving out-of-kind wetlands replacement is less amenable to resolution due to a combination of natural, engineering, social, and economic factors which constrain the availability of feasible options for mitigation. The principle wetland losses would be due to the direct physical destruction of largely forested palustrine wetlands by channel widening, construction of levees, and the excavation of associated ponding areas. (In this regard it should be emphasized that the recommended Dual Inlet Tunnel Plan is the structural plan which would actually result in the least amount of direct losses simply because it involves the least amount of these types of engineering features.) Because urban development has severely encroached on so much of the Passaic, Pequannock, Wanaque and Ramapo Rivers, it is not generally possible to avoid direct destruction of wetland areas without incurring unacceptably high social and economic costs.

1.58 Moreover, for the same reasons, it is not always possible to effect the in-kind, in-place replacement of these riparian/floodplain wetland areas together with their recognized functional values. Some wetland losses are essentially unmitigable unless consideration is given to their replacement with substitute wetlands of similar type and extent elsewhere, i.e., in a different reach, or substituting a different wetland cover type in the same place i.e., in ponding areas, substituting rarer emergent wetlands for more common palustrine forested wetlands. Therefore, in-kind mitigation can be accomplished but it would be out-of-place, or, in the ponding areas, in-place mitigation can be accomplished, but it would generally be out-of-kind. Out-of-kind wetland replacement will, therefore, continue to be a feature of the mitigation plan. However, EPA has requested that in-kind wetland planting be considered for ponding areas where lost forested wetlands would otherwise be replaced by emergent wetlands. FEIS paragraphs 5.122 and 5.123, and Attachment A38c present a discussion of wetland planting in ponding areas including the use of mixed wetland cover types.

1.59 Upgrading Wetlands for Mitigation. All three detailed alternatives recommend acquisition of 5,200 acres of palustrine emergent, scrub-shrub, and forested wetlands in the Central

Basin area as a nonstructural flood control feature. The with-project preservation of wetlands that would be acquired as natural flood storage areas was presented in the DEIS as the chief mechanism with which to mitigate for wetlands that would be directly affected by project features. In the FEIS the use of habitat restoration techniques to upgrade wetland values for 185 acres of lands within the acquisition area which have been abused by man's activities is recommended to compensate for direct and indirect project impacts to 185 acres of wetlands in the project area (see FEIS paragraphs 3.114 and 5.177). The other mitigation measure common to all alternatives is the development and permanent management of wetland environments in many of the ponding areas which are adjacent to and upland of levee construction. Largely because they permit the in-place replacement of wetland losses, these features appear to be generally acceptable to the environmental community. This issue is considered resolved since the Corps is willing to consider refinements to the mitigation plan that may emerge from FWS' additional Corps funded studies during the next engineering phase. These refinements would be formulated with guidance from an expert interagency Environmental Advisory Board. However, a related, unresolved issue with EPA involves the current planning level of detail of this mitigation plan, and the role EPA will have in the design phase regarding approval of site specific mitigation decisions (see paragraph 1.35 and 1.84).

1.60 Administration of Clean Water Act's Section 404 Program. Beyond the acknowledged fact that these wetland areas do not provide for precise in-kind or in-place replacement of wetland losses, another point of controversy has to do with the Corps' administration of the Clean Water Act's Section 404 program, and the environmental community's perception of these responsibilities. The general misconception concerning the 404 program is that it is a mechanism which could be used for preservation of all remaining wetlands in the basin. This is incorrect. Section 404 is a permitting program, not a preservation vehicle. Permitted activities, in addition to Nationwide Permits, waivers, unauthorized filling and other exceptional circumstances are the causes for the incremental losses in wetlands that have occurred since the Clean Water Act became law. While the State of New Jersey recently passed the Freshwater Wetlands Protection Act in addition to their own set of floodplain and wetland regulations, the detailed mechanisms of the new law haven't been articulated yet. Meanwhile, natural flood storage areas continue to dwindle. Despite the universality of the "404 misperception," it is clear that the most certain avenue for wetland preservation is the outright acquisition proposed in this plan.

1.61 Wetlands Downstream of the Great Piece Meadows Weir. one final disagreement relating to wetland losses concerns the 100 acres of wetlands that would be lost downstream of the Great Piece Meadows Weir. This was generally taken as an unacceptable

loss by the environmental community. This issue was resolved through the anticipated use of habitat restoration techniques for 100 acres of project lands within the acquisition area which have been abused through human intrusion. The EPA requested that the Corps' mitigation for this 100 acre wetland loss be in-place and in-kind on the impacted lands, with the surface regraded to a lower elevation, so the tunnel's bypass flows could fully inundate the 100 acres, and the wetlands could be replanted. However, since these 100 acres are not within project lands, but are currently protected within existing floodways, this request could not be accommodated by the Corps. Mitigation for this 100 acre loss would be included in the 185 acres of project lands that would be upgraded within the acquisition areas (see paragraph 1.59). EPA requested that the non-Federal sponsor give future consideration to providing for on-site mitigation. Therefore, this concept will be pursued further during the design stage when a comprehensive wetland management plan will be formulated as part of the overall operation and management plan for the project. Such a management plan was supported by the environmental community.

1.62 Anadromous Fish. In the Lower Valley, National Marine Fisheries Service (NMFS) expressed concern over fluctuating salinity and water levels and high flows' effects on spawning anadromous fish. This was resolved by expanding the text to explain more fully the sequence of events during Lower Valley flooding in terms of salinity and increases in flow (EIS paragraphs 5.20-5.22) and the fact that the project would not substantially change existing conditions velocities. The primary change resulting from the project would be the differences in timing, so that with the tunnel, flood peaks would arrive sooner, increasing peak flows with floodwaters spreading across the river asymmetrically due to the outlet's location on the right bank. Neither of these variations would cause substantial adverse effect on anadromous fish spawning. The FEIS also includes the placement of four acres of cobble-sized substrate downstream of Dundee Dam to mitigate for the loss of two acres of habitat at the tunnel's outlet.

1.63 Coastal Zone Management. Another issue concerned Coastal Zone Management (CZM). This issue arose due to a misinterpretation regarding the extent of the CZM area. The resolution of this issue included the revision of the EIS to recognize that the Coastal Management Zone extends from the mouth of the Passaic River up to Dundee Dam, and, in this reach, from each bank for 500 feet inland. This EIS also notes that the Passaic River is part of the Northern Waterfront Region and has been designated as a development region. The FEIS has been revised to address the areas of concern of the Division of Coastal Resources contained within the NJDEP August 1, 1987 letter which provided comments on the DEIS (see Attachment A44, Comment response 14, of Appendix A - Public Involvement; see paragraphs 4.140-4.145 and 5.39). A consistency determination was filed.

A copy of the letter documenting the determination of consistency of compliance is included as Attachment A21 of Appendix A - Public Involvement and the Division of Coastal Resources reply is included as A21 NJ State Letter of January 11, 1988. Their reply indicates that the determination will be made after the Division of Coastal Resources staff reviews the FEIS.

1.64 Parkland Compensation. NJDEP's Office of Green Acres requested that the Corps provide compensation for taking public parkland for flood protection. This issue was resolved with the State of New Jersey through coordination meetings and clarifications in the FEIS which highlight impacts to parkland. The FEIS systematically documents all affected parkland and conservation land. Table 27 in the FEIS lists these areas by municipality along with their existing acreages and the areas that would be displaced by the project. The aerial photographs (Figures 25 and 27) display the major resources that would be affected. Approximately 25 acres of parkland would be lost to channel widening and levees, with about 17 acres lost from Reach 1 and about 4 acres each from Reaches 4, and 5. This acreage would be directly offset in the Lower Valley, by the 3.8 miles of levee-top walkways, which is equivalent to 4.6 acres. However, the land covered by levees isn't really lost to recreation, since the side slopes are also available for recreation (see FEIS paragraph 5.28). Nonetheless, the Corps is committed to additional coordination during the design phase of the project with Green Acres, the Passaic Valley Restoration Committee and county and municipal park departments to coordinate and refine details of the beautification and recreation measures along the levees. Compensation for project impacts on parks will include providing equivalent recreational opportunities on project lands or monetary payments based on fair market value of equivalent public recreation usefulness, size, quality and location. This issue is considered resolved with the NJDEP insofar as the Corps will compensate for lost parkland. However, a related unresolved issue (which will be discussed in paragraph 1.76) pertains to the several respondent's unwillingness for any Lower Valley structural features at all, and relates to the location of the tunnel outlet.

1.65 Hazardous Substances Sites. Yet another major issue arose concerning hazardous substances sites in the basin. EPA expressed concern that construction could disturb and resuspend hazardous substances into the ambient environment. This issue was addressed using the same approach pursued in the DEIS, but the FEIS and now Appendix B - Natural Resources Section 8, provides more detailed discussions. Continuing coordination, including research and analysis of EPA's files, established more precisely the location of the hazardous substances sites relative to project features. In addition, specific information on the hazardous substances sites including site inspections,

chemicals stored, spilled or improperly disposed, and remediation plans and dates is presented in the FEIS (see paragraphs 5.32-5.38 and FEIS Tables 10 and 11). Documentation also includes commitments to continue coordination during the Phase II design with EPA and NJDEP regarding eight sites of concern, and to formulate a Health and Safety Plan for sites which are not remediated prior to construction of the flood control project. Resolution of this issue with EPA is documented in Attachments A38d, A38f, and A38h-k of Appendix A - Public Involvement.

1.66 Contaminated River Sediments. Another related issue is the effect that increased flows would have on sediments in the Lower Valley, particularly with respect to dioxin, PCB's and other contaminants at the river bottom. Although the DEIS documented that the State of New Jersey has firmly committed to the remediation of the contaminants in the Passaic River's sediments (see Attachment A16 in the Public Involvement Appendix) the EPA expressed concern regarding the uncertainty associated with the method and timing of the State's remediation effort. This effort was resolved by addressing these concerns in the FEIS. The remediation should be completed prior to construction, but in the event that the timing of the State's remediation coincides with the flood control project's construction, and should the State decide that remediation would involve capping contaminated sediments in their deep and relatively sequestered state, the Corps would make available pristine tunnel excavated cobble to cover and armor the dioxin laced river sediments (see FEIS paragraphs 4.20, 5.37, and 5.38). Attachment A38 documents the resolution of this issue with EPA.

1.67 Water Quality. Water Quality was raised as an issue by the environmental community. There was a concern that the channel flushing that normally occurs during flooding would be interrupted by the tunnel diversions with the project in place and would not always occur between the inlets and the outlet with the same magnitude or timing as currently exists. This issue was resolved through clarification of the tunnel's operating rules, specifically, the one-year bypass flows, recognition of the role of uninterrupted intervening tributary flows; and through subsequent coordination. Therefore, the "channel flushing" issue is no longer recognized as a significant adverse impact. The operating rules would allow the annual flood to bypass each tunnel inlet in order to periodically flush the sediments from the riverine system, dilute pollution loads entering the Lower Valley, and deposit nutrients in the annually flooded riparian wetlands which require periodic flooding for nourishment. FEIS paragraphs 5.15-5.26, 5.61, 5.88, 5.89, 5.118 and 5.119, and 5.161-5.172 discuss the impact of project operation within the various reaches in the project area. Attachment A36, response to EPA Comment 4, sentence 5 also provides information regarding the operational impact of the project on water quality.

1.68 Air Quality, and Noise. NJDEP raised the issue of air quality and noise as related to construction and traffic flows. During the Phase II design, when the engineering details needed to formulate traffic flow patterns and the number of pieces of heavy equipment at specific locations will be developed, the pollution emitted by these sources can be calculated to determine if National Ambient Air Quality Standards would be exceeded. If standards would be exceeded, a mitigation plan would be formulated and incorporated into the construction plans and specifications. Regardless of the outcome of this exercise, the Best Available Control Technology would be required to suppress noise and air emissions on all construction equipment, and to suppress fugitive dust at all construction sites. The Corps will continue to coordinate with NJDEP regarding these resources. A soil erosion and sedimentation control plan will be formulated in consultation with the Soil Conservation Service.

UNRESOLVED ISSUES AND REMEDIAL ACTIONS

1.69 Three issues of controversy remain unresolved. These disagreements include: (1) requests for additional reduction or elimination of the modified channel lengths; (2) objections to the location of the tunnel's outlet or the plan's impacts on Lower Valley parkland, riverside access, aesthetics, tax ratables, and flood risks; and (3) EPA's request for additional information regarding specific design details of the Corps' wetlands mitgation plan, or, in lieu of detailed mitigation design at this stage, their request for an EPA-Corps agreement which gives EPA authorization to review and approve mitigation design plans during the Phase II design stage. Each of these issues is discussed below along with the remedial actions taken.

1.70 Issue: Reduce Channel Modifications. Only one of the FWCA mitigation recommendations remains an unresolved issue. FWCA Report recommendation number 1, calls for eliminating, or greatly reducing, channel modifications upstream of the Pompton Inlet. The full incorporation of this recommendation is unresolved because it is incompatible with the flood control purpose of the plan. These channel modifications are designed to safely and efficiently, allow floodwaters to enter the Pompton River tunnel inlet. The elimination of this channel work would cause extensive backwater flooding. Nonetheless, the Corps did examine alternatives to channel modifications.

1.71 Remedial Actions: Alternatives to Channel Modifications. In response to the DEIS comments four alternatives were examined to either eliminate, reduce or minimize the adverse fish and wildlife impacts associated with the channel modifications of the Pompton tributaries. (Some of these options were actually first considered during early planning and were reconsidered at

this time). Previous design modifications during the Corps' detailed planning stage (prior to the circulation of the DEIS) had reduced the extent and depths of the channel works proposed for the Ramapo, Pequannock and Wanaque Rivers in response to concerns expressed by the FWS during coordination and in their planning aid reports.

1.72 A triple inlet scheme including three diversion tunnel branches was considered in place of the one Pompton Inlet and tunnel to eliminate the need for most of the channel modifications on the Pompton River's tributaries. The inlets would be placed upstream, one each on the Wanaque, Pequannock and Ramapo Rivers. These inlets and additional tunnel lengths proved to be too costly, at $105 million more than the single Pompton Inlet and upstream channel modifications, levees and floodwalls.

1.73 Another proposal designed to reduce channel modifications on the Pequannock River was to build a high flow bypass channel from downstream of the Wanaque River, diagonally through the wetlands, directly to the tunnel portal. This concept would require four moveable gated weirs to convey the floodwaters into the bypass channel during flood stages only. During normal flows the Pequannock River would flow through its existing channel. A major problem with this proposal is that the resulting preservation of a relatively short reach of aquatic habitat (6,000 feet) would be at the expense of forested wetland habitats. Furthermore, channel modifications would still be required along the Ramapo (1.2 miles) and Wanaque Rivers (1.0 mile). The limited reductions in impacts to aquatic habitat, and the increased impacts to terrestrial habitats, in conjunction with the high monetary cost attached to moveable weirs (about $6 million) not including the cost of excavating the bypass channel) resulted in this proposal being precluded from further consideration.

1.74 Another action designed to resolve this disagreement was to leave the channels intact, and construct higher (and wider) levees and floodwalls, so that the levee systems would contain the floodwaters enroute to the tunnel. This option would result in the disturbance of additional wetland acreage due to the greater extent of levees. The cost of this alternative would be $85 million as compared to $40.6 million, the price of levees, floodwalls and channel modification under the recommended plan.

1.75 The fourth and final alternative, the construction of the Pequannock Weir, is the action proposed to partially resolve the issue of minimizing channel modifications. The construction of this weir would maintain upstream water levels during normal periods of flow and would help maintain aquatic habitats and the viability of the upstream wetlands (see paragraphs 1.56, 3.109, 3.117, 5.112 and 5.125). The Pequannock Weir would be a structure with moveable gates that would be built across the Pequannock River's bypass channel, replacing a portion of the existing berm that directs water flow over the historic Morris

Canal feeder dams on the Pequannock and Ramapo Rivers (see Figure 47 of the Main Report). During non-flood periods (about 98% of the time), the water surface elevations in the three rivers would remain at their existing elevations. The depth of the water in the upstream tributary channels would be greater for most of their lengths, since these three rivers would still be deepened and widened as part of the recommended plan. When a flood greater than the annual event would occur, the Pequannock Weir would be gradually lowered, capturing the flows from the Pequannock and Ramapo Rivers and directing the floodwater downstream to the tunnel inlet. While this alternative doesn't directly respond to the Service's recommendation to eliminate or reduce channel modifications, it would serve to maintain water levels in the upstream wetlands (although some forested areas may have to be altered for fear of downed trees jamming the tunnel's intake structures) and it would enhance the normal water depths of these modified reaches by four to six feet for all but the upper 3,500 feet of the Pequannock River and 1,800 feet of the Wanaque River where low flow pilot channels are included for mitigation.

1.76 Issue: Tunnel Outlet Location. Another unresolved issue has emerged from concerns dealing with the Lower Valley. A number of respondents complain of specific losses in the Lower Valley (such as loss of parkland, aesthetics, riverview, and access, or if the nature of the waterfront lands isn't recreational, then the loss of tax ratables), or complain of the risks associated with the perceived potential for induced flooding from the tunnel outlet, or claim that the plan transfers the flood problem from the Central Basin to the Lower Valley. While these comments are specific in nature, the inarticulated disagreement relates to the location of the outlet at the Third River, as opposed to locating the outlet further downstream at either the Second River or Newark Bay, or abandoning the tunnel concept entirely. Actions taken to resolve the disagreements concerning mitigation of parks, vistas, and access were discussed earlier and are considered resolved to the degree possible.

1.77 Remedial Actions: Tunnel Outlet Alternatives Considered. Actions taken to resolve the underlying concern, the location of the tunnel outlet, involved considering realigning the tunnel and locating the outlet so it would surface downstream near the Second River or at Newark Bay. These options were previously considered during the formulation of plans and were not recommended because of the additional costs associated with these new locations. The additional costs would be $100 million and $300 million, respectively. The additional work cannot be incrementally justified economically and, therefore, was not included in the recommended plan. However, should the non-Federal sponsor select either option, the cost of the additional tunnel lengths would be borne by the State, in accordance with Federal water resources policies. Should this alternative be adopted, the Corps would still be responsible for its detailed planning and implementation. The comparison of

these alternatives would continue in the design phase to provide a final basis of cost comparison. These options are discussed in FEIS paragraph 3.79.

1.78 U.S. Environmental Protection Agency. The EPA raised four issues and requested a supplemental or revised draft EIS, in accordance with their EO-3 rating of the DEIS, as prevously discussed in paragraphs 1.31-1.33. These concerns are: wetlands and aquatic environments, groundwater, hazardous substances sites, and water quality. This precipitated a major coordination effort between the Corps and EPA as described in FEIS paragraph 1.33, and documented in Appendix A - Public Involvement, Attachment A36, the Corps' response to EPA's August 27, 1987 letter (Attachment A35) which requested information to address their wetlands and aquatic habitat concerns, and Attachment A38 which includes an assembly of data, memos and documentation exchanged between the Corps and EPA during this seven month coordination effort. The EPA correspondence received and transmitted subsequent to the distribution of the DEIS is included in the Public Involvement Appendix Attachments A32 through A38.

1.79 For example, the Corps' October 19, 1987 letter to EPA (Attachment A36) addresses the wetlands issue. In this letter the Corps indicated that it did not agree with EPA's assessment that the DEIS data was incomplete, inadequate, or improperly presented, and proceeded to quote wetland data extracted as it appeared in the DEIS in the exact format requested by EPA. Here excerpts from the DEIS were reiterated creating a more comprehensible unit for EPA's staff review. EPA's constructive suggestions were used to elucidate misconceptions and misunderstandings. Table 25 is the product of this coordination, along with other refinements that were made to the FEIS' text.

1.80 EPA's concern regarding the adequacy of the DEIS documentation was addressed through refinements to the FEIS. The technical issues identified by EPA were addressed by the Corps with the result that environmental impacts were either clarified, but not changed, or the project and mitigation measures were refined, thus resulting in fewer and lessened environmental impacts. Hence the Corps determined that since no significant changes were made to either the assessment of adverse impacts or the project, a supplemental draft or revised EIS was not necessary. The final draft EIS and Main Report also clarifies issues by restating what the draft report only alluded to in appendices and supporting documentation and which were incorporated into the DEIS by reference. Aerial photographs were added to help reviewers envision the critical affected resources and their impacts (see FEIS Figures 25, 27, and 29). Cross references were expanded among figures and tables, and between sections in the FEIS, Main Report, and Appendices.

1.81 The technical concerns expressed by EPA were addressed primarily through coordination which clarified misunderstandings or provided EPA with additional supporting documentation. This

was true for the groundwater, hazardous substances sites and water quality comments. In each case more detailed data was provided and an explanation of the impact assessment rationale in the FEIS was expanded.

1.82 In response to the groundwater concern, the State of New Jersey directed the N.J. State Geological Survey to undertake an independent review of the project. This review supported the Corps' impact assessment, and this analysis was also utilized in the preparation of the FEIS. The N.J. State Geologic Survey Report is included in Appendix A as Attachment A46. Documentation for groundwater resources is included in the FEIS in paragraphs 4.27-4.30, 5.13 and 5.180-5.192. Coordination with EPA also included the review of the State Geologist's report and a Corps of Engineers' sensitivity analysis of potential impacts, including a "worst case" scenario performed jointly with EPA. Attachments A38e-g and A38j-k document the coordination between EPA and the Corps on this issue. Attachment A38k documents the resolution with EPA of this groundwater concern.

1.83 For the hazardous substances sites and water quality comments, supplemental information was provided to EPA and incorporated into the FEIS (see FEIS paragraphs 5.23-5.26 and 5.32-5.38). The refined hazardous substances sites data reflected additional coordination with EPA and NJDEP regarding the future timing and nature of remediation of CERCLA hazardous substances sites. Eight sites of concern were identified and the relationship of these remediation efforts and the proposed action will be closely coordinated during the design of the project. Attachments A38d, A38f, A38h-i and A38j-k document the coordination between EPA and the Corps on this issue. The water quality issue coordination is documented in Attachment A36, responses to Comment 1, Sentence 4 and Comment 4, Sentence 5. Attachment A38k documents the resolution wth EPA of these issues.

1.84 The remaining wetlands mitigation issue is not resolved at the time of preparation of this final EIS. However, coordination to date has resulted in the refinement of the fish and wildlife mitigation plan including the Corps' reorganization of the wetland impact assessment framework utilized in the DEIS, as discussed in paragraph 1.55 and the refinement of wetland mitigation within this revised framework. Compensation for direct and indirect losses of wetlands now includes the habitat restoration and upgrading of 185 acres of wetlands on project lands within the acquisition areas, and ponding area wetland planting will include consideration of mixed cover types to minimize out-of-kind wetland replacements, as requested by EPA. Project works in the Pompton Inlet area were refined to include the Pequannock Weir in response to EPA's and other natural resource agencies' concerns regarding wetland and aquatic impacts upstream of the Pompton Inlet. In addition, the coordination with EPA clarified: the Corps' prediction of

future wetland losses, the presentation of wetland impacts, as well as the steps taken by the Corps which were included in the DEIS to virtually preclude project induced secondary impacts (see paragraph 1.48). Attachments A35-36, A38b-d and A38j-k document the coordination between EPA and the Corps on these issues.

1.85 As discussed above, and documented in Attachment A38j-k, significant progress has been made regarding the adequacy of the wetland and aquatic impact assessment and the understanding of the Corps mitigation approach. However, the current level of detail considered necessary for the wetlands mitigation plan and EPA's request for either additional details regarding the mitigation design, or the execution of an EPA-Corps agreement which gives EPA authorization to review and approve mitigation design plans during the project's Phase II design, remain unresolved. This issue is discussed further in the following paragraphs.

1.86 Issue: Level of Detail of Wetlands Mitigation Plan. The EPA views the wetlands mitigation plan developed by the Corps as a conceptual outline of potential mitigation, and have requested additional information regarding the specific design of the plan. The Corps disagrees with this assessent and finds this request unacceptable, since the current level of detail for the mitigation is consistent with the engineering details of the project contained in the Phase I Report and FEIS. The specific design of the mitigation will take place during the Phase II design stage of the project when the engineering details of the project necessary to develop site-specific mitigation would be available. EPA recognizes that the Corps has committed to mitigate project induced losses of wetlands and that the mitigation specifics will be developed during the Phase II design. Nevertheless, EPA is concerned that after the review period for the final EIS has expired there will be no further formal mechanism for the agency to review and comment on the project. (It is noted that this project is subject to Section 404(r) of the Clean Water Act, and the Section 404 permit review process is not appropriate.) Therefore, EPA has proposed that a EPA-Corps agreement be developed prior to completion of the NEPA process that will provide for EPA approval of any wetlands mtigation, with such approval to be in place before initiation of project construction.

1.87 Remedial Actions: Wetlands Mitigation and Interagency Agreements. The Corps attempted to resolve this issue by accommodating EPA's requests for additional information in conjunction with making refinements to the mitigation plan. The mitigation included in the FEIS reflects a refined wetland impact assessment framework (see paragraph 1.55) and the inclusion of compensation for 185 acres of wetlands directly or indirectly affected by the project based on the revised assessment framework; the incorporation of the Pequannock Weir into the project (paragraph 1.56); clarification of the Corps prediction of future wetland losses without the project

(paragraph 1.55), the presentation of wetlands impacts (paragraph 1.37), and the local cooperation item which avoids potential secondary effects (paragraph 1.48); along with the incorporation of aerial photos and tables to display the wetlands effects. Attachments A36 and A38b-d document the coordination of this data. In addition the Corps provided EPA more specific data regarding the existing wetlands understory upstream of the Pompton Inlet and the wetland planting plan for ponding areas (see Attachment A38c). The Corps also committed to the use of a mixed wetland cover type planting in ponding areas in response to the EPA request (see paragraphs 1.58, 5.123 and Attachment A38c).

1.88 At the conclusion of this EPA-Corps staff coordination effort, EPA indicated in their February 16, 1988 letter (Attachment A38k) that although conceptual understanding of the Corps mitigation approach has been reached, they still have outstanding concerns regarding the need for specific plans for wetlands mitigation at this time. The Corps proposed by letter dated February 2, 1988 (Attachment A38j) a joint determination of the site-specific details for wetland mitigation by the involved Federal and State agencies (i.e. Corps, EPA, FWS and NJDEP), and indicated a commitment to establish an Environmental Advisory Board during the Phase II design stage to direct the refinment of mitigation design. The Board would include Federal and State agencies, along with experts from the private and university sectors. EPA was invited to fully participate on this Board. In response EPA proposed that if an EPA-Corps agreement is developed prior to completion of the NEPA process that would authorize EPA to approve any wetlands mitigation prior to project construction, they would accept the current level of detail for the Corps mitigation plan. Although the Corps would look favorably upon an interagency agreement which would allow EPA to participate in the development of the Phase II mitigation design, the Corps cannot agree to singular determination of project mitigation by EPA. The Corps must acknowledge the roles of other Federal and State agencies involved in wetlands planning, including the U.S. Fish and Wildlife Service and N.J. Department of Environmental Protection, along with its own responsibility for mitigation determination. Therefore, the Corps maintains that a joint determination of mitigation design is required, Attachments A38j and A38k of Appendix A - Public Involvement, document the Corps of Engineers and EPA disagreement on this issue.

RELATIONSHIP OF PLANS TO ENVIRONMENTAL STATUTES

1.89 The wide range of alternatives studied in detail were developed in part as a response to legislation which relates to the environment, and an attempt to balance project costs with environmental protection. A summary table of the environmental laws applicable to the project area and the contribution of the various project alternatives to compliance with these laws is included in Table 1. Table 2 summarizes the effects of the recommended plan on resources of principal national recognition.

SECTION 2. NEED FOR AND OBJECTIVES OF ACTION

STUDY AUTHORITY

2.01 The Passaic River Basin Study, a Phase I Advanced Engineering and Design study, is being accomplished under the authority of Section 101(a) of the Water Resources Development Act of 1976 (Public Law 94-587). A map of the Passaic Basin is presented as Figure 4 of the Main Report.

PUBLIC CONCERNS

2.02 A listing of local concerns and desires which were identified during initial studies is presented in Table 3, Summary of Problems and Needs. These issues were examined in order to establish their relationship to the Corps of Engineers traditional water resources responsibilities and the specific authority and direction for the Passaic River Basin study. Based on this review, problem and opportunity statements specific to the Passaic River Basin were developed.

PROBLEMS AND OPPORTUNITIES

2.03 The final problem and opportunity statements are presented in Table 4. These statements were originally developed as a result of initial and intermediate studies, and several have been modified to reflect the availability of more specific data.

2.04 The principal problem and need addressed by this study is the reduction of tidal and fluvial flood damages to properties along the Passaic River and its tributaries. It is noted that all of the problems and needs of the Passaic River Basin could not be addressed as part of this study; only those water resource-related needs which could be addressed within the study authority to enhance the National Economic Development objective, or are legislative requirements, were included in these statements.

SECTION 3. ALTERNATIVES

PLANS ELIMINATED FROM FURTHER STUDY

3.01 Alternative flood damage reduction plans were formulated in a systematic manner to ensure that all reasonable alternatives were evaluated. The alternatives were developed through successive iterations of plan formulation and evaluation, with the level of detail increasing and the number of alternatives decreasing with each iteration. The vast number of alternative plans identified early in the planning process were systematically screened and refined through additional development and technical studies. Among the alternatives evaluated were the seven alternatives mandated for consideration by Congress in House Report 94-1702. The mandated alternatives included: a full range of nonstructural flood control measures; a tunnel diversion plan; a system of tunnels; combinations of local protection works and nonstructural solutions, including improvements to stream carrying capacity, fulfilling water supply objectives together with flood control; aquifer recharge and underground storage; and reservoir management in the headwaters. Comprehensive plans were formulated by assembling various nonstructural and structural flood management measures in varying scales, extents and combinations. During the early planning stages, the alternatives tended to consist of single management measures, while combination plans were assembled during subsequent planning iterations. See Figure 11 in the Main Report which describes planning building blocks and Table 5 in the EIS which is a summary of the screening process. This section of the EIS summarizes the screening of alternative plans based on engineering, economic and environmental factors. A full discussion of the formulation of alternatives is presented in Appendix C, Plan Formulation.

FLOODWARNING/PREPAREDNESS

3.02 The feasibility of a floodwarning/preparedness alternative was considered as mandated by Congress in HR 94-1702. The principal objective of this analysis was an evaluation of the adequacy of the existing floodwarning system in the Passaic River Basin and an assessment of the feasibility of increasing the effectiveness of the warning and response elements of existing system. The purpose of this alternative is to reduce the risk to life and property, and to minimize social losses and disruption as an interim project, until a permanent, long term solution can be implemented. (A detailed discussion of the evaluation can be found in Appendix C, Plan Formulation, Section 5.)

3.03 A review of the existing flood warning/preparedness system indicated that some or all of the flood potential warning time is lost because of slow data collection, data inaccuracies, less-than-efficient warning release systems, and potentially slow warning dissemination techniques.

3.04 This study resulted in a recommendation combining flood warning improvements and response enhancements. The flood-warning improvements include tributary flash flood warning systems, additional radio reporting rain gages, new radio towers, and additional stream forecasting gages, in conjunction with microcomputers, remote terminals and tone alert radios. The response enhancements include stage-inundation maps, updated and coordinated county/municipal response plans, periodic flood response exercises, and public education. It was found that the recommended enhancements are economically justified and should be implemented. A favorable Detailed Project Study was completed in June 1974, and a Local Cooperation Agreement for the project was signed by the Secretary of the Army and the State of New Jersey in October 1986. The project is currently being implemented under the Corps of Engineers Small Project Authority (Section 205 of the 1948 Flood Control Act) at a cost of $1,100,000. It was also determined that these enhancements are consistent with the comprehensive alternative flood damage reduction plans for the main stem Passaic River. In fact, each of the three detailed alternative plans for the Main Stem Passaic River would require an effective early warning system to ensure proper operation, as well as to provide accurate information to areas which would be protected by nonstructural measures to provide advance warning if the flooding may exceed the nonstructural design level. The floodwarning and preparedness improvements being implemented were recognized in all subsequent planning.

BASIN-WIDE NONSTRUCTURAL PLANS

3.05 Nonstructural plans were considered as a Basin-wide means of reducing flood damages. The nonstructural measures utilized in developing these alternatives were floodproofing, raising and permanent evacuation of flood prone structures. These measures were included in the alternatives mandated for consideraton by Congress. Floodproofing involves modifying structures to prevent floodwaters from entering the structure. Raising involves elevating the main floor of the structure above floodwaters. Permanent evacuation involves the acquisition of flood-prone structures, their demolition, and restoring the site to its natural condition. A detailed analysis of nonstructural flood damage reduction measures can be found in Appendix C, Plan Formulation, Section 5. A summary of this analysis follows below.

3.06 The nonstructural measures were considered for the 10-year, 50-year and 100-year floodplains. The analyses indicated that even in the most frequently flooded areas, it would not be possible to floodproof or raise all the structures, because of the depths of flood waters and the characteristics of the structures. The analyses resulted in the development of three distinct plans with varying mixes of floodproofing, raising and permanent evacuation for the 10-year, 50-year, and 100-year floodplains. Not all structures within each floodplain were treated; only those structures which would suffer significant flooding were included, in order to increase the economic efficiency of the plans. The 10-year level of protection plan would include 10,013 structures floodproofed, 732 structures raised, and 76 structures permanently evacuated, at a cost of $192.5 million. Within the 50-year floodplain, 11,960 structures would be floodproofed, 2,738 structures raised and 293 structures permanently evacuated at a cost of $438.8 million. The 100-year level of protection plan would include 12,170 structures floodproofed, 4,762 structures raised and 446 structures permanently evacuated at a cost of $620.2 million. These nonstructural plans were not economically justified and so were not considered further as basin-wide comprehensive plans. However, nonstructural measures in portions of the Central Basin and Pompton Valley 10-year floodplain were found to be feasible and were combined with other measures for further analysis resulting in Plan 16A, the non-tunnel plan, which is a detailed plan presented in the EIS.

BASIN-WIDE PERMANENT EVACUATION

3.07 Permanent evacuation was also evaluated as a Basin-wide flood damage reduction measure. A full discussion of this measure is presented in Appendex C, Plan Formulation, Section 5. Initial screening focused on the 100-year floodplain, but this was not economically feasible with a cost of $3.8 billion. Subsequently, the 50-year and the 10-year floodplains were evaluated. It was found that permanent evacuation as a Basin-wide measure for these areas was also not economically justified. Evacuation of the 10-year floodplain would cost more than $2.2 billion; and the 50-year floodplain more than $3.3 billion. However, several limited areas of the 10-year floodplain were found to have potential economic justification, and were subsequently combined with other measures for further consideration. The resulting combination plans were not among the most cost effective, and were not evaluated any further. During the screening and evaluation of the detailed alternatives, permanent evacuation consistent with these plans was again evaluated. Permanent evacuation of structures not receiving full protection from either the tunnels or levees and floodwalls was not incrementally feasible on a reach basis.

However, buyout on a limited basis was considered as part of the detailed plans where needed to implement other measures, i.e., buyout of structures to accommodate channel modification or as part of a nonstructural measure. Although the buyout of a limited number of structures may be feasible when considered on an individual basis, this would be more appropriately treated as an interim project, as authorized in Section 1148 of the Water Resources Development Act of 1986 (PL 99-622).

PRESERVATION OF NATURAL STORAGE AREAS

3.08 As of 1984, there were about 24,485 acres of low-lying floodplain in the Central Basin which store large volumes of floodwater. The loss of this flood storage would worsen flood problems downstream. Preservation of natural flood storage areas would lessen future increases in the flood hazard and would also maintain the environmental characteristics of the Basin by protecting wetlands, open space, and fish and wildlife habitats. This measure would not solve the existing flood problem, but would reduce future increases in flooding. Preservation of natural storage was considered both as an independent plan, and in conjunction with other alternatives. See Appendix C - Plan Formulation, Section 2, 5, 7 and 8 for a full discussion of the treatment of this concept.

3.09 The analysis of the natural flood storage measure included an inventory of natural flood storage areas throughout the Passaic River Basin. Areas already protected through public ownership or existing Federal, State and local laws were identified and screened from further consideration, since this alternative was directed at natural flood storage areas that remain at risk of loss. Areas currently classified as protected included lands within Federal Emergency Management Agency (FEMA) designated floodways, the Great Swamp National Wildlife Refuge State, County or local parks (including Green Acres properties) and areas under other government ownership or protection. Lands currently under private ownership, including those locally zoned for conservation/recreation, or owned by private conservation organizations, were evaluated on a case-by-case basis to determine the likelihood that such land would lose natural storage in the future. Generally, the protective status of private holdings was found to be extremely tenuous. Therefore, most of these privately-owned natural storage areas were considered to be at risk of being lost. The effect of the State of New Jersey's revised Flood Hazard Area Regulations (FHAR) and the role of Section 404 of the Clean Water Act were also analyzed.

3.10 The recently enacted New Jersey Freshwater Wetlands Protection Act will alter the protective status inventory described in paragraph 3.09 in a yet to be determined manner. This law, which was enacted on July 1, 1987 following Governor Kean's temporary moratorium on construction in wetlands, recognized the limited ability of the State's existing FHAR regulations to prevent the loss of wetland areas to development. However, the full impact of this act and the resulting regulatory procedures are not known at this time. The law allows wetland construction in certain exempted circumstances, although exactly what constitutes the permitted exemptions remains to be determined by the State. One concession of the act to developers was a provision that "grandfathered" projects in wetlands for which preliminary site plans or applications had received preliminary approvals from local authorities prior to passage of the act. Further complicating the future impact of this act is the recent U.S. Supreme Court decision of First English Evangelical Lutheran Church of Glendale vs. the County of Los Angeles, 85-1199. In that case, the Court ruled that property owners must be compensated when they are deprived of all, or substantially all, use of their property, even temporarily, by land use regulations. The extent to which this decision is applicable to the New Jersey Freshwater Wetlands Act also remains to be determined; however, if future compensation to property owners is required, the application of the act in its present form may be affected.

3.11 Of the 24,485 acres of Central Basin natural flood storage areas, the FEMA Flood Insurance program results in the protection of approximately 6,380 acres by including them within locally designated floodways in which no filling is allowed. Lands in public ownership, including the Great Swamp National Wildlife Refuge and other parks and Green Acres properties encompass another 9,485 acres, bringing the total amount of land that is considered permanently protected flood storage area to 15,865 acres. The remaining 8,620 acres are at risk of losing their natural flood storage potential in that they are considered legally vulnerable to incremental filling and development under the State's FHAR and the Federal Section 404 regulatory program. Further screening, based upon hydrologic, hydraulic, economic, and environmental criteria demonstrated that of the 8,620 acres, approximately 5,350 acres lying in eight major Central Basin wetlands provided the most significant portion of natural storage. (The locations of the 5,350 acres are denoted by the shaded areas in Figure 61 of the Main Report.) These 5,350 acres provide a substantial portion of the Central Basin's natural storage capability and the protection of the lands would prevent significant future economic losses from flood damages. The other 3,270 acres of natural storage were determined not to warrant Federal preservation as a measure to reduce flood damages. About one-third of this latter acreage

lies in fringe areas or in small isolated parcels where it is unable to store significant flood flows, and where its wildlife value has been degraded by surrounding development. The remaining two-thirds lies upstream of Chatham where significant attenuation of floodwaters is already provided by the Great Swamp and the sparseness of upper Passaic River floodplain development results in insufficient flood damages to warrant Federal preservation. These lands would continue to be at risk to incremental filling and development, subject to the State's FHAR, the N.J. Freshwater Wetlands Protection Act, and the Federal Section 404 program. Tables 6 and 7 of the Main Report presents a summary of the protection status of Central Passaic River Basin natural storage areas.

3.12 Based on historical data, current development trends (Table 8) and the protective status inventory discussed above in paragraph 3.11, a most probable future scenario of natural storage loss in the Central Passaic Basin was forecast. This forecast, which reflected the FHAR and Section 404 programs, considered the risk of the 8,620 acres of Central Basin natural storage being lost, with an emphasis on the 5,350 acres that provide the most significant storage capability. These natural storage areas would be legally vulnerable to filling and development in accordance with the State's FHAR 20% fill volume rule (20% fill volume translates geometrically to approximately 45% areal extent based on the topography of the Central Basin) provided the applicant also receives a Section 404 permit. The net fill allowed to be placed under the FHAR would be sufficient to fill approximately 2,410 acres out of the 5,350 acre risk pool providing significant storage. It is forecast that this natural storage loss is probable and would take place gradually, at a rate of approximately 45 acres/year, through the year 2040. The Corps' Section 404 program, although not absolutely prohibiting development in wetlands (i.e., potential natural storage areas), requires that all discharges comply with the Environmental Protection Agency's 404(b)(1) guidelines. Most 404 permits currently issued by the Corps in wetland areas require the applicant to mitigate for lost wetlands, and this would work in conjunction with the FHAR program to limit the loss of natural storage areas to the approximately 2,410 acres that could be filled. The areas filled would lose both natural flood storage capability and environmental value. A portion of the remaining areas may also be developed, without being filled, thus retaining their natural storage capability, but losing much of their habitat value, with impacts ranging from alterations to create roads, lawns and landscaping, to more indirect losses of wetland-wildlife values from individual wetlands becoming surrounded by development and thus isolated from other wetland tracts. Therefore, an acreage total beyond the 2,410 acres to be filled would experience a significant loss of environmental integrity.

3.13 It is estimated that the potential loss of the 2,410 acres associated with the 5,350 acres of significant natural storage areas at risk, would result in an increase in average annual equivalent flood damages of $3,750,000 when analyzed with a base year of 1990. However, to prevent this potential increase in annual damages, it is not considered feasible to preserve only 2,410 acres, since under such an action, the remaining acres would remain at risk and would still be subject to possible development and partial filling under the FHAR 20% fill rule and 404 regulations. Therefore, to guarantee the availability of the significant flood storage areas, all 5,350 acres at risk need to be preserved. Plan formulation studies demonstrated that the most certain means of preserving this natural storage would be the acquisition of these lands. (See Figure 61 of the Main Report which displays the locations of the 5,350 acres to be preserved, and Table 25 of the Main Report which tabulates the wetland acres proposed for acquisition, by municipality.) Land acquisition was mandated for consideration by Congress in HR 94-1702. The cost of the acquisition plan element is $22 million (October 1986 price levels), resulting in an annual cost of $1,898,000. The benefits for this element consist of the reduction of future increases in flood inundation damages and are $3,750,000 annually. This plan element is economically feasible and was, therefore, carried forward as an "early action" element of all three of the detailed alternative plans.

FLOODPLAIN MAPPING

3.14 Photogrammetric topographic mapping was accomplished, in accordance with the Congressional mandate in HR 94-1702, for approximately 105 square miles of floodplain along the Passaic River and its tributaries. The mapped area includes the entire Standard Project Flood floodplain. The maps are scaled at 1 inch to 200 feet, with a 2-foot contour interval. They include drainage lines, buildings, other structures, highways, railroads, and state, county and municipal boundaries. They were used in hydraulic, economic, environmental and plan formulation studies. The floodplain maps were also provided to the Basin States for use in flood insurance and floodplain studies. Official New Jersey Department of Environmental Protection (NJDEP) floodplain delineations, where available, were added to the maps which were distributed to counties and municipalities.

PUBLIC EDUCATION, INFORMATION AND GUIDANCE

3.15 Numerous public information distributions were made and meetings held to inform the public of the Passaic River Basin Study, the flood problem, and the plan formulation process. This public education has been the result of efforts by both the Corps of Engineers directly (through its Subbasin Coordination Program, general mailings through a basin-wide mailing list,

radio and news releases) and in cooperation with the environmental departments of both Basin States. In particular, the New Jersey Department of Environmental Protection played a key role in this coordination and jointly sponsored many of the activities. These information measures are also a component of the Flood Emergency Preparedness Project. (See Appendix A, Public Involvement for a comprehensive list of all meetings, publications, etc.)

LAND USE CONTROLS

3.16 The extensive development of the Passaic River Basin's floodplain prevents the use of land use controls, such as regulating building design or floodplain zoning, as effective measures to reduce the existing flood problem. However, such measures would help minimize future increases in flood damages. The State of New Jersey's program for flood hazard area regulation is also instrumental in this regard. Federal flood insurance is also available to all floodplain properties in municipalities designated by the Federal Insurance Administration as participating communities. In addition, several options exist for non-Federal interests to evacuate flood prone structures from hazard areas. (For more details see Appendix C, Plan Formulation, Section 5.)

STORM WATER MANAGEMENT

3.17 New Jersey's Storm Water Management Act (Chapter 32, PL 1981), requires on-site storm water detention basins for future commercial and residential developments, under certain conditions. One of these conditions is the appropriation by the State of 90% of the costs for local governments to develop storm water management plans. The on-site detention basins would store an equivalent volume of storm water to compensate for the loss of rain-absorptive surfaces that would be covered with buildings, driveways, parking lots, and sidewalks. Bergen County is also actively implementing a storm water management program. While storm water management would partially address future increases in runoff from these sites, it would not reduce existing flood flows. Storm water management is the responsibility of non-Federal interests, but the NJDEP regulations on storm water management were considered in the formulation of flood damage reduction alternatives. (See Appendix C, Plan Formulation, Section 5, for more information on storm water management.)

DAM AND BRIDGE MODIFICATION

3.18 The feasibility of reducing backwater flooding by modifying bridges and dams throughout the Basin was investigated. The results of these analyses are detailed in the Appendix C, Plan Formulation, Section 5, and summarized below.

3.19 The hydraulic investigations of the bridges revealed that replacement or modification of existing bridges would not produce significant flood stage reductions over a large enough area to economically justify the measure. Bridge replacement and modification were considered further only where required as part of channel modification or levee plans.

3.20 The modification of dams for flood control purposes was considered for Dundee Dam and S.U.M. Dam in the Lower Valley, and Beatties Dam, which separates the Central Basin and the Lower Valley. The locations of the dams are indicated on Figure 4 of the Main Report. In each analysis, the modifications investigated included lowering the dam crest by varying amounts, and total removal of the dam.

3.21 For both Dundee Dam and S.U.M. Dam, the hydraulic critical depth starting conditions combined with the relative flatness of the channel upstream of the dams limit flood stage reductions resulting even from dam removal to only a short distance upstream. Additionally, for either dam, lowering the crest would require the installation of gates on the dam in order to maintain the existing water surface elevations during non-flood conditions so as to sustain the existing uses of the dam (e.g., hydropower). As a result, dam removal or modification for upstream flood damage reduction is not justified economically.

3.22 The Beatties Dam analysis indicated that the most significant reductions in upstream water surface elevations would result from removal of the dam in conjunction with minor channel regrading. However, even this would not be effective as a solution to the flood control problem, because only a relatively small number of structures would receive significant flood damage reduction benefits. Significant reductions in water surface elevations above Beatties Dam would require the removal of a constriction formed by the narrow rock-lined channel, and enlargement of the Passaic River channel, in conjunction with modifications to Beatties Dam. However, removal of the natural rock-gorge constriction would eliminate flood storage in the Little Falls area, and further upstream. The elimination of this flood storage capability could have significant adverse impacts on downstream communities. The uncertainty of balancing adverse effects to downstream communities and upstream wetland areas with the beneficial flood damage reduction impacts results in the feasibility and extent of such Beatties Dam modifications being in doubt without detailed hydrologic and hydraulic study of these impacts. What is clear, however, is that the relatively limited flood protection afforded by this dam modification is not responsive

to the objective of this main stem study of providing comprehensive basin-wide protection. Therefore, specific modifications in the vicinity of Beatties Dam are best considered further as a potential interim action in accordance with Section 607 of PL 99-662.

3.23 Based on these analyses, potential modifications to Dundee, S.U.M. and Beatties Dams were eliminated from further consideration as independent measures. They were only considered further in conjunction with channel modification and/or diversion tunnel alternatives.

CHANNEL MODIFICATION

3.24 Increasing the capacities of streams through channel modification was also investigated as a flood damage reduction measure. Consideration of improvements to stream carrying capacity was mandated by Congress in HR 94-1702. Earthen/ trapezoidal and concrete/rectangular channel configurations, in conjunction with dam and bridge modifications, were formulated to provide 50-year and 100-year levels of protection. A 10-year level of protection channel plan was eliminated from consideration because the expected cost would outweigh the potential benefits.

3.25 The results of this analysis indicated that channel modifications in the Upper Passaic, the Central Basin upstream of Two Bridges and the tidal portion of the lower Passaic River below Route 3 would not be feasible. (The locations of the areas being discussed are shown on Figure 10 of the Main Report.) Channel modifications in these areas were eliminated from further consideration. The findings also revealed that a comprehensive channel plan to protect the remaining areas of the Basin, including the Pompton Valley and the Passaic River from Two Bridges downstream to Route 3, would be economically infeasible as an independent plan. The large increase in flows entering the Lower Valley as a result of modifying the channel in these areas would require extensive and prohibitively expensive local protection works in the lower Passaic River.

3.26 However, channel modifications in the remaining reach between Beatties Dam downstream to the Route 3 crossing of the Passaic River can be effectively utilized in combination with other measures to develop comprehensive Basin-wide plans. Channel modification in this reach was included as part of Plan 16A, a combination plan considered in the Detailed Planning Stage.

3.27 Channel modifications in the Pompton Valley and along the Passaic River between Two Bridges and Beatties Dam were also considered further in the Detailed Planning Stage as elements of the Dual Inlet and Beatties Inlet Tunnel Alternatives (Plans 30E and 30A, respectively). The above findings are detailed in Appendix C, Plan Formulation, Section 5.

LEVEES AND FLOODWALLS

3.28 The feasibility of levee/floodwall plans in combination with dam and bridge modifications, designed to protect against the 100-year and Standard Project Flood events, was investigated. Congress mandated the consideration of local protection works in HR 94-1702. Riverbank levees and floodwalls were evaluated throughout the Basin, except in the Central Basin area, where the natural storage wetlands would be preserved by setback levees. (See Appendix C, Plan Formulation, Section 5 for a detailed discussion of these findings.)

3.29 The initial approach was for levees and floodwalls to provide a uniform and continuous 100 year line of protection to all structures within the 100-year floodplain along the main stem Passaic River and its major tributaries. This approach was economically infeasible, because in many areas the protection would be provided only to roads or isolated structures. The benefits obtained would not justify the high cost of continuous levees and floodwalls.

3.30 This economic screening resulted in the examination of a series of intermittent levees and floodwalls which would protect most of the structures in the 100-year floodplain. However, evaluation of the levee/floodwall plan segment for the Pompton Valley indicated that the excessive heights of levees and floodwalls required to protect this area against a 100-year flood event would be both publicly unacceptable and uneconomical. As a result, levees and floodwalls were not considered further as independent local protection measures in the Pompton Valley. However, they were considered in combination with other measures, such as channel modifications, which would reduce elevations of the levees and floodwalls to more acceptable heights. A combination of levees, floodwalls and channel modifications in areas of the Pompton Valley were included in both the Dual Inlet and the Beatties Inlet Tunnel Plans considered in the Detailed Planning Stage.

3.31 The economic analyses also indicated that protection provided through the use of levees and floodwalls along the Upper Passaic River, upstream of Chatham, would be economically infeasible. The Upper Passaic was, therefore, eliminated from consideration as part of a Basin-wide levee/floodwall alternative.

3.32 The remaining intermittent systems along the Lower and Central Passaic River comprised the 100-year levee/floodwall alternative. Although this alternative was determined feasible, it was eliminated from further consideration as a Basin-wide solution because other plans were found to be more economical and provided more comprehensive protection. However, levee/floodwall systems included in these remaining areas were carried forward as elements of the three detailed plans.

3.33 The levee/floodwall alternative formulated to protect against a Standard Project Flood was not economically justified and was, therefore, eliminated from further consideration as a Basin-wide plan.

FLOOD DETENTION RESERVOIRS

3.34 Flood detention reservoirs were evaluated both for flood damage reduction and in consideration of fulfilling water supply objectives in conjunction with flood damage reduction in accordance with the Congressional mandate in HR 94-1702. More than 50 existing reservoirs and potential reservoir sites were analyzed. Their locations are shown in Figure 2 in the EIS. At existing sites, the modification of management and operational procedures, the structural modification or replacement of dam structures, and increasing storage through dredging material from the reservoir were considered. Trade-offs between existing water supply and potential flood control storage were also examined. Major facilities, such as the Boonton and Wanaque Reservoirs and Greenwood Lake, and smaller sites such as the Butler, Taylortown and Haledon Reservoirs were included. All of these reservoirs are used for water supply, recreation, or both. There are no existing single-purpose flood detention reservoirs in the Basin.

3.35 A detailed discussion of the screening and evaluation of potential reservoirs is contained in Appendix C, Plan Formulation, Section 5. Initial screening clearly showed that there are few developable sites in the Basin, either large enough or geographically situated, which could provide significant flood damage reduction. Sites evaluated in detail included the Myers Road site on the Upper Passaic River; the Washington Valley site on the Whippany River; Boonton Reservoir and the Longwood Valley site on the Rockaway River; Wanaque Reservoir and the new Monksville Reservoir on the Wanaque River; Charlotteburg Reservoir on the Pequannock River, and the Darlington site on the Ramapo River. All were evaluated hydrologically, and it was found that they all had minimal beneficial effects on reducing flood flows at main stem Passaic River damage areas. From a multiple-purpose perspective, only the Longwood Valley site had potential feasibility for combined water supply, flood control and pumped storage hydropower. This

site is currently being considered as part of the separate Upper Rockaway River feasibility study because its flood damage reduction effects are independent from the main stem Passaic River. Reregulation of existing reservoirs in the Pequannock and Wanaque River Subbasins as part of water supply/flood control trade-offs would produce flood damage reductions which are not significant for a basin-wide comprehensive plan. All other sites were found to be infeasible for providing flood damage reduction or water supply in conjunction with flood damage reduction.

AQUIFER RECHARGE

3.36 Aquifer recharge and underground storage were mandated for consideration by Congress in HR 94-1702. Recharging floodwaters in the buried valley aquifers of the Passaic River Basin were considered for the primary purpose of reducing flood flows. This investigation also considered recharge of the aquifer for water supply purposes, and for the maintenance of flows in the streams during droughts. However, recharge for flood flow reduction, which requires aquifer drawdown, is in direct conflict with recharge for water supply which requires that the aquifer be kept at maximum levels. These two competing uses cannot be reconciled. Another factor in this analysis was the distance of the flood damage areas from access to the aquifer. The most favorable area for recharge from a hydrogeologic standpoint is near the Hanover Airport, a location far removed from the Pompton River, where the primary flood flows are. The most effective location for recharge from a flood control standpoint, the Little Falls-Two Bridges area, has highly unfavorable geologic conditions for recharge. There are also water quality concerns, such as high turbidity, coliform levels, suspended sediments and inorganic and organic contaminants associated with floodwaters. These would necessitate pretreatment before artifical recharge. Such recharge would also not be compatible with the U.S. Environmental Protection Agency (EPA) designation of the buried valley aquifer as a Sole Source Aquifer in accordance with the Safe Drinking Water Act (PL 93-523). The conclusion of this evaluation was that the recharge of floodwaters and/or surface runoff is not a feasible approach to flood control for the Passaic Basin. (See Appendix C, Plan Formulation, Section 5, for additional information on Aquifer Recharge.)

TUNNEL DIVERSIONS

3.37 Tunnel diversion plans and systems of tunnels were also investigated as flood damage reduction alternatives as mandated by Congress in HR 94-1702. Numerous tunnel routes and combinations of routes were evaluated. Some were derived from

previous studies while others are modifications of new routes suggested by the Corps of Engineers, its contractors, State andlocal officials, or the general public. A complete discussion of the development of tunnel diversion flood control alterna- tives is presented in Appendix C, Plan Formulation, Section 5. Tunnels with diameters up to 50 feet, and lengths ranging up to 20 miles, were considered. It was found that diversion tunnels alone were not capable of providing flood protection to all damage centers in the Basin. Therefore, tunnels were combined with other measures to provide comprehensive flood damage reduction. The evaluation of diversion tunnels initially focused on engineering feasibility from a constructibility and cost standpoint. In subsequent plan formulation iterations, the evaluation included additional technical considerations, such as hydrologic, environmental, and economic impacts associated with inlet and outlet locations. Cost considerations also focused on specific tunnel designs and construction techniques.

3.38 The initial set of tunnel routes and outlets considered are presented in FEIS Figures 3 and 4, while the inlet and outlet locations considered are highlighted in Figure 15. The criteria for inlet site selection included access, availability of land, and constructibility. These are fully discussed in the Plan Formulation Appendix. Six inlet locations were considered in the Intermediate Planning Stage. These included Little Falls, Two Bridges, Great Piece Meadows, Three Rivers (i.e., where the Whippany, Rockaway and Passaic Rivers merge), Chatham, and Upper Pompton River. The Little Falls, Two Bridges and Pompton River sites provided the most significant flood stage reductions at the major damage areas. The Little Falls and Two Bridges inlet locations were found to be increasingly effective when channel modifications were included in combination with the tunnel. The Little Falls, Two Bridges and Pompton sites were used as the basis for developing the intermediate array of tunnel diversion alternatives.

3.39 Eight alternative outlet locations were evaluated during the initial screening stage. They were Dundee Dam, Clifton-Third River, Nutley, Lyndhurst, North Arlington, the Second River, Newark Bay, and the Hackensack River Basin. Outlet evaluation criteria included cost factors relative to the length of tunnel versus the fluvial flood protection works required, the geology of the alignments, and the availability of land for staging, construction and outlet facilities. The geology along a tunnel alignment was most important because it dictated the construction methods and determined costs. The important geological parameters include groundwater conditions, the type,

depth and condition of bedrock, thickness of bedrock above the tunnel crown, faults and contact zones, and the nature of any soft ground conditions. All of the alternative tunnel routes pass through two distinctly different rock conditions, basalt, and sandstones and shales.

3.40 Some of the outlet sites considered were found to have disadvantages: Newark Bay required a long tunnel; Dundee Dam required excessive local protection works downstream of the outlet; the Hackensack River was distant and had poor geologic conditions along the route; the Nutley site lacked access and available land; and the Lyndhurst and North Arlington sites, located in parks adjacent to residential areas, required channel modifications and an additional river crossing.

3.41 It was found that locating the outlet downstream of the point where river stages are controlled by fluvial flows would reduce flood stages downstream of Dundee Dam, minimizing the local protection works required. An analysis was made to locate the outlet where it would lower tunnel costs and minimize fluvial flood protection works. Based on this analysis, it was determined that the best outlet location would lie between the Second (river mile 8) and Third Rivers (river mile 11). The Clifton-Third River site had several advantages over the Second River site because it required a significantly shorter tunnel length, was accessible, and had open space for construction activities. The Clifton-Third River outlet site was utilized as the basis for formulating intermediate stage tunnel diversion alternatives. The Second River site was carried forward as a possible option for detailed planning while the Newark Bay site was evaluated because of public interest in this location.

3.42 Two types of tunnel design, hydraulic grade line and inverted siphon, were considered. For the hydraulic grade line design, cut and cover construction methods would be required for up to one mile in length where the bedrock is below the tunnel grade or fractured. Such construction, and attendant residential and commercial acquisitions would be very costly and unacceptable to the communities involved. These problems could be avoided by constructing the tunnel deeper, as an inverted siphon. Cost studies demonstrated that siphon designs resulted in approximately 35% cost savings over hydraulic grade line designs, because the improved geologic subsurface conditions found deeper in the bedrock would result in more timely and economic construction, and would avoid all surface cut-and-cover tunnel construction with its extensive real estate takings. For these reasons, the intermediate stage plans utilized the inverted siphon hydraulic design.

3.43 The subsurface conditions in the Passaic Basin are suitable for the use of a tunnel boring machine (TBM). Conventional drill and shoot tunnel construction techniques would cost from 20% to 50% more than the TBM. Further plan formulation was based on TBM tunnel construction.

3.44 Intermediate Stage tunnel diversion plans were developed with inlets at Little Falls, Two Bridges, and the Upper Pompton River, and the outlet at the Clifton-Third River site. An inverted siphon hydraulic design was selected, with TBM construction methods. Tunnel diameters from 35 to 40 feet were found to be most economical. Seven basic tunnel diversion plans were developed, and these alternatives were combined with other local protection and nonstructural measures in the development of comprehensive alternatives. The most economically efficient alternatives for each tunnel alignment were included among the plans presented to the State of New Jersey and the general public for review at the conclusion of the Intermediate Planning Stage. A comparison of alternatives including a trade-off analysis of beneficial and adverse effects was used to select plans for detailed planning. The tunnel diversion plans with dual Pompton-Passaic inlets (Plan 30E) and a Beatties Dam single inlet (Plan 30A) were found to be most efficient and economical and were carried into the Detailed Planning Stage.

TIDAL BARRIER

3.45 Consideration was given to the feasibility of a tidal barrier to prevent tidal flooding caused by storm surges. Such a barrier would block the mouth of the river, preventing tidal floods from moving upstream. Numerous sites were screened, based on cost considerations, location, river access and width, and navigation access. The best site was located at the mouth of the Passaic River, near the abandoned Central Railroad of New Jersey Bridge within the 30-foot-deep Federal navigation channel. The natural channel width is 700 feet wide at this location, expanding to 1,100 feet immediately downstream. The considered barrier included a 100-foot wide navigation opening with two sector gates for closures during extreme tides, a short non-overflow concrete dam, a 50-foot-wide spillway gate, and a low head river pumping plant. The top of the barrier would be at 15 feet National Geodetic Vertical Datum (NGVD) and would provide protection against the 100-year tide with five feet of freeboard. A pumping station would be required to handle more than 20,000 cubic feet per second (cfs) during a 100-year event when the barrier would be closed. To complete the line of protection necessary to protect tidal flood areas, approximately 12,600 feet of levees and floodwalls are required. The total first cost of the tidal barrier and accompanying levee/floodwalls was $152 million, resulting in a highly uneconomical

plan. It was concluded that a tidal barrier is not economically feasible, and this alternative was eliminated from further study (as detailed in Appendix C, Plan Formulation, Section 5).

NO-ACTION ALTERNATIVE

3.46 The most probable future conditions without a project to reduce flood damages in the Passaic River Basin constitute the No-Action Alternative. The most probable future conditions reflect an extrapolation of the historical development and socioeconomic characteristics of the basin. The basin's favorable geography and socioeconomic factors still exist, and the trend of continued economic growth is still strong. Population, a significant indicator of change, is expected to increase substantially by the year 2040, adding some 800,000 people over the period from 1980 to 2040. Almost half of the Basin communities will develop into suburban-urban areas by 2040. Increased growth and development will adversely affect the hydrology, hydraulics, and water quality of the Basin, increasing the frequency and extent of flood damages and impacting aquatic and terrestrial resources. A detailed description of the future without project conditions is provided in Appendix C, Plan Formulation, Section 2.

3.47 Since land use projections are based on population and employment projections, the less developed areas of the Basin, such as the Highland Area, are expected to see the greatest increases in land development. However, compared to historical growth in the Passaic River Basin, the future acreage projected to develop is relatively small. Nonetheless, it should be noted that, although comparatively more acres were developed in the past than are projected for the 1990 to 2040 period, the incremental effect of this projected growth is important since under a no-action condition, future flooding can be expected to become more frequent and more severe because this development will directly reduce pervious surface and flood storage areas.

3.48 Land use in the lower Passaic River floodplain and along many of the smaller tributaries is dominated by high-density commercial, industrial and residential development. Because few developable open areas remain, no major land use changes are anticipated. As a result, the existing acreage of parks and open space along the lower Passaic River is not expected to change. The limited terrestrial resources supported by these areas will also remain unchanged. The same is true of water quality and aquatic resources. Until they are remediated, the hazardous substance sites in the existing 100-year floodplain (see FEIS paragraphs 4.15-4.19) will be subject to more frequent inundation, with resulting damage to the human and natural environment.

3.49 Land use in the Central Basin area is suburban, with large open spaces, and vast wetlands. In the future, wetlands and other open spaces are expected to experience intense development pressure for residential, industrial and commercial uses. The most probable future scenario of natural storage loss in the Central Basin was presented previously in paragraph 3.12. The 8,620 acres of unprotected natural flood storage will be at risk for inclusion in development plans, and loss of significant portions of this storage will result in increased flooding along the central Passaic River and the lower Passaic River. Urbanization will result in increased runoff, increased nonpoint source pollution, and losses of terrestrial habitat. The increased nonpoint source pollution will degrade water quality enough to offset any improvements resulting from new sewer treatment facilities, and indirectly preclude improvements in aquatic habitat. The two Superfund and 20 CERCLA hazardous substance sites in the existing 100-year floodplain of the Central Basin, and the increased frequency and duration of flooding, will pose a threat to public health and safety until they are remediated.

3.50 Between 1990 and 2040, over 35,000 acres outside of the floodplain are expected to be developed basin-wide and 3,440 acres of natural flood storage in the Central Basin would be filled. The combined effects of urbanization and loss of natural storage areas would result in increases in flood flows with a corresponding increase in flood stages. For example, a 7.7% increase in the 1 year storm discharge at Little Falls is expected over the period from 1990 to 2040. The 100 year storm at this location would increase by 19.1% over this period. As a result, the expected annual damages for the Passaic River Basin would increase by almost $31,000,000 between 1990 and 2040.

3.51 In the absence of any flood control plan, the flood prone areas of the Passaic River Basin would continue to be subjected to periodic inundation resulting in substantial physical damage, monetary losses and associated adverse environmental and social effects. A No-Action alterative will result in continued losses of natural storage areas, mostly wetlands; continued poor quality water in the Passaic River and its major tributaries; degradation of terrestrial habitats in the Central Basin area; and an increase in the frequency, extent and duration of flooding in the Central Passaic area and along the lower Passaic River. Fishery resources will remain unchanged. The aesthetics of the Central Basin will be altered because of development, while in the Lower Valley the future without project conditions include the restoration and beautification of the riverside area and increases in its recreational use. Flood damage reduction measures would consist primarily of monetary compensation for losses through the National Flood Insurance Program, and the

acquisition of a limited number of structures through State andlocal programs. In addition, emergency flood protection and evacuation measures wuld also be relied on at the flood prone areas. Maintenance to correct flood damages would require expenditures of time and money by landowners and public service agencies to restore any damaged property, roads, drainage ditches, culverts and utilities. The health and safety of floodplain residents would be jeopardized during flood events. Temporary impacts such as relocation of affected families and the disruption of transportation routes, utilities, employment and commercial activities would be expected. Overall, the lack of flood protection would continue to incur physical damage to property and adversely affect the general well-being of those who live and work in the flooded areas.

PLANS CONSIDERED IN DETAIL

3.52 Three alternative plans were carried into the Detailed Planning Stage as a result of the iterative screening of the full range of alternatives developed during the planning process. These plans included a comprehensive plan which maximized economically feasible nonstructural measures, a single inlet tunnel diversion plan, and a dual inlet tunnel diversion alternative which is the National Economic Development (NED) plan. The three plans are: 1) Plan 16A - Levee/Floodwall/ Nonstructural and Channel Modification; 2) Plan 30A - Beatties Dam Single Inlet Tunnel Diversion; and 3) Plan 30E - Pompton River-Passaic River Dual Inlet Tunnel Diversion. A nonstructural component of each of these plans involves the Preservation of Natural Storage Areas to minimize the worsening of future flooding.

PRESERVATION OF NATURAL STORAGE AREAS

3.53 The formulation of the preservation of natural flood storage element was summarized in Paragraphs 3.08 to 3.13. This element involves the acquisition of 5,350 acres, 5,200 of which are wetlands. These acres, which are currently at risk for filling and development, include the following: Great Piece Meadows 1,580 acres; Bog and Vly Meadows, 405 acres; Hatfield Swamp, 430 acres; Troy Meadows, 1,175 acres; Black Meadows, 1,110 acres; Hatfield South, 190 acres; Canoe Brook, 175 acres; and 285 acres of unnamed wetlands in the Lower Pompton area. The development of the Preservation of Natural Flood Storage element is detailed in Appendix C, Plan Formulation, Sections 5 and 8. Tables 24 and 25 of the Main Report identify the areas proposed for acquisition by major wetland and by municipality.

Figure 61 of the Main Report presents an overview of these acquisition areas while Figures 36 to 46, 52, 54 and 55 of the Main Report show the areas identified for acquisition in relation to the location of the other elements of the Dual Inlet Tunnel Plan.

NO-TUNNEL PLAN - LEVEE/FLOODWALL/NONSTRUCTURAL/CHANNEL MODIFICATION (PLAN 16A)

3.54 This plan combines 16.1 miles of channel modification, 10.5 miles of levees, 5.0 miles of floodwalls, nonstructural measures for 5,078 structures and the preservation of 5,350 acres of natural flood storage, to provide levels of protection ranging from a 10 year to a 500 year flood, at a first cost of $385 million (October 1985 price levels). Except for the preservation element which was previously discussed, the plan elements are summarized in the following paragraphs. Chapter 5 of the Main Report provides additional information on this plan, including physical features table. Figure 20 the Main Report illustrates this plan. The selection of the level of protection scales for the plan components is presented in Appendix C, Plan Formulation, Section 8.

3.55 This plan is the most economically efficient non-tunnel alternative that provided basin-wide coverage. It serves to contrast the planning options available for the Pompton Valley and Central Passaic areas. It highlights the fact that providing a comprehensive, high level of protection through the use of nonstructural measures to the Pompton/Central Passaic areas is not economically feasible (see paragraph 3.06). Only a low level (10 year) of protection was found feasible for nonstructural measures, and if permanent evacuation measures were exclusively utilized, only limited areas could be economically justified and only at low levels of protection. Furthermore, all economically feasible structural means to provide comprehensive protection to the Pompton/Central Passaic areas through channel modification, levees and floodwalls, or diversion tunnels would result in the increase of flow flows entering the Lower Valley, with the accompanying need for additional structural works along the lower Passaic River to safely address such increases. This accounts for this plan's relatively low level of protection in the Pompton Valley and portions of the Central Passaic. Only the setback levees/ floodwalls utilized along the Passaic River upstream of Two Bridges provide more significant flood damage reduction, without resulting in substantial increased flows to the Lower Valley. This plan's inclusion of the same levee/floodwall systems for the tidal area of the lower Passaic River as provided by the other two detailed plans highlights the fact that this is the only economically feasible measure for the tidal area of the lower Passaic River.

CHANNEL MODIFICATION ELEMENT OF THE NO-TUNNEL PLAN

3.56 The key feature of this plan is the 16.4 mile long channel modification proposed for the Lower Valley. This channel modification would provide a 100 year level of protection between Route 3 in Rutherford and Beatties Dam.

3.57 The channel modification proposal for the Passaic River would start just downstream of the N.J. Route 3 crossing and extend upstream 5.4 miles to a point near Fleisher's Brook in Garfield. The bottom width of the modified channel would be 135 feet, and its alignment and top width would be within the existing channel. The modified channel would include two sections of semi-trapezoidal channel and two sections of trapezoidal channel with 2.5 horizontal:1.0 vertical side slopes. The channel would be deepened an average of 8 feet. There would be 0.3 miles of transition channel at both the upstream and downstream limits of the modified channel.

3.58 Between Dundee Dam and Great Falls, this alternative would include a trapezoidal channel with a bottom width ranging from 540 feet at Dundee Dam to 95 feet at the upstream limit. The modified channel would be approximately 7.3 miles long, and the channel would be lowered an average of 10 feet.

3.59 Between Great Falls and Beatties Dam, the plan would include 3.7 miles of trapezoidal channel with bottom widths ranging from 184 feet at the S.U.M. Dam, to 115 feet at Beatties Dam. The channel would be deepened an average of six feet. This plan also calls for lowering the crest of the S.U.M. Dam by 1.6 feet, to an elevation of 113.0 feet NGVD.

LEVEE/FLOODWALL ELEMENTS OF THE NO-TUNNEL PLAN

3.60 Five levee/floodwall systems located in the Lower Valley, between the mouth of the Passaic River upstream to the I-280 Bridge, would protect against a 500 year tidal flood. These Lower Valley systems, which are the same for all three detailed plans, would include 5.5 miles of levees and 5.0 miles of floodwalls. Six intermittent systems located in the Central Basin along the Passaic and Rockaway Rivers and Pinch Brook would protect against floods ranging from the 100 year event to the 500 year event. In conjunction with the levee/ floodwall systems, ponding areas, pressure interceptors and pumping stations would be provided to protect against interior flooding. These Central Basin systems would include 5.0 miles of levees and 200 feet of floodwalls.

NONSTRUCTURAL ELEMENTS OF THE NO-TUNNEL PLAN

3.61 Protection against a 10-year flood by nonstructural measures, consisting of floodproofing, raising and permanent evacuation, would be provided in the Pompton Valley and along the Passaic River from Beatties Dam to the upstream limit of Deepavaal Brook. As discussed in EIS paragraph 3.06 a 10 year design was the highest level of protection found feasible for this nonstructural element, and it was justified only in portions of the study area. In the development of this 10-year nonstructural plan, the least costly, engineeringly feasible measure was used for each of the 5,078 structures. The Floodwarning and Forecasting System for the Passaic River Basin, which is currently being enhanced by the Corps of Engineers in cooperation with the State of New Jersey, would be integral to ensuring the effectiveness of the nonstructural measures and to provide advance warning if flooding is expected to exceed the design level.

3.62 Floodproofing. This measure would be applied to all structures where the 10-year flood stage is at or below the main floor. Floodproofing the damageable components of structures of all types was examined for flooding up to the design flood elevation. In the Pompton Valley, including the lower reaches of the Wanaque, Ramapo and Pequannock Rivers, a total of 3,004 residential and 196 non-residential structures would be floodproofed. Along the Passaic River from Beatties Dam to the upstream limit of Deepavaal Brook, 1,176 residential and 81 non-residential structures would be floodproofed.

3.63 Raising. Raising structures was considered where the design flood stage is above the main floor. This measure involves raising foundation walls, or constructing walls for structures without basements, so that the main floor is higher than the 10-year flood elevation. A total of 516 residential and 12 non-residential structures would be raised along the Pompton River and its tributaries. Along the Central Passaic River and tributaries, 46 residential structures and 4 non-residential structures would be raised.

3.64 Permanent Evacuation. Permanent evacuation was the measure selected in cases where the depth of flooding exceeded practical engineering constraints to floodproofing or raising a structure. For the Pompton Valley, permanent evacuation would be used for 10 residential and 15 non-residential structures. Permanent evacuation along the Central Passaic River would involve 12 residential and 6 non-residential structures.

BEATTIES DAM SINGLE INLET TUNNEL DIVERSION PLAN (PLAN 30A)

3.65 This alternative combines a single inlet diversion tunnel, 14.7 miles of channel modifications, 23.7 miles of levees, 14.0 miles of floodwalls and the preservation of 5,350 acres of natural flood storage to provide levels of protection ranging from a 50 year to a 500 year flood, at a first cost of $728 million (October 1985 price levels). The features of the Single Inlet Tunnel Plan are summarized in the following paragraphs with the exception of the preservation element which was described in Paragraph 3.53. Chapter 5 of the Main Report provides additional information on this plan. Tables 16 and 17 of the Main Report provide data on the physical features. This plan is illustrated in Figure 16 of the Main Report.

TUNNEL ELEMENT OF THE SINGLE INLET TUNNEL PLAN

3.66 The key feature of the Beatties Dam Single Inlet Tunnel Diversion Plan is a 7-mile-long, 35-foot-diameter underground diversion tunnel that extends from about 2,000 feet upstream of Beatties Dam down to the lower Passaic River. The tunnel would divert floodwaters from the central Passaic River area to an outlet near the Third River/Passaic River confluence at the Clifton-Nutley border. Up to a 100 year level of protection would be provided to the flood damage areas between the inlet and Dundee Dam. The underground tunnel would be about 90 feet below ground level at the inlet and about 155 feet below the outlet. The Floodwarning and Forcasting System for the Passaic River Basin would be an integral element in carrying out the operating rules established for the tunnel.

3.67 The purpose of the single inlet diversion tunnel plan element would be to divert Central Basin flood flows to the estuarine portions of the lower Passaic River, bypassing highly developed Lower Valley damage areas between Dundee and Beatties Dams and reducing flood stages upstream in the Central Basin. In order to deliver the design flows to the tunnel inlet, extensive channel modification would be necessary along the Pompton River and its tributaries, in conjunction with levees and floodwalls along the lower Ramapo, Wanaque and at Pequannock Rivers, as discussed in the paragraphs below. The Beatties Dam Single Inlet Tunnel plan element is the second most economically efficient diversion tunnel alternative, with only the Dual Inlet Tunnel element of Plan 30E providing greater economic return.

PASSAIC RIVER INLET ELEMENT OF THE SINGLE INLET TUNNEL PLAN

3.68 The tunnel inlet and diversion works would be located on Stag Island in the Passaic River in Wayne Township, about 2,000 feet upstream of Beatties Dam. The inlet works would consist of

a gated diversion spillway to allow floodwaters to enter a morning glory tunnel inlet. A river flow restrictor would not be needed since the design pool stage at the diversion spillway is controlled by the natural rock ledge in the Passaic River upstream of Beatties Dam.

CHANNEL MODIFICATION ELEMENTS OF THE SINGLE INLET TUNNEL PLAN

3.69 The Passaic River channel would be deepened by an average of 15 feet for 3 miles from the Passaic River/Pompton River confluence down to the tunnel inlet. Channel deepening averaging 12 feet, would be required for 6.8 miles along the Pompton River. As part of the Pompton River channel modification, it would be necessary to acquire 61 structures located either on islands in the channel or along the river banks. The remaining structures along the Pompton River would receive a 50 year level of protection. A total of approximately 4.9 miles of channel modification would also be required along the Pequannock, Wanaque and Ramapo Rivers. The average channel deepening would be 14 feet in the Pequannock River and 6 feet in the other two rivers.

LEVEE/FLOODWALL ELEMENTS OF THE SINGLE INLET TUNNEL PLAN

3.70 Along the Pequannock, Wanaque and Ramapo Rivers, 3.5 miles of levee and 0.7 miles of floodwall would provide a 100 year level of protection. Levee/floodwall systems would not be required along the Pompton River. In the Central Passaic area upstream of Two Bridges, protection against 100 to 500-year floods would be provided at intermittent locations by setback levees and floodwalls. These Central Passaic systems would consist of approximately 9 miles of levee and 1/2 mile of floodwall. Diverting floodwaters through the tunnel from the Central Passaic Basin would significantly reduce the need for structural flood protection along the Passaic River from Beatties Dam down to just above the Saddle River. Along the lower Passaic River from the Saddle River downstream to Newark Bay, the plan calls for 14 levee/floodwall systems, with 11.2 miles of levee and 12.8 miles of floodwall. From upstream of the Saddle River downstream to the Second River, 5.7 miles of levees and 7.8 miles of floodwalls would be required to protect against combined tidal/fluvial flows and tunnel discharges. These systems would provide protection against a 100-year event. For the lower Passaic River from the Second River to the mouth at Newark Bay, 5.5 miles of levees and 5.0 miles of floodwalls would be required to protect against tidal flooding. These systems, which are identified to those proposed for Plans 16A and Plan 30E, would provide protection against a 500-year tidal event.

POMPTON/PASSAIC DUAL INLET TUNNEL DIVERSION PLAN (PLAN 30E)

3.71 This alternative combines two tunnels, 5.9 miles of channel modification, 23.7 miles of levees, 14.0 miles of floodwalls and preservation of 5,350 acres of natural flood storage to provide levels of protection ranging from a 100 year to a 500 year flood, at a first cost of $814 million at October 1985 price levels ($831 million at October 1986 price levels). The elements of the Dual Inlet Tunnel Plan are summarized in the following paragraphs with the exception of the preservation element which was described in Paragraph 3.53. (This plan, which is the recommended plan, is discussed in more detail in Chapter 6 of the Main Report and Chapter 10 of Appendix C, Plan Formulation.

TUNNEL ELEMENTS OF THE DUAL INLET TUNNEL PLAN

3.72 The major elements of this plan would be the two tunnels, with the key being the 13.5-mile long, 39-foot diameter main tunnel, which would carry floodwaters from an inlet at the upper Pompton River down to an outlet on the lower Passaic River (Figure 19, Main Report). A 1.2-mile long, 22-foot diameter spur tunnel, would convey Central Basin area floodwaters from an inlet just below Two Bridges on the Passaic River, to an underground connnection with the main diversion tunnel. The two inlets would be located on the Pompton and Passaic Rivers in Wayne Township, while the outlet would be located on the Passaic River at Clifton.

3.73 The tunnels would be entirely underground -- some 125 feet below the surface at the Pompton inlet, about 130 feet below the Passaic inlet, and approximately 155 feet below the outlet. The intersection of the main and spur tunnels would be about 150 feet below ground level. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the main tunnel would be some 450 feet underground. Figures 56 and 47 of the Main Report depict plan and profile views of the main and spur tunnels.

3.74 The dual inlet plan was developed to make more efficient use of the main diversion tunnel since flows could be further reduced by a second inlet on the Passaic River below Two Bridges. Operation of the tunnel would involve a priority diversion at the Pompton inlet. The double inlet takes advantage of the approximate two-day difference in timing of the Pompton and Passaic River flood peaks. The objective is to direct as much flow as possible into the Pompton River inlet and then, when the main tunnel is operating at less than capacity, allow additional flow to enter the tunnel at the Passaic inlet.

3.75 The function of the tunnel elements of the plan would be to divert flood flows from the upper Pompton River and from the Central Passaic River to the estuarine portion of the Passaic River, bypassing highly developed damage prone areas along the Pompton and lower Passaic Rivers, and also reducing flood stages in the Central Basin.

POMPTON RIVER INLET ELEMENT OF THE DUAL INLET TUNNEL PLAN

3.76 The proposed Pompton inlet site would be located upstream of the Pompton Plains Cross Road (Jackson Avenue) in Wayne Township on the east bank of the Pompton River, immediately downstream of the Ramapo/Pequannock Rivers confluence (Figure 58 Main Report). The site is currently a stockpile area for a sand and gravel mining operation. The area around the site is generally undeveloped, with low-lying floodplain on the west and north and agricultural lands to the east. Stream slopes are very flat. The inlet works consist of a river flow restrictor on the Pompton River, a gated weir on the Pequannock River, a river diversion spillway, and a morning glory tunnel inlet. The morning glory inlet would stand in the center of an 8-foot deep, 400-foot diameter concrete basin. As discussed in subsequent paragraphs, channel modifications and levees and floodwalls are needed upstream along reaches of the Ramapo, Wanaque at Pequannock Rivers to safely deliver flood flows to the tunnel inlet works.

PASSAIC RIVER INLET AND SPUR TUNNEL ELEMENTS OF THE DUAL INLET TUNNEL PLAN

3.77 The proposed Passaic River inlet would be located on the Passaic River's east bank about 500 feet upstream of the Route 80 Bridge, adjacent to Fairfield Road in Wayne (Figure 59, Main Report). The inlet leads to a 22-foot diameter, 1.2-mile long spur tunnel, which connects to the main tunnel. To access this site, a Fairfield Road Bridge would be built over the inlet structure. The surrounding area is lightly developed with residential structures, but mostly consists of undeveloped low-lying wetlands. The inlet structure is similar to the Pompton inlet, with a gated diversion spillway and morning glory tunnel inlet. The diversion spillway would include gates to control the floodwaters entering the inlet basin. Upstream of the inlet, transition channels along the Passaic and lower Pompton Rivers are needed to convey flows to the inlet, and a gated weir is located at the lower end of Great Piece Meadows. These works are discussed further in subsequent paragraphs.

TUNNEL OUTLET ELEMENT OF THE DUAL INLET TUNNEL PLAN

3.78 The proposed outlet would be located on the Passaic River's west bank just upstream of its confluence with the Third River (Figure 58, Main Report). The diverted flows would exit the tunnel through a vertical upshaft to the surface at sea level and then flow into the Passaic River. With the project, 100 year design flood stages are estimated to be 15.4 feet NGVD as compared to the 11.3 feet that would occur under without-project conditions. Because the tunnel outlet is in the tidal portion of the Passaic River, levees and floodwalls are the most economical measures for safely conveying increased flood flows. To protect against hurricane surges and to mitigate for increased flood stages, 5.7 miles of levees, averaging 9.7 feet in height, and 7.8 miles of floodwalls, averaging 9.6 feet in height, would be required in the 8.2 mile reach from the Second River up to the Monroe Street Bridge in Passaic City. These additional flows would have a negligible effect on river stages downstream of the Rutgers Avenue Bridge at Belleville to Newark Bay because of the large capacity of the navigation channel.

ALTERNATE OUTLET LOCATIONS

3.79 Consideration was given to the possibility of relocating the outlet further downstream in order to eliminate the effects of the tunnel discharges and the local protection required to safely contain these flows. Relocating the tunnel outlet to Newark Bay would eliminate the need for the nine integral levee/floodwall systems, totalling 13.5 miles, along the Passaic River from the Second River to upstream of the Saddle River. The Newark Bay outlet would require the main tunnel to be 35,000 feet longer and one-foot larger in diameter in order to maintain the same level of protection upstream of Dundee Dam. The bedrock geology along the Newark Bay outlet tunnel route was assumed to be similar to that used for the lower limb of the Dual Inlet Tunnel since specific information is not available. The additional tunnel work would extend the construction period by at least 18 months. The Newark Bay outlet option would add up to $300 million to the investment cost of the Dual Inlet Tunnel Plan, resulting in a total annual cost of $110,400,000 (October 1986 price level). The average annual equivalent benefits of the plan would be reduced by $5,500,000 to $117,000,000 (October 1986 price level. With a Newark Bay outlet, the Dual Inlet Plan would have a benefit-cost ratio of 1.06.

3.80 A tunnel outlet in the vicinity of the Second River would eliminate the need for three integral levee/floodwall systems while not entirely eliminating increased flood stages upstream. The three systems eliminated are the (Eighth Street, River St.-Main Ave., and River Drive 1 systems, which total 5.0 miles in length. The remaining six systems integral to the tunnel outlet would be one to 3.5 feet lower in height than required with the outlet in the Third River vicinity. The Second River outlet would add almost 10,000 feet to the tunnel length and extend the construction period by about one year. The investment cost of the Dual Inlet Tunnel Plan would increase by about $100 million, resulting in a total annual cost of $93,900,000. The benefits of the plan with a Second River outlet would be approximately the same as with the outlet in the Third River vicinity. The benefit-cost ratio of the Dual Inlet Tunnel Plan with a Second River outlet would be 1.3.

CHANNEL MODIFICATION ELEMENTS OF THE DUAL INLET TUNNEL PLAN

3.81 Channel modifications included as part of this plan along the Passaic, Pompton, Pequannock, Ramapo and Wanaque Rivers would be required to direct flood flows into the tunnel inlets. The channel modifications along the latter three rivers would also be required to protect the areas upstream of the Pompton tunnel inlet. Table 18 in the Main Report displays the modified channel dimensions. The Pequannock River channel modification would extend from the Pompton River main tunnel inlet, just upstream of Pompton Plains Cross Road, upstream for 2.6 miles, (Figure 47, Main Report). The modification includes deepening the existing channel by 7 feet and increasing its bottom width to an average of 74 to 100 feet. The top width of the modified channel would range from 135 to 160 feet. The top width of the existing channel is approximately 100 feet.

3.82 A gated weir would be placed in the modified Pequannock River to maintain normal river stages and flows over the Morris Canal Feeder Dams on the Pequannock and Ramapo Rivers during non-flood conditions. As a result, the weir would preserve the function of the old Morris Canal Feeder Dams while avoiding impacts to fish and wildlife resources, groundwater reources and a National Register of Historic Places landmark.

3.83 The Ramapo River channel modification would extend 1.2 miles from its mouth upstream to the Paterson-Hamburg Turnpike (Figure 49, Main Report). The modifications would include deepening the existing channel by 4 feet, and widening the channel bottom to between 60 and 100 feet. The average top width of the modified channel would be approximately 150 feet. The top width of the existing channel is approximately 110 feet.

3.84 The Wanaque River channel modification would extend from its mouth upstream about 1 mile to the Paterson-Hamburg Turnpike (Figure 48, Main Report). The proposed modifications include deepening the existing channel about 6 feet and increasing the channel bottom width to an average 74 feet. The resulting average top width would be approximately 125 feet. The top width of the existing channel is approximately 90 feet.

3.85 Transition channels, which would direct flows into the Passaic inlet to the spur tunnel, would encompass about 0.8 miles of the Passaic River from upstream of Two Bridges down to the Route 46 Bridge, and about 0.3 miles of the lower Pompton River (Figure 35, Main Report). This channel would have an average base width of 175 feet and would be deepened an average of 4 to 5 feet. The resulting top width of the channel would be approximately 235 feet. The top width of the existing channel averages approximately 220 feet. No other structural elements would be required along the Pompton River because the main tunnel would divert most of the Pompton flood flows.

3.86 A gated weir would be placed at the upstream limit of the Passaic River transition channel. The weir would stabilize the natural channel at its point of connection to the transition channel leading to the tunnel inlet. In addition, the gated weir would serve to maintain existing water surface elevations in the Great Piece Meadows and thereby preserve upstream wetlands. This, in turn, would maintain downstream water quality.

LEVEE AND FLOODWALL ELEMENTS OF THE DUAL INLET TUNNEL PLAN

3.87 Above the Pompton Inlet, along the lower Pequannock, Wanaque and Ramapo Rivers, 3.5 miles of levees and 0.7 miles of floodwalls, would work in conjunction with the modified channels to direct flood flows into the tunnel and to provide a 100 year level of protection. Table 19 in the Main Report displays levee and floodwall dimensions.

3.88 The remaining levees and floodwalls would be the same as those included in the Single Inlet Tunnel Plan. Along the Passaic River and tributaries upstream of the Pompton River confluence, protection, ranging from a 100 year to a 500 year flood level, would be provided at intermittent locations by setback levees and floodwalls. These systems include about 9.0 miles of levees and 1/2 mile of floodwall.

3.89 The tunnel diversion of floodwaters from the Central Passaic area would significantly reduce the need for structural measures from Beatties Dam down to the Saddle River. Along the lower Passaic River from upstream of the Saddle River downstream to Newark Bay, the Dual Inlet Tunnel Diversion Plan calls for 14 levee/floodwall systems, including 11.2 miles of levees and 12.8 miles of floodwalls. These levee/floodwall systems are divided into two categories, as follows.

3.90 From the Monroe Street Bridge, upstream of the Saddle River, downstream to the Second River, 5.7 miles of levees and 7.8 miles of floodwalls would be required to protect against combined tidal/fluvial flows and tunnel discharges. These systems would provide protection against a 100 year flood event. From the Second River downstream to Newark Bay, 5.5 miles of levees and 5.0 miles of floodwalls would be required to protect against tidal flooding. These levees and floodwalls would protect against a 500 year tidal event are the same element as included in Plans 16A and 30A.

OPERATION OF THE DUAL INLET TUNNEL PLAN

3.91 The operation of the tunnel component of the selected plan, both for flood control and environmental objectives, is reliant upon specific rules which designate when the tunnel would be placed into operation and what flows would bypass the tunnel inlets. Detailed discussions of the operation of the plan is provided in the Main Report, Chapter 6, and Section 10 of Appendix C, Plan Formulation.

3.92 The tunnel would not operate for any flow less than or equal to the one year flood event. The tunnel would operate only when a flood greater than the one year flood is predicted to occur. This prediction would be based upon an enhanced Passaic River Basin Floodwarning and Forecasting System with additional streamflow and rain gages to ensure accurate, timely forecasting of expected flood levels. The Floodwarning and Forecasting System would also be utilized in determining when gated closure structures and pumping stations that are part of the local protection works should be operated.

3.93 The recommended Pompton/Passaic Dual Inlet Tunnel Diversion Plans calls for two inlets as follows: the Pompton River Inlet near the upstream limit of the Pompton River, and the Passaic River Inlet downstream of Two Bridges. Although the operation of the Pompton Inlet is discussed first, in fact, the operation of the two inlets act in concert.

3.94 During non-flood conditions the center gate of the Pompton River flow restrictor would remain open to permit normal flows to continue downstream. In the event that flood flows are predicted to exceed the one year flood, the Pompton River flow restrictor would be operated for flood damage reduction purposes so that water starts to pond behind it and a maximum of 500 cubic feet per second (cfs) would bypass the inlet early in the storm. (By comparison, the average daily flow for the Pompton River is approximately 482 cfs.) At the same time the diversion spillway gates would be opened to permit the water that has ponded behind the river flow restrictor to enter the inlet basin and pass into the morning glory inlet, thereby initiating the diversion. The inlet basin is lower in elevation than the river channel, permitting the diversion of flood flows at non-damaging elevations while maintaining water surface elevations greater than the 1 year stage at upstream wetlands areas for all floods. Should flood flows exceed the capacity of the tunnel, the five gated openings on the river flow restrictor would be opened in order to pass the larger flows while maintaining maximum diversion through the tunnel.

3.95 A Passaic River flow restrictor is not needed for the Two Bridges Inlet since the design pool stage at the diversion spillway is created by the natural rock ledge in the river upstream of Beatties Dam. During non-flood conditions, the gated diversion spillway would be closed so that normal flows would bypass the inlet and continue downstream over Beatties Dam. As with the Pompton Inlet, when it is predicted that flooding greater than the 1 year event is imminent, the gates in the diversion spillway would open. The diversion gates would be operated to divert Passaic River flows into the tunnel and maintain a maximum 100 cfs bypass flow down the Passaic River during the early portion of the flood, when the Lower Valley tributaries are peaking. The Central Basin contribution to these Lower Valley tributary flows must be minimized early in the storm to prevent flooding in the Lower Valley.

3.96 Since the Pompton River flows would have priority use of the tunnel's capacity, the amount of Passaic River water actually diverted over the course of the event would be a function of how much tunnel capacity is available while the Pompton River is being diverted. For floods between the 50-year and 100-year events, as the flow into the Pompton Inlet increases to its peak, the Two Bridges Inlet diversion would be closed down to permit the maximum diversion of Pompton River water. At this point only Pompton River water would enter the tunnel. There would be no diversion of Passaic River flows at this time; all Passaic River flow would be bypassed downstream. During a 100-year flood event, diversion of Pompton River flows would require the tunnel to carry only Pompton River water for a period of 11 hours during the middle of the storm while the

Pompton River flows are peaking. During that period no water would enter the Two Bridges Inlet and about 9,000 cfs would be bypassed downstream along the Passaic River. Since this timeframe is well after the peaking of the Lower Valley tributary flooding, these additional flows can be passed downstream of the Two Bridges Inlet without flooding in the Lower Valley. Later in the storm, after the Pompton River flows have receded so that there is excess tunnel capacity, the gates to the Passaic River Inlet would reopen thereby resuming diversion so as to reduce the Passaic River peak flow entering the Lower Valley, which occurs approximately two days after the Pompton peak. For more frequent storms between the 1 year and 50 year floods, the Pompton River flow diversion is not sufficient to fill the tunnel to capacity and the Two Bridges diversion need not completely shut down.

3.97 Each inlet would continue to divert flood flows until several conditions are met. These conditions are: (1) Rainfall has stopped; (2) downstream peak flows have receded and (3) flood stages upstream and downstream of the inlets are below damaging elevations. When these conditions are met for each inlet, the inlet works would be operated to permit the bypass of discharges sufficient to produce the annual flow for environmental purposes downstream of each inlet, and would result in the one year flood stage along the Pompton River Valley and along the Passaic River from the inlet upstream to and beyond Two Bridges. This operation would provide inundation to wetlands and would simulate the natural water quality flushing actions now provided by frequent floods for river reaches downstream of the inlets.

3.98 In addition to the diversion works associated with the two tunnel inlets, two gated weir structures, the Great Piece Meadows Weir and the Pequannock River Weir, would be operated in concert with the tunnels for environmental purposes. The Great Piece Meadows Weir would be located in the Passaic River upstream of Two Bridges (see Figure 60 of the Main Report). The Pequannock River Weir would be located in the modified Pequannock River transition channel (see Figure 47 of the Main Report).

3.99 During periods of normal flow, the gates in the Great Piece Meadows Weir would remain open (lowered) and the flow regime would remain unchanged from current conditions. Under flood conditions the gates in the Great Piece Meadows Weir would remain open (in the lowered position) and the weir would help train flood flows into the Passaic River transition channel leading to the Two Bridges inlet until the peak flood flow has passed. When the peak flood stage has receded to the one year stage, or, if peak stages have not reached the one year stage as predicted, the weir gates would be raised to replicate the one

year flood stage in the Central Basin wetlands upstream of the weir. The one year flood stage would be maintained for a period of time determined necessary to satisfy fish and wildlife needs in the Great Piece Meadows. Once these needs have been met, the gates would be gradually lowered and would again remain completely open under normal conditions. Since the tunnel would not operate for events up to and including the one-year flood, there would be no change in the flow regime for these frequent floods. For all floods larger than the one-year event, the operation of the weir would result in at least the one-year water surface elevation upstream of the weir in the Great Piece Meadows. Table 22 presents water surface elevation data for the 1, 2 and 100 year flood events under with project and without project conditions. For the 100 acres of wetlands located downstream of the weir, the one-year flow bypass rules at the tunnel inlets discussed above would insure that these wetlands also receive the one-year flood stage, although the flooding duration for these 100 acres would be reduced. Although these 100 acres of wetlands may actually be altered by this flow regime change caused by the operation of the project, they were conservatively assessed to be lost with the project, as described in Section 5.

3.100 The Pequannock River Weir would remain closed (in the raised position) during normal conditions to reproduce the water surface elevations that would occur under without project conditions. This condition would maintain normal river stages and flows over the old Morris Canal Feeder Dams on the Pequannock and Ramapo Rivers. During flood events, the gates in the weir would be opened (lowered) to allow the modified channel to function as designed in conjunction with the levee/floodwall systems to provide a 100 year level of protection to the upstream damage areas. As flood flows recede, the gates would be raised to their normal closed position.

CONSTRUCTION OF THE DUAL INLET TUNNEL PLAN

3.101 This plan combines: surface works consisting of channel modifications, levee/floodwall elements, inlet and outlet works and a river flow restrictor; and subsurface works consisting of tunnel excavation. The surface works will be constructed through traditional methods, while the tunnel construction would utilize specialized methods.

3.102 The tunnel would be constructed at an elevation lower than its outlet structure to a depth necessary to reach competent rock which would allow underground construction. In this situation, those occupants located above the route would not be physically aware of the tunnel construction except at the inlet, outlet and construction shaft locations. It has been

determined that the most efficient way to construct the 13.5-mile, 39-foot diameter main tunnel and the 1.2-mile long, 22-foot diameter spur would be through the use of tunnel boring machines (TBM's). The TBM's would be used throughout except in the excavation of the vertical inlets and outlet, the junction of the two tunnels, and four construction shafts which will utilize conventional excavation methods.

3.103 Two TBM's would be used to excavate the main tunnel. Each TBM would be 42.5 feet in diameter. The first machine would begin at a work shaft near the tunnel outlet and excavate through to a work shaft in an abandoned quarry near Montclair College. Concurrent with the operation of the first machine, the second would begin at the Montclair work shaft and excavate through to a work shaft proposed to be located in Preakness Valley Park in Wayne, just above the point where the spur tunnel would join the main tunnel. One smaller TBM, 24.5 feet in diameter, would excavate the spur tunnel beginning at a work shaft located 700 feet west of where the spur will join the main tunnel. Figures 56 and 57 of the Main Report depict the approximate locations of the work shafts. After the main tunnel excavation has progressed to the work shaft in Wayne, drill and shoot excavation will be used to connect the main and spur tunnels. The upper leg of the main tunnel would be excavated last. The TBM would begin at the Pompton inlet and excavate through to the Wayne work shaft. A concrete lining would be placed in each section of the main and spur tunnels after the TBM's have been removed from these sections.

3.104. Whenever the tunnel penetrates groundwater deposits, construction methods will prevent infiltration into the tunnel. The concrete tunnel lining will seal the tunnel against both groundwater infiltration and exfiltration.

3.105. It is estimated that approximately 5,466,000 cubic yards of rock would be excavated as part of the main and spur tunnels. There would be no problem in disposing of this material since it is highly marketable and non-contaminated. As part of the surface works, approximately 1,491,000 cubic yards of earth would be excavated. A portion of this material would be marketable. Materials not marketable would be disposed of in suitable disposal areas.

OPERATION AND MAINTENANCE OF THE DUAL INLET TUNNEL PLAN

3.106 When completed, the operation and maintenance of the Pompton/Passaic Dual Inlet Tunnel Diversion Project would be performed by the local cooperating agency in accordance with government regulations. The various project features would require either periodic or annual maintenance. Periodic inspections of the tunnel structure, and the more frequent

testing of mechanical equipment at gated structures and pump stations would be required. Annual maintenance activities would include debris removal at interior flood control facilities, and at tunnel inlets and outlet structures; shoal removal, riprap repair, trash pickup and brush and tree control in the modified channels; the repair and patching of concrete structures; and mowing, trash pickup, and weed control along levees and ponding areas.

MITIGATION AND ENVIRONMENTAL DESIGN ELEMENTS OF THE DUAL INLET TUNNEL PLAN

3.107 The recommended Dual Inlet Plan includes measures to avoid, minimize, rectify, reduce or compensate for adverse environmental effects of the project. Measures designed to avoid or rectify project impacts combined standard engineering practice and environmental design features. When impacts could not be further avoided or rectified through design or operation features, the reduction or compensation for residual unavoidable impacts was provided through the incorporation of mitigation measures into the project. Significant resources for which environmental design and/or mitigation measures are recommended include terrestrial, aquatic and cultural resources, hazardous substance sites, and riparian parks. The measures provided for each of these resources are described below. Section 5 of the EIS presents a reach-by-reach discussion of project impacts and the environmental design and mitigation features, while the presentation of the recommended plan in Main Report Chapter 6 includes a summary listing of these measures.

3.108 Terrestrial Resources. Project design and operation to avoid and minimize impacts to terrestrial resources combined standard engineering practice and environmental design features. These measures include the operating rules for the project and the Pequannock and Great Piece Meadows Weirs. The project would operate only for events exceeding the one-year flood event. During larger floods for which the tunnel would operate, flood flows would be maintained downstream of the Pompton River Inlet where 500 cubic feet per second (cfs) would be bypassed while the flood peak is rising and the one-year flow would be bypassed after the flood peak recedes. At the Two Bridges Inlet, 100 cfs would be passed downstream while the flood peak is rising, and a flow at least equivalent to the annual flood would pass after peak flows subside. Intervening drainage downstream of both inlets would supplement the released flows. These operating rules, in conjunction with the proposed weirs, address impacts which would have been associated with water regime flow changes (duration, and stage).

3.109 The Pequannock Weir, in conjunction with the maintenance of the USGS weir on the Pompton River, would maintain existing water levels for 125 acres of wetlands in the vicinity of the Pompton Inlet.

3.110 The operation of the Great Piece Meadows Weir, in conjunction with the one-year bypass flows, would minimize changes to the flow regime of frequent floods in the Passaic River Cental Basin, thus avoiding impacts to 1,000 acres of wetlands in the project area. Further, since these weirs are gated, they allow for water level manipulation during periods of droughts providing the flexibility to inundate wetlands during dry periods and can be utilized to enhance the environmental values of these lands.

3.111 The preservation of natural storage areas, in concert with the State/Corps' agreement to maintain existing floodways in acquisition areas, would help avoid secondary development impacts as a result of plan implementation. And finally, the Corps would avoid, where compatible with the project, loss of riparian vegetation during construction activities.

3.112 There are also a number of project elements which rectify, and reduce adverse effects to terrestrial resources. Adverse effects would be concentrated at Central Basin and Pompton tributary levees and associated interior ponding areas, and upstream of the Pompton Inlet due to channel modification sideslopes and the removal of large trees in connection with the protection of inlet works for project operation.

3.113 Ponding areas would be excavated behind levees, removing existing natural cover, mainly forested wetlands. Measures to rectify and reduce these adverse effects include the planting of 630 acres of wetland vegetation in ponding areas to provide for continued wildlife habitat in these areas. This would change the covertype in these ponding areas from predominantly (86%) forested to a mix of wetlands with emergent and the major covertype, but this change would provide an increase in a relatively scarce covertype (emergent). To reduce project impacts to terrestial resources, nest box structures would be added to the ponding areas as a mitigation measure to support species of birds which are associated with emergent wetlands (e.g. insectiverous birds such as swallows). This would also provide insect control in these areas. Upstream of the Pompton Inlet, removal of trees would be offset by planting scrub/shrub vegetation, and placing nesting structures.

3.114 Wetland creation and improvement would be used to reduce and compensate for losses which would occur because of surface project elements including levees, channel modifications and tunnel inlet construction, and to address indirect losses associated with residual flow regime changes downstream of the Great Piece Meadows Weir that could not be avoided. These procedures would be carried out on 185 acres of project lands to return or increase productivity of wetlands which have been degraded by human intrusion.

3.115 Other methods to reduce adverse project effects include stabilization of banks expected to erode, and the use of erosion and sediment control methods (e.g. silt screens). Compensation measures also include replanting of vegetation in the first growing season following project completion, and regrading of topsoil to depths which exist at present.

3.116 Environmental commitments for the recommended plan also include studies to be performed during Phase II engineering and design. These studies are recommended by the U.S. Department of the Interior, Fish and Wildlife Service and include the Habitat Evaluation Procedure (HEP), plant community succesion modeling, and the development of a Comprehensive Wetlands Management Plan to help refine site-specific mitigation within the context of the recommended plan. In concert with these activities, the Corps will organize an Environmental Advisory Board consisting of environmental experts from the Federal, State, and public sectors to guide the detailed environmental planning and design.

3.117 Aquatic Resources. Aquatic resources would also be adversely affected by the project elements. Significant effects on the aquatic component of the project would occur in the area upstream of the proposed Pompton Inlet. Here a well balanced warmwater fishery and a "put and take" trout fishery exists. The Corps has included a number of measures aimed at avoiding, reducing and compensating for impacts to these aquatic resources. The elements include the Pequannock Weir, previously discussed regarding wetland impact avoidance, which would also avoid the loss of 15 acres of Ramapo River aquatic riverine habitat, and maintain existing water surface elevations upstream of the weir, thus increasing water depths due to channel excavation.

3.118 Reduction of aquatic impacts would be accomplished by maintaining meanders wherever possible (i.e. compatible with sound engineering practices and design), and maintaining modal flows on the Pompton River for all occasions. Modal flows at Beatties Dam would be maintained under all conditions except the initial portion of infrequent events while the flood peak is rising; during this time flows would be diverted to avoid Lower Valley flood damages.

3.119 Cobble substrate would be used in those reaches of the Ramapo, Pequannock and Wanaque Rivers, where channel modifications are required, as well as for compensation for the loss of anadromous fish habitat downstream of Dundee Dam. This substrate would be obtained from the existing river bed in the affected channel reaches, and from tunnel excavated material. Where cobble exists at present, it would be stock piled and replaced on the channel bottom after channel modifications are completed. Additionally, extra substrate from cobble sized tunnel excavation would be placed in the affected reaches to help compensate for channel modification impacts (e.g. loss of overhanging banks).

3.120 The use of tunnel excavation cobble downstream of Dundee Dam, below an existing cobble field, would provide increased habitat for anadromous clupeid fish species, and would be used to compensate for loss of habitat at the tunnel outlet.

3.121 To further reduce adverse project effects on the aquatic resources, pilot channels would be included along the upstream portions of the affected reaches of the Pequannock and Wanaque Rivers. Additional compensation would occur in the form of wing dam structures to be placed in the uppermost portion of the Pompton River. These habitat structures would help to further offset channel modification impacts. Public access for angling in the affected reaches would also be provided as part of the protective works.

3.122 In addition to the studies discussed in paragraph 3.116 above regarding terrestrial resources, during the Phase II engineering phase the Instream Flow Incremental Methodology (IFIM) will be utilized to refine site specific aquatic mitigation.

3.123 Cultural Resources. Cultural resources surveys will be conducted during the detailed design phase at all sites where structural elements of the project would be constructed. Current information regarding likely areas for site discovery, coupled with recent development, indicates a low probability of site discovery. However, in the event of such a discovery, mitigation plans would be prepared in close coordination and cooperation with the New Jersey State's Historic Preservation Office and the Advisory Council on Historic Preservation.

3.124 Hazardous Substances. The Corps will also maintain close coordination with the USEPA and NJDEP regarding the status of hazardous substance sites in the vicinity of the project that remain of concern. Coordination will determine the Preliminary Assessment and Site Inspection (PASI) status of these sites.

For sites which would not be scheduled for remediation prior to project construction, and for the sites where there is a potential for residual contamination, on site sampling efforts may include soil core analysis to determine if hazardous substances are within the soil that would be disturbed during construction. The Corps would need to determine the nature of the contaminants, their specific location, and concentrations. Once these data are gathered, a Health and Safety Plan would be formulated in concert with the USEPA, the Occupational Safety and Health Administration, and the NJDEP. The construction of levees and floodwalls would be planned to prevent the spread of any contaminants or their resuspension into the air, soil, groundwater, or surface water systems. Monitoring, if necessary would begin prior to construction to establish existing conditions and would continue as construction progresses. In the event that presently unknown hazardous material sites are encountered during construction (for instance, the discovery of buried drums), construction would be suspended at that site until the area is remediated.

3.125 Riparian Parks. The placement of levees and floodwalls along the Lower Passaic River and Pompton River tributaries would impact on existing parkland and would change the recreational opportunities and aesthetics in the affected areas. Compensation for project impacts to parks would include providing equivalent recreational opportunities on project lands, or monetary payments based on replacement of equivalent public recreation usefulness, size, and quality. These losses are addressed primarily through levee designs that incorporate walking - biking paths on top of the levees along with over-looks, benches, lighting, comfort facilities, river access for recreation and emergency purposes, and planting/beautification landscaping measures aimed at providing recreational opportunities. Final levee designs in concert with further recreational mitigation refinements will be accomplished during Phase II design in coordination with NJDEP and local recreation planners.

SECTION 4. AFFECTED ENVIRONMENT

STUDY AREA DESCRIPTION

4.00 This section describes the affected resources within the study area. The last part of this section is devoted to a summary of significant environmental resources as they occur within specific study reaches (paragraphs 4.169 through 4.201).

4.01 The Passaic River Basin encompasses 935 square miles in northern New Jersey and southeastern New York State. Eighty-four percent of the Basin lies in New Jersey, including all or parts of Passaic, Bergen, Morris, Essex, Sussex, Hudson, Union, and Somerset counties, while sixteen percent of the watershed lies in New York State, occupying parts of Rockland and Orange counties (Figure 1). The watershed is elliptical in shape, 56 miles long and 26 miles wide, with its long axis running northeast-southwest. The basin is drained by the Passaic River and its seven major tributaries: the Saddle, Pompton, Ramapo, Pequannock, Wanaque, Rockaway and Whippany Rivers (Figure 10). The flood problem area lies along the Passaic River Main Stem from its mouth in Newark Bay, upstream for 72 miles to its confluence with the Dead River. This floodplain comprises more than 85 square miles and 50 municipalities. The Passaic River above Chatham was screened from further consideration of flood damage reduction measures early in the study because of a lack of economically feasible plans. The major flood damage areas lie downstream of Chatham to the mouth of the Passaic River, along the entire Pompton Valley, and along the lower reaches of the other major tributaries.

PHYSIOGRAPHY AND GEOLOGY

4.02 The State of New Jersey is situated within parts of two physiographic provinces, commonly known as the Coastal Plain Province and the Appalachian Province. The Coastal Plain Province generally encompasses the southern two thirds of the state lying adjacent to the coastline. The Appalachian Province comprises the remaining one-third or northernmost part of the state. The Passaic River Basin is situated completely within the Appalachian Province, which extends from Central Alabama northeastward into Canada. In turn, the Appalachian Province is subdivided into six lesser geologic provinces, three of which exist in part in New Jersey. From west to east, these are known as: (1) the Appalachian Valley and Ridge (2) the Highlands, and (3) the Piedmont Plains. The Passaic watershed lies within the latter two provinces. These geologically distinct physiographic provinces are shown on Figure 5. The two provinces are divided

by a northeasterly-trending border fault from Morristown in the southwestern part of the basin and continuing along the Ramapo and Mahwah River Valleys, toward Stony Point, New York, just beyond the northeast limit of the basin. The contact of the two physiographic provinces is marked by a steep mountain scarp. The Piedmont Province encompasses a little over one half of the total watershed southeast of the border fault; the Highlands Province comprises the remaining, more rugged, northwestern part of the basin.

4.03 The Highlands Province consists of Precambrian Age metamorphic rocks of the Reading Prong. The rocks are mainly granitoid gneisses with foliated bands of hornblende, pyroxene and mica. Igneous intrusive pegmatite and diabase dikes are located within the gneisses. Iron deposits have been exploited in the metamorphic rocks while radioactive minerals are associated with the scattered pegmatite dikes.

4.04 The Piedmont Province in New Jersey is known geologically as the Newark Basin. Sedimentary rocks which underlie the Piedmont Province consist of sandstones, shales, limy shales and conglomerates. The sandstones and shales are fluvial, flood and alluvial fan deposits with bedding generally 3 feet thick or less. The Watchung Mountains are underlain by igneous basalt which originated as sheet lava flows. Each ridge of the Watchungs is not one lava flow but consists of a series of flows. Long periods of volcanic inactivity between lava flows allowed paleosoils to develop on the top of cooled flows. The rock units are of late Triassic and early Jurassic age. The structure of the Newark Basin is such that progressively younger rocks are exposed toward the northwest. To the east of First Watchung Mountains, the sedimentary rocks are late Triassic in age with the Triassic-Jurassic boundary at the basal contact of the First Watchung. Stratigraphically, the basalt and sedimentary units alternate. Within the Passaic River Basin, the oldest formation to the east is the Passaic Formation. This late Triassic age formation consists of over 4000 feet of sandstone and shale.

TOPOGRAPHY OF LOWER VALLEY AND CENTRAL BASIN

4.05 The Basin is divided naturally into three topographic areas: the Lower Valley, the Central Basin, and the Highland Area, as shown on Figure 5. The Lower Valley comprises 173 square miles along the lower Passaic River from Newark Bay upstream to Little Falls. This 8 mile wide by 26 mile long area is almost completely developed and densely populated. The valley is comparatively wide and flat-bottomed with rolling sides. It narrows down to about three-quarters of a mile wide below Dundee Dam. The average elevation of the area is about

250 feet mean sea level (msl), varying from 500 feet msl along its western edge to sea level at Newark Bay. The Main Stem Passaic has a generally flat stream slope of 2.9 feet per mile, with the exception of sharp changes in elevations at three dams. These dams result in drops of 33 feet at Little Falls, 63-feet at the Great Falls, and 17-feet at Dundee Dam. The Saddle River, the major Lower Valley tributary, has its confluence with the Passaic River 15.5 miles above Newark Bay, and has an average stream slope of 22 feet per mile. The Third River joins the Passaic River 11 miles above the mouth. The smaller tributaries, which join the Main Stem Passaic River at intervals below Two Bridges, are short and precipitous, with average stream slopes varying from 45 to 194 feet per mile. The reach of the river downstream from Dundee Dam is affected by tides from Newark Bay.

4.06 The 262-square-mile Central Basin, is a flat, oval-shaped depression about 10 miles wide and 30 miles long, that lies between the foot of the easterly slope of the Highland Area and the Watchung Mountains to the south and east. This area includes more than 24,100 acres of wetlands above Little Falls. These wetlands include the Great Piece Meadows, Hatfield Swamp, Troy Meadows, Black Meadows, and Bog and Vly Meadows.

4.07 The Passaic River enters this area from the southwest and meanders generally to the north and east until it passes through the gorge at Little Falls. The elevation of the Central Basin averages 300 feet mean sea level (msl), varying from about 500 feet msl at the rim of the basin to 160 feet msl at the northeast end. The average stream slope varies from 19.5 feet per mile in the area above Chatham to 1.4 feet per mile through the floodplain downstream of Chatham.

SEISMOLOGY

4.08 According to "Earthquake Design and Analysis for Corps of Engineers Project" (ER 1110-2-1806), the Passaic River Basin is located in Seismic Zone 2, a moderate seismic damage zone. Earthquake activity has occurred sporadically within the Passaic River Basin during the past 200 years (Figure 6). The historic earthquakes in the basin have been minor and caused no damage (Table 9). Most of the activity has occurred in the Highland Area along the Ramapo Fault outside of the Main Stem Passaic Study area. The epicenters are shallow, 2 to 6 km, with magnitudes 1 to 3 based on the Richter scale. The epicenters are deeper to the southeast, following the dip of the Ramapo fault. The Ramapo fault itself is not active, according to studies of drill cores, and there is no evidence of displacement

of the surficial deposits or glacially polished bedrock. Two sets of earthquakes did occur within the project area: the first set was located in the vicinity of Montclair in 1902; the second set was centered in the southeastern section of Hatfield Swamp in 1938.

LAND USE

4.09 The Lower Valley is the oldest and most densely developed portion of the Passaic Basin, containing older urban areas, such as the cities of Newark, Passaic and Paterson, where high-density multi-family housing predominates. The area from Newark to Paterson is almost completely developed because of its proximity to these cities and New York City. Outside the older cities, the houses are primarily single or two family (see Figure 7 in the Main Report).

4.10 Floodplain land uses in the Lower Valley are primarily commercial and industrial with large areas of residential. There is very little open space, but development is interspersed with linear parks along the lower Passaic River, particularly along its east bank in the Bergen County portion of the area. Route 21 runs along the right bank of the River from Newark to Clifton. Very little wetland area remains in the Lower Valley, with only approximately 85 acres occurring intermittently along the river (Figure 14).

4.11 The Central Basin may be characterized as almost completely suburban, with the single family house, the predominant housing type. However, garden apartments have increased along major automobile routes and in the eastern towns of Wayne and Livingston.

4.12 Many of Central Passaic area residents commute to the Newark-Paterson core and into New York City. The trend of business and light industry moving to the suburbs, however, is reflected in the Central Basin. The major highways linking the region to the urban complex are lined with strip commercial development and shopping centers.

4.13 Open land in the Central Basin is more than 13% wetland, although large areas of other types of open space may be found throughout (see Figure 61 of the Main Report). The wetland areas include Troy Meadows in East Hanover and Parsippany-Troy Hills; Black Meadows in Hanover, East Hanover, and Florham Park; Bog and Vly Meadows in Montville, Pequannock, and Lincoln Park; Great Piece Meadows in Lincoln Park, Fairfield, and Montville; Hatfield Swamp in West Caldwell, East Hanover, Montville, and Parsippany-Troy Hills; and the Great Swamp in Harding, Chatham, and Passaic Townships. Other unnamed wetlands lie along Canoe

Brook and the Pompton River and its tributaries. These wetlands are valuable habitat for flora and fauna and are significant natural storage areas for floodwaters. These expanses of open areas are subject to great development pressures. Along the Passaic River from Little Falls to Livingston, and along the Pompton River, wetlands have been filled for housing developments, shopping centers, and industry. Except for the Great Swamp, which is protected by Federal Government ownership, and Troy Meadows, parts of which are protected by the State of New Jersey and local governments, portions of the wetlands have been under intense development pressure. They are the only remaining expanses of level, undeveloped land that are relatively inexpensive, although they are low lying and flood prone.

4.14 Towns and villages throughout the Central Basin area, especially along the eastern edge, have been experiencing rapid growth. Large amounts of vacant, developable land exist in the Central Basin, even in established towns. Past development has been confined to transportation corridors, leaving many areas that are not directly contiguous to highways vacant and available for development.

HAZARDOUS SUBSTANCE SITES

4.15. The Passaic River Basin lies in the heavily industrialized section of New Jersey. Each year the Passaic Basin counties generate about 200 million pounds of hazardous substances, some of which have been placed in drums and stored in warehouses, dumped without containment in landfills and other dump sites, or illegally dumped elsewhere. Unregulated dumping in such areas has resulted in the leaching of hazardous substances into the soil, groundwater, and surface water resources. The U.S. Environmental Protection Agency, (USEPA) acting under authority of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA, also known as the Superfund Law) and similar legislation has compiled lists of sites containing hazardous substances in what is known as the CERCLIS (referring to CERCLA Information System), which itemizes inactive hazardous substances sites. Their remediation or "clean up" is the responsibility of the State of New Jersey. The most hazardous sites were elevated to the National Priority List, where they come under Federal auspices for remediation.

4.16 Fifty National Priority List and CERCLIS List sites fall within the 100-year floodplain of the Passaic River Basin. (The draft EIS listed 52 sites, double-counting Badische and BASF as two separate sites, as well as S & J Waste and S & W Waste as two separate sites, when in fact, EPA mapping indicated two separate I.D. numbers for the same business in each case). The NPL and CERCLIS sites are listed in Table 10. Most of these sites are well removed from areas of proposed construction.

Thirty-five sites were eliminated as potential impact areas because they are beyond the limits which would be expected to be affected by construction, leaving four National Priority List and 11 CERCLIS sites for a final screening. Table 10 shows that most of the sites were eliminated from further concern because they are well upstream or upland of the project limits, which are taken to be at least 500 feet from construction areas for CERCLIS sites and 2,000 feet from construction areas for N.P.L. sites. Table 11 lists each of the 15 sites resulting from the first screening, gives the rationale for the screening down to the final eight sites of concern along with the dates of all preliminary assessments (PA) and site inspections (SI), the dates of follow up inspections, lists of the hazardous substances at the site, and if remediation is scheduled, its date. Figure 7 maps all N.P.L. sites within the 100 year floodplain of the basin plus the eight final sites of concern, which are all CERCLIS sites.

4.17 As a result of this analysis, eight sites remain a concern and will require close coordination with the USEPA and the New Jersey Department of Environmental Protection (NJDEP), and will also require special construction planning due to the nature of the unconfined hazardous substances at the sites. At three sites steps have already been taken to remediate; of these, two are no longer classified as hazardous storage and disposal sites. The eight CERCLIS sites are all in the Lower Valley.

4.18 Four of the CERCLIS sites are in Kearny, one each is in Harrison and Passaic City, and two are in Newark. Beginning at Kearny Point, BASF/Badische poses a potential risk of possible residual soil contamination from spills that have already been remediated. Moving north along the Passaic River, and still in Kearny, the Modern Transportation and S & W Waste sites could also contain soil contaminated with hazardous substances. These companies are licensed by the State to handle and dispose of hazardous substances. However, during recent inspections, soil contamination was found on Modern Transportation's property, and S & W Waste has a history of documented leaks and spills. The Conrail Meadows site in Kearny doesn't contain hazardous substances, but diesel fuel is presently leaking into the soil, the groundwater, and both the Hackensack and Passaic Rivers. Moving further upstream, in Newark, Sherwin-Williams and Benjamin Moore use and generate hazardous substances. These two are remediated CERCLIS sites, but residual contamination may also be sequestered in the soil, and it could be disturbed by construction. The Diamond Shamrock site in Harrison is an unremediated hazardous substances site for which a closure plan has not yet been finalized. Contamination may extend to the bank of the Passaic River at this site. The eighth site is GAESS in Passaic City. USEPA's site inspections documented cardboard barrels, drums, and leaking containers at the site

along with carbon tetrachloride, trichloroethylene and heavy metal contamination. While uncontained runoff enters the river from this site, it has been deemed "low seriousness" in priority for remediation. Additional information concerning these CERCLIS sites is in Appendix B - Natural Resources, Section 8.

4.19 In addition to the above eight sites, a Superfund site, Diamond Alkali at 80 Lister Avenue in Newark, is currently being remediated under the joint auspices of USEPA and NJDEP. EPA selected a remediation plan and final design planning has commenced for containing the contaminated materials at the site. The standing buildings will be demolished and spread over the site along with the contaminated contents of containers that are presently stacked at the site. This rubble will then be capped with multiple layers of clay and geofabrics that will form an impermeable covering over the entire site. When completed, the waterproof cap will stand about eight feet above grade and be joined with a slurry wall that will girdle the site along with the riverside floodwall that will be built to the Corps' specifications to protect the site against flooding. The remediation of the dioxin contamination in this location would be completed prior to the construction of the flood control project, and therefore, has no potential for being impacted by the project. Additional information concerning this and other Superfund sites in the 100-year floodplain is in Appendix B - Natural Resources, Section 8.

4.20 Dioxin Contaminated River Sediments. In addition to upland hazardous sites that are near project features, the NJDEP reports the existence dioxin-contaminated sediments in the Passaic River. These sediments are related to the 80 Lister Avenue Superfund site in Newark. NJDEP has committed to the remediation of the dioxin contamination in this location which would be completed prior to the construction of the flood control project (See paragraphs 5.37 and 5.38 of EIS Section 5).

4.21 Radon. Another hazardous substance of concern is radon gas. This is a form of radioactivity that is released into the air through the natural decay of radioactive materials, generally within bedrock, and which travels to the surface where it dissipates into the atmosphere harmlessly, or seeps into basements and the lower floors of buildings. Here it can concentrate, be inhaled, and introduce radioactivity directly into the body.

4.22 Radioactive minerals are a minor constituent of the metamorphic and igneous rocks of the Highlands Province in the western portion of the Passaic River Basin. The radioactive minerals were formed either through metamorphism, which caused intense melting and heat alteration of pre-existing rocks, or as igneous fluid intrusions. Their occurrence is as a very minor rock component, yet ore-grade concentrations are sporadically located thoughout the Highlands Province. The hazard is recognized in this area and public health officials and homeowners are now dealing with the problem. The diversion tunnel, however, does not penetrate any rocks of the Highland Province and its closest occurrence is 2 miles from the Pompton Plains inlet.

4.23 The Mesozoic-age rocks of the Newark Basin, which include the bedrock along the tunnel alignment, have been extensively studied and there is no detectable presence of radioactive minerals in the rocks to be penetrated by the tunnel. It is noted that there is another area of radioactive minerals, both lesser in areal extent and public knowledge, near the base of the Mesozoic-age sedimentary strata of Newark Basin. The basal formation, the 1,300-foot thick Stockton sandstone, contains radioactive minerals mainly in its top 300 feet. The overlying 750-foot thick Lockatong Formation has concentrations of radioactive minerals mainly in its basal portion though other concentrations are scattered throughout the entire formation. The radioactive minerals are found in lacustrine deposits parallel to bedding and were formed by geochemical reactions long after sediment deposition. Stratigraphically, the Lockatong Formation and upper Stockton Formations are 7,000 feet below the lowest rock penetrated by the tunnel. At the depth of these formations, open joints, necessary for radon gas migration are nonexistent, precluding the presence of radon at tunnel depths or at the surface. Distance wise, these formations outcrop 7 miles east of the Third River tunnel outlet and 3 miles east of Newark Bay, overlain by the Palisades igneous diabase dike.

4.24 As part of the subsurface exploration program for the tunnel, the holes drilled in 1985-86 for this report were surveyed with down-hole natural gamma tools by the U.S. Geological Survey. No significant radioactivity was recorded.

4.25 Radon gas is also produced by radioactive soil contaminated with industrial waste. Its occurrence within the Passaic River Basin and elsewhere is in isolated locations. The closest known site is approximately 4 miles south of the tunnel alignment in Montclair, New Jersey, on the eastern slope of the First Watchung Mountains and of no concern in relation to the tunnel.

4.26 Based on the above, radon is not expected to be found in the tunnel during construction or at any other project location.

GROUNDWATER RESOURCES

4.27 Groundwater is a major source of potable water supply in the Highland Area and Central Basin, since the surface water supplies have been largely developed for export from these areas. Groundwater provides 75% of the potable water used upstream of Little Falls, but represents only 16% of the total developed water supply upstream of Little Falls. The publicly supplied potable water demand of the area is estimated at 61 million gallons per day (mgd) and approximately 45 mgd of this amount is taken from public wells. The importance of this resource brought about the Federal designation of the Sole Source Buried Valley Aquifer in much of Morris County, the western portions of Essex and Union counties, and under northern Somerset County. Figure 8 displays the Buried Valley's designated boundaries. The purpose of this designation is to assure that financial assistance by any Federal program does not lead to contamination of the aquifer through a recharge zone so as to create a significant hazard to public health. A large portion of this aquifer lies beneath the Passaic River between Two Bridges and Chatham and the lower Rockaway and Whippany Rivers. This resource consists of ancient bedrock valleys filled in by glacial outwash materials during the Wisconsin glacial period from about 11,000 to 18,000 years ago. These valleys range in depth up to more than 150 feet, and they have been filled in with a productive sand and gravel aquifer that ranges up to 100 feet in thickness. In some areas this aquifer is covered by a clay layer that can be more than 100 feet thick. In the southern portion of the aquifer, in Chatham and Millburn, the aquifer is largest and most productive, thinning gradually toward the north and the Great Piece Meadows. In the northern portion, the clay layers are thickest and the aquifer is less productive.

4.28 Recharge into the aquifer occurs both from the surface of the ground above the aquifer and from the hills surrounding the Central Basin. The Buried Valley Aquifer is contiguous with and hydraulically connected to the aquifers in the weathered and fractured bedrock underneath. Wells tap both the productive sand and gravel layers and the weathered and fractured bedrock. The bedrock aquifer is recharged by rain falling on the surrounding hills which then flows through the fractures in the bedrock and enters the Buried Valley Aquifer under the confining layers of clay. This source of recharge is confirmed by the artesian conditions that historically existed in the aquifer. Recharge from the ground surface of the aquifer occurs where the surface is pervious, allowing rainfall to flow vertically to the

aquifer. Many areas, however, have a clay layer above the aquifer that is impermeable and greatly reduces vertical recharge to the aquifer. This confining layer occurs throughout the Central Basin in varying thicknesses and recharge varies accordingly. Where the clay layers are thickest, for example, in the northern areas and the Great Piece Meadows, primary recharge into the Buried Valley Aquifer originates in the surrounding hills through the bedrock aquifer route. Further south, where the confining layer of clay is not as thick and, in some areas, not present at all, the Buried Valley Aquifer is recharged directly from the surface as well as from the bedrock aquifer.

4.29 While much of the surface of the aquifer is wetland, the surrounding areas have been developing rapidly, affecting the quality and the quantity of recharge to the aquifer. Although groundwater quality is good, sparse long-term records show increases in all levels of contaminants. Sulfate, nitrate, total dissolved solids, and hardness increases are evidence of low-level contamination and are ultimately related to increased urbanization.

4.30 To a lesser extent, groundwater aquifers exist along the Passaic River from Beatties Dam to Two Bridges and along the Pompton, Pequannock, Wanaque, and Ramapo Rivers. The communities in these reaches are served by public water supply derived from both ground and surface supplies. While these aquifers are less defined than the Sole Source Buried Valley Aquifer, it appears that these aquifers are generally recharged by direct infiltration from the surface, including the river beds and other surface waters. Groundwater is also found in bedrock where there are joints and fractures due to geologic events that occurred prehistorically and due to weathering resulting from exposure thousands of years ago or longer. Most bedrock below the weathered upper layer is generally tight and has a very low groundwater yield. However, the above conditions occur in many areas of the basin and there are wells that tap bedrock as a source of groundwater. Additional information on groundwater is in Appendix B - Natural Resources, Section 4; and in Appendix A - Public Involvement Attachments A46 and A47.

SURFACE WATER SUPPLY

4.31 The Passaic River Basin has already been extensively developed for water supply. The water supply study area extends beyond the basin's boundary because of the seven large water purveyors that service northeastern New Jersey, and includes the Passaic, Hackensack, and Raritan River basins.

4.32 Development of the surface water supply systems began in the 1800's when cities experienced groundwater contamination and heavy surface water contamination of local sources; large quantities of pure water were required and even greater quantities were anticipated for the future. As a result, upstream tributaries were developed for the municipal water systems, primarily in the Lower Valley, far removed from their sources. These systems were developed and have grown to their large existing sizes over the years. The Hackensack Water Company, for example, while drawing most of its water from the Hackensack River, also draws water from the Saddle River, and has recently participated with the North Jersey Water Supply Commission in the construction of the Wanaque South Project and Monksville Reservoir. It has a service area that includes 60 communities in Bergen and Hudson Counties. North Jersey District Water Supply Commission is jointly owned by five communities in the Lower Valley, and operates the Wanaque Reservoir as well as the share of the Wanaque South diversion at Two Bridges and Monksville Reservoir. Jersey City, located to the southeast of the basin, draws its supply from reservoirs on the Rockaway River and serves some communities in the basin. Newark, which also owns a large share of the North Jersey District Water Supply Commission, draws from several reservoirs on the Pequannock River in a similar manner. Typically, this water is impounded on the headwaters of rivers that are tributary to the Passaic and transmitted via pipeline to the center of demand. The Passaic Valley Water Commission now draws its water from the Pompton River at the Two Bridges Wanaque South Diversion. It also pumps water from the Pompton River to Point View Reservoir. The purveyors are interrelated directly through many interconnections with each other and with several smaller companies. Figure 9 displays the major surface water supply systems in the Passaic River Basin. Additional information on surface water supply is in the Plan Formulation Appendix.

SEDIMENT TRANSPORT AND RIVERBED CHARACTERISTICS

4.33 Suspended sediment measurements are being taken at area recording stations under normal flow conditions in the Passaic River Basin. Although no data is gathered during floods, some conclusions can be drawn about the existing sediment transport regime based on the substrate characteristics of the channels. Stream bottoms in the upland areas of the Passaic Basin, where slopes are steep, generally consist of cobble, gravel, and sand. These characteristics change to sand, silt, and muck in the flatter, more developed downstream areas. Suspended sediments settle and accumulate at several locations throughout the Basin. There are accumulations behind the Pompton Lakes Dam along the Ramapo River, at the Wanaque Reservoir on the Wanaque

River, in several Newark Water Supply Reservoirs along the Pequannock River, and in Boonton Reservoir on the Rockaway River. Sediment entering the Central Basin is deposited in the meanders and wetlands as the Passaic River flows through Great Piece Meadows. NJDEP's Office of Science and Research studies indicate that only 9% of the sediments in Newark Bay come from the Passaic River.

4.34 Flood events provide mixed effects on the rivers. Higher velocities cause channel bottoms to be scoured and eroded, suspending sediment and transporting it through the system. At the same time, suspended sediment is carried out of the stream-beds and onto the floodplains where it settles as floodwaters recede. The sideslope runoff into the rivers from storm events, will bring new particles into the system that can settle in the channels. In general, there is a net removal from the channels and a net deposition in the floodplain.

AQUATIC RESOURCES AND SURFACE WATER QUALITY

4.35 Overview. The Passaic River proper is approximately 100 miles long, arising in Mendham Township, Morris County, and emptying into Newark Bay (Figure 10). The river displays a varied physical and biological character throughout its course to the bay. The Lower Passaic River from Newark Bay to Beatties Dam at Little Falls flows through highly urbanized areas. The Lower Passaic River has two distinct reaches, its tidal reach from the mouth to Dundee Dam, and its fluvial reach from Dundee Dam to Beatties Dam. The central Passaic River, from Little Falls upstream to the stream gage at Chatham Borough, meanders through Morris, Passaic, Bergen and Essex Counties, maintaining extensive wetlands and supporting a warmwater fish community. The Central Basin area has three distinct reaches, Beatties Dam to Two Bridges, the Pompton River Valley and Two Bridges to Chatham. The Passaic River upstream of Chatham gage was eliminated from consideration early in the study because of a lack of Federal interest. More detailed information on aquatic resources is in Appendix B - Natural Resources, Section 3.

4.36 Lower Valley. The Lower Passaic River, which is designated as Reaches 1 (Newark Bay-Dundee Dam), and 2 (Dundee Dam-Beatties Dam) for the purposes of impact assessment in Section 5, lies between Newark Bay and Little Falls (Beatties Dam), a distance of 29.7 miles. This reach is estuarine for 12.3 miles from Newark Bay to the Rutgers Street Bridge in Belleville, and riverine for 17.4 miles further from there upstream to Beatties Dam (Figure 12). The exact influence of the estuarine effect, i.e., salinity greater than 0.5 parts per thousand, varies with the river flows and the tides. Upstream of Dundee Dam, the aquatic habitat is freshwater.

4.37 Water Quality. Both the freshwater reach and the tidal reach are considered to have very poor water quality (see Figure 11 and Table 12). The density of industrial development and associated land uses generates 10 million gallons per day (MGD) of domestic and processed water, discharged by the 22 Lower Valley sewage and wastewater treatment facilities. The poor quality water flowing from upstream, in combination with nonpoint runoff, results in severely degraded water quality in the Lower Passaic River. The Federal fishable and swimmable goals are not met because of low dissolved oxygen (DO), high nutrients and ammonia, and high fecal coliform counts. The effluent of approximately 100 NJDEP-permitted point sources enter this reach of the Passaic River. Eighty-nine are industrial point sources. The estimated average discharge rate from point sources is approximately 122 MGD (16% of average flow, 820% of the low flow of 15 MGD), 105 MGD from power plants (Table 13). The Peckman River at West Paterson, is an important contributor to poor water quality in the lower Passaic River. Poor water quality is expected to continue as development continues and nonpoint source pollution increases.

4.38 Aquatic Resources. Benthic macroinvertebrate species tolerant of heavy inorganic pollutant loads, are characteristic of the Lower Passaic River (Table 14). Benthic species found include chironomid larvae, tubificid worms, nematodes, leeches, and polychaete worms.

4.39 Sampling in the lower portion of the tidal Passaic River, where open access to Newark Bay still exists, revealed species characteristic of the lower Hudson River estuary. These include Atlantic tomcod, red and silver hake, northern pipefish. Species characteristic of estuarine marsh areas, such as mummichogs and Atlantic silversides, were also found, as were several anadromous fish species including alewife, American shad, blueback herring, striped bass, and white perch. The Dundee Dam blocks the upstream movement of anadromous fish (Figure 13, Tables 15 through 17).

4.40 Fish sampling in the freshwater Lower Passaic River and tributaries indicates a warmwater fishery consisting principally of carp, goldfish, white sucker, American eel and killifish. This abundance of rough, pollution-tolerant fish is indicative of heavy organic loading. However, the persistence of gamefish, such as largemouth bass, indicates that the fishery has not shifted totally to a rough fish composition. Some of the species act as top predators and provide recreational fishing (Table 18 and Figure 12) although NJDEP has advised anglers not to eat finfish or shellfish taken from the Passaic River downstream of Dundee Dam due to high levels of PCB's and dioxin in their edible tissue.

4.41 Lower Valley Tributaries. The Saddle River is the largest Lower Passaic tributary extending 23 miles from Rockland County, New York, to the Passaic River at Garfield, New Jersey. With the exception of its headwaters, the Saddle River suffers from water pollution problems similar to those of the Lower Passaic River, and is also considered to have poor water quality. High organic pollution levels from suburban runoff begin in the upper Saddle River reaches and increase throughout its course. Dissolved oxygen is low, and biological oxygen demand (BOD), fecal coliform content, and ammonia, nitrate, and phosphorus levels are high, especially during low summer flows. The 1500 feet of Saddle River upstream of its mouth would be affected by backwater from the project. Similarly, the Third River tributary also experiences significant water quality problems under low flow conditions. The Third River Bleachery Dam is about 2000 feet upstream of its mouth.

4.42 Central Basin. Moving upstream, the Central Passaic River includes the Main Stem Passaic River between Beatties Dam and Two Bridges, and upstream of Two Bridges, including the lower reaches of the Rockaway and Whippany Rivers. These areas are designated as Reaches 3 and 5 for the purpose of impact assessment in Section 5 of the EIS. These areas are remarkably flat and contain extensive acreages of marshes and swamps, the Great Piece Meadows being the largest. Substantial suburban and industrial development exists in the wetlands of the Caldwells and Fairfield. The Little Falls stream gage, which measures the combined Pompton and Passaic River flows, has recorded an average discharge of 1,160 cubic feet per second (cfs), with recorded extremes of 28,000 and 0 cfs. The Passaic Valley Water Supply Commission has a back-up intake on the Passaic River at Beatties Dam. This facility would only be used in the event that this primary intake on the Pompton River would become inoperable (see 4.53). The major dischargers in this river segment are the Caldwell, Livingston, and Florham Park municipal sewage treatment plants.

4.43 Water Quality. Water quality in the Central Passaic River reach is considered poor. In general, Federal fishable and swimmable goals are not met because of low DO and high BOD, nutrients, ammonia, and fecal coliforms. The relatively higher quality Pompton River water improves the water quality of the main stem at the confluence, but the downstream portions of the reach are degraded by the influx of upstream Passaic River flows and non-point sources. Some 29 NJDEP permitted point sources discharge into the Main Stem (20 of these are industrial) (see Table 13). The estimated average (14-15 MGD) flow from these sources is significant in comparison with low flow conditions. Contravention of the fecal coliform standards continues, and less than minimum acceptable levels of DO, a 24-hour average of

5.0 mg/l, probably occurs during certain times of the year. The nonpoint source loadings of suspended sediment are estimated to be five times that of point sources; however, for BOD, phosphates, and nitrogen, the point source loadings predominate. This situation is expected to continue into the future.

4.44 Aquatic Resources. Sampling of the Central Passaic River revealed a benthic invertebrate community poor in species diversity and number of individuals present. Dredge sampling in the Passaic River at the Route 10 Bridge, produced only aquatic oligochaetes, while sampling near the Route 46 Bridge in Pine Brook found aquatic oligochaetes, and chironomids (fly larvae and pupae). Aquatic oligochaetes and chironomids were also found in the Two Bridges area. These samples indicate a pollution-tolerant community of very low diversity (Table 14 and Figure 12).

4.45 A warmwater fishery regime is found within the Passaic River's reaches in the Central Basin. Carp and golden shiner were the predominant fish species captured during sampling at the Pine Brook and Two Bridges sites. At the Route 10 Bridge-East Hanover site, pumpkinseed and carp predominated. Other fish species represented in low numbers included white sucker, black crappie, spottail shiner, goldfish and silvery minnow. The composition of this fishery, dominated by rough and forage fish and lacking in predatory gamefish, is indicative of a stressed aquatic ecosystem (Table 24 and Figure 12).

4.46 Rockaway River. The Rockaway River, the Central Passaic's largest tributary, is 43 miles long and drains an area of 206 square miles. With the exceptions of limited channel modifications and two impoundments, the Rockaway is largely unaltered. However, floodplain encroachment is severe below Boonton. Physical features of the river vary considerably, and streamflow is dependent on the amount of water released from the Boonton (Jersey City) Reservoir.

4.47 Water Quality. The water quality of the Rockaway River is considered generally good above Boonton Reservoir. The study area reach below the reservoir is considered moderately polluted. Although approximately 18 permitted dischargers are in the Rockaway Subbasin, only minor municipal/institutional dischargers and the Rockaway Valley Regional Sewerage Authority are within the study area. Occasional contravention of the minimum DO standard has been measured at the Pine Brook Station, and fecal coliform levels generally exceed the standards.

4.48 Aquatic Resources. The benthic macroinvertebrate community of the lower Rockaway River is composed largely of organisms tolerant of organically enriched waters. Chironomid larvae, aquatic oligochaetes, amphipods, and caddisfly larvae were found at lower Rockaway River sampling sites (see Table 14, and Figure 12).

4.49 Fish sampling in the Rockaway River produced a moderate array of forage species, panfish, and gamefish. This distribution indicates a warmwater fishery with some degradation of water quality. This shift toward more pollution-tolerant species increases in the lower Rockaway River (Table 22 and Figure 12).

4.50 Whippany River. The Whippany River is 21 miles long, and drains an area of 72 square miles in Morris County. It has two distinct zones that influence water quality. The headwaters consist of rapidly moving stretches with small pools and eddies. Downstream, the Whippany widens, forming a slow, meandering river traversing large wetlands. It meets the Rockaway River in the Hatfield Swamp-Troy Meadows area in Hanover, East Hanover and Parsippany-Troy Hills. Black Meadows, Lee Meadows, and Troy Meadows are the three major freshwater wetlands. The Whippany River is moderately channelized in its lower reaches. Suburban development in the floodplain is a severe problem.

4.51 Water Quality. The water quality of the Whippany River is good above Morristown, and fair to poor in the study area reach. While the upper reach meets Federal fishable and swimmable goals, the lower study area reach does not. There are 38 permitted point source discharges that exist in the subbasin, 17 within the study area including Hanover and Parsippany-Troy Hills as the major dischargers. Point sources are the principal source of BOD, nitrogen, and phosphorus loadings, while nonpoint sources contribute most of the suspended sediment. In general, minimum DO standards are contravened during certain periods, and the fecal coliform standard is substantially contravened.

4.52 Aquatic Resources. The benthic sample was somewhat diverse (10 taxa), but was dominated by pollution-tolerant species i.e. chironomidae (59%) and oligochaeta (11%). Samples from the headwaters of the Whippany River (Brookside in Mendham Township) show brown and rainbow trout and other species more characteristic of a coldwater fishery. Downstream, in the project area, fish samples indicate a stressed warmwater fishery, dominated by white sucker, carp, spottail shiner, golden shiner and panfish. This assemblage of species reflects the poor water quality of the Whippany River below Morristown (Table 23 and Figure 12).

4.53 Pompton River. The Pompton River, with a drainage area of 17 square miles, is the smallest Passaic River tributary. It originates at the confluence of the Pequannock, and Ramapo Rivers, which drain 354 square miles, and flows 6.8 miles south to join the Passaic River at Two Bridges. The Pompton River including the reaches of its tributary streams (Ramapo, Pequannock, and Wanaque Rivers downstream of Hamburg Turnpike) has been designated as Reach 4 for the impact assessment discussion presented in Section 5. The Pompton River flows through a relatively flat and suburban area. Near Two Bridges, the Wanaque South pumping station has the capacity to pump 250 mgd (385 cfs) under specified water quality conditions on an intermittent basis. In addition, the Passaic Valley Water Commission now has its primary intake at this location and is entitled to withdraw up to 75 mgd (115 cfs) on a daily basis. At the upper Pompton, the commission also has a pumping station which diverts water to Point View Reservoir for water supply. The floodplain of the Pompton River is largely developed, with accompanying streambank encroachments.

4.54 Water Quality. Pompton River water quality is considered fair to good. Water quality data is limited for the Pompton Plains Station and the Two Bridges Station. Effluent enters the river from 11 permitted point source dischargers, three minor industrial and eight municipal/institutional. Nonpoint sources are the major producers of suspended sediment loadings, and point sources are predominant in estimated nitrogen, phosphate, and BOD loadings. There are currently two municipal wastewater facilities, at Pompton Lakes and Lincoln Park, discharging about 1.0 and 7.5 MGD, respectively, into the river. The Pompton River is able to assimilate these discharges, and its waters are generally above State standards. The waters of the Pompton are considerably cleaner than the Passaic at the confluence.

4.55 Aquatic Resources. The Pompton River benthic macroinvertebrate community, as characterized by Surber sampling at Jackson Avenue in Pompton Plains and Route 202 in Mountain View, is rather limited (Table 14 and Figure 12). Few specimens were collected at Jackson Avenue, indicating a stressed environment. At Route 202, Chironomid larvae and pupae comprised 98.6% of the sample and is indicative of a stressed environment containing heavy pollutant loads.

4.56 Fish sampling produced five species at Jackson Avenue; sampling at the Route 202 Station produced nine species (see Table 19 and Figure 12). The limited fishery is dominated by spottail shiner and panfish, but the species composition of rough fish, forage fish, panfish, and gamefish is better balanced than in the Main Stem Passaic River.

4.57 Pequannock River. The Pequannock River drains an area of 85 square miles. It originates below Canistear Reservoir near Stockholm, and flows 31 miles to join the Ramapo River near Pompton Plains. The basin includes six reservoirs developed by the City of Newark for water supply. Route 23 has eliminated large tracts of floodplain wetlands along the entire length of the river. Only the lower three miles of the Pequannock River fall within the study area.

4.58 Water Quality. The water quality of the Pequannock River is among the best in the Passaic Basin, upstream of the project area. Of the approximately 16 permitted point sources, the average discharge flow is 3-4 MGD over the length of the river, and 2-3 MGD in the study area. However, the reach of the Pequannock River in the project area is located downstream from the Butler-Bloomingdale sewage treatment plant and has been affected by its effluent. The BOD and ammonia concentrations are raised and DO lowered. The Pequannock River meets fishable and swimmable standards, except in the project area downstream of the sewage treatment plant. However, this plant is scheduled to be decommissioned in mid-December 1987. The State of New Jersey anticipates water quality improvement will occur as a result of this closing.

4.59 Aquatic Resources. Benthic invertebrates were moderately broad in diversity, but were dominated (90%) by lumbricalid worms and chironomidae (Table 14 and Figure 12). This imbalance indicates signs of water quality stress.

4.60 A balanced fishery, above the potential project area, was observed on the Pequannock River at Bloomingdale. In the project area sampling at the Riverdale Road Bridge in Pompton Lakes produced 13 fish species, with forage fish predominating (91%) (Table 20). These included white sucker, spottail shiner and creek chub. Panfish were also well represented. Predators were absent, and a large percentage (48%) of the fish were young-of-the-year, indicating an unbalanced fishery. This imbalance is likely the result of degraded water quality and/or reduced flow conditions.

4.61 Wanaque River. The 25-mile-long Wanaque River drains an area of 108 square miles from its origin at Greenwood Lake to its confluence with the Pequannock. The Wanaque Basin can be described as hilly with brooks and lakes in the valleys. It's water quality is high and it meets Federal fishable and swimmable goals. For the most part, the Basin is sparsely developed, with pockets of concentrated population around its numerous lakes. Monksville and Wanaque Reservoirs occur within this subbasin and provide water supply to the Lower Valley and other urban communities. In addition, water is pumped into Wanaque Reservoir from the Ramapo River at Pompton Lake and from

the Pompton River at Two Bridges. There are 16 permitted point source dischargers in the subbasin. The Borough of Wanaque is well developed and has the largest (0.3 MGD) of eight municipal and industrial wastewater treatment facilities. The total discharge of these point sources is 0.6 MGD. The water quality in the Wanaque River is, for the most part, above State standards due to the limited development and small point source contributions. Only the lowest mile of the Wanaque River falls within the study area.

4.62 Aquatic Resources. The benthic macroinvertebrate diversity was found to be moderately broad in the proposed project area and fairly well distributed among the taxa indicating good water quality (see Table 14 and Figure 12).

4.63 A large number of fish species (17) were observed in the Wanaque River at the Riverdale Road Bridge in Pompton Lakes (near the Pequannock/ Wanaque confluence) (Table 20). Spottail shiner and white sucker dominated, and panfish and predatory gamefish were also present. The population structure shows a slight imbalance in favor of forage fish but is, nonetheless, a good warmwater fishery. Additionally, the presence of brown trout in the September collection indicates a holdover marginal coldwater fishery.

4.64 Ramapo River. The Ramapo River drains an area of 160 square miles in New York and New Jersey. It originates at Round Lake near Monroe, New York, and flows 36 miles to the Pequannock River at Pompton Plains. The Ramapo River floodplain has been encroached upon by suburban development, roads, highways, and railroad tracks. The water quality is considered good. The North Jersey District Water Supply Commission has a 150 mgd (231 cfs) pumping station at Pompton Lake Dam which is used intermittently to pump water to the Wanaque Reservoir. The few water quality problems result from nonpoint source pollution. The lower two miles of the Ramapo River, below Pompton Lake Dam, are in the study area.

4.65 Water Quality. Water quality on the Ramapo River in the project reach is generally good, meeting state standards for temperature, pH, and dissolved oxygen, although turbidity occasionally exceeds standards. Specific conductivity and alkalinity are generally moderate and the water can be classified as moderately hard.

4.66 Aquatic Resources. The benthic macroinvertebrate diversity on the Ramapo River was broad with a moderate distribution of individuals of species, indicating relatively good water quality (Table 14 and Figure 12).

4.67 A relatively limited, but balanced, fishery was observed on the Ramapo River near Pompton Lakes (Table 21). Species numbers were lower than the Wanaque River's, but the percentage of forage to predator species was in better balance with the number of predator species present. This area can be characterized as a fair fishery. This river reach is stocked with trout by NJDEP.

ANADROMOUS FISH

4.68 The connection of the Passaic River to Newark Bay and the Hudson River/New York Bay estuary, coupled with the existence of fresh or nearly freshwater habitats at the upper reaches of the lower Passaic River, downstream of Dundee Dam, creates an aquatic system potentially capable of supporting the reproduction of anadromous fish (see Figure 13). In the Hudson River/New York Bay estuary, anadromous fish species include members of the herring or clupeid family (American shad, hickory shad, blueback herring and alewife), and the temperate bass family (white perch and striped bass).

4.69 Sampling in the lower Passaic River and its tributaries has demonstrated the presence of ripe (ready to spawn) adult alewife, blueback herring and white perch (Table 15). Juvenile (immature) American shad, alewife, blueback herring and white perch have also been captured in the Main Stem and the lower portions of the Passaic River's major tributaries in the reach elow Dundee Dam. These samples indicate successful spawning of American shad, alewife, blueback herring, and white perch. Striped bass have been sighted in the area on a limited basis, although their spawning has not been confirmed. All striped bass specimens collected in this survey were immature fish.

4.70 Poor water quality and limited spawning habitat are the apparent principal reasons preventing the spawning success of anadromous clupeids in the lower Passaic River. Specifically, reduced levels of dissolved oxygen associated with the warm summer temperatures produce "blocks" which can prevent the emigration of juvenile clupeids. Short term drops in dissolved oxygen, such as that documented in September 1981, may kill large numbers of juveniles before emigration can occur. Evidence also indicates that juvenile American shad are not found in waters with dissolved oxygen levels below 5 mg/l.

4.71 Spawning habitat requirements for anadromous clupeids varies from clean, swift-moving water with a sand and gravel substrate, for blueback herring, to sluggish flows where the bottom substrate may range from gravel to detritus, in the case of alewife. American shad prefer sandy to pebbly flats, with the clarity of the water not an important factor. The lower Passaic River is a relatively slow-moving river, with

substantial amounts of fine substrate, and some limited flats. Therefore, alewife are the anadromous clupeid, which should have the best chance of finding suitable habitat. Surveys indicate only limited recruitment of all three species of clupeids; thus, physical-chemical factors such as limited dissolved oxygen, appear to be the crucial elements curbing spawning success. In the future the mix of pollutants is expected to change. That is, point source discharge will continue to abate, but non-point sources are expected to increase due to continued upstream development. Therefore, the future water quality is expected to remain stressed even through the pollution constituence will change.

4.72 PCB and dioxin contamination of aquatic animals and sediments has resulted in fishing restrictions on the lower Passaic River. In 1983, the New Jersey Department of Environmental Protection prohibited the sale and issued an advisory against consumption of all fish and shellfish taken from the tidal Passaic River. In 1984, the advisory was extended to include striped bass and blue crabs in Newark Bay, the Arthur Kill, the Kill Van Kull, and the tidal Hackensack River. A 1985 NJDEP study showed elevated levels of dioxin in the edible tissues of all resident and migratory species tested. These species included blue crab, striped bass, American eel, carp, catfish, and goldfish.

TERRESTRIAL RESOURCES OVERVIEW

4.73 Despite the preponderance of urban and industrial land uses along the lower Passaic River, some habitat types still remain to enhance otherwise limited urban wildlife resources (Figure 14). The few remnants of riparian (riverside) strands, upland habitat areas and linear riverside parks that remain are particularly important as these are the last areas capable of supporting some urban wildlife species (e.g., raccoon and opossum) and of providing contrast to the biologically homogeneous nature of the surrounding cityscape. The habitat diversity in the ravine at Little Falls and the riverbanks that extend for about half a mile above and below the Great Falls also add to the limited habitat diversity and species richness in the Lower Valley. The estuarine and riverine wetlands of the Passaic River downstream of Dundee Dam provide some habitat for spawning anadromous fish, which are known to occur there in low numbers.

4.74 The dominant feature of the Central Basin's terrestrial resources is the wetlands in its floodplains (Figure 61 in the Main Report). Most, but not all, of the 24,485 acres of natural storage acres in the Basin are wetlands. Approximately 13,000 acres of wetlands are in the project area, and constitute

habitats with plant and animal communities different from those typical of northern New Jersey uplands. Some of these wetlands are isolated and fragmented and not all serve as natural flood storage areas. Additional information on terrestrial resources is in Appendix B - Natural Resources, Section 2.

VEGETATION

4.75 Most of the land along the lower Passaic River up to Beatties Dam is in urban use and most of its vegetation is classified as upland cover types of an urban nature.

4.76 Lower Passaic River wetlands have been almost all eliminated, with over 7,500 acres filled and developed in the Lower Valley alone since 1940. Only a few remnant pockets of wetlands exist. Riparian wetlands in the Lower Valley are characterized as irregularly spaced, discontinuous, remnant pockets.

4.77 Below Dundee Dam, 45 acres of wetlands remain. They consist of four acres of palustrine forest, one acre of palustrine scrub-shrub wetland, and 40 acres of emergent wetlands.

4.78 Between Dundee Dam and Beatties Dam some 40 acres of wetlands exist. They consist of 30 acres of palustrine forest and 10 acres of palustrine scrub-shrub, and are scattered along the river edge.

4.79 The Central Basin consists of the remnants of glacial Lake Passaic, which ponded at the inside edge of the recessional moraine associated with the melting Wisconsin glacier, approximately 18,000 years ago. Wetland vegetation, which dominates the remarkably flat areas of the Central Basin, reflects its subsurface clay and silt beds that prevent the infiltration of water. Wetlands are the dominant natural ground cover. The most significant wetlands occur in the Black Meadows, Bog and Vly Meadows, Great Piece Meadows, Troy Meadows, and the Hatfield Swamp. Other wetlands occur along the Passaic River in Florham Park, East Hanover, and Livingston (Hatfield Swamp South and Canoe Brook), along the Lower Pompton Valley and the Upper Pompton Valley (Figure 61 in the Main Report and Table 26).

4.80 The types of wetlands in the Central Basin reflect their stages of seral succession as well as their local soils and hydrologic regimes. The three terrestrial wetland types present include 8,195 acres of palustrine (temporarily to seasonally flooded) forest, 1,530 acres of palustrine scrub-shrub

vegetation, and 3,275 acres of palustrine emergent vegetation (Figure 16). The other natural cover includes upland forests and old fields (Table 26). Over the last 40 years, development has replaced much of the natural vegetation. Remaining vegetation in developed areas is dominated by grass with some shrubs and shade trees.

4.81 Although out of the project area, wetlands upstream of Chatham provide some degree of flood control to the Central Basin by storing, and thus attenuating, floodwaters (Figure 61 in the Main Report). Central Basin wetlands are subject to intense development pressure. Past development has claimed 6,400 acres of wetlands in the Central Basin between 1940 and 1984. The major wetlands in the project area are further described below and additional information can be found in Appendix B - Natural Resources, Section 2.

BLACK MEADOWS

4.82 Black Meadows consists of 1,300 acres within the townships of Florham Park, East Hanover, and Hanover (Figure 17). This wetland is bounded by New Jersey State Highway Route 10 to the north, Ridgedale Avenue to the east, and Park Avenue, Ford Hill and Whippany Road to the west. Columbia Road (County Route 510) divides the southern portion of Black Meadows from the other major wetlands leaving two small wetland areas to the south.

4.83 A large portion (42%) of Black Meadows is covered by a broad-leaved persistent emergent vegetation community consisting of reed grass (Phragmites australis), reed canary grass (Phalaris arundinacea), and cattails (Typha spp.). Concentrations of the reed canary grass seem to occur most extensively in the noticeably drained areas of Black Meadows. Scattered throughout this wetland are patches of palustrine scrub-shrub communities (13%) and open sedge-grass wetlands (8%). Along the edges of the meadow is a border of scrub-shrub with a mixed hardwood palustrine forest (36%). (See Figure 17 for the vegetation map of Black Meadows and Table 26.) Black Meadows vegetation has been affected by landfills along its perimeter and the placement of Morristown Airport. A boundary and zoning map of Black Meadows and additional information is in Appendix B - Natural Resources, Section 2.

BOG AND VLY MEADOWS

4.84 Bog and Vly Meadows, encompassing an area of approximately 650 acres, is located within Lincoln Park, Pequannock, and Montville. Vegetation types and habitats found in Bog and Vly Meadows are diverse. They include palustrine mixed hardwood

forest (60%), palustrine scrub-shrub (13%), and palustrine emergent (27%) communities. A hillside on the northwest edge of the meadow rises 100-200 feet above the 185-foot base elevation of the Bog and Vly Meadows. A mixed oak hardwood upland forest and several palustrine forest types dominate this hillside. A wide stretch of an old field plant community now succeeding to shrub and young tree stages extends from the top of the hill to the wetland base level between two of the wooded areas. If one travels east, a vast area consisting of cattails and reeds extends eastward across West Ditch. In the past, Bog and Vly Meadows vegetation has been adversely affected by transverse ditching (see Figure 18 for the vegetation map of Bog and Vly Meadows and Table 26). A boundary and zoning map of Bog and Vly Meadows and additional information is in Appendix B - Natural Resources, Section 2.

GREAT PIECE MEADOWS

4.85 The Great Piece Meadows, 4,005 acres in area, is located in Fairfield, Lincoln Park, and Montville. The largest and lowest of the wetlands, it acts as a natural flood retention area, receiving backwater from the Pompton River and the flow of the Main Stem Passaic River. During non-flood periods, these wetlands provide habitats for a great diversity and number of reptiles, amphibians, birds and mammals.

4.86 More than 77% of the Great Piece Meadows consists of palustrine mixed hardwood forested wetland, or swamp (Figure 19 and Table 26). The remaining vegetative cover types consist of stretches and islands of palustrine scrub-shrub communities (10%), scatterings of cattail-reed communities, and small areas of open sedge-grass communities. Much of this open sedge-grass (13%) has been drained, and is dry enough to support crop feeding game, stocked in a wildlife hunting preserve.

4.87 In the Great Piece Meadows, vegetation near the river is greatly affected by the extreme fluctuations in flood levels. This meadow has functioned as a natural retention basin for centuries. However, evidence of washouts resulting from severe flooding is characterized by the silty soils, scanty forest ground cover, and exposed tree roots in forested areas. A boundary and zoning map of Great Piece Meadows and additional information is in Appendix B - Natural Resources, Section 2.

HATFIELD SWAMP

4.88 Hatfield Swamp comprises an area of 1,775 acres located in Roseland, East Hanover, West Caldwell, Fairfield, Montville and Parsippany-Troy Hills. The Passaic River flows through the swamp to the north. The Rockaway and Whippany Rivers merge in the western portion, and the Rockaway River meets the Passaic River in the central portion. A large number of drainage and mosquito control ditches extend from the Passaic River throughout the eastern region of the swamp.

4.89 The two major vegetation communities found in Hatfield Swamp are the mixed palustrine forest (66%) and open sedge-grass emergent (23%) wetlands (Figure 20 and Table 26). Scrub-shrub communities (5%) fringe electricity-gas corridors and are interspersed among the mixed hardwood floodplain forests and border drainage ditches. A maple floodplain forest (5%) is located in the southeastern sector. Abandoned fields lie south of the border forest west of Passaic Avenue. The southwest sector contains emergent aquatic vegetation dominated by river bulrush (Scirpus fluviatilis); the south central sector east of the Passaic River has several well-drained fields dominated by goldenrod (Solidago spp.) and species of smartweed (Polygonum spp.). Hatfield Swamp has a variety of vegetation communities but has been adversely affected by mosquito ditching.

4.90 Hatfield Swamp South. The area designated Hatfield Swamp South is at present somewhat separated from the main body of Hatfield Swamp by a combination of high ground and development along the river. There are 605 acres within this wetland in large, but segmented, sections. About 190 acres are in the floodway and 175 acres are parkland. The predominant wetland cover type is palustrine forested (79%) with 12% scrub-shrub and 9% emergent wetland. As with many other wetlands, activity of man has segmented and encroached upon this wetland, thus diminishing its capacity to support wildlife (Figure 61 in the Main Report). A boundary and zoning map of Great Piece Meadows and additional information is in Appendix B - Natural Resources, Section 2.

TROY MEADOWS

4.91 Troy Meadows has been designated a National Natural Landmark and includes a large cattail marsh and a number of different plant communities. The wetland is the second largest wetland in the study area, encompassing approximately 2,390 acres. It is located in Parsippany-Troy Hills, Hanover and East Hanover. Troy Brook and the Whippany River flow though Troy

Meadows. West Brook drains the west central section of the meadow eastward into Troy Brook, which empties into the Whippany River. Smith Ditch, a major drainage ditch, begins near Perrine Road and runs in a southeasterly direction to the Whippany River.

4.92 More than 55% of Troy Meadows consists of cattail-reed wetland communities, which favor certain species of waterfowl, rails, and wrens as well as long-tailed weasels (Figure 22 and Table 26). The remaining vegetative habitats include expanses and islands of mixed hardwood forests (29%) and scrub-shrub communities (15%). Troy Meadows also has some distinctive habitats. In contrast to the heavy silt and clay soils that border most of the periphery of the other wetlands, the northeastern sector of Troy Meadows has extensive sandy deposits supporting unusual vegetation communities. The "Pine Island" area in the central region is also apparently a Pleistocene glacial deposit. These habitats, once old farm areas, are unique for a limited number of wildlife and vegetation, and are partially included in the protected area owned by the State of New Jersey. A boundary and zoning map of Troy Meadows and additional information is in Appendix B - Natural Resources, Section 2.

LONG MEADOW

4.93 Long Meadow is the smallest of the major wetlands in the Central Basin, encompassing 200 acres in West Caldwell and Fairfield, and its encroached-upon-nature has greatly dimished its ability to support wildlife. Therefore, Long Meadow is not identified as a major Central Basin wetland. Two watercourses flow through the center of Long Meadow. These are Deepavaal Brook and a canal that flows into the brook from the southern border of the wetland. Deepavaal Brook flows west from the eastern boundary of Long Meadow along the Fairfield-West Caldwell border. Beyond its confluence with the canal, Deepavaal Brook flows north out of the meadow to the Passaic River. Numerous drainage ditches run perpendicular to the brook and canal.

4.94 Approximately 60% of Long Meadow consists of mixed hardwood palustrine forest (Figure 21 and Table 26). Most of this vegetation community is found in the remaining open southern section. The canals and ditches in this area are edged with a disturbed shrub community consisting largely of multiflora rose and blackberry. There are also scattered islands of shrubs on the western side of the canal. The

undeveloped northern area of Long Meadow consists largely of shrubs and sedges. The mixed hardwood palustrine forest in Long Meadow has little understory other than poison ivy and herbs such as jewelweed and clear weed. About 40% of the meadow is palustrine scrub-shrub.

4.95 The close proximity of Route 46, and the completion of Routes I-80, and I-280 have greatly spurred development in this meadow so that it is now a remnant of its former size, has been greatly fragmented, and the remainder is zoned for development. With increased development pressure the remainder of the meadow is in great jeopardy. Site plans for some of the remaining Long Meadow area have been filed (e.g.. portion of Essex County Airport land in natural cover). Past development coupled with ongoing construction continues to greatly diminish this wetland's capability to support wildlife. The same development has also increased runoff, and decreased flood storage capacity. A boundary and zoning map of Long Meadows and additional information is in Appendix B - Natural Resources, Section 2.

UPPER POMPTON VALLEY WETLANDS

4.96 The Pompton tunnel inlet would be located downstream of the confluence of the Pequannock and Ramapo Rivers (Figure 61 in the Main Report). Seasonal flooding at this confluence has produced 215 acres of wetland habitats that have been preserved as undeveloped parkland. The plant community of this wetland is dominated by palustrine forest (84%) and palustrine scrub-shrub (16%). The habitat characteristics of this unnamed area have generally lower habitat suitability index values than the characteristics of other Central Basin wetlands. Productivity of these wetlands is inhibited by the housing development surrounding the river banks, by the relatively small area of the wetlands, and by scouring and erosion of forest floor litter that occurs during seasonal flooding.

LOWER POMPTON VALLEY WETLANDS

4.97 Of the 845 acres in the lower Pompton Valley potential preservation area, 815 acres are wetlands. They are located mainly along Packanack and Beaver Dam Brooks and various sections of the Pompton River. The predominant cover type is palustrine forested (85%), with approximately 12% scrub-shrub, and 3% emergent wetlands. This wetland area is stressed by surrounding development, utilization of the areas for recreational activity, and segmenting by the addition of roads and new housing (Figure 61 in the Main Report).

CANOE BROOK WETLANDS

4.98 This is part of a larger area comprising some 1,245 acres, a substantial portion of which is located on water supply property. About 745 acres are within the floodway, with 140 acres in parkland. This area is predominantly palustrine forested wetland (73%) with 18% scrub-shrub, and 9% emergent wetland. Generally, this area is less developed and segmented than some of the other wetlands, because it has been used to maintain water quality of water supply sites, and, therefore, has the potential to support more wildlife species and individuals (Figure 61 in the Main Report).

WILDLIFE

4.99 The general lack of terrestrial habitats along the Lower Passaic River has changed its wildlife composition from indigenous fauna to predominantly human-tolerant species found only in urban settings. Wildlife such as the raccoon, eastern gray squirrel, eastern cottontail rabbit and opossum still exist, but the species numbers are very low, with tolerant species present in disproportionately high numbers. For example, an abundance of house sparrows have filled the environmental niche left by song birds intolerant to humans and their activities.

4.100 Because wetlands in the Lower Valley are isolated and limited in number, their value has been greatly diminished (Figure 14). Loss of bank slopes and wetland habitat has reduced or eliminated almost all sensitive species of amphibians, reptiles and birds. The Passaic River still provides stopover habitats for certain species of waterfowl, such as canvasback, redhead, bufflehead, mallard, and black duck. More tolerant mammals including raccoon, eastern gray squirrel and opossum, survive using the remaining wetlands, parks and the remnant riparian corridors.

4.101 Outside the lower Passaic floodplains, upland habitats provide substantial refuge for wildlife in large parks such as the Garrett Mountain Reservation. Within the project area, only small linear parks provide a little wildlife habitat, except where larger trees and undergrowth are present. This is expected to continue in the future.

4.102 Wildlife in the Central Basin is abundant and diverse, owing largely to the extensive wetlands. Since water is a life requirement for many species, wildlife populations diminish away from the major wetlands for many species. Within the project area, suburban housing and commercial development continue to encroach into the wetlands, destroying them as habitats and

lowering carrying capacities. This, in turn, adversely affects wildlife species composition and numbers. Projected losses of wetlands will greatly reduce their abundance and diversity. Additional information on wildlife is in Appendix B - Natural Resources, Section 2.

AMPHIBIANS

4.103 While a wetland faunal survey (see Appendix B, Natural Resources, Section 2) showed widespread distribution of amphibians throughout the major wetlands, the infrequency with which they were found was noteworthy. Six of the eight salamanders and newts were found infrequently, one only occasionally. Only the red-backed salamander was widely distributed, suggesting that this animal was more adaptable than most amphibians. Since only one salamander species was widely distributed, and seven of the eight were observed only rarely, is likely that newt-salamander habitats are probably diminished and/or degraded by man's intrusion (e.g. roadways, buildings), which reduces large wetland tracts, and their protective nature.

4.104 The blue-spotted salamander, a New Jersey endangered species found exclusively in Passaic River Basin wetlands, has been found in one colony in Great Piece Meadows, and at least two colonies in Troy Meadows. The Jefferson salamander, a New Jersey "undetermined species," was found in Black Meadows. It is important to note that endangered and rare amphibians still exist in the limited wetland habitats remaining.

4.105 Frog and toad species were more commonly found than salamanders and newts. Five of the major wetlands support seven or eight kinds of frogs and toads. The field survey indicated that Long Meadow had only three. An analysis of the frequency with which frogs and toads occurred gives a further indication of this group's viability. While seven frogs and toads were found in abundance and widely distributed, four others were found only rarely. This suggests that habitat loss and degradation may also be affecting this amphibian group. Additional tables and other information on amphibians is in Appendix B - Natural Resources, Section 2.

REPTILES

4.106 Reptiles were found in all major wetlands. The eastern painted turtle and snapping turtle were found in each wetland, and snakes were well distributed. The eastern garter and northern water snakes were present in all wetlands except Long Meadow. The abundance with which reptiles were found presents a more realistic perception of their status. While six reptiles were widely distributed or abundant, eight were rarely found.

The following reptiles are classified as threatened in New Jersey: the wood turtle, the five-lined skink, the black rat snake, and the eastern milk snake. These reptiles were found in only one wetland, indicating that this is probably a declining resource. The greatest reptilian species numbers were in Great Piece Meadows and Troy Meadows, with 11 each. Long Meadow had only three species, the lowest number, and no snakes were found. The other meadows had intermediate numbers of species, six or seven, divided evenly between turtles and snakes.

4.107 There was a relative abundance of turtles. Three species were widely distributed, or common, while three other species were rarely seen. The wood turtle, a New Jersey threatened species, was found only in Great Piece Meadows. The bog turtle, once indigenous to the Passaic River Basin, was not detected. Additional tables and other information on amphibians is in Appendix B - Natural Resources, Section 2.

BIRDS

4.108 A substantial number of bird species inhabit all of the wetlands in the Central Passaic Basin. Many species breed in these locations, while others use them for stopovers during their spring and fall migrations. The wetlands are also used during the winter by northern bird species such as winter finches.

4.109 Troy and Great Piece Meadows have many birds of diverse families, occupying various environmental niches. These include waders, waterfowl, pheasants, rails, shorebirds, woodpeckers, flycatchers, swallows, wrens, warblers, blackbirds and finches. Warblers were most common at Great Piece Meadows and Troy Meadows, reflecting the variety of habitat. Raptors, apex avian predators, were varied and relatively abundant in these two wetlands. Additionally, these two wetlands contained the most New Jersey endangered and threatened species. Great Piece Meadows contained eight State-designated endangered or threatened bird species, including the sedge wren and Cooper's hawk. Troy Meadows contained five New Jersey endangered or threatened species, including the sedge wren. Additional tables and other information on birds is in Appendix B - Natural Resources, Section 2.

MAMMALS

4.110 Troy Meadows with 24, Bog and Vly Meadows had 20; and Great Piece Meadows with 20, supported the greatest numbers of mammalian species. Black Meadows, 17; Hatfield Swamp, 18; and Long Meadow, the most developed, had 11. White-tailed deer, raccoon, striped skunk, muskrat, fox, chipmunk, and rodents were

found in all named wetlands. Because of their size and requirement for several cover types, white-tailed deer were the most sensitive mammals present. Bat species might begin to be eliminated, since they are very sensitive to habitat changes. Smaller mammals vary in adaptability. Chipmunks were still present in all wetlands, but their numbers might be reduced substantially by development. Raccoons, on the other hand, are very adaptable and coexist well with man in suburban settings.

4.111 Troy Meadows had the highest number of mammal species because of its minimal water fluctuations. The hydrologic regime varies greatly in Great Piece Meadows, with considerable flood scouring, but its large size still provides extensive refuges and supports a diversity of mammals. While Black Meadows, Bog and Vly Meadows, and Hatfield Swamp have been partially developed, they still host a moderate diversity of mammals due to their relatively large size and relatively stable water levels. Long Meadow still has a population of white-tailed deer, which is surprising in view of its small size, proximity to humans, and lack of habitat diversity. Continued existence of this herd is unlikely. In summary, Troy, Bog and Vly, and Great Piece Meadows represent the largest refuges with the most diverse mammalian species. Additional tables and other information on mammals is in Appendix B - Natural Resources, Section 2.

UPLAND WILDLIFE

4.112 Within the Central Basin, six randomly selected upland sites were inventoried to obtain a generalized picture of wildlife associated with upland ground cover. Birds were the most common wildlife found. The number and types of species of birds observed varied in relation to nearby suburban development, and the age and density of the tree stand. Greatest species richness was encountered along the Pompton River near Bog and Vly Meadows. Here, large numbers and species of warblers found include yellow, magnolia, Tennessee, ovenbird, and common yellowthroat. This area appears to be on a warbler migration route. Also present were the tufted titmouse, black-capped chickadee, red-winged blackbird, rufous-sided towhee, rose-breasted grosbeak, and the cardinal.

4.113 Fewer bird species were found along the Passaic River, because of suburban development and the homogeneous age of the tree stands. Nonetheless, many of the same species were seen, although warblers were less common.

4.114 Only four species of mammals were found in the limited upland survey: the eastern cottontail rabbit, opossum, chipmunk and the white-tailed deer. Certain species of rodents and the raccoon also occur in these sites. No amphibians or reptiles (herpetiles) were observed either directly or through indirect evidence in the Central Passaic River Basin's upland surveys. The failure to observe herpetiles and small mammals may have been reflective of the limited nature of the survey, in the upland areas.

4.115 Because birds are vocal and most visible, they represent a group that can be used to indicate species diversity between differing ground cover types. Comparison of natural upland sites to suburban sites revealed a much greater species richness for the natural areas. The natural upland sites had an average of 11 species, while suburban sites averaged only four species per site. Suburban areas contained human-tolerant species such as rock dove, starling, song sparrow, grackle and bluejay.

ENDANGERED AND THREATENED SPECIES

4.116 A literature and herbarium search was conducted to determine the existence of Federal designated or nominated endangered or threatened plant species in the Lower Valley. No designated or nominated species were discovered. Similarly, no New Jersey endangered or threatened plant species were found in the potential project area.

4.117 With the exception of incidental occurrences associated with the migratory patterns of the bald eagle and peregrine falcon, there are no Federal designated threatened or endangered animal species known to inhabit the Lower Valley. One fish species which the State of New Jersey classifies as threatened, the American shad, was found in the Lower Valley. It was documented as being there during a 1981 fishery survey.

4.118 A herbarium and field search was also conducted for Federal endangered and threatened plant species in the Central Basin. None were found in the study area. Also, no New Jersey endangered plant species have been reported in the project area, although, two rare plant species may still exist, one species in Troy Meadows and another in Great Piece Meadows.

4.119 A literature search was conducted for Federal threatened or endangered animal species that might occur within the potential project area in the Central Basin. None were found, although the bald eagle and the peregrine falcon use the project area during their migratory movements.

4.120 Currently, at least five of New Jersey endangered animal species are known to inhabit the Passaic River Basins project area. They include the blue-spotted salamander, pied-billed grebe, northern harrier, Cooper's hawk, and the sedge wren. All were found in the Central Basin. The blue-spotted salamander, which historically inhabit the Troy, Bog and Vly, Great Piece Meadows and Hatfield Swamp, was found only in Troy and Great Piece Meadows.

4.121 Great Piece Meadows sustains the following State-endangered species: blue-spotted salamander, pied-billed grebe, Cooper's hawk, northern harrier, and the sedge wren. Northern harriers were seen in Bog and Vly Meadows and Hatfield Swamp, while the sedge wren occurs not only in Troy and Black Meadows and in the Hatfield Swamp. New Jersey's threatened species, in the project area, include; wood turtle, great blue heron, osprey, red-shouldered hawk, barred owl, bobolink and Savannah sparrow. Three threatened species were found exclusively in Great Piece Meadows: the wood turtle, the red-shouldered hawk, and the barred owl. The barred owl was formerly also known to exist in Hatfield Swamp. The bobolink was observed in Black Meadows. The Savannah sparrow occurred in Bog and Vly, Great Piece, and Troy Meadows. The great blue heron was formerly recorded by NJDEP as having only one active colony in the project area. A survey recorded great blue herons not only in Great Piece Meadows, but also in Bog and Vly Meadows and in Hatfield Swamp, although their breeding status was not determined. Other categories of animals in need of protection, whose status is uncertain, include the Jefferson salamander (Black Meadows), upland chorus frog (Black Meadows and Bog and Vly Meadows, black duck (Black Meadows and Troy Meadows), and the sharp-shinned hawk (Troy Meadows). Animals in the declining category include northern red salamander (Great Piece Meadows), common loon (Troy Meadows), least bittern (Troy Meadows), American bittern (Troy Meadows, Hatfield Swamp), horned lark (Black Meadows), purple martin (Black Meadows, Bog and Vly Meadows, Great Piece Meadow), white-eyed vireo (Bog and Vly Meadows), yellow-breasted chat (Troy Meadows), hooded warbler (Troy Meadows), and the eastern meadowlark (Great Piece Meadows). Additional on endangered and threatened species is in Appendix B - Natural Resources, Section 5.

PREHISTORIC RESOURCES

4.122 Prehistoric resources along the Passaic River's project reaches vary in number, quality and the amount of disturbance to which they have been subjected. All known sites were mapped as described in Appendix B - Natural Resources, Section 7. The mapped densities are described here. No data exist on pre-historic sites along the Passaic River from Newark Bay to the

Third River. Historic development and subsequent redevelopment of the riverbanks have disturbed areas in which archaeological sites are likely to occur. Building, paving and other structures preclude subsurface testing for prehistoric resources in many areas. Along the Passaic River from the Third River to upstream of its confluence with the Saddle River, prehistoric sites have been identified in relatively high densities of more than three sites per square mile. The Dundee Dam area has from one to three sites per square mile. The area from the Garden State Parkway to 0.8 miles upstream of the Lincoln Avenue Bridge in Paterson has high densities, with more than three sites per square mile. The Great Falls area has a low density. The Totowa Road area also has few sites, while the Passaic River near Route 46 has a high number of sites. No data are available on densities upstream of Route 46.

4.123 Generally, pristine areas of the Central Basin have high probabilities for the occurrence of archaeological sites. Much of this area is flat and low and is still covered with vestiges of swamps that are the relics of Glacial Lake Passaic. At the time of the glacial lake, estimated at 12,000 B.C., the basin had no drainage to the south and east because notches in the Watchung Mountains at Millburn and Paterson were filled with glacial till deposits. Since the Millburn notch is still blocked, the Passaic River presently exits the Central Basin at Paterson. Much of the region is poorly drained, with 24,100 of its acres still wetland. Extensive swamps and marshes are located at the confluences of the Whippany, Rockaway, and Pompton Rivers with the Passaic River. These environments would have provided prehistoric populations with (1) berries in spring through fall, (2) migratory fowl in spring and fall, (3) freshwater shellfish and finfish year-round, and (4) various small game mammals such as raccoons and muskrats. Given this diversity of food resources, a high density of archaeological sites from all prehistoric periods is anticipated, with particularly high densities predictable for Paleo-Indian and Archaic occupations. The most likely location for such sites would be the small knolls remaining in and around the swamps (see Appendix B - Natural Resources, Section 7).

4.124 The likelihood of finding prehistoric archaeological sites intact is greatly diminished by disturbances which followed the digging of mosquito drainage ditches in the 1930's. These excavations permanently lowered the water table levels in the Central Basin wetlands. Subsequent development encroached into the newly emerged dried land on the wetland's edges. Prehistorically, these locations would have been seasonally dry and available for occupation.

4.125 Limited information is available for prehistoric sites in Troy and Black Meadows, although small rises around swamp areas have some potential for prehistoric sites, if they haven't been developed. The Pompton River is predicted to have high site densities from its beginning, at the confluence of the Ramapo and Pequannock Rivers, downstream to about 2 miles above Two Bridges. From Two Bridges to about one and one half miles upstream, medium densities of prehistoric resources are predicted. The entire reach of the Ramapo River in the project area, from its mouth to the Pompton Lakes Dam also has expected densities of three or more prehistoric sites per square mile, as does the Pequannock River to just upstream of Riverdale Avenue in Pompton Lakes Borough. From this point to the upper end of the project area, densities of one to three sites per square mile have been predicted. Additional information on prehistoric resources is in Appendix B - Natural Resources, Section 7.

HISTORIC RESOURCES

4.126 While prehistoric resurces tend to be buried, many historic sites and districts remain above the surface throughout the potential project area. Near the mouth of the Passaic River, a National Historic District includes the Pulaski Skyway and contiguous areas. The riverside areas, starting beneath the Pulaski Skyway and upstream to within 0.5 miles of Great Falls, have a high probability for being nominated as additional historic districts. The Mount Pleasant Cemetery is already recognized as a National Historic District. The area from 0.5 miles downstream of Great Falls to 0.4 miles upstream is a National Historic District. Much of the remainder of the potential project area in the Lower Valley has been predicted to have a high potential for historic districts that may be nominated to the National Register of Historic Places. This high probability exists because Passaic River-related uses of land in the potential project areas are well documented. In addition, the Morris Canal, a National Historic District, closely parallels the Passaic River in Little Falls and West Paterson.

4.127 Many historic properties may remain along the Passaic River within the Central Basin area. Some of the areas near older settled centers and roadways leading to Canoe Brook Reservoir No. 2 may qualify as historic districts. The Canoe Brook Reservoir area itself is not expected to contain historic sites.

4.128 There is high potential for National Historic District quality zones along older north-south roadways such as Passaic Avenue, Walnut Street, Hanover Neck Road, and what is now Eisenhower Parkway, as well as east-west roads such as Orange Avenue, Route 10 and Eagle Rock Avenue. Another major historic east-west transportation route is US 46, located just south of the glacial terminal moraine, which has been used for roads, the Morris Canal, and railroads. The entire area around Route 46 has a high potential for nomination to the National Register of Historic Places. Suburban settlements are likely to contain only isolated or disturbed sites, and marsh areas that are currently unsettled have a very low potential.

4.129 Pompton River's upland areas were first settled by iron producers, with major centers of iron production developing at Pompton Lakes and Bloomingdale. The Pompton Valley has had sand-mining operations as well as a gunpowder works. The river is paralleled by U.S. Route 202, a Revolutionary War road, along which major encampments of the Continental Army were located.

4.130 Two National Historic Districts have been designated in the Pompton Valley. They include the Morris Canal and the Pompton Iron Works. The Morris Canal followed Route 46 and its 4.2 mile long branch went up the Pompton River to the Pompton Iron Works. The Pompton Iron Works is located in the area of the Paterson-Hamburg Turnpike at the Pompton Lakes Dam. The old Morris Canal Feeder Dam is located upstream of the Pompton Plains Cross Road where it straddles both the Pequannock and Ramapo Rivers upstream of their natural confluence. Although it was constructed more than a century ago to divert river flows to the no longer functioning Morris Canal, it is now used for recreational purposes and is owned by the State of New Jersey. The structures consist of dams across both the Pequannock and Ramapo Rivers and earthen dikes between them and at the ends of the dams, for a total length of almost 3,500 feet. Additional information on historic resources is in Appendix B - Natural Resources, Section 7.

PARKS AND RECREATIONAL RESOURCES

4.131 Historically, the Passaic River Basin was a popular recreational area. Up to the first decades of this century, trains brought vacationers who used the rivers for swimming, fishing, and canoeing, but opportunities for fishing, wildlife study, and recreation are still plentiful. The Passaic River Basin's use as a recreational resource arises from the

coincidence of its rich diversity of physical attributes and its proximity to the densely populated New York and New Jersey Metropolitan Region. The demand for outdoor recreational facilities is growing because of increasing population, greater per capita incomes, and increasing leisure time, with larger numbers using a fixed amount of recreational land. The annual visitor attendance of New Jersey State recreation areas quadrupled between 1950 and 1970, testifying to the rapid increase in use. The State Comprehensive Outdoor Recreation Plan (SCORP) documents deficits, expressed in activity days, which represent the extent to which the existing supply fell short of demand for 1980, along with projected deficits which were forecast for the year 2000. Table 28 displays extracts of these for freshwater swimming, boating, fishing, hiking, bicycling, and picnicking.

4.132 Pollution has shifted the use of recreational resources from direct contact water sports to land-based activities in riverside parks, particularly in the Lower Valley, although sculling and fishing from boats persists in some areas. There are also undeveloped parks, riparian preservation areas, and historic sites adjacent to the rivers.

4.133 Most Federal parklands occur as large parcels well upstream and upland of project areas, such as the Morristown National Historic Park and the Great Swamp National Wildlife Refuge, both in Morris County. However, the Great Falls Historic District in Paterson is a riverside preserve, although it is not in the recommended plan's project area. For the most part, the state forests and preservation lands are relatively undeveloped. There is also a large number of county parks with a range of activities and numerous municipal parks and recreational facilities that are available to serve the needs of local residents, although the demands exceed the supplies.

4.134 Recreational activities in the basin occur mainly in county and municipal facilities. Riverside parkland in the Lower Valley is mapped in Figure 14, while Figure 25 provides an aerial view of Riverside Park in Lyndhurst and North Arlington. Table 27 lists all riverside parks that are adjacent to the river and have the potential of being affected by project elements. These parks are generally not able to meet recreational demand during peak days of use, creating peak day demand deficits. For example, in Bergen County, peak day recreational demand deficits exists for all facilities, particularly fresh water swimming, hiking, biking, and picnicking. Most of the counties' and municipalities' recreational facilities currently experience severe peak day deficits in most activities (Table 28).

AESTHETICS

4.135 The aesthetics of the potential project area in the Lower Valley have been affected by urbanization and development along its riverbanks. Parks, pockets of wetlands, cemeteries, the Great Falls, the Little Falls, and the Watchung Mountains represent the only visual diversity from the urbanized landscapes. At Great Falls, a National Natural Landmark and Historic District, the Passaic River drops 77 feet over the First Watchung Mountain from a 280-feet-wide natural waterfall into a deep, narrow chasm. At Little Falls, the Passaic River flows over the Second Watchung Mountain, with rapids descending through a verdant ravine. Its vegetation provides habitats for a wider diversity of wildlife than would be possible in the surrounding cityscape.

4.136 The aesthetics of the Central Basin vary with the extent of the natural setting and the location of the observer. Generally, aesthetics are confined to the rivers themselves and their riparian vegetative corridors, which in some places are a very narrow buffer, and in other places expand into major wetlands. The visual characteristics include the water form, usually extending into the distance, the natural irregular shoreline configuration, and vegetative patterns and textures with many large trees overhanging the water. The water reflecting the vegetation adds interest, but the river's uniform gradient and quiet flow contribute little to visual variety. There are many places, in Wayne and Pequannock for instance, where distant topographic features add depth and visual diversity to a riparian scene.

NATIONWIDE RIVERS INVENTORY

4.137 In accordance with a 10 August 1980 Memorandum to Agency Heads from Chairman, Council on Environmental Quality, it is necessary for Federal agencies to avoid or mitigate adverse effects on rivers identified in the Nationwide Rivers Inventory conducted by the U.S. Department of the Interior. The objective of the Nationwide Rivers Inventory was to identify free-flowing rivers or river segments that possess wild, scenic, or recreational river qualities, but which are not now covered by the protective provisions of the National Wild and Scenic Rivers system (16 U.S.C. 1271 et seq.), and through administrative means provide for the proper consideration of these qualities in Federal and Federally assisted programs. Three reaches within the Passaic River study area are included in the Nationwide Rivers Inventory for recreational qualities.

4.138 The lowermost reach, which has been listed based on its recognized botanical values, extends from Two Bridges upstream a distance of eight miles to Interstate 80. This reach is largely contained within the confines of Great Piece Meadows. The middle reach, a five-mile segment that is noted for its recreational values, extends from Cook's Bridge upstream to the Morris Turnpike, Route 24. The uppermost reach, which is also noted for its botanical values, includes a six-mile segment of the Passaic River from Route 78 to Osborn Mills, as well as a five-mile segment on its Great Brook tributary from its confluence with the Passaic River to Silver Lake. The latter reach is located adjacent to the Great Swamp National Wildlife Refuge.

4.139 Only the lowermost reach in Great Piece Meadows would have the potential to be impacted by the final flood control alternatives for the Passaic River Basin. Therefore, the description and assessment of impacts are limited to that reach. No dams or other obstructions now exist in this reach of river. Its free-flowing condition, therefore, fulfills one of the principal criteria relating to wild and scenic river potential. However, according to the National Park Service, which conducted the Nationwide Rivers Inventory, this reach is also prominently noted for the botanic values of its related lands. (Section 2, Appendix B, Natural Resources, provides details pertaining to the physical, biological, and human use characteristics of the Passaic River within Great Piece Meadows.) While the Passaic River is free-flowing over its eight-mile nominated reach, the Great Piece Meadows near Two Bridges is bordered by Two Bridges Road for 650 feet along its northern bank while its southern bank has been developed from the riverside along Camp Lane to Route 80 and Two Bridges, detracting from its natural setting. (See Vegetation Map in Figure 19, and Aerial Photograph in Figures 28 and 29).

COASTAL RESOURCES

4.140 Coastal resources in the Passaic River Basin fall under the jurisdiction of the Federal Coastal Zone Management Act (P.L. 92-583). This act allows states to manage the program when they promulgate their own regulations. This was accomplished by the State of New Jersey on 28 September 1978 when the State adopted its rules (NJAC7:7E-1.1, et seq.), which were amended six times through 3 February 1986.

4.141 The reach of the Passaic River flood control study that is included in the Coastal Zone extends from the Passaic River's mouth to Dundee Dam, about 17 miles upstream, and for 500 feet of contiguous land on each bank.

4.142 The Passaic River is contained in the Coastal Zone's Northern Waterfront Region, and includes the special urban areas of Belleville, Newark, and Passaic City. This reach, which is designated as a development region, is subject to the criteria established for this region. The Corps' proposed plan has the potential to affect the following areas of Coastal Zone Management concern: anadromous fish, wetlands, historical and archaeological sites, hazardous substances sites, special urban areas, public access, recreational resources, scenery (aesthetics), traffic (transportation), and development potential. Special urban areas, public access, and development potential are discussed below, and the remainder are discussed in their appropriately labeled sections in Section 4 (Affected Environment), and Section 5 (Environmental Effects - Reach 1).

4.143 The special areas within the Passaic Basin that include Belleville, Newark, and Passaic City, have flood protection measures, i.e., floodwalls and levees, proposed as part of the recommended plan. These municipalities would, therefore, receive increased protection from flood events.

4.144 The levees and floodwalls would limit public access unless there are offsetting provisions. Public access, including maintaining commercial, industrial, and recreational facilities, boat ramps and pedestrian amenities have been provided.

4.145 Development potential would not be adversely affected with the project in the development zone (non-wildlife habitat). Although the project's elements (e.g., levees) would greatly reduce the potential for flooding impacts, the protected area is fully developed for residential, commercial, industrial, or recreational uses.

PUBLIC HEALTH AND SAFETY

4.146 In addition to the more obvious hazards and dangers from flooding, such as drowning, cutoff of access and egress, and electrical hazards, there are several other health and safety issues. These include mosquito control, toxic and/or hazardous substances sites, and potable water supply.

4.147 Freshwater swamps and marshlands are potential breeding grounds for mosquitoes, which affect the health, comfort and economic security of the area. Smaller, warm-weather floods, occurring on the average of twice per year, are followed by the

hatching of countless mosquitoes. Up to 10% of the mosquitoes can be of the malaria-transmitting type. The continued development of the floodplain bordering these swamps and marshlands has increased the possibility of a health hazard by bringing increased population in proximity to the mosquito breeding areas.

4.148 The dioxin site at 80 Lister Avenue, in Newark, New Jersey, is well within the 100-year tidal floodplain. The New Jersey Department of Environmental Protection reports the existence of buried, dioxin-contaminated sediments in the Passaic River. Remedial actions for the Lister Avenue site include waterproof capping tied into an impermeable subsurface barrier surrounding the site along with an on-site effluent treatment plan which will contain the dioxins. The State has also committed to remediate the Passaic River sediments. Both of these would be remediated prior to construction of a Corps flood control project, but until remediation, their presence threatens public health and safety, particularly during flood events. The eight CERCLA sites of concern (4.17 and 4.18) in the Lower Valley also pose health risks since a flood of sufficient magnitude could spread hazardous substances into the environment, primarily in the lower Passaic River. (Additional information on dioxin is in 4.19).

4.149 There are also innumerable major hazardous substances waste storage facilities, generators, and sites within the floodplains which could introduce contamination into the human environment during floods.

4.150 In those areas of the floodplain that have on-site sewage disposal, cesspools or septic tanks, home heating oil storage tanks and drinking water wells, flooding contaminates the well water. Many sewage treatment plants are also located in the floodplain where they pollute floodwaters during extreme floods. Dilution of this waste, however, would be very high during flood events, with more likely health problems being caused by the contamination of living areas and the total shutdown of the sewage treatment plants or the inadequate treatment of sewage because of overloaded (flooded) systems. Health hazards associated with this contamination are those virus and associated with human waste products, e.g., typhus and other virus and bacteria-caused diseases, and hazards associated with human exposure to toxic and hazardous substances.

TRANSPORTATION

4.151 Transportation in the Lower Valley is oriented to the movement of people and goods to and from the gateways into Manhattan. Many limited access and multiple-lane highways radiate to the north, west, and south. These multiple-lane highways, and a complex network of secondary highways and local streets illustrate the area's heavy dependence on automobiles and trucks.

4.152 Rail transportation, including freight, commuter and long distance passenger service centers in the Newark-Kearny area where lines converge in large railyards from which only a few commuter tracks leave for the tunnels to New York City. Most of the freight is transferred to trucks. Almost all of the industrial areas from Newark to Paterson are serviced by rail lines or spurs. Many of the highways and commuter rail lines, such as PATH (Port Authority Trans Hudson), in the Lower Valley are subject to flooding and resulting traffic delays.

4.153 Several major highways, are routed through the Central Basin. These include I-80, I-280, U.S. 46, U.S. 202, NJ 10, and NJ 23. Besides these major highways, transportation is provided by primary and secondary highways connecting major highways with well-developed local street networks, a few rail lines through the larger suburbs, and two large general aviation airports, in Morristown and Caldwell. Several small airports, in Basking Ridge, Totowa and Lincoln Park, also service the area. Several large pipeline and powerline rights-of-way also cross the area. Many primary highways and secondary roads are subject to frequent and prolonged flooding, causing significant traffic delays both locally and regionally. Additional information on transportation is in the Main Report, Section 3.

NOISE

4.154 Noise levels are fairly high within the project area because of its urban nature. Higher noise levels are found near major transportation routes and industrial/commercial complexes. These levels are significantly lower in residential areas. Where trees are present in large numbers, dampening of noise levels can be substantial.

4.155 Noise levels in the Central Basin are not as high as those in the Lower Valley because of the Central Basin's more suburban and rural character. Highest levels are found near major transportation routes and commercial zones. However, with projected development, noise levels can be expected to rise.

AIR QUALITY

4.156 EPA and NJDEP have designated the New Jersey area as an Air Quality Maintenance Area. The Lower Basin air quality is monitored primarily at Paterson, the nearest station of NJDEP's Air Quality Monitoring Matrix. Particulates, carbon monoxide, nitrogen oxides, and sulfur dioxide are monitored at this station. For the 11 year period from 1975 to 1985, all but one of the sulfur dioxide, nitrogen dioxide, and total suspended particulate readings at Paterson were lower than the National Ambient Air Quality Standards (NAAQS). The exception was the annual geometric mean primary and secondary standards for total suspended particulates (TSP), which were violated in 1980 However, there were no violations of the 24-hr standards. Carbon monoxide, which was measured for specific 8-hr periods, exceeded primary and secondary standards 53 times from 1975 through 1980, but was below the standards for 1981 and 1982. The NAAQS for the overall photochemical oxidant group, including ozone, nitrogen oxides, carbon monoxide, and hydrocarbons, are exceeded in the project area and throughout northern New Jersey.

4.157 The Central Basin's air quality for sulfur dioxide and carbon monoxide is monitored at the NJDEP Air Quality Monitoring Matrix in Morristown. Particulate matter is measured at various locations in Morris County. Sulfur dioxide, TSP, and ozone levels did not exceed standards for primary or secondary criteria for the period of 1975 through 1985. Carbon monoxide exceeded the 8-hour average standard every year, with the number of contraventions being the highest in the state from 1975 to 1981. From 1982 to 1985 contraventions still occurred, but in greatly reduced numbers. The NAAQS for the overall photochemical oxidant group, including ozone, nitrogen oxides, carbon monoxide, and hydrocarbons, are exceeded in the project area and throughout Northern New Jersey.

4.158 Air quality trends indicate improvements in ozone, carbon monoxide, and lead levels (all predominantly motor vehicle-related improvements) for the 1975 to 1985 period. Contraventions still occur, however, for these and other NAAQs pollutants. This pattern will continue into the future.

SOCIOECONOMIC PROFILES

4.159 The pattern of development and land use in the Passaic River Basin is a result of old urban development in the Lower Valley, while the Central Basin's recent growth is a result of product of the post-World War II trend of suburbanization, interacting with natural physical characteristics. From the City of Newark to the rural western perimeter of the Passaic River Basin, all degrees and stages of development caused by the suburban trend are displayed.

4.160 Concentric patterns of suburban development radiate from the New York-Newark core of the central cities. Smaller urban cores such as Paterson, Passaic, and Morristown generate their own scaled-down patterns of development. This suburbanization trend will continue.

4.161 The impact of this suburban trend on northeastern New Jersey has been dramatic. As suburban development moved progressively away from the urban centers, cities such as Newark lost not only population but part of their economic and social vitality as well. Many of the older suburbs close to the areas underwent extensive redevelopment,and were transformed into high density urban areas. Farther out, development occurred along major highways, but the highest density development occurred closer to the New York City-Hudson-Newark core, and, to a lesser extent, near the secondary urban centers. (Socioeconomic factors are discussed in the Main Report, pages 31 through 36.)

POPULATION

4.162 In 1980, the Passaic River Basin's total population reached 2.5 million. Increases in population between 1970-1980 were reached by the suburban counties of Morris (3%), Somerset (102%), Sussex (68%), Orange (34%), and Rockland (48%), while decreases in population were experienced by the more urbanized counties of Bergen (7%), Essex (9%), Hudson (3%), Passaic (3%), and Union (9%). The total population of the Basin experienced a 38% increase between 1950 and 1980.

4.163 Based on 1980 population densities, the Basin's communities are primarily "suburban" or "suburban/urban" in character. Some 70 municipalities, approximately 53%, are classified as suburban. The mean population density among this group is about 1,203 persons per square mile. More than half of the suburban communities were found in Morris and Bergen counties. A total of 47, or 36%, of all the Basin's municipalities, fall within the suburban/urban category, exhibiting a mean density of 5,153 persons per square mile. Bergen County contained nearly 37% of all such communities. A number of communities in Essex and Passaic counties achieved this density level. (Population is also discussed in Chapter 3 of the Main Report.)

HOUSING

4.164 Housing patterns in the basin follow its concentric land use patterns. The Lower Valley is the oldest and most densely developed portion of the Basin where high-density multifamily housing predominates, with low income and minority groups comprising a large proportion of their populations.

4.165 The portion of the Lower Valley between Newark and Paterson is almost completely developed. This area contains many of the older suburbs that, redeveloped at higher densities because of their strategic locations. Continuous industrial land uses dominate the riverside through the Newark-Kearny reach. Further upstream, apartments, single and two-family homes are interspersed among industrial and commercial land uses until at the northern end, housing dominates the riverside.

4.166 The Central Basin may be characterized as almost completely suburban. Densities range from 2-4 dwelling units per residential acre (d.u./res. acre) in the outer suburban eastern rim and older towns, to less than 2 d.u./res. acre in the rural-suburban western section. In this western section, zoning ranges from one-half to 10 acres. The predominant housing type is the single family house. However, garden apartments have increased along major automobile routes. The eastern towns of Wayne, Livingston, and others have several large apartment complexes. As development increases densities should rise in this area.

INCOME

4.167 In 1980, the median family income in the average of 132 municipalities was $28,892. This figure was well above the median family incomes in New York State ($16,164), New Jersey ($19,800), and throughout the U.S. ($16,841).

4.168 Per capita income is another major indicator of economic conditions within the Basin. Per capita income for the mean community was approximately $9,735, higher than New York State ($7,498), New Jersey ($8,127), and throughout the U.S. ($7,298). These figures are based on 1980 data. (Personal income is discussed in the Main Report, page 34.)

AFFECTED ENVIRONMENT SUMMARY

4.169 This portion of Section 4 includes a reach-by-reach summary of the affected environment as the framework for the environmental effects presented in Section 5 of the EIS. Significant environmental resources which are likely to be affected by one or more of the alternative plans are highlighted and summarized below. Environmental resources which possess institutional, technical or public recognition are designated as significant resources within the evaluation framework. The significant designations were derived in coordination with Federal, State and local agencies, and the public through EIS scoping and reflect refinements based on comments to the DEIS.

Resources determined not to be significant are also treated in Section 5 within the context of the potential degree of impact and/or designation in Section 122 of the 1965 River and Harbors Act. The significant resources are presented within specific reaches as they are organized in paragraph 5.01 of Section 5. These reaches are: Reach 1 - Passaic River mouth to Dundee Dam; Reach 2 - Passaic River from Dundee Dam to Beatties Dam (Little Falls); Reach 3 - Passaic River from Beatties Dam to Two Bridges; Reach 4 - Pompton River Valley; and Reach 5 - Passaic River from Two Bridges to Chatham. Figure 23 displays these planning reaches.

SIGNIFICANT RESOURCES - REACH 1 - PASSAIC RIVER MOUTH TO DUNDEE DAM

4.170 Anadromous Fish. As discussed in paragraphs 4.68 through 4.72, sampling in Reach 1 of the lower Passaic River and its tributaries indicates successful spawning of American shad, alewife, blueback herring, and white perch. Striped bass also use the area on a limited basis, although spawning of striped bass here has not been confirmed. Anadromous fish are recognized as significant because of national institutional recognition by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. However, in the future this is expected to remain a limited resource.

4.171 Wetlands. The extremely dense development in Reach 1 of the Passaic River Lower Valley has diminished and degraded its environmentally sensitive areas. Because so much natural vegetation has been destroyed, the environmentally sensitive areas remaining are even more important owing to their scarcity. Their value as a last refuge for the fish and wildlife species that still exist, however, is limited due to their small size. Within Reach 1, 45 acres of wetland habitat remain, which include 40 acres of emergent wetland (both estuarine and freshwater), four acres of palustrine forested, and one acre of palustrine scrub-shrub wetland.

4.172 The wetlands in Reach 1 are significant, based on technical recognition of their ability to sustain migratory birds and anadromous fish by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

4.173 Parks and Recreation. Riverside parkland in the Lower Valley is significant based on public recognition and existing land use plans, particularly the Passaic Valley Restoration Plan. The plan, formulated through a cooperative effort of Lower Valley residents and communities, grew out of their

original efforts to clean the banks of debris. Through Federal grants and a concerted effort, the Restoration Plan emerged. Riverside parkland, which has the potential to be affected by project features is listed in Table 27.

4.174 Cultural Resources. Due to the extensive riverside development and redevelopment along the Lower Passaic, it is probable that cultural resources have been disturbed or destroyed within the potential project area. Systematic cultural resources surveys will be conducted at all project impact areas prior to construction in order to determine and identify any remaining intact cultural properties and to evaluate their significance.

4.175 Hazardous Substances Sites. As presented in paragraphs 4.15 through 4.20, there are a number of known hazardous substance sites in the Lower Valley that are of concern to potential construction activities associated with the alternative plans. These include eight CERCLA sites, the Diamond Alkali superfund site in Newark, and dioxin-contaminated sediments in the Passaic River channel. Remediation activities at these sites are at various stages of completion (remediation at two CERCLA sites in Newark, Sherwin-Williams and Benjamin Moore, has been completed, although concern exists regarding residual contamination, see paragraph 4.18) and close coordination will be maintained with USEPA and NJDEP.

4.176 Coastal Resources. Reach 1 resources are under the jurisdiction of the State of New Jersey's regulations developed in response to the Coastal Zone Management Act. The Passaic River lies in the Coastal Zone's Northern Waterfront Region, and is designated as a development region which includes the special urban areas of Belleville, Newark, and Passaic City. Coastal resources of concern include anadromous fish, wetlands, historical and archaeological sites, hazardous substances sites, special urban areas, public access, recreational resources, scenery (aesthetics), traffic, and development potential. Coastal resources are significant based on institutional and technical recognition.

4.177 These resources in Reach 1 have been deemed not significant for the reasons listed:

> Air resources in the basin will continue to contravene existing standards for the overall photochemical oxidant group, including ozone, nitrogen oxides, carbon monoxide and hydrocarbons when the project construction would begin. State of the art pollution control devices would be required at construction sites.

Water quality is severely degraded and contaminated. A health advisory exists against eating fish taken from this river reach. (See 4.38 through 4.41.)

Noise levels are high within the project area because of its urban nature. Noise is not considered a significant effect of any of the alternatives. However, there will be temporary construction related noise effects typical of existing levels for the area.

Aesthetics within the project area have been affected by urbanization and development. Natural visual diversity is confined to the remaining riparian parks and wetlands.

Community cohesion would be temporarily disrupted during construction of a project. After a project is completed, community cohesion would be enhanced by eliminating the threat and fear of floods, thereby improving personal income and well being.

Employment would be created by the construction of the recommended plan, contributing to local and regional growth and increased tax revenues. Tax bases would increase, reflecting the higher values of the newly-protected structures within the 100-year floodplain.

Public facilities would no longer be stressed during flood events with flood protection. Police, firemen, rescue workers, and social workers who treat flood victims would be less active during and after flood events. Federal disaster assistance funding would decrease. Neither people nor businesses would be displaced in the study area.

SIGNIFICANT RESOURCES - REACH 2 - DUNDEE DAM TO BEATTIES DAM

4.178 Wetlands. As with Reach 1, this reach has also been highly developed, except for some areas directly adjacent to the river. Thus, environmentally sensitive areas have been eliminated or degraded, and at present only 40 wetland acres, all palustrine forested habitat, remain in the project area. They are scattered throughout the reach, with most of the acreage just downstream of Great Falls and Little Falls, and as the last remaining habitat, are more important due to their scarcity even though their value is limited by small size. The wetlands of Reach 2 are significant, based on technical recognition from FWS and because of their ability to sustain migratory birds.

4.179 Cultural Resources, Aesthetics and Parks. The Great Falls Historic District in Paterson is a 119-acre Federal Park that provides aesthetic views of a National Natural Landmark, the Great Falls, along with picnic facilities within its bounds. In addition to providing recreational facilities, the District has restored factory buildings and the system for deriving power from the water falling through its labyrinthine raceways. It has institutional, technical, and public recognition of its significance.

4.180 Hydropower. Hydropower facilities in the Passaic River Basin are presently limited to three sites, all contained in Reach 2. Moving upstream along the Passaic River, the first facility is encountered at Dundee Dam, located between the cities of Garfield and Clifton. The maximum power capacity of this facility, operated by American Hydropower, is 2.3 megawatts (MW). The next facility, the S.U.M. (Society for Establishing Useful Manufacturers) Dam, is located at the Great Falls in Paterson. The S.U.M. Dam was recently refurbished and is capable of generating 11 MW of electricity. The third facility, Beatties Dam, located at Little Falls, is under the jurisdiction of the Passaic Valley Water Commission. The facility is presently under a feasibility study for hydropower refurbishment. The possible total power output of these plants, however, is a small fraction of the total basin's energy supply.

4.181 These resources have been deemed not significant for the reasons listed:

Air resources as discussed in Reach 1.

Aquatic Resources. The aquatic resources in Reach 2 can be characterized as stressed, due to the presence of both benthic macroinvertebrates and fish which are very tolerant of pollution, and the general lack of pollution-sensitive species. The urbanized and industrialized nature of the area, no doubt, in large part, accounts for this stress. Thus the aquatic resources for this reach are considered to be not significant. (See 4.38 and 4.40.)

Water quality in Reach 2 is degraded and contaminated as discussed in paragraph 4.37.

Noise levels as discussed for Reach 1.

Aesthetics within the project area, except for the Great Falls Historic District described above, are confined to riparian parks and wetlands. The urban character of this reach does not impact technical institutional or public recognition of its aesthetic significance.

Community cohesion as discussed for Reach 1.

Employment as discussed in Reach 1.

Public facilities as discussed for Reach 1.

SIGNIFICANT RESOURCES - REACH 3 - BEATTIES DAM TO TWO BRIDGES

4.182 Wetlands. This reach is relatively short and contains only 5 acres of scattered wetlands. Wetlands are recognized as significant based on technical recognition.

4.183 Cultural Resources. At present, no cultural resources are known to exist on project-related land. The Passaic River impact areas would be systematically surveyed to identify and evaluate any cultural resources prior to construction.

4.184 These resources have been deemed not significant for the reasons listed:

Parks. There are no parks in the project area in Reach 3.

Air resources as discussed in Reach 1.

Water quality is poor, as discussed in paragraph 4.43. The relatively higher quality Pompton River water improves the water quality of the Main Stem at the confluence, but the downstream portions of the reach are degraded by the influx of poor quality Passaic River flows and non-point sources.

Aquatic Resources in Reach 3 can be characterized as a stressed and imbalanced warmwater fishery, which reflects the poor quality of incoming Passaic River flow, and is not considered a significant resource (see 4.44).

Water Supply. The Passaic Valley Water Supply intake at Little Falls is no longer the primary intake but is used as a standby facility. The new intake is located in Reach 4. There are no other water supply intakes in Reach 3 (see 4.42).

Noise levels as discussed for Reach 1.

Community cohesion as discussed for Reach 1.

Employment as discussed in Reach 1.

Aesthetics within Reach 3 have been adversely affected by the urban character of the area.

Public facilities as discussed for Reach 1.

SIGNIFICANT RESOURCES - REACH 4 - POMPTON VALLEY INCLUDING PARTS OF THE PEQUANNOCK, WANAQUE AND RAMAPO RIVERS

4.185 Aquatic Resources. The Pompton Valley, the Pequannock River (lower 2.6 miles), the Wanaque River (lower 1.0 miles), and the Ramapo River (lower 1.2 miles), contain areas of good fishery and are, except for the Pequannock River, stocked with trout by NJDEP. The Pequannock River, while not stocked with trout at present, is expected to be stocked in the future after the closing of the Butler-Bloomingdale Sewage Treatment Plant. Aquatic resources in Reach 4 are considered a significant resource based on the existing fishery in selected areas (e.g., the Wanaque River), as well as for the State trout stocking program. Further, these resources also have public recognition for providing angling/recreational opportunities of at least 19,000 angler days per year at present, with the likelihood of increase to 23,000 angler days when the Pequannock trout stocking is initiated. The peak day demand for angling in this region greatly exceeds the supply at present and it is expected to increase in the future, thus making these reaches all the more valuable (see Table 28). Aquatic resources are discussed as follows: Pompton River - 4.55, 4.56; Pequannock River - 4.59, 4.60; Wanaque River - 4.62, 4.63; Ramapo River - 4.66, 4.67.)

4.186 Water Quality. Water quality in the Pompton Valley and the lower reaches of the Wanaque and Ramapo Rivers can generally be described as good. The water quality in the Pequannock River is lower than the other reaches, but with the closing of the antiquated Butler-Bloomingdale Sewage Treatment Plant scheduled for December 1987, it is expected to improve substantially. The Pompton River water actually improves the Passaic River water quality at their confluence. Water quality is discussed in 4.54, 4.58, 4.61 and 4.65.

4.187 Surface Water Supply. There are three water supply diversions that are located in the Pompton Valley. The Wanaque South diversion is a 250 million gallons per day million gallons per day (mgd) pump station located at Two Bridges and owned by the North Jersey District Water Supply Commission and the Hackensack Water Company to pump water to available storage, in the Wanaque Reservoir, on an intermittent basis. The Passaic Valley Water Commission also has an intake at this location, with 75 mgd capacity, which is a continuously operated facility. The Passaic Valley Water Commission also has a pumping station just upstream of Pompton Plains Cross Road on the upper Pompton River. This station pumps water intermittently to Point View Reservoir to be stored for use during low flow conditions. These projects are significant in their contribution of water supply locally and to northeastern New Jersey. (See 4.32 and 4.53.)

4.188 Groundwater Resources. There are buried valley aquifers beneath in the Pompton Valley and upstream, to a lesser extent, under the Pequannock, Wanaque, and Ramapo Rivers. These aquifers, are not as well defined in terms of stratigraphy, yield, and areal extent as the Sole Source Buried Valley Aquifer in Reach 5. However, they can be described as more directly connected to the river and other surface bodies of water above the aquifer. The communities in the area are served by both surface and groundwater sources. About 4.0 million gallons per day (mgd) are pumped from wells, which is less than half of the demand for Pompton Valley communities (see 4.30).

4.189 Wetlands. Some 1,680 acres of wetland are present within this reach of the project area. Included in these wetlands are those of the Lower Pompton River, (815 acres), Bog and Vly Meadows (650 acres), the Upper Pompton (215 acres) which are upstream of the Pompton Plains Cross Road Bridge. Palustrine forested wetland predominates (1,260 acres), followed by palustrine scrub-shrub (220 acres), and 200 acres of palustrine emergent wetlands. Above Pompton Plains Cross Road, 180 acres of palustrine forested and 35 acres of palustrine scrub-shrub wetlands exist. These wetlands (1,680 acres) are cited as significant for technical, institutional, and public recognition, because they provide areas for improvement of water quality, flood storage, habitat for wildlife, aesthetic appeal, and recreational opportunities (see 4.84, 4.96 and 4.97).

4.190 Cultural Resources. Two National Historic Districts are already recognized in this area. They are the Morris Canal and the Pompton Iron Works. While the Morris Canal generally follows Route 46, a 4.3-mile-long branch of the canal, known as the Pompton Feeder, enabled boats to navigate as far upstream as the Pompton Lake. The old Morris Canal Feeder Dam is located upstream of the Pompton Plains Cross Road where it straddles both the Pequannock and Ramapo Rivers upstream of their natural confluence. It was originally constructed more than a century ago to divert river flows to the Morris Canal, and is now used for recreational purposes and is owned by the State of New Jersey. The Pompton Iron Works is located at the Pompton Lake Dam in the area of the Paterson-Hamburg Turnpike. There is a high potential for the identification of additional historic districts, eligible for nomination to the National Register of Historic Places, along the Pompton River corridor, as well as nearby Route 23, and in other older historic settlements (see 4.130).

4.191 Parks. There is extensive county and municipal riverside parkland in Reach 4, as itemized in Table 27. Aquatic Park contains 75 acres of land in the Borough of Pompton Lakes, and 50 acres in Pequannock Township along the Pequannock and Wanaque rivers. In addition, the Pompton Lakes municipal park system extends along the left bank of the Wanaque River from 800 feet downstream of the Paterson-Hamburg Turnpike for about one-half of a mile in a continuous riverside strip known locally as the "Old Swimming Hole," Snodgrass Park, and Hershfield Park. They cover 26 acres. Two additional riverside parks, covering nine acres, are on the Wanaque River's right bank, Veteran's Park and P.L.Y.O. Field. Recreational deficits are discussed in Parks and Recreational Reosurces, 4.131 through 4.134.

4.192 These resources have been deemed not significant for the reasons listed:

Air Resources as discussed in Reach 1.

Noise as discussed for Reach 1, is not considered a significant effect related to water resource projects. However, there will be some temporary construction-related noise associated with any of the alternatives.

Employment as discussed for Reach 1.

Aesthetics in Reach 4 are locally significant and related to wetland and parkland locations. Aesthetics will be preserved through the acquistion of preservation of natural flood storage lands, and the use of set-back levees. Where possible, bankside vegetation will be preserved, and levees will be planted with native food plants and levee-compatible shrubbery.

Community Cohesion as discussed for Reach 1.

Public facilities as discussed for Reach 1.

SIGNIFICANT RESOURCES - REACH 5 - TWO BRIDGES UPSTREAM ON THE PASSAIC RIVER INCLUDING THE LOWER ROCKAWAY AND LOWER WHIPPANY RIVERS

4.193 Groundwater Resources. The Sole Source Buried Valley Aquifer provides about 45 mgd in water supply which is the sole source of water supply for more than a dozen communities in the Central Basin, which is part of the project area. Maintenance of quality and yield of this aquifer is most important as

pollution has closed wells in recent years. The Sole Source designation emphasizes the Federal interest in protecting this significant resource by monitoring Federal programs to assure that they do not lead to contamination of the aquifer through a recharge zone (see 4.27 through 4.30).

4.194 Wetlands. There are 11,320 acres of wetland in Reach 5 within the study area. This includes: 6,935 acres of palustrine forest, 1,310 acres of palustrine scrub-shrub, and 3,075 acres of palustrine emergent wetland. These areas are recognized as significant for technical, institutional, and public reasons, because they provide large areas of open space that attenuates and stores floodwaters, improves water quality, and provides habitat for wildlife, including state endangered species, as well as provides aesthetic appeal and recreational opportunities (see 4.73 through 4.95).

4.195 Troy Meadows National Natural Landmark. This resource is significant based on technical, institutional and public recognition because of its wetland which supports diverse flora and fauna (see 4.91 and 4.92).

4.196 State of New Jersey Endangered and Threatened Species. The Central Basin includes Great Piece Meadows, Hatfield Swamp, Troy, and Black Meadows. The areas and the flora within them form habitat for a substantial number of state endangered and threatened species including: the blue spotted salamander, pied-billed grebe, northern harrier, sedge wren and Cooper's hawk (see Appendix B - Natural Resources Section 5). These species have technical, institutional, and public recognition (See 4.121 and 4.121. The two rare species of plants that may still exist (one each in Troy, and Great Piece Meadows) have technical institutional and public recognition.

4.197 Cultural Resources. There is a slight possibility that prehistoric sites may exist in this area. The likelihood of finding these sites intact has been greatly diminished, however, by development which followed excavating the mosquito drainage ditches which permanently lowered the water levels in these wetlands. Building in the floodplain has disturbed the most likely sites for finding prehistoric artifacts.

4.198 Parks. West Essex Park in Fairfield, West Caldwell, Roseland, and Livingston covers over 1300 acres of undeveloped wetlands and lies south and east of the Passaic River between Eisenhower and Industrial Parkways. Parks are significant, based on existing land use and public recognition.

4.199 Parkland use is encouraged through local and government sponsored activities in this area where recreational facilities are at a premium. Municipal and county parkland covers large portions of the study area. Parks include nature trails and horseriding paths that lace the study area. Nature study centers within these parks sponsor educational and recreational activities in the wetlands that attract participants who value these resources and their aesthetic attributes. Some current wetland and water-related activities include hiking, bicycle trips, canoe trips, fossil hunts, herbal lore, and bird walks.

4.200 Nationwide Rivers Inventory. Three Passaic River Central Basin reaches have been identified in the Department of the Interior's Nationwide Rivers Inventory. Only the downstream reach in Great Piece Meadows from Two Bridges upstream for eight miles to Interstate 80 lies within the potential project area. This resource is institutionally recognized for its botanic attributes as discussed in paragraphs 4.137 through 4.139.

4.201 The following resources have been deemed not significant for the rationale provided:

Air resources as discussed in Reach 1.

Water quality is poor in Reach 5 as discussed in 4.43.

Aquatic resources in Reach 5 can be characterized as stressed. The type and number of benthic invertebrates and fish species found in this reach confirm its characterization as an imbalanced warmwater fishery. The likely reason for the stressed aquatic environment is poor water quality due to pollution loading from the Passaic River upstream of Great Piece Meadows. Aquatic resources in Reach 5 are not considered to be a significant resource (see 4.44 through 4.52).

Noise as discussed in Reach 1.

Employment as discussed in Reach 1.

Aesthetics in Reach 5 are locally significant and integral to wetland and parkland locations. Aesthetics will be preserved through preservation of natural storage, and the placement of setback levees contained in each of the alternative plans. Where possible, bankside vegetation will be preserved, and levees will be planted with compatible shrubbery.

Community Cohesion as discussed for Reach 1.

Public facilities as discussed for Reach 1.

SECTION 5. ENVIRONMENTAL EFFECTS

5.01 This section presents the effects on environmental resources of the three detailed plans -- the recommended plan (the Dual Inlet Tunnel Diversion Plan) and two alternatives (the Single Inlet Tunnel Diversion Plan, and the No-Tunnel Plan). These three alternatives are described in EIS paragraphs 3.52 - 3.106, while additional detail is provided in the Main Report, Appendix C - Plan Formulation (Sections 7 and 9). Table 29 presents a summary description and comparison of the three alternatives, Table 30 summarizes comparative impacts among the alternatives, and Figure 23 displays the planning reaches utilized to present the environmental effects. These reaches are:

Reach 1 - Lower Valley, the Passaic River from its Mouth upstream to Dundee Dam.

Reach 2 - Lower Valley, the Passaic River from Dundee Dam upstream to Beatties Dam (at Little Falls).

Reach 3 - Central Basin, the Passaic River from Beatties Dam upstream to Two Bridges at the confluence of the Pompton and Passaic Rivers.

Reach 4 - Central Basin, Pompton River Valley and Tributaries (the lower Ramapo, Pequannock, and Wanaque Rivers).

Reach 5 - Central Basin, the Passaic River from Two Bridges upstream to Chatham.

The significant environmental resources for each of the planning reaches are presented in paragraphs 4.169 to 4.201 of Section 4. The plan effects on these resources are highlighted in the discussions below.

5.02 This section of the EIS is organized as follows:

- First, in Part A (paragraphs 5.03-5.208) the plan elements of each of the three detailed plans are summarized and the accompanying environmental effects presented on a reach-by-reach basis. Within this framework, impacts to significant resources within each reach are presented. A summary discussion comparing the impacts of the three alternatives concludes the presentation for each reach.

- Then, in Part B (paragraphs 5.209-5.257), a summary of environmental effects for the overall project area is presented for each significant resource with references to Part A discussions. Readers focusing on an individual resource may find that a review of the summary assessment in PART B will provide an overview for that resource before proceeding to the specific reach-by-reach assessments contained in PART A.

PART A - PLAN EFFECTS REACH BY REACH

REACH 1 - PASSAIC RIVER: MOUTH UPSTREAM TO DUNDEE DAM (FIGURE 23)

5.03 The flood control measures proposed for Reach 1, from the mouth of the Passaic River to Dundee Dam, would include levees and floodwalls, channel modifications, and the tunnel's outlet, in various combinations, for each of the three plans. The Dual Inlet and Single Inlet Plans provide protection to Reach 1 through the diversion of flood flows and the use of levee/ floodwall systems, while the No-Tunnel Plan utilizes a combination of channel modification and levee/floodwalls. The tunnels and associated levees and floodwalls for the Dual Inlet and Single Inlet alternatives, and the channel modification element of the No-Tunnel Plan are all designed for protection against a flood with a one percent exceedence frequency (100-year flood) based on future conditions projected for the year 2040. Each of the three alternatives also includes levee/ floodwall systems to provide protection against a 500-year tidal flooding event. The Reach 1 project features for the three plans can be summarized as follows:

Dual Inlet Plan	Single Inlet Plan	No-Tunnel Plan
o Tunnel Outlet and Work shaft	o Same as Dual Inlet Plan	o Channel Modification (5.4 miles)
o Levees and Floodwalls Integral to Tunnel (13.5 miles)		o Tidal Levee/ Floodwall Systems (10.5 miles)
o Tidal Levee/ Floodwall Systems (10.5 miles)		

DUAL INLET PLAN - REACH 1

5.04 Tunnel Outlet. The tunnel's outlet would be located on the west bank of the Passaic River just upstream of the Third River. See Figure 24, which shows a model of the outlet structure, and Figure 25, which is an aerial photograph of the Third River-Passaic River confluence.

5.05 Third River Work Shaft. The work shaft for the lower portion of the tunnel would be located on the north shore of the Third River near its confluence with the Passaic River. Since the land is currently a paved construction equipment storage area, there would be no significant environmental impacts from the four acre construction site. Tunnel excavation material (a

marketable commodity) would be removed from this site by conveyor to barges in the Passaic River and transported to off-site locations for use in construction as fill, pavement base and sub-base courses, concrete aggregate, slope erosion protection, riprap and other uses. See Figure 56 of the Main Report which shows the work shaft location.

5.06 Levees and Floodwalls Integral to the Tunnel. Levee/floodwall systems totalling 5.7 miles of levees and 7.8 miles of floodwalls would lie along the Passaic River from upstream of its confluence with the Saddle River downstream to the Second River, and are integral to the operation of the tunnel. These systems would safely contain increased river stages resulting from discharges exiting from the tunnel as well as from combined fluvial/tidal flooding. Average levee/floodwall heights would range from 4.5 to 12.5 feet, with base widths of up to 86 feet. See Table 19 and Figures 26 to 29 of the Main Report.

5.07 Tidal Levee/Floodwall Systems. Levee/floodwall systems downstream of Route 280 to Newark Bay provide protection against hurricane and tidal surges. These systems total 5.5 miles of levees and 5 miles of floodwalls with average heights ranging from 7.4 to 10.5 feet and associated base widths of up to 63 feet. See Table 19 and Figures 24 and 25 of the Main Report.

EFFECTS OF DUAL INLET PLAN - REACH 1

5.08 The Dual Inlet Plan's effects on the Reach 1 significant resources are described below. These resources include anadromous fish, wetlands, parks and recreation, hazardous substances sites, and cultural resources, as identified in the EIS in Section 4. In addition to the effects on significant resources, Reach 1's effects from the tunnel construction and operation on groundwater, sediment transport and water quality are also discussed, since the tunnel outlet lies in this reach.

5.09 Construction Related Effects. Temporary changes in land use would occur during construction at all the project sites. Staging areas, access areas and related storage facilities would be constructed along the rivers. It is expected that these sites would be located within project areas and would not result in any major conflicts with surrounding land or water uses. Operation of construction equipment, with best available technology for emission control, would cause some temporary low level emissions, adding to the air pollution load of the region. Fugitive dust would be generated. Some unavoidable oil, gas and grease spills would undoubtedly occur. Construction equipment operation and activities would cause some safety hazards to residents of the area. All of these effects are short-term. Their intensity and duration would be related to the extent of the construction at specific locations.

5.10 Construction of twenty gated structures across bridges and roads, which would maintain the levees' unbroken line of protection against floodwaters, and the relocation of two roads to accommodate levee systems, would undoubtedly cause some traffic congestion. However, where possible, traffic delays would be kept to a minimum because local ordinances would be adhered to and the construction activities would be scheduled to ensure that traffic would be allowed to move in both directions. Although the high density of roads and bridges in the Lower Valley provides numerous opportunities to use alternative routes, the construction activities would cause delays.

5.11 Temporary adverse aesthetic effects would result due to the presence and operation of construction equipment in the project area. The aesthetics of several areas along the lower Passaic River, particularly riverside parks, and residential areas upstream of Route 3, would be negatively affected by the construction of levee/floodwall systems. Public access to the shoreline would be restricted by this construction work, but access points would be available after construction is completed.

5.12 Tunnel Construction. The tunnel construction would take place underground and would be unnoticed on the surface except at the work shaft location at the Third River and the outlet on the Passaic River. With the exception of the vertical work shafts, rock excavation for the tunnel would be accomplished by a tunnel boring machine which literally grinds the bedrock into cobble sized material 150 to 450 feet beneath the surface. Excavation material would be brought to the surface at the Third River work shaft and carried by conveyor, about 600 feet, to the river to be transported away from the area by barge. There will be temporary increases in traffic and construction noise at the shaft site. These effects would be minimized by the barge transport system for the excavated materials and for the delivery of construction materials.

5.13 Throughout the length of the tunnel, there are wells drilled into the overlying bedrock to take advantage of the weathered upper layer and fractures in the bedrock, which are conduits for groundwater. During construction, the perimeter of the tunnel would be sealed by a cutoff grouting procedure and an application of shotcrete as the tunnel is bored by the Tunnel Boring Machine (TBM) to eliminate infiltration of groundwater into the tunnel. Tunnel construction by TBM would not create a disturbed zone in the bedrock around the tunnel's perimeter and would not increase hydraulic conductivity of regional groundwater flow paths, because the TBM bores the tunnel with a grinding action, as compared to a drill and blast method, which uses explosives to fracture the bedrock. The drill and blast method would be used only at the start of the project to

construct the vertical shafts and starting chamber for the TBM. In these locations, cutoff grouting would be used to seal the disturbed zones. The construction of a concrete tunnel lining would provide a permanent seal against infiltration of groundwater and exfiltration of floodwaters, thus protecting both the yield and quality of groundwater in the bedrock.

5.14 Tunnel Excavated Material Disposal Sites. The cobble-sized material removed from the tunnel in Reach 1 would likely be pristine, because it is drawn from far beneath the earth's surface, and is less likely to have come into contact with man's activities. Approximately 1.25 million cubic yards of material would be removed at the Third River work shaft. Radioactive minerals or radon are not expected to be found along the tunnel's route based on the geologic formations that the tunnel would penetrate and the negative results of the radioactive testing during the subsurface exploration program (see paragraphs 4.21-4.26). Since the tunnel-excavated material would be of high quality, it is planned to be used as a source of construction material for surface project elements, or sold for use elsewhere. Some of it is planned to create fish habitat downstream of Dundee Dam as discussed in paragraphs 3.120 and 5.20. Currently, the supply of aggregate for many quarries in the Connecticut-New York-New Jersey area is being exhausted and aggregate must be acquired from quarries located at the margins of the metropolitan area, at increasing costs due to longer haul distances. The market for material excavated from the tunnel would be very large because of the shorter haul distance, strong demand for material, and the sheer size and number of construction activities within the N.Y. Metropolitan Area. While it is probable that this market will continue into the future through the potential construction period for a Passaic River flood control project, there are many quarries in the area where such clean materials could be disposed of or stockpiled for future use. In the event that contaminated or problematical materials are encountered, care would be taken to ensure that they are disposed of in accordance with Resources Conservation and Recovery Act regulation.

5.15 Tunnel Operational Effects. The tunnel's operations would change the hydraulics of Reach 1 during events greater than the one-year flood. Such events would occur on average for about five days each year in the area of the tunnel outlet. Passaic River stages for flow conditions expected in the year 2040 are estimated to be 15.4 feet National Geodetic Vertical Datum (NGVD) with the project as compared to 11.3 feet without the project for the 100-year design flood. Levees and floodwalls are designed to contain these stages, with a freeboard (factor of safety) of at least 3 feet. Stages, flows, and velocities at various locations along the Passaic and Pompton Rivers are

presented in Table 31. These are for the one-year, two-year and 100-year flooding events, under existing, future without, and future with-project conditions. The one-year flood event flows, velocities, and stages would remain unchanged because the tunnel would not be operated, with the only effect reflected in Table 31 due to preserved natural storage in the Central Basin which would reduce flows by a minor amount.

5.16 The two-year event would reflect increased flows downstream of the outlet because of tunnel operation. At the mouth, flows would increase from 8,694 cubic feet per second (cfs) to 13,312 cfs, velocities would increase from 0.6 to 0.9 feet per second (fps), but stages would remain unchanged. At the tunnel outlet, stages would increase from 6.0 to 6.7 feet NGVD. Upstream of the tunnel outlet, flows would decrease from 8,635 to 6,348 cfs and velocities would decrease from 1.5 to 1.1 fps.

5.17 For the 100-year flood event, flows at the outlet would increase from 33,706 cfs without the project to 50,543 cfs with-project operation, and velocities would increase from 4.2 feet per second (fps) without the project to 5.3 fps with the plan in effect. Flows for the 100-year event at the mouth would increase from 33,645 cubic feet per second (cfs) to 48,544 cfs, and velocities would increase from 2.3 to 3.3 feet per second (fps). Corresponding flows and velocities would decrease upstream of the outlet. For the 100-year flood event upstream of the proposed outlet, flows would decrease from 33,621 cfs without the project to 18,892 cfs with operation of the project, with an associated decrease in velocities from 3.8 to 2.1 fps.

5.18 The effects of the increased velocity and flow in this reach would be minimal. The increase in velocities due to the project are not significant and these velocities in Reach 1 would not require channel protection based on Corps criteria. For frequent flooding, existing flood stages and velocities would only increase slightly. The tunnel would be utilized for approximately five days each year and would not alter the river's capacity to carry sediment. The flow regime would be modified only during tunnel operation.

5.19 Net sediment transport out of the Basin and into Newark Bay would decrease, if only slightly. Higher peak flows would be transmitted to the Lower Valley, but the duration of flood peaks would be reduced, resulting in a net transmittal of approximately the same volume of runoff under both with and without-project conditions. The sediment load would decrease as

a result of protecting the 100-year floodplain, thus preventing floodwaters from picking up sediments in the floodplain. However, this is not expected to have a noticeable impact on Newark Bay, particularly since the Passaic River contributes only about 9% of the sediment deposited in Newark Bay.

5.20 Anadromous Fish. The tunnel's outlet itself would cover about two acres of anadromous fish habitat. As discussed in Section 3, paragraphs 3.119 and 3.120, mitigation for this loss of habitat would be provided by the placement of four acres of cobble substrate downstream of Dundee Dam. The placement site is located immediately downstream of existing habitat at the bas of Dundee Dam, a distance of 500 feet downstream from the dam. Based on field studies, the existing habitat is an area preferred by juvenile anadromous clupeids. Therefore, the existing cobble substrate would be extended by placing four acres of tunnel excavated cobble in the Passaic River, from just downstream of where the existing field ends, to offset the two acres of habitat impacted at the tunnel outlet.

5.21 During the tunnel's operation the diversions are expected to have minimal effects on anadromous fisheries. The outlet will prevent the entrance of fish when the tunnel is not in use. When in use, the entrance of migrating anadromous clupeids would be unlikely, because the fish would have to be running upstream to spawn at the same time the tunnel would be in use, and would have to find the tunnel opening. Even if they managed to get into the tunnel, it is unlikely that the fish would continue to swim downward against the upward flow of water, (along the tunnel axis) because of their ability to perceive changes in hydrostatic pressure. Although the water velocities would be increased over existing conditions during tunnel discharge, the outlet is located on the west bank of the river and lower velocity areas would still be available to fish nearer the eastern bank.

5.22 The diversion of floodwaters via the tunnel system would not modify the saltwater/freshwater interface that exists in the lower Passaic River. During flood events, for both with and without-project conditions, the interface is pushed seaward and returns when flood flows decrease. The volume of floodwater entering the tidal portion of the Passaic River would be the same for both with and without-project conditions; with the tunnel diversion, the water would arrive at the Third River reach about six hours sooner than it would flowing along the existing Passaic River's channel. The tunnel outlet is on the western bank of the river, and floodwaters exiting the tunnel would spread out gradually along the full width of the channel.

5.23 Surface Water Quality. No adverse water quality effects would be caused in Reach 1 by diversions of floodwaters through the tunnels. The volumes of floodwaters diverted into the lower Passaic River in Reach 1 would be approximately equivalent to the without-project conditions. The waters would arrive earlier but with no adverse water quality impact. Under most flood conditions, the diverted water would be cleaner because it would not pick up runoff-associated sediment or contaminants collected from out-of-bank flow through populated areas. When the tunnel is in operation during the initial stages of the flood events, the diversion of Central Basin's flows away from Reaches 2 and 3, and the upper portion of Reach 1 in the Lower Valley, may cause some temporary reductions in water quality due to less dilution. However, because the tunnel would only operate for flows greater than the one-year flood event, the flows entering the upper reaches of the Lower Valley from early peaking Passaic River tributaries, such as the Peckman River and Molly Ann's Brook, would provide sufficient flows to minimize any dilution reduction during this initial stage of the event. Later in the storm, the tunnel's operation would bypass one-year flows from the Central Basin, which will serve as a cleaner, flushing flow for the Lower Valley's reaches.

5.24 During flood events, the dissolved oxygen (DO) level of water entering the tunnel is expected to be similar to, or to exceed levels in the Lower Passaic River. The maximum deficit of the water entering the tunnel that could occur would be the initial DO deficit plus the ultimate oxygen demand. Because of intense mixing at the inlets, the initial DO level of water entering the tunnel should be near saturation, so the initial deficit would be zero. The average five-day biochemical oxygen demand in the rivers near the inlets is 3 milligrams per liter (mg/l), which converts to an ultimate demand of about 5 mg/l. With an initial saturated DO concentration of 9 to 10 mg/l, the resulting tunnel water would end up at a level of 4-5 mg/l, similar to existing levels in the Lower Passaic.

5.25 Following a flood, approximately 20 million cubic feet (about 150,000,000 gallons) of water would remain in the tunnel because the proposed siphon design places the lower one-fourth of the tunnel at elevations below sea level. The quality of this resident water should not have adverse impacts when later released during the tunnel's operation. There should be little effect from river bottom deposits, because the light organics, clays and silts would be dissolved or suspended, so high tunnel flood velocities would remove them from the tunnel. Cleaner, heavier loads, such as rocks and gravel, would settle out in the areas above the inlets. If they should enter, they would not degrade the resident water quality, because they are relatively inert. These materials would be removed during periodic

maintenance. There would be virtually no sewage in the tunnel water since sewage contamination associated with out of bank flooding would be prevented by the project. The minor amounts of sewage that could get into the tunnel would be diluted by the flood flows.

5.26 The dissolved oxygen (DO) level of the water remaining in the tunnel between floods is not expected to be a concern because of the tidal mixing that would occur. The tidal range at the outlet is approximately five feet, and when low tide rises to high tide, the water level within the tunnel would also rise five feet, if mixing is permitted. The resulting average tidal flow into the tunnel would be approximately 40 cfs, with a peak flow of 65 cfs. This would result in approximately 5% of the water residing in the tunnel that would be replaced during every tidal cycle. It would take 14 tidal cycles (one week) for the concentration of DO in the tunnel water to be recovered 50% towards the concentrations in the river; and about three weeks to achieve the 90% level. Therefore, it is expected that the quality of the water residing in the tunnel will be at or near levels of the Lower Passaic River. Information contained on pages 15, 16 and 17 of Attachment A-36 Appendix A - Public Involvement present the details of this analysis.

5.27 Wetlands. Reach 1's levees would cover a total of 84 acres, approximately ten of which are wetlands along riverside parks and riparian corridors. Due to the urbanized nature of the Lower Valley, with little undeveloped space, in-kind mitigation for terrestrial losses was not practicable within Reach 1 (see 1.57). Therefore, mitigation would be provided for this ten acre loss by upgrading ten acres of wetlands on project lands in Reach 5, as discussed in paragraphs 3.114 and 5.177. Other than the wetlands, the cover types would be expected to be the same with and without the project. The levees and floodwalls would prevent further encroachment into the river but would allow improving and upgrading existing buildings and their contents on the upland side of the levees. The levee/floodwall systems would also remove remnant riparian corridors and limit access to the river for wildlife. However, because of the urban nature of the area, this effect would be minor (see Figure 25).

5.28 Parks and Recreation. Reach 1's levees would alter the surface configuration of riverside parks. There are about 160 acres of riverside parkland in Reach 1. About 17 acres of these parks would be adversely affected by the construction of levees (see Table 27). Recreational opportunities and aesthetics would be changed in reaches where the project would be built. Of the nearly 17 acres of park that would be covered by levees, 3.8

miles of levee-top walkways would directly offset this loss, a linear distance equivalent to 4.6 acres. An additional 11.5 acres of levee slopes on the park side of the levee would also be available for recreational uses, although there would be a change in setting and potential use.

5.29 Using the 109 acre Bergen County Riverside Park Complex in Lyndhurst and North Arlington as an example, under existing conditions, walking through most parts of the park affords views of the water. With the project, levees would be built along the riverside and would cover parkland so the river would no longer be visible from most parts of the park. In addition, the aesthetics of the riverside itself would be diminished, due to the loss of the vegetation that fringes the river and includes many large old trees. While these losses would be significant, the levees, would only cover less than an average 100 feet wide swath from the top of the bank, so no major park facilities, such as baseball diamonds, football fields, basketball courts or restrooms, would be taken or affected. While the surface configuration of the parks' riverside edges would be altered by the levees, this does not mean that the land would be lost to recreation. The 100 feet wide slopes of the levees would be gentle, with a three foot horizontal increment for every foot of elevation, to enable easy walking, or reclining. Therefore, recreational opportunities would be provided along the levee top walking/bike trails, and, depending on the season, the parkside levee slope would also be used for sledding or sunbathing, while fishing would be possible from the riverside slope. In addition to the out-of-kind replacement of recreational opportunities, a project benefit that would result from the plan would be the linking of pocket parks along the river that are now separated by long stretches of private lands. Project levees would provide linkages to a series of vest pocket parks providing a riverside trail through much of the Lower Valley. The system of riverside levees would eliminate forcing pedestrians to return to busy streets, enabling pedestrians and bicyclists to get closer to the river through longer reaches. The added elevation will afford views, both along the walkways and at the overlooks.

5.30 Project related adverse impacts to parkland would be offset in several ways. Levee topped bike/walkways along with overlooks, benches, lighting, comfort facilities, drinking fountains and landscaping, and the creation of pocket parks would partly offset the losses. Refinements of levee designs, such as making slopes more gentle or contoured, can be included if desired by local interests. Access to the river for recreation and boating will be provided, including access for marinas and emergency vehicles. Full compensation for project impacts to parks will include providing equivalent recreational opportunities on project lands, or monetary payments based on

the fair market value of equivalent public recreational usefulness, size, quality and location. Recreational mitigation could also be enhanced by the cooperative planning of local interest groups and parks departments to accommodate requests for riverside access, cleanup, and recreational facilities.

5.31 Cultural Resources. Minimal adverse impacts would be expected from the construction of the levees and floodwalls. Testing would be carried out at construction sites, and if significant resources are found a mitigation plan would be development and implemented. Throughout its history, the Passaic River waterfront has been valuable as the focus of either water-related industry or the movement of goods from water to land transportation, so the shoreline has been developed and redeveloped. Therefore, no hidden cultural resources are expected to be found. However, systematic cultural resources surveys will be conducted at all project impact areas prior to construction in order to determine and identify any remaining cultural properties and to evaluate their significance.

5.32 Hazardous Substances Sites. Of the 50 identified hazardous substances sites that occur within the 100-year floodplain in the Passaic River Basin, 42 will not be affected during construction of this project (See Sections 4.15 through 4.19 and Tables 10 and 11). The remaining eight CERCLIS sites in the Lower Valley may contain soil contaminated with hazardous substances. All National Priority List sites in the 100-year floodplain and the CERCLIS sites of concern are noted in Figure 7 and discussed in paragraphs 4.15 through 4.19 of the EIS and in Section 8 of Appendix B - Natural Resources.

5.33 An analysis was done for all levees and floodwalls by comparing U.S. Environmental Protection Agency's (USEPA) site files for National Priority List and CERCLIS sites having potential to be affected by project construction (See Section 4.15 for the distinction between National Priority List (N.P.L.) and CERCLIS sites). This screening indicated that eight CERCLIS List (inactive hazardous substances sites) occur within 500 feet of levee/floodwall alignments. Table 11 presents the results of the screening analysis and lists the sites that are within 2,000, and 500 feet of levee and floodwall alignments, along with the dates of their preliminary and follow up site inspections, the locations of hazardous substances found at the site, what types of substances are present, if the site will be remediated, and the projected dates. If remediation will be completed prior to project construction, the flood control project could proceed normally, since there would be no project induced impacts anticipated.

5.34 The eight CERCLIS List sites of concern are: BASF (Badische), Modern Transportation, S & W Waste, and Conrail Meadows Yard in Kearny; Sherwin-Williams and Benjamin Moore in Newark; Diamond Shamrock in Harrison; and GAESS in Passaic City. Of the eight remaining CERCLIS List sites, three have been remediated: BASF/Badische, in Kearny, and the two paint companies in Newark, Sherwin-Williams and Benjamin Moore. Only the potential for disturbing residual soil contamination during construction remains at these three locations. The two Kearny companies that are licensed to handle and dispose of hazardous substances, Modern Transportation and S & W Waste, have similar risks associated with soil contamination discovered during site inspections. The three remaining sites, Conrail Meadows Yard, Diamond Shamrock in Harrison and GAESS, extend to the river and planned levee alignments. Overland flows during rain events yield uncontained runoff that enters the soil and groundwater system, and the river. The Conrail Meadows overland flow carries diesel fuel which enters both the Hackensack and Passaic Rivers. Another site, GAESS, in Passaic City, was found to contain drums, cardboard barrels and leaking containers along with documented hazardous substances such as carbon tetrachloride, trichloroethylene and heavy metals. Since the USEPA has assessed this as a "low seriousness" site, it may not be remediated prior to the project's construction. Therefore, close coordination with the USEPA will be conducted through the next design stage. The extent of contamination at the Diamond Shamrock site in Harrison has not yet been determined. The outcome of State enforcement actions at this site will be watched closely to determine what future action may be needed.

5.35 The Corps will maintain continued close coordination with the USEPA and the N.J. Department of Environmental Protection (NJDEP) for the eight CERCLIS sites. Coordination will determine their Preliminary Assessment (PA) and Site Inspection (SI) status. If the preliminary assessments and site inventories indicate that the site will be remediated, the construction could proceed normally, assuming remediation would be completed prior to the beginning of project construction. For sites which would not be scheduled for remediation prior to project construction, and for the sites whose files indicated that there is a potential for residual contamination, the Corps would continue to coordinate with the USEPA and NJDEP. Corps-sponsored on-site sampling efforts may include soil core analysis to determine if hazardous substances are within the soil that would be disturbed during construction. For the three sites whose runoff enters the river, Conrail, GAESS, and Diamond Shamrock in Harrison, samples will also be taken from the shoreline and within the potential impact area in the river channel. The Corps would need to determine the nature of the contaminants, their specific location, and concentrations. Once these data are gathered, a Health and Safety Plan would be

formulated in concert with the USEPA, the Occupational Safety and Health Administration, and the NJDEP. The construction of levees and floodwalls would be planned to prevent the spread of any contaminants or their resuspension into the air, soil, groundwater, or surface water systems. Monitoring, if necessary, would begin prior to construction to establish existing conditions and would continue as construction progresses. In the event that presently unknown hazardous substances sites are encountered during construction (as, for instance, the discovery of buried drums), coordination would be affected with USEPA, NJDEP, and, if applicable, the U.S. Coast Guard, to assess the nature of the hazard and to determine the appropriate remedial action. Should the material to be excavated for construction be contaminated, it would be properly disposed of in accordance with Resource Conservation and Recovery Act (RCRA) regulations.

5.36 The long term effect of the project on hazardous substances sites would be beneficial, since the project would protect areas that are now subject to flooding which spreads hazardous substances into human living areas, terrestrial, and aquatic ecosystems. Levees and floodwalls in the Lower Valley are designed to prevent all floods up to the 500-year recurrence interval downstream of the Second River and the 100-year interval elsewhere, which would prevent floodwaters from entering the other CERCLIS and NPL sites.

5.37 Dioxin also exists in the Lower Passaic River sediments in Reach 1, as discussed in paragraph 4.20. These sediments are associated with the Superfund site at 80 Lister Avenue in Newark. Close coordination with the State of New Jersey indicates that the sediments that are contaminated with dioxin will be remediated prior to the implementation of this project. The dioxin-contaminated sediments will be remediated under the auspices of NJDEP, as is articulated in their letter in the Main Report Appendix A - Public Involvement Attachment A16, and confirmed in the NJDEP's Commissioner's comments to the draft report and EIS, Attachment A39 in the same appendix.

5.38 Hydraulic studies indicate that with-project conditions would not result in erosion or scouring problems in Reach 1 (see paragraphs 5.16 through 5.19 for a discussion of the project's flow and velocity conditions). The Corps will continue to coordinate with the NJDEP by providing the results of engineering studies that will be performed in the Phase II design stage, including final project design flows, velocities, and with- and without-project sediment transport data, which can be used in their remediation effort. At this time it is not known what the State's selected remediation plan will involve, although removal of dioxin "hot spots" and/or capping contaminated sediments are possible alternatives. The State of

New Jersey has advised the Corps that their evaluation of remediation alternatives will address not only the existing situation but will also include potential areas of concern related to the implementation of the recommended plan. If the Phase II design sediment transport studies indicate a concern under with or without-project conditions that cannot be addressed by NJDEP, or in the event that the timing of the State's remediation coincides with-project construction and the State decides that remediation would involve capping contaminated sediments, the Corps could make available, at a cost equivalent to disposal, pristine tunnel excavated cobble-sized material which could be used to armor dioxin-laced river sediments in their deep and relatively sequestered state.

5.39 Coastal Resources. The Dual Inlet Plan in Reach 1 would affect areas of concern covered under the Coastal Zone Management Act. The elements of the plan specifically involved include the levees and floodwalls located along the river's edge, and the tunnel's outlet, including the associated disturbance to two acres of the river bottom's aquatic habitat. Therefore, Coastal Zone Management concerns which would be affected include: anadromous fish, habitat disturbance at the outlet, (see paragraphs 5.20 through 5.22 for discussion) and ten acres of wetlands lost due to levee/floodwall placement (see paragraph 5.27 for discussion). Historical and archeological sites, are unlikely to be adversely affected due to the developed nature of the area (see paragraph 5.31). Hazardous substances sites have the potential to be effected by the project (see paragraph 5.32). Because the Passaic River is within the Northern Waterfront Region, the areas of special concern include special urban areas, public access, and development potential. Special urban areas would be both adversely and beneficially affected since levees and floodwalls would limit the use of the river in some reaches, but would beneficially effect these areas by reducing flooding risks (see paragraph 5.249). Public access would be affected by the project. However, provisions have been made to help mitigate this effect by providing access to the river for recreational and other uses (see paragraphs 5.28 through 5.30). Recreation resources include small playgrounds where effects of the project would be adverse. (See Figures 27 and 28 in the Main Report, and paragraph 5.29). The scenic aspect of the river would change with the project but the incorporation of beautification measures as an integral part of the project would help offset aesthetic changes, and in some areas, provide improvement. Traffic would be adversely affected in some areas during construction, but would be beneficially affected by reducing the risk of future traffic delays during flood events after project elements are completed. The development potential of the coastal zone would also be affected since some loss of access

would occur, but a reduced risk of flooding would help increase redevelopment of existing businesses. The Corps has filed a consistency determination with the State of New Jersey (see Appendix A, Attachment A-21). The State has indicated that their review will be accomplished upon receipt of the FEIS.

SINGLE INLET PLAN - REACH 1

5.40 The physical elements of this plan are virtually identical to the Dual Inlet Plan and the effects would be the same for all practical purposes.

NO-TUNNEL PLAN - REACH 1

5.41 The No-Tunnel Plan would include tidal levee/floodwall systems totaling 5.5 miles of levees and 5.0 miles of floodwalls in this reach. The levee/floodwall systems would have an average height of about 8.5 feet and cover 41 acres. This plan would need fewer levees and floodwalls (5.7 miles and 7.8 miles less than the tunnel plans, respectively) because only protection against tidal events would be provided by this plan element.

5.42 There would also be 4.8 miles of channel modification (Table 15 in the Main Report) from Route 3 in Rutherford up to Dundee Dam in Garfield. The bottom width of the modified channel would be 135 feet. From Route 3 to 0.3 miles downstream, the modified channel would transition into the existing channel. At the upstream end of the channel, there would be another 0.3 mile long transition channel.

EFFECTS OF NO-TUNNEL PLAN - REACH 1

5.43 The channel modification would affect the limited benthic macroinvertebrate community that exists in this reach. However, this should be no more significant than the existing maintenance dredging that occurs from the mouth up to the Eighth Street Bridge in Wallington. Once the project would be completed, benthic fauna would begin to reestablish itself. The necessary periodic maintenance dredging upstream of Eighth Street would, however, preclude a return to existing conditions. The No-tunnel alternative would require close coordination with NJDEP to ensure that the channel modification is compatible with remediation plans for dioxin contaminated sediments in Reach 1. The channel modification would also eliminate 84 acres of aquatic habitat, of which 45 acres are riverine flats upstream of the Third River. Therefore, the No-Tunnel Plan would have a significant impact on anadromous fish habitat, particularly

when compared with the tunnel alternatives. To partially mitigate for this loss, 21 acres of aquatic habitat would be created in this reach. Mitigation was constrained by the limited opportunity to create habitat in this Reach 1.

5.44 There would be a negligible difference in peak flows with this plan; the 10-year flood flow would increase by 0.4% at the mouth and the 100-year flood flow would increase by 1.4% (see Table 31). No impacts, other than during construction and any maintenance dredging required, are anticipated on water quality or sediment transport due to hydrological changes. Protection ranging from the 100-to-500-year levels would be provided by this plan.

5.45 Levees and floodwalls would be required in less than half of the areas included in the tunnel plans. Approximately 6 acres of wetlands would be lost to levees, which cover a total of 45 acres in this reach. This loss would be mitigated for in a manner similar to the tunnel plans by enhancing the wetland values for project lands within the natural storage acquisition areas.

5.46 Seven of the eight CERCLA hazardous substances sites identified in the Dual Inlet Plan discussion would be of concern for levee/floodwall systems included in the No-Tunnel Plan. The disposition of the eighth site, GAESS in Passaic City, would also have to be closely followed to determine if any contamination has spread to the river banks that would be affected by the channel modification required for this plan. The channel modification element of this plan would require close coordination with USEPA and NJDEP to ensure that the remediation of dioxin contaminated channel sediments is consistent with the No-Tunnel Plan. Unlike the tunnel plans, the no-tunnel alternative includes 5.4 miles of construction directly in the channel and would not provide a source of cobble-sized material that could be utilized to cap the contaminated sediments, if this was part of the State's remediation solution.

SUMMARY OF REACH 1 EFFECTS

5.47 Because of current development and environmental degradation along this reach in the Lower Valley, low levels of environmental impacts are predicted with the tunnel plans, but substantial aquatic impact would occur with the No-Tunnel Plan. The major difference between the tunnel and No-Tunnel Plans is that the hydraulic regime would be altered during flood events by tunnel diversions. The No-Tunnel Plan would require less

riverbank disturbance because of fewer levees and floodwalls, but it would include 5.4 miles of channel modification not in the tunnel plans. There would be some temporary, construction related impacts including noise and traffic congestion associated with all three alternatives.

5.48 Anadromous Fish. The tunnel plans are not expected to significantly affect anadromous fisheries, since they would only eliminate about two acres of riverine flats at the tunnel's outfall. Mitigation would be provided by placing four acres of cobble substrate downstream of Dundee Dam. The channel modification in the No-Tunnel Plan would remove 84 acres of tidal and shallow water flats used by these species, of which 21 acres would be mitigated.

5.49 Wetlands. About ten acres of riparian wetlands would be lost in this reach with both tunnel plans and six acres with the No-Tunnel Plan. Mitigation is provided for these losses on project lands in Reach 5 (see Section 3 paragraph 3.14). Table 25 provides a summary of wetland and aquatic effects.

5.50 Cultural Resources. Due to the extensive riverside development and redevelopment along the Lower Passaic River, it is probable that all significant cultural resources have been destroyed within the potential project area. However, systematic cultural resources surveys will be conducted at all project element sites prior to construction. Should any significant cultural resources be discovered at that time, appropriate mitigation programs would be developed and implemented prior to construction for all three plans.

5.51 Hazardous Substances Sites. All three plans would include additional coordination regarding the status of remediation efforts under USEPA's and NJDEP's auspices. Eight sites of concern have been identified in the floodplain in the vicinity of surface works. Dioxin contaminated sediments are also known to exist in the Passaic River channel in Reach 1 related to the Superfund site at 80 Lister Avenue in Newark. NJDEP has committed to remediation of this problem prior to the construction of a flood control project. All of the plans would provide a long term benefit of protecting areas now subject to flooding and the spread of hazardous substances.

5.52 Parks. Public and river access (boat ramps) will be maintained in all plans. The loss of riverviews from the open spaces in the parks would be an aesthetic loss that would be offset by walkways along the levee systems and the recreational opportunities provided by use of the side slopes. The more extensive levee/floodwall systems of the tunnel plans will have a greater impact on parks than the No-Tunnel Plan.

REACH 2 - PASSAIC RIVER: DUNDEE DAM TO BEATTIES DAM (FIGURE 23)

5.53 Reach 2 is bounded by the Dundee Dam at Garfield and upstream by the Beatties Dam at Little Falls. It is divided into two independent sections by the Great Falls-S.U.M. Dam in Paterson. Both sections have similar stream slopes, mild over the downstream two-thirds of each reach, but considerably steeper at the upstream ends. The area is heavily developed with industrial complexes and high-density residential areas. Much of this development is on the riverbanks. These characteristics severely limit the potential for the implementation of levees and floodwalls and extensive channel modifications.

5.54 The flood control measures lying in Reach 2 include only the channel modification feature of the No-Tunnel Plan. The tunnel plans provide protection to this reach by the upstream diversion of flood flows, resulting in modified flow conditions during floods. All three alternatives would provide protection in Reach 2 against a flood with a one percent exceedence frequency (100-year flood). The Reach 2 project features for the three plans are as follows:

Dual Inlet Plan	Single Inlet Plan	No-Tunnel Plan
o No Features (protection provided by upstream diversion)	o Same as Dual Inlet Plan	o Channel Modification (11.0 miles)

DUAL INLET PLAN - REACH 2

5.55 Since there are no physical modifications in this reach, the only potential impact would be caused by reduced flows, velocities and stages during tunnel operation. (See Table 31). The tunnel would not operate for flood events up to and inlcuding the one-year event. Thus, the flow regime for frequent events in Reach 2 would not be affected, allowing these flows to continue to support aquatic habitats, nourish wetlands in the one-year floodplain, provide a flushing effect for sediments in the channel, and provide dilution to incremental Lower Valley flows for maintaining water quality. During the larger floods for which the tunnel would operate, flows by cubic feet per second passing the Two Bridges Tunnel inlet into Reach 2 would be 100 cfs early in the storm (approximately the first 20 hours) while the flood peak is rising, to prevent flood damages in the Lower Valley. Intervening drainage from Passaic River Reach 2 tributaries, which would still reach flood peaks, would supplement the bypass flows during the initial flood diversion period. After peak flood flows begin to subside,

flows at least equal to the annual event (6,194 cfs) would be bypassed into Reach 2 to provide the beneficial effects described above for the one-year flood. Flood stages in Reach 2 would not exceed the one-year flood stage for relatively frequent floods between the two and five year events.

5.56 The flow downstream of Beatties Dam for the two-year event under future with-project conditions would be 6,279 cfs rising to 6,296 cfs at Dundee Dam; without the project, the flow would be over 8,500 cfs. The velocities above Dundee Dam drop from 1.4 to 1.1 fps, and stages would decrease from 28.8 feet to 28.2 feet NGVD for the two-year flood. For the 100-year flood under future without-project conditions, the flow between Beatties Dam and Dundee Dam is about 33,000 cfs. With the plan in effect, the flow below Beatties Dam is 9,500 cfs, rising to 12,400 cfs at Dundee Dam because of incremental flows from tributaries. River velocities above Dundee Dam drop from 3.6 to 1.8 fps, while flood stages are lowered 3.5 feet to 29.7 NGVD with the project. Table 31 provides a comparison of flow data with and without the project.

EFFECTS OF DUAL INLET PLAN - REACH 2

5.57 The Dual Inlet Plan effects on the Reach 2 significant resources are described below. These resources include wetlands, cultural resources, aesthetics and parks, and hydropower. The effects that reduced flood flows would have on aquatic resources, water quality and sediment transport are also discussed.

5.58 Wetlands. The wetlands in this reach are generally scattered. There are 40 acres of wetlands upstream of Dundee Dam, with 20 of these lying in the densely vegetated gorge at Little Falls (Figure 14). Despite the tunnel operating rule described in paragraph 5.55 above, five acres of intermittent riparian/wetland habitat is expected to be lost due to indirect effects of the changed Passaic River flow regime between the two and five-year events. Because the affected acres are scattered it is impractical to mitigate at these sites. Therefore, mitigation for this loss would be provided by upgrading five acres of wetlands on project lands in Reach 5, as discussed in Section 3, paragraph 3.114 and paragraph 5.177. Table 25 provides a summary of wetland effects for this reach.

5.59 Cultural Resources, Aesthetics and Parks. Since there are no physical modifications in this reach, there would be no direct effects on cultural resources, aesthetics or parks. The Great Falls National Natural Landmark and Historic District would not be affected by the plan because the diversion of flood flows would only take place when flows exceed the one-year event, and the operation of the tunnel would occur for limited periods of time, on the average about five days each year.

5.60 Hydropower. Flows during flood events are ordinarily well above the flow capacity of the power plants at the Great Falls (1,800 cfs) and Dundee Dam (2,300 cfs). Power plants would be virtually unaffected by the Dual Inlet Plan's operation and bypass flows, see Table 31. The operation of the Two Bridges Inlet was established to minimize flood damages downstream in the Lower Valley. Once river levels recede to non-damaging stages in the Lower Valley, the Two Bridges Inlet would be gradually closed to bypass increasing but non-damaging flows past Beatties Dam until the inlet would be completely closed. When plans are finalized for the Little Falls powerplant, the operation of the tunnel can be reevaluated in view of the powerplant's requirements and capacity. Therefore, there will be a minimal, if any, effect on the level of hydropower generation in the Lower Valley.

5.61 Other Effects. The effect of flood flow reductions on fisheries and water quality are not expected to be significant, because sufficient flows would be provided in this reach, first by incremental drainage from Lower Valley tributaries, such as the Peckman River, Molly Ann's Brook and Goffle Brook which reach flood peak before peak Central Basin flood flows enter the Lower Valley; and later, after upstream Central Basin flood peaks are diverted into the tunnel, the annual flood flow would be allowed to pass into Reach 2, as discussed in paragraph 5.55. The flows for the one-year flood would remain unchanged because the tunnel would not operate for this event, while the two-year flood flows would be reduced but would still be greater than the one-year flow (see Table 31). There would be greater reductions for larger events, but the incremental flows provided by Lower Valley tributaries would also be significantly larger, and for floods approaching the 100-year event, up to 9,500 cfs would be passed at Beatties Dam into this reach. Tunnel operation is expected only for limited periods of time, on the average about 5 days each year, when flows are greater than the annual flood. Sedimentation effects in this reach are difficult to quantify. Under normal flow conditions the tunnel would not operate and the sedimentation regime would remain the same with or without the project. Currently, flood flows may serve to

wash out settled solids. However, because there is a netaccumulation of solids, as evidenced by sediment deposition behind dams, it is probable that over the long term, the status quo will remain with the project.

5.62 Because there are no physical modifications in this reach, there would be no effects on other terrestrial resources, benthic flora and fauna, or public concerns such as access and noise.

EFFECTS OF SINGLE INLET PLAN - REACH 2

5.63 All of the impacts for the Dual Inlet Plan apply to the Single Inlet Plan, because the indirect changes caused by reduced flood flows are very similar in this reach. The annual flood would also be bypassed into Reach 2 with this plan.

NO-TUNNEL PLAN - REACH 2

5.64 Channel modifications are the only component of this plan in this reach. Between Dundee Dam and the Great Falls, the proposed channel would be an earthen trapezoidal with a bottom width ranging from 95 feet at Great Falls to 540 feet at Dundee Dam. The existing channel bottom would be lowered by an average of 10 feet. The channel would extend some 7.3 miles.

5.65 Moving upstream from the Great Falls to Beatties Dam, the proposed earthen trapezoidal channel would extend for 3.7 miles and be deepened an average of 6 feet. The crest of the S.U.M. Dam above the Great Falls would be lowered by 1.6 feet to 113 feet NGVD.

EFFECTS OF NO-TUNNEL PLAN - REACH 2

5.66 Wetlands. In Reach 2, all forty acres of wetland (30 forested, 10 scrub-shrub) present would be lost along the river's edge due to the channel modification which require widening. Compensation for this loss in the form of upgrading of forty acres of project lands in Reachs 4 and 5 is included in the plan (see Table 25).

5.67 Cultural Resources, Parks, and Aesthetics. The No-Tunnel Plan would require extensive works in the Passaic River channel in this reach and would adversely affect cultural resources, parks, and aesthetics in the Great Falls National Natural Landmark and Historic District during construction. However, the plan's long term reduction in flood events and damages to historic properties and sites would be beneficial.

5.68 Other Effects. The No-Tunnel Plan would require lowering the crest of S.U.M. Dam by 1.6 feet, resulting in the interruption of generation of hydropower during construction, and a long-term loss of power generation capacity as a result of dam height. During construction there would also be a temporary impact on water quality during channel modification activities, resulting in increased sediment levels. Sediment control techniques would be employed to minimize this impact.

5.69 Aquatic Habitats. Although not identified as a significant resource in this reach, aquatic habitat (325 acres) would be altered significantly during the construction of channel modification plans and subsequent maintenance of the channel. The channel modification would essentially result in the loss of the remaining fishery in the area. The existing limited warmwater fishery supports some panfish and gamefish. The general effects of channel modifications on aquatic habitat are described in paragraph 5.130.

5.70 Flows in this reach would increase slightly during flood events, but stages and velocities would decrease as a result of channel modifications. Sedimentation would be expected to remain the same, lower velocities being offset by deeper channels.

5.71 Dredged material from the river would be disposed of in upland sites such as at the Riverdale Quarry in Riverdale, New Jersey and/or the Clarkstown Landfill, located in Clarkstown, New York.

SUMMARY OF REACH 2 EFFECTS

5.72 The tunnel plans would not cause any direct effects from Dundee Dam upstream to Beatties Dam. However, the altered hydrologic regime and lower flood flows would indirectly cause a loss of five acres of wetlands. The No-Tunnel Plan, with over eleven miles of channel modifications, would cause substantial adverse effects to the aquatic habitats (325 acres) in Reach 2 and eliminate 40 acres of riparian wetlands. Only partial mitigation for these losses would be possible.

5.73 There would be no construction related impacts with either tunnel plan, but the No-Tunnel Plan would generate temporary traffic congestion, noise and air pollutants from the heavy construction equipment and trucks, as discussed in 5.09.

5.74 Wetlands. About five acres of wetlands would be adversely affected in this reach by the tunnel plans. Mitigation would be provided for this loss. Forty acres of riparian wetlands would be affected by the No-Tunnel Plan. Mitigation would be provided for this loss.

5.75 Cultural Resources, Parks, and Aesthetics. The Great Falls area would not be impacted by the tunnel plans, although flood flows would be reduced on the average of five days in any year. The No-Tunnel Plan requires channel works in these areas and would cause adverse effects and mitigation for cultural resources, parks and aesthetics, primarily in the Great Falls National Natural Landmark and Historic District.

5.76 Hydropower. There would be no significant effects on the generation of hydropower due to the tunnel alternatives. The No-Tunnel Plan would require the lowering of the crest of the S.U.M. Dam by 1.6 feet,which would result in a temporary interruption of power generation during construction, and a permanent loss resulting from the lower head and, therefore, reduced power output.

REACH 3 - PASSAIC RIVER: BEATTIES DAM TO TWO BRIDGES (FIGURE 23)

5.77 This reach extends from Beatties Dam in Totowa and Little Falls upstream to Two Bridges between Wayne and Fairfield. Both tunnel plans would include a tunnel portal within this reach, and in order to efficiently convey floodwaters into the tunnel, inlet structures for both plans would require channel modifications. The No-Tunnel Plan would not require structural modifications; instead more than 1,200 structures would require floodproofing, 50 would be raised and 18 structures would be removed from the floodplain. The plans provide significantly different levels of flood protection in Reach 3: the tunnel plans would each protect against a flood with a one percent exceedence frequency (100-year flood) while the No-Tunnel Plan would protect the structures in the reach against an event with a ten percent exceedence frequency (10-year flood). The Reach 3 project features for the three plans are summarized as follows:

Dual Inlet Plan	Single Inlet Plan	No-Tunnel Plan
o Two Bridges Tunnel Inlet	o Stag Island (Beatties Dam) Tunnel Inlet	o Nonstructural Measures - 1,257 structures floodproofed - 50 structures raised - 18 structures acquired and removed
o Channel Modification (1.1 miles)	o Channel Modification (3 miles)	
o 3 Tunnel Work Shafts	o 3 Tunnel Work Shafts	

DUAL INLET PLAN - REACH 3

5.78 Two Bridges Tunnel Inlet. The tunnel inlet would be located about 500 feet upstream of the Route I-80 bridge, adjacent to Fairfield Road in Wayne (see Figure 26 in the Main Report and Figure 28 in the EIS, an aerial photo of the intake site). To utilize this site, a bridge for Fairfield Road would be built over the inlet structure. The inlet would consist of a gated diversion spillway and a morning glory tunnel inlet. The diversion spillway would consist of four-15 feet high by 100 feet wide moveable bascule gates with five-4 feet round nose supporting piers designed for the 420 feet wide Two Bridges diversion spillway structures. The gates would be opened to allow floodwaters to enter the basin which contains the morning glory inlet to the spur tunnel. Flows would enter the basin when waters pond to an elevation controlled by the downstream rock ledge just upstream of Beatties Dam. The morning glory spillway would be located in a 280-feet diameter semicircular

access basin which would widen at its mouth to 412 feet. The 56 feet diameter morning glory spillway would have a crest length of 176 feet and a crest elevation seven feet above the floor of the access basin. The surrounding area is developed for residential use, while the intake site consists of undeveloped forested wetlands.

5.79 Channel Modification. No channel modifications are planned from Beatties Dam up to the Route 46 bridge. A modified channel for the inlet would extend 0.8 miles, from upstream of Two Bridges Road (on the Passaic River) downstream to the Route I-80 bridge. The channel would have an average base width of 175 feet, top width of 235 feet, and be deepened an average of 4 to 5 feet. The existing channel top width is 220 feet; therefore, about two acres of riparian edge and backyard lawns would be eliminated. The Two Bridges Inlet would also require a 0.3 mile transition channel on the Pompton River upstream of Two Bridges. This transition channel is included along with the work in Reach 3 to which it is related, although, it actually lies in Reach 4.

5.80 Work Shafts. The Dual Inlet Tunnel Plan would require three work shafts in areas that do not coincide with the river reaches used in this impact statement. Since these work shafts are closest to Reach 3 their effects are discussed here. One work shaft would be located in Little Falls in the vicinity of the Montclair State College and would be used in conjunction with a nearby abandoned quarry. The other main tunnel work shaft is located near the sewage treatment plant adjacent to the Preakness Valley Park in Wayne, would only be used as an exit shaft, where the tunnel boring machine would be removed at the end of the first and second phase of construction. It would not be an area used to remove or store excavated tunnel material. The spur tunnel work shaft would be located north of Interstate Route 80 near Riverview Drive in the Borough of Totowa. Approximately 1.25 million cubic yards of tunnel excavation material would be removed at the Montclair quarry work shaft and approximately 114,000 cubic yards removed at the spur tunnel work shaft. This material would be disposed of as discussed in paragraph 5.14. The locations of these work shafts are shown in Figures 56 and 57 in the Main Report.

EFFECTS OF DUAL INLET PLAN - REACH 3

5.81 The Dual Inlet Plan's effects on the Reach 3 significant resources are described below. These resources include wetlands and cultural resources. In addition to these resources, the operational effects on aquatic resources and surface water supply are discussed.

5.82 Tunnel work shafts are adjacent to land that has been developed. They are in flat, paved areas. No significant long term adverse environmental effects would occur at these sites, although construction-related effects would occur as discussed in 5.12, with the exception that tunnel excavation material would be removed by truck rather than by barge as in the Third River work shaft. The precise locations of these sites is subject to change during more detailed planning.

5.83 Operating rules for the Dual Inlet Plan were formulated to avoid and minimize adverse environmental effects at areas downstream from the diversion inlets, as discussed for Reach 2 in paragraph 5.55. For the one-year flood, velocities would remain unchanged, since the tunnel would not operate for this event. For storms greater than the one-year event, velocities in the Passaic River below Route 80 would change. For instance, for the two-year flood event velocities would decrease from 3.0 to 2.4 fps. After the peak has passed, flows equivalent to the one-year event would be bypassed to maintain the integrity of the downstream wetlands and channels. Water surface elevations for the two-year flood would drop 1.2 feet to 163.6 feet NGVD, but would still remain greater than the one-year flood stage. For the 100-year flood, velocities in the Passaic River below Route 80 would change from 5.2 to 2.7 fps, with peak flows dropping from 33,400 cfs to 9,200 cfs. Water surface elevations would decrease 8 feet, from 173.2 to 165.2 feet NGVD.

5.84 Wetlands. The tunnel inlet area would eliminate approximately five acres of forested wetlands, including the area used for construction, equipment storage, and disposal of excavation material. Although at this location there are many viable wetlands nearby, some of the wildlife may be eliminated instead of displaced; therefore, the animals from this area would be presumed to be lost. Due to the developed nature of Reach 3 the mitigation for this loss in this reach is impractical. Therefore, the plan includes mitigation in the form of regrading and replanting of wetland species, or otherwise improving the habitat of five acres of project lands in Reach 5 (see paragraph 5.177). The staging area used during construction would be restored.

5.85 Aquatic Resources. With the exception of changes in the flow regime, no impacts would occur from Beatties Dam to the Route 46 Bridge. Just upstream of the bridge, channel modification effects would be expected to affect 20 acres of aquatic habitat. Within the modified channel, the aquatic environment would be adversely affected by the physical changes to the stream course. The channel modification from the Passaic

River inlet upstream to the Two Bridges area would have adverse impacts as described in paragraph 5.130. The channel work would affect the aquatic biota of this reach adversely, however, since the affected reach is limited in length, and there are only limited fish and invertebrate species present, the losses would not be significant.

5.86 The effect of tunnel operation on the fisheries, would be expected to approximate the future without the project conditions. During a floodwater diversion (on average occurring five days a year) some fish would be lost due to stranding in the tunnel access basin, but few would be washed into the tunnel This is because the tunnel's portal is eight feet above the tunnel's access basin and only a laminar flow of surface water would enter the tunnel. Since most fish tend to seek bottom, few fish would be in the laminar surface flow. Any fish which would be entrained in the tunnel would be presumed to be lost. Substantial numbers of fish would find shelter in overbank areas upstream of the tunnel inlet where project floodwaters would be pooled.

5.87 Cultural Resources. At present, no historic or archaeological resources are known to exist on project related land. The Passaic River Inlet site and work areas will be systematically surveyed to identify any cultural resources prior to construction, and if any are found, mitigation programs would be developed and implemented.

5.88 Surface Water Supply. It is noted that the Passaic Valley Water Commission (PVWC) has a water supply intake and treatment plant located at Beatties Dam, downstream of the proposed Passaic River Inlet. This intake is now used as a standby facility. However, a new intake facility is included at the Wanaque South water supply intake site on the Pompton River (Reach 4) which provides cleaner Pompton River water to the Little Falls treatment plant. Because the Little Falls intake is no longer the primary intake, there would be no effects to surface water supply in this reach.

5.89 The minimum bypass flows of 100 cfs early in the storm and the passage of the annual event after flood peaks recede would not only assure downstream flows but would also maintain normal streamflow stages in this reach. This would also maintain groundwater levels during prolonged flooding periods and maintain water tables and river recharge to the adjacent surface aquifers and any nearby wells. The channel excavation upstream of the Two Bridges Inlet ranges from three to five feet in sands and gravels which will have little effect on the surface aquifer in this area other than a minor enhancement to recharge due to the removal of overburden.

SINGLE INLET PLAN - REACH 3

5.90 Beatties Dam Inlet. The proposed inlet would be located on Stag Island in the Passaic River at Wayne. This undeveloped site lies approximately 2,000 feet upstream of Beatties Dam, where the river descends rapidly through the basalt gorge over minor falls and rapids. Gradients in the stream above Beatties Dam are extremely mild in slope. The inlet would include a morning glory inlet structure and a gated diversion spillway. The morning glory inlet would divert flows into the tunnel under the same conditions described for the Dual Inlet Tunnel Plan. Flood flows larger than tunnel capacity would continue downstream.

5.91 Channel Modification. The channel modification would extend from the inlet upstream along the Passaic River for 3 miles to Two Bridges Road. This channel would have an average base width of 160 feet and would be deepened an average of 15 feet. The resulting top width of the channel would be approximately 290 feet. The top width of the existing channel averages 220 feet.

EFFECTS OF SINGLE INLET PLAN - REACH 3

5.92 The general effects of the channel modification on aquatic habitat are described in Paragraph 5.130. About 55 acres of aquatic habitat would be affected in this reach with this plan. Approximately 25 acres of riparian edge and backyards would be lost. This includes about five acres of wetlands. The proposed tunnel intake at Stag Island would permanently eliminate about five acres of wetland wildlife habitat. Mitigation for this loss would be provided on project lands in Reach 5, as described above for the Dual Inlet Plan (see paragraph 5.84). Construction equipment storage and disposal of excavated material would temporarily affect another acre of adjacent land. These activities would displace wildlife from the construction site. This displacement would effectively eliminate the animals because almost no adjacent habitat exists in this location. However, since the existing natural area is small, many of the sensitive species have already been eliminated due to the proximity of man, and wildlife's inability to acquire all of their life requirements there. Any acreage used temporarily for construction would be restored.

5.93 This plan modifies flows in this reach. The inlet would be located at the downstream end of the reach. During floods, flows upstream of the inlet would increase while flows downstream of the inlet would decrease.

5.94 The minimum bypass flow would have the same effects as the Dual Inlet Plan on the shallow sand and gravel aquifers near the surface in this reach. However, deepening the channel bottom by approximately 10 feet may serve to increase recharge in this reach in the surface aquifer. Because the buried valley aquifer (not believed to be associated with the designated Sole Source Buried Valley Aquifer) is capped with very thick layers of clay, the new channel would not penetrate the aquifer. However, the aquifer is not defined in this area and it may rise with the rock ledge at the Tunnel Inlet on Stag Island. If this was the case, recharge would be enhanced by the removal of overburden.

5.95 Surface water supply is not affected as described in paragraph 5.88.

5.96 The potential for impacts on cultural resources would be similar to the Dual Inlet Plan (see paragraph 5.86).

NO-TUNNEL PLAN - REACH 3

5.97 Nonstructural measures under the no-tunnel plan, floodproofing, raising, and permanent evacuation, are used to provide a 10-year level of protection to this reach. These measures are described in paragraphs 3.05 to 3.06. In this reach, 1,176 residential and 81 nonresidential structures would be floodproofed, 46 residential and 4 nonresidential structures would be raised, and 12 residential and 6 nonresidential structures would be evacuated.

5.98 An enhanced floodwarning and preparedness system is integral to this plan because of the relatively low level of protection provided, the isolation of structures during flooding, and the potentially catastrophic consequences during very infrequent events. Temporary evacuation of homes would be warranted for flood events that threaten to exceed the 10-year design level.

EFFECTS OF NO-TUNNEL PLAN - REACH 3

5.99 There are virtually no environmental effects on natural resources associated with the No-Tunnel Plan except for disposal of demolition materials from the evacuated structures at a proper disposal site. Evacuated structures would cause a beneficial effect because real estate would be converted into public parks or open space. However, this plan would cause disruption and adverse impacts on human resources. The affected communities would be disrupted during the construction period since the construction activity would be within the neighborhood itself. Residents whose homes are being raised and/or flood-proofed would be stressed due to the construction itself,

including noise, and the disruption of their daily routines. Residents and employees would have to leave their homes and businesses while they would be raised. Families, business owners, and employees from evacuated structures would have to face the stress of finding, negotiating and funding a new home or business location, moving, and changing schools and other community services and facilities. Business revenues may not recover if they relocate in less attractive sites.

5.100 The greatest disadvantage to this plan is the very low level of flood protection that it affords. During a flood, the raised and floodproofed structures would remain isolated in the floodplain, with an accompanying risk to life, especially for events that exceed the 10-year design level. While the physical contents of the structures would not be subject to flood damages, residents and employees would remain at risk due to their isolation. Should a flood occur while a person is away from the structure, the raised and floodproofed structures would be inaccessible, except by boat.

SUMMARY OF REACH 3 EFFECTS

5.101 The tunnel plans would each require structural works in Reach 3, with the Single Inlet Plan having the most extensive surface works. This plan includes a tunnel inlet at Stag Island and approximately three miles of channel modifications, almost three times the extent required by the Dual Inlet Plan. By contrast, the No-Tunnel Plan would not require structural modifications. This plan utilizes nonstructural measures and would not result in adverse environmental effects, although it provides only a ten-year level of protection.

5.102 Wetlands. Five acres of wetlands in Reach 3 would be lost to each tunnel plan. Mitigation for this loss is provided on five acres of project lands in Reach 5. The No-Tunnel Plan would have no adverse impacts on wetlands.

5.103 Cultural Resources. None of the three plans would affect existing or potential future National Historic Sites. There is some potential for the discovery of prehistoric sites. This would be investigated during preconstruction cultural resources site surveys. If any resources are found appropriate mitigation programs would be developed and implemented.

REACH 4 - POMPTON VALLEY AND TRIBUTARIES (FIGURE 23)

5.104 Reach 4 includes the entire Pompton River from the Passaic/Pompton confluence and further upstream past the mouths of the Pequannock River, the Wanaque River, and the Ramapo River. The flood control measures proposed for Reach 4 include channel modifications, levees and floodwalls, nonstructural measures, and the Pompton River Tunnel Inlet in various combinations. The three alternatives reflect contrasting approaches for providing protection to this reach. The Dual Inlet Plan provides a 100-year level of protection by combining the diversion of Pompton River flows with channel modifications, levees and floodwalls on the Pompton tributaries, with virtually no works on the Pompton River; while the Single Inlet Plan includes surface works throughout the reach providing a 100-year level of protection; and the No-Tunnel Plan includes the exclusive use of nonstructural measures to provide a 10-year level of protection. All three plans include elements of natural storage acquisition areas within this reach. The Reach 4 project features can be summarized as follows:

Dual Inlet Plan	Single Inlet Plan	No-Tunnel Plan
o Pompton Tunnel Inlet Works	o Channel Modifications	o Nonstructural Measures
o Channel Modifications	- Pompton River (6.8 mi.)	- 3,200 Structures Floodproofed
- Ramapo River (1.2 mi.)	- Ramapo River (1.2 mi.)	- 528 Structure
- Pequannock River (2.6 miles) (2.6 miles)	- Pequannock River (2.6 miles)	- 528 Structure Raised
- Wanaque River (1 mi.)	- Wanaque River (1 mi.)	- 25 Structures Acquired
o Levee/Floodwall Systems (4.2 mi.)	o Levee/Floodwall Systems (4.2 mi.)	
o Natural Flood Storage Preservation (690 ac.)	o Natural Flood Storage Preservation (690 ac.)	o Natural Flood Storage Preservation (690 ac.)

DUAL INLET PLAN - REACH 4

5.105 The Pompton River Inlet. The Pompton Inlet would be located on the east bank of the Pompton River just downstream of the confluence of the Pequannock and Ramapo Rivers. The inlet structure would lie upstream of the Pompton Plains Cross Road (Jackson Avenue) in Wayne. Figure 26 shows a model of the intake structure, and Figure 27 is an aerial photograph of the site. The site is currently a storage facility for a sand and gravel mining operation. The area around the site is generally

undeveloped floodplain to the west and north, and agricultural lands to the east. Stream slopes are very flat in the vicinity of the inlet. There is extensive suburban development upstream of the proposed inlet along the Pequannock and Ramapo Rivers and further upstream along the Wanaque River.

5.106 The inlet works would include a river flow restrictor, a river diversion spillway and a morning glory inlet, as shown in Figure 58 of the Main Report. Levees, floodwalls, and channel modifications would be required upstream of the inlet along the lower reaches of the Pequannock, Ramapo and Wanaque Rivers.

5.107 The river flow restrictor would be constructed across the Pompton River for the purpose of diverting flows toward the inlet and allowing bypass flows to continue down the river. It would consist of a concrete bridge-type structure with a 32-feet-wide by 16.5-feet-high center gated opening, and four 28-feet-wide by 16.5-feet-high gated openings. During non-flood conditions, the center gate on the river flow restrictor would remain open to permit normal flows. During a flood the center gate would be initially operated to allow a bypass flow of 500 cubic feet per second. This flow would sustain downstream aquatic resources and provide sufficient flows for water supply intakes located further downstream on the Pompton and Passaic Rivers. After the flood crests and stages begin to recede, the restrictor would be operated to permit an annual flood to pass downstream along the Pompton River. (The annual flood would maintain the viability of downstream wetlands and aquatic habitats.) When flows would exceed the 100-year design flow condition, all the gates would be opened to pass the larger flows and maintain maximum diversion through the tunnel.

5.108 Training-levee embankments would tie into the restrictor on both banks to assure that the tunnel functions at 100-year flow levels. Embankment heights would range from 4 to 5 feet, and they would be 720 feet long on the east bank and 750 feet long on the west bank. A 7-feet-high berm would circle the inlet basin's 500-feet long perimeter. The inlet basin would be 400 feet wide at its largest dimension.

5.109 A gated diversion spillway would be located on the east bank of the Pompton River to regulate the flow of floodwaters into the inlet basin. Five 75-feet-wide gates would control these flows. These gates would be opened for diversions to the tunnel only for flows projected to exceed or exceeding the one-year flood.

5.110 Channel Modifications. Channel modifications would be required to direct flood flows safely to the inlet works. Channel modifications would also provide protection to the areas upstream of the Pompton inlet.

5.111 Pequannock River channel modification would extend upstream for 2.6 miles above the inlet (Figure 47 of the Main Report). The modification would include deepening the existing channel by 7 feet and increasing the bottom width to an average of 74 to 100 feet. The average top width of the modified channel would range from 135 to 160 feet. The top width of the existing channel is approximately 100 feet.

5.112 A gated weir would be constructed across the tunnel inlet transition channel on the Pequannock River and would replace the berm structure of the Old Morris Canal at this location (Figure 47 of the Main Report). It would consist of two 85-feet wide, 15-feet high bascule gate sections tying into the existing berm between the feeder dams. The top elevation of the weir would be 180 feet NGVD, about three feet higher than the existing feeder dams on the Pequannock and Ramapo Rivers. This weir, in conjunction with maintaining the existing U.S.G.S. Weir on the Pompton River downstream, would maintain normal water levels upstream of the proposed inlet, which would have otherwise been lowered due to the transition channel around the feeder dam and the upstream channel modifications. Under normal flows the gates in the Pequannock Weir would be in the up or "closed" position. During tunnel operation the gate in the weir would be gradually lowered to pass flood flows through the transition channel to the flow restrictor and inlet works.

5.113 Ramapo River channel modification would extend from a short transition with the Pequannock River, upstream for about 1.2 miles to the Hamburg Turnpike (Figure 49 of the Main Report). The modification would include deepening the existing channel by 4 feet and increasing the bottom width to between 60 and 100 feet. The average top width of the modified channel would be approximately 150 feet. The top width of the existing channel is about 110 feet.

5.114 Wanaque River channel modification would extend from its mouth upstream one mile to the Hamburg Turnpike (Figure 48 of the Main Report). The modification would include deepening the existing channel by about 6 feet and increasing the bottom width to an average 74 feet. The top width of the modified channel would be an average 125 feet as compared with the existing top width which averages about 90 feet.

5.115 Levee and Floodwall Systems. The levee systems in this reach total 3.5 miles of levees, and 0.7 mile of floodwalls (see Table 19, Main Report). To maintain an unbroken line of protection against floodwaters, three stretches of roads would need to be raised in Reach 4. The levee construction and road-raising impacts are discussed in 5.09 through 5.11.

5.116 Preservation of Natural Flood Storage. The preservation of natural storage areas within this reach includes acquiring 690 acres of floodplain, 660 acres of which are wetlands, as shown in Main Report Figure 23.

EFFECTS OF DUAL INLET PLAN - REACH 4

5.117 The Dual Inlet Plan's effects on the Reach 4 significant resources are described below. These resources include wetlands, groundwater and aquatic resources, surface water supply and quality, cultural resources and parks. Central to the discussion of impacts in Reach 4 is the operation of the project.

5.118 Project Operation. Operating rules for the Dual Inlet Plan were formulated to avoid and minimize adverse environmental affects at areas upstream and downstream of the Pompton River Tunnel Inlet. The tunnel would not operate for flood events up to the one-year event. Thus the flow regime for frequent events in Reach 4 would not be affected, allowing these flows to continue to support aquatic habitat, nourish wetlands in the one-year floodplain, provide a flushing effect for sediments settling in the channel, and provide dilution to downstream incremental flows for water quality. During floods greater than the one-year event, for which the tunnel would operate, flows of 500 cfs would by-pass the Pompton Inlet into the Pompton Valley, early in the storm (approximately the first 25 hours) while the flood peak is rising, in order to avoid flood damages in the Pompton Valley. Intervening drainage from Pompton River tributaries downstream of the proposed tunnel inlet would reach flood peak and enter the Pompton River, supplementing the 500 cfs bypass during flood periods. After peak flood flows subside, flows equivalent to the one-year event would be bypassed downstream into the Pompton Valley to provide the beneficial effects described above for the one-year flood.

5.119. The operation of the Pequannock Weir would ensure that the minimum flood stage upstream of the Pompton Inlet would be equal to the one-year flood event during operation of the project. The Pequannock Weir, which would be located upstream of the Pompton Inlet in the Pequannock River bypass channel (see Figure 27) includes controllable gates which would remain in the up or "closed" position in order to maintain normal upstream water surface elevation and maintain flows over the historic Morris Canal feeder dams. During flood events the gates would be gradually closed to pass water downstream into the bypass channel while maintaining at least the one-year flood elevation

upstream. The Pequannock Weir was incorporated into the project design and operation subsequent to the circulation of the DEIS in order to address concerns regarding the impacts of the Pequannock River bypass channel and operation of the Pompton Inlet on upstream water surface elevations, wetlands and groundwater levels, as discussed in paragraph 1.30.

5.120 Wetlands. A total of 1,680 acres of wetlands presently exist in Reach 4. All plan components would be located within and around 215 acres of these existing wetlands. The extensive modifications required to control the flood flows from the three converging rivers would affect the wetlands. Wetlands would be lost directly due to the placement of levees (20 acres), ponding areas (30 acres) and channel modifications (40 acres), and 90 acres of forested wetlands would be altered due to the clearing of large trees to ensure safe tunnel operation.

5.121 Of the 25 acres of land that would be covered by levees, 20 acres are forested wetlands. The destruction of these wetlands would be offset by the regrading and replanting of wetland species or otherwise improving the habitat for 20 acres of forested wetlands within the natural storage acquisition area in Reach 5 (see Section 3 paragraph 3.114).

5.122 An additional 30 acres of wetlands that would be upland of the levees, and no longer subject to riverine inundation, would be used as ponding areas. In these ponding areas, the existing wetland vegetation would be removed, and the ground would be excavated and regraded to allow the retention of interior drainage until after the flood peak passed. In order to offset the loss of forested wetlands due to ponding area construction, the ponding areas would be replanted with obligative and facultative wildlife-food plants. As proposed in the DEIS, emergent wetlands were planned for these areas based on comments from the FWS, the relative scarcity of this cover type, and because of the relative ease and current state-of-the-art for emergent wetland creation when compared to forested wetlands. Based on discussions with EPA subsequent to the DEIS' circulation, their preference for mixed habitat wetland planting in ponding areas is recognized. A final decision regarding this design aspect will be made with the Environmental Advisory Board during Phase II design.

5.123 Therefore, a mixed wetland cover type planting will be consiered for ponding areas. The bottom surface of the ponding areas would be contoured to provide a range of elevations and soil moisture conditions to accommodate a variety of cover types. The need to ensure sufficient volume for interior runoff storage through ponding area excavation would result in the 30 acres of forested wetlands changing to a combination of emergent, scrub-shrub and less mature forested wetlands. The mix of wetlands would change, with emergent as the predominant cover type, but the area would continue to provide food,

shelter, and reproductive cover for wildlife. The species of animals using the areas, however, would change. The lands which are to be used for ponding and planting would be subject to a change in mosquito populations since the cover type of the wetland would change. The species to be planted in the ponding areas, would be based on the FWS plant community succession model and developed through coordination with NJDEP and consultation with noted experts during Phase II design. A similar process would be used to control mosquitoes. Attachment A-38 of Appendix A - Public Involvement provides additional discussion of the proposed ponding area planting.

5.124 Another 40 acres of forested wetlands would be directly lost to the channel widening that would be required - the Pequannock would be widened by 35 to 60 feet, the Ramapo by about 40 feet, and the Wanaque by about 35 feet. The rivers would be deepened by 7, 4, and 6 feet, respectively. To offset this loss, 40 acres of emergent wetland would be created in Reach 4's ponding areas from areas that are now uplands.

5.125 The inclusion of the gated Pequannock Weir across the tunnel inlet transition channel on the Pequannock River, as an integral part of the tunnel inlet design, would maintain 90 acres of project area wetlands upstream of Pompton Plains Cross Road, which would otherwise have been lost due to channel modifications. These wetlands would be converted from 90 acres forested, to all scrub-shrub due to tree clearing necessary to protect tunnel elements of the project during operation. Field investigation of this forested wetland site confirms that the understory now present consists primarily of facultative plant species adapted to the current moisture conditions that would be maintained with the project, and that the area would change into a scrub-shrub wetland with the removal of large trees. (See Attachment A-38c of Appendix A - Public Involvement.)

5.126 Due to the need to ensure proper functioning of the tunnel, the 90 acres of forested wetland may need to have trees removed. This would prevent the trees from falling and jamming and otherwise damaging the tunnel elements of the project. Every effort will be made during the design stage of the project to reduce the extent of tree clearing through the use of fencing and an anchoring program for fallen trees, within the limits of design and operation risks. At this stage of planning, however, the clearing of the larger trees for the entire 90 acres is utilized for impact assessment. Based on the species composition of the wetlands understory as described in paragraph 5.125, these areas would still remain scrub-shrub wetland, however, due to the Pequannock Weir.

5.127 The existing U.S.G.S. weir, located downstream of the proposed Pompton flow restrictor, would be maintained in its present state. This would provide the water surface elevation to maintain 35 acres of scrub-shrub wetlands under normal flows in the vicinity of the weir.

5.128 The net residual affect to wetlands in Reach 4 is the loss of 20 acres of forested wetlands (due to levee placement paragraph 5.121), and the change in cover type of 160 acres (90 acres of forested to scrub-shrub due to tree clearing, paragraphs 5.125 and 5.126, and 70 acres of forested to mixed cover types (predominate emergent) due to ponding areas and channel construction, paragraphs 5.122-5.124). Mitigation is proposed to address the loss of 20 acres through the upgrading and/or creation of 20 acres of forested wetlands in Reach 5 which have been abused by man's intrusions (see paragraph 5.177).

5.129 Aquatic Resources The Pompton Valley tributaries within the modified channel reaches, the Ramapo River (1.2 miles), the Pequannock River (2.6 miles) and the Wanaque River (1 mile), contain areas of good fishery and are, except for the Pequannock River, currently stocked with trout by NJDEP. The Pequannock River, while not stocked with trout at present, is expected to be stocked in the future, with the closing of an upstream sewage treatment plant. The existing benthic invertebrate groups are, in general, characteristic of relatively good water quality in the Ramapo and Wanaque Rivers and would take some time to reestablish with the project. The extensive channel modifications on the Ramapo, Pequannock, and Wanaque Rivers would cause significant adverse affects to aquatic habitats during construction. The types of effects include: a reconfiguration of the stream morphology, elimination of substantial tree shade and, therefore, an increase in water temperature, coupled with a decrease in dissolved oxygen and removal of aquatic flora and fauna during construction.

5.130 During construction, river bottom excavation would remove instream debris and all aquatic vegetation, as well as benthic organisms and their habitats. Some natural meanders would be cut off. The modified channel side slopes would be cleared of vegetation. Productivity would be reduced during river bottom excavation both from the effects of turbidity as well as from the loss of aquatic plants and other food organisms. Some fish would be destroyed by the machinery. Removal of instream debris, such as fallen trees and boulders, and regrading the river bottom would improve hydraulic efficiency, at the expense of eliminating the variability of flows. This loss would cause a decline in overall fish and invertebrate diversity. The eddies and stilling pools which many fish species prefer as habitats would be lost and changed to a uniform current, from which many

fish species tend to emigrate. The removal of overhanging trees would reduce shade and leaf litter, a primary source of nutrients for microscopic biota, the ultimate source of food for fish. The periodic removal of sediment for maintenance purposes would adversely affect the aquatic biota that recolonizes this reach. Finally, the channel modification would adversely affect riverine aesthetics.

5.131 It is anticipated that New Jersey's trout stocking program would be suspended during construction. Public access for angling in the affected reaches would be provided as part of the protective works and fish and wildlife mitigation plan. Measures to offset the adverse impacts to aquatic habitats include maintaining channel meanders in the modified reaches where possible, and the replacement of channel substrate (which would stockpiled during removal from the existing channel) subsequent to channel deepening. In addition, cobble substrate would be placed in modified reaches where it does not exist at present and channel sections and banks susceptible to erosion would be protected with riprap. Low flow pilot channels would be provided along the upper 3,500 feet of the Pequannock River and upper 1,800 feet of the Wanaque River where existing flood stages are not maintained, as described below. Fish habitat structures would be placed on the Pompton River, downstream from the flow restrictor. Concern expressed during the review of the DEIS regarding the loss of 15 acres of Ramapo River aquatic habitat resulted in the refinement of the Pompton Inlet design works. The Pequannock River Weir would now allow this 15 acres of aquatic habitat to remain unchanged from existing conditions. Further, the Pequannock Weir would maintain water surface elevations upstream of its location, and in conjunction with channel deepening, increase pool depths along the lower Ramapo, Wanaque and Pequannock Rivers. Paragraphs 3.117-3.122 provide a full description of these measures.

5.132 During operation of the project fish entrainment in the tunnel is not expected to be significant because the inlet design places the tunnel portal eight feet above the floor of the access basin, resulting in a laminar surface flow entering the inlet, as described in paragraph 5.86 for the Two Bridge Inlet.

5.133 Groundwater. Along the Pequannock, Wanaque, and Ramapo Rivers, groundwater levels would remain unchanged except at the upper 3,500 feet of the Pequannock River and upper 1,800 feet of the Wanaque River, where normal river stages would be lowered. The Pequannock Weir would close the breach caused by the Pequannock transition channel around the Feeder Dam and would maintain water surfaces under normal conditions in the modified channels. However, the channel work would lower normal flow levels as much as 2.5 feet along the upper 3,500 feet of the

Pequannock River channel, and as much as 5.0 feet along the upper 1,800 feet of the Wanaque River. However, this is not expected to create a significant impact because there are no public water supply wells along the Wanaque River, and the small change along the Pequannock River would not affect the yields of public wells that are over 100 feet deep. The lower end of the Pompton River will experience no change in normal water levels because bypass flow rules will maintain flows over Beatties Dam and river stages will never fall below the crest of the dam. Because channel excavation is minimal in this reach, no effects on groundwater are expected (see Attachment A38f, Appendix A - Public Involvement).

5.134 Water Supply and Quality. There would be no change in flow conditions for floods up to the one-year event since the tunnel would not operate for these floods. During the operation of the tunnel for the more frequent flood events, velocities and flows in the Pompton River would decrease as compared to future without project conditions. These changes for relatively frequent events like the two-year flood would not be significant since velocities and flows would still generally exceed the one-year event. For the 100-year event, velocities would drop from 4.5 to 2.6 fps, while the flood stage would decrease 10 feet. Flows in the Pequannock, Wanaque, and Ramapo Rivers would increase slightly with this project. Velocities would remain about the same, but stages would drop because of the increased channel capacities (see Table 31).

5.135 During construction there would be a temporary impact on water quality while channels are modified, resulting in increased levels of suspended sediments in Pompton River flows. Sediment control techniques including the use of silt screens and Soil Conservation Service erosion control methods would be employed during construction to minimize this impact.

5.136 During the operation of the Pompton Inlet, there would be no impact to downstream water supply withdrawals because of the infrequent use of the project and the 500 cfs and one-year flow bypass rules which would insure sufficient flows to meet these needs. In the long term, water quality would also not be affected at the downstream intake sites since the Pompton flows would be unchanged during normal flow conditions. During flooding conditions, quality would be no worse with the plan, and may be improved. This is because flood flows would be contained within banks and the out-of-the-bank flow conditions which pick up contaminants and sediment would not take place.

5.137 Cultural Resources. The Pequannock transition channel is located adjacent to the Pequannock Feeder Dam, which is part of the Morris Canal Historic District, so there is a possibility of the discovery of historic artifacts in this area. The transition channel would affect an element of the Pompton Spur to the Morris Canal, a property on the National Register of Historic Places. An earthen berm that creates a ridge connecting the Pequannock River Dam with the Ramapo River Dam and guides the rivers' flows over both of these dams would be breached by the construction of the bypass channel and its moveable weir. The Pequannock Weir serves to maintain flows over both the Pequannock and Ramapo Feeder Dams associated with this historic district, thus avoiding an impact to these structures. A variety of locations were considered in aligning the bypass channel, including removing the dams. Since the main purpose of the bypass channel would be to convey flood flows efficiently into the tunnel, the planned location was judged sufficient to meet that requirement, while causing the least impact to the Morris Canal's elements. Prior to construction, a detailed cultural resources survey will be performed, a case report will be prepared, and a mitigation plan will be formulated in consultation with the Advisory Council on Historic Preservation, the State Historic Preservation Office, and County and local historical societies, including the Morris Canal Historical Society. It would be noted that in addition to conveying floodwaters into the tunnel portal, the bypass channel's moveable weir serves other purposes during non-flood stages. During non-flood periods, it would allow normal flows to pass over the existing dams, while maintaining water levels and wetlands upstream, preserving wetlands and partically mitigating for aquatic impacts.

5.138 There is also the possibility that prehistoric sites may exist in this area. Site specific surveys would be carried out during the design stage of the project.

5.139 Parks. Over 160 acres of parkland exists in the upper portion of Reach 4. Approximately 4.4 acres of parkland would be affected by the project's levees and/or channel modification features. Recreational opportunities and the aesthetics of these impacted areas would change due to the project. With the project, access to the river would be provided for angling opportunities, and levee-top walking/biking paths would be included in the beautification and planting designs. Due to the replacement of private lands with public project lands, the opportunity exists for improvements to access to the rivers for fishing and other recreation experiences. However, the aesthetic impact of the project would be negative, because these natural river reaches would be replaced by man-made channels and banks.

SINGLE INLET PLAN - REACH 4

5.140 This plan would call for substantially more channel modifications than the Dual Inlet Plan. Channel modifications on the Pompton River would extend 6.8 miles over its entire length. The modified channel would be deepened an average of 12 feet, with an average base width of 95 feet. The resulting top width of the modified channel would be 190 feet as compared with the top width of the existing channel of 135 feet. It would be necessary to evacuate 61 structures located on an island in the river and along the banks. The levees and floodwalls for the Pequannock, Ramapo, and Wanaque Rivers would be higher than those in the Dual Inlet Plan, and the channels would be deeper. A weir on the Pequannock River Weir was incorporated into the plan and would be used for the same purpose as the recommended Plan (see paragraph 5.131).

EFFECTS OF THE SINGLE INLET PLAN - REACH 4

5.141 Wetlands. The effects of the Single Inlet Plan would be slightly more severe than those of the Dual Inlet Plan in the Pequannock, Wanaque and Ramapo Rivers because the single inlet channel modifications in these areas are more extensive. Like the Dual Inlet Plan, about 40 acres of wetlands would be lost to channel widening, and about 20 acres of wetlands would be lost and covered by levees. The 30 acres needed for ponding of interior drainage behind the levees would be transformed from forested to emergent wetlands, containing both faculative and obligative plants, and, as in the Dual Inlet Plan, 20 acres would be mitigated for in Reach 5. The major difference in this reach would be the permanent loss of about 40 additional acres of riparian forested wetland from widening the Pompton River channel. However, lower groundwater tables along the Pompton River would further alter terrestrial habitat by causing it to succeed to a more upland cover type. A gated weir on the Pequannock River would be utilized to prevent changes in normal water levels on the Pompton River tributaries.

5.142 Aquatic Resources. The proposed 6.8 miles of channel modification on the Pompton River, in addition to the modifications of the Ramapo, Wanaque and Pequannock Rivers, would have adverse impacts on the aquatic habitats of these streams. The existing fishery would be degraded for some time to come, and NJDEP's trout stocking in this area would also cease during the long construction period. Substantial time and mitigation would be needed to help offset these losses.

5.143 Groundwater. There is a productive buried valley aquifer located in Pompton Plains which is in direct connection with surficial sands and gravels immediately west of the Pompton River. While this aquifer is not well defined, it is possible that it may be in direct connection with the river. If clays are present in this area, it is possible that they may be penetrated by the excavation for the channel modification along the Pompton River. This would result in an increase of recharge to the aquifer. For the Pompton River's upper tributaries, the plan effects are the same as those described for the Dual Inlet Plan, which are not considered significant. (See 5.133.)

5.144 Water Supply and Quality. The construction of the Pompton River channel would result in temporary increases in sediment loads and the water supply drawn from the Pompton River would require additional treatment during the construction period. Water quality under low flow conditions would be lowered due to the removal of tree cover along the banks and the uniformity of the modified channel bottom. The deepening of the channel would also cause water surface elevations to decrease under non-flood conditions in the Pompton River.

5.145 Parks and Cultural Resources. Plan impacts to parks and cultural resources are similar to those described for the Dual Inlet Plan, although the additional 6.8 miles of channel works along the Pompton River would be expected to increase the extent of impacts to parks and increase the potential for cultural resources effects.

NO-TUNNEL PLAN - REACH 4

5.146 Under this plan, protection against the 10-year flood would be provided through the Pompton Valley by nonstructural measures. These measures would include floodproofing, raising and permanent evacuation.

5.147 In the Pompton Valley, including the lower Wanaque, Ramapo and Pequannock Rivers, a total of 3,004 residential and 196 nonresidential structures would be floodproofed, while 528 structures would be raised, including 516 residential and 12 nonresidential structures. In addition, in the Pompton Valley, 10 residential and 15 nonresidential structures would be permanently evacuated. A total of 3,753 structures would be provided with a 10-year level of protection by nonstructural measures.

EFFECTS OF NO-TUNNEL PLAN - REACH 4

5.148 The environmental effects of this plan on this reach are insignificant. Outside of the minor local disturbances of construction work on the structures, there would be no impacts on the wetlands, fisheries or other natural resources. Human resources would be stressed by the relocation of homes and businesses as discussed in 5.99 and demolition materials for the 25 evacuated structures would have to be properly disposed.

SUMMARY OF REACH 4 EFFECTS

5.149 In the Pompton Valley, limited floodproofing, raising and permanent evacuation measures of the No-Tunnel Plan would cause minimal to no adverse effects on the terrestrial and aquatic resources. This plan would, in fact, improve terrestrial resources, because land where permanent evacuations occur would be turned into parkland and open space. The Single Inlet Plan would have the most pronounced effect on the terrestrial and aquatic environments. The Dual Inlet Plan would have fewer effects on terrestrial and aquatic resources than the Single Inlet Plan, since it would eliminate over six miles of channel modification and the need for structural protection works along the Pompton River, by placing a greater portion of the construction underground. The contrasting impacts associated with this reach constitute some of the most significant differences among the alternatives in the basin.

5.150 Wetlands. In the three river confluence area, 90 acres of forested wetlands would be permanently lost to levees, ponds, and channel widening under both tunnel plans. The Single Inlet Plan would have the same impact upstream of Pompton Plains Cross Road and a substantially greater impact in the Pompton River reach because the Single Inlet Plan would destroy 40 acres of Pompton Valley wetlands to channel widening.

5.151 The effects of the three plans vary, although the two tunnel plans closely parallel each other's impacts on terrestrial resources along the Pequannock, Wanaque and Ramapo Rivers. With both tunnel plans, 90 acres would be lost due to structural elements (e.g. levees), and 90 acres of forested wetland would have large trees removed to protect tunnel elements. Lost and altered wetlands would be compensated for by use of standard engineering practices or mitigation as previously discussed in Section 3, 3.114.

5.152 In summary, the Dual Inlet Plan's levees, ponding areas and channel modifications would destroy 90 acres of forested wetlands, of which 70 acres would be converted to mixed cover types with primarily emergent wetlands, and 20 acres would be mitigated for on Reach 5's project lands. Additionally, 90 acres of forested wetland would be converted to scrub-shrub wetland due to the removal of large trees. The Single Inlet Plan would destroy 130 acres of forested wetland, which would be replanted as 110 acres of wetland. Twenty acres of forested wetland would be mitigated for on Reach 5's project lands, and 90 acres of forested wetland would convert to scrub-shrub wetland. The no-tunnel plan would have no adverse effect on wetlands in Reach 4.

5.153 Aquatic Resources. Both tunnel plans would have a substantial impact on aquatic resources in this reach as each would result in the loss of 25 acres of aquatic habitat along the Pompton's tributaries. The two tunnel plans differ markedly, however, in the Pompton River reach where the need for channel modification with the Single Inlet Plan would adversely effect 120 acres of additional aquatic habitat. The No-Tunnel Plan would not have this adverse effect on aquatic habitat.

5.154 Surface Water Quality. Water quality in Reach 4 is relatively good as evidenced by the State of New Jersey's trout stocking program and the two intakes for water supply, one on the Pompton River just downstream of the inlet, and another further downstream near its confluence with the Passaic River. It is expected that during construction additional filtering of intake water would be needed, and the State would suspend their stocking program. During project construction, water quality would be temporarily affected by increased sediment loading but all measures associated with best available technology and Soil Conservation Service practices (e.g., silt screens) would be used to lessen these adverse effects. Negative impacts from the Single Inlet Plan would be worse, since it would disturb a much greater extent surface water and have a longer construction period. The No-Tunnel Plan would have no effect on water quality.

5.155 Cultural Resources. Prehistoric sites may be located in this reach. The berm adjacent to the Morris Canal Feeder Dam elements of the Morris Canal Historic District would be affected, and would be surveyed as would all project sites. A case report would be prepared and a mitigation plan would be formulated in consultation with Federal, state and local authorities. The Morris Canal Historic District would not be affected. Any other cultural resources discovered would also be mitigated for with appropriate programs developed and implemented .

5.156 Parks. Riparian corridors would be reduced under the tunnel plans, more so with the Single Inlet Plan. With the No-Tunnel Plan, parkland would be created from evacuated homesites.

REACH 5 - PASSAIC RIVER: TWO BRIDGES TO CHATHAM (FIGURE 23)

5.157 The major components of all three plans in this reach would be the preservation of natural storage areas and the construction of setback levees, which would have essentially the same effect on terrestrial resources as the levees discussed previously, with minimal impacts on aquatic resources. Setback levees differ from levees and floodwalls in that they are not constructed on or near the riverbank, but at the outermost limit of the floodplain landward of the riverbank. They are designed to preserve flood storage areas within the flood control plan, so setback levees would minimize increases in downstream floodwater stages or velocities. All three plans are designed to provide a 100-year design level to the protected areas. (Note that areas in Fairfield and West Caldwell protected by the No-Tunnel Plan with 10-year nonstructural measures are included in the plan descriptions for this plan in Reach 3 although they geographically lie within Reach 5.) The two tunnel plans additionally include the gated weir at the downstream end of Great Piece Meadows. The Reach 5 project features can be summarized as follows:

Dual Inlet Plan	Single Inlet Plan	No-Tunnel Plan
o Natural Storage Preservation (4,660 acres)	o Same as Dual Inlet Plan	o Setback Levee/ Floodwall Systems (5 miles)
o Setback Levee/ Floodwall Systems (9.5 miles)		(Nonstructural measures were included in Reach 3)
o Great Piece Meadows Weir		

DUAL INLET PLAN - REACH 5

5.158 Setback Levees. A total of 9.0 miles of levees, covering 105 acres, and 0.5 miles of floodwalls would be included in the Dual Inlet Plan (Figures 36, 37, 39, 40, 42, 51 and 52 in the Main Report). The breakdown of the levee systems is as follows: Whippany River tributary, 0.7 mile; Rockaway River, 2.9 miles; and Passaic River/Deepavaal Brook, 5.9 miles. The floodwalls lie along Deepavaal Brook and Pinch Brook, a Whippany River tributary. To assure the integrity of several levee systems, eight stretches of roads would need to be raised in Reach 5. The construction of road raising and levee effects

would be similar to those discussed in 5.09 and 5.10. Culverts under Route 80 would be modified to close during floods. Runoff from behind the levees would be collected in 148 acres of ponding areas along the Rockaway River, 7 acres on the Whippany River tributary, and 415 acres on the Passaic River and Deepavaal Brook.

5.159 Preservation of Natural Flood Storage. The majority of floodplain acres that would be acquired for the preservation of the natural floodwater storage element lie in this reach. This includes 4,660 acres of floodplain of which 4,540 acres are wetlands. Of this total acquisition, 4,200 acres would be left intact in their natural wetland state. The balance, 340 acres, would be located behind levees where they would be later deepened, regraded and transformed by replanting with obligative and facultative wildlife-food plants, creating wetlands that would also store interior drainage floodwater.

5.160 Great Piece Meadows Weir. The gated Great Piece Meadows Weir would lie approximately 2,000 feet upstream of Two Bridges Road. The weir would consist of a 100 feet-wide, 14.7-feet high bascule gate and 600-feet long embankment which would tie into Two Bridges Road on the left bank and a 150-feet embankment which would tie into Camp Road on the right bank. The crest of the weir would be 164.2 feet and Camp Road would be raised from one to two feet to that elevation. The normal position of the weir would be open, or in the lowered position, so as not to affect normal flows. During a flood event, the weir would remain in the lowered position until the flood peak would have passed the weir and would then be raised to simulate the one-year flood stage in Great Piece Meadows. Environmental benefits are associated with this location because it would allow the continued inundation of 1,000 acres of wetlands upstream of the weir that are located within the annual floodplain. Additionally, most of the 2-year floodplain would still be flooded to the same extent. The weir would be operated after the peak flooding ended in order to ensure against inducing flood damages. Since the weir is gated, it would have the additional benefit of being used to maintain water surface elevations during drought periods, thus providing a mechanism to effectively manage the wetlands.

EFFECTS OF THE DUAL INLET PLAN - REACH 5

5.161 The effects of the Dual Inlet Plan on the significant resources in Reach 5 are described below. The significant resources identified in Section 4 for this reach include wetlands, the USEPA designated Buried Valley Sole Source

Aquifer, State of New Jersey endangered and threatened species, the Troy Meadows National Natural Landmark, a National Inventory River reach, parkland, and cultural resources. Central to the discussion of impacts in this reach is the effect of the diversion on the flow regime.

5.162 Project Operation. The major impact in this reach would be the effect of the tunnel diversion on the flow regime. However, hydrologic and hydraulic studies performed early in the planning of diversion tunnel alternatives highlighted these effects. This led to the incorporation of measures and operating rules into the detailed plan to avoid indirect impacts from flow regime changes. For Reach 5, the key environmental design features are the tunnel plan's one-year flow bypass rule and the Great Piece Meadows Weir.

5.163 Operating rules for the Dual Inlet Tunnel Diversion Plan have been formulated to replicate the existing conditions one-year flood stage throughout the project area as a minimum water surface elevation for all flood events. The tunnel plan will not begin to function unless the river flows are predicted to exceed the one-year flow. This prediction would be based upon an enhanced Passaic River Basin floodwarning and forecasting system with additional streamflow and rain gages to ensure accurate and timely forecasting of expected flood levels. It is clear that the Passaic River itself is in flood stage for only a small percentage of each year. Historical records indicate that flows exceed the one-year level at both Little Falls and Chatham for less than 2% of any year (approximately five days), based on a long term average of gage records.

5.164 Due to the nature of the flooding in the basin, it is possible to bypass a minimum flow past the tunnel inlets. During the ascending limb of the storm hydrograph (while the flood is rising) for flood control purposes, and, later in the event, a significantly greater bypass flow can be allowed. This would produce the one-year flood event for environmental purposes during the descending limb of the storm hydrograph, once the peak flood flows have been diverted from the damage areas. During the initial period of operation for flood control purposes, all flood flows would be diverted into the tunnel except for a 500 cfs bypass at the Pompton River Inlet and a 100 cfs bypass at the Two Bridges (Passaic River) Inlet. The rationale and impacts of these initial bypass flows are discussed in the respective reaches affected (see 5.55 and 5.118). The initial bypass flows would continue until peak

flood flows have receded and downstream flood stages are below the annual flood stage. The initial period of diversion with minimum bypass flows would be approximately 25 hours for the Pompton Inlet and about 20 hours for the Passaic River Inlet. At that time the tunnel inlets would begin to permit the bypass of sufficient discharges to produce the annual flood stage in downstream reaches, including Reach 5. In conjunction with the hydraulic control of the Passaic River at Beatties Dam, the one-year bypass would result in water surface elevations in Reach 5 of at least the one-year flood stage. However, without the weir the duration of the one-year flood stage would be reduced. Therefore, the operation of the Great Piece Meadows Weir is utilized to replicate the existing one-year stage duration in much of the Great Piece Meadows.

5.165 During periods of normal flow, the gates in the Great Piece Meadows Weir would remain open (lowered) and the flow regime would remain unchanged from current conditions. Under flood conditions, the gates in the Great Piece Meadows Weir would remain open (in the lowered position) until the peak flow would have passed during a flood event. When the peak flood stage would have receded to the one-year stage, or, if peak stages would not reach the one-year stage as predicted, the weir gates would be raised to replicate the one-year flood stage in the Central Basin wetlands upstream of the weir. The one-year flood stage would be maintained for a period of time determined necessary to satisfy fish and wildlife needs in the Great Piece Meadows. Once these needs were met, the gates would be gradually lowered and would again remain completely open under normal conditions. Since the tunnel would not operate for events up to and including the one-year flood, there would be no change in the flow regime for these frequent floods. For all floods greater than the one-year event, the operation of the weir would result in at least the one-year water surface elevation upstream of the weir in the Great Piece Meadows.

5.166 For 100 acres of wetlands downstream of the weir, the one-year flow bypass rules at the tunnel inlets would insure that these wetlands also received the one-year flood stage, although the flooding duration for these 100 acres would be sharply reduced. In addition, the two-year flood stage for these 100 acres would be lowered by approximately 1.6 feet. Although these 100 acres of wetlands may actually retain some wetland characteristics, they are assessed to be lost with the project, as described below.

5.167 The minimum flood stage for all flooding events would be the existing conditions one-year flood level for all areas upstream of Two Bridges. This would be assured by the one-year bypass flow at the tunnel inlets and the utilization of the Great Piece Meadows Weir. Upstream of the Great Piece Meadows, the Dual Inlet Tunnel Diversion Plan would result in no stage reductions for frequent flooding (one through five year events). Thus the impact to tunnel operation on frequent flood stages would be limited to the Great Piece Meadows.

5.168 The greatest effects of the plan would be in the lower Great Piece Meadows, immediately upstream of the Two Bridges Inlet. For this area flood stages would be reduced by up to 12 feet for the larger floods (i.e., 100-year events) at Two Bridges. However, for the 1-year flood there would be no effect, and for the 2-year and 5-year floods, stages would be reduced by 1.6 feet and 3.6 feet, respectively, downstream of the weir at Two Bridges.

5.169 Upstream of the weir, into the Great Piece Meadows almost up to Tom's Point, which is the lower one-third of the Meadows, the one-year event would be unchanged and the two year flood would be lowered by 0.6 feet, although the extent of inundation would not measurably change due to the flatness of the area. There would be reductions of flood stages ranging from 1 to 7 feet for more infrequent events between the 5-and 100-year flood frequencies. This is the area of significant impact in terms of reduced flood stages for less frequent events that would result in flood damages without the project.

5.170 The balance of the Great Piece Meadows, upstream to Pine Brook and above Route I-80, would experiences no flood stage reductions for the 1-to 2-year floods, and reductions of less than one foot for events in the 5-to 10-year range. For rarer floods, the reductions would be greater, for example, 4 to 5 feet reductions for the 100 year flood.

5.171 The Passaic River reaches upstream to Chatham experience lesser reductions. At Route I-280 the reductions would be less than one foot up to the 10-to 25-year range and would be almost 3 feet for the 100-year flood. At Passaic Avenue in Livingston and downstream of Canoe Brook, the flood stage reductions would be less than one foot. These reaches are, therefore, subject to no impacts for frequent flooding and minor stage reductions for larger floods of 25-year frequencies or greater. Similar conditions occur on the Rockaway and Whippany Rivers.

5.172 To summarize, the major impacts of the plan on flood stages would be in the Great Piece Meadows, but only for the infrequent flood events. The more frequent flood stages would be maintained by flood flow bypass rules which require the operation of tunnel inlets to assure that there are flows in the river sufficient to replicate the one-year flood stages. The areas upstream of the Great Piece Meadows are little affected except for the larger but infrequent events.

5.173 Wetlands. The direct effect of the project's stage reductions without the one-year bypass rule and the Great Piece Meadows Weir would be to reduce the land areas nourished by floodwater during frequent flood events in the downstream portion of Great Piece Meadows. This would have caused an adverse effect on 1,100 acres of wetlands as a result of tunnel operation which would reduce flood stages and durations. The reduction in durations of flooding would subject these acres to stress and possible vegetative seral succession.

5.174 Although not fully quantifiable, it is accepted that without a hydrologic control to re-create a flood, decreases in stages would reduce the floodplain and wetlands substantially. As discussed in paragraphs 5.162-5.172 above, the project design and operation include integral elements to ameliorate these losses. Approximately 1,100 acres would be adversely affected and likely lost due to reduction in stage and duration of floodwaters without the inclusion of the one-year bypass flows and Great Piece Meadows Weir. With the project in place, including the weir, it is estimated that 100 acres of wetlands, downstream of the Great Piece Meadows Weir, would be lost through seral succession of vegetation to a more upland cover type. This loss would be mitigated for through the upgrading of 100 acres of wetlands on project lands within the acquisition area.

5.175 The slight increase in velocities in the Great Piece Meadows may modify the meander pattern of the river. Scour and erosion would increase slightly during flood events. (See Table 31.) Flows, stages, and velocities would not be changed substantially in the Rockaway and Whippany Rivers, where levees would provide local flood protection.

5.176 The major effects of the levee systems would be on wetlands and terrestrial resources at the levee sites and in associated ponding areas. The levees themselves would cover about 105 acres of terrestrial habitat, including 45 acres of wetlands. Mitigation for this loss is included in the project in the form of enhancement of wetland values for 45 acres of

existing wetlands on project lands within the acquisition areas. The associated ponding areas would alter about 570 acres of terrestrial habitat, of which 560 are wetlands. Since many of these areas are near existing development, they are less productive than if they were pristine. To mitigate these impacts, the ponding areas would be replanted with obligative and facultative plants which provide wildlife food for wetland animals, as described in paragraphs 5.122 and 5.123. Levees would be planted with vegetative cover indigenous to the area.

5.177 The net residual affect to wetlands in Reach 5 would be the loss of 145 acres (100 acres due to flow regime changes downstream of the Great Piece Meadows Weir, paragraph 5.174, and 45 acres due to levee construction paragraph 5.175). The change in cover type of 480 acres of forested wetlands in the ponding areas to 560 acres of predominately emergent wetlands would compensate for 480 acres of forested and 80 acres of emergent wetlands lost to ponding area construction, paragraph 5.176. Mitigation in Reach 5 addresses the residual loss of 145 acres in Reach 5, in addition to the previously described losses of 20 acres in Reaches 1, 2 and 3, and 20 acres in Reach 4 for a total mitigation acreage of 185 acres. Mitigation would be in the form of upgrading the wetland habitat of 185 acres of lands within the Natural Flood Storage purchase area which have been abused due to human intrusion, or otherwise degraded from man's activities. These wetlands would be regraded, replanted or otherwise manipulated to improve their wetland values.

5.178 Groundwater. The Dual Inlet Tunnel Plan is not expected to have any adverse impacts on the recharge quantity or quality and yield of aquifers in the project area. However, the geologic complexity of the Sole Source Buried Valley Aquifer and the operating rules devised to minimize project environmental impacts require an explanation to clarify the no effect assessment.

5.179 The major impacts of the plan on flood stages would be in the Great Piece Meadows, but only for the infrequent flood events. The more frequent flood stages would be maintained by flood flow bypass rules which would require the operation of tunnel inlets to assure that there would be flows in the river sufficient to replicate the one-year flood stages. Flooding in the areas upstream of Great Piece Meadows would be little affected except for the larger but infrequent events. Therefore, the portion of the aquifer upstream of the Great Piece Meadows would be unaffected by the operation of the project.

5.180 Sole Source Buried Valley Aquifer. The USEPA Sole Source Buried Valley Aquifer lies beneath the Passaic River upstream of Two Bridges towards Chatham, and along the lower Rockaway and Whippany Rivers. The aquifer is the largest and most productive in its southern portion in Chatham and Millburn, thinning gradually toward the north and Great Piece Meadows. In the northern portion, the clay overburden layers are thickest, the aquifer is less important in terms of recharge, and the area is less productive in terms of yield.

5.181 There is also a buried valley aquifer under the Great Piece Meadows which is filled with overburden material to a depth of well over 100 feet below the surface at the downstream and upstream ends of the Meadows. Based on wells drilled in the area, there is a sand and/or gravel layer at bedrock level up to 20 feet thick at the western end of the Meadow, up to 40 feet thick on the south side of the Meadow and 10-20 feet in the northeast portion of the Meadow. This acknowledges the existence of the Great Piece Meadows buried valley aquifer, although it is not certain that it is hydrogeologically connected to the major Sole Source Buried Valley Aquifer to the south.

5.182 The Great Piece Meadows aquifer is a relatively thin water-producing layer when compared with the thick highly productive formations of the Buried Valley Aquifer, further upstream on the Passaic and Whippany Rivers to the south. The current allocation for groundwater use in Fairfield amounts to about 2 million gallons per day (mgd) or less than 2% of the total allocation of the sole source aquifer. Furthermore, this layer is overlain by up to more than 100 feet of clay which is impervious and makes the Great Piece Meadows a very poor area for recharge, particularly in the center where the clay overburden is the thickest. Estimates of the permeability of the confining clay in the Great Piece Meadows provided by New Jersey Geologic Survey is approximately 10- cm/sec, which severely limits vertical movement of groundwater. Therefore, where the change in water surface elevations from tunnel operation is the most significant, in the eastern quadrant of the Meadows, there are very poor recharge conditions.

5.183 Because of the thick impervious layer over the aquifer, primary recharge is believed to take place outside of the floodplain on the edges of the buried valley, where the clay becomes thinner, and from the weathered upper layer of bedrock that underlies the sands and gravels. The recharge through the weathered bedrock originates in the higher elevations of Hook

This would explain the artesian conditions that existed in this area historically. Current use of the aquifer has drawn down the water table below surface elevations. Because this recharge occurs outside of the floodplain where the tunnel plan has no effect, and because of the thick confining layer of impervious clay underlying the Great Piece Meadows, there would be no project impact on the buried valley aquifer in the Great Piece Meadows. This conclusion is confirmed by an independent review of the project by the New Jersey State Geological Survey (see Attachment A46, Appendix A), and by a Corps of Engineers sensitivity analysis which evaluates the effects of the change in flood stages on groundwater recharge in the Great Piece Meadows (see Attachments A38e and A38g). As part of the sensitivity analysis two critical variables, the thickness of the confining clay layer and the coefficient of permeability, were varied from what were judged to be appropriate values to test an extreme "worst case" scenario in coordination with EPA. The potential recharge loss in the Great Piece Meadows due to the project operation ranges from the 0.00023 to 0.0068 cfs or the water supply equivalent to provide for 2 to 65 people in the "worst case" scenario. This is extremely small when compared with a population of 500,000 people in 43 communities served wholly, or in part, by the Sole Source Buried Valley Aquifer. Since this is the only area where the flood elevations of frequent floods are measurably reduced, the tunnel operation would have no impact on the USEPA designated Sole Source Buried Valley Aquifer.

5.184 Project Structures. Levees and floodwalls in the floodplain protect areas from flooding and can affect recharge to groundwater sources. The systems in the Central Basin, however, will not affect recharge for several reasons that are explained in the following text.

5.185 Central Basin levees are generally set back from the river at the margins of development to protect or enclose developed areas only. All protected areas consist of some form of development that has been persistently flooded historically with enough damage to justify the inclusion of these components in the plan. The existence of this development has affected recharge by replacing pervious ground surfaces suitable for recharge with the impervious surfaces which decrease recharge. (It is noted later in the discussion, however, that pre-development ground surfaces are not always naturally pervious). Homes, commercial structures, parking lots, roads, etc. all tend to retard recharge. Most of the protected areas behind the levees in the Central Basin are intensively developed and, therefore, are poor recharge areas. In addition, as discussed in the previous paragraphs, the Great Piece Meadows is in flood stage for only a small percentage of each year based on the historical gage records for the duration of the 1-year event

at Little Falls and Chatham. Most of the protected area is above and beyond the 1-year floodplain and is flooded less frequently. Given this combination of conditions, the reduction in recharge in the protected areas behind levees will not be measurable.

5.186 The levees will tend to reduce recharge by placing material on the ground surface and lengthening the seepage path to the aquifer, thereby reducing recharge. The common material that makes up the side slopes of the levee outside of the core is free-draining, when compared with surface materials in most areas of the Central Basin, and will not impede recharge. However, the levees' impervious clay core, which is 10 feet wide and extends the entire length of the levee, is intended to minimize seepage from the flooded riverside through the levee to the protected area. It is the placement of this clay component which could locally reduce recharge. However, it is necessary to view the potential impact of this component within the context of the total levee design, including ponding area placement. It is also noted that the the levees are set back from the river in order to minimize the drainage area behind the levee, and to minimize the area of floodplain encroachment.

5.187 In general, ponding areas are located in the lowest areas behind levees and are designed to pond within the existing one-year floodplain, thus ensuring and actually enhancing recharge. The one-year floodplain stage is usually the encroachment fringe of development and damages occur above that elevation. This requires that the ponding area be designed to contain interior drainage flows behind the levees to a level not greater than the one-year flood stage. In order to accomplish this, using as little land as possible, the ponding areas are excavated to depths of up to 5 feet, and result in the removal of impervious organic wetland materials, which normally occur in the areas of concern in the Central Basin. By reducing the thickness of the impervious material over the aquifer, recharge capability is enhanced. Any water collected in the ponding area will remain there until the flood recedes outside of the levee system below the water level in the pond. Therefore, the period of recharge would be extended because the excavated pond will be lower than the existing land surface, and, therefore, be flooded for a longer duration. This overall effect of the ponding areas would more than offset the impact of the levee placement, resulting in the enhancement of recharge.

5.188 The Central Basin levee systems include the following with their locations noted by local buried valley aquifer subregion, as defined in The Buried Aquifer Systems: Resources and Contamination, Passaic River Coalition, 1986:

Levee System	Aquifer Subregion
Passaic #2A and #2C	- Northwest Essex
Passaic #10	- Chatham/Millburn
Pinch Brook, Rockaway #1, #2, #3	- Whippany/Lower Rockaway

5.189 In the Northwest Essex subregion of the aquifer, the Great Piece Meadows, Fairfield and West Caldwell are of concern. Ponding areas for the Passaic #2A and #2C systems total 379 acres, compared with six acres of levee core area indicating the possibility of recharge enhancement. Discussion of this aquifer is included in the preceding paragraphs, however, the conclusion was that there is little recharge through the thick clay overburden materials, up to 100 feet thick over the buried valley. Therefore, the project structures will do little to reduce or enhance recharge in the area of Passaic #2A and #2C.

5.190 The Passaic #10 system is located on the northern boundary of the Chatham/Millburn Valley subregion. Livingston Township has several productive wells along the Passaic River. Some wells are drawn from the buried valley deposits, while others are drawn from the bedrock, and one well apparently induces recharge from the Passaic River. This levee system, located over the buried valley, includes 4,500 feet of levees and two ponding areas totaling 18.94 acres. The impervious levee core will cover approximately 1.0 acre. For reasons cited in the previous paragraphs, it is apparent that recharge will be affected but, by design, the large ponding area will more than offset the impervious levee core and enhance recharge.

5.191 In the Whippany/Lower Rockaway subregion all levee systems are located over or in the vicinity of the Buried Valley Aquifer. The Pinch Brook levee system is located adjacent to the East Hanover Valley near wells used by East Hanover Township. The three Rockaway levee systems are located adjacent to or over a buried valley, which begins south of Boonton Reservoir, and dips south toward Route 46, and perhaps toward the Millburn Valley in East Hanover. One of the more productive wells developed by the Parsippany Water Department is adjacent to Rockaway #1. For reasons given in the earlier discussion, however, impacts expected due to construction of the project levee systems will not reduce recharge. Pertinent information on these levee systems is shown below:

System	Levee/Floodwall Length (feet)	Core Area (Acres)	Ponding Area (Acres)
Pinch Brook	3580	0.82	7.23
Rockaway #1	3640	0.84	84.2
Rockaway #2	5340	1.23	38.0
Rockaway #3	6320	1.45	26.0

5.192 Finally, the Great Piece Meadows Weir must be considered. The operational function of this structure is to assure that the one-year flood levels are replicated in the Great Piece Meadows in both stage and duration. For reasons described in the previous paragraphs on operating rules, the location of the structure is in an area of very poor recharge to the Buried Valley Aquifer. The presence of the embankment structure on both banks which is similar to that of a levee, and the weir structure, as well as its operation, will have no impact on recharge.

5.193 Nationwide River Inventory. Plan impacts on the recreational river potential of the Passaic River within Great Piece Meadows have been assessed using relevant criteria provided by the National Park Service, Department of the Interior (NPS). The plan's transition channel on the Passaic River extends 900 feet into Great Piece Meadows, requiring that the existing channel be deepened slightly and widened from its existing 100 feet to 160 feet. (See Figure 35 in the Main Report) The side slopes of the widened channel would be regraded to appear natural and replanted with indigenous forbes and herbs (and possibly low growing shrubs) to maintain a continuous strip of riparian vegetation throughout the nominated reach in Great Piece Meadows. The Passaic River channel's rock ledge at Little Falls and Beatties Dam, located downstream of the Passaic River's tunnel portal, act together as the hydraulic control creating backwaters extending upstream well into Great Piece Meadows. As discussed above, the existing hydrologic regime in Great Piece Meadows would not be altered during non-flood conditions, which, on average, would be 98% of the time. During flood events, about five days each year, the tunnel portal would be opened and would be the overriding hydraulic control in this reach, because of the volume of water flowing into the tunnel. Early in the flood event, the surface water elevation in Great Piece Meadows until the bypass rule and weir become operational, after the flood peak has passed. The tunnel diversion works reflect engineering and environmental design, including the moveable weir, to insure replication of natural flooding in the Meadows, thereby maintaining their biological integrity. Although a weir has been included in the plan to train flows to the transition channel and to maintain the viability of the wetlands, under normal conditions it would not obstruct the free flowing nature of the river. The weir would consist of three elements: the raised Camp Lane on the right bank, an earthen vegetated berm on the left bank, and the moveable gates, which would be open (in the down position) and submerged in the water and would not visible from the river under normal flows. According to NPS criteria, the weir is regarded as a "minor structure" which should not automatically

bar consideration of the river for inclusion in the National Wild and Scenic Rivers System. The weir's purpose is to maintain the existing hydrologic regime in Great Piece Meadows, and the botanic values of the relict swamp portion of Lake Passaic, the large glacial lake of the Wisconsin period.

5.194 The potential beneficial aspects of the plan are twofold. First, in addition to the weir's principle purpose of maintaining the existing hydrologic regime in Great Piece Meadows, it should also permit the better overall control of water levels, thereby making it possible to enhance the botanical and wildlife habitat values of the river's associated lands. Second, acquisition of the recommended flood storage lands around the perimeter of Great Piece Meadows beyond the reaches of the state designated floodway would enhance both the scenic and biological values of the Passaic River. Of 4,660 acres of lands acquired, including 1,580 acres within Great Piece Meadows, most would be maintained intact in their natural condition, thereby maintaining its insulation from surrounding urban development and enhancing its "wild" setting. The fact that the lands would be acquired in fee and remain in public ownership would also serve to increase the size and manage-ability of a National River Inventory segment, should such designation someday become a reality. The additional lands, being slightly higher and less frequently flooded than the more immediate floodway lands, would also serve to preserve a broader spectrum of the overall botanical wetland types which exist in Great Piece Meadows.

5.195 State Endangered and Threatened Species. Effects on State endangered and threatened species in Reach 5 would vary with the plan elements. The preservation element would maintain habitat throughout the project area. This preservation would act to continue populations of these species. The levees would adversely affect State endangered and threatened species present in their immediate vicinity, although mitigation has been provided to help offset losses of habitat. The ponding areas associated with the levees would have a variable effect on wildlife, depending on the species. The pied-billed grebe, great blue heron, northern harrier, sedge wren, savannah sparrow and bobolink are all likely to benefit from the ponding areas (i.e. conversion to emergent from forested). The blue-spotted salamander, wood turtle, red-shouldered hawk, barred owl and Cooper's hawk are likely to be adversely affected by the habitat conversion in the ponding area. Changes in the hydraulic regime would adversely affect the species which are most water dependent, such as the great blue heron. Other species, i.e. northern harrier, would not be affected since this area is forested and they do not utilize this cover type.

5.196 Troy Meadows. This wetland is a National Natural Landmark and a significant resource. Structural project elements would not affect this landmark. Further, the nonstructural project element proposed for this area, the Preservation of Natural Storage (acquisition) would have beneficial effects on the 1,175 acres of Troy Meadows preserved as part of the project.

5.197 Cultural Resources. There is a slight possibility that prehistoric sites may be unearthed during levee or weir construction. However, encroachment in the floodplain has disturbed the most likely sites on the fringes in and around the wetlands. Nonetheless, a cultural resources survey will be conducted at all surface construction sites, and if cultural resources are found mitigation programs would be developed and implemented.

5.198. Parks. The Dual Inlet Plan would adversely affect about 4 acres of West Essex parkland in Reach 5. This loss would be offset as described in paragraph 5.30. On the contrary, the preservation of natural flood storage would, on the other hand, provide a positive effect on the 4,660 acres of open space that would be acquired for posterity in Reach 5. Many of these acres are in or adjacent to the major named wetlands, other parts of which have already been preserved in the State's floodways or acquired as undeveloped parkland for the conservation of its open space and wetland attributes. Great Piece Meadows would add 1,580 acres to permanent preservation, 1,175 acres would be preserved in Troy Meadows, 430 in Hatfield Swamp with another 190 acres just south of Hatfield Swamp, 1,110 acres in Black Meadows and 175 acres in Canoe Brook's wetlands.

SINGLE INLET PLAN - REACH 5

5.199 The physical features of the Single Inlet Plan in this reach are identical to the Dual Inlet Plan. The impacts would be the same for both tunnel plans.

NO-TUNNEL PLAN - REACH 5

5.200 A total of 5 miles of levees, covering 45 acres, would be included in this plan, mostly in the Rockaway/ Whippany area. Thirty of the 45 acres are wetlands. Mitigation would be provided for this loss in wetlands on project lands. Another 174 acres of wetlands would be required for ponding areas. They would be altered from their natural ground cover to facultative and/or obligative wetland wildlife food plants. Structures in other portions of the Central Basin, such as near Deepavaal Brook, would be protected by nonstructural measures. While this plan's environmental effects are similar to those described for

the Dual Inlet Plan in this reach, its magnitude would be diminished by about one-third, equivalent to the smaller land area that would be directly affected. The No-Tunnel Plan would be credited with maintaining this reach's national river inventory recreational attributes stemming from preservation of natural flood storage.

SUMMARY OF REACH 5 EFFECTS

5.201 The major impacts in this reach would be to its wetland resources. Both tunnel plans would cause decreased stages for large infrequent floods in Great Piece Meadows, as well as increases in velocity. The potential impacts to frequent flood events are ameliorated by the one-year bypass rule and the Great Piece Meadows Weir, except for the potential for the destruction of 100 acres of wetlands downstream of the weir. The Preservation of Natural Storage element for all three plans would acquire of 4,660 acres of floodplain of which 4,540 acres are wetlands (120 acres cover a golf course). Forty-five acres of wetlands would be covered by levees for all three plans.

5.202 Wetlands. The Passaic Basin's largest wetland, Great Piece Meadows, would be protected from risk and uncertainty associated with likely future encroachment by all plans through the preservation of natural storage and setback levees. Minimal hydrologic changes are expected with the tunnel plans because of the moveable weir (paragraphs 5.162-5.172). The tunnel plans' levee systems would result in the direct loss of 605 acres of wetlands due to levee and ponding area construction. Mitigation is provided in the form of wetland planting in the ponding areas (560 acres) and wetland restoration within the natural storage areas (45 acres). The No-Tunnel Plan would result in lesser impacts; only 204 acres of wetlands lost directly.

5.203 Sole Source Buried Valley Aquifer. This resource was institutionally designated as a sole source aquifer in 1980 to give official recognition of its importance to the Central Basin as a source of water, and to protect it from contamination through recharge. This resource would be unaffected by all plans primarily due to the nature of plan effects on water surface elevations, and the location of recharge areas to the aquifer. The major recharge areas are either outside of the floodplain or are located upstream of Pine Brook on the Passaic, Rockaway and Whippany Rivers, and are outside the area of plan effects. The major plan effects are at the downstream end of the Great Piece Meadows near Two Bridges where over 100 feet

impervious clay layer covers a relatively thin water producing sand and gravel layer. In this area, the short term river fluctuation caused by flooding has no effect on recharge. Levees/floodwall systems would leave no net effect on the aquifer because their ponding areas would offset any loss of recharge.

5.204 Nationwide River Inventory. None of the plans are expected to adversely affect the Passaic River's potential for inclusion in the National Wild and Scenic Rivers System.

5.205 State of New Jersey Endangered and Threatened Species. Many of the State's endangered, threatened and declining species are wetland dependent, and are found in Central Basin Wetlands. The plan calls for the preservation of 4,660 acres of natural storage in this reach, about 4,540 acres of which are wetlands, thus having beneficial effects. The Single Inlet Plan and recommended plan (Dual Inlet Plan) would cause loss or change to 705 acres of wetlands in this reach. Mitigation would be provided for these impacts. The No-Tunnel Plan would not adversely affect these wetlands. None of the three plans would adversely effect the two rare plant species, if they still exist.

5.206 Troy Meadows. All three plans would benefit this National Natural Landmark through the acquisition and preservation of 1,175 acres of Troy Meadows.

5.207 Cultural Resources. None of the plans are expected to affect known prehistoric or historic sites or cultural resources that may still be undiscovered. But in the event that sites would be discovered during cultural surveys, mitigation programs would be developed and implemented.

5.208 Parks. About 4 acres of parkland would be lost to levees in Reach 5. Protection of 4,540 acres of wetlands would provide the opportunity for large wildlife refuges and associated recreational uses such as hiking and bird watching.

PART B. SUMMARY OF ENVIRONMENTAL EFFECTS

5.209 In contrast with PART A which presented environmental effects reach-by-reach, this portion of Section 5 provides a brief summary of significant environmental effects of the three alternatives for each resource in the overall project area.

5.210 The environmental effects are further summarized in Table 30, Comparative Impacts of Alternatives. Table 29 compares the three plans by reach and Table 25 compares wetland and aquatic habitats by reach and by plan. Cross references are made to the main impact discussion in Section 5 by the paragraph numbers shown in parenthesis.

5.211 The Dual Inlet Tunnel Plan provides for a 100-year level of protection in the Pompton Valley, 100-to 500-year levels of protection at intermittent locations along the Passaic River upstream of Two Bridges, and 100 to 500-year protection in the Lower Valley. The Single Inlet Plan would provide 100-to 500-year levels of protection in the Lower Valley, intermittent protection ranging from the 100-to the 500-year events in the Central Passaic and a 50-to 100-year level of protection in the Pompton Valley. The No-Tunnel Plan provides only a 10-year level of protection in the Pompton Valley and along the Passaic River between Beatties Dam and the upstream limit of Deepavaal Brook. The No-Tunnel Plan provides a 100-to 500-year level of protection in the Lower Valley and the Central Basin, upstream of Deepavaal Brook.

TERRESTRIAL RESOURCES

5.212 Table 25 presents the wetland acreage that would be lost by each plan for each reach. The Dual Inlet Plan has direct effects on 905 acres altered or lost to levees, ponding areas, channel modifications, flow regime changes and tree cutting. The Single Inlet Plan has the greatest direct effect, with over 945 acres altered or lost to levees, ponding areas, channel modifications, flow regime changes and tree cutting. The No-tunnel Plan has the smallest direct effect, with about 250 acres for levees, ponding areas and channel modifications.

5.213 In Reach 1, ten acres of wetlands would be lost with both tunnel plans, while the No-Tunnel Plan would destroy six acres. (see PART A paragraphs 5.27, 5.40, 5.45, and 5.49). In Reach 2, five acres of wetlands would be lost under both tunnel plans, while 40 would be lost with the No-Tunnel Plan (paragraphs 5.58, 5.63, 5.66, and 5.74). In Reach 3, five acres would be lost under both tunnel plans, but none under the No-Tunnel Plan (paragraphs 5.84, 5.92, 5.99, and 5.102).

5.214 In Reach 4, the Single Inlet Plan would have the greatest adverse effects on the wetlands in the Pompton Valley due to physical modifications. Channel widening would eliminate 40 riparian acres along the Pompton River (paragraph 5.141). The Pompton River Valley would not be affected under the Dual Inlet Plan, or with the No-Tunnel Plan. In the three river confluence area both tunnel plans would have approximately the same effects on wetlands including 20 acres for levees, 30 acres for ponds, 40 acres for channel modifications and 90 acres of trees removed (see paragraphs 5.120-5.128 and 5.141). The No-Tunnel Plan would cause no adverse effects to the Pompton Valley wetlands (paragraph 5.148). A summary of the three plans' impacts to Reach 4 terrestrial resources can be found in PART A, paragraphs 5.150-5.152.

5.215 In Reach 5 terrestrial resources are affected by both tunnel plans mainly by the creation of ponding areas (560 acres) associated with interior drainage which would be cleared of vegetation but replanted with emergent wetland flora; flow regime changes downstream of the Great Piece Meadows Weir (100 acres), and 45 acres of wetlands lost to levees. It should be noted that 340 acres of the Preservation Plan element described below would be utilized for ponding area construction in conjunction with setback levee systems associated with the tunnel plans. The No-Tunnel Plan would only require 30 acres for levees, and 174 acres for interior drainage ponds, which would disturb and alter wetlands.

5.216 Mitigation for all project losses is provided as previously described in Section 3, paragraphs 3.107-3.125, and Part A of Section 5.

5.217 Preservation of Natural Flood Storage. The preservation of natural flood storage project element proposes the acquisition of 5,350 acres of floodplain storage in the Central Basin, 5,200 acres of which are wetlands lying in Reaches 4 and 5 (see paragraphs 5.116 and 5.159). The acquisition consists of large portions of major wetlands including over 1,500 acres in Great Piece Meadows, over 1,100 acres in Troy Meadows and Black Meadows, in addition to over 400 in Hatfield Swamp, and Bog and Vly Meadows. Also other significant acquisitions include Canoe Brook wetlands, Hatfield Swamp (south) and the lower Pompton River wetlands. These areas were included in the project primarily because of their significance for natural flood storage, but also for their high environmental values. If these areas are not protected, the loss of flood storage associated with future filling and development would result in increases in the speed, frequency, depth, and duration of flood flows arriving at the Passaic River Central Basin and Lower Valley.

These increased flood flows would be accompanied by increases in flood damages, without a flood control project. If these 5,350 acres are not preserved, the level of protection provided by a project would also be diminished.

5.218 In addition to the beneficial effect on decreasing flood flows, the preservation of these wetlands would conserve many positive wetland attributes and effects. It would preserve large refuges for wildlife, providing wildlife with food, escape, and reproductive cover. Wetlands also provide a unique gene pool repository. From one-third to one-half of all the State's endangered, threatened and declining species are wetland dependent. Preservation of these wetlands would preserve an important stop over for migratory bird species on the Atlantic Flyway. The acquired acreage would be preserved intact as wetlands, except for the 340 acres associated with ponding area creation for the two tunnel alternatives, as discussed above in paragraph 5.215. Acquisitions within Troy Meadows would help preserve this National Natural Landmark, and land preserved within Great Piece Meadows lies within a reach listed on the Nationwide River Inventory, as noteable list for its recreational attributes.

5.219 This preservation, which would not occur without the plan, would not only reduce future flood flows, depths, durations and time to their peaks, but also serve to maintain areas that recharge the surface and sole source aquifers, maintaining both groundwater supplies and base flow to surface water supplies. The preservation of these wetlands from development would conserve the landscape diversity and aesthetics which are reflected in the satisfaction derived from recreational experiences such as canoeing, bird watching, or hiking. These wetlands also provide considerable recreational satisfaction, as previously discussed.

AQUATIC RESOURCES

5.220 The magnitude of the plan's impacts on aquatic resources is directly related to the quality of the existing resources, which varies widely throughout the basin. The Passaic River's water quality and aquatic resources are generally stressed and degraded, while the Pompton River's three major tributaries are the best in the project area.

5.221 The other construction related effects on aquatic resources would be greatest in river reaches which would be altered most by construction. In Reach 1, the No-Tunnel Plan would require widening and deepening, adversely effecting 84 acres of aquatic habitats (see PART A paragraph 5.43). Neither of the tunnel plans would require channel modifications in this reach, although the tunnel's outlet would alter about two acres of aquatic habitat (see PART A paragraph 5.20 and 5.40).

5.222 The No-Tunnel Plan would permanently alter 325 acres of aquatic habits in Reach 2 since extensive channel modifications would be required to move flood flows past potential damage areas (see paragraph 5.69). While the aquatic resources are stressed in this reach, the areal extent of the initial construction and the periodic dredging maintenance would cause substantial adverse effects. Both tunnel plans would eliminate the need for channel modifications in Reach 2, since they would safely be transporting floodwater beneath the surface. However, the diversion of flood flows from the river channels would modify the periodic channel scouring and nourishment of riparian wetlands. To address this impact, the operating rules for the tunnel plans have been refined so that once peak flows have entered the tunnel, the annual flood flows would be bypassed into the Lower Valley to continue to scour sediments from the channel and nourish adjacent wetlands (see paragraphs 5.55, 5.61 and 5.63). Due to the stressed and degraded quality of the fisheries resources in Reach 2, aquatic resources and their impacts have not been deemed significant.

5.223 The Single Inlet Plan would adversely effect 55 acres of aquatic habitats in Reach 3 (see paragraph 5.92). The single tunnel inlet would be located further downstream on the Passaic River than the dual inlet's portal. Therefore, the aquatic impacts would be caused by channel deepening, smoothing, and widening needed to convey flood flows into the downstream inlet near Beatties Dam. The Dual Inlet Plan would cause 20 acres of aquatic habitat to be lost within Reach 3 (see paragraph 5.85). The No-Tunnel Plan would not require in-channel construction. Instead it would raise and floodproof structures in Reach 3 (see paragraph 5.99). The operational effects of the tunnel plans in Reach 3 would be similar to those in Reach 2. Due to the stressed and degraded quality of the fishery resources in Reach 3, aquatic resources and their impacts have not been deemed significant.

5.224 The diversity and relatively high quality of the fishery resources in Reach 4, particularly upstream of the Pompton River, would result in the Pequannock, Wanaque and Ramapo Rivers' aquatic habitats being the most affected by the tunnel plans. The Single Inlet Plan would cause the most significant adverse effects, destroying 120 acres of aquatic habitat due to

the placement of channel modification along not only the Pompton tributaries, but along 6.8 miles of the Pompton River itself. Thus, this combination of greatest instream and bank manipulation in the area of greatest natural diversity would cause the greatest impact upon the aquatic environment (see paragraphs 5.142 and 5.153). The Dual Inlet Plan would have less of an affect on aquatic resources than the Single Inlet Plan, but its impact to the aquatic habitats of Reach 4 would, nonetheless, be significant. The Dual Inlet Plan would adversely effect 25 acres of aquatic habitat (see paragraphs 5.129-5.132). The No-Tunnel Plan would use nonstructural measures of flood-proofing, raising and evacuation in Reach 4, so it would not affect aquatic resources in this reach (see paragraph 5.148).

5.225 There would be no significant adverse aquatic effects in Reach 5 because the aquatic resources would generally be undisturbed by the construction of setback levees, the main structural element associated with the three alternatives in this reach. There would be no channel modification in Reach 5 by either the Single Inlet Plan or the No-Tunnel Plan. However, the Dual Inlet Plan would require a 2,000 feet long transition channel that would extend from Two Bridges up to the Great Piece Meadows' Weir. Because of the poor species diversity and low numbers of fish present in this reach, aquatic resources are not considered significant.

5.226 There would be no significant operational effects on aquatic resources caused by any of the three projects. The relationship of the tunnel's operational effects at the outlet on anadromous fish is discussed in paragraphs 5.21 and 5.22 while operational effects at the tunnel inlets are discussed in paragraphs 5.85 (Reach 3) and 5.130 (Reach 4).

CULTURAL RESOURCES

5.227 Due to the extensive development and redevelopment of riverside land in Reach 1, it is probable that cultural resources have been destroyed (see PART A paragraphs 5.31 and 5.50). Systematic cultural resources surveys will be conducted at all areas of direct project impacts for each plan to identify any remaining cultural properties, and to evaluate their significance. If it should develop that such properties do exist and that they are significant, a mitigation plan would be formulated in coordination with municipal and county historical societies, the State Historic Preservation Officer and the Advisory Council on Historic Preservation. All three plans have similar levee alignments in Reach 1. Reach 2 encompasses the Great Falls Historic District in Paterson, and only the No-Tunnel Plan would affect this resource (see paragraphs 5.59, 5.63, 5.67 and 5.75).

5.228 In Reaches 3 and 5 no cultural resources are known to exist on project land. The same type of strategy described for Reach 1 would be used throughout the project area for cultural resources. Reach 4 was traversed by a 4.26 mile long spur of the Morris Canal, known as the Pompton Feeder. Two of its Historic Dams are located upstream of the Pompton Inlet on the Ramapo and Pequannock Rivers. Channel modifications associated with the tunnel plans pass through the berm adjoining the Morris Canal Feeder Dams. The integrity of the feeder dams would be assured by including the Pequannock Weir, bascule gates that would be built in a bypass channel that breeches the berm connecting the dams. (See Figure 27 in EIS and Main Report Figure 47). Impacts to cultural resources in Reach 3 are presented in PART A of Section 5 in paragraphs 5.87, 5.96, 5.99 and 5.103; for Reach 4 in paragraphs 5.137, 5.145, 5.148 and 5.155; for Reach 5 in paragraphs 5.197, and 5.207.

PARKLAND

5.229 There are a number of riparian parks whose use would be altered by project elements in Reaches 1 and 4. Parks are described in 4.191, 4.198 and 4.199 and their impacts are in 5.28-5.30, and 5.52 for Reach 1 and 5.139, 5.145 and 5.156 for Reach 4. In Reach 1, riverside levees would cover about 17 acres of parkland, mostly in Lyndhurst and North Arlington. These losses of active recreational areas would be partially offset by the 4.6 acres of levee topped bike/walking trails, and the 11.5 acres of levee slopes that would be available for passive recreation through the warmer months, and active recreation when snow covered. However, these compensatory uses would not be equivalent to what would be lost, and would be mitigated. Close coordination with municipal, county and Green Acres recreational experts will be carried into the Phase II engineering stage to refine project design to compensate for these impacts.

5.230 The Great Falls National Natural Landmark and its 119 acre Historic District in Paterson is a significant Reach 2 recreational resource, which would not be affected by the tunnel plans, although the No-Tunnel Plan would impact on the S.U.M. Dam through the lowering of the dam crest by 1.6 feet (paragraphs 5.67 and 5.68).

5.231 Riverside parks in Reach 4 would loose 4.4 acres to channel widening and levees, however, 660 acres of wetland would be preserved. As in Reach 1, the levees would obstruct park wide views of the rivers and would not replace equivalent recreational activities. The parkland losses are almost equivalent for both tunnel plans. The No-Tunnel Plan would add to the recreational land in this reach, where some riverside structures would be demolished and the land converted to open space.

5.232 Reach 5's open space would be enhanced and its permanently preserved land would be significantly expanded with all three plans' preservation of natural flood storage element. The acquisition of 4,540 acres of Reach 5 wetlands in their natural state would preserve relict swamps and wetlands for posterity, some of which have achieved national recognition (see paragraph 5.159).

TROY MEADOWS: NATIONAL NATURAL LANDMARK

5.233 Troy Meadows, a National Natural Landmark would be more fully preserved for posterity with the acquisition 1,175 acres of its wetlands. This land is not presently protected from development (see 4.193, 5,196 and 5.206).

NATIONAL INVENTORY RIVER REACH

5.234 Great Piece Meadows has also achieved national recognition for the botanic value of its wetlands adjacent to the eight mile reach of the Passaic River from Two Bridges upstream to Route 80. Since this reach was placed on the Nationwide River Inventory, it is eligible for nomination as a Recreational River under the Wild and Scenic Rivers Act. Large tracts of this wetland have been zoned for development and are unprotected from changed land uses. However, the acquisition of 1,580 of its acres would preserve significant portions of this wetland, maintaining its integrity and vast areas in an undisturbed state (see 4.200, 5.193, 5.194 and 5.204).

STATE ENDANGERED AND THREATENED SPECIES

5.235 From one-third to one-half of the state endangered and threatened species thrive in the Passaic River Basin's wetlands. The permanent acquisition of 5,200 acres of wetlands would enhance the chances of these wildlife species survival in Reaches 4 and 5. Construction of levees and ponding areas would adversely affect any State endangered and threatened species present in the immediate vicinity of these measures. Mitigation has been provided to help offset losses of habitat (see 4.196, 5.195 and 5.205).

WATER QUALITY

5.236 Water quality varies widely throughout the basin, tempering the magnitude of direct project impacts. This parameter is most closely reflected by fish diversity and populations, and impacts to water quality closely parallel those to aquatic resources. The Passaic River's water quality is generally degraded and not deemed a significant resource. The waters of the Pompton River and its tributaries, in Reach 4, is

of high quality, is used as potable water, and is a significant resource. Turbidity related to construction would be a major adverse impact with both tunnel plans, but it would much worse with the Single Inlet Plan which would require major channel modifications for the entire Pompton River, including the reaches where water is removed for treatment and distribution (see paragraphs 5.144 and 5.154). The No-Tunnel Plan would not cause any adverse effects on water quality in Reach 4. While this plan would require extensive in-channel construction in Reaches 1 and 2, the degraded quality of the existing resource precludes judging the adverse effects as significant.

5.237 Measures are included in the operating rules of the tunnel plans to minimize impacts to water quality during operation of the tunnels. Bypass flow releases past tunnel inlets, with flows at least equivalent to the one-year event, would continue to flush sediments and dilute flows downstream of the proposed diversion inlets. Existing conditions for water quality are described in 4.184 and impacts are described in 5.23-5.26 and 5.144 (Reach 1), 5.61 (Reach 2), 5.88, 5.89, 5.94 and 5.95 (Reach 3), and 5.134-5.136, 5.144 and 5.154 (Reach 4).

SURFACE WATER SUPPLY

5.238 None of the alternatives would have long term impacts on surface water supplies, although the channel modification works associated with the two tunnel plans would require sediment control techniques during construction to minimize turbidity and increased levels of suspended sediments in the Pompton River flows. Operation of the tunnel plans include the bypass of sufficient flows for downstream water supply purveyors intake operations (see paragraphs 5.88, 5.89, 5.95, 5.134-5.136, 5,144 and 5,154).

GROUNDWATER

5.239 Sole Source Buried Valley Aquifer. This resource, located in Reach 5, would be unaffected by all plans primarily due to the nature of plan effects on water surface elevations and the location of the aquifer recharge areas as described in paragraphs 4.193 and 5.180-5.183 and 5.203.

5.240 During construction of the tunnel plans, the perimeter of the tunnel would be sealed by a cutoff grouting procedure and an application of shotcrete as the tunnel is bored by the Tunnel Boring Machine (TBM). Tunnel construction by TBM would not create a disturbed zone in the bedrock along the tunnel route

and would not significantly impact water levels in the Brunswich aquifer during construction. The construction of a concrete tunnel lining would provide a permanent seal against infiltration and exfiltration and would protect the yield and quality of groundwater in the bedrock over the life of the project (see paragraph 5.13).

5.241 The channel modification of the Single Inlet Plan in Reach 3 would remove up to ten feet of a very thick layer of clay that overlies a buried valley aquifer in this reach. It is not believed to be connected with the designated Sole Source Buried Valley Aquifer, although the channel would not penetrate the aquifer. This may serve to increase recharge due to removal of overburden, as discussed in PART A paragraph 5.94.

5.242 In Reach 4, the addition of the Pequannock Weir to the tunnel plans would maintain normal water surface elevations except for the upper 1,800 feet of the Wanaque River and upper 3,500 of the Pequannock River where normal river stages would be lowered by 5.0 and 2.5 feet, respectively. However, no significant impacts on groundwater and well yields are expected because of the small variation in groundwater elevation and because the only public wells near the Pequannock River are over 100 feet deep and will not be affected by the small change in river level (see paragraph 5.133).

HYDROPOWER

5.243 Hydropower generation at the three dam sites in Reach 2 would be unaffected by the tunnel alternatives because flood flows during tunnel operation would continue to meet the required flow capacity of existing and planned plants. However, the No-Tunnel Plan would result in a temporary interruption of power generation at Great Falls during construction, and permanently reduce output due to the lowering of S.U.M. Dam, associated with Reach 2 channel modifications (see paragraphs 4.180, 5.60 and 5.68).

HAZARDOUS SUBSTANCES SITES

5.244 All of the plans would provide long term benefits of protecting areas now subject to flooding and preventing the spreading of hazardous materials. Hazardous substances sites, while not significant resources, have the potential of causing significant impacts, during construction if not properly monitored and/or handled. All three plans would include additional coordination regarding the status of remediation efforts under USEPA's and NJDEP's auspices. Eight sites of concern have been identified in the floodplain in the vicinity

of surface works in Reach 1. Dioxin contaminated sediments are also known to exist in the Passaic River channel in Reach 1; NJDEP has committed to remediation of this problem prior to the construction of a flood control project. The existing sites are described in 4.15 through 4.26 and the manner in which their potential impacts would be avoided or managed is described in 5.32 through 5.38 and in 5.51.

AESTHETICS

5.245 All the plans would adversely affect the aesthetics of the basin. The levee heights and widths (up to 12 feet high and 90 feet wide) in Reach 1 are similar for all three plans and would obstruct views of the river and the landscape beyond. The No-Tunnel Plan's levee/floodwall systems are less extensive (see PART A paragraphs 5.40 and 5.52). While these losses would be partially offset by views from the levee topped walkways and overlooks, from most locations in the parks and many riverside homes, these would be unmitigated losses. In channel modified reaches, natural irregular shorelines would be replaced with smooth, symmetrical, structured man made views. The No-Tunnel plan would also modify Reaches 2 and 3. The views at Little Falls and Great Falls are not expected to be adversely affected by either tunnel plan, although the No-Tunnel Plan requires alteration of the S.U.M. Dam (see paragraphs 5.68 and 5.76). No other physical modifications are planned for Reaches 2 and 3, and the use of the tunnel for flood flow diversion would not adversely affect the vista of the waterfalls.

5.246 The Single Inlet Plan's channel modification would affect all of Reach 4 the entire Pompton Valley and its major tributaries in the project area, while the Dual Inlet Plan would only modify the Pompton tributaries in the project area. In Reach 5, only 2,000 feet of channel would be modified upstream of Two Bridges. Levees in this reach would be setback from the river, restricting river views.

5.247 The No-Tunnel Plan would improve the aesthetics of Reaches 3, 4 and 5, where nonstructural measures would include buying structures, razing them and using the land for open space.

5.248 The inlet and outlet structures would be designed and constructed with aesthetics in mind. The Passaic inlet would remove about five acres of forested wetlands, changing the land use from natural to structured. The Pompton Inlet location is currently a storage facility for a sand and gravel operation, and the potential exists for partial restoration.

COASTAL RESOURCES

5.249 The Passaic River and its adjacent banks downstream of Dundee Dam to the mouth (17.0 miles), is covered by the Federal "Coastal Zone Management Act" and is administered by the State of New Jersey. The Passaic is in the Northern Waterfront Region. The categories of special concern for this development area are: special urban area designation, public access, and development potential (see Section 5 paragraph 5.39 for full discussion). Generally, the plan will have some adverse effect by limiting access to the river for commerce, but would be beneficial, by providing a high level of protection against flooding, thus increasing the value of businesses and their ability to redeveloped. The Corps has filed a consistency determination with the State of New Jersey (see Appendix A, Attachments A21, and A44).

NOISE

5.250 All the projects would have no long term effect on the noise levels in the area. Noise would be generated during construction in all areas, because of the heavy construction equipment. The exception would be the excavation of the tunnel, where a tunnel boring machine would be used, with no noise impacts at the surface. Construction-related noise would be short term with individual homes being affected for shorter periods, as surface construction progresses upstream. Since most of the heavy construction work would be deep beneath the surface, the tunnel boring will be imperceptible at ground level. Construction trucks would generate noise, but the decibel levels would be equivalent to existing highway levels and probably lower than existing levels at the sand mining operation at the Pompton Inlet's site. The Passaic Inlet site is adjacent to a road that presently carries large trucks, so the construction-related noise would be equivalent to existing decibel levels. However, the duration would be longer. Best available technology would be used to suppress noise on all construction equipment. Construction of the Single Inlet Plan would cause the most noise, not only because the construction period would be so long, but also because the work would be at the surface along the entire Pompton Valley.

AIR QUALITY

5.251 The operation of construction equipment would generate some temporary low-level emissions, adding to air pollution. Fugitive dust would escape from the construction sites and along the truck routes. These are short term effects and would be limited by the best available air pollution control technology

for the machinery. The Single Inlet Plan would cause most degradation of air quality because of the large amount of surface construction and its longer duration. The nonstructural measures of the No-Tunnel Plan would cause the least, since the construction period would be shortest, as it moved from structure to structure.

SOCIAL EFFECTS AND PUBLIC SAFETY

5.252 The magnitude of the social effects associated with providing flood protection are virtually unlimited. Health and safety would be greatly enhanced as major sources of floodwater contamination would be removed, and stress related to flood threats would decrease, thereby improving the real or perceived well-being of the residents of the Basin. Property values in the flood prone areas would increase to a level on a par with much higher priced surrounding structures.

TRANSPORTATION

5.253 The elimination of flooding would improve the highway and railway network in this area. Currently, even small storms such as the one-year event, cause road flooding and significant traffic delays, both locally and regionally. The effects of a 100-year event disabling a major highway, such as I-80, would be disastrous. Traffic delays and detours are expected during construction, due to slow-moving construction equipment on the roads, and the replacement and raising of several roads and bridges.

CONSTRUCTION

5.254 The construction time for the Dual Inlet Tunnel Plan is estimated to be 90 months. Construction scheduling would be done to minimize environmental impacts. The Single Inlet Plan would take 145 months to complete, while the construction period for the No-Tunnel Plan would be approximately 72 months.

5.255 After the project would be constructed, periodic within bank maintenance would be required upstream of the tunnel inlets to ensure the efficient flow of floodwater into the tunnel. The environmental impacts of periodic maintenance would not be as severe as those discussed for the Single Inlet Tunnel Plan because the major channel widening and shaping would have already occurred during project construction, and all maintenance work would be done within the designed channel banks. Therefore, the impacts in the referenced paragraphs that discuss removing side slope vegetation and widening the river would be irrelevant to maintenance. Nonetheless, over time, the aquatic habitats and vegetation in the modified reaches would become reestablished with shoals, instream vegetation and debris

that would create a variability of flows and habitats which fish prefer and would recolonize. Maintenance of these reaches would require removing shoals, all aquatic vegetation, trees, logs, large bushes, debris and other obstructions. The adverse effects of these activities discussed in 5.130 pertain to this aspect of the channel modifications. These construction effects would lower the recreational value of the rivers for fishing, boating, nature walks and aesthetic appreciation.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

5.256 Irreversible or irretrievable commitments of resources to this flood control project include human resources and natural resources. Human resources include the time, labor and capital that would be expended to solve the flood control problem. Natural resources include fuel, steel, concrete, asphalt, stone, clay, soil, erosion control fabrics and certain land areas.

LIST OF PREPARERS

5.257 Table 32 presents a list of the people who were primarily responsible for the preparation of this Environmental Impact Statement.

SECTION 6. PUBLIC INVOLVEMENT

PUBLIC INVOLVEMENT AND CITIZEN PARTICIPATION PROGRAM

6.01 The public involvement and scoping effort began with the distribution of a letter announcing the initiation of the study, dated 31 December 1977, to all parties on our mailing list. The letter contained a list of resource information needed to gather a data base for the basin, as well as a request for information concerning water and related land resource needs. Early in the study, environmental commissions and organizations were solicited and invited to participate in the formulation of plans, by indicating areas of special environmental concern and consideration. The concerns, needs, and constraints expressed by these commissioners, organizations, and individuals were translated into problem and opportunity statements which served as the focus for subsequent plan formulation. A series of public meetings were then held on the Plan of Study to gather comments. Subsequently, environmental commissioners from each of the flood-affected municipalities were invited to another round of meetings. The meetings were held to solicit a more site specific inventory of sensitive environmental areas. Field trips were made to participating municipalities, where consideration was given to potential flood control measures, and to inventory and assess the environmentally sensitive areas.

6.02 During the intermediate planning stage, the broad array of "building block" measures and the resulting alternative plans were coordinated through the PRB Study Subbasin Coordination Program. Environmental concerns were discussed at every public involvement activity including a major public information meeting, seven formal public meetings, approximately 25 coordination meetings with subbasin groups in the PRB Study Subbasin Coordination Program, in speeches and presentations, and at briefings and scoping workshops for Federal, State, Municipal, and County Governments. Once the array of alternative plans was screened to a more manageable number (seven), the final coordination leading to plan selection was through a series of NJDEP-sponsored public meetings, culminating in the State selection for detailed study of a plan on June 28, 1984.

6.03 Consideration was given to environmental issues throughout the planning process, particularly for the purpose of avoiding or minimizing rectifying, reducing and compensating impacts and assessing their significance and magnitude. Coordination with concerned State and local interests was largely accomplished through the Passaic River Subbasin Coordination Program and NJDEP. Decisions regarding the implementation of acceptable solutions were and are an objective of this coordination effort.

REQUIRED COORDINATION

6.04 Scoping meetings were held on November 7, 1985 and December 5, 1985 with Federal Agencies, on November 13 and 14 with the public, and in two meetings on December 16, 1985 with State Agencies. A late stage public meeting regarding the Draft EIS and Main Report was held on May 12, 1987 in Little Falls, N.J.

6.05 Continuing coordination with Federal, State and local interests will be effected by the circulation of this Final EIS for review and comment. Specific coordination will continue into Phase II advanced design planning with the agencies and authorities which are responsible for the protection of significant resources. Concerning terrestrial resources, particularly wetlands, coordination will be effected with the Department of Interior's Fish and Wildlife Service. The Corps will fund the seral plant succession model of Great Piece Meadows, with the goal of refining in-field data while integrating theoretical plant succession that would be expected to occur with the plan in place. The results of this model will then be used to complete the Habitat Evaluation Procedures and refine mitigation recommendations. An expert interagency panel will be convened with the Corps to develop and design refinements to the project's mitigation. Agencies that will be invited to participate include the Department of Interior's Fish and Wildlife Service, the U.S. Environmental Protection Agency; New Jersey's Department of Environmental Protection, along with environmental experts in the university and private sectors. The Corps' Waterways Experimental Station's wetland habitat restoration experts will also assist in the consultation and coordination effort.

6.06 Concerning the wetlands upstream of the Pompton Inlet, the current plan calls for removing large trees from 90 acres of forested wetlands and allowing the scrub-shrub understory to become the predominant wetland ground cover. This facet of the plan will be reanalyzed by the Corps' wetland habitat restoration experts. They will verify whether the need to remove all of the trees as presently used for the basis of impact assessment or whether other possible alternatives to tree removal, such as fencing or interlaced cabling to prevent storm-damaged runaway trees from damaging or damming the tunnel's intake structures are possible. Another consideration will be the design for the levee related interior drainage ponding pools. Plant species that would be included along with the ponds' final design, will be the recommendations that are expected to emerge from this coordination. Finally, a project lands management plan, including wetlands management, will be

formulated, based on the Department of Interior's Fish and Wildlife Service's recommendations and the competing needs and desires of other agencies with overlapping resource responsibilities, including the Nationwide River Inventory for Wild and Scenic River reach nominations. Other Phase II coordination concerning aquatic habitats would be effected with the Fish and Wildlife Service concerning the nature, scope and funding of the Instream Flow Incremental Methodology that would be conducted on the Pompton River tributaries' affected fishery reaches. The results of this study would be used to formulate recommendations that would be considered in consultation with the other agencies responsible for their protection, including the EPA, and NJDEP's Division of Fish and Game.

6.07 Additional Phase II coordination that would be affected concerning parkland would be with NJDEP's Office of Green Acres, the Bergen County Park Commission, the Passaic Valley Restoration Committee, and other county and municipal directors of parks. Cultural resources surveys to be conducted at all surface construction sites will be scoped and planned in consultation with the State Historic Preservation Officer. Should significant resources be discovered, case reports would be prepared and coordinated through the State Historic Preservation Officer, and transmitted to the Advisory Council on Historic Preservation with the purpose of developing mitigation plans for each affected site. The process for developing a mitigation plan for the Morris Canal's earthen berm, which would be breached by the transition channel upstream of the Pompton Inlet, would also involve coordination with the County historic preservation officer and the Morris Canal Society. Similar local coordination would be effected if other significant sites are discovered during surveys.

6.08 Hazardous Substances Sites that are located within the potential project area will be the focus of close coordination with the EPA and NJDEP's Bureaus of Waste Management, Site Management and Case Management. Although this coordination was planned for Phase II, EPA specifically requested that it begin now and that it should determine the Preliminary Assessment and Site Inspection (PASI) status of the eight CERCLA sites that remain of concern. Coordination will continue through the design phase of the project. For sites which would not be scheduled for remediation prior to project construction, and for the sites whose files indicated that there is a potential for residual contamination, the Corps would continue to coordinate with the EPA and NJDEP through the construction stage. The Corps would need to determine the nature of the contaminants, their specific location, and concentrations. Once these data

are gathered, a Health and Safety Plan would be formulated in concert with the USEPA, the Occupational Safety and Health Administration, and the NJDEP. In the event that presently unknown hazardous substances sites are encountered during construction (as, for instance, the discovery of buried drums), coordination would be affected with EPA, NJDEP, and, if applicable, the U.S. Coast Guard, to assess the nature of the hazard and to determine the appropriate remedial action.

6.09 Dioxin also exists in the Lower Passaic River sediments in Reach 1, as discussed in paragraphs 4.20, 5.37 and 5.38. Close coordination with the State of New Jersey indicates that the sediments that are contaminated with dioxin will be remediated prior to the implementation of this project. The Corps will continue to coordinate with the NJDEP regarding the dioxin contaminated sediments in the Lower Passaic River by providing the results of engineering studies that will be performed in the Phase II design stage, including final project design flows, velocities, and with and without project sediment transport data, which can be used in the State's remediation effort.

6.10 Other coordination that would be required to offset short term construction related impacts includes coordination with NJDEP regarding noise and air pollution. The best available control technologies would be used to minimize noise and air quality degradation, including fugitive dust. The Federal and N.J. Department of Transportation would be consulted with in formulating traffic routing during construction. The U.S. and County Soil Conservation Services would be consulted with in formulating erosion control plans at all construction sites.

PUBLIC VIEWS DURING EARLY PLANNING (PRIOR TO CIRCULATING THE DEIS)

6.11 A number of issues became the subject of controversy among public interests during the Passaic River Basin Study. Specific issues that emerged regarding plan formulation during public involvement activities included the desire to: minimize impacts to developed areas; preserve natural flood storage areas, including wetlands, which attenuate flood flows; preserve the natural flushing of river sediments by flood flows; clean up, the lower Passaic Riverside, provide recreational opportunities and restore its east bank from Kearny to Garfield; and utilize nonstructural measures wherever possible, rather than modifying the existing rivers. Major modifications to the recommended plan resulted from considering these issues.

6.12 The key elements of the recommended plan are its subsurface diversion tunnels which minimize surface elements and disturbances. Channel modifications are limited to reaches upstream of both tunnels' inlets.

There is an absence of any structural features along the 6.8 mile Pompton River downstream of the inlet, and a total absence of structural features along the Passaic River from its Two Bridges inlet downstream to the confluence with the Saddle River.

6.13 A major nonstructural element was incorporated into the plan in the form of the preservation of natural flood storage which would involve acquiring and preserving 5,350 Central Basin acres, including 5,200 acres of wetlands.

6.14 The tunnel's operating rules were refined, so that the tunnel would not operate for floods up to and including the one-year event, ensuring that annual floods would scour the rivers and nourish the wetlands. For larger floods, tunnel operating rules would first divert flood peaks and then bypass annual flood flows that would inundate wetlands and flush river channels. In conjunction with the operation of the Great Piece Meadows Weir, the bypass rules would maintain the stability of the channels and the viability of wetlands along the lower Pompton and Central Passaic Rivers.

6.15 In the Lower Valley, beautification measures and recreational opportunities include walking/bike trails, overlooks, comfort facilities, recreational amenities and river access have been included in the levee systems. These amenities would also be included in other reaches where desired by local interests.

6.16 Permanently evacuating the floodplain (the "buyout plan") and relying on a basin-wide nonstructural plan was evaluated several times during the plan formulation process. These plans were found to be either too costly ($3.8 billion for the 100-year evacuation plan, more than four times the cost of the tunnel plan or $2.2 billion for the 10-year evacuation plan). If scaled down to be comparable in cost to the Dual Inlet Plan, would still did not provide sufficient flood damage reduction benefits for economic justification (preventing damages only in portions of the 10-year floodplain).

COORDINATION FOR THE DRAFT EIS

6.17 A notice of availability for the Draft EIS for the flood control plan for the Pompton/Passaic Dual Inlet Tunnel Plan was filed in the Federal Register dated April 17, 1987. This was followed by a 45 day review period that was subsequently extended to August 1, 1987.

6.18 The following is a list of Agencies and Environmental Groups which were sent copies of the Main Report and Draft EIS.

6.19 Federal Offices

Advisory Council on Historic Preservation
Environmental Protection Agency
  Office of Federal Activities
  Region II Administrator
Department of Agriculture
  Forest Service/Regional Forester
  Soil Conservation Service, State Conservationist
  River Basin Branch
Department of Commerce
  National Oceanic and Atmospheric Administration
  Office of Ecology and Conservation
  Deputy Asst. Secretary for Environmental Affairs
Department of Energy
Department of Health and Human Services
  Office of Secretary
  Public Health Services Center for Disease Control
Department of Housing and Urban Development Region II
Department of the Interior
  Office of Environmental Project Review
  U.S. Geological Survey, District Chief
  Fish and Wildlife Service, Field Supervisor, State College, Pa.
  National Park Service, Heritage
  Conservation and Recreation Service
  National Park Service, Regional Director
  Bureau of Indian Affairs, Eastern Area Director
  Regional Environmental Officer
  Archaeology/Historic Preservation
Department of Transportation
  Federal Highway Administration
  Federal Railroad Administration
Federal Emergency Management Administration
Interstate Commerce Commission
U.S. Coast Guard

Regional Offices

Interstate Sanitation Commission
Regional Planning Association
Planning Association of New Jersey
Wetlands Institute

State Offices

Hon. Thomas H. Kean
New Jersey State Clearinghouse
New Jersey Department of Education
New Jersey State Museum/Bureau of Archaeology

Hon. Mario Cuomo
New York State Clearinghouse
New York State Department of Environmental Conservation

New Jersey Department of Environmental Protection
  Division of Environmental Quality
  Bureau of Waste Management
  Bureau of Site Management
  Bureau of Case Management
  Division of Fish, Game and Wildlife
  Division of Parks and Forestry
  Green Acres and Recreation
Division of Water Resources
  Bureau of Floodplain Management
  Planning Group
  New Jersey State Historic Preservation Office
  Flood Protection Bureau

Environmental Groups and Commissions

Friends of the Earth
Citizens for Environmental Quality
Bloomfield Environmental Group
Chatham Nature Club
Fyke Nature Association
League for Conservation Legislation
Mosquito Extermination Association
Kearny Environmental Commission of Concerned Citizens
Garden Club of America
Defenders of Wildlife
Conservation and Environmental Studies Center
Parsippany Citizens for Conservation
Passaic Township Conservation Trust
Resources Recovery Committee
Fish and Game Protection Association
Wildlife Preserves Inc.
Oakland Environmental Commission
Urban Wildlife Research Center
Environmental Lobby, Teaneck
Bergen County Park Commission
Essex County Center for Environmental Studies
New Jersey Environmental Federation
Association of New Jersey Environmental Commissioners
American Fisheries Society
American Conservation Association
National Wildlife Federation
National Park Conservation Association
Nature Conservancy
New Jersey Environmental Lobby
Rutgers School of Law, Environmental Law Council
Princeton University, Center For Environmental Studies

New Jersey Outdoor Education Association
New Jersey Federation of Women' Clubs, Garden and Conservation Department
New Jersey Conservation Foundation
New Jersey Association of Natural Resources Division
New Jersey Education Association, Environmental Education Commission
New Jersey Nature Club

PUBLIC VIEWS AND RESPONSE TO THE DRAFT EIS

6.20 These final paragraphs discuss all substantive comments received on the Draft EIS which resulted in major changes in the study's decision making factors. See Appendix A (separate volume) for all correspondence received regarding this project. These changes have been made in appropriate discussions elsewhere in the statement. Plan formulation, environmental designs and mitigation refinements have considered concerns and recommendations made by the U.S. Department of the Interior (DOI), the U.S. Environmental Protection Agency (EPA), the New Jersey Department of Environmental Protection (NJDEP) and its Bureau of Freshwater Fisheries, Office of Green Acres, State Historic Preservation Office, Division of Coastal Resources, and other departments dealing with noise, air quality and hazardous substances sites, and the other Federal agencies and public interest groups.

6.21 The principle public views that influenced the study's decision making factors are summarized in Section 1, paragraphs 1.25-1.86 of the FEIS. Many environmental community respondents found the draft mitigation plan unacceptable. Specific comments from the DOI, EPA, and NJDEP are highlighted in paragraphs 1.26-1.34, while the actions taken to resolve areas of controversy are subsequently discussed beginning in paragraph 1.35. Refinements to the project's environmental design and mitigation plan were included in the actions taken to resolve areas of controversy. Such environmental design and mitigation refinements are integrated into the mitigation plan description in Section 3, paragraphs 3.107-3.125.

6.22 DEIS comments that caused major changes in the study's decision making factors as reflected in the plan formulation, environmental design, mitigation and documentation in the FEIS are summarized below:

o Agreement with the FWS to perform studies during the Phase II design, including HEP, plant community succession modeling and IFIM, in conjunction with the development of a Comprehensive Wetlands Management Plan (see FEIS paragraphs 1.51-1.54 and 3.116 and Attachment A28, comment response 16g, 17, 21, 22 and 53a, and Attachment A27 of Appendix A - Public Involvement).

o The incorporation of the Pequannock Weir into the project works for the Pompton Tunnel Inlet to avoid the loss of 15 acres of Ramapo River aquatic habitat and to maintain upstream water depths on the Pompton River tributary streams and wetlands (see FEIS paragraphs 1.30, 1.56, 5.112, 5.119, 5.125-5.128 and Attachment A28, comment response 29c and 30d of Appendix A - Public Involvement.

o Refinement of the wetland impact assessment framework which modified the discounting of project wetland losses against acquisition land. This decision making adjustment resulted in the FEIS recommendation for the wetland restoration of 185 acres of project lands within the acquisition area. This would mitigate for direct and indirect losses of wetlands resulting from the construction and operation of the project (see FEIS paragraphs 1.55, 1.59, 3.114 and 5.177 and Attachment A28, comment response 19, Appendix A - Public Involvement.

o Cobble substrate would be placed downstream of Dundee Dam to create four acres of anadromous fish habitat to compensate for the loss of habitat at the tunnel outlet (see FEIS paragraphs 3.120, 5.20 and 5.48).

o Wetland planting in ponding areas will include consideration of a mixed cover type design in order to increase in-kind replacement of forested wetlands lost to the project (see FEIS paragraphs 3.113, 5.122 and 5.123).

o The Corps will organize an Environmental Advisory Board consisting of environmental experts from the Federal, State and public sectors to guide the Phase II environmental design and make decisions regarding site specific mitigation (see FEIS paragraphs 3.116 and 5.123).

o Clarification of the operation of the Dual Inlet Plan with emphasis on the one-year flow bypass operating rule addressed the need for this information as a basis for impact assessment and mitigation documentation in the FEIS (see FEIS paragraphs 3.91-3.100).

o Inclusion of explicit provisions for public accessibility for angling in the watercourse within the project area addressed the FWS's FWCA recommendation number 5 (see FEIS paragraphs 1.30, 3.121 and 5.131).

o Coordination with EPA, increased documentation in the FEIS of the Sole Source Buried Valley Aquifer, and the incorporation of the results of an independent review of the project by the New Jersey State Geological Survey which concurred with the Corps' assessment, addressed concerns regarding this resource (see FEIS paragraphs 1.38, 4.27-4.30 and 5.178-5.183 and Attachment A34, comment response 15, and Attachment A38k, Appendix A - Public Involvement.

o Compensation for project impacts on parks, which had been addressed in the DEIS primarily through levee designs which incorporate levee-topped walking/bike paths, overlooks, benches, lighting, comfort facilities, river access and planting/ beautification landscaping, will include compensation for residual project impacts on parks in the form of providing equivalent recreational opportunities on project lands, or monetary payments based on fair market value of equivalent public recreation usefulness, size, quality and location (see FEIS paragraphs 1.54, 3.125, 5.28-5.30 and 5.52).

o Documentation in the FEIS resulting from coordination with EPA subsequent to the DEIS regarding hazardous substances sites. This included a commitment for continued coordination with EPA and NJDEP during the Phase II design and construction phases. The coordination will determine the status of any remaining sites of concern that will not be remediated prior to construction of a flood control project. In addition to this coordination, the formulation of a Health and Safety Plan and on-site monitoring, if necessary, would be accomplished prior to construction (see FEIS paragraphs 3.124, 5.32-5.38 and 5.51).

o Additional Phase II design stage coordination as previously documented in paragraphs 6.05-6.10.

6.23 Considerable confusion was created during the public involvement process and the circulation of the DEIS due to the dissemination of disinformation that prejudicially presumed that the Corps' Dual Inlet Plan was formulated with disregard for Congressional guidance, laws and regulations, and was neither scientifically designed nor sensitive to the environment. This disinformation discredited the plan by overstating its costs and impacts, fabricating impacts where there are none, and generally misquoting or misstating the facts, confusing both agencies and the public, and creating fear. A review of the topics that the disinformation presumes to treat, reveals the original source of many of the DEIS comments by others.

6.24 This disinformation included comparison of the Pompton-Passaic Dual Inlet Tunnel Diversion Plan with a purported alternative -- a "resources protection plan" -- which was never transmitted to the Corps, or presented at a meeting which Corps' representatives attended. We, therefore, have no clear evidence that the plan actually exists. It is put forth as an alternative to a "structural project" and supposedly already has $62.5 million of funding towards an $800 million buyout of 48,000 acres of "watershed lands" and 11,000 acres of wetlands. Many constituents have been misled by the manner in which the "resources protection plan" has been presented, pretending to be a summary to a fully documented plan. Attachment A93 in the Public Involvement Appendix reproduces the comparison of the Dual Inlet Plan with the "resources protection plan." Printed next to it is the Corps' response which gives the correct facts relative to the Dual Inlet Plan.

FINAL ENVIRONMENTAL IMPACT STATEMENT
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* = main entry

TABLE 1. RELATIONSHIP OF PLANS TO ENVIRONMENTAL STATUTES

FEDERAL POLICIES	
Archaeological and Historic Preservation Act of 1974, as amended.*	ALL PLANS IN FULL COMPLIANCE
Clean Air Act, as amended.	ALL PLANS IN FULL COMPLIANCE
Clean Water Act (Federal Water Pollution Control Act), as amended.	ALL PLANS IN FULL COMPLIANCE
Coastal Zone Management Act of 1972, as amended.	ALL PLANS IN FULL COMPLIANCE
Endangered Species Act of 1973, as amended.	ALL PLANS IN FULL COMPLIANCE
Estuary Protection Act	NOT APPLICABLE
Fish and Wildlife Coordination Act, as amended.	ALL PLANS IN FULL COMPLIANCE
Federal Water Project Recreation Act, as amended.	ALL PLANS IN FULL COMPLIANCE
Land and Water Conservation Fund Act of 1965, as amended.	ALL PLANS IN FULL COMPLIANCE
Marine Protection, Research, and Sanctuaries Act of 1972, as amended.	NOT APPLICABLE
National Environmental Policy Act of 1969, as amended.*	ALL PLANS IN FULL COMPLIANCE
National Historic Preservation Act of 1966, as amended.	ALL PLANS IN FULL COMPLIANCE
River and Harbors Appropriation Act of 1899, as amended.	ALL PLANS IN FULL COMPLIANCE
Watershed Protection and Flood Prevention Act, as amended.	ALL PLANS IN FULL COMPLIANCE
Wild and Scenic Rivers Act, as amended.	ALL PLANS IN FULL COMPLIANCE
Executive Order 11593, Protection and Enhancement of the Cultural Environment*	ALL PLANS IN FULL COMPLIANCE
Executive Order 11988, Floodplain Management	ALL PLANS IN FULL COMPLIANCE
Executive Order 11990, Protection of Wetlands	ALL PLANS IN FULL COMPLIANCE
STATE AND LOCAL POLICIES	
Land Use Plans	ALL PLANS IN FULL COMPLIANCE

*Additional work and coordination will be performed during Phase 2 planning.

TABLE 2 (Page 1 of 3)

EFFECTS OF THE RECOMMENDED PLAN ON NATURAL AND CULTURAL RESOURCES

Types of Resources	Authorities	Measurement of Effects
Air Quality.....	Clean Air Act, as amended (42 U.S.C. 1857h7 et seq.)	Temporary increased due to construction and traffic congestion. Air quality standards are currently violated.
Areas of Particular Concern Within the Coastal Zone.....	Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.)	Some access to river by business is lost. Gain in flood damage protection for riverfront businesses.
Endangered and Threatened Species' Critical Habitat....	Endangered Species' Act of 1973, as amended (16 U.S.C. 1531 et seq.)	None Federally listed. Many State listed species were found in wetlands. Their habitat would be preserved as part of plan.
Fish and Wildlife Habitat.....	Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 et seq.)	<u>Terrestrial Habitat</u> Lost 85 acres Gained - 100 acres <u>Wetlands</u> Direct Loss 710 Indirect Loss 105 Lost as forested Cover type 90 905 <u>Env. Design/Offset</u> Planted Wetlands (Ponding Areas) 630 Recreated/Upgraded 185 Gained as Scrub/ shrub wetlands 90 905 Land preserved (Intact) 4,860 <u>Aquatic</u> Adverse Effect 47 acres (5.9 miles) <u>Env. Design/Offset</u> 47 acres (5.9 miles)

TABLE 2 (Page 2 of 3)

EFFECTS OF THE RECOMMENDED PLAN ON NATURAL AND CULTURAL RESOURCES

Types of Resources	Authorities	Measurement of Effects
Floodplains.....	Executive Order 11988 Floodplain Management	Existing condition acres downstream of Chatham inundated by 100-yr event: 41,000. With-project acres inundated: 14,500.
Historic and Cultural Properties	National Historic Preservation Act of 1966, as amended (16 U.S.C. Sec. 470 et seq.) Archeological and Historic Preservation Act of 1974, as amended. Executive Order 11593, Protection and Enhancement of the Cultural Environment	Two sites are on the National Register of Historic Place. The recommended plan would breach an elememn of the Morris Canal spur, an earthen berm connecting the feeder dams on the Pequannock and Ramapo Rivers. Several more sites have the potential for nomination to the National Register. No effect on known sites from the selected plan. Preconstruction will include surveys National Register sites and at all undisturbed construction sites.
Groundwater.....	Safe Water Drinking Act, as amended (42 U.S.C. Sec.1424 (e))	No effect on Buried Valley Aquifer, designated as a sole source aquifer.
Prime and Unique Farmland.....	CEQ Memorandum of August, 1, 1980 Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act.	None present in project area.
Water Quality.....	Clean Water Act of 1987.	Water quality will be maintained during construction.

TABLE 2 (Page 3 of 3)

EFFECTS OF THE RECOMMENDED PLAN ON NATURAL AND CULTURAL RESOURCES

Types of Resources	Authorities	Measurement of Effects
Wetlands.....	Executive Order Protection of Wetlands; Clean Water Act of 1977 (42 U.S.C. 1857h-7 et seq)	Adverse effects on wetlands by Cover-type — Acres palustrine forested — 786 palustrine scrub/shrub — 26 palustrine emergent — 93 905 Project environmental design to offset impact palustrine forested — 146 palustrine scrub/shrub — 116 palustrine emergent — 643 905 Wetland Preserved Intact — 4,860
Wild and Scenic Rivers.....	Wild and Scenic Rivers Act, as amended (16 U.S.C. 1271 et seq.)	Free flowing characteristics of the Passaic River in the vicinity of Great Piece Meadows will be adversely affected but recommended plan will not adversely impact other natural values or diminish its potential for wild and scenic river designation.

TABLE 3

SUMMARY OF THE PROBLEMS AND NEEDS OF THE PASSAIC RIVER BASIN

I. Water

A. Control of flooding.
B. Hurricane protection.
C. Erosion control.
D. Storm water management
E. Water conservation/supply.
F. Maintain quality of drinking water.
G. Control point and non-point sources of pollution.
H. Improve overall quality of Basin waters.
I. Increase hydropower potential/energy conservation.
J. Maintain free flowing rivers.
K. Preserve, restore, and create wetlands.
L. Provide additional water based recreation, i.e.,lakes, white water canoeing, and fishing.
M. Protect and/or enhance aquatic habitat, particularly rare or endangered species.
N. Control areas that provide habitat for mosquitoes and other disease vectors.
O. Aquatic weed control.
P. Maintain or increase water borne commerce opportunities in the Lower Passaic River.

Q. Education of the public regarding the flood hazard and other associated problems and needs of the Basin.
R. Protection of groundwater sources.

II. LAND

A. Control development in floodplain and other environmentally sensitive areas (including flood fringe, and aquifer recharge areas).

B. Preserve open space for passive and/or recreational recreational use.
C. Preserve structures or sites of cultural significance, i.e., existing or potential national and state historic sites.

D. Preserve scenic areas, i.e., Great Falls.
E. Protection of trees and plants, particularly those of State and National significance.
F. Protect and/or enhance aquatic habitat, particularly rare or endangered species.
G. Improvement and locations of transportation networks.
H. Preserve agricultural lands.
I. Control of brush fires.
J. Create opportunity for land development.

III. POLLUTION

A. Control dumping and discharges into Basin waters.
B. Solid waste management/additional sewage treatment facilities.
C. Management of storm water runoff.

D. Improve air quality.
E. Reduce noise levels.
G. Remediate hazardous substance sites.

IV. OTHER

A. Create master plan for basin to protect its existing natural resources.
B. Develop institutional framework to address and control exploitation of natural resources.
C. Maintain status quo.
D. Creation of new jobs.
E. Health and safety of residents.

TABLE 4
STATEMENTS OF PROBLEMS AND OPPORTUNITIES

The following problem and opportunity statements have been developed for the Passaic River Basin Study.

1. Reduce tidal and fluvial flood damages at areas along the Passaic River mainstream and tributaries, including those areas within the development region of the Passaic River Coastal Zone Management Act jurisdiction.

2. Preserve the water supply potential of the Passaic River Basin in conjunction with the new regional water supply sources which have been identified for the State of New Jersey by the New Jersey Department of Environmental Protection, Division of Water Resources.

3. Preserve and/or enhance fish and wildlife habitat in the study area, including anadromous fish species, which are a national concern.

4. Preserve and/or enhance low head hydropower generation potential at possible sites in the study area, such as S.U.M. Dam, Beatties Dam and Dundee Dam along the mainstream.

5. Preserve and enhance the Basin's remaining wetlands, such as the Great Swamp, Black Meadows, Troy Meadows, Great Piece Meadows, Bog and Vly Meadows, Hatfield Swamp, Hatfield Swamp South, Canoe Brook and others, which lie within potential project boundaries.

6. Protect and improve surface and groundwater quality, including the E.P.A. designated sole source aquifer in Morris County, within the Passaic River study area in conjunction with water quality standards and policies of the New Jersey Department of Environmental Protection.

7. Provide additional outdoor recreational opportunities and open space in the Passaic River study area, such as fishing, boating, picnicking, bicycling, hiking and nature study, consistent with local and regional recreation needs.

8. Preserve commercial and recreational navigation opportunities along the lower Passaic River from its mouth upstream to the Eighth Street bridge in Passaic, N.J. consistent with the needs of the study area.

9. Preserve and protect all Federal and State endangered and threatened species and their habitats which are found within potential project boundaries.

TABLE 4 (CONT)
STATEMENTS OF PROBLEMS AND OPPORTUNITIES

10. Reduce streambank erosion along the Passaic River and its tributaries within potential project boundaries.

11. Preserve all significant archaeological, cultural or historic resources discovered within potential project boundaries.

12. Prevent the disturbance of known toxic waste sites and protect them from flooding that could cause the further disbursement of contaminants.

13. Improve aesthetics and preserve scenic or unique sites within potential project boundaries.

14. Protect and enhance the three free-flowing Passaic River reaches identified in the U.S. Department of the Interior's Nationwide Rivers Inventory. They have potential for future addition to the National Wild and Scenic Rivers System as recreational river reaches (Passaic River from: 1) Two Bridges to Interstate 80; 2) Route 24 to Route 10; 3) Route 78 to Osborn Mills, including Great Brook from its confluence with the Passaic River to Silver Lake).

TABLE 5

SUMMARY OF PLAN SCREENING

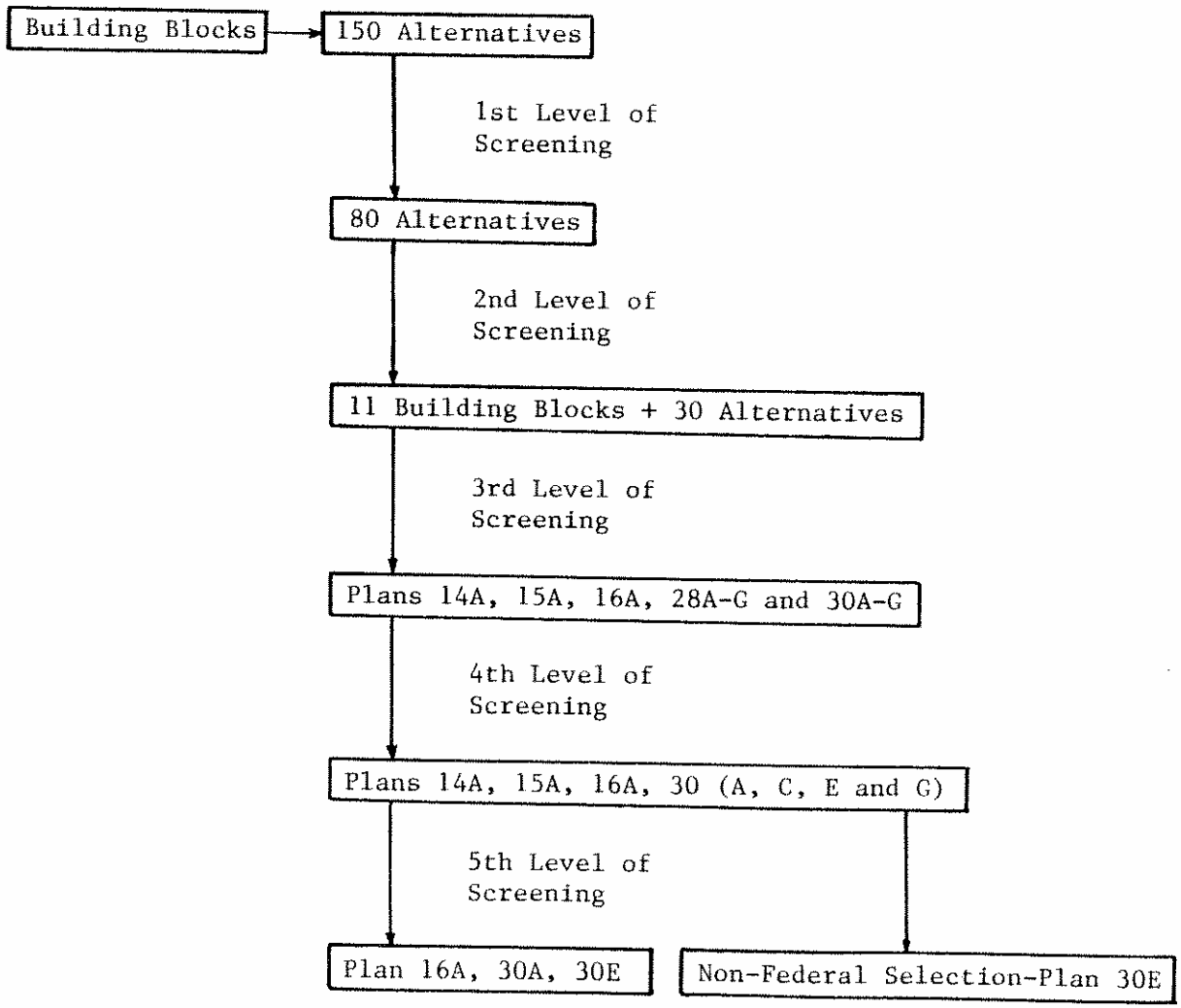


TABLE 6
ACRES OF NATURAL FLOOD STORAGE THAT ARE PROTECTED AND UNPROTECTED 1/
(1984 Conditions)

STORAGE AREA NAME	ACRES	ACRES 2/ PROTECTED BY FLOODWAY DELINEATIONS	ACRES 3/ PROTECTED AS PARKLAND OR OPEN SPACE	TOTAL ACRES PROTECTED	PERCENT PROTECTED	REMAINING DEVLOPABLE ACRES	DEVELOPABLE 5/ ACRES PROTECTED WITH FHAR	ACRES LEGALLY 6/ SUSCEPTABLE TO FILL	ACRES INCLUDED IN PRESERVATION ACQUISTION
Great Piece Meadows	4125	2185	220	2405	58%	1720	945	775	1580
Troy Meadows	2390	805	315	1120	47%	1270	700	570	1175
Canoe Brook	1245	745	140	885	71%	360	200	160	175
Upper Passaic River	2200	675	930	1605	73%	595	330	265	0
Hatfield Swamp	1775	1045	205	1250	70%	525	290	235	430
Black Meadows	1300	40	0	40	3%	1260	695	565	1110
Great Swamp	8500	0	7500	7500 4/	88%	1000	550	450	0
Dead River	850	180	0	180	21%	670	370	300	0
Bog & Vly Meadows	650	205	0	205	32%	445	245	200	405
Hatfield Swamp (South)	605	220	175	395	65%	210	115	95	190
Lower Pompton	845	280	0	280	33%	565	310	255	285
TOTAL	24,485	6,380	9,485	15,865	65%	8,620	4,750	3,870	5350

1/ Storage areas are not always analogus to wetland designations.
2/ Approximate acreage protected by floodway delineations.
3/ Approximate acreage protected consists of those areas in public ownership expected to remain as parkland or open space.
4/ The Great Swamp National Wildlife Refuge/Lord Sterling Park protects 7500 acres.
5/ Developable acres estimated to remain as open space due to the Flood Hazard Area Regulations limitation on fill placement in flood fringe.
6/ Developable acres estimated to be filled under the Flood Hazard Area Regulations.

TABLE 7

PASSAIC RIVER BASIN WETLAND PROTECTIVE STATUS

Name of Area	Acres Designated As Protected (Parks or Open Space)	Land Use	Brief Definition	Status
Great Swamp/Lord Sterling Refuge Park	7500	National Wildlife Refuge/ County Park (Passaic - Harding Twps. and Somerset County Park)	Great Swamp is dedicated to migratory birds and wildlife conservation; Lord Sterling Park is nature education and recreation (horseback riding).	Great Swamp is protected by Federal Regulation. Lord Sterling Park is protected as a county park.
Upper Passaic River	930	Morris Co. and Green Acres Parkland	Lands dedicated to open space.	Protected as Morris Co. parkland and by State's Green Acres program.
Troy Meadows	315	New Jersey Green Acres	Lands dedicated to open space.	Protected under State's Green Acres Program.
Great Piece Meadows	220	Parkland	Lands dedicated to open space.	Will remain protected.
Hatfield Swamp	205	Parkland West Essex Co. Park (Several Communities)	Lands dedicated to open space.	Will remain protected.
Canoe Brook	90	Conservation District (Milburn)	Lands dedicated to open space and to protect water supplies.	Township expects most of this acreage to remain under current zoning.
	25	Parkland (Florham Park)	Lands dedicated to open space.	Will remain protected.
	25	Parkland (Chatham)	Lands dedicated to open space.	Will remain protected.
Hatfield South	85	Parkland (Roseland)	Lands dedicated to open space.	Will remain protected.
	90	Parkland (Livingston)	Lands dedicated to open space.	Will remain protected.

TABLE 8

HISTORIC AND FUTURE TREND OF IMPACTS ON WETLANDS
AND NATURAL FLOOD STORAGE AREAS

YEAR	CENTRAL BASIN WETLAND ACRES	WETLAND ACRES IMPACTED	NATURAL STORAGE ACRES LOST
1940	30,500		
		5,200	5,200 2/
1978	25,300		
		1,200	1,200 2/
1984	24,100		
		945 1/	430 3/
1990	23,155		
		7,535 1/	3,440 3/
2040	15,620		
		TOTAL 14,880	10,270

1/ This reflects the maximum wetland acreage impacted by development, i.e., filled (20% of the volume, which represents about 45% of the areal extent based upon geometric determination) altered without filling (natural cover removed and lawns planted, etc.) or indirectly impacted without filling (isolation, flow regime changes).

2/ For historic purposes, wetlands and natural storage losses are assumed interchangeable.

3/ The loss of natural storage between 1984 and 1990 and between 1990 and 2040 reflects the inclusion in development plans of 960 and 7,660 acres, of natural storage respectively.

TABLE 9

SEISMIC ACTIVITY WITHIN THE PASSAIC RIVER BASIN

DATE	APPROXIMATE LOCATION OF EPICENTER		INTENSITY-MODIFIED MERCALLI SCALE
24 Nov 1783	Green Pond	HA	IV
30 Nov 1783	Green Pond	HA	IV
30 Nov 1783	Green Pond	HA	VI
30 Nov 1783	Green Pond	HA	IV
10 Aug 1880	Whippany	HA	III
1 Sep 1880	Whippany	HA	III
27 May 1902	Montclair	LV	II
11 Aug 1902	Montclair	LV	II
30 Sep 1937	West Caldwell	CB	III
16 May 1938	West Caldwell	CB	II
6 Dec 1938	West Caldwell	CB	III
1 Apr 1947	Bloomingdale	HA	III
11 Mar 1976	Kinnelon	HA	VI

Highland Area.
Lower Valley.
Central Basin.

TABLE 10 (Page 1 of 5)

ALL NPL (SUPERFUND) AND CERCLA SITES IN THE 100-YEAR FLOODPLAIN
OF THE PASSAIC RIVER

TOWN	COUNTY	FIRM/ SITE	LIST	CONCERN	REASON	COMMENTS
Passaic	Morris	Asbestos Dump	National Priority List	No	Upstream of project area	More than 2,000 feet from any project construction
Parsippany-Troy Hills	Morris	Sharkey Lankfill	National Priority List (Superfund)	Yes	Uncontained contamination on the immediate banks of the Rockaway River	See Table 11
Fairfield	Essex	Caldwell Trucking	National Priority List (Superfund)	Yes	Extensive contamination migrating to the Passaic River	See Table 11
Newark	Essex	Diamond Shamrock also known as Diamond Alkali	National Priority List (Superfund)	Yes	Major Dioxin-contaminated site in and on the banks of the Passaic River	See Table 11
Kearny	Hudson	SYNCON Resins	National Priority List (Superfund)	Yes	Uncontained contamination on the banks of the Passaic River	See Table 11
Pequannock	Morris	Eastern Chemical	CERCLA	No	More than 500 feet from the Pompton River	Site remediated in 1972; chance of some residual contamination
Passaic	Morris	Standex Int'l Corp., Eastern Engraving	CERCLA	No	More than 500 feet from any project element	
Passaic	Morris	Passaic Sewage Treatment Plant	CERCLA	No	More than 500 feet from any project element	

ALL NPL (SUPERFUND) AND CERCLA SITES IN THE 100-YEAR FLOODPLAIN OF THE PASSAIC RIVER

TOWN	COUNTY	FIRM/ SITE	LIST	CONCERN	REASON	COMMENTS
Berkeley Heights	Union	Millmaster Onyx	CERCLA	No	More than 500 feet from any project element	
Hanover	Morris	EPA File # NJD000 025230	CERCLA	No	More than 500 feet from any project element	
East Hanover	Morris	Rowe Inter-national	CERCLA	No	More than 500 feet from the Whippany River	
East Hanover	Morris	EPA File # NJD980 505069	CERCLA	No	More than 500 feet from any project element	
Parsippany-Troy Hills	Morris	Parsippany Redeposit	CERCLA	No	Sited within Sharkey Landfill, Superfund Site	See Sharkey Landfill Table 11
West Caldwell	Essex	PCI Sanitary	CERCLA	No	No hazardous sub-stances on site	Broker for hazardous waste treatment for Modern Transportation, Kearny
West Caldwell	Essex	Firestone Tire and Rubber Co.	CERCLA	No	More than 500 feet from any project element	
Fairfield	Essex	EPA File # NJD065 812950	CERCLA	No	More than 500 feet from any project element	
Fairfield	Essex	EPA File # NJD002 148484	CERCLA	No	More than 500 feet from any project element	
Montville	Morris	Moran Paint Co.	CERCLA	No	No construction along affected riverbank	Complaint of leaking drums remediated in 1981
Wayne	Passaic	Parker Chemical	CERCLA	No	More than 500 feet from any project element	

ALL NPL (SUPERFUND) AND CERCLA SITES IN THE 100-YEAR FLOODPLAIN OF THE PASSAIC RIVER

TOWN	COUNTY	FIRM/ SITE	LIST	CONCERN	REASON	COMMENTS
Wayne	Passaic	Wayne Urban Renewal Site, Quadrant #4	CERCLA	No	More than 500 feet from any project element	
Totowa	Passaic	Continental Can Corp.	CERCLA	No	More than 500 feet from any project element	
West Paterson	Passaic	Singer-Keerfott Div.	CERCLA	No	More than 500 feet from any project element	
Paterson	Passaic	EPA File # NJD980 771620	CERCLA	No	More than 500 feet from any project element	
Hawthorne	Passaic	EPA File # NJD000 310961	CERCLA	No	More than 500 feet from any project element	
Paterson	Passaic	EPA File # NJD980 771927	CERCLA	No	More than 500 feet from any project element	
Garfield	Bergen	Kalama Chemical Inc.	CERCLA	No	More than 500 feet from any project element	
Passaic	Passaic	Pantasote Inc.	CERCLA	Yes	Site within 500 feet of project elements	See Table 11
Passaic	Passaic	Gaess Environmental Services	CERCLA	Yes	Uncontained contamination on the bank of the Passaic River	See Table 11
Nutley	Essex	OMI International	CERCLA	Yes	Site within 500 feet of project element	See Table 11

ALL NPL (SUPERFUND) AND CERCLA SITES IN THE 100-YEAR FLOODPLAIN OF THE PASSAIC RIVER

TOWN	COUNTY	FIRM/ SITE	LIST	CONCERN	REASON	COMMENTS
Belleville	Essex	EPA File # NJD065 811168	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	AMAX Specialty Metals	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	Englehard Mineral & Chemical	CERCLA	No	More than 500 feet from any project element	
Harrison	Hudson	Diamond Shamrock	CERCLA	Yes	Uncontained contamination on the bank of the Passaic River	See Table 11
Newark	Essex	Apex Color Works	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	Sherwin-Williams	CERCLA	Yes	Within 500 feet of project elements	See Table 11
Newark	Essex	SCA Chemical Services	CERCLA	Yes	Within 500 feet of project elements	See Table 11
Newark	Essex	Benjamin Moore	CERCLA	Yes	Within 500 feet of project elements	See Table 11
Newark	Essex	EPA File # NJD980 530224	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	Campbell Foundry	CERCLA	No	More than 500 feet from any project element	

ALL NPL (SUPERFUND) AND CERCLA SITES IN THE 100-YEAR FLOODPLAIN OF THE PASSAIC RIVER

TOWN	COUNTY	FIRM/ SITE	LIST	CONCERN	REASON	COMMENTS
Newark	Essex	Fairmont Chemical	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	EPA File # NJD980 529747	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	Alliance Color & Chemical	CERCLA	No	More than 500 feet from any project element	
Newark	Essex	EPA File # NJD079 929044	CERCLA	No	Outside project area	
Newark	Essex	Vulcan Materials Co. (McKessen)	CERCLA	No	Outside project area	
Kearny	Hudson	EPA File # NJD980 770150	CERCLA	No	More than 500 feet from any project element	
Kearny	Hudson	Sanitary Waste Carrier	CERCLA	No	More than 500 feet from any project element	
Kearny	Hudson	Conrail Meadows Yard	CERCLA	Yes	Operation near bank of Passaic River	See Table 11
Kearny	Hudson	S & W Waste	CERCLA	Yes	Operation near bank of Passaic River	See Table 11
Kearny	Hudson	Modern Transpor-tation	CERCLA	Yes	Operation near bank of Passaic River	See Table 11
Kearny	Hudson	BASF Wyandotte (Badische)	CERCLA	Yes	Operation near bank at the mouth of Passaic River	See Table 11

TABLE 11 (Page 1 of 4)

SUPERFUND AND CERCLA SITES
PART A. SITES NOT AFFECTED BY PROJECT CONSTRUCTION

TOWN	COUNTY	FIRM/ SITE	LIST	DISTANCE TO PROJECT ELEMENT	DATE OF PA	DATE OF SITE INSPECTION	NATURE OF MATERIAL	REMEDIATION SCHEDULED BY	COMMENTS
Parsippany/ Troy Hills	Morris	Sharkey Landfill	National Priority List (NPL/ Superfund)	About 500 feet	3/1/84	10/1/81- 8/1/82	Municipal Waste & Sludge, Halogenated Organics, Industrial Septic Waste	Approx. 1997	Not a serious concern: 1. All nearby project elements are upstream of the site. 2. Remediation will likely be completed before project construction.
Fairfield	Essex	Caldwell Trucking	National Priority List (NPL/ Superfund)	0-1000 feet; migrating plume may reach to the Passaic River and beyond	8/1/82	7/1/82- 8/1/82	Organic Solvents	Unknown	Not a serious concern: 1. All nearby project elements are upstream of the site.
Passaic City	Passaic	Pantasote Inc.	CERCLA	About 100 feet	-	-	Polyvinyl chloride resins	Completed 1985	Not a serious concern: 1. Removed from State's list of hazardous storage and disposal sites.
Nutley	Essex	OMI	CERCLA Inter- national	About 250 feet	-	-	Acids, cyanide, metals	Completed 1986	Not a serious concern: 1. Removed from State's list of hazardous storage and disposal sites. 2. Site separated from project levees by major arterials: Main St. and McCarter Highway.

SUPERFUND AND CERCLA SITES
PART A. SITES NOT AFFECTED BY PROJECT CONSTRUCTION

TOWN	COUNTY	FIRM/ SITE	LIST	DISTANCE TO PROJECT ELEMENT	DATE OF PA	DATE OF SITE INSPECTION	NATURE OF MATERIAL	REMEDIATION SCHEDULED BY	COMMENTS
Newark	Essex	Diamond Alkali	National Priority List (NPL/ Superfund)	0 feet; contamination extends into Passaic River	6/1/80		Dioxin	1990	Bank disturbance not a serious concern: 1. Remediation will be completed prior to project construction. 2. Remediation will include floodwall and levee construction to Corps' project specifications.
Newark	Essex	SCA Chemical Services	CERCLA	About 500 feet	12/1/79	2/1/83-3/1/83	Sludge, oily waste, solvents, acids, caustics, cyanide, metals	None; determined to be no imminent hazard	Not a serious concern: 1. No record of spills. 2. Site well-contained with dikes and concrete base.
Kearny	Hudson	SYNCON Resins	National Priority List (NPL/ Superfund)	Less than 500 feet	7/1/82-8/1/82		Lacquers, PCB, Trichloroethane	1996	Not a serious concern: 1. Remediation will likely be completed prior to project construction. 2. Contract for designing remediation plan is underway.

PART B. HAZARDOUS MATERIALS SITES OF CONCERN

TOWN	COUNTY	FIRM/ SITE	LIST	DISTANCE TO PROJECT ELEMENT	DATE OF PA	DATE OF SITE INSPECTION	NATURE OF MATERIAL	REMEDIATION SCHEDULED BY	COMMENTS
Passaic City	Passaic	GAESS Environmental Services	CERCLA	Less than 100 feet	7/1/80	1/1/81	Carbon tetrachloride trichlorethylene heavy metals	None; determined to be no imminent hazard	Concern remains: 1. Will require soil sampling and near shore sediment sampling to determine presence and extent of contamination. 2. Additional action to be determined by sampling results.
Harrison	Hudson	Diamond Shamrock (Oxidental Chemical)	CERCLA	Less than 100 feet	-	1/87	PCB, benzene, corrosives, solvents	Uncertain	Concern remains: 1. Contamination may extend into river. Closure plans now being negotiated. 2. Outcome of closure plans will determine further action. 3. May require soil sampling and near shore sediment sampling to determine presence and extent of contamination.
Newark	Essex	Sherwin-Williams	CERCLA	About 100 feet	-	-	Solvents	1987 in progress	Concern remains: 1. Removed from state's list of hazardous storage and disposal sites. 2. Residual contamination may remain, possibly necessitating soil sampling to decide future action.
Newark	Essex	Benjamin Moore	CERCLA	About 200 feet	-	-	Solvents	Completed 1986	Concern remains: 1. Removed from State's list of hazardous storage and disposal sites.

PART B. HAZARDOUS MATERIALS SITES OF CONCERN

TOWN	COUNTY	FIRM/ SITE	LIST	DISTANCE TO PROJECT ELEMENT	DATE OF PA	DATE OF SITE INSPECTION	NATURE OF MATERIAL	REMEDIATION SCHEDULED BY	COMMENTS
									2. Residual contamination may remain, possibly [illegible] sitating [illegible] to decide fut[illegible]
Kearny	Hudson	Conrail Meadows Yard	CERCLA	Within 500 feet	5/1/85	8/9/87	Diesel fuel oil, no hazardous waste known	U[illegible]	Concern remains: 1. Clean-up scheduled prior to construction of new facility; some residual contamination may remain. 2. Follow-up soil sampling and near shore sediment sampling, if needed, will determine future action.
Kearny	Hudson	S & W Waste	CERCLA	Within 500 feet	5/1/85- 5/31/85	3/1/83 8/1/85- 9/13/85	Oil sludges, solvents, acids, trichloro-ethylene	Uncertain	Concerns remain: 1. Clean-up schedule uncertain. 2. Soil sampling of riverbank may be necessary to decide future action.
Kearny	Hudson	Modern Trans-portation	CERCLA	Less than 500 feet	8/20/85	5/31/84	Sludge, oily waste, acids, bases, metals, PCB	Uncertain	Concerns remain: 1. Clean-up schedule to be developed per State enforcement measures. 2. Soil sampling of riverbank may be necessary to decide future action.
Kearny	Hudson	BASF Wyandotte (Badische)	CERCLA	Less than 500 feet	11/2/83	-	Phthalate esters, powdered carbon sludge	Completed 1982 not considered a serious threat	Concerns remain: 1. Old hazardous storage site decommissioned and removed. 2. Residual contamination may remain. 3. Soil sampling of riverbank may be necessary to decide fut[illegible]ction.

TABLE 12

AVERAGE WATER QUALITY MEASUREMENTS AT PASSAIC RIVER AND NEARBY TRIBUTARY STATIONS, 1972-1985

PARAMETER MEASURED	UNITS	APPLICABLE WATER QUALITY** STANDARDS	STATIONS* PASSAIC RIVER AT MILLINGTON	PASSAIC RIVER AT CHATHAM	ROCKAWAY RIVER AT PINE BROOK	WHIPPANY RIVER AT PINE BROOK	POMPTON RIVER AT TWO BRIDGES	PASSAIC RIVER AT LITTLE FALLS	PASSAIC RIVER AT ELMWOOD PARK	SADDLE RIVER AT LODI
Water Temp.	deg C	27.8 (max)	14.3	15.4	15.9	16.1	15.5	14.3	13.5	15.1
Turbidity	JTU	15 (ave)	6.2	18.2 !!!	7.2	10.6	4.9	7.2	7.6	6.7
Diss. Solids	mg/l	500 (max)	119	262	170	196	153	200	@	290
Susp. Sed.	mg/l	40 (max)	17.7	23.8	19.5	29.3	@	25.0	25.0	14.2
D.O.	mg/l	4 (min)	7.3	7.1	7.8	6.3	8.9	8.7	10.0	7.6
BOD5	mg/l	***	2.1	4.7	4.7	6.3	3.5	5.0	@	5.6
pH	units	6.5-8.5 (range)	7.3	7.4	7.4	7.4	7.4	7.5	7.5	7.5
Total Phos.	mg/l	0.1	0.1	0.6 !!!	0.6 !!!	0.5 !!!	0.2 !!!	0.5 !!!	0.5 !!!	0.9 !!!
NO3-N	mg/l	***	0.3	0.9	0.9	1.1	0.6	1.0	@	2.5
NH3+NH4-N	mg/l		0.1	0.6	1.5	1.1	0.3	1.3	0.8	1.9
Chloride	mg/l	250 (max)	18.9	56.5	33.2	37.5	26.7	44.2	41.7	48.9
Sulfate	mg/l	250 (max)	17.5	34.9	24.6	38.0	24.1	33.4	27.3	38.7
Phenols	ug/l	***	2.3	4.0	2.3	0.8	@	1.8	@	2.5
PCBs (mud)	ug/kg	0.001 (ppm)	7 NA	128 NA	55 NA	133 NA	79 NA	20 NA	@	@
Fecal Col.	MPN/100ml	200 (ave)	696 !!!	2069 !!!	2061 !!!	6729 !!!	1481 !!!	1390 !!!	@	3915 !!!
Cadmium	ug/l	10 ****	1.0	1.0	1.0	1.4	@	2.5	2.4	1.0
Chromium	ug/l	50 ****	24.2	13.0	11.7	15.4	@	13.7	22.0	10.0
Lead	ug/l	50 ****	8.4	11.0	8.2	17.2	7.2	8.9	20.0	28.5
Mercury	ug/l	2 ****	0.2	0.2	0.2	0.3	0.5	1.3	0.9	0.1

* Stations are in upstream to downstream order from left to right. Not all years present for all stations.

** FW-2 Non-trout classification.

*** None which would render the water unsuitable for designated uses.

**** Included in N.J. Standards as a guideline which should not be exceeded for the protection of potable water supplies.

!!! Violation of standard shown. NA - Not applicable. @ - no data.

See Figure 7 for locations.

TABLE 12 (continued)

UNITIZED[a] WATER QUALITY MEASUREMENTS AT PASSAIC RIVER AND NEARBY TRIBUTARY STATIONS, 1972-1985
(Page 2 of 2)

PARAMETER MEASURED	UNITS	APPLICABLE WATER QUALITY** STANDARDS	STATIONS*: PASSAIC RIVER AT MILLINGTON	PASSAIC RIVER AT CHATHAM	ROCKAWAY RIVER AT PINE BROOK	WHIPPANY RIVER AT PINE BROOK	POMPTON RIVER AT TWO BRIDGES	PASSAIC RIVER AT LITTLE FALLS	PASSAIC RIVER AT ELMWOOD PARK	SADDLE RIVER AT LODI
Water Temp.	deg C	27.8 (max)	0.51	0.55	0.57	0.58	0.56	0.51	0.49	0.54
Turbidity	JTU	15 (ave)	0.41	1.21 !!!	0.48	0.71	0.33	0.48	0.51	0.45
Diss. Solids	mg/l	500 (max)	0.24	0.52	0.34	0.39	0.31	0.40	a	0.58
Susp. Sed.	mg/l	40 (max)	0.44	0.60	0.49	0.73	a	0.63	0.63	0.36
D.O.	mg/l	4 (min)	1.83	1.78	1.95	1.58	2.23	2.18	2.50	1.90
BOD5	mg/l	3 ***(arb)	0.70	1.57 !!!	1.57 !!!	2.10 !!!	1.17 !!!	1.67 !!!	a	1.87 !!!
pH	su	6.5-8.5 (range)	1.04	1.06	1.06	1.06	1.06	1.07	1.07	1.07
Total Phos.	mg/l	0.1	1.00	6.00 !!!	6.00 !!!	5.00 !!!	2.00 !!!	5.00 !!!	5.00 !!!	9.00 !!!
NO3-N	mg/l	1 ***(arb)	0.30	0.90	0.90	1.10 !!!	0.60	1.00	a	2.50 !!!
NH3+NH4-N	mg/l	1 (arb)	0.10	0.60	1.50 !!!	1.10 !!!	0.30	1.30 !!!	0.80	1.90 !!!
Chloride	mg/l	250 (max)	0.08	0.23	0.13	0.15	0.11	0.18	0.17	0.20
Sulfate	mg/l	250 (max)	0.07	0.14	0.10	0.15	0.10	0.13	0.11	0.15
Phenols	ug/l	1 ***(arb)	2.30 !!!	4.00 !!!	2.30 !!!	0.80	a	1.75 !!!	a	2.50 !!!
PCBs (mud)	ug/kg	0.001 (ppm)	7.00 NA	128.00 NA	55.00 NA	133.00 NA	79.00 NA	20.00 NA	a	a
Fecal Col.	mpn/100ml	200 (ave)	3.48 !!!	10.35 !!!	10.31 !!!	33.65 !!!	7.40 !!!	6.95 !!!	a	19.58 !!!
Cadmium	ug/l	10 ****	0.10	0.10	0.10	0.14	a	0.25	0.24	0.10
Chromium	ug/l	50 ****	0.48	0.26	0.23	0.31	a	0.27	0.44	0.20
Lead	ug/l	50 ****	0.17	0.22	0.16	0.34	0.14	0.18	0.40	0.57
Mercury	ug/l	2 ****	0.10	0.10	0.10	0.15	0.25	0.65	0.45	0.04

* Stations are in upstream to downstream order from left to right. Not all years present for all stations.

** FW-2 Non-trout classification.

*** None which would render the water unsuitable for designated uses.

**** Included in N.J. Standards as a guideline which should not be exceeded for the protection of potable water supplies.

!!! Violation of standard shown. NA - Not applicable. arb - Arbitrary selection. a - no data.

[a] Data are unitized by dividing the value by the standard. If the value is greater than 1 (except for DO), it is a violation.

TABLE 13

POINT SOURCE AND LOW FLOW DISCHARGES

REACH DESCRIPTION*	POINT SOURCE DISCHARGES WITHIN REACH		CUMULATIVE POINT SOURCE DISCHARGES		10 YEAR 7 DAY LOW FLOW		AVERAGE FLOW		RATIO OF CUMULATIVE POINT SOURCES TO LOW FLOW
	cfs	(mgd)	cfs	(mgd)	cfs	(mgd)	cfs	(mgd)	
Passaic River, Chatham to Two Bridges	34	(22)	51	(33)	3.1	(2.0)	168	(108)	16.5
Pompton River and Tributaries Pompton Lakes to Two Bridges	9	(6)	14	(9)	39.0	(25.2)	508	(328)	0.4
Passaic River, Two Bridges to Little Falls	5	(3)	70	(45)	23.1	(14.9)	1160	(748)	3.0
Passaic River, Little Falls to Dundee Dam	9	(6)	79	(51)	24.5[a]	(15.8)	1233[a]	(795)	3.2
Passaic River, Dundee Dam to Newark Bay	175	(113)[b]	254	(164)	37.3[a]	(24.1)	1340[a]	(865)	6.8

[a]Estimated values using runoff per unit drainage area.
[b]105 mgd is from Public Service Electric and Gas Company power plants.

cfs = cubic feet per second
mgd = million gallons per day

TABLE 14 (1 OF 5)

PASSAIC RIVER BASIN
BENTHIC MACROINVERTEBRATES

SITE LOCATION ON FIGURE 12

Passaic River, Molly Ann's and Deepavaal Brook

LOCATION

A. Passaic River Elmwood Park — Date: 9/24/80 — Gear: dredge

			Number
Insecta (larvae)	Diptera	Chironomidae	2
Oligochaeta Lumbriculidae	Lumbrieulida		26

B. Passaic River Lackawanna Ave. — Date: 9/15/80 — Gear: dredge

Crustacea Asellidae	Isopoda		1
Insecta (larvae)	Diptera	Chironomidae	24
Insecta (pupae)	Diptera	Chironomidae	7
Oligochaeta Lumbriculidae	Lumbriculida		3
Insecta Cochagriidae	Odonata		1

C. Molly Ann Brook — Date: 8/17/80 — Gear: surber

Crustacea Gammaridae	Amphipoda	1
Crustacea Astacidae	Decapoda	1
Castropoda Pleuroceridae	Mesogastropoda	10
Hirudinea Hirudidae	Gnathobdellida	1

D. Passaic River — Date: 8/19/80 — Gear: dredge

Oligochaeta Lumbriculidae	Lumbriculida	10

E. Passaic River Rt. 46, Pine Brook — Date: 9/30/80 — Gear: dredge

Insecta Chironomidae(larvae)	Diptera	32
Insecta Chironomidae(pupae)	Diptera	1
Oligochaeta Lumbriculidae	Lumbriculida	28

F. Passaic River Two Bridges — Date: 11/20/80 — Gear: dredge

Insecta Chironomidae(larvae)	Diptera	10
Oligochaeta Lumbriculidae	Lumbriculida	12

P. Deepavaal Brook — Date: 8/17/80 — Gear: dredge

Oliogochaeta Naididae	Haplotaxide	10

TABLE 14 (2 of 5)

PASSAIC RIVER BASIN
BENTHIC MACROINVERTEBRATES

SITE
LOCATION
ON FIGURE 12

Rockaway River Subbasin

G. Rockaway River, Knoll Rd., Montville — Date: 8/18/80 — Gear: Surber

Insecta	Diptera	Chironomidae	Gammarus	12
Crustacea	Ampipoda	Gammaridae		10

H. Rockaway River, Vail Rd. Bridge, Lake Hiawatha — Date: 8/17/80 — Gear: Surber

Insecta	Trichoptera	Hydropsychidae	Hydropsyche	2
Oligochaeta	Lumbriculida	Lumbriculidae		6

I. Black Brook, Route 510 Bridge, Florham Park — Date: 9/15/80 — Gear: dredge

CLASS	ORDER	FAMILY	GENUS	NOS.
Crustacea	Amphipoda	Gammaridea	Gammarus	3
Crustacea	Amphipoda	Isopoda	Asellus	1
Insecta	Odonata	Corduliidae	Dorocordulia	1
Insecta	Odonata	Coemagriidae		
Oligochaeta				

J. Whippany River, Troy Road Bridge, East Hanover — Date: 9/9/80 — Gear: Surber

Crustacea	Amphipoda	Gammaridae	Gammarus	8
Crustacea	Isopoda	Asellidae	Asellus	8
Gastropoda	Basommatophora	Ancylidae	Ferrissia	2
Gastropoda	Basommatophora	Physidae	Physa	2
Hirudinea	Rhynchobdellida	Glossiphonidae	Helobdella	3
Insecta	Diptera	Chironomidae(larvae)		59
Insecta	Diptera	Chironomidae(pupae)		7
Insecta	Diptera	Simulidae larvae		7
Insecta	Trichoptera	Hydropsyhidae	Hydropsyche	2
Oligochaeta	Lumbriculida	Lumbriculidae		12
Oligochaeta	Haplotaxida	Niadidae		1
			Gear: dredge	
Crustacea	Isopoda	Asellidae	Asellus	1
Insecta	Diptera	Chironomidae		5
Oligochaeta	Lumbriculida	Lumbriculidae		12

TABLE 14 (3 of 5)

PASSAIC RIVER BASIN
BENTHIC MACROINVERTEBRATES

SITE LOCATION ON FIGURE 12

Pompton River Subbasin

K. Pompton River Date: 8/26/80 Gear: Surber
Pompton Plains, Jackson Ave

Crustacea	Amphipoda	Gammaridae	Gammarus	1
Insecta	Diptera	Chironomidae(larve)		3
Insecta	Ephemeroptera	Heptageniidae	Stenonema	1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	3

L. Pompton River Date: 9/17/80 Gear: dredge
Rt. 202
Mountain View

Gastropoda	Basommatophora	Planorbidae	Helisoma	1
Insecta	Diptera	Chironomidae(larvae)		213
Insecta	Diptera	Chironomidae(pupae)		3
Insecta	Ephemeroptera	Caenidae	Caenis	2
Oligochaeta	Lumbriculida	Lumbriculidae		22
Phylactolaemata		Cristatellidae	Cristatella (statoblast)	11

Pequannock River Subbasin

M. Pequannock River Date: 9/3/80 Gear: Surber

CLASS	ORDER	FAMILY	GENUS	NOS.
Crustacea	Dicapodaa	Astacidae	Orconectes	1
Gastropoda	Basommatophora	Ancylidae	Ferrissia	19
Gastropoda	Basommatophora	Physidae	Physa	4
Gastropoda	Basommatophora	Planoribidae	Helisoma	1
Gastropoda	Basommatophora	Planoribidae	Gyraulus	3
Insecta	Coleoptera	Psephinidae	Psephenus	1
Insecta	Diptera	Chironomidae(larvae)		318
Insecta	Diptera	Chironomidae(pupae)		20
Insecta	Diptera	Simulidae(larvae)		3
Insecta	Ephemeroptera	Baetidae	Baetis	1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	30
Insecta	Trichoptera	Hydropsychidae(pupae)		2
Insecta	Trichoptera	Hydroptilidae(pupae)		2
Hirudinea	Rhynchobdellida	Glossiphonidae	Helobdella	2
Adenophorea	Enoplida	Mermithidae	Neomesomeris	4
Oligochaeta	Lumbriculida	Lumbriculidae		353

TABLE 14 (4 of 5)

PASSAIC RIVER BASIN
BENTHIC MACROINVERTEBRATES

SITE LOCATION ON FIGURE 12

Wanaque River Subbasin

N. Wanaque River Date: 9/3/80 Gear: Surber
Riverdale Rd. Bridge, Pompton Lakes

Crustacea	Amphipoda	Gammaridae	Gammarus	23
Insecta	Diptera	Chironomidae(larvae)		35
Insecta	Diptera	Chironomidae(pupae)		2
Insecta	Diptera	Tipulidae	Antocha(larvae)	3
Insecta	Ephemeroptera	Heptageniidae	Stenema	1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	18
Insecta	Trichoptera	Leptoceridae(pupae)		2
Gastropoda	Mesogastropoda	Hydrobidae	Amnicola	1
Gastropoda	Basommatophora	Planorbidae	Gyraulus	1
Adenophorea	Enoplida	Mesmithidae	Neomesomermis	1
Oligochaeta	Lumbriculida	Lumbriculidae		10
Pelecypoda	Heterondonta	Sphaeriidae	Musculium	2
Hirudinea	Rhychobellida	Glossiphonidae	Helobdella	2

O. Ramapo River Date: 9/17/80 Gear: Surber
Below Hamburg Tpk. Br.

CLASS	ORDER	FAMILY	GENUS	NOS.
Crustacea	Amphipoda	Gammaridae	Gammarus	19
Crustacea	Isopoda	Asellidae	Asellus	1
Gastropoda	Basommatophora	Planorbidae	Helisoma	2
Gastropoda	Mesogastropoda	Hydrabiidae	Amnicola	12
Gastropoda	Basommatophora	Planorbidae	Gyraulus	7
Gastropoda	Mesogastropoda	Pleuroceridae	Pleurocera	18
Gastropoda	Mesogastropoda	Vivibaridae	Campeloma	
Hirudinea	Rhynchobdellida	Glossiphonidae	[illegible]bdella	1
Insecta	Coleoptera	Dryopidae	[illegible]rochus(larvae)	2
Insecta	Coleoptera	Psephenidae	Psephenus	1
Insecta	Diptera	Chironomidae(larvae)		6
Insecta	Diptera	Chironomidae(pupae)		3
Insecta	Ephemeroptera	Heptageniidae	Stenonema	1
Insecta	Odoonata	Coenagridae		2
Insecta	Trichoptera	Hydroptilidae	Leucotrichia	2
Insecta	Trichoptera	Hydroptilidae	Oxyethira	1
Oligochaeta	Lumbriculida	Lumbriculidae		20
Oligochaeta	Lumbriculida	Lumbriculidae		
Turbellaria	Tricladida	Planariidae	Dugesia	10

TABLE 14 - (5 of 5)
Sampling Sites Locations for the Aquatic Inventory of Invertebrates and Fishes in the Central Basin

Site Location on Fig. 12	Sample Stream	Sampling Sites	Municipality	County
A.	Passaic River	From Elmwood Park Marina to I-80 Bridge (Table 10)	Elmwood Park	Bergen
B.	Passaic River	600 yards downstream of the Lackawanna Ave. Bridge (Table 10)	Paterson	Passaic
C.	Molly Ann's Brook	Upstream of the Union Ave. Bridge (Table 10)	Paterson	Passaic
D.	Passaic River	Rt. 10 Bridge (Table 12)	E. Hanover/ Livingston	Morris/ Essex
E.	Passaic River	Rt. 80 to Rt. 46 Pine Brook (Table 12)	Montville/ Fairfield	Morris/ Essex
F.	Passaic River	200 yards upstream of Two Br. (Table 12)	Lincoln Pk/ Fairfield	Morris/ Essex
G.	Rockaway River	Knoll Road Bridge (Table 13)	Montville	Morris
H.	Rockaway River	Bridge on Vail Road, Lake Hiawatha (Table 13)	Montville/Par-Troy	Morris
I.	Black Brook, Tributary of Whippany River	50 yards downstream of Rt. 510 Bridge (Table 14)	Florham Pk/Hanover	Morris
J.	Whippany River	Troy Road Bridge (Table 14)	East Hanover	Morris
K.	Pompton River	100 yards below Jackson Ave. Bridge (Table 15)	Pequannock/Wayne	Morris/ Passaic
L.	Pompton River	At 202, Alt. Rt. 511 Bridge, View (Table 15)	Lincoln Park/Wayne	Morris/ Passaic
M.	Pequannock River	100 yards upstream of Riverdale Rd. Bridge (Table 16)	Riverdale/ Pompton Lks	Morris/ Passaic
N.	Wanaque River	100 yards upstream of Riverdale Rd. Bridge (Table 16)	Pompton Lks	Passaic
O.	Ramapo River	100 yards downstream of Hamburg Tpk. Bridge (Table 17)	Pompton Lks/ Wayne	Passaic
P.	Deepavaal Brook, Tributary of Passaic River	Upstream of New Dutch Lane Bridge (No fin fish were collected.)	Fairfield	Essex

TABLE 15 (Page 1 of 2)

REACH 1 MOUTH TO DUNDEE DAM
ADULT AND JUVENILE ANADROMOUS FISH SPECIES COMPOSITION

SPRING SAMPLING
MARCH - JUNE 1981

SAMPLING LOCATION	ALEWIFE		BLUEBACK HERRING		AMERICAN SHAD		WHITE PERCH		STRIPED BASS	
	ADULT	JUV	ADULT	JUV	ADULT	JUV	ADULT	JUV	ADULT	JUV
Kearny Pt., southern tip	1						2			3
Passaic River mouth, Conrail Br.	1						2	1		1
Pulaski Skyway										
NJ Turnpike										
Kearny, Conrail Br.	1									
Second River, mouth	2		1				4			
Third River, mouth	9		2	2			1	6		
Rutherford, Union Ave. Br.	3						1			
Wallington, Eighth St. Br.								4		
Saddle River, mouth							6	2		1
Garfield, Passaic St.			1							
Dundee Dam	10	22	4							3
Totals	27	22	8	2	0	0	16	13	0	8

Additional data are in the Natural Resources Appendix B, Table B-17, B-18, B-19, and B-20.

See Figure 13 for locations.

TABLE 15 (Page 2 of 2)

REACH 1 MOUTH TO DUNDEE DAM
ADULT AND JUVENILE ANADROMOUS FISH SPECIES COMPOSITION

LATE SUMMER SAMPLE
AUGUST - SEPTEMBER 1981

SAMPLING LOCATION	ALEWIFE		BLUEBACK HERRING		AMERICAN SHAD		WHITE PERCH		STRIPED BASS	
	ADULT	JUV	ADULT	JUV	ADULT	JUV	ADULT	JUV	ADULT	JUV
Second River, mouth						1				
N. Arlington, Riverside Pk.				22		33				
Third River, mouth				2		75				
Garfield, Passaic St. Bridge	1	14		32		1		1		2
Dundee Dam										
Totals	1	14	0	56	0	110	0	1	0	2

Numbers of fish listed under "adult" classification are those demonstrated to possess mature gonads. Numbers of fish listed under "juvenile" classification include young-of-the-year, yearling, and larger fish with immature gonads. Also included in this category are fish for which no state of maturity was recorded, and fish damaged during sampling.

Additional data on juvenile anadromous fish are in the Natural Resources Appendix, Table B-21.

See Figure 13 for locations.

TABLE 16 (Page 1 of 2)

ANADROMOUS FISH STUDY-LIST OF FISHES
COLLECTED IN THE PASSAIC RIVER AND TRIBUTARIES

COMMON NAME		SCIENTIFIC NAME
I.	Freshwater eel family	Anguillidae
	American eel	Anguilla rostrata
II.	Herring family	Clupeidae
	Alewife	Alosa pseudoharengus
III.	Salmon family	Salmonidae
	Brown trout	Salmo trutta
IV.	Mudminnow family	Umbridae
	Eastern mudminnow	Umbra pygmaea
V.	Pike family	Esocidae
	Redfin pickerel	Esox americanus americanus
	Eastern chain pickerel	Esox niger
VI.	Minnow family	Cyprinidae
	Goldfish	Carassius auratus
	Carp	Cyprinus carpio
	Cutlips minnow	Exoglossum maxillingua
	Silvery minnow	Hybognathus nuchalis
	Golden shiner	Notemigonus crysoleucas
	Satinfin shiner	Notropis analostanus
	Common shiner	Notropis cornutus
	Spottail shiner	Notropis hudsonius
	Blacknose dace	Rhinichthys atratulus
	Longnose dace	Rhinichthys cataractae
	Creek chub	Semotilus atromaculatus
	Fallfish	Semotilus corporalis
VII.	Sucker family	Catastomidae
	White sucker	Catostomus commersoni
	Creek chubsucker	Erimyzon oblongus

TABLE 16 (Page 2 of 2)

ANADROMOUS FISH STUDY-LIST OF FISHES
COLLECTED IN THE PASSAIC RIVER AND TRIBUTARIES

COMMON NAME	SCIENTIFIC NAME
VIII. Catfish family	Ictaluridae
White catfish	*Ictalurus catus*
Yellow bullhead	*Ictalurus natalis*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Margined madtom	*Noturus insignis*
IX. Killifish family	Cyprinodontidae
Banded killifish	*Fundulus diaphanus*
Mummichog	*Fundulus heteroclitus*
X. Temperate bass family	Percichthyidae
White perch	*Morone americana*
XI. Sunfish family	Centrarchidae
Rock bass	*Ambloplites rupestris*
Bluespotted sunfish	*Enneacanthus gloriosus*
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
XII. Perch family	Percidae
Tesselated darter	*Etheostoma olmstedi*
Yellow perch	*Perca flavescens*

TABLE 17

FISH SPECIES COMPOSITION BY NUMBERS

Lower Passaic River
below Second River
Reach 1

COMMON NAME	SITE[1] P
American eel	7
Blueback herring[2]	27
Alewife[2]	431
American shad[3]	5
Gizzard shad	rare
Bay anchovy	11
Rainbow smelt	1
Goldfish	1
Carp	6
White sucker	rare
Brown bullhead	rare
Silver hake	1
Atlantic tomcod	33
Red hake	rare
Mummichog	8761
Tidewater silverside	4
Atlantic silverside	rare
Threespine stickleback	rare
Northern pipefish	1
White perch	11
Striped bass[2]	1
Pumpkinseed	1
Bluegill	3
Largemouth bass	6
Black crappie	rare
Spot	rare
Total	9311

[1]This area is in the vicinity of the NJ Turnpike Bridge and was sampled by a private consulting firm. Fishes collected using trawl and seine only.
[2]Adults and juveniles.
[3]Juveniles.

TABLE 18 - FISH SPECIES COMPOSITION BY NUMBERS

Lower Passaic River and Tributaries Freshwater
Reach 2 - Dundee Dam to Beatties Dam

COMMON NAME	SITE* A	B	C
American eel	1	12	2
Alewife			
Brown trout			
Eastern mudminnow			
Redfin pickerel			
Eastern chain pickerel			
Goldfish		15	30
Carp	130	18	
Cutlips minnow			
Silvery minnow			
Golden shiner	13		
Satinfin shiner		5	
Common shiner			
Spottail shiner		17	3
Blacknose dace			1
Longnose dace			
Creek chub			8
Fallfish			
White sucker	20	13	15
Creek chubsucker			
White catfish			
Yellow bullhead			
Brown bullhead			4
Channel catfish			
Margined madtom			
Banded killifish	1	1	14
Mummichog			12
White perch			
Rock bass			
Bluespotted sunfish			
Redbreast sunfish			
Pumpkinseed	10		1
Bluegill			
Smallmouth bass			
Largemouth bass	3		
Black crappie			
Tesselated darter			1
No. individuals	178	81	91
No. species	7	7	11

*Site Code

A - Passaic River Route 80 Bridge, Elmwood Park, Bergen County; electrofishing.
B - Lackawanna Avenue Bridge, Paterson, Passaic County; electrofishing.
C - Molly Ann's Brook 1000 feet upstream of confluence with the Passaic River Union Avenue Bridge, Paterson, Passaic County; Electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 2 is in Appendix B, Natural Resources.

TABLE 19 - FISH SPECIES COMPOSITION BY NUMBERS

Reach 4 - Pompton River

COMMON NAME	SITE* K	SITE* L
American eel		
Alewife		
Brown trout		
Eastern mudminnow		
Redfin pickerel		1
Eastern chain pickerel		
Goldfish		
Carp		1
Cutlips minnow		
Silvery minnow		
Golden shiner		
Satinfin shiner		
Common shiner		
Spottail shiner	2	42
Blacknose dace		
Longnose dace		
Creek chub		
Fallfish		
White sucker		2
Creek chubsucker		
White catfish		
Yellow bullhead		
Brown bullhead	2	
Channel catfish		
Margined madtom		
Banded killifish		
Mummichog		
White perch		
Rock bass		
Bluespotted sunfish		
Redbreast sunfish	21	7
Pumpkinseed	3	28
Bluegill		12
Smallmouth bass		
Largemouth bass		3
Black crappie		4
Tesselated darter	3	
Yellow perch		
No. individuals	31	100
No. species	5	9

*Site code

K - Pompton River-Jackson Avenue Bridge, Pompton Plains, Morris County; electrofishing.
L - Pompton River-Route 202, Route 511 Bridge, Mountain View, Wayne, Passaic County, electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 5 is in Appendix B, Natural Resources.

TABLE 20 - FISH SPECIES COMPOSITION BY NUMBERS

Reach 4 - Pequannock and Wanaque Rivers

COMMON NAME	SITE* M	SITE* N
American eel		3
Alewife		
Brown trout		4
Eastern mudminnow		
Redfin pickerel		1
Eastern chain pickerel		
Goldfish		
Carp		
Cutlips minnow	2	15
Silvery minnow		
Golden shiner		
Satinfin shiner	2	6
Common shiner	1	29
Spottail shiner	62	15
Blacknose dace	3	2
Longnose dace		
Creek chub	18	3
Fallfish	6	16
White sucker	142	51
Creek chubsucker	1	
White catfish		
Yellow bullhead	1	2
Brown bullhead		
Channel catfish		
Margined madtom		
Banded killifish		
Mummichog		
White perch		
Rock bass		2
Bluespotted sunfish		
Redbreast sunfish	10	10
Pumpkinseed	12	1
Bluegill		
Smallmouth bass		1
Largemouth bass		
Black crappie		
Tesselated darter	2	5
Yellow perch		
No. individuals	262	166
No. species	13	17

*Site code

M - Pequannock River north of Riverdale Rd. Bridge, Pompton Lakes, Passaic County; electrofishing.
N - Wanaque River north of Riverdale Rd. Bridge, Pompton Lakes Passaic County; electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 4 is in Appendix B, Natural Resources.

TABLE 21
FISH SPECIES COMPOSITION BY NUMBERS
Reach 4 - Ramapo River

COMMON NAME	SITE* O
American eel	
Alewife	
Brown trout	
Eastern mudminnow	
Redfin pickerel	
Eastern chain pickerel	
Goldfish	
Carp	
Cutlips minnow	
Silvery minnow	
Golden shiner	
Satinfin shiner	
Common shiner	
Spottail shiner	
Blacknose dace	
Longnose dace	
Creek chub	
Fallfish	1
White sucker	29
Creek chubsucker	
White catfish	
Yellow bullhead	
Brown bullhead	
Channel catfish	
Margined madtom	
Banded killifish	
Mummichog	
White perch	
Rock bass	2
Bluespotted sunfish	
Redbreast sunfish	4
Pumpkinseed	14
Bluegill	17
Smallmouth bass	22
Largemouth bass	5
Black crappie	
Tesselated darter	1
Yellow perch	
No. individuals	95
No. species	9

*Site code

O - Ramapo River-Hamburg Turnpike Bridge, Pompton Lakes, Passaic County; electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 4 is in Appendix B, Natural Resources.

TABLE 22 - FISH SPECIES COMPOSITION BY NUMBERS

Reach 5 - Rockaway River

COMMON NAME	SITE* G	SITE* H
American eel		
Alewife		
Brown trout		
Eastern mudminnow		
Redfin pickerel	3	1
Eastern chain pickerel	1	
Goldfish		1
Carp		15
Cutlips minnow		
Silvery minnow		
Golden shiner		6
Satinfin shiner		2
Common shiner		
Spottail shiner	38	117
Blacknose dace		
Longnose dace		
Creek chub	40	2
Fallfish		
White sucker	197	105
Creek chubsucker		
White catfish		
Yellow bullhead		
Brown bullhead	1	
Channel catfish		
Margined madtom		
Banded killifish		
Mummichog		
White perch		3
Rock bass		
Bluespotted sunfish		
Redbreast sunfish		
Pumpkinseed	2	6
Bluegill		3
Smallmouth bass		
Largemouth bass		1
Black crappie		6
Tesselated darter	4	9
Yellow perch	1	
No. individuals	287	277
No. species	9	14

*Site code

G - Rockaway River-Knoll Road Bridge, Montville, Morris County; electrofishing.
H - Rockaway River-Vail Road Bridge, Lake Hiawatha, Morris County; electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 5 is in Appendix B, Natural Resources.

TABLE 23 - FISH SPECIES COMPOSITION BY NUMBERS

Reach 5 - Whippany River and Black Brook

COMMON NAME	SITE* I	SITE* J
American eel		
Alewife		
Brown trout		
Eastern mudminnow		
Redfin pickerel	3	6
Eastern chain pickerel		
Goldfish		
Carp	1	
Cutlips minnow		
Silvery minnow		
Golden shiner	8	15
Satinfin shiner	2	
Common shiner		
Spottail shiner	10	
Blacknose dace		
Longnose dace		
Creek chub		
Fallfish		
White sucker	14	
Creek chubsucker		
White catfish		
Yellow bullhead	4	1
Brown bullhead		
Channel catfish		
Margined madtom		
Banded killifish		
Mummichog		
White perch		
Rock bass		
Bluespotted sunfish		
Redbreast sunfish	7	
Pumpkinseed	6	10
Bluegill	1	1
Smallmouth bass		
Largemouth bass		3
Black crappie		
Tesselated darter	2	
Yellow perch		
No. individuals	58	36
No. species	11	6

*Site code

I - Whippany River Troy Road Bridge, East Hanover, Morris County; electrofishing.
J - Black Brook, Route 510 Bridge, Florham Park; Morris County.

See Figure 12 for locations. Additional information on fish in Reach 5 is in Appendix B, Natural Resources.

TABLE 24 - FISH SPECIES COMPOSITION BY NUMBERS

Passaic River and Tributaries
Reach 5 - Two Bridges to Chatham

COMMON NAME	SITE* D	E	F
American eel			
Alewife			
Brown trout			
Eastern mudminnow			
Redfin pickerel			
Eastern chain pickerel			
Goldfish	4	1	
Carp	26	31	44
Cutlips minnow			
Silvery minnow	3		
Golden shiner	4	60	7
Satinfin shiner			
Common shiner			
Spottail shiner	4	4	2
Blacknose dace			1
Longnose dace			
Creek chub			
Fallfish			
White sucker			
Creek chubsucker			
White catfish			
Yellow bullhead			
Brown bullhead			
Channel catfish			
Margined madtom			
Banded killifish			
Mummichog			
White perch			
Rock bass			
Bluespotted sunfish			
Redbreast sunfish			
Pumpkinseed	40		
Bluegill			
Smallmouth bass			
Largemouth bass			
Black crappie	2		
Tesselated darter			
No. individuals	86	101	55
No. species	8	5	4

*Site code

D - Passaic River Route 10 Bridge, East Hanover. Morris County; electrofishing.
E - From Route 80 to Route 46, Pine Brook, Morris County; electrofishing.
F - Passaic River, upstream of Two Bridges, Morris County; electrofishing.

See Figure 12 for map and Table 14 for verbal locations. Additional information on fish in Reach 5 is in Appendix B, Natural Resources.

TABLE 25 (Page 1 of 11)

DUAL INLET PLAN

EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS {1}

	AQUATIC HABITAT	WETLAND (ACRES) HABITAT			
	(ACRES)	FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
REACH 1 MOUTH TO DUNDEE DAM					
Aquatic Habitat in Project Area	930	-	-	-	-
Wetland Habitat in Project Area	-	4	1	40	45
Effects of Levees (Without Mitigation) {2}					
Direct Effect - Loss	0	-1	-1	-8	-10
Direct Effect - Habitat Change	0	0	0	0	0
Indirect Effect - Loss	0	0	0	0	0
Indirect Effect - Habitat Change	0	0	0	0	0
Mitigation for Levee Effects	0	+1	+1	+8	+10{3}
Effects of Tunnel (Without Mitigation)					
Direct Effect - Habitat Change	-2	0	0	0	0
Mitigation For Tunnel Effects	+4	0	0	0	0
NET EFFECT OF PLAN - REACH 1	+2	0	0	0	0{4}
REACH 2 DUNDEE DAM TO BEATTIES DAM					
Aquatic Habitat in Project Area	325	-	-	-	-
Wetland Habitat in Project Area	-	30	10	0	40
Effect of Tunnel (Without Mitigation)					
Indirect Effect - Loss	0	-5	0	0	-5
Mitigation For Tunnel Effects	0	+5{5}	0	0	+5{3}
NET EFFECT - REACH 2	0	0	0	0	0{4}
REACH 3 BEATTIES DAM TO TWO BRIDGES					
Aquatic Habitat in Project Area	80	-	-	-	-
Wetland Habitat in Project Area	-	5	0	0	5
Effect of Tunnel Inlet Structure (Without Mitigation)					
Direct Effect - Loss	0	-5	0	0	-5
Mitigation For Tunnel Inlet Structure	0	+5{5}	0	0	+5{3}

DUAL INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC HABITAT	WETLAND (ACRES) HABITAT			
	(ACRES)	FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
Effects of Channel Modifications {6} (Without Mitigation)					
Direct Effect - Habitat Change	-20	-	-	-	-
Mitigation For Channel Modification/ Effects	+20	-	-	-	-
NET EFFECTS OF CHANNEL MODIFICATION REACH 3	0{4}	-	-	-	-
NET EFFECT - REACH 3	0	0	0	0	0{4}
REACH 4 POMPTON VALLEY					
Aquatic Habitat in Project Area	40	-	-	-	-
Wetland Habitat in Project Area	-	1260	220	200	1680
Effects of Levees (Without Mitigation)					
Direct Effect - Loss	0	-20	0	0	-20
Mitigation For Levee Effects	0	+20{5}	0	0	+20
NET EFFECTS OF LEVEES - REACH 4	0	0	0	0	0{4}
Effects of Ponding Areas (Without Mitigation)					
Direct Effect - Loss	0	-30	0	0	-30
Wetland Planting For Ponding Areas	0	0	0	+30	+30
NET EFFECT OF PONDING AREAS - REACH 4	0	-30	0	+30	0{4}
Effects of Channel Modifications - Sideslopes, and Tunnel Works (Without Mitigation)					
Pequannock, Ramapo and Wanaque Rivers					
Direct Effect - Loss	0	-40	0	0	-40
Direct Effect - Habitat Change	-25	0	0	0	0
Mitigation For Channel Modifications Effects	+25	0	0	+40	+40{7}
NET EFFECTS OF CHANNEL MODIFICATION - REACH 4	0{4}	-40	0	+40	0{4}
Effects of Tunnel and Channel Modifications (including Engineering and Environmental Design) on Flow Regime {8}					
Direct Effect - Habitat Change	0	-90	+90	0	0{9}

DUAL INLET PLAN

(1)
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC HABITAT	WETLAND (ACRES) HABITAT			
	(ACRES)	FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
NET EFFECT OF TUNNEL AND CHANNEL MODIFICATION ON FLOW REGIME - REACH 4	0	-90	+90	0	0(4)
NET EFFECT TOTAL - REACH 4	0	-160	+90	+70	0(4)
REACH 5 TWO BRIDGES UPSTREAM ON THE PASSAIC RIVER					
Aquatic Habitat in Project Area	50	-	-	-	-
Wetland Habitat in Project Area	-	6935	1310	3075	11320
Effects of Levees (Without Mitigation)					
Direct Effect - Loss	0	-30	-10	-5	-45
Mitigation For Levee Effects	0	+30(5)	+10	+5	+45
NET EFFECT OF LEVEES - REACH 5	0	0	0	0	0(4)
Effects of Ponding Areas (Without Mitigation)					
Direct Effect - Loss	0	-480	0	-80	-560
Wetland Planting For Ponding Effects	0	0	0	+560	+560
NET EFFECT OF PONDING AREAS - REACH 5	0	-480	0	+480	0(4)
NET EFFECT OF CHANNEL MODIFICATIONS - REACH 5	0(4)	-	-	-	-
Effects of Tunnel (including Engineering and Enviornmental Design) on Flow Regime (10)					
Direct Effect - Loss	0	-85	-15	0	-100
Mitigation Tunnel Effects	0	+85(5)	+15	0	+100
NET EFFECT OF TUNNEL - REACH 5	0	0	0	0	0(4)
NET EFFECT OF TOTAL - REACH 5	0	-480	0	+480	0(4)
NET EFFECT TOTAL PROJECT	+2	-640	+90	+550	0(4)

DUAL INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

{1} Direct effects include modifications and losses resulting from construction of project components such as tunnel inlets, levees and floodwalls and excavation of ponding areas. Indirect effects include modifications and losses resulting from changes in the flow regime (i.e. changes to flood elevations and durations). Secondary effects (i.e. encroachment of development of natural areas) will not occur as a result of project in Reaches 1-3 since virtually all areas are developed, or dedicated parkland. In Reaches 4 and 5, floodways contiguous to acquisition areas will be maintained according to the New Jersey State - Corps agreement in Items of Local Cooperation.

{2} The categories (eg. Direct Effect - Loss, etc.) are fully arrayed only once, in subsequent iterations only the pertinent category(s) are displayed.

{3} Mitigation would be carried out in Reach 4 and 5, on project (acquisition) lands.

{4} The Net Effect (eg. 0) does not necessarily imply full compensation, (eg. in kind, in place) but rather the maximum mitigation attainable with the plan as proposed.

{5} Areas of replacement (forested cover type wetland) would succeed to this cover type with time.

{6} The 20 acres include portions of Reaches 3, 4 and 5.

{7} This forty acres of emergent wetland is being created in Reach 4 ponding areas, which at present are not wetlands.

{8} Engineering and Environmental Design Features in Reach 4 include the 1 year bypass rule, and operation of the Pequannock Weir in conjunction with the retainage of the existing U.S.G.S. Weir to maintain existing water surface and groundwater levels upstream of the Pompton Inlet.

{9} The plan as currently developed calls for the removal of trees to prevent damage to structural elements of the project. The Pequannock Weir would maintain water surface elevations, therefore, wetland would remain, but would change from forested to scrub-shrub.

{10} Engineering and Environmental Design Features in Reach 5 include the 1 year bypass rule, and operation of the Great Piece Meadows Weir.

SINGLE INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	WETLAND (ACRES) FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
REACH 1 MOUTH TO DUNDEE DAM					
Aquatic Habitat in Project Area	930	-	-	-	-
Wetland Habitat in Project Area	-	4	1	40	45
Effects of Levees (Without Mitigation) {2}					
Direct Effect - Loss	0	-1	-1	-8	-10
Direct Effect - Habitat Change	0	0	0	0	0
Indirect Effect Loss	0	0	0	0	0
Indirect Effect Habitat Change	0	0	0	0	0
Mitigation For Levee Effects	0	+1	+1	+8	+10{3}
Effects of Tunnel (Without Mitigation)					
Direct Effect - Habitat Change	-2	0	0	0	0
Mitigation For Levee-Tunnel Effects	+4	0	0	0	0
NET EFFECT OF PLAN - REACH 1	+2	0	0	0	0{4}
REACH 2 DUNDEE DAM TO BEATTIES DAM					
Aquatic Habitat in Project Area	325	-	-	-	-
Wetland Habitat in Project Area	-	30	10	0	40
Effects of Tunnel of Water Surface Elevation Change (Without Mitigation					
Indirect Effect - Habitat Change	0	-5	0	0	-5
Mitigation For Tunnel Effect	0	+5 {3}{5}	0	0	+5
NET EFFECT OF PLAN - REACH 2	0	0	0	0	0{4}
REACH 3 BEATTIES DAM TO TWO BRIDGES					
Aquatic Habitat in Project Area	80	-	-	-	-
Wetland Habitat in Project Area	-	5	0	0	5
Effects of Tunnel Inlet Structure (Without Mitigation)					
Direct Effect - Loss	0	-5	0	0	-5
Mitigation For Tunnel Inlet Structure	0	+5 {3}{5}	0	0	+5

SINGLE INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	WETLAND (ACRES)			
		FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
NET EFFECT OF PLAN - REACH 3	0	0	0	0	0{4}
Effects of Channel Modifications {6} (Without Mitigation)					
Direct Effect - Habitat Change	-55	-	-	-	-
Mitigation for Channel Modification/ Effects	+55	-	-	-	-
NET EFFECTS OF CHANNEL MODIFICATION REACH 3	0{4}	-	-	-	-
NET EFFECT OF PLAN - REACH 3	0	0	0	0	0{4}
REACH 4 POMPTON VALLEY					
Aquatic Habitat in Project Area	120	-	-	-	120
Wetland Habitat in Project Area	-	1260	220	200	1680
Effects of Levees (Without Mitigation)					
Direct Effect - Loss	0	-20	0	0	-20
Mitigation For Levee Effects	0	+20	0	0	+20
NET EFFECT OF LEVEES - REACH 4	0	0	0	0	0{4}
Effects of Ponding (Without Mitigation)					
Direct Effect - Loss	0	-30	0	0	-30
Mitigation For Ponding Effect	0	0	0	+30	+30
NET EFFECTS OF PONDING AREA - REACH 4	0	-30	0	+30	0{4}
Effects of Channel Modification - Sideslopes, etc. (Without Mitigation) Pequannock, Ramapo, Wanaque and Pompton Rivers					
Direct Effect - Loss		-80	0	0	-80
Direct Effect - Habitat Change	-120	0	0	0	0
Mitigation For Channel Modification	+120	0	+40	+40{7}	+80
NET EFFECTS OF CHANNEL MODIFICATIONS - REACH 4	0	-80	+40	+40	0{4}

SINGLE INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	WETLAND (ACRES)			
		FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
REACH 4					
Effects of Tunnel and Channel Modifications on Flow Regime {8}					
Direct Effect - Habitat Change	0	-90{9}	+90	0	0
NET EFFECT OF TUNNEL AND CHANNEL MODIFICIATION ON FLOW REGIME - REACH 4	0	-90	+90	0	0{4}
REACH 5 TWO BRIDGES UPSTREAM ON THE PASSAIC RIVER					
Aquatic Habitat in Project Area	50	-	-	-	-
Wetland Habitat in Project Area	-	6935	1310	3075	11320
Effects of Levees (Without Mitigation) Direct Effect - Loss	0	-30	-10	-5	-45
Mitigation For Levee Effects					
Levee Effects With Mitigation	0	+30{5}	+10	+5	+45
NET EFFECT OF LEVEES - REACH 5	0	0	0	0	0{4}
Effects of Ponding Areas (Without Mitigation) Direct Effect - Loss	0	-480	0	-80	-560
Mitigation For Ponding Effects	0	0	0	+560	+560
NET EFFECT OF PONDING AREAS - REACH 5	0	-480	0	+480	0{4}
NET EFFECT OF TUNNEL DOWNSTREAM - REACH 5	0{4}	-	-	-	-
Effects of Tunnel Downstream of Weir (Without Mitigation)					
Direct Effect - Loss	0	-85	-15	0	-100
Direct Effect - Habitat Change		-	-	-	-
Effects of Tunnel Downstream of Weir {10}					
Direct Effect - Loss	0	+85{5}	+15	0	+100
Direct Effect - Habitat Change		-	-	-	-
NET EFFECT OF TUNNEL DOWNSTREAM OF WEIR - REACH 5	0	0	0	0	0{4}
NET EFFECT - TOTAL PROJECT	+2	-700	+130	+570	0{4}

SINGLE INLET PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

FOOTNOTES:

{1} Direct effects include modifications and losses resulting from construction of project components such as tunnel inlets, levees and floodwalls and excavation of ponding areas. Indirect effects include modifications and losses resulting from changes in the flow regime (i.e. changes to flood elevations and durations). Secondary effects (i.e. encroachment of development of natural areas) will not occur as a result of project in Reaches 1-3 since virtually all areas are developed, or dedicated parkland. In Reaches 4 and 5, floodways contiguous to acquisition areas will be maintained according to the New Jersey State - Corps agreement in Items of Local Cooperation.

{2} The categories (eg. Direct Effect - Loss, etc.) are fully arrayed only once, in subsequent iterations only the pertinent category(s) are displayed.

{3} Mitigation would be carried out in Reach 4 and 5, on project (acquisition) lands.

{4} The Net Effect (eg. 0) does not necessarily imply full compensation (eg. in kind, in place), but rather the maximum mitigation attainable with the plan as proposed.

{5} Areas of replacement (forested cover type wetland) would succeed to this cover type with time.

{6} The 20 acres include portions of Reaches 3, 4 and 5.

{7} This forty acres of emergent wetland is being created in Reach 4 ponding areas. which at present are not wetlands.

{8} Engineering and Environmental Design Features in Reach 4 include the 1 year bypass rule, and operation of the Pequannock Weir in conjunction with the retainage of the existing U.S.G.S. Weir to maintain existing water surface and groundwater levels upstream of the Pompton Inlet.

{9} The plan as currently developed calls for the removal of trees to prevent damage to structural elements of the project. The Pequannock Weir would maintain water surface elevations, therefore, wetland would remain, but would change from forested to scrub-shrub.

{10} Engineering and Environmental Design Features in Reach 5 include the 1 year bypass rule, and operation of the Great Piece Meadows Weir.

TABLE 25 (Page 9 of 11)

LEVEE/FLOODWALL/NONSTRUCTURAL/CHANNEL MODIFICATION PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	WETLAND (ACRES)			
		FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
REACH 1 MOUTH TO DUNDEE DAM					
Aquatic Habitat in Project Area	930	-	-	-	-
Wetland Habitat in Project Area	-	4	1	40	45
Effects of Levees (Without Mitigation){2}					
Direct Effect - Loss	0	-1	-1	-4	-6
Direct Effect - Habitat Change	0	0	0	0	0
Indirect Effect Loss	0	0	0	0	0
Indirect Effect Habitat Change	0	0	0	0	0
Mitigation For Levee Effects	0	+1	+1	+4	+6{3}
NET EFFECT OF PLAN - REACH 1	0	0	0	0	0{4}
Effects of Channel Modification (Without Mitigation)					
Direct Effect - Habitat Change	-84	-	-	-	0
Mitigation For Channel Modification	+21	0	0	0	0
NET EFFECT OF PLAN - REACH 1	-63	0	0	0	0
REACH 2 DUNDEE DAM TO BEATTIES DAM					
Aquatic Habitat in Project Area	325	-	-	-	-
Wetland Habitat in Project Area	-	30	10	0	40
Effects of Channel Modification (Without Mitigation) Direct Effect - Habitat Change	-325	-30	-10	0	-40
Mitigation For Channel Modification	+80	+30{5}	0	0	+30{3}
NET EFFECT OF PLAN - REACH 2	-245	0	-10	0	-10{4}

TABLE 25 (Page 10 of 11)

LEVEE/FLOODWALL/NONSTRUCTURAL/CHANNEL MODIFICATION PLAN

(1)
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	WETLAND (ACRES)			
		FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
REACH 3 BEATTIES DAM TO TWO BRIDGES					
Aquatic Habitat in Project Area	80	-	-	-	-
Wetland Habitat in Project Area	-	5	0	0	5
Effects of Structure Buyout Without Mitigation					
Direct Effect -	0	0	0	0	0
Mitigation Applied to Nonstructural Plan					
For Ponding Areas	0	0	0	+5	+5
NET EFFECT OF STRUCTURE BUYOUT - REACH 4	0	0	0	+5	+5
REACH 4 POMPTON VALLEY					
Aquatic Habitat in Project Area	40	-	-	-	-
Wetland Habitat in Project Area	-	1260	220	200	1680
Effects of Nonstructural Plan (Without Mitigation)	0	0	0	0	0
Mitigation Applied to Nonstructural Plan					
For Ponding Areas	0	0	0	+10	+10
NET EFFECT OF NONSTRUCTURAL PLAN - REACH 4	0	0	0	+10	+10
REACH 5 TWO BRIDGES UPSTREAM ON THE PASSAIC RIVER					
Aquatic Habitat in Project Area	50	-	-	-	60
Wetland Habitat in Project Area	-	6935	1310	3075	11320
Effects of Levees (Without Mitigation)					
Direct Effect - Loss	0	-20	-5	-5	-30
Mitgiation For Levee Effects	0	+20(5)	0	+5	+25
NET EFFECT OF LEVEES - REACH 5	0	0	-5	0	-5(4)

TABLE 25 (Page 11 of 11)

LEVEE/FLOODWALL/NONSTRUCTURAL/CHANNEL MODIFICATION PLAN

{1}
EFFECTS OF STAGE III PLANS ON AQUATIC AND WETLAND AREAS, AND MITIGATION, AND OTHER TECHNIQUES TO OFFSET EFFECTS

	AQUATIC (ACRES)	(WETLAND ACRES) FORESTED	SCRUB-SHRUB	EMERGENT	TOTAL
Effects of Ponds (Without Mitigation)					
Direct Effect - Loss	0	-164	-10	0	-174
Mitigation For Pond Effects	0	0	0	+174	+174
NET EFFECT OF PONDING AREAS - REACH 5	0	-164	-10	+174	0{4}
NET EFFECT - TOTAL PROJECT	-308	-164	-25	+189	0{4}

FOOTNOTES:

{1} Direct effects include modifications and losses resulting from construction of project components such as tunnel inlets, levees and floodwalls and excavation of ponding areas. Indirect effects include modifications and losses resulting from changes in the flow regime (i.e. changes to flood elevations and durations). Secondary effects (i.e. encroachment of development of natural areas) will not occur as a result of project in Reaches 1-3 since virtually all areas are developed, or dedicated parkland. In Reaches 4 and 5, floodways contiguous to acquisition areas will be maintained according to the New Jersey State - Corps agreement in Items of Local Cooperation.

{2} The categories (eg. Direct Effect - Loss, etc.) are fully arrayed only once, in subsequent iterations only the pertinent category(s) are displayed.

{3} Mitigation would be carried out in Reach 4 and 5, on project (acquisition) lands.

{4} The Net Effect (eg. 0) does not necessarily imply full compensation (eg. in kind, in place), but rather the maximum mitigation attainable with the plan as proposed.

{5} Areas of replacement (forested cover type wetland) would succeed to this cover type with time.

TABLE 26

COVER TYPE COMPOSITION OF TEN PASSAIC RIVER BASIN WETLANDS BY ACREAGE AND PERCENT

WETLAND NAME	ACRES/ /PERCENT	VEGETATION CLASS BY APPROXIMATE ACREAGE AND PERCENTAGE[a] PFO1-A	PFO1-B	PFO1-C	PFO1-D	PSS-1	PEM-1	PEM-6
Black Meadows	1300/ /100	-/ /b	468/ /36	13/ /1	-/ /b	169/ /13	104/ /8	546/ /42
Bog and Vly Meadows	650/ /100	-/ /-	312/ /48	-/ /b	78/ /12	84/ /13	91/ /14	85/ /13
Great Piece Meadow	4005/ /100	-/ /-	2804/ /70	81/ /2	200/ /5	400/ /10	120/ /3	400/ /10
Hatfield Swamp	1775/ /100	89/ /5	1172/ /66	-/ /-	17/ /1	89/ /5	408/ /23	-/ /-
Long Meadows	200/ /100	-/ /-	120/ /60	-/ /-	-/ /b	80/ /40	-/ /b	-/ /b
Troy Meadow	2390/ /100	-/ /-	526/ /22	72/ /3	96/ /4	359/ /15	-/ /-	1337/ /56

OTHER WETLANDS	ACRES/ /PERCENT	PFO-1	PSS-1	PEM
Canoe Brook	1245/ /100	915/ /73	225/ /18	105/ /9
Hatfield South	605/ /100	480/ /79	70/ /12	55/ /9
Lower Pompton	815/ /100	690/ /85	100/ /12	25/ /3
Pequannock Ramapo	215/ /100	180/ /84	35/ /16	-/ /-

a) Adaptation of Fish and Wildlife Service's Wetland Classification System.

PFO1 - A Palustrine Forested, Broad-leafed Deciduous
- B Mixed Forested
- C Stream and River Border Forest
- D Mixed Oak-Beach Border Forest

PSS - 1 Palustrine Scrub-Shrub

PEM - 1 Palustrine Emergent Persistent
- 6 Palustrine Emergent Broad-leafed Persistent

b) Acreage of this cover type less than 10 acres.
c) Approximately 350 acres are widely scattered and not included in this table.

TABLE 27

PARKS AFFECTED BY FLOOD CONTROL PLAN

REACH	COUNTY PARKS COUNTY	NAME	MUNICIPALITY	ACRES IN PARK	ACRES AFFECTED
1	Bergen	Riverside Park	N. Arlington		3.4
			Lyndhurst	109	8.3
5	Essex	W. Essex Park	Fairfield		0.0
			W. Caldwell		0.0
			Roseland	1303.1	0.0
			Livingston		3.8
4	Passaic	Pompton	Pompton Lks	75	1.7
4		Aquatic Park	Pequannock	50	0.3
	MUNICIPAL PARKS				
1	Bergen	Pocket Park	Lyndhurst	0.03	0.0
1	Bergen	Pocket Park	Lyndhurst	0.2	0.2
1	Bergen	Callegher/DeLog	Lyndhurst	4.45	0.0
1	Bergen	Pocket Park	Lyndhurst	0.24	0.24
1	Bergen	Daniel Morris Park	N. Arlington	0.7	0.3
1	Bergen	Memorial Park	Rutherford	25.45	1.9
1	Bergen	Van Winkle Park	Rutherford	0.63	0.15
1	Passaic	Pulaski Pk/Dundeels	Passaic Cty	20.69	2.0
1	Passaic	North Pulaski	Passaic Cty	2.66	0.1
4	Passaic	Wilderness Park	Pompton Lks	2.35	0.8
4	Passaic	Old Swimming Hole	Pompton Lks	10.64	
4	Passaic	Snodgrass	Pompton Lks	5.75	Total 0.85
4	Passaic	Hershfield Park	Pompton Lks	9.65	
4	Passaic	Veteran's Park	Pompton Lks	1.4	0.1
4	Passaic	P.L.Y.O. Field	Pompton Lks	7.8	0.2
4	Passaic	Stiles Park	Pompton Lks	0.55	0.4

SUMMARY

PARKLAND AFFECTED IN:	ACRES
REACH 1	16.59
REACH 2	-
REACH 3	-
REACH 4	4.35
REACH 5	3.8
TOTAL	24.74

TABLE 28

1980 DEVELOPED RECREATIONAL FACILITY NEEDS

	SWIMMING FRESHWATER	MOTOR BOATING AND BOAT FISHING FRESHWATER	HIKING	BICYCLING	PICNIC
Bergen	56,803	(+710)	36,154	247,659	(+1897)
Essex	59,329	193	40,337	248,882	41,667
Hudson	39,373	(+592)	28,899	164,089	1,788
Morris	(+57,001)	11,753	17,418	113,074	15,734
Passaic	49,940	8,242	22,024	132,918	4,838
Somerset	(+49,142)	(+2,765)	9,093	51,422	7,823
Sussex	(+181,743)	13,859	3,858	25,107	6,847
Union	21,822	493	22,802	151,723	1,403

NOTE: FACILITY DEFICITS OR (SURPLUSES) ARE EXPRESSED IN ACTIVITY DAYS AND REPRESENT THE EXTENT TO WHICH 1980 SUPPLY CAN MEET ESTIMATED 1980 PEAK DAY DEMAND.

2000 DEVELOPED RECREATIONAL FACILITY NEEDS

	SWIMMING FRESHWATER	MOTOR BOATING AND BOAT FISHING FRESHWATER	HIKING	BICYCLING	PICNIC
Bergen	83,552	(+247)	45,882	292,815	8,306
Essex	84,768	611	49,648	293,416	49,106
Hudson	55,437	(562)	34,764	193,205	2,416
Morris	(+44,052)	19,036	22,815	133,839	22,237
Passaic	57,869	11,340	27,419	155,990	6,975
Somerset	(+41,931)	(+2,577)	11,375	61,897	12,334
Sussex	(+178;839)	20,139	5,636	29,465	9,787
Union	37,854	647	28,413	178,714	2,697

NOTE: FACILITY DEFICITS OR (SURPLUSES) ARE EXPRESSED IN ACTIVITY DAYS AND REPRESENT THE EXTENT TO WHICH 2000 SUPPLY CAN MEET ESTIMATED 1980 PEAK DAY DEMAND.

THESE DATA WERE EXTRACTED FROM THE OUTDOOR RECREATION PLAN OF NEW JERSEY, 4TH EDITION, NOVEMBER, 1984.

TABLE 29 (Page 1 of 2)

DESCRIPTION AND COMPARISON OF DETAILED PLANS

DESCRIPTION OF REACH	REACH 1 - PASSAIC RIVER FROM MOUTH TO DUNDEE DAM	REACH 2 - PASSAIC RIVER FROM DUNDEE DAM TO BEATTIES DAM	REACH 3 - PASSAIC RIVER FROM BEATTIES DAM TO TWO BRIDGES CONFLUENCE	REACH 4 - POMPTON VALLEY POMPTON, RAMAPO, PEQUANNOCK, AND WANAQUE RIVERS	REACH 5 - PASSAIC RIVER TWO BRIDGES TO CHATHAM
EXISTING REACH SETTING	Both shorelines have generally been filled and developed. Extensive portions of the riverbank are bulkheaded, riprapped, and floodwalled. Some small tidal flats exist.	Same shoreline development as Reach 1. Scattered wetland remanants as riparian edge (40 acres). Great Falls historic district. About 15-20 acres of wetland exist near Little Falls.	Riparian corridors, both banks. Some lowlying wetlands and small, occasionally flooded islands.	About 215 acres of wetlands exist here, at the three rivers' confluences. Riparian vegetation exists along the Pompton. There are about 1,680 acres of wetlands in the entire Reach 4.	13,000 acres of wetland exist in the project area above Little Falls. These offer extensive wildlife habitat. The lower portions of the Rockaway and Whippany Rivers are in this reach.
DESCRIPTION OF RECOMMENDED PLAN Diversion tunnel with dual inlets; levees and floodwalls; preservation of natural storage areas; channel modifications.	11.2 miles of levees and 12.8 miles of floodwalls, an average of 9 ft. in height. Tunnel outlet located on right bank of Passaic just above the Third River.	No physical modifications.	Construction of a tunnel inlet downstream of Two Bridges, covering about 5 acres. Channel modifications for 1.1 mile up the Pompton and Passaic, widened an average of 15 ft. and deepened an average of 5 ft.	Construction of a tunnel inlet at the rivers' confluence, with a flow restrictor and diversion structure. A total of 3.5 miles of levees and 0.7 mile of floodwall. Channel modifications: Pequannock - 2.6 miles, deepened 7 ft., widened 35-60 ft. Ramapo - 1.2 miles, deepened 4 ft., widened 40 ft., Wanaque - 1 mile, deepened 6 ft., widened 35 ft. Movable weir above inlet to maintain 95 acres of wetland and 15 acres of aquatic habitat. Preservation of 660 acres of wetland as natural storage.	9.0 miles of set-back levees and 0.5 mile of floodwall. Preservation of natural storage areas, 4,200 acres of wetlands intact. Movable weir in Great Piece Meadows would preserve 1,000 acres of wetland.

DESCRIPTION AND COMPARISON OF DETAILED PLANS

	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5
DESCRIPTION OF SINGLE INLET PLAN Diversion Tunnel with single inlet upstream of Beatties Dam; levees and floodwalls; channel modifications; preservation of natural storage areas.	Same as Dual Inlet Plan.	No physical modifications.	Construction of an inlet in the Passaic 2,000 ft. above Beatties Dam. 3 miles of channel modifications, deepened an average of 15 ft. and widened an average of 70 ft.	Pequannock, Ramapo, and Wanaque Rivers would have deeper channels, higher levees than Dual Inlet Plan. Pompton River 6.8 miles of channel modifications Sixty one structures along Pompton permanently evacuated. Preservation same as Dual Inlet Plan.	Same as Dual Inlet Plan.
DESCRIPTION OF NO-TUNNEL PLAN Levees and floodwalls; channel modifications; and non-structural.	5.5 miles of levees and 5.0 miles of floodwalls, with an average of 8.5 ft. in height. 4.8 miles of channel modifications, an average of 8 ft. deep, with 135 ft. bottom width. 0.6 miles of channel dredging.	Between Dundee Dam and Beatties Dam and 11 miles of channel modification. The channel would be lowered an average of 8.5 ft. Bottom widths go from 540 ft. at Dundee Dam to 115 ft. at Beatties Dam. Crest of S.U.M. Dam will be lowered 1.6 ft.	Nonstructural measures of floodproofing, raising, and evacuation.	Same as Reach 3. Preservation same as Dual Inlet Plan.	5.0 miles of levees and 200 ft. of floodwalls along the Passaic Rockaway and Whippany Rivers. Nonstructural measures elsewhere. Preservation of natural storage areas.

TABLE 30

COMPARATIVE IMPACTS OF ALTERNATIVES
(1 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
ANADROMOUS FISH, LOWER VALLEY MOUTH TO DUNDEE DAM (REACH 1)	Downstream of Dundee Dam: 130 acres of tidal flats; some spawning by anadromous fish.	AT BEST, NO CHANGE	ADVERSE - Loss of 2 acres of anadromous fish habitat.	ADVERSE - Same as Dual Inlet Plan.	ADVERSE - Loss of 84 acres of riverine habitat due to channel modifications.
			BENEFICIAL - Creation of 4 acres of anadromous habitat as part of the project.	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - 21 acres of riverine habitat re-created.
FRESHWATER FISHERY LOWER VALLEY (REACH 2)	Above Dundee Dam Upstream to Beatties Dam: 325 acres of riverine/lacustrine habitat.	NO CHANGE	NO ADVERSE EFFECT	NO ADVERSE EFFECT	ADVERSE - 325 acres of riverine habitat adversely affected.
WETLANDS - DOWNSTREAM OF DUNDEE DAM, LOWER VALLEY (REACH 1)	45 acres of wetlands.	NO CHANGE	ADVERSE - Loss of 10 acres of riparian/ wetland habitat.	ADVERSE - Same as the Dual Inlet Plan.	ADVERSE - Loss of 6 acres of riparian wetland.
			BENEFICIAL - Creation of 10 acres in Reach 4 or 5.	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Creation of 6 acres of wetland in Reach 4, or 5.
WETLANDS - ABOVE DUNDEE DAM UPSTREAM TO BEATTIES DAM, LOWER VALLEY (REACH 2)	40 acres of wetlands	NO CHANGE - Unless washed out due to large storm event.	ADVERSE - Loss of 5 acres of adverse forested wetland from scattered remnants downstream of Little Falls.	ADVERSE - Same as Dual Inlet Plan.	ADVERSE - Loss of 40 acres of riparian wetlands to channel widening.
			BENEFICIAL - 5 acres recreated/upgraded in Reach 5 to offset loss	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Upgrade/re-create 30 acres of wetland in Reach 5 and 10 acres in Reach 4 to offset loss

TABLE 30 (CONT)

COMPARATIVE IMPACTS OF ALTERNATIVES
(2 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
ENDANGERED AND THREATENED SPECIES, LOWER VALLEY (REACH 1)	Federal: None NJ Threatened: American Shad.	NO CHANGE	NO EFFECT	NO EFFECT	NO EFFECT
WATER QUALITY, LOWER VALLEY (REACHES 1 AND 2)	Poor	Remain the same or worsen due to increased development.	NO EFFECT	NO EFFECT	ADVERSE - Water quality would degrade temporarily during maintenance dredging occasionally necessary.
CULTURAL RESOURCES, LOWER VALLEY (REACHES 1 AND 2)	2 National Historic Districts.	More nominations to National Register may occur.	NO ADVERSE EFFECT	NO ADVERSE EFFECT	ADVERSE EFFECT - Bank slope work likely to affect sites.
			BENEFICIAL - Prevention of flood damages.	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Same as Dual Inlet Plan.
HAZARDOUS SUBSTANCE SITES, LOWER VALLEY (REACHES 1 AND 2)	There are 2 Superfund and 26 CERCLA, hazardous substance sites within the 100-year floodplain.	Flooding could spread substances into living areas, fish and wildlife habitats.	BENEFICIAL - Protecting all sites from flooding within the 500 year floodplain up to Second River, and within the 100 year from the Second River to Beatties Dam.	BENEFICIAL - Same protection as Dual Inlet Plan.	BENEFICIAL - Same protection as Dual Inlet Plan.

TABLE 30 (CONT)

COMPARATIVE IMPACTS OF ALTERNATIVES
(3 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
FISHERIES, CENTRAL BASIN - INCLUDING POMPTON VALLEY AND TRIBUTARIES (REACH 4) AND BEATTIES DAM TO TWO BRIDGES (REACH 3) AND TWO BRIDGES TO GREAT PIECE MEADOWS (REACH 5)	Angler use is high in some areas with active NJDEP fish stocking program. Demand for fisheries exceeds the supply of 250 acres of habitat	Water quality remains about same - Point Source pollution lessens. Non-Point source pollution increases.	ADVERSE - Impact on 45 acres of riverine habitat, due to construction of channel modifications. Habitat restoration techniques would help restore fishery.	ADVERSE - 120 acres impacted, otherwise the same as the Dual Inlet Plan.	NO ADVERSE EFFECT
WETLANDS, CENTRAL BASIN BEATTIES DAM TO TWO BRIDGES (REACH 3)	5 acres of wetlands.	AT BEST NO CHANGE	ADVERSE - 5 acres of forested wetland lost to tunnel inlet structures.	ADVERSE - Same as Dual Inlet Plan.	NO ADVERSE EFFECT
WETLANDS, CENTRAL BASIN - UPSTREAM TO LOWER ROCKAWAY, WHIPPANY (REACH 5) AND POMPTON VALLEY AND TRIBUTARIES (REACH 4)	13,000 acres in the Central Basin study area providing habitat for numerous plant and animal communities, including State endangered species: and acting as flood storage areas. 8,620 acres are unprotected by public ownership or regulations.	High degree of risk and uncertainty regarding development. Increased pressure to allow development as upland alternative sites become unavailable. Up to 3,870 acres expected to be lost by 2040.	ADVERSE - With plan 815 acres of mostly forested wetland lost, 90 acres of forested altered. BENEFICIAL - With plan 905 acres lost and adversely affected wetland would be replanted, created, managed to offset loss.	ADVERSE - With plan 945 acres of mostly forested affected adversely or lost. BENEFICIAL - With plan 945 acres of adverse effect offset/gained. Same as Dual Inlet Plan.	NO ADVERSE EFFECTS
			BENEFICIAL - Preservation 4,860 acres of wetland saved from risk of development 2,190 acres are saved from	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Preservation of about 5,200 acres saved from risk of development 2,340 acres are saved from risk of filling.

COMPARATIVE IMPACTS OF ALTERNATIVES
(4 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
NATIONAL NATURAL LANDMARK - TROY MEADOWS (REACH 5)	2,390 acre wetland area.	Increased threat of development especially at periphery of the meadows.	BENEFICIAL - 1,175 would be preserved for posterity with this plan.	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Same as Dual Inlet Plan.
WILD AND SCENIC RIVERS (REACH 5)	8-mile reach of Passaic River in Great Piece Meadows is recognized as having wild and scenic river values based on its botanical characteristics.	Progressive botanical changes in adjacent wetlands due to increased frequency and magnitude of inundation caused by development-related hydrologic changes in watershed. Also, reduction of wild and scenic values due to progressive development of the wetland fringe bordering the immediate floodway.	ADVERSE - For about five days each year, free-flowing characteristics of the Passaic River upstream of Two Bridges would be altered by use of a low weir. BENEFICIAL - Preservation intact of 1,240 acres of natural setting of the remaining river reach through acquisition of flood storage areas in Great Piece Meadows.	ADVERSE - Same as Dual Inlet Plan. BENEFICIAL - Protection of habitat. Same as Dual Inlet Plan.	NO ADVERSE IMPACT BENEFICIAL - Same as Dual Inlet Plan.

TABLE 30 (CONT)

COMPARATIVE IMPACTS OF ALTERNATIVES
(5 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
ENDANGERED AND THREATENED SPECIES, CENTRAL BASIN (REACH 5)	No Federal. Six NJ endangered species, 7 threatened species.	Reduction of wetland habitat; subsequent elimination.	BENEFICIAL - Protection of 4,200 acres of wetland habitat.	BENEFICIAL - Same as the Dual Inlet Plan.	BENEFICIAL - Protection of 4,540 acres of wetland habitat.
WATER QUALITY, CENTRAL BASIN (REACHES 4 AND 5)	Poor to fair on Passaic River (Reach 5). Good in Pompton Valley (Reach 4).	Degradation from increased non-point-source runoff especially during floods.	ADVERSE - Short term impacts during construction. Possible temperature increase due to river bank clearing.	ADVERSE - Same as Dual Inlet Plan, except in Pompton Valley where channel work would cause increased temporary degradation.	NO EFFECT - No degradation.
			BENEFICIAL - Project would reduce contaminents entering the river during flood events.	BENEFICIAL - Same as Dual Inlet Plan.	
GROUNDWATER RESOURCES (REACHES 4 AND 5)	Generally good. Quality decreasing due to increased development.	Continued degradation of quality.	NO EFFECT	BENEFICIAL - Recharge of the aquifer.	NO EFFECT
CULTURAL RESOURCES, CENTRAL BASIN (REACHES 4 AND 5)	2 National Historic Districts.	Possibly more nominations to National Register of Historic Places.	BENEFICIAL - Possible discovery of new prehistoric sites. Protection from floods.	BENEFICIAL - Same as Dual Inlet Plan.	NO EFFECT - Same as future without project.

TABLE 30 (CONT)

COMPARATIVE IMPACTS OF ALTERNATIVES
(6 of 6)

CATEGORIES SIGNIFICANT RESOURCES	BASE CONDITION (Today)	FUTURE WITHOUT ACTION (2040)	DUAL INLET PLAN	SINGLE INLET PLAN	NO-TUNNEL PLAN
HAZARDOUS SUBSTANCE SITES, CENTRAL BASIN (REACHES 3-5)	There are 2 Superfund and 20 CERCLA hazardous substances sites in the 100 year floodplain.	Flooding could spread hazardous substances into living areas, fish and wildlife habitats.	Protection of all sites within the 100 year floodplain in the Pompton Valley, within the 100 to 500 year floodplain in the Passaic.	Sames as with Dual Inlet Plan, but only 50 year protection on Pompton River.	No site protection in the Pompton River Valley or the Passaic River upstream from Beatties Dam to Pine Brook.
RECREATION, FISHING (REACHES 1-5)	Limited due to lack of shoreline access and water quality, except in the Pompton Valley and its upstream tributaries where there is shoreline and trout stocking fishing.	Continued limitations and reduction in use.	ADVERSE - Access only at selected points. Fisheries affected during construction and maintenance.	ADVERSE - Same as Dual Inlet Plan.	BENEFICIAL - No adverse effects. Additional parkland or open space from evacuated home sites.
BOATING AND SWIMMING	Severe peak demand day deficits occur in basin for all water-related recreational activities.	Deficits projected to increase with more people using fixed amount of resources.	BENEFICIAL - Preservation of natural storage, along with recreational/beautification areas as part of plan components, would decrease projected deficits.	BENEFICIAL - Same as Dual Inlet Plan.	BENEFICIAL - Similar to Dual Inlet Plan but benefit less extensive in Lower Valley.

TABLE 31 (Page 1 of 3)

DUAL INLET TUNNEL PLAN
PEAK FLOWS (Q), PEAK STAGES (H) AND VELOCITIES (V)
CORRESPONDING TO PEAK STAGES

1 YEAR FLOOD

LOCATION	NODE	STATION	WITHOUT PROJECT CONDITIONS 1986 Q	1986 V	1986 H	WITHOUT PROJECT CONDITIONS 2040 Q	2040 V	2040 H	WITH PROJECT CONDITIONS 2040 Q	2040 V	2040 H	DIFFERENCE BETWEEN 2040 CONDITIONS WITH PROJECT AND WITHOUT PROJECT Q	V	H
Pompton River, USGS gage	25	34975	3992	1.2	174.3	4672	1.2	175.0	4672	1.2	175.0	0	0.0	0.0
Pompton River	26	25060	3997	0.5	170.3	4658	0.5	171.0	4659	0.5	171.0	1	0.0	0.0
Pompton River, above Pack. Brk	31	16710	4050	0.6	168.3	4717	0.5	169.0	4700	0.6	168.9	-17	0.1	-0.1
Pompton River, at Pack. Brk	33	7940	4132	0.2	165.6	4800	0.2	166.1	4783	0.2	165.8	-17	0.0	-0.3
Pompton River at mouth	34	1480	4128	0.3	164.2	4805	0.3	164.8	4778	0.3	164.4	-27	0.0	-0.4
Passaic River, Pine Brk	23	235585	2933	2.7	167.6	3504	3.0	168.1	3262	2.9	168.0	-242	-0.1	-0.1
Passaic River, at Horseneck Rd	24	219860	2511	2.2	166.4	2822	2.5	166.7	2773	2.3	166.7	-49	-0.2	0.0
P.R., 1.5 m. above Tom's Point	24	213370	2511	1.8	166.0	2822	1.6	166.3	2773	1.7	166.2	-49	0.1	-0.1
P.R., 1 m. below Tom's Point	24	194000	2511	1.6	164.4	2822	1.4	164.9	2773	1.6	164.8	-49	0.2	-0.1
Passaic River above Pompton	24	184170	2511	0.9	164.3	2822	0.7	164.8	2773	0.8	164.6	-49	0.1	-0.2
Passaic River below Pompton	35	169300	5201	2.4	163.1	5918	2.6	163.5	5871	2.5	163.5	-47	0.1	0.0
Passaic R. above Little Falls	41	157310	5486	2.6	161.3	6232	2.8	161.6	6182	2.6	161.6	-50	-0.2	0.0
P.R. below Beatties Dam	100	151270	5492	2.2	123.5	6243	2.3	124.0	6194	2.3	124.0	-49	0.0	0.0
P.R. above Great Falls	200	134220	5505	2.4	117.9	6262	2.7	118.2	6213	2.6	118.2	-49	-0.1	0.0
P.R. @ Diamond Brook	300	117468	5517	2.7	33.3	6277	2.9	33.6	6228	2.9	33.6	-49	0.0	0.0
P.R. above Dundee Dam	400	92400	5514	1.0	28.0	6271	1.1	28.2	6225	1.1	28.2	-46	0.0	0.0
P.R. @ Saddle River	500	82200	5576	1.8	6.0	6351	1.9	6.8	6305	1.9	6.8	-46	0.0	0.0
P.R. @ Third R. above outlet	600	58765	5576	1.1	5.2	6350	1.1	5.8	6305	1.1	5.8	-45	0.0	0.0
P.R. @ Third R. below outlet	700	54243	5603	0.9	5.2	6379	1.0	5.8	6335	1.0	5.8	-44	0.0	0.0
P.R. @ Second River	800	30018	5596	0.7	4.9	6370	0.8	5.5	6329	0.8	5.5	-41	0.0	0.0
P.R. above mouth	800	22200	5596	0.4	4.9	6370	0.4	5.5	6329	0.4	5.5	-41	0.0	0.0

Flow in cfs, velocity in fps, stage in ft NGVD.
P.R. = Passaic River

DUAL INLET TUNNEL PLAN
PEAK FLOWS (Q), PEAK STAGES (H) AND VELOCITIES (V)
CORRESPONDING TO PEAK STAGES

2 YEAR FLOOD

			WITHOUT PROJECT CONDITIONS						WITH PROJECT CONDITIONS			DIFFERENCE BETWEEN 2040 CONDITIONS WITH PROJECT AND WITHOUT PROJECT		
			1986			2040			2040					
LOCATION	NODE	STATION	Q	V	H	Q	V	H	Q	V	H	Q	V	H
Pompton River, USGS gage	25	34975	6462	1.2	176.6	7279	1.2	177.2	4672	1.2	175.0	-2607	0.0	-2.2
Pompton River	26	25060	6449	0.4	172.8	7237	0.4	173.5	4622	0.5	171.1	-2615	0.1	-2.4
Pompton River, above Pack. Brk	31	16710	6429	0.5	170.3	7254	0.4	170.9	4703	0.5	169.0	-2551	0.1	-1.9
Pompton River, at Pack. Brk	33	7940	6529	0.2	166.9	7357	0.2	167.2	4806	0.2	166.1	-2551	0.0	-1.1
Pompton River at mouth	34	1480	6521	0.2	165.8	7360	0.2	166.2	4800	0.3	164.8	-2560	0.1	-1.4
Passaic River, Pine Brk	23	235585	3876	3.7	168.9	4649	4.3	169.5	4321	3.3	169.3	-328	-1.0	-0.2
Passaic River, at Horseneck Rd	24	219860	3447	3.0	167.2	3944	3.7	167.5	4132	1.3	167.5	188	-2.4	0.0
P.R., 1.5 m. above Tom's Point	24	213370	3447	1.6	166.8	3944	1.5	167.1	4132	1.4	167.1	188	-0.1	0.0
P.R., 1 m. below Tom's Point	24	194000	3447	1.6	166.0	3944	1.3	166.4	4132	2.2	165.8	188	0.9	-0.6
Passaic River above Pompton	24	184170	3447	0.8	165.8	3944	0.6	166.3	4132	1.1	165.4	188	0.5	-0.9
Passaic River below Pompton	35	169300	7535	2.8	164.4	8214	3.0	164.8	6273	2.4	163.6	-1941	-0.6	-1.2
Passaic R. above Little Falls	41	157310	7787	3.2	162.2	8496	3.4	162.4	6273	2.8	161.6	-2223	-0.6	-0.8
P.R. below Beatties Dam	100	151270	7795	2.6	124.1	8503	2.6	125.6	6279	2.3	124.1	-2224	-0.3	-1.5
P.R. above Great Falls	200	134220	7806	3.2	118.8	8523	3.4	119.1	6288	2.7	118.3	-2235	-0.7	-0.8
P.R. @ Diamond Brook	300	117468	7817	3.3	34.3	8540	3.5	34.6	6295	2.9	33.6	-2245	-0.6	-1.0
P.R. above Dundee Dam	400	92400	7821	1.3	28.6	8554	1.4	28.8	6296	1.1	28.2	-2258	-0.3	-0.6
P.R. @ Saddle River	500	82200	7893	2.3	7.0	8621	2.4	7.7	6345	1.7	7.5	-2276	-0.7	-0.2
P.R. @ Third R. above outlet	600	58765	7902	1.5	5.5	8635	1.5	6.1	6348	1.1	6.8	-2287	-0.4	-0.7
P.R. @ Third R. below outlet	700	54243	7940	1.3	5.4	8674	1.4	6.0	13257	2.0	6.7	4583	0.6	0.7
P.R. @ Second River,	800	30018	7951	1.0	4.9	8694	1.1	5.5	13312	1.7	5.6	4618	0.6	0.1
P.R. above mouth	800	22200	7951	0.6	4.9	8694	0.6	5.5	13312	0.9	5.5	4618	0.3	0.0

Flow in cfs, velocity in fps, stage in ft NGVD.
P.R. = Passaic River

DUAL INLET TUNNEL PLAN
PEAK FLOWS (Q), PEAK STAGES (H) AND VELOCITIES (V)
CORRESPONDING TO PEAK STAGES

100 YEAR FLOOD

LOCATION	NODE	STATION	WITHOUT PROJECT CONDITIONS 1986 Q	V	H	WITHOUT PROJECT CONDITIONS 2040 Q	V	H	WITH PROJECT CONDITIONS 2040 Q	V	H	DIFFERENCE BETWEEN 2040 CONDITIONS WITH PROJECT AND WITHOUT PROJECT Q	V	H
Pompton River, USGS gage	25	34975	32515	4.6	185.9	32907	4.5	186.1	5171	2.2	175.2	-27736	-2.3	-10.9
Pompton River	26	25060	30575	4.3	182.7	32405	4.4	183.0	4536	2.0	171.4	-27869	-2.4	-11.6
Pompton River, above Pack. Brk	31	16710	28969	2.8	180.6	30561	2.8	180.7	4914	2.4	169.4	-25647	-0.4	-11.3
Pompton River, at Pack. Brk	33	7940	29200	4.9	175.9	30821	4.8	176.6	5191	1.7	167.2	-25630	-3.1	-9.4
Pompton River at mouth	34	1480	29144	6.1	173.6	30802	5.8	175.0	5180	1.6	166.4	-25622	-4.2	-8.6
Passaic River, Pine Brk	23	235585	12283	1.6	174.2	14921	2.9	176.4	13768	3.5	172.1	-1153	0.6	-4.3
Passaic River, at Horseneck Rd	24	219860	12040	0.9	173.6	14451	1.8	175.2	11482	2.1	170.1	-2969	0.3	-5.1
P.R., 1.5 m. above Tom's Point	24	213370	12040	0.5	173.6	14451	0.7	175.1	11482	2.0	169.6	-2969	1.3	-5.5
P.R., 1 m. below Tom's Point	24	194000	12040	0.4	173.5	14451	0.6	175.0	11482	2.2	167.7	-2969	1.6	-7.3
Passaic River above Pompton	24	184170	12040	0.4	173.5	14451	0.5	175.0	11482	1.2	166.6	-2969	0.7	-8.4
Passaic River below Pompton	35	169300	26843	4.9	171.8	32547	5.2	173.2	9232	3.1	165.2	-23315	-2.1	-8.0
Passaic R. above Little Falls	41	157310	27533	7.0	167.3	33053	7.2	168.4	9232	3.8	162.7	-23821	-3.4	-5.7
P.R. below Beatties Dam	100	151270	27566	4.4	134.3	33085	4.8	135.9	9496	2.7	126.4	-23589	-2.1	-9.5
P.R. above Great Falls	200	134220	27626	7.7	123.8	33123	8.6	124.8	9768	3.7	119.5	-23355	-4.9	-5.3
P.R. @ Diamond Brook	300	117468	27692	5.9	41.4	33157	6.4	42.7	12774	4.3	36.4	-20383	-2.1	-6.3
P.R. above Dundee Dam	400	92400	27693	3.2	32.4	33098	3.6	33.2	12402	1.8	29.7	-20696	-1.8	-3.5
P.R. @ Saddle River	500	82200	28207	4.3	15.7	33621	4.4	18.3	18892	2.7	17.2	-14729	-1.7	-1.1
P.R. @ Third R. above outlet	600	58765	28222	4.0	9.7	33592	3.8	11.3	21279	2.1	15.4	-12313	-1.7	4.1
P.R. @ Third R. below outlet	700	54243	28362	3.8	9.4	33706	4.2	10.8	50543	5.3	14.7	16837	1.1	3.9
P.R. @ Second River	800	30018	28635	3.6	5.2	33645	4.2	5.9	48544	5.9	6.5	14899	1.7	0.6
P.R. above mouth	800	22200	28635	2.0	5.0	33645	2.3	5.6	48544	3.3	5.9	14899	1.0	0.3

Flow in cfs, velocity in fps, stage in ft NGVD.
P.R. = Passaic River

Table 32

LIST OF PREPARERS

The following people were primarily responsible for preparing this Environmental Impact Statement:

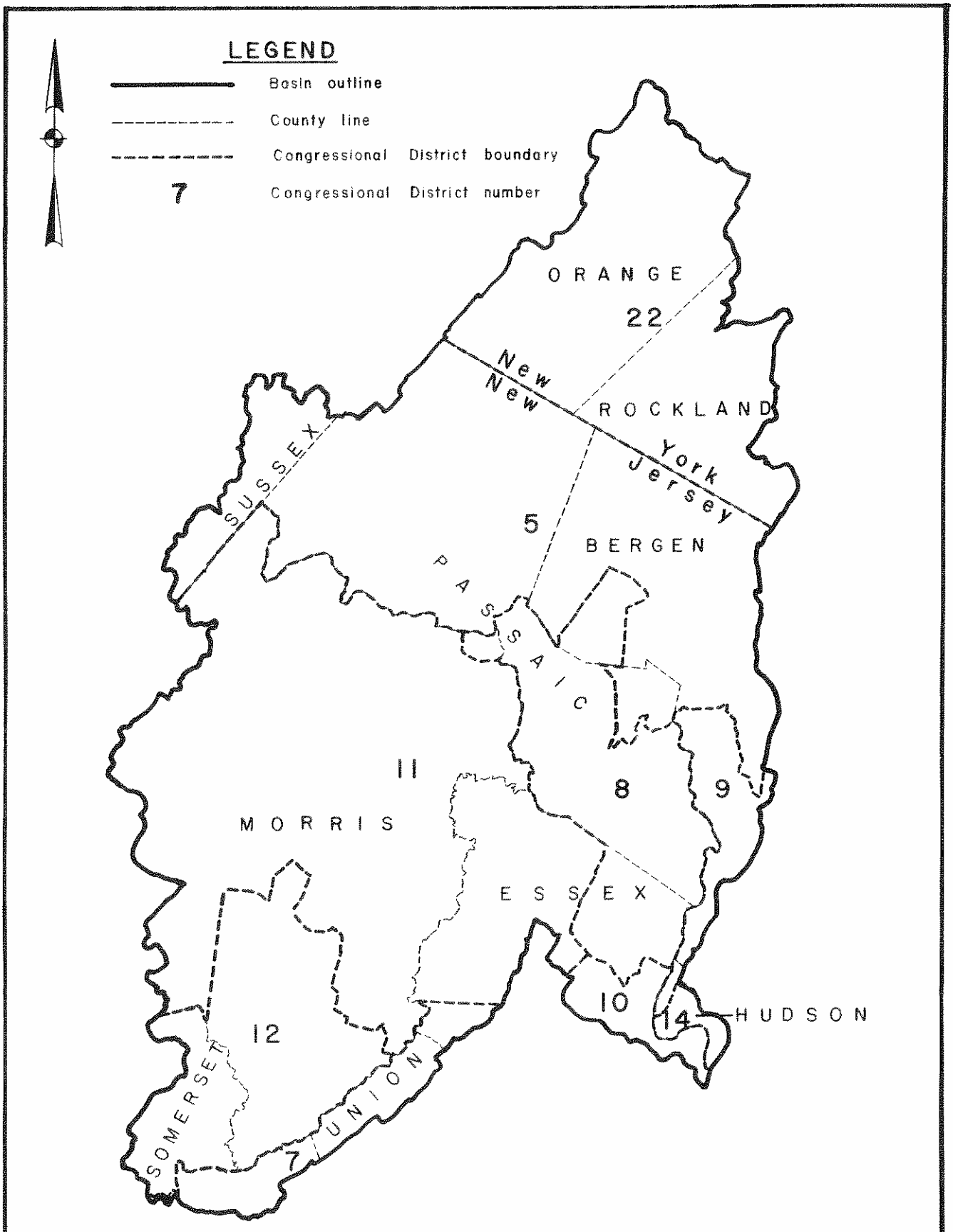
Name and Role in Preparing EIS	Discipline And Expertise	Experience
Robert L. Callegari, Study Management, DEIS Editor and Public Involvement	Economics Water Resources Planning	5 years, Northeast Water Supply Study, North Atlantic Division, CE 10 years PRSSB, N.Y. District, CE
Robert A. Pietrowsky M.S. Study Management, EIS Editor, Plan Formulation and Public Involvement	Civil Engineering Water Resources Planning	15 years (9 years PRSSB) N.Y. District, CE
E. Raymond Boc, P.E. Study Management, Engineering Studies Coordinator, Public Involvement	Civil Engineering Water Resources Planning	7 years N.Y. District, CE 6 years, Northeast Water Supply Study. North Atlantic Division, CE 10 years PRSSB, N.Y. District, CE
Sheila Rice McDonnell, M.S., P.E. Study Management, Formulation of Alternatives	Civil Engineering Water Resources Planning	8 years Project Manager PRSSB, N.Y. District, CE
M. Lou Benard, M.A. EIS Coordinator, Environmental Resources Studies Manager, Effects on Natural and Cultural Resources	Physical Science Environmental Resources Planning	10 years Environmental Studies and Water Resources Planning, PRSSB, N.Y. District, CE
Robert J. Kurtz, M.S. EIS Coordinator, EIS Studies Manager for and Fish, Wildlife, Wetlands, and Water Quality	Biology Fisheries Biology	10 years Biological Studies Water Resources Planning PRSSB, N.Y. District, CE
Jared Miller Public Involvement and Public Information DEIS/Report Writer-Editor	Public Involvement Public Information Water Resources Writing-Editing	2 years Baltimore District, CE. 11 years North Atlantic Division CE. 10 years PRSSB, N.Y. District CE
Henri A. Langlois, Jr., M.C.E., P.E. Formulation of Alternatives	Civil Engineering Water Resources Planning	7 years Project Manager, PRSSB, N.Y. District, CE

TABLE 32 (CONT)

Henry F. Kiefer, Jr., Cost Estimates, Graphics, Real Estate Studies Coordinator	Engineering Technician, Water Resources Planning	10 years Technical Engineering Planning, PRSSB, N.Y. District, CE
Reginald Perry Formulation of Alternatives	Civil Engineering Water Resources Planning	8 years Project Manager PRSSB, N.Y. District, CE
Cornell Pippens Economic Assessments, Economic Effects	Economics: Water Resources Planning	5 years Economist PRSSB, N.Y. District, CE
John P. Lawler, Ph.D. EIS Editor and Public Involvement	Environmental Engineering Water Resources Planning	Senior Partner, Lawler, Matusky & Skelly Engineers
Thomas B. Vanderbeek, P.E. Project Manager, EIS Production	Environmental Engineering Water Resources Planning	10 years Engineer, Lawler, Matusky & Skelly Engineers
Bruce L. Lippincott, Ph.D. EIS Reviewer	Biology:Fisheries Biologist	12 years Biologist, Lawler, Matusky & Skelly Engineers
David M. Bell, Ph.D. EIS Reviewer	Biology:Fisheries Biologist	5 years Biologist, Lawler, Matusky & Skelly Engineers

The following people were primarily responsible for preparing reports which have been incorporated in this EIS.

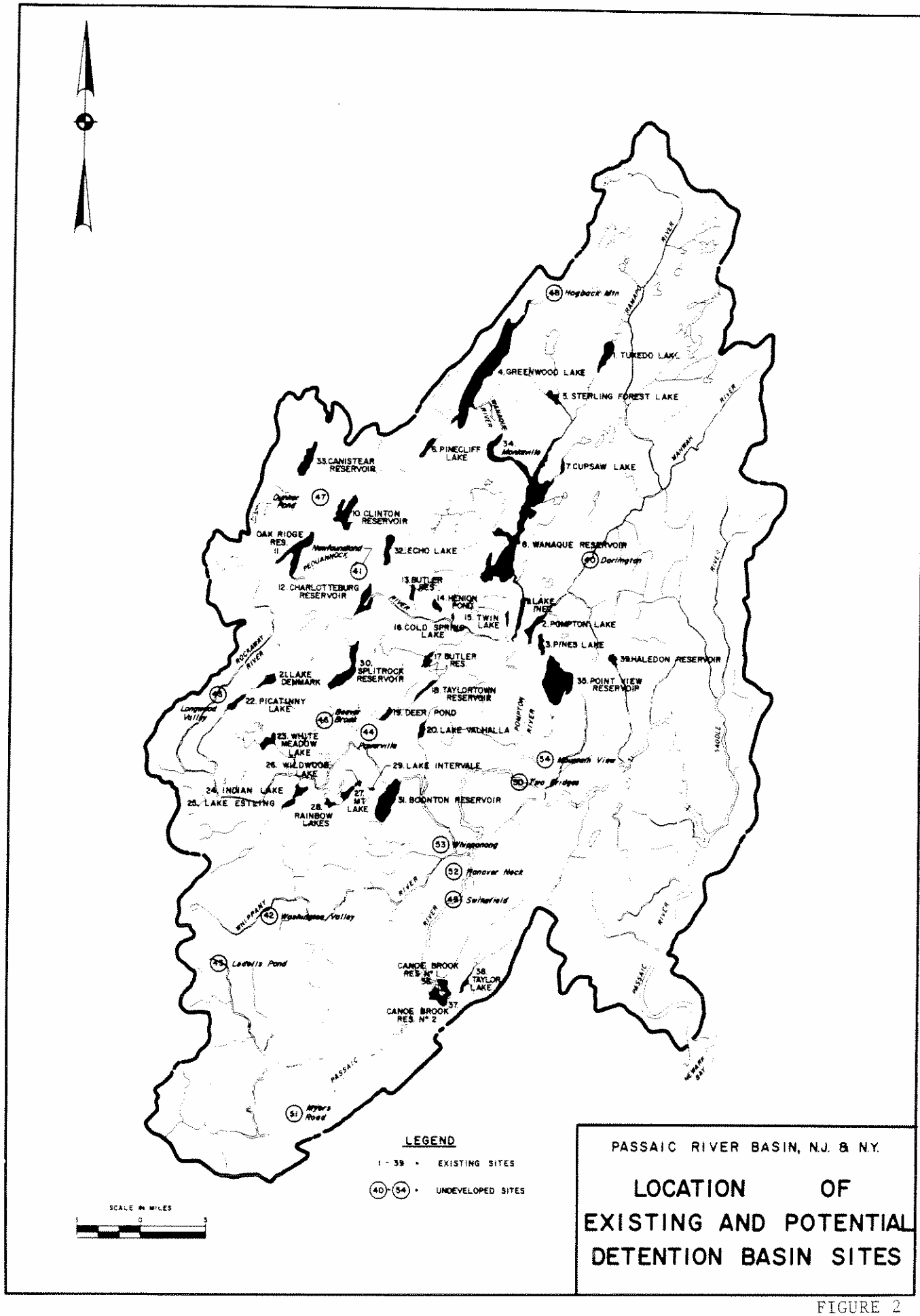
Clifford Day Effects on Fish and Wildlife Resources and Their Supporting Habitats	Biologist:Fishery Biologist	10 years, U.S. Fish and Wildlife Service
Robert Papson Fishery Survey	Fishery Biologist	10 years, NJ Bureau of Freshwater Fisheries
G. Horvitz Consultant for Water Quality Analysis	Metallurgist	Water Quality Analysis, Grain Size Analysis, Bulk Sediment Analysis, 65 years owner and manager of testing laboratory



Passaic River Study N.J. & N.Y.

COUNTIES AND CONGRESSIONAL DISTRICTS

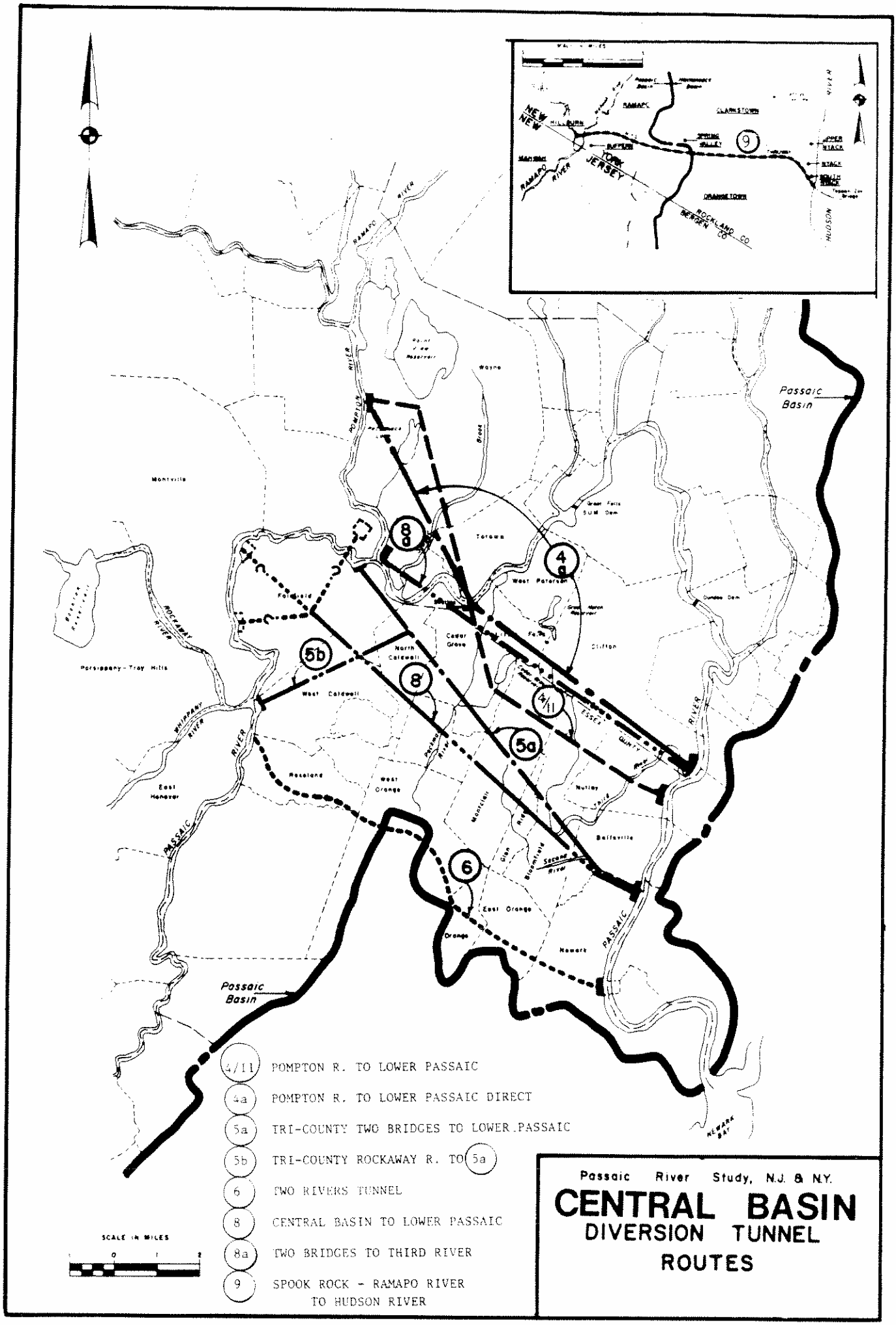
FIGURE 1

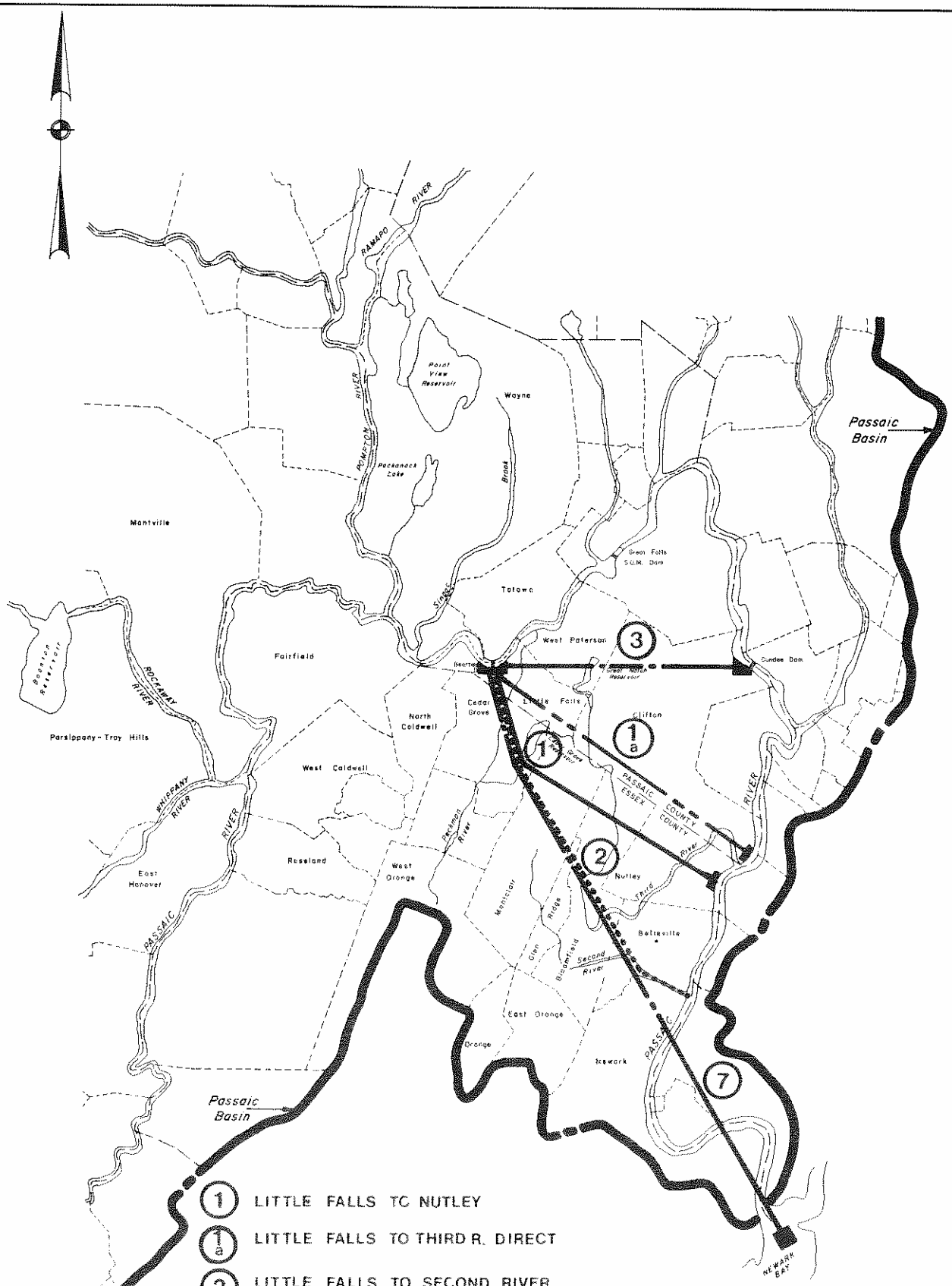


PASSAIC RIVER BASIN, N.J. & N.Y.

LOCATION OF EXISTING AND POTENTIAL DETENTION BASIN SITES

FIGURE 2


Passaic Basin
Passaic Basin
4/11 POMPTON R. TO LOWER PASSAIC
4a POMPTON R. TO LOWER PASSAIC DIRECT
5a TRI-COUNTY TWO BRIDGES TO LOWER PASSAIC
5b TRI-COUNTY ROCKAWAY R. TO 5a
6 TWO RIVERS TUNNEL
8 CENTRAL BASIN TO LOWER PASSAIC
8a TWO BRIDGES TO THIRD RIVER
9 SPOOK ROCK - RAMAPO RIVER TO HUDSON RIVER
SCALE IN MILES
0 1 2
Passaic River Study, N.J. & N.Y.
CENTRAL BASIN
DIVERSION TUNNEL
ROUTES



Passaic River Study, N.J. & N.Y.

LITTLE FALLS DIVERSION TUNNEL ROUTES

FIGURE 4

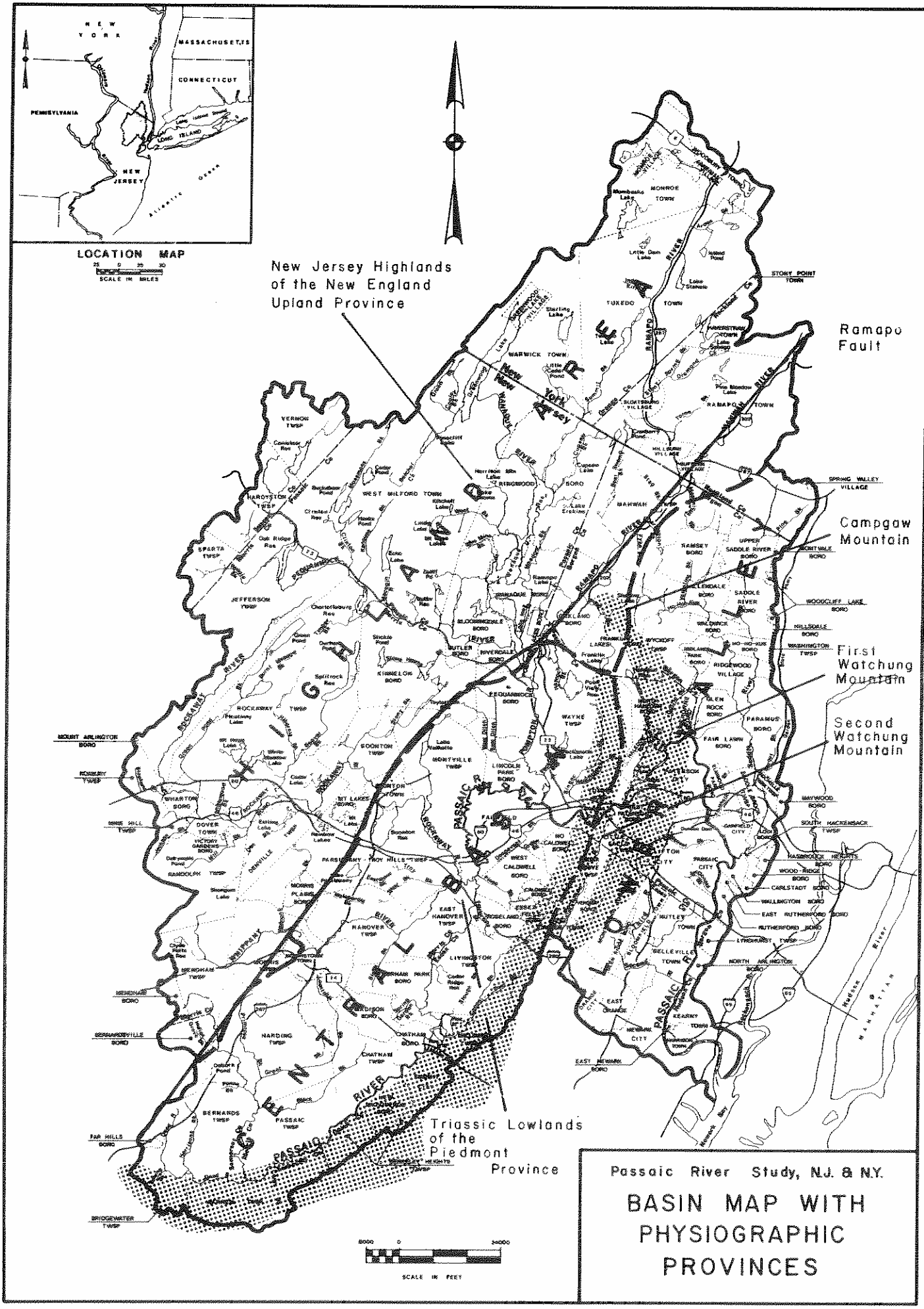
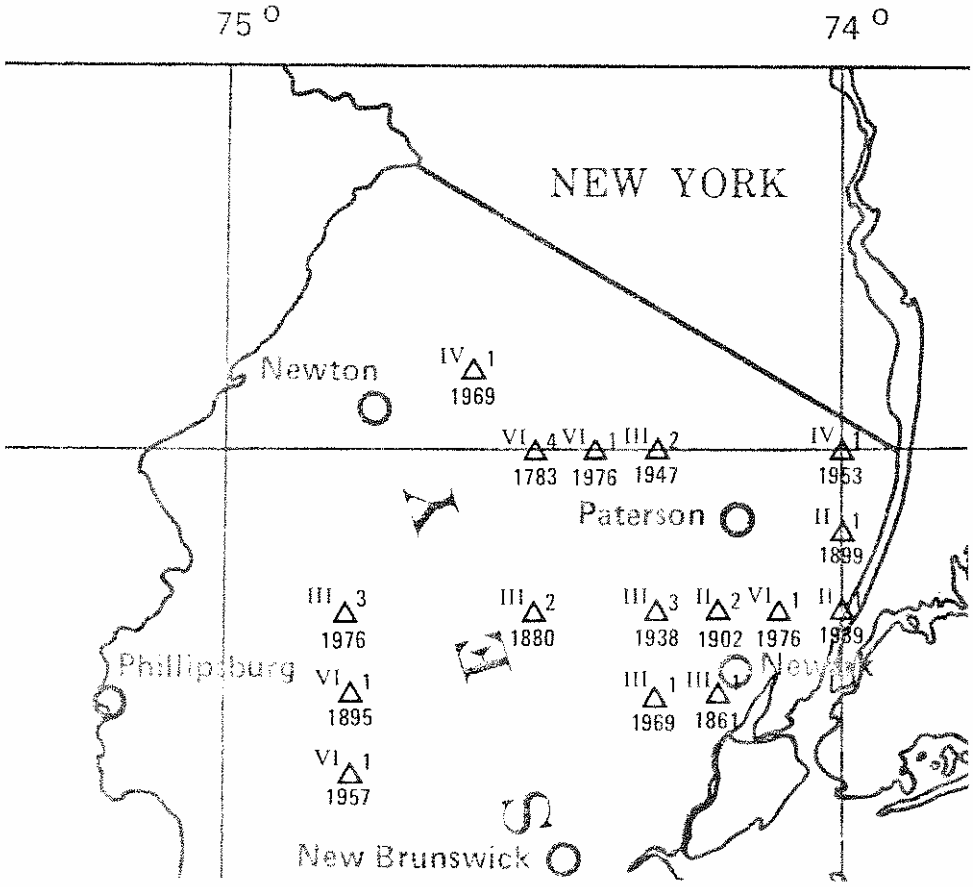

LOCATION MAP
SCALE IN MILES
New Jersey Highlands of the New England Upland Province
Ramapo Fault
Campgaw Mountain
First Watchung Mountain
Second Watchung Mountain
Triassic Lowlands of the Piedmont Province
SCALE IN FEET
Passaic River Study, N.J. & N.Y.
BASIN MAP WITH PHYSIOGRAPHIC PROVINCES

FIGURE 5



Key:

MODIFIED MERCALLI SCALE

RICHTER SCALE △

YEAR

SOURCE:

STOVER et al 1980

Passaic River Study N.Y. & N.J.

EARTHQUAKE ACTIVITY IN NORTHERN NEW JERSEY THROUGH 1980

FIGURE 6

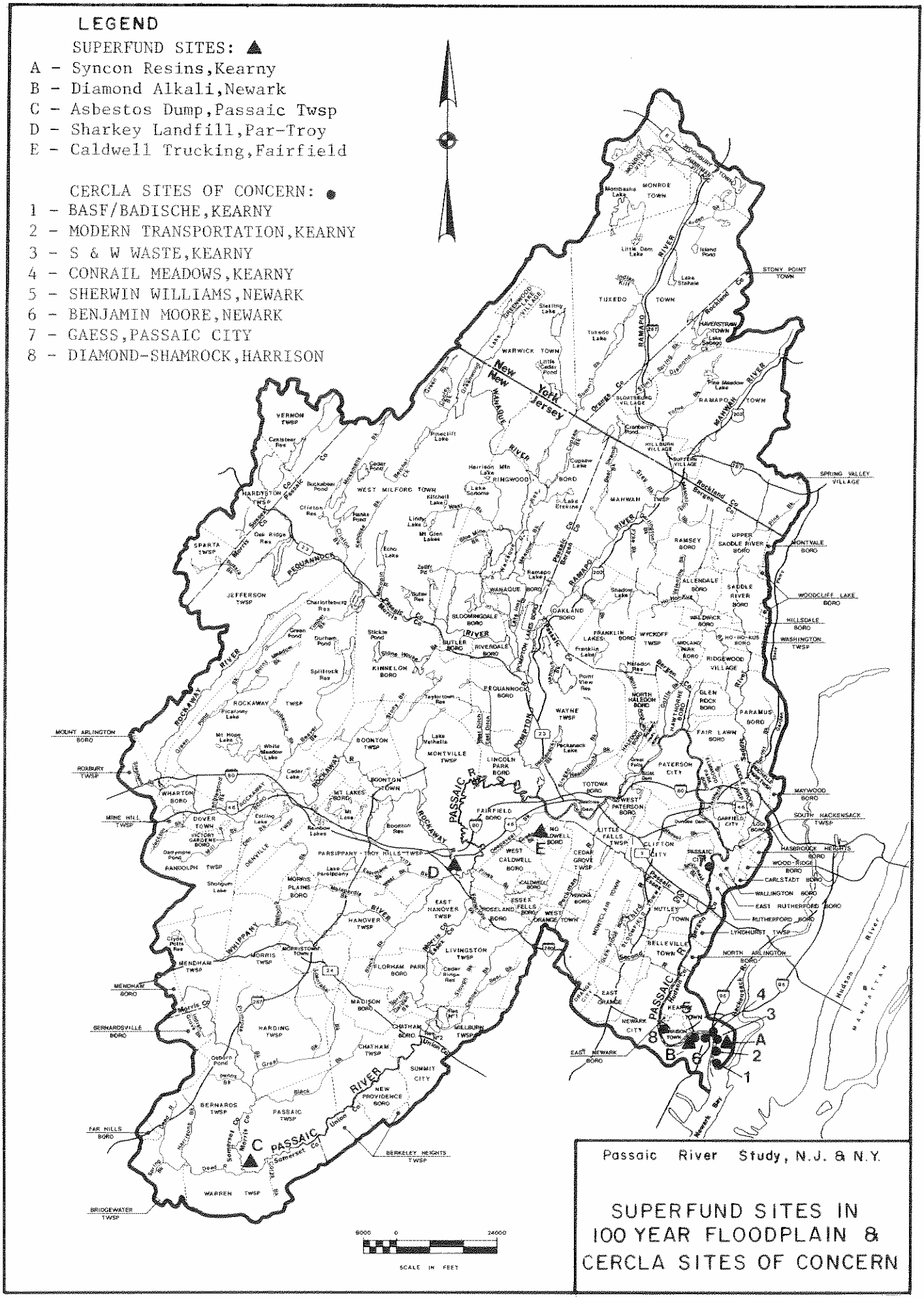

LEGEND
SUPERFUND SITES: ▲
A - Syncon Resins, Kearny
B - Diamond Alkali, Newark
C - Asbestos Dump, Passaic Twsp
D - Sharkey Landfill, Par-Troy
E - Caldwell Trucking, Fairfield
CERCLA SITES OF CONCERN: ●
1 - BASF/BADISCHE, KEARNY
2 - MODERN TRANSPORTATION, KEARNY
3 - S & W WASTE, KEARNY
4 - CONRAIL MEADOWS, KEARNY
5 - SHERWIN WILLIAMS, NEWARK
6 - BENJAMIN MOORE, NEWARK
7 - GAESS, PASSAIC CITY
8 - DIAMOND-SHAMROCK, HARRISON
New York
New Jersey
PASSAIC RIVER
SCALE IN FEET
Passaic River Study, N.J. & N.Y.
SUPERFUND SITES IN 100 YEAR FLOODPLAIN & CERCLA SITES OF CONCERN

FIGURE 7

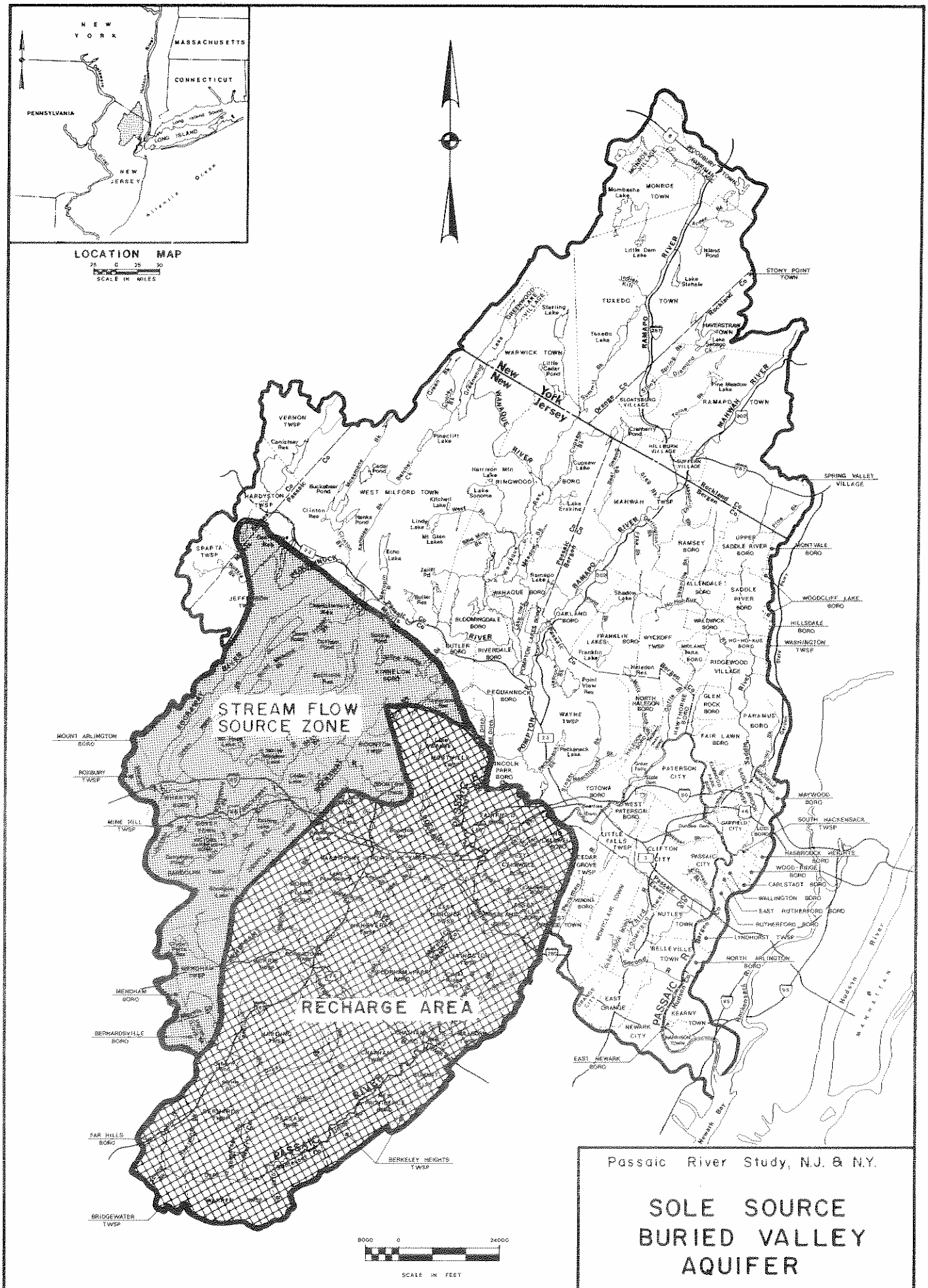

NEW YORK
MASSACHUSETTS
CONNECTICUT
PENNSYLVANIA
NEW JERSEY
LONG ISLAND
LOCATION MAP
SCALE IN MILES
STREAM FLOW SOURCE ZONE
RECHARGE AREA
SCALE IN FEET
Passaic River Study, N.J. & N.Y.
SOLE SOURCE BURIED VALLEY AQUIFER

FIGURE 8

MAJOR SURFACE WATER SUPPLY SYSTEMS

OPERATOR	BASIN	SUPPLY
City of Newark	Pequannock River	Canistear, Oak Ridge, Clinton, Echo Lake, Macopin & Charlottsburg Reservoirs, NJDWSC
Jersey City	Rockaway River	Boonton, Splitrock and Longwood Valley Reservoir
North Jersey District Water Supply Commission	Wanaque & Ramapo Rivers	Wanaque and Monksville Reservoirs, pumped diversion from Ramapo and Pompton Rivers
Passaic Valley Water Commission	Passaic & Pompton Rivers	Diversion from Passaic River and Little Falls, pumped diversion from Pompton River to Point View Reservoir & North Jersey District Water Supply Commission
Commonwealth Water Co.	Passaic R. & Canoe Brook	Osborn Pond Reservoir, pumped diversion from Passaic River, Canoe Brook
Hackensack Water Co.	Wanaque, Ramapo, Pompton, Saddle and Hackensack Rivers	Monksville Reservoir, pumped diversion from Pompton River, diversion from Saddle River

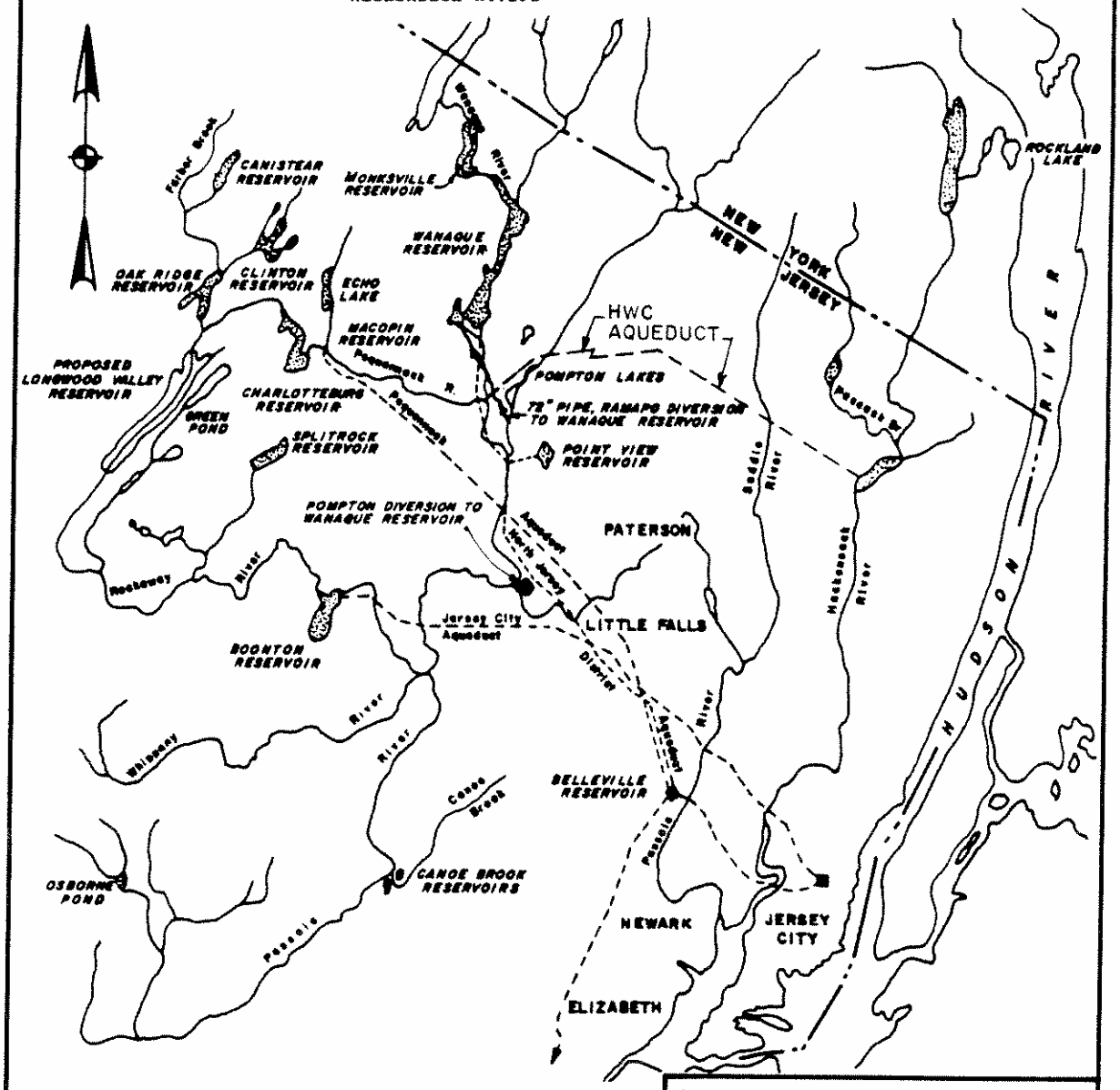
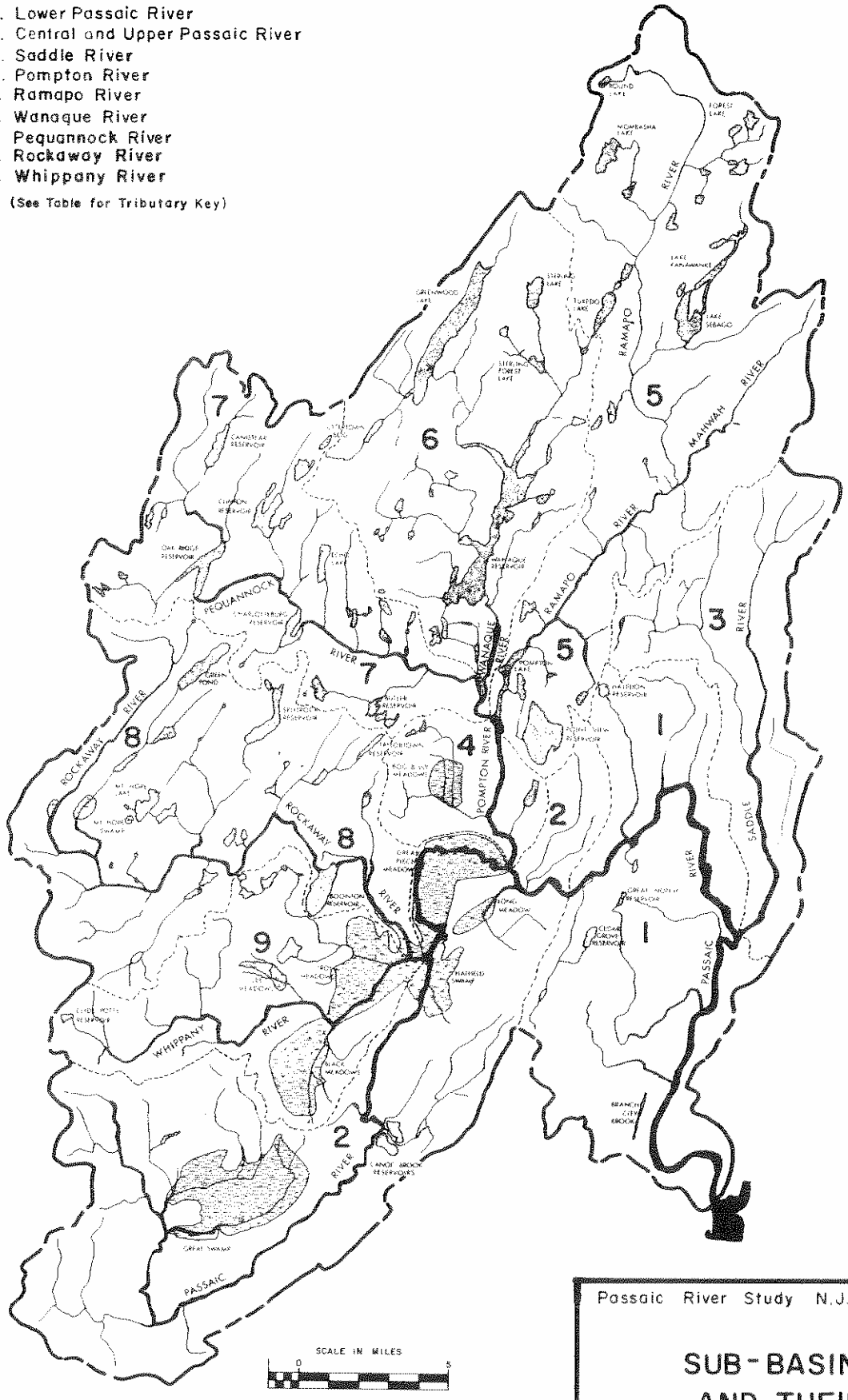


FIGURE 9

LEGEND

1. Lower Passaic River
2. Central and Upper Passaic River
3. Saddle River
4. Pompton River
5. Ramapo River
6. Wanaque River
7. Pequannock River
8. Rockaway River
9. Whippany River

(See Table for Tributary Key)



Passaic River Study N.J. & N.Y.

SUB-BASINS AND THEIR TRIBUTARIES

FIGURE 10

KEY FOR FIGURE 10

(Subbasins and Tributaries in the Passaic River Basin)

SUBBASIN	TRIBUTARY
1-Lower Passaic River	1-Second River 2-Third River 3-Weasel Brook 4-Diamond Brook 5-Goffle Brook 6-Molly Ann Brook 7-Slippery Rock Brook 8-Peckman River
2-Central and Upper Passaic River	1-Naachtpunkt Brook 2-Preakness Brook 3-Deepaval Brook 4-Green Brook 5-Foulerton's Brook 6-Spring Garden Brook 7-Slough Brook 8-Canoe Brook 9-Taylor Brook 10-Bear Brook 11-Cory's Brook 12-Dead River 13-Harrisons Brook 14-Spring Brook 15-Black Brook 16-Great Brook 17-Loantaka Brook 18-Primrose Brook 19-Penns Brook 20-Indian Grove Brook
3-Saddle River	1-Sprout Brook 2-Hohokus Brook 3-Ramsey Brook 4-Valentine Brook 5-Pine Brook

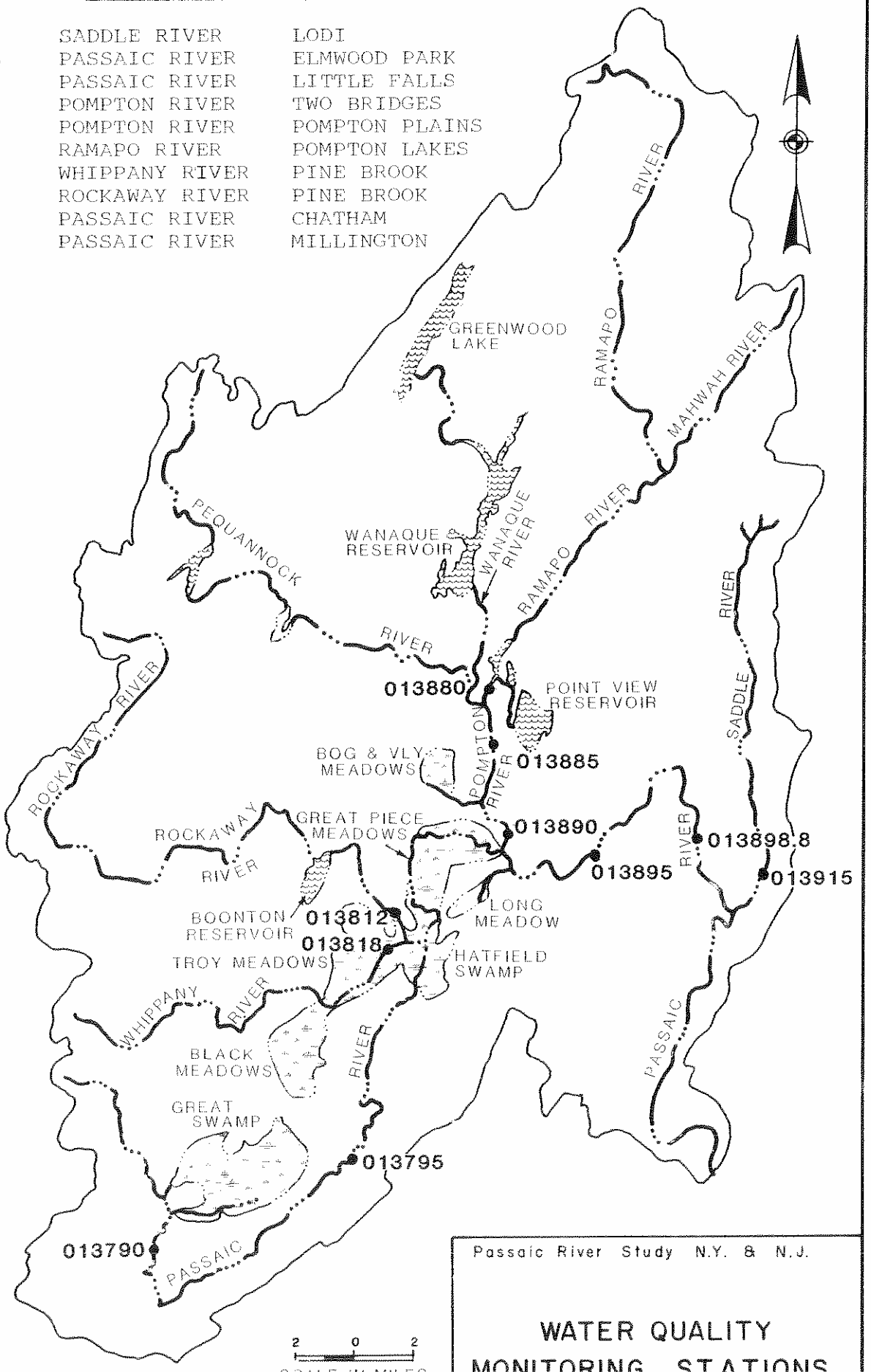
KEY FOR FIGURE 10 (Continued)

SUBBASIN	TRIBUTARY
4-Pompton River	1-Packanack Brook
5-Ramapo River	1-Haycock Brook 2-Pond Brook 3-Fox Brook 4-Bear Swamp Brook 5-Fyke Brook 6-Darlington Brook 7-Stag Brook 8-Clove Brook 9-Masonicus Brook 10-Mahwah River 11-Torne Brook 12-Stony Brook 13-Spring Brook 14-Pine Meadow Brook 15-Summit Brook 16-Indian Kill 17-Stahale Brook 18-Arden Brook
6-Wanaque River	1-Posts Brook 2-Meadow Brook 3-High Mountain Brook 4-Blue Mine Brook 5-Burnt Meadow Brook 6-West Brook 7-Beech Brook 8-Hewitt Brook 9-Jennings Creek 10-Green Brook 11-Cooley Brook 12-Belcher Brook 13-Morsetown Brook 14-Ringwood Creek 15-Ringwood River
7-Pequannock	1-Stonehouse Brook 2-Apshawa Brook 3-Macopin River 4-Timber Brook 5-Kanouse Brook

KEY FOR FIGURE 10 (Continued)

SUBBASIN	TRIBUTARY
7-Pequannock (cont.)	6-Clinton Brook 7-Mossmans Brook 8-Russia Brook 9-Pacock Brook 10-Cherry Ridge Brook
8-Rockaway River	1-Crooked Brook 2-Den Brook 3-Beaver Brook 4-Hibernia Brook 5-Mill Brook 6-Jackson Brook 7-Spring Brook 8-Green Pond Brook 9-Burnt Meadow Brook 10-Stephens Brook
9-Whippany River	1-Troy Brook 2-West Brook 3-Eastmans Brook 4-Black Brook 5-Malapardis Brook 6-Washington Valley Brook

STA. NO.	WATER BODY	LOCATION
013915	SADDLE RIVER	LODI
013898.8	PASSAIC RIVER	ELMWOOD PARK
013895	PASSAIC RIVER	LITTLE FALLS
013890	POMPTON RIVER	TWO BRIDGES
013885	POMPTON RIVER	POMPTON PLAINS
013880	RAMAPO RIVER	POMPTON LAKES
013818	WHIPPANY RIVER	PINE BROOK
013812	ROCKAWAY RIVER	PINE BROOK
013795	PASSAIC RIVER	CHATHAM
013790	PASSAIC RIVER	MILLINGTON



Passaic River Study N.Y. & N.J.

WATER QUALITY MONITORING STATIONS

FIGURE II

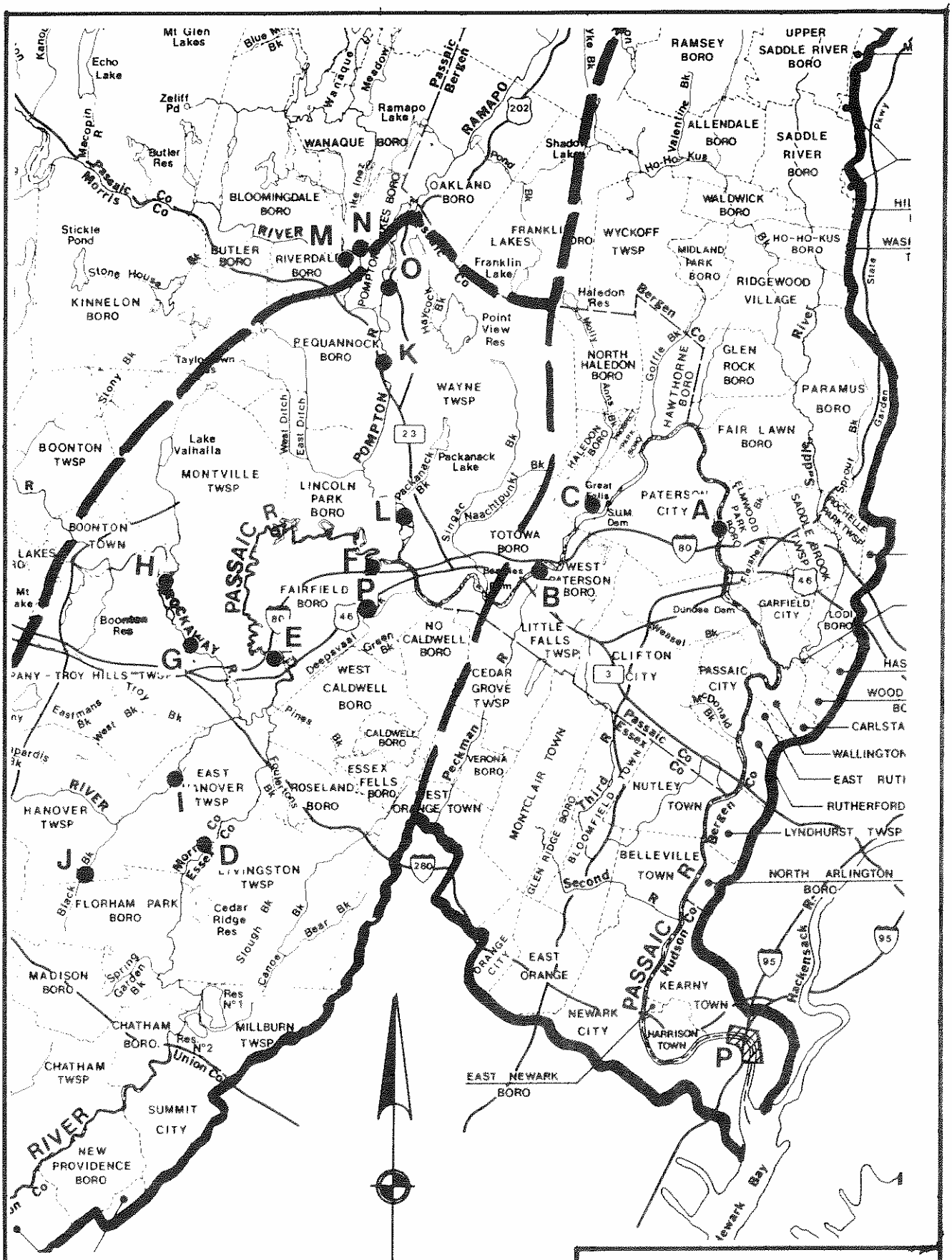


FIGURE 12

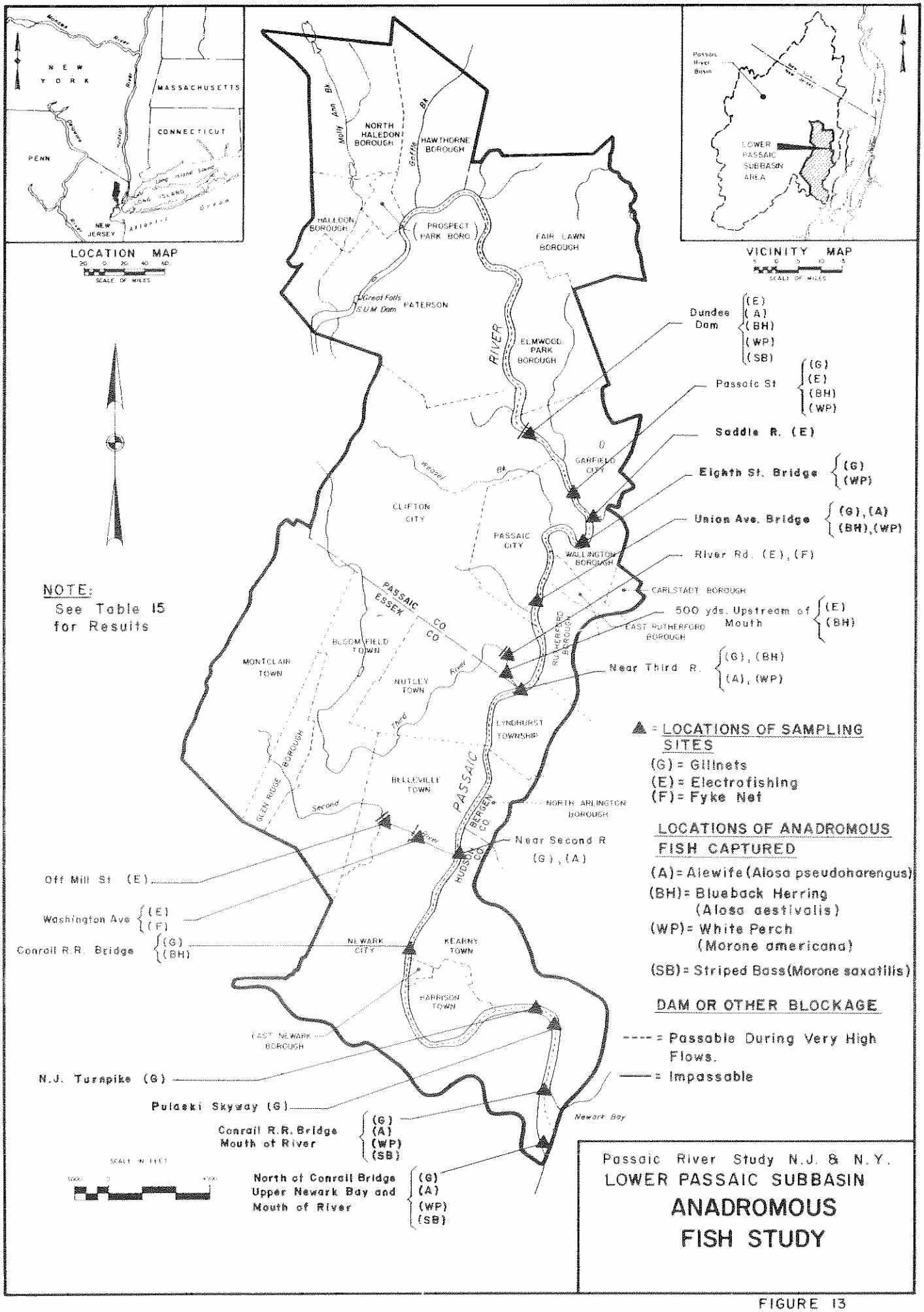
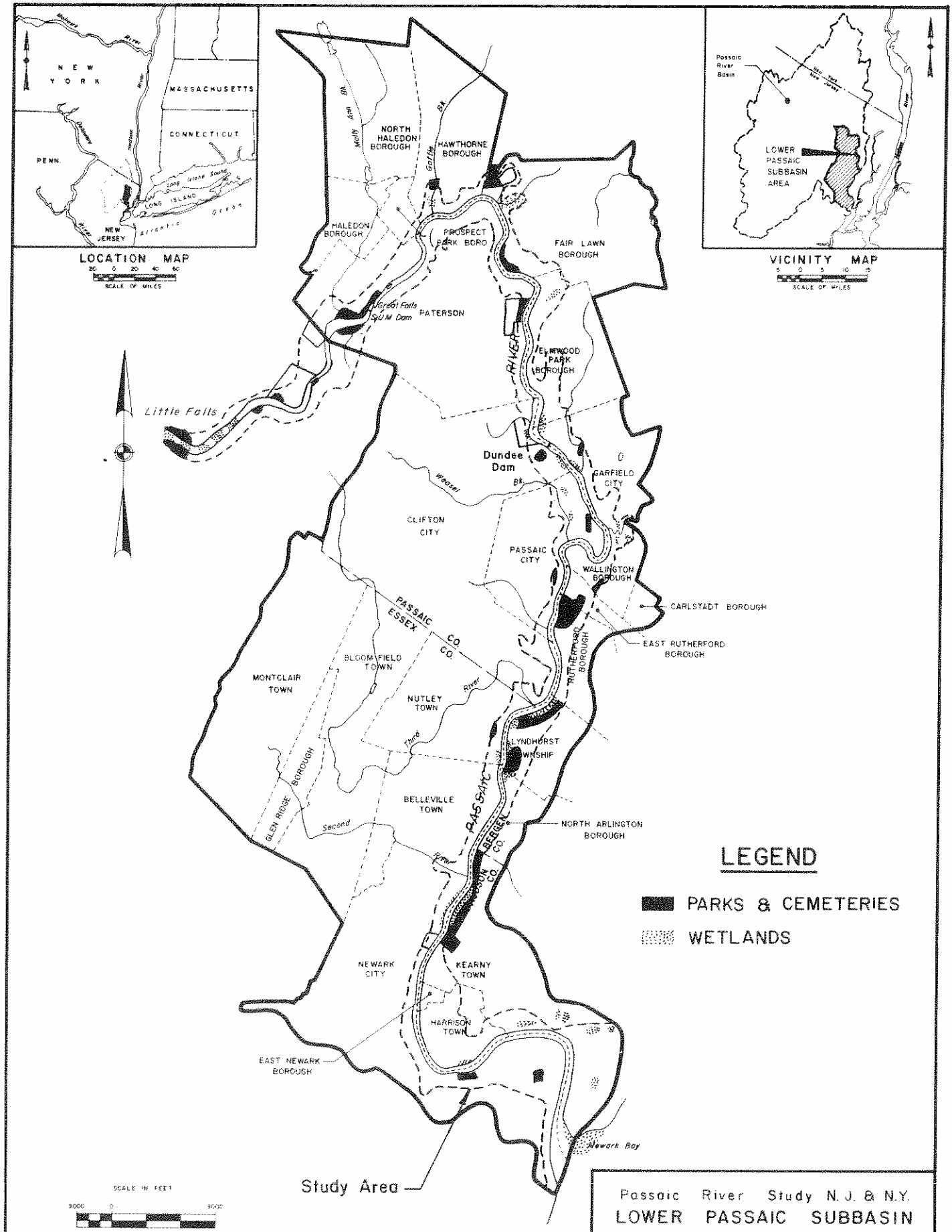

LOCATION MAP
NEW YORK
MASSACHUSETTS
CONNECTICUT
PENN
NEW JERSEY
LONG ISLAND
VICINITY MAP
LOWER PASSAIC SUBBASIN AREA
NORTH HALEDON BOROUGH
HAWTHORNE BOROUGH
HALEDON BOROUGH
PROSPECT PARK BORO
FAIR LAWN BOROUGH
Great Falls U.S.D.M. Dam
PATERSON
ELMWOOD PARK BOROUGH
RIVER
GARFIELD CITY
CLIFTON CITY
PASSAIC CITY
WALLINGTON BOROUGH
CARLSTADT BOROUGH
EAST RUTHERFORD BOROUGH
RUTHERFORD BOROUGH
MONTCLAIR TOWN
BLOOMFIELD TOWN
NUTLEY TOWN
LYNDHURST TOWNSHIP
GLEN RIDGE BOROUGH
BELLEVILLE TOWN
NORTH ARLINGTON BOROUGH
NEWARK CITY
KEARNY TOWN
HARRISON TOWN
EAST NEWARK BOROUGH
PASSAIC CO.
ESSEX CO.
BERGEN CO.
HUDSON CO.
Newark Bay
NOTE:
See Table 15
for Results
Dundee Dam (E) (A) (BH) (WP) (SB)
Passaic St (G) (E) (BH) (WP)
Saddle R. (E)
Eighth St. Bridge (G) (WP)
Union Ave. Bridge (G), (A) (BH), (WP)
River Rd. (E), (F)
500 yds. Upstream of Mouth (E) (BH)
Near Third R. (G), (BH) (A), (WP)
Near Second R (G), (A)
Off Mill St (E)
Washington Ave (E) (F)
Conrail R.R. Bridge (G) (BH)
N.J. Turnpike (G)
Pulaski Skyway (G)
Conrail R.R. Bridge Mouth of River (G) (A) (WP) (SB)
North of Conrail Bridge Upper Newark Bay and Mouth of River (G) (A) (WP) (SB)
▲ = LOCATIONS OF SAMPLING SITES
(G) = Gillnets
(E) = Electrofishing
(F) = Fyke Net
LOCATIONS OF ANADROMOUS FISH CAPTURED
(A) = Alewife (Alosa pseudoharengus)
(BH) = Blueback Herring (Alosa aestivalis)
(WP) = White Perch (Morone americana)
(SB) = Striped Bass (Morone saxatilis)
DAM OR OTHER BLOCKAGE
---- = Passable During Very High Flows.
—— = Impassable
Passaic River Study N.J. & N.Y.
LOWER PASSAIC SUBBASIN
ANADROMOUS FISH STUDY

FIGURE 13



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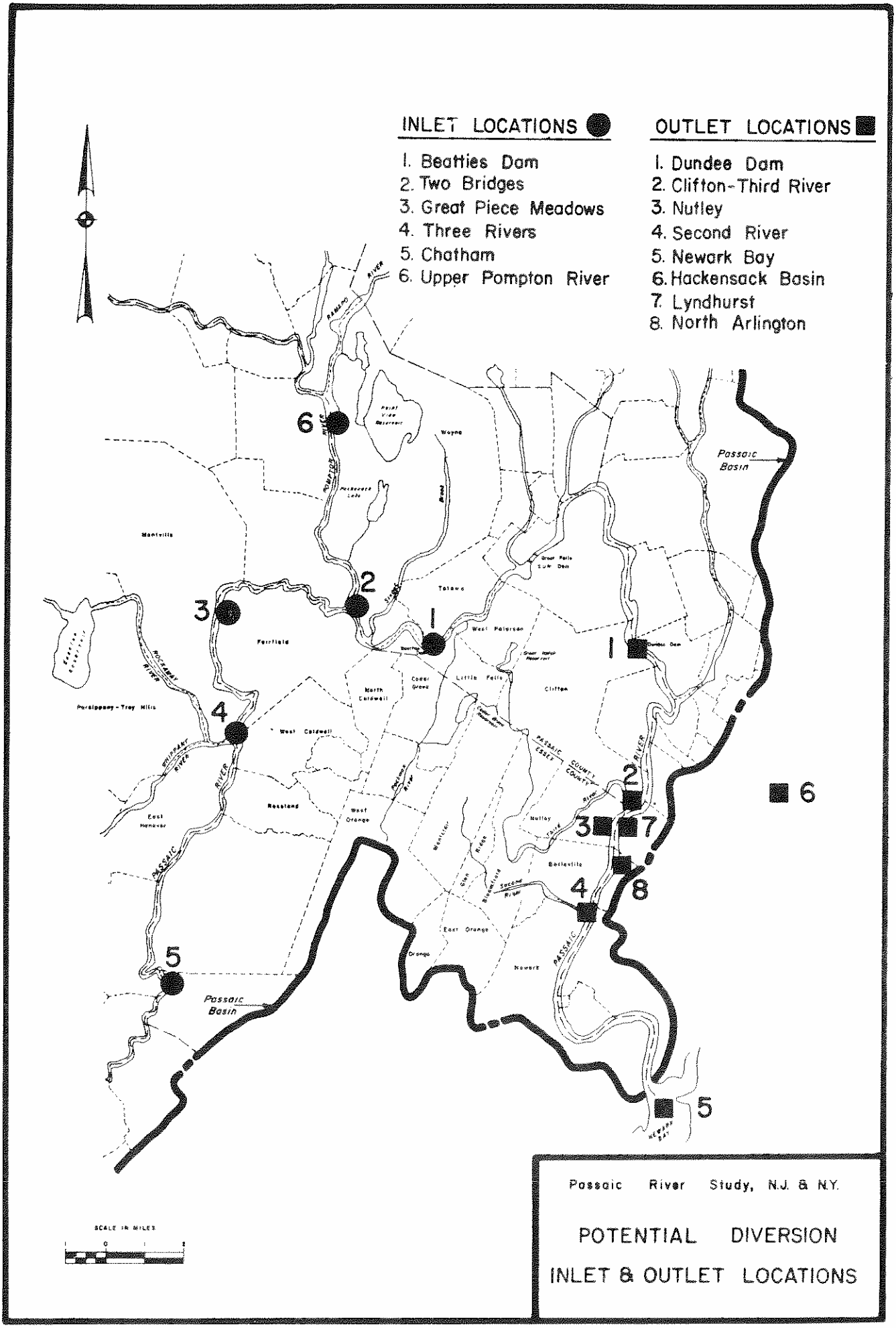
LOWER PASSAIC SUBBASIN

WETLANDS, PARKS AND CEMETARIES

FIGURE 14



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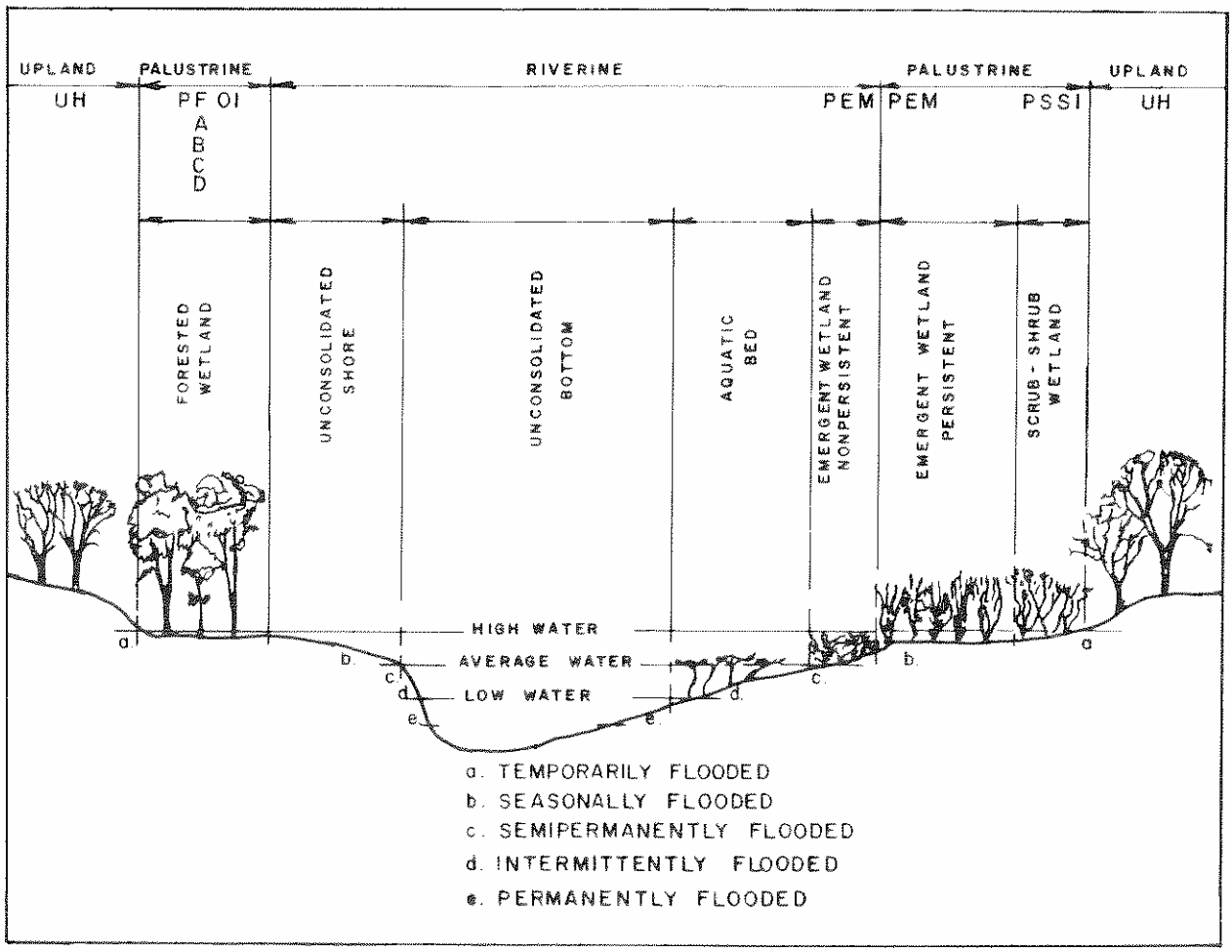
POTENTIAL DIVERSION
INLET & OUTLET LOCATIONS

FIGURE 15



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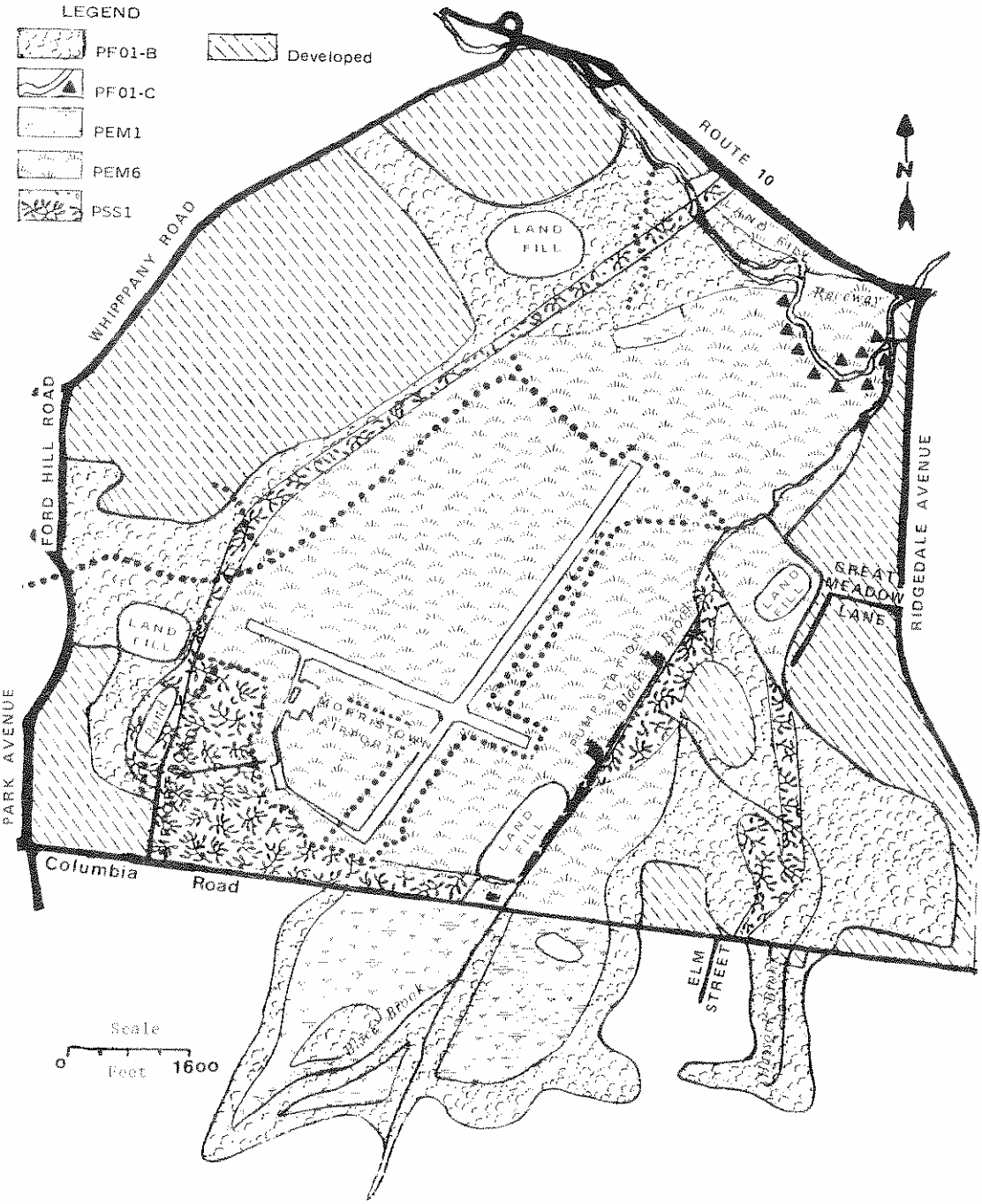
Typical RIVERINE SYSTEM HABITATS

FIGURE 16



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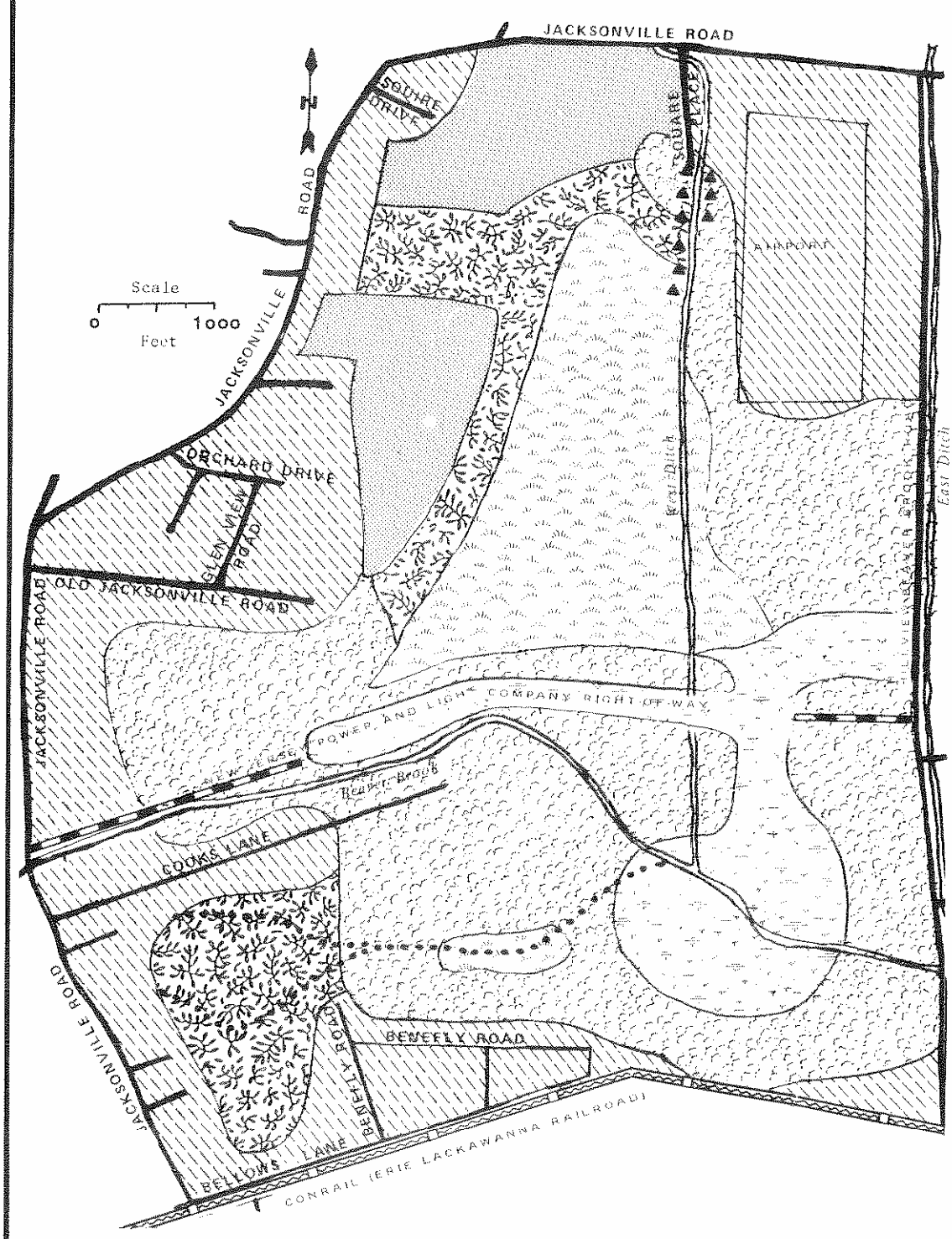
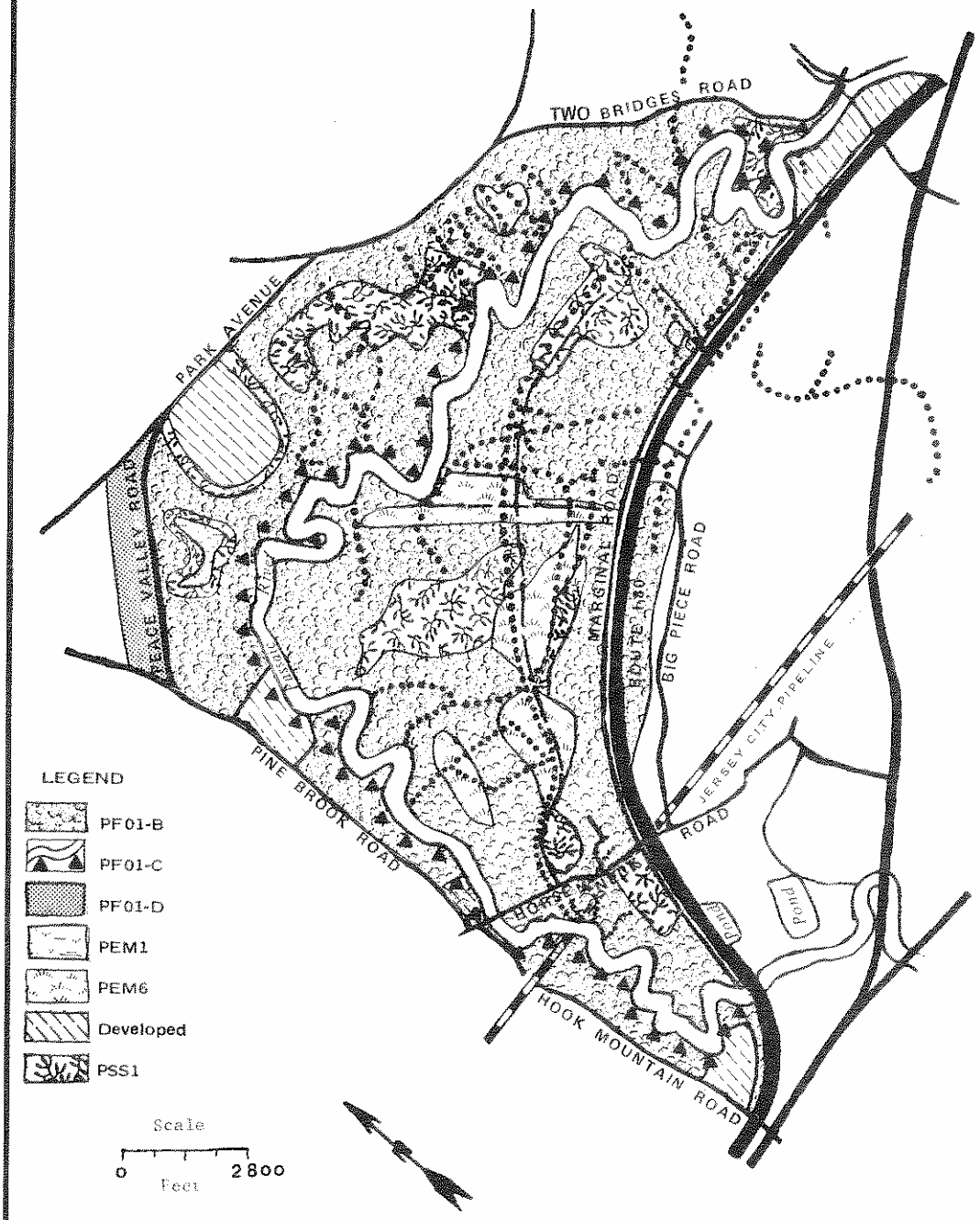
VEGETATION MAP OF BLACK MEADOW

FIGURE 17



Passaic River Study, N.J. & N.Y.

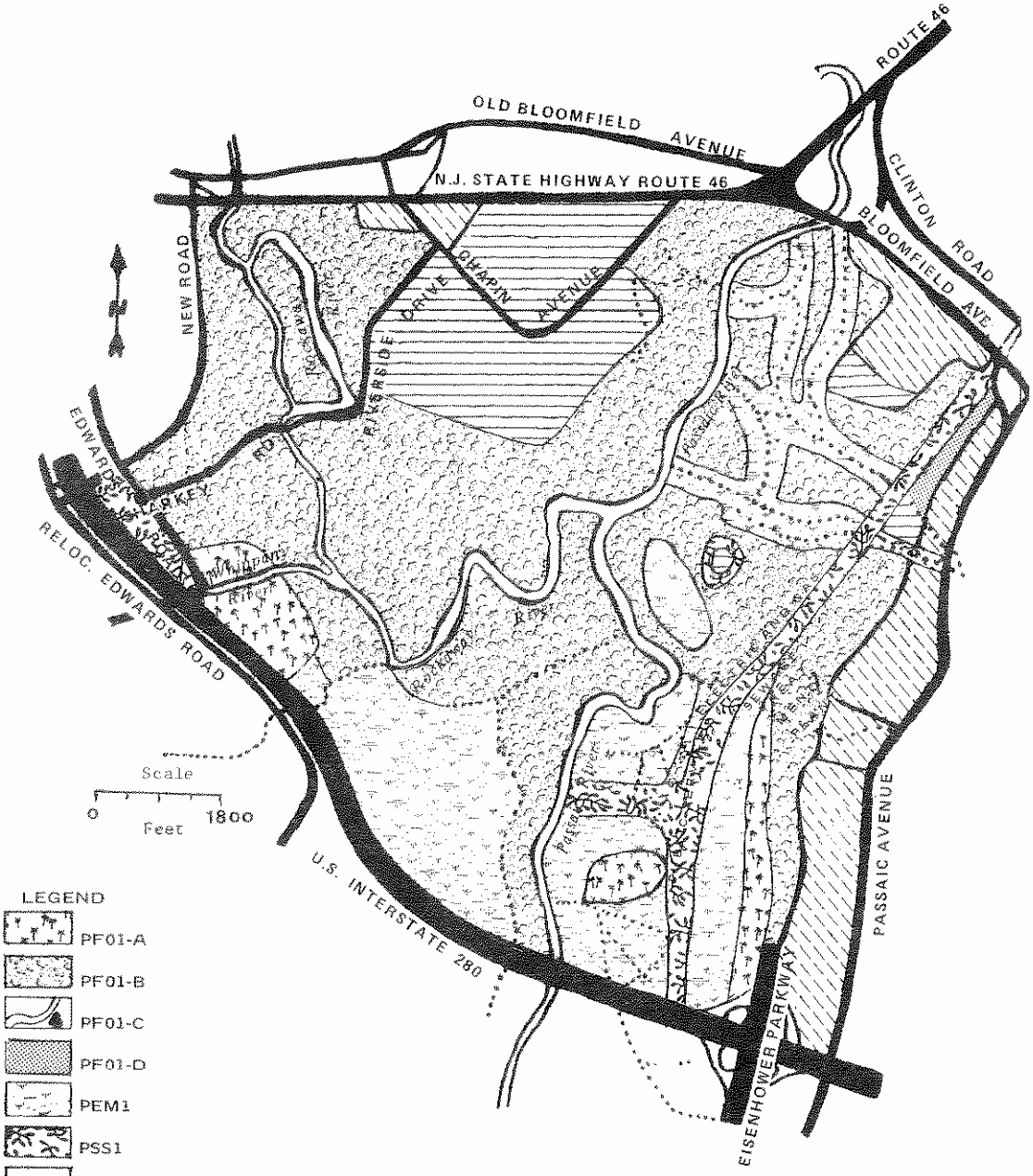
VEGETATION MAP OF BOG AND VLY MEADOW



Passaic River Study, N.J. & N.Y.

VEGETATION MAP OF GREAT PIECE MEADOW

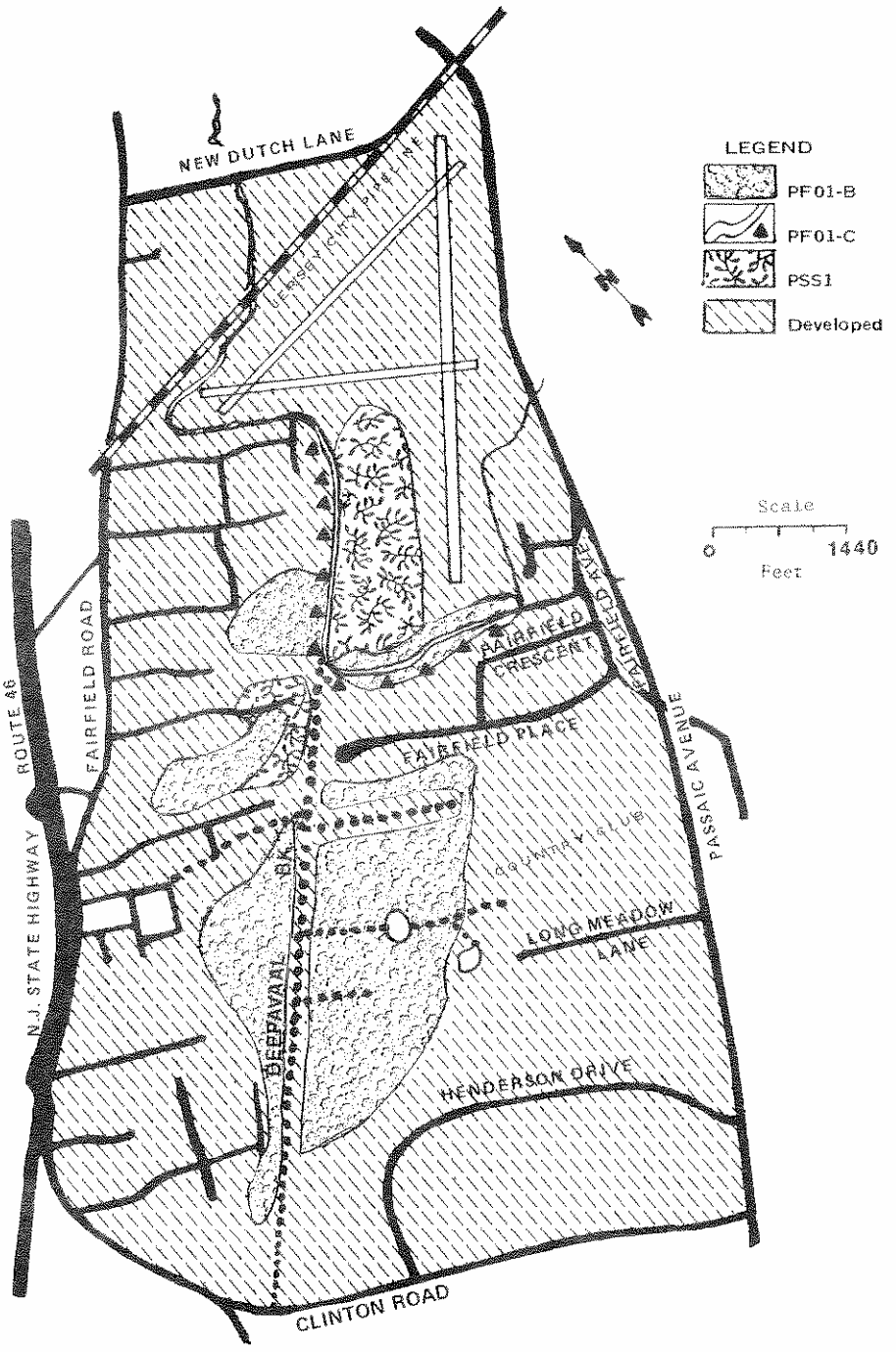
FIGURE 19



Passaic River Study, N.J. & N.Y.

VEGETATION MAP OF HATFIELD SWAMP

FIGURE 20



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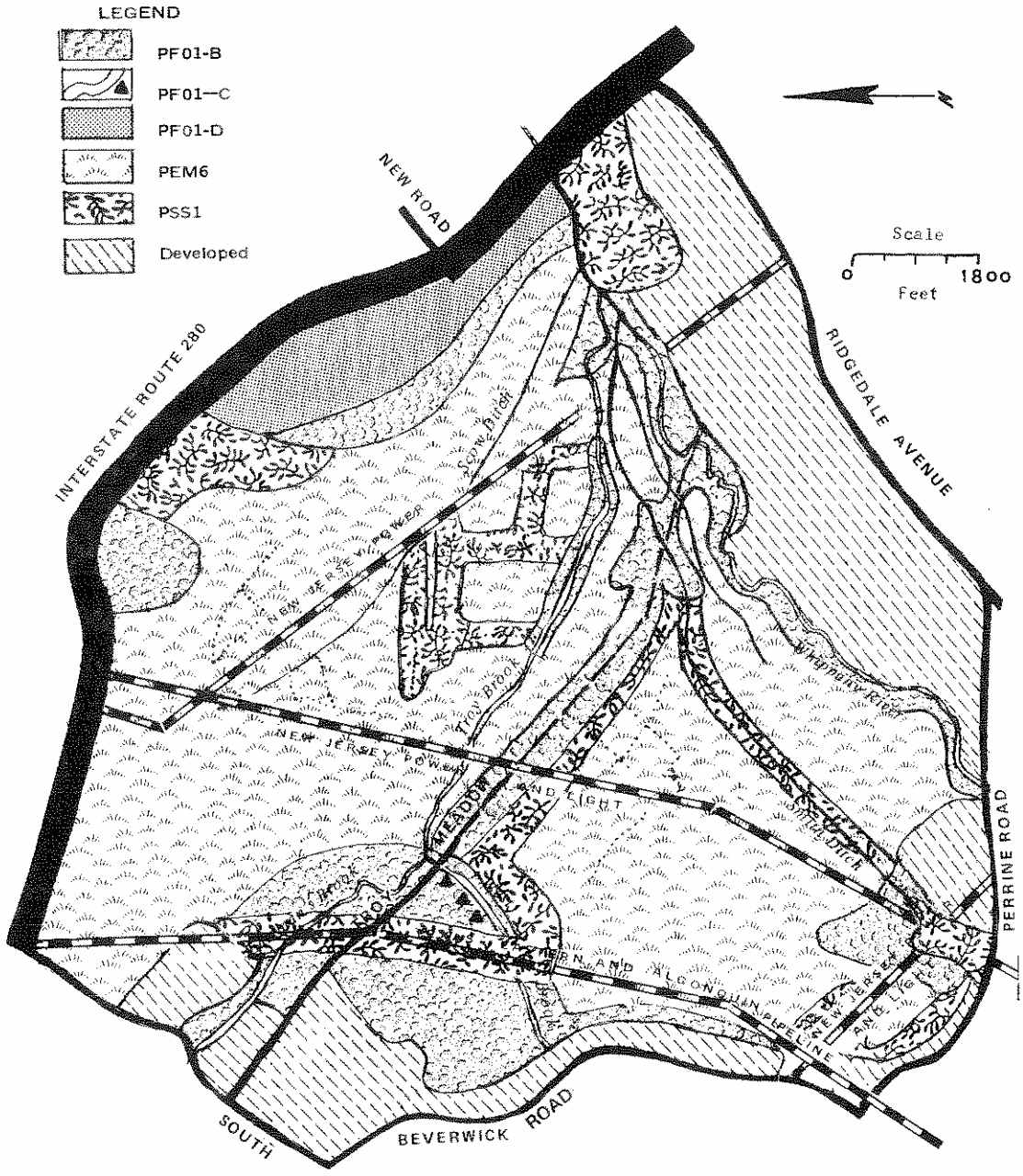
VEGETATION MAP FOR LONG MEADOW

FIGURE 21



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VEGETATION MAP OF TROY MEADOW

FIGURE 22

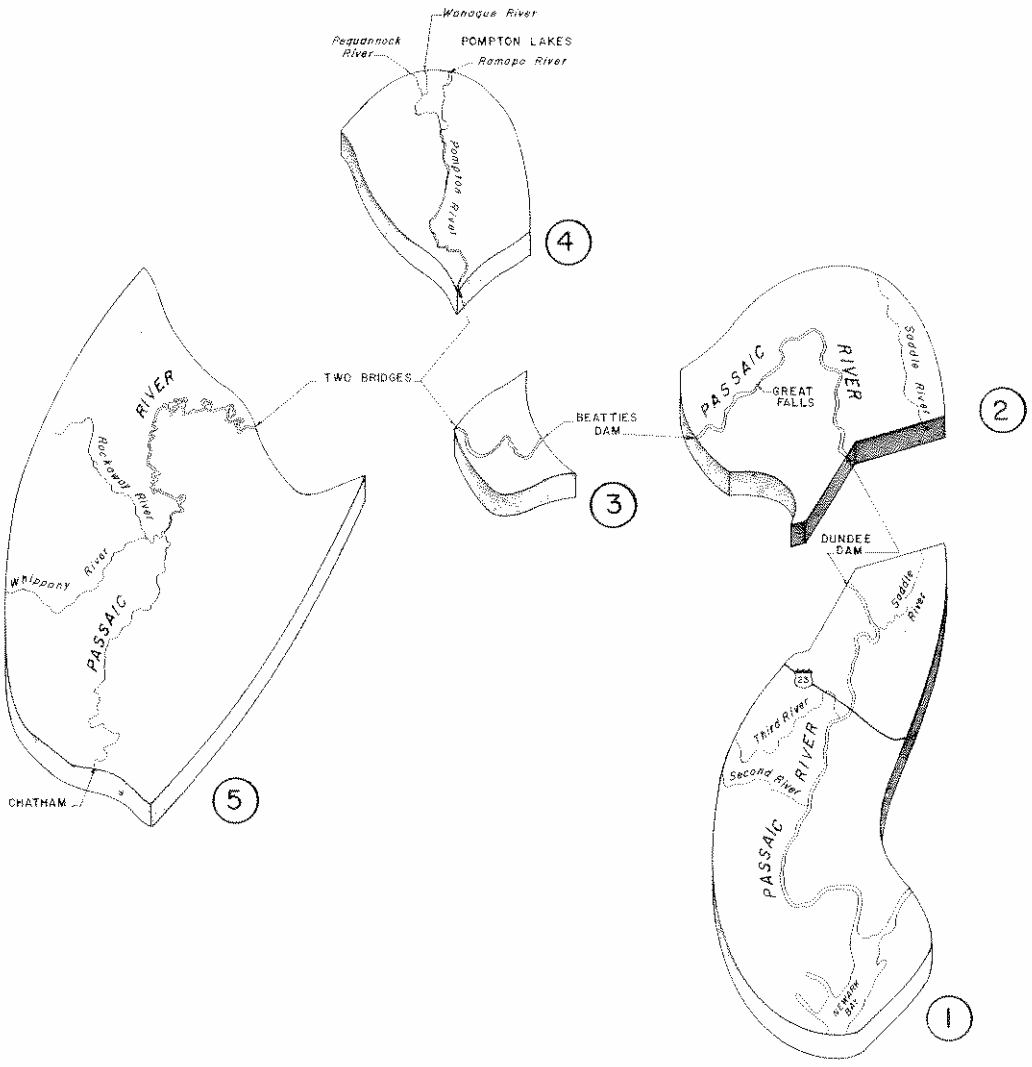
REACH-1 = MOUTH — DUNDEE DAM

REACH-2 = DUNDEE DAM — BEATTIES DAM

REACH-3 = BEATTIES DAM — TWO BRIDGES

REACH-4 = POMPTON VALLEY

REACH-5 = TWO BRIDGES — CHATHAM



Passaic River Study N.J. & N.Y.

IMPACT ASSESSMENT REACHES

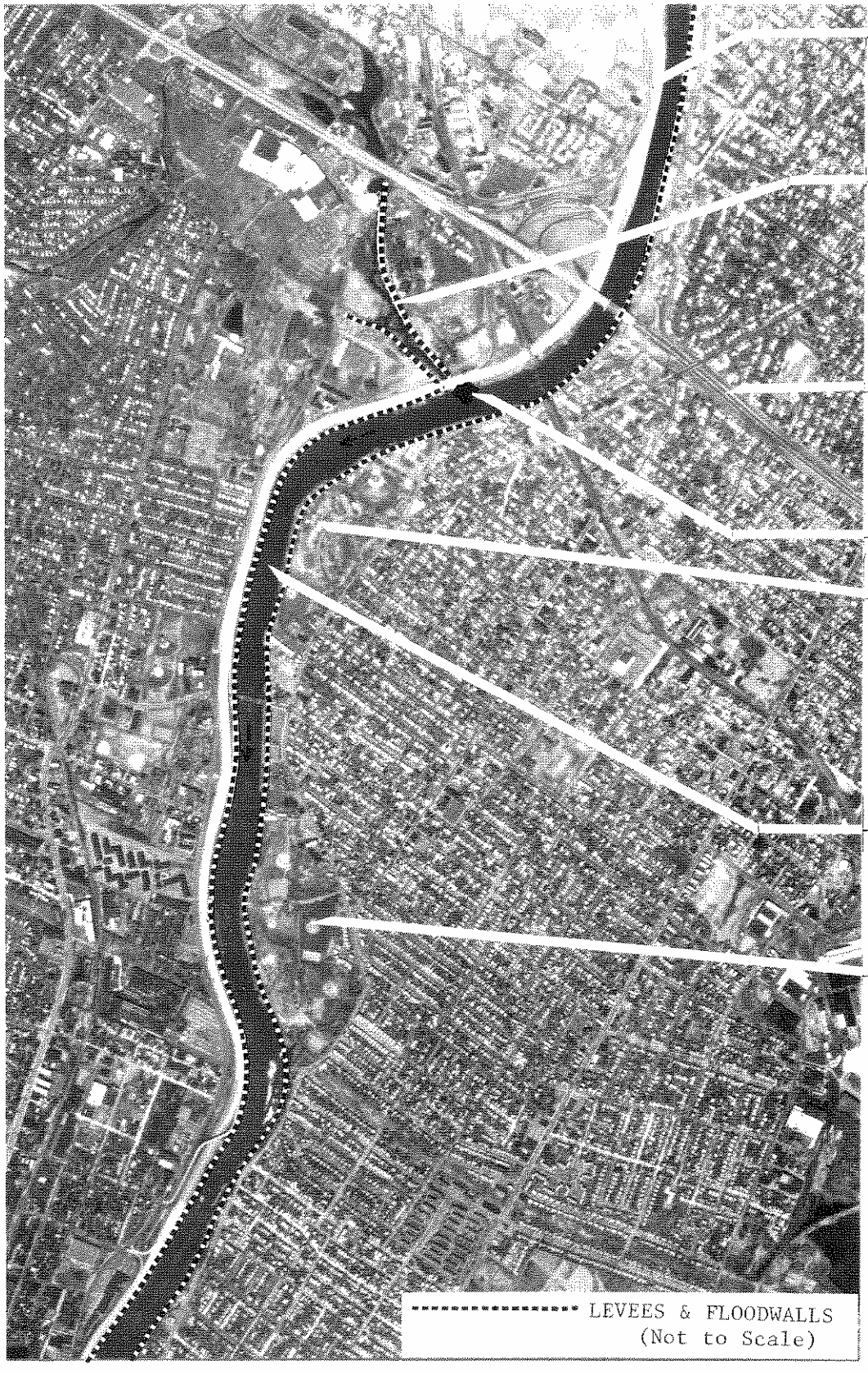
FIGURE 23



Passaic River Study, N.J. & N.Y.

MODEL OF PROPOSED PASSAIC RIVER OUTLET

FIGURE 24



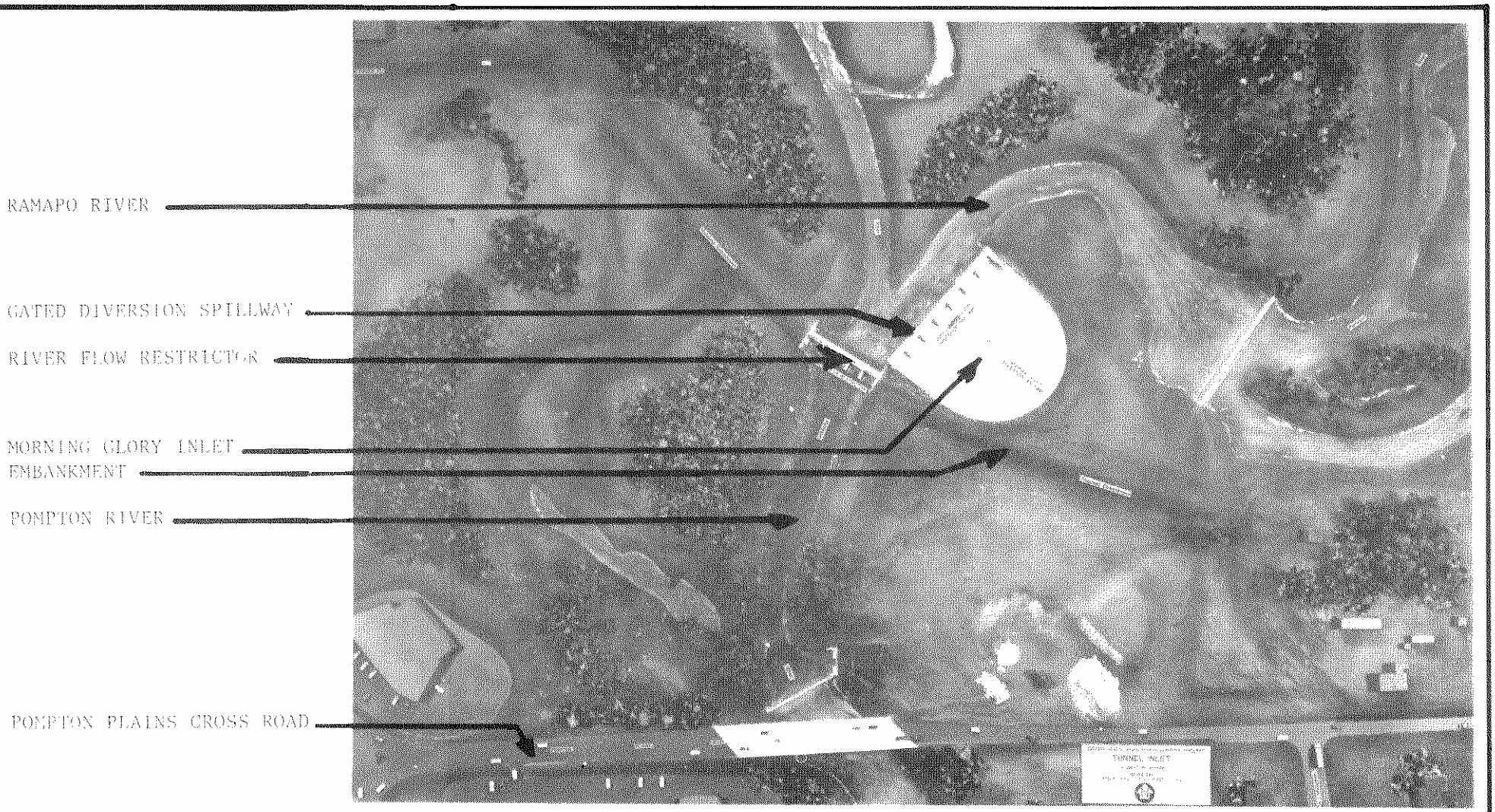
FOR DETAILED PROJECT DRAWINGS SEE FIGURES 27 and 58 OF THE MAIN REPORT.

1 INCH = 1,667 FEET = 0.32 MILE

Passaic River Study, N.J. & N.Y.

AERIAL PHOTO OF OUTLET SITE REACH 1

FIGURE 25



Passaic River Study, N.J. & N.Y.

MODEL OF PROPOSED POMPTON RIVER INLET REACH-4

FIGURE 26



CHANNEL MODIFICATIONS WOULD BEGIN AT THE INLET AND EXTEND UPSTREAM FOR 2.6 MILES ON THE PEQUANNOCK RIVER, 1 MILE ON THE WANAQUE RIVER AND FOR 1.2 MILES UP THE REROUTED RAMAPO RIVER.

FOR DETAILED PROJECT DRAWINGS SEE FIGURES 46,47,48,49 and 58 OF THE MAIN REPORT.

1 INCH = 1,667 FEET = 0.32 MILE

Passaic River Study, N.J. & N.Y.

AERIAL PHOTO OF POMPTON RIVER INLET REACH 4

FIGURE 37



PASSAIC RIVER

STA. 1693+00

PROPOSED MORNING GLORY INLET

PROPOSED GATED DIVERSION SPILLWAY

TWO BRIDGES

POMPTON RIVER

GREAT PIECE WEIR

GREAT PIECE MEADOWS

LITTLE PIECE MEADOWS (Developed)

REFERENCE POINT TO FIGURE 29

TRANSITION CHANNEL WILL BEGIN AT THE RT. 46 BRIDGE AND EXTEND UP THE PASSAIC RIVER FOR 0.8 MILE AND UP THE POMPTON RIVER FOR 0.3 MILE.

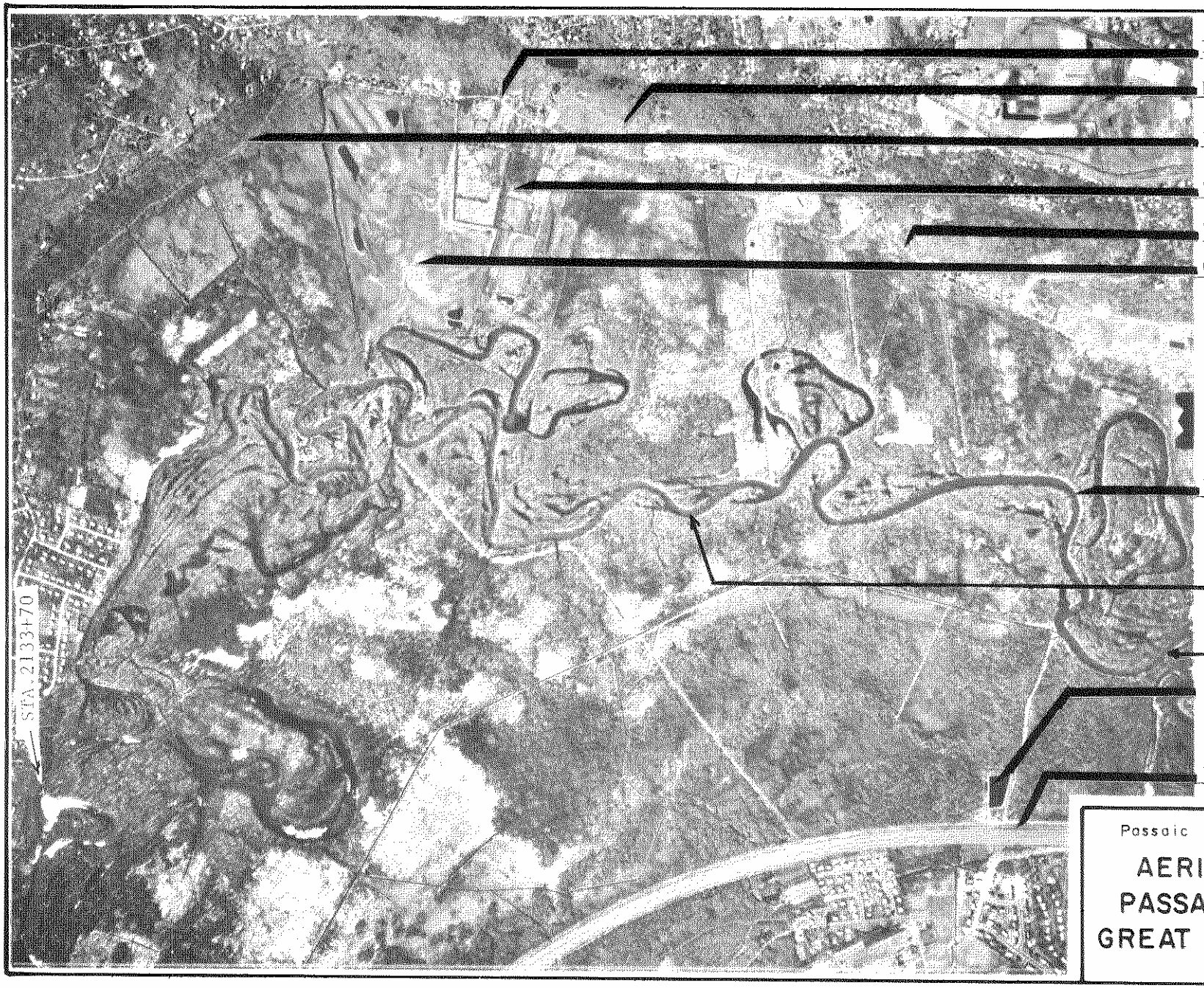
FOR DETAILED PROJECT DRAWINGS SEE FIGURES 35,59 and 60 OF THE MAIN REPORT.

1 INCH = 1,667 FEET = 0.32 MILE

Passiac River Study, N.J. & N.Y.

AERIAL PHOTO OF PASSAIC RIVER INLET SITE, REACH 3

FIGURE 28



Passaic River Study, N.J. & N.Y.

AERIAL PHOTO OF PASSAIC RIVER AND GREAT PIECE MEADOWS

FIGURE 29

CHAPTER 9. RECOMMENDATIONS

I recommend that the plan of improvement for the Main Stem Passaic River in New Jersey, selected herein for flood control purposes, be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable. This project, known as the Pompton/Passaic Dual Inlet Tunnel Diversion Plan, has a first cost to the United States presently estimated at $622,500,000. The exact amounts of Federal and non-Federal contributions shall be determined by the Chief of Engineers, subject to cost sharing and financing arrangements satisfactory to the President of the United States and the Congress. This recommendation is made with the provision that non-Federal interests will fulfill the requirements of law for this type of project and agree to comply with the following requirements:

a. Provide without cost to the United States all lands, easements and rights-of-way, exclusive of lands for fish and wildlife mitigation, including borrow, ponding, and disposal areas determined suitable by the Chief of Engineers and necessary for implementation and maintenance of the project;

b. Accomplish without cost to the United States all alterations and relocations of buildings, transportation facilities, storm drains, utilities and other structures and improvements made necessary by implementation of the project;

c. Provide all lands, easements, and rights-of-way, and relocations, alterations and dredged material disposal areas determined by the United States to be necessary for construction of the project, and a cash contribution of at least five (5) percent of total flood control costs, so that the total value of the non-Federal contributions will not be less than twenty-five (25) percent of total costs assigned to flood control; provide twenty-five (25) percent of the costs of nonstructural project components; and provide thirty-five (35) percent of the costs assigned to hurricane and storm damage reduction;

d. Hold and save the United States free from damages due to the construction works, not to include damages due to the fault or negligence of the United States or its contractors;

e. Acquire all lands for fish and wildlife mitigation, sharing in their cost and the cost of development of fish and wildlife mitigation in the same proportion as the non-Federal share of the costs of the project elements which caused the requirement for mitigation;

f. Maintain and operate the project after completion, including fish and wildlife mitigation features, in accordance with regulations prescribed by the Secretary of the Army;

g. Prior to initiation of construction, prescribe and enforce regulations or other floodplain management techniques designed to maintain existing Central Basin floodway delineations in the areas of natural storage acquisition and to prevent obstruction or encroachment on floodplain storage, channels, and rights-of-way, which would reduce their flood-carrying capacity or would interfere with maintenance and operation of the project and to control development in the project area to prevent an increase in flood damage potential;

h. Publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project; and

i. At least annually, inform affected interests regarding the limitations of the protection afforded by the project.

j. Comply with the applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved January 2, 1971, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act; and

k. Comply with all applicable Federal and State laws and regulations, including section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-352) and Department of Defense Directive 5500.II issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, as well as Army Regulation 600-7, entitled "Non-discrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

MARION L. CALDWELL, Jr.
Colonel, Corps of Engineers
Commanding

ADDENDUM 1

Section 404 (b) (1) Evaluation

PASSAIC RIVER AND TRIBUTARIES, NEW JERSEY
PHASE I GENERAL DESIGN MEMORANDUM

SECTION 404(b)(1) Evaluation

In order to implement the requirements of Section 404 of the Clean Water act, an exemption is being sought under Section 404(r) as part of the authorization process by including the Section 404(b)(1) evaluation to this Phase I General Design Memorandum and EIS. The Corps has found that this project is in conformance with the 404(b)(1) guidelines.

FINDING OF COMPLIANCE FOR THE PASSAIC RIVER
AND TRIBUTARIES, NEW JERSEY FLOOD CONTROL PROJECT

1. No significant adaptation of the guidelines were made relative to this evaluation.

2. A number of upland disposal sites are available for this project since the excavated material passed the E.P, Toxicity tests. Upland sites are identified in the EIS. One or more would be the candidate sites. Use of diversion structures (e.g. cofferdams or sheet piling) and dewatering methods would ensure that the excavated riverbottom material would not return to the river.

3. The upland disposal and channel fill sites would not violate State criteria or pose a threat to potable water. There would be an increase in ammonia and other organic components (see Natural Resources Appendix Table B-45) as a result of channel excavation due to high concentrations of these constituents in the bottom sediment. Ammonia would increase enough to cause substantial added stress to the aquatic biota. This effect would only be temporary and removal of bottom sediment may reduce water column contaminant levels in the long term. Additionally, dissolved oxygen (D.O.) would decrease during construction and river temperatures during the summer months would increase due to loss of riparian cover.

4. Use of the selected disposal sites would not harm any endangered species nor their critical habitats nor violate protective measures for any of the disposal sites.

5. The proposed disposal of dredged material would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife would not be adversely affected permanently. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values would not occur, as a result of dredged material disposal.

6. Appropriate steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem include: use of silt screens, diversion structures, and soil filter fabrics.

7. On the basis of the guidelines, the proposed disposal site for the discharge of dredged material is specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystems.

404 (b)(1) EVALUATION

I. PROJECT DESCRIPTION

A. Location

The Passaic River Basin encompasses 935 square miles in northern New Jersey and southeastern New York State (Figure 5). Eighty-four percent of the Basin lies in New Jersey, including all or parts of Passaic, Bergen, Morris, Essex, Sussex, Hudson, Union, and Somerset counties, while sixteen percent of the watershed lies in New York State, occupying parts of Rockland and Orange counties. (Figure 1) The watershed is elliptical in shape, 56 miles long and 26 miles wide, with its long axis running in northeast-southwest. The basin is drained by the Passaic River and its seven major tributaries: the Saddle, Pompton, Ramapo, Pequannock, Wanaque, Rockaway and Whippany rivers (Figure 2). The flood problem area lies along the Passaic River Mainstem from its mouth in Newark Bay, upstream for 72 miles to its confluence with the Dead River. This floodplain comprises more than 85 square miles and 50 municipalities. The Passaic River above Chatham was screened from further consideration of flood damage reduction measures early in the study because of a lack of economically feasible plans. The major flood damage areas lie downstream of Chatham to the mouth of the Passaic River, along the entire Pompton Valley, and along the lower reaches of the other major tributaries. For detailed locations of project elements see Main Report text, and Figures in EIS.

B. The proposed flood control project for the Main Stem Passaic River and its tributaries includes the structural elements;

Tunnel Elements

- Inlet on the Pompton River just upstream of Pompton Plains Cross Road which contains a diversion spillway, surrounding berms and wing levees, including an instream flow restrictor.

- Inlet on the Passaic River just downstream of the confluence of the Pompton and Passaic Rivers with berm and diversion spillway.

- Outlet on the right bank of the Passaic River just upstream of the Third River

- A main tunnel 13.5 miles long, 39 feet in diameter from Pompton Plains to Nutley, N.J.

- A spur tunnel 1.2 miles long, 22 feet in diameter in Wayne, N.J.

Levee/Floodwall Elements

- Lower Valley - Levee---------- 11.2 miles
- Lower Valley - Floodwall---------- 12.8 miles
- Central Basin - Levee---------- 9.0 miles
- Central Basin - Floodwall---------- 0.5 mile
- Pompton Valley - Levee ---------- 3.5 miles
- Pompton Valley - Floodwall ---------- 0.7 mile
- Lower Valley - Pond Area ---------- 207 acres
- Central Basin - Pond Area ---------- 571 acres
- Pompton Valley - Pond Area ---------- 71 acres

Channel Modification Elements

- Passaic River 0.8 mile - from about Route 46 Bridge upstream

- Pompton River 0.3 mile - from confluence with Passaic River upstream

- Pequannock River 2.6 miles - upstream from its confluence with the Pompton River

- Wanaque River 1.0 mile - upstream from its confluence with the Pequannock River

- Ramapo River 1.2 miles - upstream from its confluence with the Pequannock River

The majority of the project which involves the tunnel is located underground away from water courses and, therefore, is not a part of this evaluation. Most of the intake structures and their supporting elements do interact with the waterways and are addressed in this document.

The levees and floodwalls are addressed in this document although the majority of levees in the Central Basin are setback from water bodies and will not affect them.

Channel modifications which will affect about 5.9 miles of the Passaic River and its streams are addressed in this document.

C. Authority and Purpose

1. The Passaic River Basin Study, a Phase I Advanced Engineering and Design study, is being accomplished under the authority of Section 101(a) of the Water Resources Development Act of 1976 (Public Law 94-587). A map of the Passaic Basin is presented as Figure 4 of the Main Report.

2. The purpose of the project is to provide flood protection for residents in the Central Basin and Lower Valley, and eliminate damages to approximately 20,620 structures in the 100 year floodplain (500yr. in some tidal reaches.)

D. General Description of Materials

1. General Characteristics of Materials (See Tables B-45 and B-46 in Appendix B)

2. Quantity of Material:

Some 80 acres of leves would be placed in wetlands. The acres are given for this element since the coverage of the wetlands is of primary concern. About 115,000 cu. yds. of concrete would be utilized for floodwalls, (about 10 acres) 850 cu. yds. of concrete at the Pompton River flow restrictor, 1,500 cu. yds. for the Pompton River diversion spillway, and 2,400 cu. yds. for the spur tunnel diversion spillway, and 2,500 cu. yds. of concrete for the outlet structure, as well as 205 cu. yds. of concrete for the Great Piece Meadows Weir and 335 cu. yds. for the Pequannock River Weir. The concrete would be poured using cofferdams; therefore, no discharge into the waterway would occur. Riprap would be placed in the Passaic River at the outlet 4,220 cu.yds, and in the Pequannock River 27,465 cu.yds. Cobble (32,000 cu.yds) would be placed to help offset habitat losses. Additionally, 2,000 cu.yds of riprap would be placed for fish habitat structures.

3. Source of Material:

The source of material to line the channel would come from existing supply or cobble in the river, and cobble-sized tunnel material.

E. Description of the Proposed Discharge Sites

1. Location:

Most of the disposal of channel and tunnel-excavated material would occur at upland sites. The remainder would be sold or used in construction, except for cobble from the various reaches which would be returned to the stream, and tunnel-excavated material to be used (approximately 32,000 cu. yds.) for habitat maintenance and improvement. (See Figures EIS-25, 27 and 28). Areas for concrete placement for inlets, outlets, flow restrictors and weirs can be found in the Main Report (see Figures 25-59).

2. Size

a. 80 acres of wetlands would be filled due to levee placement .

b. About 31,700 cu.yds. of riprap would be placed for erosion.

c. About 32,000 cu.yds. of additional cobble (2"-4") would be placed to offset adverse habitat change.

d. About 2,000 cu.yds. of riprap sized material would be placed for fish habitat structures.

Size of extra (tunnel) cobble would range from 2" to 4" and be elliptical in shape.

3. Type of Disposal Site:

River. Placement of extra cobble on the channel bottom would be by use of crane or bulldozer, depending upon location.

4. Type(s) of Habitat:

Riverine Habitat - some inadvertent, spillage of excavated material would occur.

The disposal site for unsold excavated river substrate would be at an appropriate upland site.

5. Timing and Duration of Discharge:

This project would take 7.5 years to complete.

The project in the channel modification area by Two Bridges would take about 6 months to complete. The project in the channel modification area above Pompton Inlet would take about 2 years to complete.

F. Description of Disposal Method

Cofferdams or sheetpiling would be used to form dry areas to work in channels, as well as for floodwalls, and other concrete structures.

The location of the cofferdams and sheetpilings for floodwalls and tunnel elements can be found on Table 19a-c in the Main Report (Volume 1). It should be noted that a vast majority of the floodwall cofferdams would be located in the Lower Valley, below Dundee Dam. Other places where cofferdams would be used include: - the Pompton River flow restrictor, Pompton River diversion spillway, Two Bridges diversion spillway, Passaic River outlet, the Great Piece Meadows, and Pequannock Weirs.

The excavated material would be used for levees, concrete aggregate, sold, or would be disposed of at an upland site.

Discharge includes spillage during excavation.

About 205 cu. yds. of concrete would be used in the Great Piece Meadows Weir.

About 335 cu. yds. of concrete would be used in the Pequannock River Weir.

About 850 cu. yds. of concrete would be used in the Pompton River flow restrictor.

About 1,500 cu. yds. of concrete would be used in the Pompton River diversion spillway.

About 2,400 cu. yds. of concrete would be used in the Passaic River diversion spillway.

About 2,500 cu. yds. of concrete would be used for the outlet structure.

About 115,000 cu. yds. of concrete would be used in floodwalls.

About 31,700 cu.yds. of riprap would be used in the project reaches.

About 32,000 cu.yds. of additional cobble would be used in the project reaches.

About 2,000 cu.yds. of riprap sized material would be placed for fish habitat structures.

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope:

	Feet		%
Passaic River at Two Bridges----------	150.9	MSL, Slope	0.04
Pequannock River at 2,965 ft. above confluence with the Pompton-------	165.9	MSL, Slope	0.47
Pequannock River at 8,436 ft. above confluence with the Ramapo--------	168.6	MSL, Slope	0.47
Wanaque River at 2,110 ft. above confluence with the Pequannock----	173.0	MSL, Slope	0.17
Wanaque River at 5,215 ft. above confluence with the Pequannock----	180.6	MSL, Slope	0.26
Ramapo River at 7,230 ft. above confluence with the Pompton River-	164.3	MSL, Slope	0.23

2. Sediment Type:

The excavated material consists of gravel (21.6%), sand (73.9%), silts and clays (4.5%). Some of this meander material would be used to fill the straightened meander. (See Table B-46 of Appendix B for grain size analysis for ten sites.)

3. Dredge/Fill Material Movement:

Any fill material needed for levees in wetlands would be, in part, from excavated areas. Additional cobble (32,000 cu. yds.) would be added to the river bottom to help offset aquatic adverse effects.

4. Physical Effects on Benthos:

Removal of substrate by excavation would also remove benthic organisms. This would effectively remove all benthic macroinvertebrates during construction.

5. Other Effects:

None

6. Action Taken to Minimize Impacts:

Use of soil filter fabrics on bank side slopes to prevent erosion.

Use of silt screens in fill placement areas and downstream of excavation.

Cofferdams or sheetpiling would be used in areas where floodwalls, inlet diversion, and flow restrictor are placed.

B. Water Circulation, Fluctuation and Salinity Determinations:

1. Water Quality:

(a) Salinity - the reach of the river below Dundee Dam is tidal. A portion of this reach contains salinities in excess of 0.5 ppt. The river experiences two tidal cycles per day. The range in salinity is normally from a trace at the upstream terminus of effect to 15 ppt at the mouth of the Passaic River. By comparison, Newark Bay is about 18-19 ppt. The generally given boundary for the saline effect is the Second River. This boundary fluctuates, however, depending upon the tidal effects of astronomic and meteorologic phenomena (e.g. heavy rains and increased river flows would displace the saline effect further downstream).

(b) Water Chemistry - elutriate tests were performed on potential excavated material sites. And all passed.

(c) Clarity - reduced temporarily during construction

(d) Color - water would become mud-colored during construction

(e) Odor - no effect is expected

(f) Taste - Downstream of Little Falls, there will be no effect on water taste since no potable water supply is taken from the river. Potable water supply intakes do occur on the Pompton River and on the Passaic River at Little Falls. Any effects on taste as a result of the project would be temporary, occurring only during construction. Further use of filters at water intakes could be used to mitigate any taste changes.

(g) Dissolved Gas Levels - dissolved oxygen levels would decrease during construction due to the rise in biological and chemical oxygen demand.

(h) Nutrients - would increase in the water column during construction.

(i) Eutrophication - no effect is expected.

2. Current Flow and Water Circulation

(a) Current Patterns and Flow are fluvial from the upstream terminus of the project to Dundee Dam, and tidal from the base of the dam to the mouth of the Passaic River. There are two tidal cycles per day.

(b) Velocity at the time of the peak stage is 2.18 fps for the 1 year event just below Beatties Dam under without project condition. The average flow is 1161 cubic feet per second at the Little Falls, N.J. U.S.G.S. gage.

(c) Stratification - none

(d) Hydrologic Regime - generally, flowing waters from the upper end of the project downstream to mouth; then tidal waters to its mouth (Newark Bay) except just above Beatties Dam - Little Falls, S.U.M. Dam - Paterson, and Dundee Dam - Garfield.

3. Normal Water Level Fluctuation - Stages:

The overbank flooding, under existing conditions, varies at different points along the river. Existing elevations during the one year flood event for selected locations in the project area follow:

Location	River Station	Water height in feet of one year event (existing conditions) 1986
1. Passaic River at Two Bridges..	- 1693+00	163.1
2. Pequannock River at.....	- 29+65	170.0
3. Pequannock River at.....	- 84+36	182.7
4. Wanaque River at.....	- 21+10	185.7
5. Wanaque River at.....	- 52+15	188.8
6. Ramapo River at.....	- 72+30	180.6

Location	River Station	Water height in feet of one year event (project1/ conditions) 2040
1. Passaic River at Two Bridges..	- 1693+00	163.5
2. Pequannock River at.....	- 29+65	170.3
3. Pequannock River at.....	- 84+36	182.7
4. Wanaque River at.....	- 21+10	185.7
5. Wanaque River at.....	- 52+15	188.8
6. Ramapo River at.....	- 72+30	180.6

1/ Stages 'with project' in 2040, approximate existing stages due to ponding effect. However, since levees and floodwalls would be used on the tributary reaches, flood damages would be avoided.

4. Salinity Gradients - Salinity gradients within the Passaic River vary with astronomic and meteorologic phenomena. Generally, the gradient is from 0.5 ppt at Second River to 15ppt at the Passaic River mouth.

5. Action Taken to Minimize Impacts:

Use of soil filter fabrics on bank side-slopes to prevent erosion.

Silt screens would be used in the channel downstream of excavation and in the fill placement areas.

Cofferdams or sheetpiling would be used during concrete pouring for floodwalls, flow restrictors, and inlet diversion structures.

C. Suspended Particle/Turbidity Determinations

1. Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site:

No long-term effect.

2. Effect (degree and duration) on Chemical and Physical Properties of the Water Column:

No long-term effects are expected.

(a) Light Penetration - light penetration would be reduced during construction.

(b) Dissolved Oxygen - dissolved oxygen concentrations would be reduced during construction.

(c) Toxic Metals and Organics - No long-term effects are expected, but increases in ammonia and organics would occur temporarily during construction. Ammonia would substantially increase the risk of stress to remaining aquatic organisms. Removal of any contaminants has potential positive effects, in the long term.

(d) Pathogens - none

(e) Aesthetics - loss of some riparian habitat would occur, turbidity would temporarily increase and would reduce the aesthetic appeal of the river during construction.

3. Effects on Biota:

(a) Primary Production, Productivity - No impact

(b) Suspension/Filter Feeders - no long-term effects, but organisms would be removed during sediment excavation, others would be buried or have filter mechanisms clogged as a result of increased sediment transportation during construction. Use of habitat structures would help replace substrate and allow benthic organisms to reestablish.

(c) Sight feeders - no long-term effects, but sight predators would have reduced fields of vision caused by the increased turbidity during construction. With use of aquatic habitat structures, site feeders, such as fish which would leave during construction, should reestablish after construction completion.

4. Action Taken to Minimize Impacts:

Soil filter fabrics would be placed on bank slopes to prevent erosion.

Silt screens would be used in the channel adjacent to fill and downstream of construction areas.

Cofferdams or sheetpiling would be used to contain the effluent from poured concrete for floodwalls and inlet structures.

D. Contaminant Determinations

No long-term effects are expected.

E. Aquatic Ecosystem and Organism Determination

1. Effects on Plankton: No effect

2. Effects on Benthos:

Benthic organisms would be removed from excavated channel reaches during construction. After completion of the project these organisms would reestablish, aided by the use of habitat structures.

Some change in species composition of benthic organisms may occur due to warmer summer water temperature caused by loss of riparian habitat.

3. Effects on Nekton:

Construction would cause some covering of spawning areas of warmwater fish species, the loss of protective cover, and the elimination of most of the aquatic organisms from the channel construction area. After project completion, reestablishment of the biota would occur. Due to loss of some riparian tree shade, ambient water temperatures during leafout, May through September would occur. The most adverse effect would be on the Wanaque River where a marginal coldwater fishery is likely to be eliminated.

4. Effects on Aquatic Food Web:

Construction would cause a temporary decrease in productivity including the loss of spawning sites, and aquatic macroinvertebrates, and microinvertebrates.

5. Effects on Special Aquatic Sites:

(a) Sanctuaries and Refuges - N/A

(b) i. Wetland - approximately 80 acres of wetlands would be lost permanently as a result of fill associated with the implementation of this flood control project. Of this total, levees would account for 75 acres, and the spur tunnel for 5 acres. However, the project, as proposed, includes the re-creation or management of 80 acres of wetlands on project lands in order to help offset these losses.

ii. Wetlands - As part of the project, ponding areas in wetlands (590 acres) would require that vegetation be removed, and the area regraded, which may include use of minor amounts of fill during recontouring. However, the project as proposed calls for these lands to be replanted with wetland vegetation to help offset loss of original wetlands in the ponding areas.

(c) Mud flats - none

(d) Vegetated Shallows - none

(e) Coral Reefs - N/A

(f) Riffle and Pool Complex - These complexes would be eliminated during construction. After construction, use of specially constructed aquatic habitat structures, to restore some of the bottom configurations and substrate, would be employed.

6. Threatened and Endangered Species:

No Effect

7. Other Wildlife:

The fill used to create levees on wetland (10 acres below Beatties Dam, 20 acres in Pompton Valley, and 45 acres in the Central Basin and at the Passaic River Inlet (5 acres) would directly impact wildlife. Individuals of the species involved would die immediately or be displaced. Assuming that the carrying capacity of the surrounding area is at maximum, the displaced individuals may be expected to die or replace individuals present in surrounding areas, at which point they would be expected to succumb. Additionally, the 590 acres of ponding, while mostly tree and earth removal, may entail some minor filling on the periphery. These areas would be greatly altered from the existing cover type (mostly Palustrine Forested). The Corps has, therefore, included under standard engineering practice a plan to convert these areas into emergent wetland cover type, lowering the project's O&M cost and maintaining wildlife habitat. Thus, while the species composition would change substantially, wetlands and wildlife would still be supported in these areas.

8. Action Taken to Minimize Impacts

Use of weirs, silt screens, soil fabrics, cofferdams, and instream habitat structures.

F. Proposed Disposal Site Determinations

1. Mixing Zone Determinations:

(a) At floodwalls, cofferdams or sheetpiling would be used to prevent effluent from entering the water column.

The balance of the excavated material would be placed at an upland disposal site, or sold since E.P. Toxicity tests indicate the excavated material is not toxic.

(b) Current Velocity - None. - The tunnel cobble (32,000 cu. yds.) would be placed in the affected reach on the channel bottom. The floodwall sites would be dry during construction. Some horizontal mixing at riverbottom excavation sites would occur as a result of spillage. Cobble can be placed the at time of channel shaping (in the dry).

(c) Degree of Turbulence - The use of cofferdams would eliminate turbulence from some excavated fill, and concrete pouring areas.

(d) Stratification Attributable to Causes at Disposal Site - None.

(e) Discharge vessel speed and direction - not applicable (N/A).

(f) Rate of Discharge - N/A

(g) Ambient concentration of constituents of interest - None. Soils from riverbottom-excavated areas would be disposed of at upland sites. Cobble taken from the rivers would be stockpiled and used to re-create existing substrate conditions and, additionally, some 32,000 cu. yds. of tunnel cobble would be used to improve aquatic habitat. Further about 31,700 cu. yds. of riprap would be placed for erosion control. Additionally approximately 2,000 cu.yds. of riprap sized material would be placed for fish habitat structures.

(h) Fill material characteristics - The material would mostly be from riverbottom excavations. The majority would be sand (about 74%) and gravel (21%).

(i) Discharge actions/unit of time - N/A

2. Determination of Compliance with Applicable Water Quality Standards

(a) EP Toxicity Test (See Table B-47 of Appendix B).

All constituents passed this test.

(b) Elutriate Tests (See Table B-46 of Appendix B).

All constituents passed this test.

3. Potential Effects on Human Use.

(a) Municipal and Private Water Supply. During construction, water intakes on the Pompton and Passaic Rivers would receive some increased sediment load and thus require more frequent filter changing.

(b) Recreational and Commercial Fisheries

Recreational fisheries effects are expected to be adverse. For the project construction period (2 years in duration upstream of the Pompton Inlet), recreational fishing efforts for all species of warmwater fish plus stocked trout, would be eliminated. Further, for about 2 years after the construction ends, fishing effort would be minimal, until the fishery reestablishes.

Commercial fisheries - none in project area.

(c) Water Related Recreation - See recreational fishery above. Little other water recreation occurs due to shallowness of the river.

(d) Aesthetics - Permanent loss of some riparian tree cover: turbidity would temporarily degrade water color.

(e) Parks, National Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves.

Two Morris canal feeder dams are located above the Pompton Inlet, but neither would be affected by the project. The more upstream feeder dam is in front of the Pequannock River feeder to the Pompton Inlet. The project plan has been designed to avoid adverse impact on this historic dam, by creating a new channel just east of this dam.

G. Determination of Cumulative Effects on the Aquatic Ecosystem.

Cumulative effect - No cumulative impacts are expected. Initial impacts would occur, however, as a result of the project (see Section 5, EIS paragraphs 5.48, 5.85, 5.129-5.132, 5.153, and 5.220-226). Use of aquatic habitat structures would be employed. The design of these structures would allow continuous scour of sediments, in order to reduce or eliminate the need to maintenance dredge the project reaches. This would help avoid periodic disruption of the benthic community.

H. Determination of Secondary Effects on the Aquatic Ecosystem

No secondary effects would be anticipated.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

A. Adaptation of the Section 404(b) (1) Guidelines to this Evaluation.

Project is in compliance - under Part 230 II, Subpart A 230.12.

B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site, Which Would Have Less Adverse Impact on the Aquatic Ecosystem.

The preferred alternative is: 1. Upland disposal, project use, and sale of excavated fill. 2. The other alternative is disposal of all material at upland sites.

Use of the less costly method (1) with proper construction techniques is in compliance with Restrictions on Discharge.

C. Compliance With Applicable State Water Quality Standards

Project is in compliance; no long-term effects are expected.

D. Compliance With Applicable Toxic Effluent Standards or Prohibition Under Section 307 of the Clean Water Act.

The project is in compliance.

E. Compliance With Federal Endangered Species Act 1973 (as amended).

The project is in compliance; no federally endangered species or habitats for these species have been identified in the project area or at the disposal sites.

F. Compliance With Specific Protection Measures for Marine Sanctuaries Designed by the Marine Protection, Research and Sanctuaries Act of 1972.

Not applicable; none are in project area.

G. Evaluation of Extent of Degradation of the Waters of the United States.

1. Significant Adverse Effects on Human Health and Welfare

(a) Municipal and Private Water Supplies - No significant effect.

(b) Recreational Fisheries - adverse impact during construction (2-1/2 years) and for about two years after project completion until biota reestablishes. Some increase in summer ambient water temperatures with project; however, aquatic habitat structures would help mitigate adverse effects.

Commercial Fisheries - No effect; none present

(c) Plankton - No significant effect.

(d) Fish - No effect on commercial fisheries - none present. The Wanaque River, which has a marginal coldwater fishery in addition to a good warmwater fishery, would likely lose the marginal coldwater fishery as a result of project implementation.

(e) Shellfish - No significant effect; no effect on human health and welfare.

(f) Wildlife - No significant effect. See Page B- for wetland impact discussion.

(g) Special Aquatic Sites - No significant effect.

2. Significant Adverse Effects on Life Stages of Aquatic Life and other Wildlife Dependent on Aquatic Ecosystems -

Effects are not significant in the long term. Short term construction effects would be severe, however.

3. Significant Adverse Effects on Aquatic Ecosystems Diversity, Productivity and Stability

No significant effects with use of aquatic habitat mitigation. Wanaque River is likely to lose its marginal coldwater fishery.

4. Significant Adverse Effects on Recreational, Aesthetic and Economic Values.

No significant permanent effect is expected; however, temporary losses of recreational areas as well as warmwater, and trout stock fishery would occur during construction.

H. Appropriate and Practicable Steps taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem

Use of soil filter fabrics on bank slopes to prevent erosion.

Use of silt screens in rivers at fill placement areas and downstream of river bottom excavation.

Use of diversion structures or sheetpiling in areas where floodwalls and channel excavation are placed.

Riprap would be placed where needed to prevent erosion.

I. On the Basis of the Guidelines, the Proposed Disposal Sites(s) for the Discharge of Dredged or Fill Material

Specified as complying with the requirements of these guidelines.

ADDENDUM 2

Fish and Wildlife Coodination Act Report 2(b)

Corps Responses To The Fish And Wildlife Service's Mitigation Recommendations

FISH AND WILDLIFE COORDINATION ACT REPORT
Section 2(b)

PASSAIC RIVER BASIN STUDY
NEW JERSEY AND NEW YORK

Analysis of the Corps of Engineers' Selected Flood Control Project for the Central and Lower Passaic River Basin Study Area: Dual Inlet Tunnel Diversion Plan



U.S. Department of the Interior
Fish and Wildlife Service

November 1986

FISH AND WILDLIFE COORDINATION ACT REPORT
Section 2(b)

PASSAIC RIVER BASIN STUDY
NEW JERSEY AND NEW YORK

Analysis of the Corps of Engineers' Selected Flood Control Project for the Central and Lower Passaic River Basin Study Area: Dual Inlet Tunnel Diversion Plan

Prepared for:
U.S. Army, Corps of Engineers
New York District
New York, New York 10278-0090

Prepared by:
U.S. Department of the Interior
Fish and Wildlife Service, Region 5
State College, Pennsylvania 16801

November 1986

Preparers: Clifford G. Day
Harvey M. Katz
William Zinni, Jr.
Principal Investigator: Clifford G. Day

Project Leader: Charles J. Kulp

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Suite 322
315 South Allen Street
State College, Pennsylvania 16801

November 13, 1986

Colonel Marion L. Caldwell, Jr.
District Engineer, New York District
U.S. Army, Corps of Engineers
26 Federal Plaza
New York, New York 10278-0090

Dear Colonel Caldwell:

This constitutes our report on the effects of proposed flood control project features (final Stage III plan: dual inlet tunnel diversion plan) on fish and wildlife resources in the central and lower Passaic River basin study area in Hudson, Bergen, Passaic, Morris and Essex Counties, New Jersey. It has been prepared pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and is for inclusion into your final feasibility report.

This report presents a general assessment of project impacts on fish and wildlife resources. In addition to describing existing fish and wildlife resources and project impacts at target year 1990, the report discusses differences in resource conditions between the future-with and future-without the selected plan for target year 2040. It is anticipated that the report recommendations will be supplemented in fiscal year 1987, depending upon the results of the planned Habitat Evaluation Procedures (HEP) report. Since a baseline HEP was conducted in 1980 for the Passaic River basin (PRB) central study area, the 1987 effort would involve a "futures analysis" and thus, quantify differences in fish and wildlife habitat conditions between future scenarios.

The enclosed report is based upon the selected plan, including the narrative description, maps and other information provided by your Passaic River Basin and Special Studies Branch via a May 15, 1986 letter (Appendix A). We submitted three planning aid reports (PAR's) for the central and lower PRB study area, dated November 1981, June 1983 and June 1985. Additionally, the Service submitted eight PAR's addressing baseline terrestrial and aquatic resources of the central and lower PRB. Information in these reports was used to help assess the impacts of the selected plan.

This report has been reviewed by and has the concurrence of the New Jersey Division of Fish, Game and Wildlife as indicated by the enclosed correspondence (Appendix B). Division personnel participated in field investigations, project impact assessments and contributed to the formulation of recommendations presented in the report.

Comments submitted by the COE on the June 1985 PAR were given careful consideration in formulating this report. These comments included a request to revise the PAR to provide the following: 1) a more complete comparative

analysis of the two alternative flood control plans; 2) quantified mitigation for each alternative plan; and, 3) future-without project scenarios for target years 1990 and 2040. Since the COE has now submitted a "selected plan," we believe there is no need to conduct further comparative analyses on previous alternative plans. Because the selected plan is very similar to the dual inlet tunnel diversion system discussed in the June 1985 PAR, some of the information in this report is extracted from that report. We made every attempt to review and update information in the June 1985 report as it reflects the selected plan. Secondly, although mitigation is addressed in this report, mitigation needs will be refined by using the results of the proposed HEP report. Also, a future-without-project scenario regarding target year 2040 was not included in the June 1985 PAR. Nevertheless, an attempt is made in this report to project habitat conditions in the year 2040. We consider resource projections to 2040 highly speculative and we are not aware of a reliable procedure for determining future fish and wildlife conditions so far distant in the future, particularly in a highly developed area such as the PRB.

Endangered Species Act

Except for occasional transient species (bald eagle, peregrine falcon), no federally listed or proposed threatened or endangered species under our jurisdiction are known to exist in the project impact area. The shortnose sturgeon (Acipenser brevirostrum) is an endangered species that has historically been found in the Passaic River. However, that species is under the jurisdiction of the National Marine Fisheries Service which should be contacted for its views. No Biological Assessment or further Section 7 consultation under the Endangered Species Act is required with the Service. However, this determination may be reconsidered if additional information on listed or proposed species becomes available or if project plans are changed substantially. A compilation of federally listed threatened and endangered species for New Jersey is enclosed in Appendix C. Information on wildlife species classified by the State of New Jersey as being threatened, endangered or of another status of concern is in the text of this report.

Fish and Wildlife Mitigation Policy

Service recommendations for reducing adverse impacts of land and water developments on fish, wildlife, their habitats, and uses thereof are based on a Mitigation Policy published in the Federal Register on January 23, 1981. This policy outlines internal guidance for Service biological investigations and recommendations for mitigation under relevant Service authorities, particularly the Fish and Wildlife Coordination Act. The policy's rationale for mitigation planning is based on the value and scarcity of the habitat at risk. Therefore, four predetermined resource categories of decreasing importance have been identified . The Service's mitigation goals are as follows: Category-1 no loss of existing habitat value; Category-2 no net loss of in-kind habitat value; Category-3 no net loss of habitat value while minimizing loss of in-kind habitat value; and, Category-4 minimize loss of habitat value. The Service's Mitigation Policy is provided as Appendix D.

Generally, we consider the central Passaic wetlands to be Resource Category 2. Terrestrial areas within the PRB are classified as Resource Category 3. Site-specific determinations for resource categories will be made during the proposed HEP study concurrent with implementing field work. Final recommendations for mitigation may change, dependent upon the results of the HEP effort.

Habitat Evaluation Procedures

Review and assessment of the selected plan was not begun until June 1986 and resulted in a modification of proposed work tasks such as postponing the HEP analysis. Nevertheless, as recommended in the June 1985 PAR, it is necessary that HEP be used to evaluate the selected plan. Project implementation is expected to result in major environmental changes which must be offset by achieving mitigation planning goals. The application of HEP will encourage objectivity, since a team approach and scientific measurements will be applied to account for losses and gains associated with project implementation. Without the use of a scientific methodology to define and measure impacts, subjectivity, omissions and assumptions can influence decisions that should be based upon firm data. The specific work tasks, including a HEP in fiscal year 1987 should be discussed at an interagency meeting as soon as possible.

By previous arrangement, your office is to provide 10 additional copies of this report for our use and transmittal.

If you have any questions concerning any aspect of this report, please contact us. We would appreciate receiving the COE's written comments on this report within 60 days.

Sincerely,

Charles Kulp

Charles J. Kulp
Field Supervisor

Enclosures

The mission of the U.S. Fish and Wildlife Service is to:

PROVIDE THE FEDERAL LEADERSHIP TO CONSERVE, PROTECT AND ENHANCE FISH AND WILDLIFE AND THEIR HABITATS FOR THE CONTINUING BENEFIT OF THE PEOPLE.

The goal of Service activities relating to land and water development projects is to assure that wildlife conservation shall receive equal consideration and be coordinated with other features of Federal water resource development through effectual and harmonious planning, development, maintenance and coordination of wildlife conservation and rehabilitation in the United States, its Territories and possessions. The goal is to:

CONSERVE, PROTECT AND ENHANCE FISH AND WILDLIFE AND THEIR HABITATS AND FACILITATE BALANCED DEVELOPMENT OF THIS NATION'S NATURAL RESOURCES BY TIMELY AND EFFECTIVE PROVISION OF FISH AND WILDLIFE INFORMATION AND RECOMMENDATIONS.

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SECTION 1. INTRODUCTION AND STUDY SCOPE

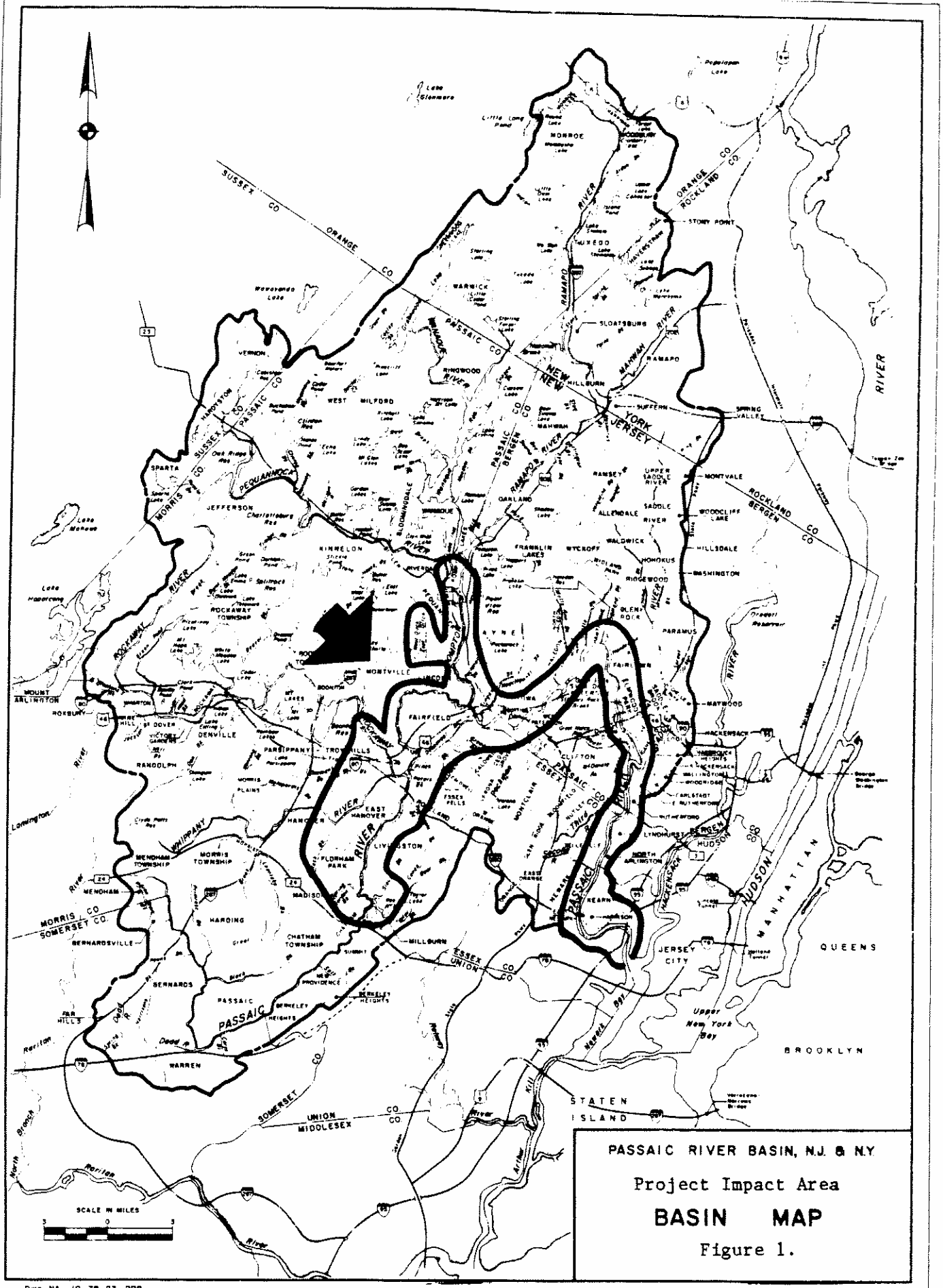
This is our Fish and Wildlife Coordination Act, Section 2(b), report on the potential effects of the selected flood control plan (Stage III plan: dual inlet tunnel diversion plan) on fish and wildlife resources in the central and lower PRB. A map showing the location of the PRB and the project impact area is presented as Figure 1.

This report provides a general assessment of the consequences of project implementation on fish and wildlife. In addition to describing existing fish and wildlife resources and project impacts at target year 1990, this report describes general differences in resource conditions between the future-with and the future-without the selected plan for target year 2040. It is anticipated that a supplemental report will be submitted in fiscal year 1987 which could change the recommendations in this report. Resource category determinations based upon habitat values would be made during the implementation of a HEP and as part of the mitigation planning process. Since a baseline HEP was conducted in 1980 (Day and Bosenberg, 1980; 1981a), the 1987 effort would involve a "future analysis" and thus, help to quantify differences in habitat values between future scenarios. Therefore, the HEP effort in 1987 would be used by the Service as a basis for further defining mitigation needs.

In November 1981, the Service submitted a PAR to the COE entitled, "Fish and Wildlife Resources and Their Supporting Ecosystems: A Habitat Evaluation Report of the Passaic River Lower Valley Study Area, Passaic River Basin, New Jersey (Baseline Aquatic and Terrestrial Resources)" (Day and Bosenberg, 1981b). The information presented in that report provided a general characterization of fish and wildlife resources in the lower portion of the PRB (i.e., Beatties Dam in Little Falls downstream to the mouth of the Passaic River at Newark Bay).

A second PAR (Day, 1983) was submitted to the COE regarding Stage II flood control alternatives proposed for the central and lower PRB. The purpose of that PAR was to present a general characterization of potential adverse impacts to fish and wildlife resources resulting from implementation of the following plans: 1) 100-year tunnel diversion; 2) 100-year levee and floodwall; and, 3) 100-year channelization. The Service found each of the proposed plans unacceptable and recommended that they not be implemented. Further, the Service recommended that these alternative plans be revised to more fully evaluate the ecological consequences of flood control/water management planning, especially in the central and lower PRB and the overall PRB.

A third PAR (Day et al., 1985) was submitted to the COE regarding early Stage III flood control alternatives proposed for the central and lower PRB. The purpose of that PAR was to present further characterizations of the potential adverse impacts that would result to fish and wildlife resources from the implementation of the following plans: 1) dual inlet tunnel diversion; and 2) Beatties Dam inlet tunnel diversion. These plans, including subsurface tunnel diversion systems, channelization and levee/floodwall systems, would be implemented from the Pompton Lake Dam in Passaic County, downstream to the


PASSAIC RIVER BASIN, N.J. & N.Y.
Project Impact Area
BASIN MAP
Figure 1.
SCALE IN MILES
Dwg. N° 10-78-23 PRB

Third River/Passaic River confluence at Clifton and Nutley, Passaic and Essex Counties. The Service concluded that the implementation of either plan as proposed would be unreasonably destructive to existing fish and wildlife resources in the central and lower PRB. Although the dual inlet plan was favored over the Beatties Dam inlet plan, the Service recommended further study to develop a flood control plan that would be less damaging to fish and wildlife resources. The Service received comments on the June 1985 PAR in a letter dated September 17, 1985 from the COE's Passaic River Basin and Special Studies Branch. These comments included a request to revise the PAR to provide the following: 1) a more complete comparative analysis of the two alternative plans; 2) quantified mitigation for each alternative plan; and, 3) future without project scenarios for target years 1990 and 2040. First, since the COE has now submitted a "selected plan" for review, there is no need to conduct a comparative analysis regarding previous alternative plans. Second, although mitigation could be addressed in general terms, detailed recommendations to reduce adverse impacts should be developed using HEP. Third, a discussion of project construction impacts as well as a future without-project scenario regarding target year 1990 was presented in the June 1985 PAR. Attempts to make predictions about land uses and ecology after 1990 become more speculative and lead to highly subjective conclusions. We know of no relative scientific procedure for determining the changes to fish and wildlife over such a long period of time.

The Service conducted a general assessment of the PRB in 1978. In addition, baseline assessments of terrestrial resources supported in the central portion of the PRB (i.e., Beatties Dam upstream into the Pompton, Ramapo, Wanaque, Pequannock, Rockaway and Whippany Rivers) are presented in the following PAR's: 1) "A Habitat Evaluation Procedures Report on Fish and Wildlife Resources and Their Supporting Ecosystems: Preliminary Habitat Evaluation Report of the Rockaway River Subbasin, Passaic River Basin, New Jersey (Baseline Terrestrial Resources)" (Day and Bosenberg, 1980); and, 2) "A Habitat Evaluation Procedures Report on Fish and Wildlife Resources and Their Supporting Ecosystems: Preliminary Habitat Evaluation Report of the Upper Wetlands, Central Wetlands and Upper Passaic Study Areas, Passaic River Basin, New Jersey (Baseline Terrestrial Resources)" (Day and Bosenberg, 1981a). Furthermore, aquatic and terrestrial resources of the central and lower PRB were investigated by the New Jersey Division of Fish, Game and Wildlife (Papson, 1981a, 1981b) and the Conservation and Environmental Studies Center, Inc., (1980a, 1980b, 1981) while under contract to the Service to study the PRB.

Since completion of the June 1985 PAR, the COE has requested that the Service evaluate the final Stage III selected flood control plan for the central and lower PRB. This plan represents a modification of the previous early Stage III dual inlet tunnel diversion plan. In comparison with previous alternatives, the selected plan reduces the length of channelization, levees and floodwalls; locates the outlet structure in the Passaic River rather than on the Third River; incorporates a subsurface spur tunnel, directing flood waters to the main trunkline which reduces channelization on the Passaic River, thus minimizing the adverse impacts that were expected to occur to Great Piece Meadows; and, includes the acquisition of natural storage areas such as wetlands. The selected plan is comprised of various structural

elements, including a subsurface tunnel diversion system, channelization, levee/floodwall systems and extensive land clearing. These elements would be implemented at various locations from the Pompton Lake Dam area, Pompton Borough, Passaic County, downstream to the Passaic River near the Passaic/Third River confluence at the Clifton-Nutley border (Passaic/Essex Counties).

The Service requests that no part of this report be used out of context and if the report is reproduced, it should appear in its entirety. Furthermore, data, opinions, figures, recommendations and conclusions which are excerpted from the report should be properly cited and include the page number from which the information was taken. This report should be cited as follows:

Day, C.G., W. Zinni, Jr., and H. Katz. 1986. "A Fish and Wildlife Coordination Act Report, Section 2(b): Passaic River Basin Study, New Jersey and New York (Analysis of the Corps of Engineers' Selected Flood Control Project for the Central and Lower Passaic River Basin Study Area - Dual Inlet Tunnel Diversion Plan), Phase I - Overview Assessment." USDI, Fish and Wildl. Serv. FWCA Rpt., Div. Ecol. Serv., State College, Pa.

Questions or comments regarding this report would be welcomed by the Service. Written inquiries should be addressed to:

U.S. Fish and Wildlife Service
P.O. Box 534
705 White Horse Pike
Absecon, New Jersey 08201

SECTION 2. PROJECT DESCRIPTION

The selected flood control plan (dual inlet tunnel diversion plan) includes a subsurface tunnel diversion system that incorporates two intake structures, one outlet structure, a spur tunnel, channelization, levees and floodwalls. Flood protection is generally for the 100-year event but would range up to the 500-year event upon project implementation. The following information describes the selected plan and is extracted from the COE's presentation of the plan (Appendix A) and from coordination with the COE during the writing of this report.

STRUCTURAL CONCEPT

GENERAL OVERVIEW

In general, the dual inlet tunnel diversion system would require the construction of 13.4 mi. of a tunnel 39 feet in diameter from the Pompton intake structure located near the Pompton/Ramapo/Pequannock Rivers' confluence in Wayne, Passaic County, and then across the basin to the outlet structure located on the Passaic River near the Third/Passaic Rivers' confluence at the Clifton-Nutley border (Passaic/Essex Counties). The dual inlet plan includes a second intake structure that will service a 1.3 mi., 22-ft. diameter spur tunnel to the main tunnel. The actual intake structure for this spur tunnel is located upstream of I-80 on the Passaic River at Two Bridges. The tunnel would be constructed about 125 ft. below ground at the Pompton River inlet, about 130 ft. below ground at the Two Bridges inlet and about 155 ft. below the Passaic River outlet. The tunnel would be 450 ft. under the Watchung Mountains in the area of the Little Falls-Clifton border.

Approximately 5.5 mi. of levees, 0.6 mi. of floodwalls and 4.9 mi. of channelization upstream of the Pompton inlet would be required to direct flood waters into the tunnel and provide flood protection along upstream reaches. Except for a 0.3-mi. channel transition at the confluence with the Passaic River, no additional channelization is proposed on the Pompton River. Near the Pompton/Passaic confluence, the Passaic River would be channelized and dredged for a total distance of 0.8 mi., extending from upstream of Two Bridges to the spur tunnel's inlet structure in order to divert flood waters into the tunnel. Upstream of Two Bridges, approximately 13 mi. of set-back levees and 0.5 mi. of floodwall would be constructed along the mainstem Passaic River and Passaic tributaries. These levees would range in height from 4 ft. to 11 ft. and have an average height of 7 ft.

From Beatties Dam downstream to Newark Bay, the dual inlet plan would include 15 levee/floodwall systems. These systems would include 11 mi. of levees and 11 mi. of floodwalls. Levees and floodwalls constructed downstream of I-280 would provide protection against a 500-year tidal flood.

A river flow restrictor is located on the Pompton River below the inlet, but is not included on the Passaic River below the spur tunnel's inlet because a rock ledge controls flows. Diversion spillways are included at each of the two tunnel inlet structures. The restrictor and spillways are designed to regulate flows. For example, gates on the diversion spillways would be opened

only when discharges are expected to meet or exceed the one-year event (4,300 cfs). Therefore, mean annual flow (about 500 cfs) would be allowed to bypass the Pompton inlet and continue downstream on the Pompton River. Flows will be diverted into the Two Bridges inlet structure when flood waters reach 161.0 ft. National Geodetic Vertical Datum (NGVD), which approximates the annual flood stage.

POMPTON RIVER INLET

The inlet portal is located upstream of the Pompton Plains Cross Road (Jackson Avenue) in Wayne Township on the Pompton River immediately downstream of the Ramapo/Pequannock Rivers' confluence. The inlet structure consists of a river flow restrictor, a river diversion spillway and a morning glory tunnel inlet. The flow restrictor will be constructed across the Pompton River and consists of a concrete bridge-type structure with a 24 ft. wide by 17.2 ft. high permanent opening and four 30-ft. wide by 17.2 ft. high gated openings which will remain closed until volume flow exceeds the 100-year design. Embankments are located on both banks with heights between 4.5 ft. to 6.5 ft. and lengths of 795 ft. on the east bank and 765 ft. on the west bank. Additionally, there is a 500-ft. long, 7-ft. high berm around the inlet basin perimeter. The river diversion spillway is located on the east bank of the river and will allow flood waters to enter the morning glory inlet. Seven 40-ft. wide gates would be utilized to control flood waters. The morning glory inlet is contained in a 300-ft. wide basin. The floor of this basin is 8 ft. below the crest of the morning glory inlet. According to the COE, extensive clearing of vegetation would occur at the Pompton River inlet site.

TWO BRIDGES INLET AND SPUR TUNNEL

The Two Bridges Inlet is located on the east bank of the Passaic River about 500 ft. upstream of the I-80 bridge. The inlet structure, which is similar to the Pompton River inlet, would consist of a gated diversion spillway and morning glory inlet. The diversion spillway would consist of gates to control the flood waters entering the basin containing the morning glory inlet. The basin containing the morning glory is similar to the Pompton River inlet.

The diversion spillway will have a spillway crest at elevation 161.0 ft. NGVD topped by eight 40-ft. wide by 19-ft. high gated openings which are designed to allow the diversion of flood waters. The inlet will begin diverting flows when flood stages are expected to meet or exceed the estimated annual flood stage of 161.0 NGVD. When flood discharge exceeds tunnel capacity, the excess flows would continue downstream.

The Two Bridges inlet will siphon flood waters into a 22-ft. diameter, 1.3-mi. long spur tunnel which connects to the main tunnel.

TUNNEL OUTLET

Diverted flows would exit the tunnel through an upshaft to the surface at sea level (greatly reducing water velocity) and then flow out into the Passaic River. Levees and floodwalls are proposed for both banks of the Third River. Additionally, a total of 34,000 ft. of levees averaging 9 ft. in height, and

11,350 ft. of floodwalls averaging 9 ft. in height would be required between the Second River and the Rutherford-East Rutherford boundary, a distance of 8.2 mi.

CHANNELIZATION

Approximately 6.0 mi. of channelization are required to implement the dual inlet plan. Channelization of the Passaic (0.8 mi.) and Pompton Rivers (0.3 mi.) would extend from upstream of Two Bridges Road, downstream for a distance of 1.1 mi. to the I-80 bridge. This new channel would remain within banks with a base width between 170 ft. to 250 ft. and would be deepened an average of 4 ft. to 5 ft. The resulting top width of the channel would approximate existing top widths. Channelization of the Pequannock River would extend 2.6 mi. upstream from the Pompton intake structure. This new channel would have an average base width of 150 ft. and be deepened by 5 ft. to 6 ft. The resulting top width of the channel would be 160 ft. Existing top widths average approximately 100 ft. Channelization of the Ramapo River extends from the Ramapo/Pequannock Rivers' confluence upstream 1.3 mi. to the Hamburg Turn pike Road. The new channel would have an average base width of 55 ft. and be deepened by 6 ft. The resulting top width of the channel would be 150 ft. Existing top widths average approximately 110 ft. Channelization of the Wanaque River extends from the Wanaque/Pequannock Rivers' confluence upstream 1.0 mi. to Hamburg Turnpike. The new channel would have an average base width of 75 ft. and be deepened by 6 ft. The resulting top width of the channel would be 150 ft. Existing top widths average about 90 ft.

LEVEE/FLOODWALL SYSTEMS

Overall, the dual inlet plan will include the construction of 31 levees and 23 floodwalls. Levee heights and base widths average 8.5 ft. and 61.0 ft., respectively. Average floodwall height is 8.5 ft. Upon project completion, levee bases will cover approximately 225 ac. and floodwall bases 3.0 ac. Levees and floodwalls will extend for total lengths of 24.0 mi. and 11.4 mi., respectively. A series of ponding areas are associated with levee/floodwall systems. These ponds will have a depth of 3 ft. to 4 ft.

NONSTRUCTURAL CONCEPT

ACQUISITION OF NATURAL STORAGE AREAS

Acquisition of natural storage areas in the central PRB is also being proposed. Land acquisition (which contains wetlands), serves a dual purpose: protection of existing natural storage areas from development, ensuring that the tunnel project can accommodate anticipated flood waters; and wetlands preservation. Acquisition areas in the Great Piece Meadows are located along floodway boundaries. Major areas of Black, Troy, Bog and Vly Meadows and Hatfield Swamp are also being proposed for acquisition. Table 1 presents a summary of the 5,350 ac. being considered for acquisition.

Table 1. Proposed Natural Storage Acquisition Areas.

Natural Storage Area	Municipality	Acres
Black Meadows	Hanover	660
	East Hanover	195
	Florham Park	255
		1110
Bog & Vly Meadows	Lincoln Park	360
	Montville	45
		405
Hatfield Swamp	Montville	35
	Fairfield	20
	West Caldwell	290
	East Hanover	85
		430
Great Piece Meadows	Montville	130
	Lincoln Park	420
	Fairfield	1030
		1580
Troy Meadows	Parsippany-Troy Hills	765
	Hanover	25
	East Hanover	385
		1175
Canoe Brook	Livingston	175
Lower Pompton	Pequannock	120
	Wayne	165
		285
Hatfield South	East Hanover	135
	Livingston	55
		190
	Total:	5,350

ENVIRONMENTAL MEASURES

In order to minimize the adverse environmental effects of project implementation, the following measures are under consideration by the COE for mitigation purposes:

1. To maintain the wetlands along the Passaic River, specifically the Great Piece Meadows, the operating rule as established will maintain a flow over Beatties Dam of 100 cfs during a flood event and current water levels during normal flow conditions. Additionally, a weir is being investigated for use in the Great Piece Meadows to maintain a water surface elevation of about 164 ft. (annual flood stage) during flood events and possibly at other times to maintain wetlands in these meadows.

2. Channel modification reaches will provide adequate water depths to maintain passage by fish.

3. Channel meanders in modified channel reaches will be maintained where compatible with sound engineering practice and design.

4. Channel modification will provide for aquatic habitat structures where feasible.

5. Erosion control methods will be used during construction, using techniques similar to those utilized by the Soil Conservation Service (SCS).

6. Banks susceptible to erosion will be protected with riprap.

7. Riparian vegetation will be maintained where compatible with the project.

8. Areas disturbed during construction will have vegetation planted in the first growing season.

9. Topsoil will be replaced to existing depths.

10. The diversion structures located at the Pompton and Two Bridges Inlets will be designed to bypass non-flood discharges up to the one-year flood.

11. Present modal flows will be maintained since only flood flows would be diverted.

SECTION 3. METHODS AND PROCEDURES

The central and lower PRB study area has been studied over the last 9 years by the Service. The Service's initial investigation of the PRB was conducted in 1978 (U.S.F.W.S., 1978). In addition to investigating baseline aquatic and terrestrial resources in the Passaic River lower valley study area (Day and Bosenberg, 1981b), the Service and the COE conducted HEP throughout the PRB (Day and Bosenberg, 1980, 1981a). In conducting the HEP, approximately 88 sites were visited to rate habitat suitability for 12 evaluation species in 5 cover types. Excluding the Rockaway HEP sites, the project impact area for the selected dual inlet tunnel diversion plan overlaps much of the other HEP study areas in the upper and central PRB.

Several studies were conducted under contract to the Service concerning fish and wildlife resources in the central and lower PRB. During the summer of 1980, the New Jersey Bureau of Freshwater Fisheries (NJBFF) (Papson, 1981a) conducted an aquatic analysis, including a fisheries survey, of selected non-tidal portions of PRB streams. Field sampling included segments of the Passaic River between the Dundee Dam upstream to and including the Pequannock, Wanaque, Ramapo, Rockaway, Whippany and Pompton Rivers. Additional information about aquatic resources associated with the Passaic River downstream of Dundee Dam, particularly the anadromous fishery, was obtained during a field study conducted by the NJBFF (Papson, 1981b). Field sampling occurred between March and September 1981. Terrestrial resources of the central and lower PRB were investigated by the Conservation and Environmental Studies Center Inc., (1980a, 1980b, 1981) under contract to the Service.

In June 1983, the COE proposed Stage II flood control alternatives for the central and lower PRB. The Service evaluated and commented on 3 alternative plans and described the potential adverse impacts that would result to fish and wildlife resources from project implementation. The Service submitted a PAR (Day, 1983) to the COE regarding these Stage II plans.

Two early Stage III flood control alternatives were submitted to the Service by the COE in 1985. Both of these alternative plans were based upon a subsurface tunnel diversion system. The Service evaluated and commented on these alternative plans and submitted a PAR (Day et al., 1985) to the COE. Overall, the Service concluded that the plans as proposed were unacceptable and thus, recommended further planning to formulate a flood control project less damaging to fish and wildlife resources.

For the purposes of this study, the Service met with COE representatives twice for information about the selected plan (final Stage III plan: dual inlet tunnel diversion plan). The first meeting was held in the COE's office on June 27, 1986 and the second meeting involved field inspections on July 15 through July 17, 1986. Representatives of the New Jersey Division of Fish, Game and Wildlife along with a representative of the New Jersey Green Acres Program (N.J. Department of Environmental Protection) participated in the field inspections. Green Acres has stewardship responsibility for various landholdings in the PRB wetlands and was asked to provide comments on the project proposal, particularly the natural storage areas being considered for

acquisition (Appendix E). Similarly, Wildlife Preserves, Inc., which has considerable landholdings (approximately 2,500 ac.) in the central Passaic wetlands, many of which overlap the proposed acquisition areas, was solicited for general comments (Appendix F). Additionally, the Service met with representatives of the New Jersey Division of Fish, Game and Wildlife and Green Acres on July 24, 1986 (Beck, 1986; Didun, 1986; Papson, 1986; Pyle, 1986; Sciascia, 1986; Widjeskog, 1986) to discuss project impacts on state-owned lands, state-designated threatened and endangered species, game and nongame species and fisheries. A list of preparers and contributors who formulated the information in this report is presented as Appendix G.

The Service has been conducting on-site inspections and biological investigations of wetland and terrestrial areas in the central and lower PRB study area for several years. The information and data obtained during field inspections and through coordination were used to prepare the aquatic and terrestrial baseline characterizations (Day and Bosenberg, 1981a, 1981b), initial Stage II and early Stage III plan review (Day, 1983; Day et al., 1985) and the future-without and future-with-project scenarios in this report.

The Service is concerned about project-related impacts to Passaic River wetlands. Although wetlands within the project area were mapped by the Service's National Wetlands Inventory (NWI) program (U.S.F.W.S., 1979), it was necessary to refine wetland boundaries to a larger scale to determine the extent of project-related impacts. This was accomplished by updating the NWI wetland information, which originally had been photo-interpreted from 1:80,000 black and white photography flown on October 29, 1976, with 1:60,000 color infra-red photography flown on March 26, 1984, for the Federal High Altitude Program. Field inspections conducted in 1985 and 1986 by Service biologists preceded the wetland updating.

Wetlands were delineated and classified according to the current system developed by the Service (Cowardin et al., 1979). Wetlands were then carefully delineated on 1:500 ft. topographic maps provided by the COE. Wetland delineation was accomplished by using aerial photo-interpretation, ground-truthing during field inspections and by using the SCS (1975, 1976) soils identification and classification with the floodplain. Wetland acreage was determined by using a Numonics planimeter.

The year 1990 has been established by the COE as the baseline year (i.e., first year of construction) for the purpose of making target year 2040 projections of future-without and future-with-project scenarios. Pursuant to direction provided by the COE, certain changes and alterations are expected in water quality, habitat losses, human population increases and land uses in the project area prior to 1990. The COE's letters of direction regarding projections is presented in Appendix A. Additionally, the COE has illustrated proposed land uses for existing conditions regarding years 1990 and 2040 on five U.S.G.S. topographic quadrangle maps. These maps were submitted with project plans. Projections in this report are made as general assumptions.

SECTION 4. DISCUSSION AND CONCLUSIONS

AQUATIC

FUTURE-WITHOUT-PROJECT (1990 BASELINE CONDITIONS)

BASIN MORPHOMETRY

The mainstem of the Passaic River flows 87.6 miles from its source at Mendham to Newark Bay (Papson, 1981a). The first visible channel appears at about 600 ft. elevation while the surrounding hills reach approximately 900 ft. With the exception of Little Falls and Passaic Falls, most of the river's gradient is low throughout the project area. From Cooks Bridge in East Hanover to Newark Bay, river elevations decrease about 165 ft. Of this, 130 ft. is accounted for by the Little Falls and Passaic Falls. Thus, the river's gradient, for most of its length in the study area, is represented by a fall of about 35 ft. over a length of approximately 50.7 mi., or 0.69 ft. per mi. This characterizes the river as slow-moving or sluggish. The Passaic River is a freshwater stream down to the Dundee Dam. Below Dundee Dam the waters are tidal and brackish. Brydon (1974) estimates that 27,000 to 30,000 ac. of adjacent wetlands exist in the PRB. However, thousands of acres of wetlands have been eliminated during the last decade. Almost all of these wetland losses are due to development.

BENTHOS

Pequannock River

Papson (1981a) collected 14 species of invertebrates from the Pequannock River at a site just upstream of Riverdale Road. More than 86% of these species were represented by midge larvae (Chironomidae) and oligochaete worms which are typically found in waters with somewhat degraded water quality.

Wanaque River

Papson (1981a) collected 12 species of invertebrates from the Wanaque River at a site about 100 yd. upstream of Riverdale Road. The dominant species included scuds (Gammaridae) (23%), midge larvae (35%) and mayfly nymphs (Heptageniidae) (18%). These species are usually present in good to high quality waters.

Ramapo River

Papson (1981a) collected 17 species of invertebrates from the Ramapo River downstream of the Hamburg Turnpike bridge. The three most abundant species included hydroptilid beetles (18%), amphipods (Gammaridae) (17%) and snails (Planorbidae) (16%). These species are frequently associated with good water quality.

Pompton River

Papson (1981a) sampled two sites on the Pompton River. The first site was 100 yd. downstream of Jackson Avenue and the second site was at the N.J. Route 202 bridge. Eight invertebrates were taken from the Jackson Avenue site. This sample size is insufficient to make any relevant conclusions about benthic biota or water quality. The Route 202 site resulted in 219 individuals with chironomid larvae making up about 98% of the sample. Water quality in this segment of the Pompton River is marginal.

Rockaway River

Papson (1981a) collected two species, chironomid larvae and Gammarus, at the Knoll Road site. Additionally, hydropsychid caddisfly larvae and oligochaete worms were collected at the Vail Road site. Water quality in this segment of the Rockaway is marginal.

Whippany River

Papson (1981a) sampled two sites on the Whippany River: Black Brook; and Troy Road bridge. Oligochaete worms, Gammarus and coenagriida larvae were the most common species present in Black Brook. Chironomid larvae were the most abundant species collected from the Troy Road bridge site. Water quality in this segment of the Whippany River is marginal.

Passaic River

Papson (1981a) collected data from the following sites: Route 46, Pine Brook; Two Bridges; Lackawanna Avenue, Paterson; and Elmwood Park. At the Route 46 site, only chironomid larvae and pupae and oligochaete worms were collected. Both the number of individuals and species are considered low and suggest poor habitat conditions. The Two Bridges site was similar in regard to species and the low number of individuals found. Four species of invertebrates were sampled at the Lackawanna site. These included isopods (Asellidae), chironomid larvae and oligochaete worms (Lumbriculidae). Chironomids represented 67% of the invertebrates collected. The Elmwood site revealed both chironomids and oligochaete worms, with the worms representing 93% of the sample. All 4 sites are considered in ecologically poor condition as reflected by the invertebrate population.

Other Tributaries

1. Deepavaal Brook

According to Papson (1981a) naidid worms were the only invertebrates collected from Deepavaal Brook. This brook is under severe biological stress.

2. Molly Ann Brook

Papson (1981a) collected five invertebrate species from Molly Ann Brook. These included amphipods, snails (Pleuroceridae) and leaches (Hirudidae). Astacidae (crayfish) were also observed in large numbers. This brook is under biological stress.

FISH

Pequannock River

Of the 13 species of fish sampled at the Riverdale Road site, two species, the white sucker (Catostomus commersoni) (54%) and spottail shiner (Notropis hudsonius) (24%) dominated (Papson, 1981a). The presence of satinfin shiner (N. analostanus), blacknose dace (Rhinichthys atratulus), fallfish (Semotilus corporalis) and cutlips minnow (Exoglossum maxillingua) (5% combined) suggest a marginally healthy ecosystem.

Wanaque River

During the spring and fall of 1985, the NJBFF stocked (spring only) 267 brown trout (Salmo trutta), 460 and 375 rainbow trout (S. gairdneri) and 364 and 263 brook trout (Salvelinus fontinalis) into the Wanaque River (Papson, 1986). In September 1980, 17 species were sampled from the Riverdale Road site. In terms of total numbers of species, high relative abundance of pollution intolerant species, and the presence of smallmouth bass (Micropterus dolomieui), brown trout (possible holdover), cutlips minnow and fallfish, the Wanaque is one of the best sites in the study area. Dominant species included white sucker (31%), common shiner (Notropis cornutus) (17.5%) and fallfish (10%). The NJBFF plans continue its recreational trout-stocking program on the Wanaque River.

Ramapo River

During the spring of 1985, the NJBFF stocked 1,145 brook trout and 830 rainbow trout into the Ramapo River (Papson, 1986). The Hamburg Turnpike site sampled by Papson (1981a) resulted in nine species with the dominant species being white sucker (31%), smallmouth bass (23%) and bluegill (Lepomis macrochirus) (18%). Panfish made up 38% of the sample. The NJBFF plans to continue its recreational trout-stocking program on the Ramapo River.

Pompton River

During the spring in 1985, the NJBFF stocked 2,290 brook trout and 1,665 rainbow trout into the Pompton River (Papson, 1986). Two sites, one at Jackson Avenue and the second at N.J. Route 202 were sampled by Papson (1981a) yielding 5 and 9 species, respectively. Though low in diversity, the Route 202 site appears to be as good if not better in habitat quality as the Jackson Avenue site. The redbreast sunfish (Lepomis auritus), a fish tolerant of sluggish waters, low DO, and other parameters normally associated with degraded water quality and habitat dominated (68%) the Jackson Avenue sample.

The dominant species at the Route 202 site were the spottail shiner (42%), pumpkinseed (Lepomis gibbosus) (28%) and the bluegill (12%). The NJBFF plans to continue its recreational trout-stocking program on the Pompton River.

Rockaway River

Papson (1981a) sampled two sites downstream of the Boonton reservoir. The Knoll Road bridge site yielded nine species of fish while the Vail Road bridge site yielded 14 species. Spottail shiner and white sucker accounted for most (81.9% at Knoll Rd. and 80.1% at Vail Rd.) of the fish species sampled. All species found are considered highly tolerant of pollution.

Whippany River

Papson (1981a) sampled two sites on the Whippany River: Black Brook and Troy Road bridge. In Black Brook, redfin pickerel and largemouth bass accounted for the principal predator species sampled. Golden shinner and pumpkinseed sunfish accounted for most (70%) of the fish species present. At the Troy Road bridge site, redfin pickerel was the only predator species collected. Golden shinner (14%), spottail shinner (17%), white sucker (24%), pumpkinseed (10%) and redbreast (12%) sunfishes were the most common species. Although species diversity is relatively broad in these Whippany reaches, population numbers are low due to limited habitat suitability, particularly water quality.

Passaic River

Shad were known to reach the base of the Passaic Falls and both Indians and white settlers harvested fish at this location. Hundreds of shad were taken during the spawning season. Sturgeon, perch, trout, bass, catfish, herring, chub, suckers, pickerel, and white and yellow perch as well as other freshwater species were also reportedly caught. A sturgeon weighing 130 lbs. was taken at the Falls in 1817, another weighing 250 lbs. was taken in 1838. With the exception of sunfish (Lepomis spp.) and the common carp (Cyprinus carpio), other fish species ceased to exist by the middle to late 1800's (Brydon, 1974). At Dundee Dam all traces of fish disappeared by 1920. Although the present dam was constructed in 1858, an earlier dam was in place in 1828. Thus, this portion of the Passaic River has been altered by man for at least 152 years. The dam eliminated the annual shad run to the Passaic Falls and tidal influence upriver. The Passaic River and its tributaries once supported eel and freshwater mussels. Brydon (1974) cites a letter to the Newark Courier reporting that Mr. Beattie removed 2,400 lbs. of eels in a single day from the Beatties Dam flume.

Water quality was believed to be excellent until about 1870. Brydon (1974) cites a local report that the water in the Passaic River at Belleville was so pure and clear that stones could be seen on the bottom. The Passaic River at this time was used directly as a source of drinking water for the cities of Jersey City and Hoboken. In the late 1920's, the Federal Government began to deepen the Passaic River channel below Dundee Dam for navigational purposes.

Changes in the fish community resulting from this deepening were not documented. Dredged materials were probably deposited in wetlands or other low areas along the river eliminating fish nursery areas.

Residential and commercial development has greatly increased demands for Passaic River water. As a result of this water removal freshwater flows into the lower river have decreased to such an extent that dilution during dry periods is no longer present. This has allowed water quality to decrease. Brydon (1974) reports that by 1908 the effect of the increased pollution eventually destroyed what was left of the lower Passaic River fishing industry.

During 1980, Papson (1981a) sampled fish in the mainstem Passaic River. Five species; carp, white sucker, golden shiner (Notemigonus crysoleucas), goldfish (Carassius auratus) and spottail shiner were collected at the Route 46 sampling site. Carp and golden shiner accounted for about 90% of the catch. The same species (except for goldfish) were collected at the Two Bridges sampling site. Carp species accounted for 80% of the sample. Local fisherman catch brown and yellow bullhead (Ictalurus nebulosus and I. natalis). Seven species of fish were collected at the Lackawanna Avenue site. Carp, spottail shiner, goldfish and white sucker made up 78% of the catch. Seven species were collected at the Elmwood Park Marina site with carp representing 73% of the fish taken. The presence of these pollution-tolerant species suggest that this portion of the Passaic River is under extreme ecological stress.

Anadromous fish studies of the Passaic River from its mouth to Dundee Dam demonstrate that anadromous fish continue to use the river (New Jersey Division of Fish, Game and Wildlife, 1978; Papson, 1981b). Results indicate that American shad (Alosa sapidissima), alewife (A. pseudoharengus), striped bass (M. saxatilis) and blueback herring (A. aestivalis) migrate up the Passaic from late April to the end of May. Historically, herring travelled as far upstream as the Passaic Falls, a natural barrier at mile 25.3. Today, anadromous fish are blocked at Dundee Dam at mile 17.4. Analysis shows that 31.2% of the historical herring run area is currently denied to these species. No trout are stocked in the Passaic River downstream of its confluence with the Rockaway River. American shad is classified as threatened by the State of New Jersey. Atlantic sturgeon (Acipenser oxyrhyachus) is classified as being of undetermined status by the State of New Jersey and may be occasionally found in the tidal segment of the Passaic River.

Other Tributaries

Deepavaal Brook has been cited, by old-time residents, as providing good catches of "sunnies, perch, and eel" (Brydon, 1974). However, no fish were captured or observed by Papson (1981a) during the September 1980 sampling. Papson (1981a) reported chronic pollution as the overriding reason for the lack of fish life in the stream. Eleven species of fish were found in Molly Ann Brook. Four species; goldfish, white sucker, banded killifish (Fundulus diaphanus) and mummichog (F. heteroclitus) accounted for 78% of the fish taken

Papson (1981a). Two species; banded killifish and mummichog, are commonly associated with estuarine waters. This population of fish, though under some ecological stress, is one of the more diverse in the lower PRB.

WATER QUALITY

Pequannock River

The water temperature at the Riverdale Road sampling site on the Pequannock River was unusually high (28 C, 82.4 F) when samples were taken by Papson (1981a). Dissolved oxygen, pH, turbidity, hardness and total alkalinity were normal. Papson indicated that alkalinity was low and total hardness was classified as moderately hard.

Wanaque River

Wanaque River water chemistry at the Riverdale sampling site appears satisfactory with water temperature at 23 C (73.4 F), DO at 8.8 ppm and pH at 7.3. Conductivity and total alkalinity were reported as low for New Jersey waters (Papson, 1981a).

Ramapo River

Water chemistry at the Hamburg Turnpike sampling site on the Ramapo River included temperature of 23 C (73.4 F) DO at 7.0 ppm and pH of 7.6. Dissolved oxygen was considered slightly low for this site since it was only at 80% of saturation. Turbidity of 135 NTU's exceeded the New Jersey State FW-2 maximum limit of 110 NTU's (JTU's) (Papson, 1981a).

Pompton River

Water chemistry was examined by Papson (1981a) at the Jackson Avenue and the Route 202 sampling sites on the Pompton River. Water temperature of 27 C (80.6 F) at the Jackson Avenue site was considered high and may result from sewage effluent released upstream. Dissolved oxygen exceeded saturation by 120% at 9.6 ppm. A pH of 8.0 suggests that the sewage effluent was having an impact on these waters. As noted above, fish species diversity was abnormally low. Substantial improvement in water quality was noted at the next downstream sampling site at Route 202. Here water temperature was 22 C (71.6 F), DO 8.2 ppm (90% saturation) and pH 7.6. Even though stress, indicated by low fish species diversity was evident at both sites, the water quality was within the State's water quality criteria for FW-2 Non-trout classification.

Rockaway River

The gradient at the Knoll Road sampling site (Rockaway River) was described as slight (Papson, 1981a). The substrate consisted of 20% rock and 80% gravel. Flows in streams with gravel substrates are usually indicative of flows reaching at least 80 cm/s (Hynes, 1970). Downstream of the site, the stream shows substantial alteration from channelization. The riparian vegetation is almost non-existent due to placement of rock and gravel on the banks. Dissolved oxygen of 8.4 ppm indicates 100% saturation, pH was alkaline at

8.0, while the turbidity, conductivity, hardness and total alkalinity were within acceptable limits. No data about concentrations of heavy metals and organic compounds are available. At the Vail Road sampling site, substrate consisted of 10% gravel and 90% sand and silt indicating a slightly slower flow than the upstream site. Hynes (1970) indicates that the critical mean current velocity typical of streams with coarse sand to fine gravel would be expected to range from 30 to 60 cm/s. Though only a short distance downstream from the Knoll Road site, DO at the Vail Road site was considerably lower (6.6 ppm). No explanation is available for this difference. The pH was 7.0. All other parameters of water quality for this site are similar to the Knoll Road site.

Riparian vegetation at the Knoll Road site consisted of black willow (Salix nigra), silver maple (Acer saccharinum) and sycamore (Platanus occidentalis) upstream of the bridge. At the Vail Road site, grasses were prominent (70%). Maples (Acer spp.) and oaks (Quercus spp.) comprised the remaining 30% (Papson, 1981a). At the Route 46 sampling site, water quality was within state regulatory limitations. However, a DO of 5.6 ppm was considered lower than desirable for fish. Substrate consisted of silt and gravel. Water depths were about 2.5 ft. Riparian vegetation consisted of smartweed (Polygonum spp.), grasses and hardwoods. Steep banks with adjacent mud flats were prominent (Papson, 1981a).

Whippany River

The gradient of the Black Brook (Whippany River) sampling site was described as slight (Papson, 1981a). The substrate was classified as very soft muck. The water was very turbid (200 NTU's), exceeding the State of New Jersey's FW-2 maximum limit of 110 NTU's. Water temperature of 10 C (50 F), DO (9.4 ppm) and pH (7.4) were measured at acceptable levels. Total alkalinity was at a moderate level (125 mg/l). With a total hardness of 182 mg/l this stream was classified as having hard water. Papson (1981a) also noted that Black Brook was supporting heavy growths of aquatic vegetation. Duckweed and coontail covered much of the surface and substrate areas.

The gradient at the Troy Road bridge sampling site was described as slight (Papson, 1981a). The substrate consisted of sand and muck (80%) and rock, gravel and boulders (20%). During sampling DO was very low (4.2 ppm and 45% saturation). Water temperature was 10 C (50 F) and pH 7.4. The total alkalinity exhibited a moderate level and the total hardness (135 mg/l) classified the stream as being moderately hard. A small community of Elodea was the only aquatic vegetation observed at this site.

Passaic River

Water quality parameters measured at the Lackawanna Avenue sampling site on the Passaic River met state standards. Dissolved oxygen of 7.0 ppm (65% saturation) and a pH of 7.2 were determined. Substrate of sand and gravel (95%) and rock and boulders (5%) characterized the area. Riparian vegetation was limited to grasses, shrubs and mature hardwoods. Aquatic vegetation was sparse. Tires, shopping carts, metal drums and nondescript garbage littered the banks. The Elmwood Park site had a DO concentration of 13.6 ppm (160%

saturation) and a pH of 8.2. The presence of tidal waters and a sewage treatment plant in the vicinity may explain these results. The river's substrate consisted of mud and gravel. Riparian vegetation consisted of grasses (20%) and hardwoods (80%). Some milfoil (Myriophyllum humile), curlyleaf pondweed (Potamogeton crispus) and arrowhead were observed in shallow areas along shorelines (Papson, 1981a).

Water quality at the Two Bridges site appeared slightly better than at the Route 46 location. A DO of 7.0 ppm (72% saturation) was measured. The substrate consisted of clay and mud with average water depths of 6 ft. Emergent plants, such as smartweed, arrowhead (Sagittaria spp.) and water lily (Nymphaea spp.) were common adjacent to and on the stream banks. Riparian vegetation consisted of swamp maple (Acer rubrum) and pin oak (Quercus palustris) (Papson, 1981a).

Even though no fish were found at Deepavaal Brook, water quality at the site met state standards. A DO of 9.2 ppm (109% saturation) and a pH of 7.5 were measured. The substrate consisted of sand and silt with water depth averaging 1/2 foot. Riparian vegetation consisted of grasses, wild grape (Vitis sp.) and a secondary growth of maple and black willow. The water quality at the Molly Ann Brook location, like most of the other sites sampled, was at acceptable levels relative to the State's water quality criteria. A DO of 10.4 ppm (118% saturation) and a pH of 8.0 were recorded. Fifty percent of the riparian vegetation has been replaced with concrete. The remaining riparian area consisted of unidentified weeds. Algae were noticeable (10% cover) in the brook itself (Papson, 1981a).

Two indicators of less-than-desirable water quality for the Passaic River were noted in the NJBFF's anadromous fish study (Papson, 1981b). These included the appearance of a major fish kill at the Passaic Street location in Garfield and the fact that low DO levels were repeatedly measured in the river near Dundee Dam and in estuarine areas near Staten Island. In reality, fish kills may be more frequent in the lower Passaic River than records indicate.

FUTURE-WITH-PROJECT (1990 PROJECT IMPLEMENTATION)

OVERVIEW

The selected plan includes channelization, dredging and alteration of riparian areas. Habitat quantity and quality are expected to be reduced. The amount of time that rivers, especially downstream of the tunnel inlets, will experience increased flows (during freshets) is expected to be reduced. Decreased flows will reduce scouring typical and essential to natural river systems. In addition, loss of benthic substrate, riparian vegetation and shallow backwaters are expected. Finally, in channelized river sections, the relative stream velocity is expected to increase, particularly during low flow periods. The impacts of these effects are discussed below.

BENTHOS

"Dredging and straightening of channels have the two-fold effect of eliminating littoral areas and rooted plants, and of producing great

uniformity along the watercourse," (Hynes, 1970). It has been demonstrated that dredging greatly reduces the variety and abundance of the flora and invertebrate fauna. Newly cut channels develop very little of their own flora and fauna if they are swift and canal-like (Engelhardt, 1951; Gaufin, 1959; Hynes, 1960).

Pequannock River

The initial effect of the COE's proposed 2.6 mi. of channel modification on benthic invertebrates is expected to be catastrophic. Substrate required by these invertebrates will be physically removed and siltation rates are expected to increase during construction of the project. In addition, remaining substrate is expected to be adversely affected by project-related siltation.

Based on Papson's (1981a) studies, benthic invertebrates in this section of the river are representative of somewhat degraded water quality. Following construction, the invertebrate population should slowly reestablish itself after 5 to 10 years or perhaps 25 years (Edwards et al., 1984). Since the channel bottom will be widened, it is likely that for most of the year, especially during low flow periods, the river will be characterized as a meandering stream within a modified channel resulting in reduced benthic habitat diversity. As a result, faunal diversity is expected to decrease. Since the bottom of the modified channel will be lowered 6.0 ft., it is highly likely that waters flowing through this section of the Pequannock will average higher velocities than currently experienced which may result in a slightly improved benthic fauna. However, continued development in the watershed resulting from increased flood protection could offset any positive effects through increased siltation.

Wanaque River

The initial effect of the 1.0 mi. proposed channel modification on benthic invertebrates is expected to be catastrophic. Substrate required by these invertebrates will be physically removed and siltation rates are expected to be high during the construction phase of the project. In addition, remaining substrate is expected to be adversely affected by project-related siltation.

Based on Papson's (1981a) studies, benthic invertebrates in this section of the river indicate good to high quality waters. It is estimated that proposed project construction will degrade fauna to one representing poor quality waters. However, following construction, the invertebrate population should slowly reestablish itself after 5 to 25 years (Edwards et al., 1984). Since the channel bottom will be enlarged, it is likely that for most of the year (during low flow periods) the river will be nothing more than a meandering stream within a modified channel. This should result in substantial reductions in benthic habitat diversity. As a result, faunal diversity is also expected to decrease. Since the bottom of the modified channel will be lowered by 6 ft., it is likely that the Wanaque will average higher velocities than currently experienced. This may result in an improved benthic flora. However, increased runoff and siltation resulting from increased flood protection could offset any positive effects.

Ramapo River

Much of this section of the Ramapo River is currently impounded by the dam at the confluence with the Pequannock River. Changes in gradient are not expected to adversely effect benthic invertebrates in the impounded area. Impacts to invertebrate communities at the upstream end of the 1.3 mi. proposed channel modification is expected to be similar to that described in the Wanaque River. At the downstream end, the benthic community will be initially eliminated by construction. Following construction, this section of the river is expected to be adversely affected by siltation. Recovery of the benthic community is expected to take at least 5 to 10 years.

Rockaway River

Some floodplain and wetland areas adjacent to the river will be lost to the construction of levee systems #1, #2 and #3. Sediment deposition and turbidity will be increased during construction activities. Substrate in channels adjacent to the levee sites are expected to be adversely affected by siltation. However, recolonization of the existing benthic community is expected.

Whippany River

Project implementation is not expected to result in adverse impacts to this segment of the Whippany River. Acquisition of wetland and floodplain areas in Black and Troy Meadows and Hatfield Swamp will help sustain the aquatic resources of this river.

Passaic River and Pompton River

The 1.1 mi. of river proposed for channelization, including dredging the channel 4 to 5 ft., will initially result in severe impacts to benthic fauna. The river segments proposed for channelization are expected to be adversely affected by the project. In general, water levels are expected to be lower since channels would have a base width between 170 ft to 250 ft. Lower water levels will result in increased emergent vegetation along the existing channel as mud flats are exposed. This may alter the distribution of benthic invertebrates. At the juncture of the upstream modified channels and the adjacent normal channels, a transition similar to a pool-riffle area will probably be established.

FISH

Pequannock River

Of the 13 species (Papson, 1981a) known to exist in this section of the river, species usually present in fast moving waters will probably be eliminated during construction. These species include the satinfin shiner, blacknose dace, fallfish and cutlips minnow. Deepening the channel by 6 ft. is expected to result in reduced stream flow and an increase in pooled water. During low water periods, a channel may appear within the trapezoidal-shaped

streambed and fish such as the satinfin shiner and the fallfish may reoccupy the river. It is unlikely that species such as blacknose dace and cutlips minnow will be present. The overall effect of the project will be to decrease fish species diversity.

Wanaque River

Similar to the Pequannock, this section of the Wanaque is expected to experience reduced fish species diversity from project-related activities. Additionally, depending upon post-project conditions, the recreational trout-stocking program could be terminated by the NJBFF (Didun, 1986; Papson, 1986; Pyle, 1986).

Ramapo River

Since much of this section of river already shows lentic characteristics, the overall impact may be less than in the two rivers noted previously. Papson (1981a) reported the 3 dominant fish species as white sucker, smallmouth bass, and bluegill. The initial construction period may result in the elimination of most fish species. Following construction, it is expected that these species will reestablish themselves because of available nesting sites. However, loss of habitat may cause the NJBFF to terminate the recreational trout-stocking program (Didun, 1986; Papson, 1986; Pyle, 1986).

Rockaway River

Some floodplain and wetland areas adjacent to the river will be lost to the construction of levee systems #1, #2 and #3. Sediment deposition and turbidity will be increased during levee construction. Although this segment of the Rockaway River has water quality problems, a warmwater fishery will continue to persist. This river segment will continue to offer limited recreational angling opportunities.

Whippany River

The Whippany River exhibits fair to poor water quality in its lower reaches. Project implementation is not expected to result in adverse impacts to this segment of the river. Acquisition of wetland and floodplain areas in Black and Troy Meadows and Hatfield Swamp will help sustain habitat suitability of the river. A warmwater fishery and limited angling opportunities are expected to continue.

Passaic River and Pompton River

The 1.1 mi. section of river influenced by channelization is much like the Ramapo River except that water quality seems to be lower. As a result, carp, white sucker, golden shiner and spottail shiner predominate. As with the Ramapo River, adverse effects on fish populations are expected during the construction phase of the project. Eventually, all species of fish currently in the system are expected to reestablish. Spottail shiners are not expected

to be adversely affected by the alteration in flow patterns and water depths. This species usually spawns in closely packed groups, with no evidence of nesting (Greeley and Greene, 1931).

In the lower Passaic River (below Beatties Dam), water quality and habitat diversity are already under stress which limits species diversity of fish and invertebrates. In the Passaic River section between the Two Bridges inlet structure and the Passaic River outlet structure, it is expected that flood waters will decrease substantially resulting in reduced cleansing and scouring. The best prediction for this river section is that fish species may decline below existing low levels.

Recent improvements to water quality of the Pompton River in the project area may be offset and adversely impacted by the project. The fish species diversity in this section of river is currently low. Post project conditions, particularly habitat suitability, will determine whether or not the NJBFF will continue the recreational trout-stocking program.

HABITAT LOSS

Much of the anticipated project-related habitat loss and alteration has already been discussed in other sections of this report. The proposed project will, in our opinion, reduce habitat diversity and quality, especially in un-impounded areas. These losses would occur after the construction phase of the channel-alteration project.

CHANGES IN RIVER SUBSTRATE

Changes in river substrate will be significant in the 6.0 mi. of the proposed channel modification areas. Biological impacts from downstream siltation and suspended sediment during and after construction are anticipated, but a literature search is needed to better define those impacts. An extensive biological sampling program should also be conducted to better determine impacts if the project is authorized.

WATER INTAKE EFFECTS

It is assumed from our review of project plans that the proposed water intake structures would be constructed on the floor of a 300-ft. wide basin that is 8 ft. below the crest of the inlet opening. A river diversion spillway would control discharge entering the basin. Although some individual fish and other life forms could be injured or killed by the shearing action and mechanical damage of the spillway gates (Bell, 1974; Ulanowicz, 1975), the height of the inlet opening will prevent fish (and debris) from entering the tunnel. Low DO levels, water velocities and unavailability of food make the tunnels uninhabitable for fish.

WATER DISCHARGE EFFECTS

Adverse impacts of water discharges at the Passaic River outlet are not expected to be significantly different from existing conditions. No major impact on habitat is expected. Anadromous species such as American shad,

alewife and blueback herring could experience delayed migration to spawning areas by changes in currents near the outlet during tunnel operation. Contaminants contained in bottom sediments, particularly dioxins and PCB's, could be resuspended and transported downstream by increased velocities during tunnel operation.

HYDROLOGY AND WATER QUALITY

Velocities are expected to increase after the completion of the proposed project. The length of time that floodwaters occupy river channels would decrease and thus, reduce cleansing and scouring the existing channels, particularly downstream of inlet locations. Species of animals, especially fish, that require certain periods of high water for spawning could be affected. In the 6.0 mi. of modified channel, shallow water would be impounded more often. At low water periods, a distinct channel within the bottom of the trapezoidal-shaped river would be a prominent feature.

Within the study area, 117 tributaries discharge into the Passaic River. At the confluence of these tributaries with the mainstem, flooding occurs causing substantial backup and nutrient rejuvenation. In general, waters would flood the respective tributary upstream anywhere from a few feet to several thousand feet. With the proposed channel modification, the degree of flooding into these tributaries will be reduced. Thus, nutrient depletion could be expected. The tributaries vary in size so it is difficult to predict for any single tributary, without an extensive analysis, what the overall impact of this change would be on fish or wildlife.

FUTURE-WITHOUT-PROJECT (2040)

GENERAL EVALUATION

Fish and wildlife resources supported in the PRB and in the tunnel diversion system's project impact area are and will continue to be adversely impacted by poor water quality via point and non-point sources of pollution. The toxicity of point-source pollution to aquatic ecosystems is correlated with the effluent being discharged from sewage treatment plants, and lesser in number, but more toxic, industrial discharges. The Environmental Protection Agency and the State of New Jersey will continue to monitor these sewage and industrial discharge points for upgrading. Most sewage treatment plants have been upgraded and further incremental improvement is expected to be minimal. Point source pollution from sewage treatment plants is expected to increase to accommodate additional development. Although industrial discharge is closely monitored, there is a need for research on environmental contaminants. Nonetheless, contaminants are a major public concern and increased levels of toxicity are not expected to be tolerated. This public concern will increase monitoring, research and regulation of toxic materials.

Non-point sources of pollution are expected to continue in the future. The PRB, particularly the industrialized and urbanized areas, will always have water quality problems to some degree. Continued development will accelerate non-point sources. Petroleum, salt and sand from highway and parking lot runoffs and fertilizer, lime and pesticides from suburban lawns will continue

to contaminate the aquatic ecosystem. Filters and traps could reduce the petroleum products, road salt, sand and sediments entering the watercourse. Similarly, storm water detention basins, reclaimed floodplain and wetlands will filter runoff.

Floodplain, wetland and riparian areas adjacent to a watercourse are part of the aquatic ecosystem and influence habitat quality by controlling runoff, bank erosion, sedimentation and high water temperatures. Municipalities, eager for tax ratables, increase flood damages by zoning these areas for development. As development continues, the frequency, duration and depth of flooding will increase. Local flood control measures such as channelization will be implemented, increasing downstream flooding and structural damage. Flooding intensity will encourage further development on the floodplain or sime reaches.

Watercourses draining the project impact area are discussed below:

PEQUANNOCK RIVER

The Pequannock River will continue to show fair to good water quality. Continued development and additional non-point sources of pollution may decrease water quality. A warmwater fishery is expected to persist in the future. A trout stocking program is being conducted upstream of the project impact area. Habitat suitability would allow this stocking to occur downstream. This segment of the Pequannock River will continue to offer recreational angling opportunities.

WANAQUE RIVER

The Wanaque River will continue to exhibit good water quality. The fish population supported by this segment of the Wanaque characterizes a moderately balanced warmwater fishery and a marginal coldwater trout fishery. Continued upstream development could adversely impact the coldwater fishery. However, the trout stocking program that supports this coldwater fishery is expected to continue. The Wanaque segment draining the project impact area is expected to continue to support important recreational angling opportunities.

RAMAPO RIVER

The Ramapo River will continue to show good water quality and a balanced warmwater fishery below the Pompton Lake Dam. The river will also support a troutstocking program. The segment of the Ramapo River draining the project impact area is expected to continue to support existing aquatic resources and recreational angling opportunities.

POMPTON RIVER

The Pompton River will continue to show fair to good water quality. Water quality is expected to remain similar to present conditions and a warmwater fishery will persist in the future. The segment of the Pompton River draining

the project area will continue to offer some recreational angling opportunities. Trout stocking would be expected to continue in 2040 without the project.

ROCKAWAY RIVER

Water quality in this segment of the Rockaway River is influenced by pollution problems in the project area. Although point source discharge quality should improve in the future, it will be offset by an increase in non-point source runoff from new development. Therefore, a warmwater fishery will continue to persist in the future. This segment of the Rockaway River will offer limited recreational angling opportunities in the future.

WHIPPANY RIVER

The Whippany River will continue to exhibit fair to poor water quality in its lower reaches. A warmwater fishery is expected to persist in the future. The Whippany River will offer limited recreational angling opportunities in the future.

PASSAIC RIVER

In recent decades the water quality of the Passaic River has shown an improvement. Water quality problems are most severe in the lower PRB. The quality of point source discharges is expected to stabilize or improve in the future. Non-point sources are expected to increase in the central PRB with continued development.

Fish populations supported in the lower reaches of the river (i.e., Beatties Dam to Dundee Dam) will continue to support and be dominated by eurytolerant species such as carp, white sucker and goldfish. Fish populations supported in the tidal segment of the river (i.e., Dundee Dam to Newark Bay) will continue to characterize species found in the lower Hudson River/New York Bight estuarine system. It is hopeful that anadromous blueback herring, alewife, American shad, and semi-anadromous species including white perch and striped bass will continue to inhabit the tidal segment of the river. Poor water quality, particularly DO levels, will continue to limit the reproductive success of anadromous fish in the Passaic River.

The only known use of consumptive fishery resources in the lower Passaic River is for carp. This recreational use is expected to continue. A lack of public accessibility to the watercourse constrains angling and other recreational opportunities (e.g., boating).

FUTURE-WITH-PROJECT (2040)

GENERAL EVALUATION

Similar to the "future-without-project" scenario for aquatic resources, a reduction in the severity of point sources and an increase in non-point sources of pollution are expected to occur in the central and lower PRB. In some areas (e.g., along the Pequannock, Ramapo, Wanaque and Pompton Rivers)

project implementation could further increase non-point source runoff from residential development constructed behind levee/ponding systems or adjacent to floodplain areas that are inundated annually. In comparison, periodic inundation anticipated under the "future-without-project" scenario would discourage development adjacent to the watercourse.

Tunnel inlet operation will regulate volume flow and thus influence aquatic habitat. Channel flushing, sediment deposition, summer water temperatures, dissolved oxygen and flow regimes contribute to habitat suitability for aquatic resources and will be altered by tunnel operation. For example, cleansing and scouring of the Passaic channel help dilute polluted river waters in the Paterson/Clifton area. Tunnel inlet operation at Two Bridges would allow a flow rate of 100 cfs over Beatties Dam. This low volume flow is inadequate to maintain existing aquatic conditions and to provide necessary channel flushing. Mean annual flow and the one-year flood event at this location is approximately 1,100 cfs and 6,100 cfs, respectively. Although the information provided by the COE to explain the operation of the Two Bridges inlet structure indicates that up to the one-year flood event would be allowed to bypass the tunnel, the duration and frequency of this discharge is unknown. Additionally, the operation of both tunnel inlets will influence the physical dimensions of the river channels by controlling erosion and deposition via flow rate. A channel limited to carrying the one-year flood event will eventually stabilize in size. Overall, project implementation could make the Passaic River more slow-moving, sluggish and a smaller watercourse.

Upstream tributaries (i.e., Pequannock, Ramapo and Wanaque Rivers) help improve water quality conditions in the Pompton and lower Passaic Rivers. In addition to limiting flow rate to the one-year flood event, project implementation would successfully control floodplain and wetland inundation. In comparison to the "future-without-project" scenario, the development of existing floodplain could be encouraged.

According to the information provided by the COE, the tunnel will contain approximately 170 million gallons of water. Some anerobic water is expected. Some of the water being discharged will be oxygenated at the outlet. The lower oxygenated water remaining, given the volume and rate of flushing, would be removed within 7 hours of the initiation of tunnel operation. Aeration caused by Great Falls and Beatties Dam will increase oxygen levels in the mainstem Passaic River. Water discharging from the tunnel will circumvent the lower PRB and should be of higher water quality.

The proposed acquisition areas, if incorporated into the tunnel project, would contribute to improved aquatic habitat conditions. These areas will be important for discouraging development, filtering runoff, controlling erosion and sedimentation, providing detritus to the aquatic ecosystem, and along some reaches, providing shade and bank stabilization.

Watercourses draining the project impact area are discussed below:

PEQUANNOCK, WANAQUE AND RAMAPO RIVERS

Project implementation including channelization and levees, would adversely impact habitat suitability. An evaluation of post-project conditions in target year 2040 would be necessary to determine habitat suitability for aquatic resources. Proposed levee systems may interfere with public access and thus, limit recreational angling opportunities.

POMPTON RIVER

Project implementation will change the existing pattern of inundation along the Pompton River by limiting discharge to the one-year flood event. Hence, this flood control may encourage floodplain development. A warmwater fishery and marginal recreational angling opportunities are expected in the future. Of the four acquisition areas that are proposed along the lower Pompton River as part of the tunnel project, three would maintain public access to the watercourse.

ROCKAWAY RIVER

Impacts on aquatic resources in the Rockaway River would be similar to those presented under the "future-without-project" scenario. Floodplain and wetland areas adjacent to the river will be lost to the construction of levee systems #1, #2 and #3. This segment of the Rockaway River should continue to support a warmwater fishery and recreational angling opportunities.

WHIPPANY RIVER

Impacts on aquatic resources in the Whippany River would be similar to those presented under the "future-without-project" scenario. Acquisition of wetland and floodplain areas in Black and Troy Meadows and Hatfield Swamp would, as part of the tunnel project, contribute to the future quality of the river. A warmwater fishery and limited recreational angling opportunities are expected in the future.

PASSAIC RIVER

Impacts on aquatic resources in the Passaic River would be similar to those presented under the "future-without-project" scenario. Fish populations will continue to support and be dominated by eurytolerant species in the lower reaches of the river (i.e., Beatties Dam to Dundee Dam). Tunnel operation to achieve continuous low flows could decrease fish diversity in the mainstem Passaic by altering habitat suitability. The tunnel outlet is not expected to have adverse impacts on anadromous species. The future of anadromous fish in the Passaic River will be determined by water quality.

Consumptive uses of fishery resources will continue to be limited. Public access to the watercourse may be further restricted by levee/floodwall systems.

WETLANDS

INTRODUCTION

Previous Service PAR's have described general wetland distribution in the PRB (Day et al., 1985; Day and Bosenberg, 1980, 1981a; 1981b; U.S.F.W.S., 1979). Therefore, the information presented in this report will focus primarily on project-related wetland impacts.

LOCATION

Wetlands are located within the central and lower PRB and occur on or adjacent to floodplains of the Passaic, Pompton, Ramapo, Pequannock, Wanaque, Whippany and Rockaway Rivers. Minimal attention will be given to the lower PRB, since relatively small amounts of vegetated wetland occurs adjacent to the river below the Little Falls area.

GLACIAL GEOLOGY AND TOPOGRAPHY

The central PRB, including the southern portion of the Pompton subbasin, contains the major wetlands to be impacted by the project and occurs within the Triassic Lowland section of the Piedmont physiographic province. The northern portion of the Pompton subbasin lies in the Eastern Highlands physiographic province. This portion of the Pompton subbasin is mentioned only because of a difference in topography and drainage that ultimately results in differences in flood peak timing between the Passaic and Pompton Rivers in the Two Bridges area. In general, the Piedmont province slopes gently southward, from a mean elevation of 200 ft. in the study area to sea level at Newark Bay. Similar to the entire PRB, this province was subjected to glacial erosion and deposition during the Wisconsin glaciation period. Robichaud and Buell (1973) state that in addition to changing the landscape by its sculpturing force and deposits, glaciation left a physical impact on stream drainage patterns. Furthermore, in New Jersey as in other areas, natural lakes were originally formed when glaciers scoured depressions in rock beds and glacial deposits blocked stream channels. Such was the case with Glacial Lake Passaic, an extinct lake that originally occupied the Upper Passaic Valley between the New Jersey Highlands on the northwest and Second Watchung Mountain on the south and east, when the Passaic River and other outlets were blocked (Wolfe, 1977). Although Lake Passaic has long since drained, the glacial lake sediments that remain have formed the soils that support much of the existing wetland vegetation in the study area. Today, wetlands are found on stratified lacustrine sand, silt, or clay (in the broad lowlands of the Great Piece Meadows/Troy Meadows/Hatfield Swamp area) or on stratified outwash sand and gravel along the Pompton and more northern Passaic River tributaries.

HYDROLOGY

The aquatic habitat occurring within the Passaic, Pompton, Ramapo, Pequannock, and Wanaque, Whippany and Rockaway Rivers is classified as "riverine lower

perennial" (Cowardin et al., 1979). The lower perennial subsystem is characterized as having a low gradient, low water velocities and a well-developed floodplain.

Floodplain and riparian areas are adapted to and dependent on flooding, as explained by Brinson (1980). Over geologic time, streams undergo erosive downcutting and alluvial deposition. At the same time, stream channels migrate across floodplains, a process which results in a continual replacement and displacement of flora and fauna. Therefore, stream channel movement is responsible for "organizing" the floodplain into a variety of diverse communities, many of which are controlled by the depth, duration and frequency of inundation (Brinson, 1980).

Flooding is primarily responsible for depositing and eroding sediments, resulting in a varied or uneven topography within floodplains in general. Commonly used topographic terms that would be used to describe situations existing in the study area are as follows: 1) first bottoms or annual floodplain; 2) second bottoms or terraces; 3) levees; 4) poorly-drained flats or swamps; 5) well-drained flats; and, 6) sloughs or old meander scars. Of these, first and second bottoms differ in elevation relative to river flood levels. Levees are naturally occurring features, slightly higher than the surrounding floodplain, found along river channels and old meanders. They are composed of coarser alluvial sediments deposited immediately adjacent to channels during overbank flooding and normally only remain flooded for brief periods. Some flat expanses of floodplain drain off quickly and water tables are lowered by the middle of the growing season. However, drainage back into the river channel can be impeded by levees, or affected by the type of soil present. In this situation, water tables are high throughout the growing season. Old meander scars are long, narrow depressions that take a "serpentine" form. They indicate former locations of the river channel, and hold surface water well into the growing season.

It is the variation in topography, flooding and drainage described above that ultimately affects the composition and distribution of wetland plant communities in the study area. Wistendahl (1958) explains that "A floodplain, although a single physiographic feature, possesses a varied topography with equally varied local vegetational patterns. These patterns intergrade from place to place, but nevertheless are distinctive enough to be recognized as composed of plant communities." It can be seen that wetland plant patterns (i.e., communities) are adapted to a "fluctuating water level ecosystem" characterized and maintained by a natural hydrologic regime of alternating wet and dry periods (Wharton et al., 1982). The plant species that thrive under such conditions are well adapted to the stress imposed by the hydroperiod and hence, the more mesic species not adapted to flooding are out competed. As Teskey and Hinckley (1978) report, flooding eliminates intolerant species and creates a diverse pattern of soil and vegetation.

DESCRIPTION OF WETLAND VEGETATION

GENERAL OVERVIEW

Wetlands can be described as ". . . lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface" (Cowardin et al., 1979). The water table is at, near, or above the land surface long enough to promote the formation of hydric soils and to support the growth of hydrophytes. Under these conditions a wide variety of plant communities become established. The wetland information presented in this report will deal with a description of plant communities occurring in the project area. Furthermore, hydric soils associated with wetlands in the project area will also be described.

Both natural and human influences have played a role in determining the plant composition of individual wetlands. Natural factors, such as geography, geology, climate, hydrology and water chemistry are largely responsible for the development of wetland soils and the distribution of associated flora. Timber harvesting and clearing for agriculture have created earlier successional stages, and drainage, filling, highway construction and flood control are examples of land use activities that have altered hydrologic regimes and subsequently led to changes in plant community structure and composition.

No attempt will be made to provide detailed and complete lists of plant species found in wetlands within the project area. Lists have been provided as appendices in previous PAR's (Day and Bosenberg, 1980, 1981a; U.S.F.W.S., 1978, 1979). However, representative vegetation found along the rivers proposed for channelization or flow modification will be described.

Areas identified and delineated as wetland in the floodplain were characterized by a predominance of hydrophytic vegetation determined by field investigations and color infra-red stereo photo-interpretation. Hydric soils mapped by the SCS and the topographic information provided by the COE's maps (submitted with early stage III plans) were used to support these delineations.

DESCRIPTION OF WETLAND COVER TYPES

Wetlands are classified according to the Classification of Wetlands and Deepwater Habitats (Cowardin et al., 1979). The majority of wetlands in the project area fall into the palustrine system, with the exception of the riverine channel itself and a few small riverine and estuarine mudflats in the lower PRB. All wetland plant species listed below are assigned an "indicator status" as either "obligate hydrophyte" or "facultative hydrophyte" on the Service's "wetland plant list" developed by the NWI. When a predominance of these species is present in conjunction with hydric soil, wetland hydrology or flooding conditions are also present. This condition can be seen in portions of the project area floodplains. The presence of these three characteristics indicates wetland.

1. PFO1 PALUSTRINE BROAD-LEAVED DECIDUOUS FORESTED WETLAND.

The PFO1 wetland type is characterized by an overstory of woody vegetation that is approximately 20 ft. tall or taller, an understory of young trees or shrubs (although this layer is not always present) and a herbaceous layer. The main characteristic species found in this area include red maple (Acer rubrum), silver maple (A. saccharinum), pin oak (Quercus palustris), American sycamore (Platanus occidentalis), white ash (Fraxinus americana), slippery elm (Ulmus rubra), and some sweetgum (Liquidambar styraciflua). The understory usually consists of young trees as listed above and spicebush (Lindera benzoin), viburnums (Viburnum spp.), highbush blueberry (Vaccinium corymbosum) and dogwoods (Cornus amomum, C. stolonifera). Composition of the herbaceous layer varies and can include skunk cabbage (Symplocarpus foetidus), jack-in-the-pulpit (Arisaema triphyllum), ferns (Polypodiaceae), asters (Aster spp.), stinging nettle (Urtica dioecia), false nettle (Boehmeria cylindrica), clearweed (Pilea pumila), jewelweed (Impatiens capensis) and beggars-tick (Bidens spp.).

In the drier forested wetlands, characterized by the "temporarily-flooded" water regime, a mix of the tree species mentioned above occurs. Along the old meander scars and sloughs, in a "seasonally-flooded" water-regime situation, river birch, silver maple and red maple can be found. The wettest swamps usually exhibit an organic, muck type soil situation, are always at least saturated and are characterized by red maple with a herbaceous layer of tussock sedge (Carex stricta). This herbaceous layer causes "mounds and pools" to develop with water standing in the pools. An example of this situation is found in Great Piece Meadows on the "flats" or floodplain behind the naturally occurring levees and closer to the margins of the floodplain. These wetland areas drain off much slower than other portions of the floodplain and are so wet that plant communities may be held at an earlier successional stage. Trees cannot become established in such areas and thus, the cover types are comprised of emergents or shrubs.

2. OXBOWS

Oxbows usually occur within forested wetland, and are characteristic of floodplains. Oxbows or "sloughs" are old meander scars that represent previous river channel positions in the floodplain. These low, linear features usually hold floodwaters well into the growing season and in some cases throughout the year. Oxbows add diversity to floodplain landscapes and provide much "edge" with the forest community due to the openings created in the canopy. Oxbow cover types are usually classified as palustrine persistent and non-persistent emergent communities.

3. PFO1/SS1 MIXED PALUSTRINE DECIDUOUS FORESTED-SHRUB WETLAND.

The PFO1/SS1 wetland type is characterized by a mix of forest species and shrub species, where canopy cover is not continuous and structural diversity is in some ways greater and of a different nature than in non-mixed types. Shrub species, occurring with the previously described forest species, are listed below.

4. PSS1 PALUSTRINE BROAD-LEAVED DECIDUOUS SCRUB-SHRUB WETLAND.

Scrub-shrub wetlands include areas dominated by woody vegetation less than 20 ft. tall. Species include shrubs, young trees and trees or shrubs that are small or stunted because of environmental conditions, including amount and duration of flooding, or because of previous clearing and subsequent abandonment. This wetland type may represent a successional stage leading to the development of a forested wetland, or may be a relatively stable community type. Commonly occurring species include red maple, alders (Alnus spp.), red-osier dogwood, silky dogwood, rushes (Juncaceae), sedges (Cyperaceae) and grasses (Gramineae). Also occurring are willows (Salix spp.), sweet pepperbush (Clethra alnifolia), azalea (Rhododendron spp.), viburnums and blueberry.

5. PSS1/EM MIXED PALUSTRINE SHRUB-EMERGENT WETLAND.

Similar to PFO1/SS1, the PSS1/EM cover type includes a mixed community which exhibits the same structural diversity. Shrubs mentioned above are intermixed with emergents listed below, although this list is obviously not all-inclusive.

6. PEM1 PALUSTRINE EMERGENT WETLAND.

The PEM1 cover type is characterized by the presence of erect, rooted, herbaceous hydrophytes. Perennial plants usually dominate the PEM1 cover type. Typically, the dominant species remain standing, at least until the beginning of the next growing season (persistent) or fall to the surface of the substrate or below the surface of the water at the end of the growing season (non-persistent). Thus, no obvious sign of emergent vegetation is apparent in the latter situation. Most of the emergent wetland found in the project area is dominated by persistent emergents with the exception of oxbow situations and edges of open-water bodies and ditches. Typically, many species occur in PEM1 wetland areas but characteristic species are cattails (Typha spp.), bulrushes (Scirpus spp.), sedges (Carex spp.), smartweeds (Polygonum spp.), pickerelweed (Pontederia cordata), arrowheads (Sagittaria spp.) and common reedgrass (Phragmites australis). "Cattail," "sedge-swale," "floodplain," "river bank," "wet-meadow," and other communities have been described in more detail by Jervis (1963) for the Troy Meadows area, and by the Service (1979) for the PRB in general. Vegetative community descriptions are provided in previous PAR's (Day and Bosenberg, 1980, 1981a, 1981b; U.S.F.W.S., 1979).

7. POW PALUSTRINE OPEN-WATER

Small open water bodies such as ponds are present to a limited extent in the project area and littoral communities may occur along their borders.

DESCRIPTION OF SOILS

As previously mentioned, the central PRB and lower Pompton subbasin have been subjected to glacial deposition. The soils along the rivers, formed in glacial lake sediment and stratified glacial outwash, are found in lake basins, on low plains and on terraces.

The following soil associations have been mapped and described by the SCS (1975, 1976) along the rivers in the project area (taken from Morris and Passaic Counties soil surveys):

1. **CARLISLE-PARSIPPANY-PREAKNESS ASSOCIATION**

"Deep, poorly drained and very poorly drained, nearly level mucks, silt loams, and sandy loams that overlie stratified lacustrine sand, silt, and clay or stratified outwash sand and gravel; in depressions or along low-gradient streams"

This association consists of organic and mineral soils. The organic soils formed in partly decayed remains of herbaceous and woody plants in deposits 6 ft. or more deep. The mineral soils formed in stratified clayey or sandy loam glacial outwash. Bedrock is below a depth of 10 ft.

This association covers 4 percent of the county. It is 50 percent Carlisle soils, 30 percent Parsippany soils, 10 percent Preakness soils and 10 percent minor soils.

Carlisle soils are in depressions or along low-gradient streams. These are nearly level, very poorly drained, dark-colored organic soils. Parsippany soils are in the basin formerly occupied by Glacial Lake Passaic. They are nearly level, poorly drained mineral soils. Preakness soils are in depressions on terraces and outwash plains. These soils are nearly level, poorly drained sandy loams.

Minor soils in this association are in the Adrian and Biddeford series and the Preakness series, dark surface variant. Also included are areas of Muck, shallow to clay or shallow to loam. Adrain soils are in depressions and low areas near streams. The Preakness dark surface variant is in depressions on terraces and outwash plains. Biddeford soils are in depressions, along streams, and in old meander scars in the basin formerly occupied by Glacial Lake Passaic. Muck is commonly around bogs and swamps.

This association is severely limited by poor to very poor drainage and by the organic soils.

If drained, the soils in this associated are well suited to vegetables and other specialty crops. They are poorly suited to community development. They are suited to open-space activities.

This association is used mostly for trees and marsh plants.

2. **PARSIPPANY-BIDDEFORD-WHIPPANY ASSOCIATION**

"Deep, somewhat poorly drained to very poorly drained, nearly level and gently sloping silt loams that overlie stratified lacustrine sand, silt and clay; on broad low-lands"

The soils in this association formed in moderately fine textured glacial outwash 3 ft. or more thick over loamy to gravelly and sandy outwash several feet think. Bedrock is below a depth of 10 ft.

This association covers 5 percent of the county. It is 45 percent Parsippany soils, 15 percent Biddeford soils, 15 percent Whippany soils and 25 percent minor soils.

Parsippany soils are in the basin formerly occupied by Glacial Lake Passaic. They are nearly level and poorly drained. Biddeford soils are in depressions along streams, and in old meander scars of the basin formerly occupied by Glacial Lake Passaic. These soils are nearly level and very poorly drained. Whippany soils are on slight elevations or gently sloping peripheral areas of the basin formerly occupied by Glacial Lake Passaic. These soils are nearly level to gently sloping and somewhat poorly drained.

Minor soils are in the Adrian, Carlisle, Pompton, Riverhead, and Preakness series. Also included are areas of Muck. Adrian and Carlisle soils and areas of Muck are in depressions and low areas near streams. Pompton, Riverhead and Preakness soils are on terraces and outwash plains; Riverhead soils are well drained, Pompton soils are somewhat poorly drained and Preakness soils are poorly drained.

The soils in this association are limited for farming and most community development by very poor to somewhat poor drainage, clayey texture and frequent flooding.

This association is poorly suited to farming and most community development. It is well suited to habitat for waterfowl and associated wetland wildlife.

About half of the areas of this association are woodland. Most of the rest have been cleared and cultivated. In recent years, extensive areas have become idle and are now part of the Great Swamp National Wildlife Refuge.

The soils listed in the first two associations all support wetland or hydrophytic vegetation with the exception of Riverhead and Pompton series. These two soils have been observed as occurring within floodplain areas along the rivers in the project area, but do not usually support wetland communities. They appear to be located on slightly higher terraces or "second bottoms." Much of the urban/residential land along the Passaic east of Two Bridges has been mapped as a "Urban land-Riverhead" complex, explained in the association described below by the SCS (1975, 1976):

3. RIVERHEAD-URBAN LAND-POMPTON ASSOCIATION

"Deep, well drained to somewhat poorly drained, nearly level to strongly sloping gravelly sandy loams and sandy loams that overlie stratified outwash sand and gravel; on outwash plains and terraces"

The soils in this association formed in gravelly sandy loam or loamy sand glacial outwash. The outwash is derived mostly from granitic gneiss, red to brown shale and sandstone, and basalt. Bedrock is below a depth of 10 ft.

This association covers 12 percent of the Passaic County. It is 40 percent Riverhead soils, 25 percent Urban land-Riverhead complex, 10 percent Pompton soils and 25 percent minor soils.

Riverhead soils are on terraces and outwash plains. These soils are nearly level to strongly sloping and well drained. The areas of uban land have been cut, filled, smoothed, or otherwise mixed during construction. Most of the areas are covered by buildings and pavement. Most of the soils in the remaining open spaces have been reworked to the extent that the original profile cannot be identified. Pompton soils are on terraces and outwash plains. These soils are nearly level to gently sloping and somewhat poorly drained.

Minor soils are in the Preakness, Otisville, Parsippany, Boonton, and Adrian series and the Preakness series, dark surface variant. Preakness soils and the Preakness dark surface variant are in depressions on terraces and outwash plains. Otisville soils are on gently rolling high terraces. Parsippany soils are in old glacial lake basins. Boonton soils are on ridgetops, side slopes and hills. Adrian soils are in depressions and low areas near streams. Isolated knobs of excessively drained coarse-textured soils are also present.

The soils in this association are limited for farming and community development by inadequate drainage in low areas, the hazard of erosion on sloping soils and coarse texture. The wet areas and the coarse-textured soils are severely limited for onsite disposal of septic tank effluent.

This association is well suited to farming and to community development. Most of this association was once cleared and used extensively for vegetables and nursery crops, but now it is idle or is used for residential, commercial and industrial purposes. In the western part of the county and in the Berkshire Valley, areas of this association are mostly woodland. This association is a source of sand, gravel, and road fill. Pit operations are extensive in the northwestern part of Mount Olive Township. Near Succasunna and Pequannock, sand and gravel have been mixed by means of dredging, leaving large ponds or lakes. Urban land is used as building sites and for other nonfarm uses.

Although there is no up-to-date soil survey available for Essex County, an older soil survey of the Bergen County area was reviewed (U.S.D.A., 1925) and soils for the entire Great Piece Meadows area were found to be classified in a very general way, as "Papakating silt loam." This classification is no longer used, but was described as having "imperfect to poor drainage" and supported a wetland plant community of pin oak, elm, maple, gum, some hickory and an undergrowth of ferns, grasses and sedges.

Hydric Soils List

Hydric soils are soils that for a significant period of the growing season have reducing conditions in the major part of the root zone and are saturated within 9.8 in. of the surface. Most hydric soils have properties that reflect dominant wetness characteristics. Features frequently associated with hydric soils include:

1. an aquic moisture regime;

2. a deficiency of oxygen near the surface during much of the growing season; and,

3. flooding or ponding of long duration during the growing season.

The official list of New Jersey hydric soils is presented as Tables 2a, 2b and 2c. This list was developed by the SCS and the Service during the NWI. Hydric soils are grouped according to their degree of association with wetland.

Table 2a. Official List of New Jersey's Hydric Soils

GROUP 1 - Soils that nearly always display consistent hydric conditions.

SOIL SERIES OR LAND TYPE	TAXONOMY	SOIL SERIES OR LAND TYPE	TAXONOMY
Adrian	Terric Medisaprists	Lyons	Mollic Haplaquepts
Bayboro	Umbric Paleaquults	Lyons, Stony	Mollic Haplaquepts
Berryland	Typic Haplaquods	Manahawkin	Terric Medisaprists
Bibb	Typic Fluvaquents	Matlock	Typic Umbraquults
Biddeford	Histic Humaquepts	Muck	N/A
Bowmansville	Aeric Fluvaquents	Mullica	Typic Humaquepts
Carlisle	Typic Medisaprists	Norwick	Typic Fragiaquepts
Chippewa	Typic Fragiaquepts	Norwick, Stony	Typic Fragiaquepts
Cokesbury	Typic Fragiaquults	Pocomoke	Typic Umbraquults
Cokesbury, Stony	Typic Fragiaquults	Portsmouth	Typic Umbraquults
Colemantown	Typic Ochraquults	Preakness	Typic Humaquepts
Croton	Typic Fragiaqualfs	Sloan	Fluvaquentic Haplaquolls
Doylestown	Typic Fragiaquults	St. Johns	Typic Haplaquods
Elkton	Typic Ochraquults	Sulfaquents	N/A
Fluvaquents	N/A	Sulfihemists	N/A
Fresh Water Marsh	N/A	Swamp	N/A
Halsey	Mollic Haplaquepts	Tidal Marsh	N/A
Humaquepts	Cumulic Humaquepts	Wallkill	Thapto-histic Fluvaquents
Keansburg	Typic Umbraquults	Wayland	Mollic Fluvaquents
Lamington	Typic Fragiaquults	Weeksville	Typic Humaquepts
Livingston	Mollic Haplaquepts	Whitman	Humic Fragiaquepts
		Whitman, Stony	Humic Fragiaquepts

Table 2b. Official List of New Jersey's Hydric Soils

9/26/84

Group 2 - Soils displaying consistent hydric conditions in most places, but additional verification is needed.

SOIL SERIES	TAXONOMY	SOIL SERIES	TAXONOMY
Atherton	Aeric Haplaquepts	Passaic (Parsippany variant)	Aeric Ochraqualfs
Atsion	Aeric Haplaquods	Plummer	Grossarenic Paleaquults
Fallsington	Typic Ochraquults	Raynham	Aeric Haplaquepts
Fredon	Typic Ochraquults	Reaville (wet variant)	Aquic Hapladalfs
Haledon (wet variant)	Aquic Fragiudalfs	Ridgebury	Aeric Fragiaquepts
Leon	Aeric Haplaquods	Ridgebury, Stony	Aeric Fragiaquepts
Othello	Typic Ochraquults	Shrewsbury	Typic Ochraquults
Parsippany	Aeric Ochraqualfs	Watchung	Typic Ochraqualfs
Pasquotank	Typic Haplaquepts	Watchung, Stony	Typic Ochraqualfs

Table 2c. Official List of New Jersey's Hydric Soils

Group 3 - Soils displaying hydric conditions in few places and additional verification is needed.

SOIL SERIES	TAXONOMY	SOIL SERIES	TAXONOMY
Abbottstown	Aeric Fragiaqualfs	Rowland	Fluvaquentic Dystrochrepts
Amwell	Aquic Fragiudalfs	Turbotville	Aquic Fragiudalfs
Chalfont	Aquic Fragiudalfs	Venango (Albia)	Aeric Fragiaqualfs
Hammonton	Aquic Hapludults	Venango, Stony	Aeric Fragiaqualfs
Klej	Aquic Quartzipsamments	Whippany	Aquic Hapludalfs
Lenoir	Aeric Paleaquults	—	Udifluvents and Ochrepts

Alluvial land as mapped by soil surveys does include wetland. However, due to its variability (including wet and dry environments) alluvial land could not be categorized within one of the three groups. Alluvial land has been mapped along the Pompton and Pequannock Rivers and consists of water-deposited sediment. Although the material and drainage is variable, this land type has a permanent high water table and is flooded annually (U.S.S.C.S., 1976). In regard to alluvial land, the SCS (1976) states: "The hazard of flooding makes this land type poorly suited to most uses. The areas generally are not farmed. Some areas are used for pasture, and some are woodland. Other areas are used for residential commercial, and industrial developments." In some developed areas, such as the towns of Dover and Pequannock, alluvial soils support residential, commercial and industrial sites; however, damage from floods is generally extensive in these areas. Soils associated with wetland in the project area are listed in Table 3.

Table 3. Soils Associated With Wetland in the Project Area.

SOIL SYMBOL	SOIL MAPPING UNIT	HYDRIC SOIL CLASSIFICATION	COMMENTS
Ad	Adrian muck	Hydric, Group 1	very poorly drained, organic
Bd	Biddeford silt loam	Hydric, Group 1	very poorly drained
Cm	Carlisle muck	Hydric, Group 1	very poorly drained, organic
Ms	Muck, shallow over clay	Hydric, Group 1	very poorly drained, organic
Ph,Pk	Parsippany silt loam	Hydric, Group 2	poorly drained
PtA	Pompton sandy loam	Non-hydric	somewhat poorly drained
PvA	Pompton fine sandy loam	Non-hydric	somewhat poorly drained
Pw	Preakness sandy loam	Hydric, Group 1	poorly drained
Px	Preakness silt loam	Hydric, Group 1	poorly drained
RhB	Riverhead sandy loam	Non-hydric	well-drained
Un	Urban land-Preakness complex	--	disturbed, poorly drained
Up,UrB	Urban land-Riverhead complex	--	disturbed, well-drained
WlA	Whippany silt loam	Hydric, Group 3	somewhat poorly drained
Ae	Alluvial Land	Not classified	variable drainage and material

FUTURE-WITHOUT-PROJECT (1990 BASELINE CONDITIONS; 2040)

WETLAND DISTRIBUTION AND SUCCESSIONAL TRENDS

Along the river segments proposed for modification, the distribution of wetland cover types has been governed by two major factors: 1) flooding; and, 2) previous land use activities. Rather than one cover type throughout the study area, these two factors are responsible for the presence of a diversity of cover types, particularly within the floodplains.

Flooding has influenced wetland cover type distribution in two ways. First, the presence of surface water and high water tables has directly affected plant growth. Cover types are comprised of hydrophytic vegetation. Water-tolerant species are readily established. Where the period of inundation or saturation is of adequate duration, tree species have not been able to become established and the cover type is characterized by emergents and some extremely water-tolerant shrubs, such as alder, willow and dogwood. Second, erosion and deposition of alluvial sediment maintains early successional emergent and shrub "fringes" along some sections of river channel, edges of islands and on bars. The "scouring" effect of floodwater can also influence the understory within the PFO1 cover type.

Excluding development, the land use activity that has influenced wetland cover type distribution is previous agricultural use. Agricultural use includes both harvest of hay and pasturing. The SCS (1976) explains that most of the areas mapped in their alluvial land category were formerly cleared and used for pasture, but large areas are now reverting to woodland. The abandonment of agricultural land has resulted in shrub and mixed forested/shrub wetland successional stages in portions of study area floodplains.

GREAT PIECE MEADOWS

Great Piece Meadows exhibits a high degree of diversity, due to the interspersion of various wetland cover types. Although much of this large wetland complex is forested (2,343 ac. north of Rt. 80), all cover types discussed under "Description of Wetland Cover Types" are represented. This is illustrated as Figure 2., a section of the Service's NWI map (Pompton Plains quadrangle). Distributed within the forested cover type, in an irregular/non-uniform type of pattern, are the following additional cover type acreages (classification labels indicated in previous descriptions): PFO1/SS1=117 ac., PSS1=208 ac., PSS1/EM1=201 ac., PEM1=157 ac., POW=6 ac. Increasing diversity further is the presence of 81 ac. of oxbows or old meander scars, indicating previous river channels and containing standing water and emergent vegetation.

Both of the factors mentioned earlier, previous land use and flooding, have contributed to the present appearance of Great Piece Meadows. Jervis (1963), in his discussion of Troy Meadows, explains that the large wetland complexes in the Great Piece/Troy Meadows area were dense swamps covered with original timber during colonial times. The timber was removed and swampland cleared for agriculture, mainly hay production facilitated by crude ditching for drainage. Haying was apparently discontinued around 1930 and since then Great Piece Meadows has been subject to successional change. Although some of Great

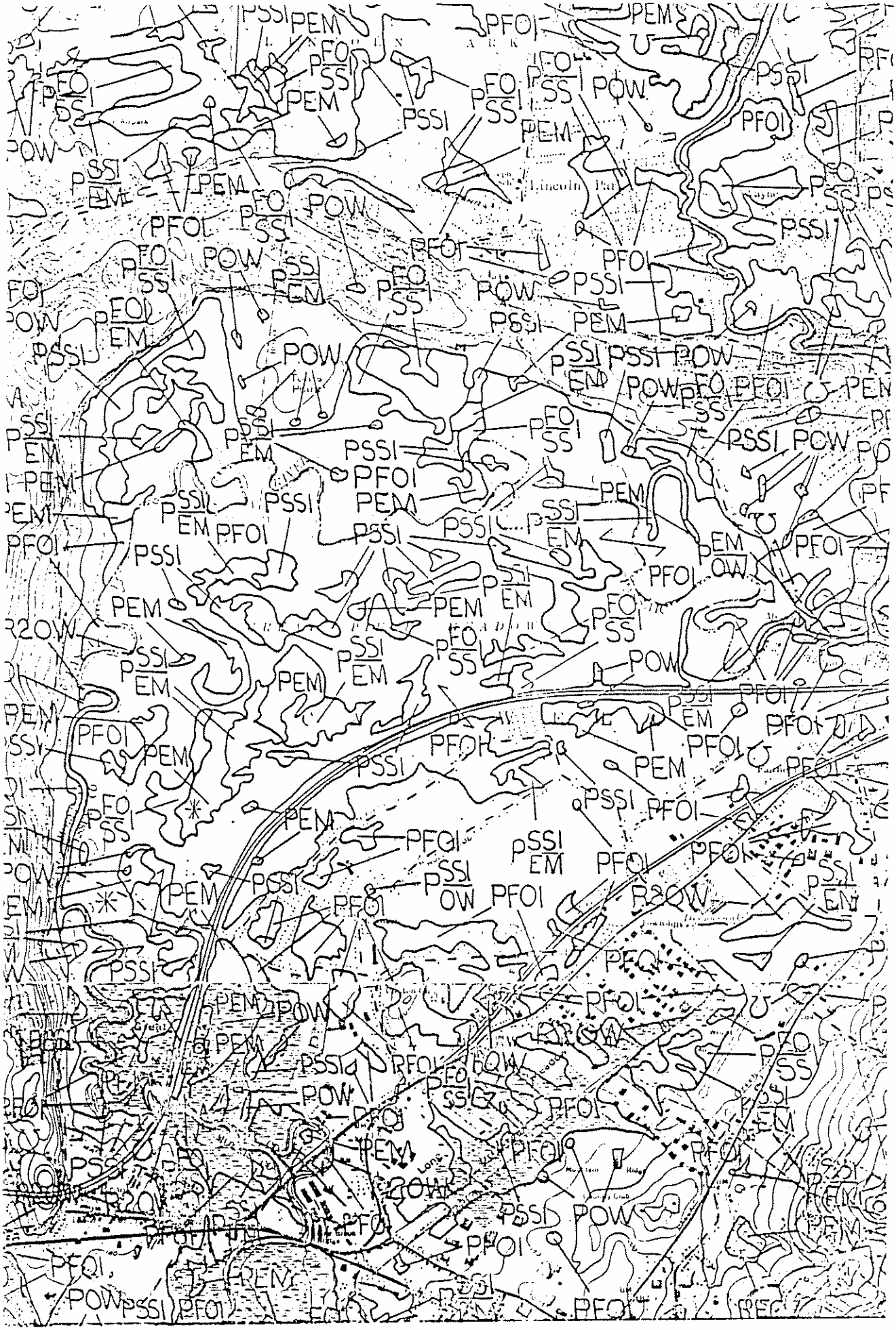


Figure 2. Great Piece Meadows NWI Map

Piece Meadows may never have been cleared, this would explain why much of the wetland has returned to the forested and mixed forested/shrub stage. However, it appears that succession has been retarded, and possibly prevented, on most of the poorly drained flat or backswamp areas. These portions of the floodplain are now occupied by the PEM1, PSS1 and some PFO1/SS1 cover types, and have not changed much in appearance as observed on 1971, 1976 and 1984 aerial photography. Jervis (1963) points out that these wetlands were hayed regularly from the late 1800's until about 1930, at which time the combined effects of peat subsidence by physical shrinkage and aerobic decomposition, and filling of drainage ditches rendered agriculture impractical. This situation, plus the fact that current flood levels are higher due to runoff via urbanization in the PRB, seems to indicate that conditions are no longer favorable (i.e., too wet) for succession to a completely forested stage. The emergent, shrub, and portions of the mixed forested/shrub communities occurring on the poorly drained flats are not expected to change much by 1990 or 2040. Better drained sections of the Great Piece Meadows floodplain, if not already forested, should succeed eventually to a forested wetland stage. One example of succeeding to a forested wetland stage would be sections of PFO1/SS1 located on better-drained flats and levees closer to the river channel. Another example is the PSS1/EM1 at the extreme eastern end of the Great Piece Meadows, semi-enclosed by Passaic River meanders (recently cleared and abandoned).

Soils in the Great Piece Meadows are mapped as Biddeford, Parsippany and Shallow Muck, all classified as being hydric. Differences in water regime (Cowardin et al., 1979), or the amount and duration of flooding, can be superimposed over the wetland cover type map and are illustrated in Figure 3. Different water regimes result from topographic and soils variation, as described under "Hydrology". Water regime differences influence species composition as explained in the PFO1 cover type composition. The "temporarily flooded" regime applies to higher terraces and levees, "seasonally flooded" applies to lower flats along channels and meander scars, and "seasonally flooded/saturated" describes the low, poorly drained flats with organic soils remaining saturated after floodwaters subside. Much of the latter remained as emergent and shrub cover types.

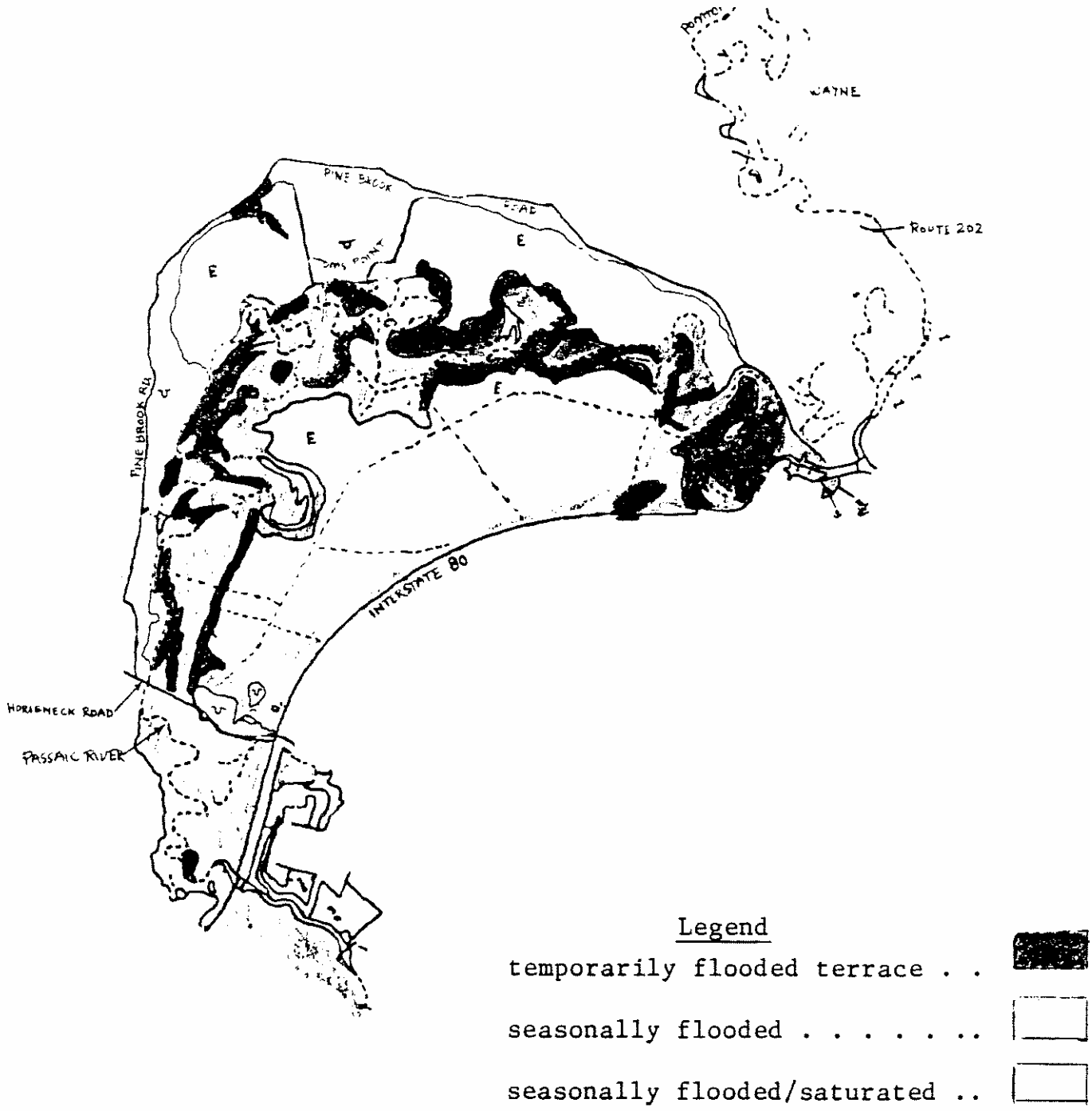


Figure 3. Water Regimes in Great Piece Meadows

remaining saturated after floodwaters subside. Much of the latter remained as emergent and shrub cover types.

OTHER WETLAND

Forested wetlands occur in the Deepavaal drainage and south of Interstate Route 80 (formerly part of Great Piece Meadows, now isolated by the highway). These areas are not expected to undergo any substantial successional changes prior to target years 1990 or 2040.

Along the southern portion of the Pompton River, just north of the Passaic confluence, exists a large block of PFO1 wetland. Diversity is increased here due to the presence of a well-defined oxbow. Successional changes in this area are not expected to occur here prior to 1990 or 2040.

Further north along the Pompton River near the community of Wayne, the presence of PFO1 wetland is again verified by the occurrence of hydric soils and hydrophytic vegetation. No successional change is expected by 1990 or 2040. However, at the northern edge of the Wayne residential area adjacent to the river channel (opposite Lincoln Park), is a large section of cleared floodplain now in various stages of regrowth. Wetland here exhibits mixed cover types of forest, shrub and emergent with many old oxbows. Structural diversity of the plant communities is high at the present time and should continue to exist at least until 1990. However, succession toward a forested community is expected to eventually occur by 2040.

At the confluence of the Ramapo and Pequannock Rivers a high number of smaller river channels and old oxbows exist interspersed with many small islands of forested wetland. The large island immediately north of the confluence, dominated by a PFO1/SS1 community, appears to be slowly succeeding from a previously cleared area to a PFO1 stage. All islands in this area have been classified as Preakness silt loam by SCS (1975), a "Group I hydric soil," and support hydrophytic plant communities. Structural diversity of the plant communities is high due to the degree of interspersion of vegetation and "braided" open water channels, the presence of oxbows and emergent fringes resulting from flood "scour" and alluvial deposition.

Along the Pequannock, at the southern boundary of Pompton Lakes Boro, previously cleared portions of floodplain have reached the PFO1/PSS1 wetland stage and will eventually become PFO1 by target year 2040. Preakness soil is present.

Small areas of temporarily flooded PFO1 wetland are present along the Ramapo and Wanaque Rivers, such as that found at Wilderness Island Park, Pompton Lakes. This area shows signs of intense flooding for brief periods resulting in a sparse understory. No successional changes are expected in this area by 1990 or 2040.

WILDLIFE

General

The central PRB wetlands support a rich assemblage of fauna. In the faunal survey of the seven wetlands in the middle PRB, 175 species were observed (Conservation and Environmental Studies Center, 1980a). The 175 species were comprised of 8 species of salamanders, 11 species of frogs, 114 species of birds, 6 species of turtles, 7 species of snakes, 1 species of lizard and 28 species of mammals. Development of the central PRB wetlands would adversely affect the fauna.

Herpetofauna

Herpetofauna are completely dependent upon wetlands, whether for reproduction (frogs and toads), overwintering (terrestrial turtles), food (snakes) or essential habitats (mud turtles). Although this dependence upon wetlands is species specific, the diversity, distribution, abundance and habitat use patterns of herptofauna respond to structural changes in the vegetation (Clark 1978).

As the wetland ground cover changes in response to the hydrologic regime, the network of surface water connections between wetland and other aquatic or terrestrial systems will increasingly influence the way herptofauna use available habitat. This is particularly important because a species' habitat is a function of its preference for microclimates in different vegetation zones.

Avian

The number of bird species in an area is a function of tree canopy volume and cover type surface area (Foreman et al., 1976; Galli et al., 1976). A change in either canopy volume or surface area would result in a corresponding change in the number of nesting and feeding sites. However, no substantial increase in surface area of any cover types in the project area is expected. Thus, bird species may change in response to successional vegetation changes and landscaping.

Mammals

Changes in population attributes of small mammal species (e.g., shrews, mice, voles, rabbit) are generally related to the volume of ground cover, shrub cover and habitat diversity. Population attributes include density, dispersion and reproduction rate, which are controlled by microclimate and food quality and availability. Changes in larger mammal species populations (e.g., skunk, raccoon) are generally related to the amount and dispersion of adequately sized areas that provide travel corridors and cover for escape, food and reproduction. The difference between these two groups of mammals is based primarily upon mobility. Accordingly, cover type sizes and interspersion are important considerations when assessing project-related impacts on larger mammal species populations. Because surface area size and interspersion of cover types are not expected to change appreciably by 1990,

any increase in the proportion of mesic cover types will result in a greater increase in the carrying capacity of wetlands for small mammals rather than for larger mammals.

Endangered and Threatened Species

The bald eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrinus) are the only species classified as "endangered" by both the Federal Government and the State of New Jersey that may occur in the central PRB wetlands. These species are found as occasional migrants only. The Tremblay's salamander (Ambystoma tremblayi), blue-spotted salamander (A. laterale), bog turtle (Clemmys muhlenbergi), and northern harrier (Circus cyaneus) are state-designated endangered species reported to occur within the central PRB wetlands. Additionally, state-designated threatened species include the wood turtle (C. insculpta), osprey (Pandion haliaetus), red-shouldered hawk (Bute lineatus), great blue heron (Ardea herodias), barred owl (Strix varia), red-headed woodpecker (Melanerpes erythrocephalus) and bobolink (Dolichonyx oryziuorus).

LAND USE PATTERNS

Land use in the study area is diverse and ranges from urban/suburban/commercial development and major transportation arteries to large undeveloped wetland complexes, such as Hatfield Swamp and Great Piece Meadows along the Passaic River. Furthermore, wetlands also occur on the Pompton, Ramapo, Pequannock, and Wanaque River floodplains. Unfortunately, suburban development constitutes a competitive land use on these floodplains and is becoming more prevalent. Major human population pressures are expected in the entire PRB and future development will undoubtedly occupy additional floodplain by 1990 and/or 2040.

From 1940 to the mid-1970's, Passaic County lost a total of 853 ac. of wetland, or 14.5 percent of the wetland existing in 1940 (Tiner et al., 1984). Furthermore, comparing 1970 wetland acreage (4,639 acres) with the SCS's figures on hydric soils (13,490 acres), an estimated 66 percent loss of the county's original wetlands may have occurred since early colonial settlement. These figures are conservative in that they do not reflect the amount of wetland destruction that has occurred since the mid-1970's. The remaining wetlands in the study area, as elsewhere in northern New Jersey, are vulnerable to development for the following major reasons: 1) in many cases, wetlands represent the last large tracts of open land; 2) increased population growth has increased demand for real estate; 3) the lack of any state protection for inland wetlands; and, 4) wetlands are zoned for light industry, commercial use, or residential housing by local municipal governments; 5) lack of enforcement of the Clean Water Act.

Brinson (1980) states that "In one sense riparian ecosystems have been afforded some degree of de facto protection because they are too wet and too floodprone to be considered ideal for many types of development." However, in the Passaic and Pompton River valleys it appears that previous land use practices have not been based on this perspective, and that poor land use management has occurred. This can be seen in the extent of urban encroachment

that has been allowed to take place within floodplain areas, which by definition flood periodically. Flooding hazards and soil limitations for these areas have been clearly pointed out by the SCS in county soil surveys. However, Brinson's (1980) statement takes on greater meaning for the study area, as both aerial and field inspections revealed. Heavy development pressure has caused urbanization of the 100, 50, 10, and even 5-year floodplain. The only portions of floodplain remaining vegetated are sections of the floodplain that flood annually, since the frequency of flooding has discouraged development. Obviously, flooding along the river has been the major factor in keeping development out of remaining wetland areas. Examples of this can be seen in the community of Wayne in the Pompton floodplain, at Pompton Lakes near the confluence of the Pequannock and Ramapo, and along the periphery of Great Piece Meadows and Hatfield Swamp, and in other areas. Also remaining undeveloped are old meander scars, or "oxbows," and other areas within the floodplain that hold surface water during the growing season, or intercept the ground-water table and as a result, support wetland vegetation.

WETLAND VALUES

Wetlands in the study area provide public benefits to the local communities. These benefits have rarely been given consideration in previous land use planning. Wetland resources have been, in many cases, misused. In view of flooding problems in the PRB, it should be apparent that wetlands located along rivers in the project area play an important role in flood control. Sather and Smith (1984) document the general theory that wetlands associated with streams provide flood storage, reduce flood peaks and increase the duration of flow. Therefore, if floodplain wetland is destroyed by development, their flood values must be replaced by structural flood control measures. Structural measures include levees, floodwalls, channelization and diversion tunnels.

The flood storage function provided by the Great Piece Meadows wetland complex, and also the other large wetland complexes along the Passaic River, can be seen by comparing the timing and magnitude of peak discharges occurring on the Pompton and Passaic Rivers at Two Bridges during a major storm event. For example, in 1902, the state geologist for New Jersey presented the following information (Smock, 1902):

> "Two Bridges is at the confluence of two branches having nearly equal catchments, viz: the Pompton and the Upper Passaic.
>
> The northerly affluent, the Pompton, is formed by the confluence of the Ramapo, Wanaque and Pequannock, all of which meet about six miles north of Two Bridges, at the village of Pompton. The catchment of the Pompton, which lies mostly upon the Northern Highlands, is mountainous and forested. There is very limited opportunity for the flood-waters to spread and accumulate, as the valleys above Pompton are narrow and confined, consequently the floods are discharged promptly and the maximum rate of discharge is high. The southerly affluent, the Upper Passaic, has large areas of flat land over which the flood-waters spread..."

This is a clear indication of the storage and velocity reducing abilities of the Passaic wetlands complex. During a major flood situation water flows from the Pompton, upstream along the Passaic, and is temporarily stored in the wetlands, thereby reducing immediate flood peaks downstream. This stored floodwater is later released slowly in a less catastrophic manner, as the Passaic subsides in "its customary, regular, but tardy manner" (Smock, 1902).

As discussed under "Wildlife", wetlands in the study area provide important habitats for wildlife resources. Especially notable would be Great Piece Meadows and the wetlands in the vicinity of the Ramapo and Pequannock Rivers confluence which are extremely valuable due to their diversity and non-fragmented nature.

Wetlands also function as natural filters which remove sediments and pollutants, thereby improving the water quality of the PRB in general.

Socioeconomic benefits of wetlands can usually be divided into two categories, consumptive and non-consumptive. Of these, the consumptive benefits provided by wetlands in the study area would appear to be minimal, except for activities such as hunting and trapping in Great Piece Meadows, fishing in the river channels, and possibly some fuel wood cutting. Non-consumptive benefits include scenic, recreational, educational, scientific, aesthetic, archaeological and historical values.

Although not within the immediate study area, the Borough of Chatham is located in the PRB, adjacent to the Passaic River. Chatham's Environmental Commission provides an example of the importance of socio-economic benefits that are derived from open space to local PRB communities. The Commission's report on open space (1975) states:

> "We have shown that Chatham's open space consists largely of environmentally critical areas performing natural functions of considerable benefit to the community; that it contains an excellent potential for a variety of recreation uses; and that it adds beauty and character to the town, contributing to its desirability as a residential community."

In view of the continued pressure for development in the PRB, there is an urgent need for initiating a clearly defined, long-range program for providing permanently protected open space.

FUTURE-WITH-PROJECT (1990 PROJECT IMPLEMENTATION, 2040)

GENERAL EVALUATION

Implementation of the dual inlet plan would result in major adverse impacts to the wetlands located in the study area. As indicated in the project plan, wetland along the floodplains would suffer direct losses during construction and indirect losses over the life of the project. Wetland vegetation would be directly destroyed by channelization, including excavation and realignment, operation of machinery, as a result of "side slope taking" and along permanent

and temporary easements (10 and 20-ft. widths, respectively). The reduction in water surface elevation and floodplain in channelized areas, and the changes in frequency, amount, and duration of flooding due to tunnel operation will inevitably result in successional (i.e., hydric to mesic) and land-use changes such as development and associated deposition of fill in wetlands.

RELATED STUDIES

The ecological effects of channelization and flow modification have been described by several researchers. Frederickson (1979) found that channelization of the St. Francis River in southeastern Missouri effectively reduced the depth of flooding and the frequency of inundation regardless of the river stage. As drainage improved, a greater forest area was cleared by landowners than was lost during channel construction, for agricultural use in this case. When natural fluctuations in water levels are changed by channelization or drainage, the plant community slowly changes to one characteristic of drier sites. Succession from a hydric to a more mesic plant community takes place.

Woody species can be indirectly impacted by water level changes resulting from channelization. A shift from water-tolerant species to water-intolerant species will occur, depending on the efficiency of the channel and the effects it has on groundwater. This shift from hydric to mesic species has been documented in North Carolina (Maki et al., 1980), Oklahoma (Barclay, 1980) and Missouri (Frederickson, 1979).

In general, water is described as being the dominant environmental factor influencing the distribution of tree species in the floodplain (Bedinger, 1978). The differences in diversity and composition of the forest are controlled in part by the varying frequency, duration and depth of flooding and shifts in soil texture and layering as a result of floods.

Wetlands in the study area are not only affected by flooding but by the groundwater table as well. In their study of the Sangamon River in Illinois, Bell and Johnson (1974) found that water levels in the soil profile of the floodplain areas of the streamside forest were strongly controlled by the level of the water in the stream channel. Bell and Johnson (1974) also state the following:

> "For all river stages the level of the groundwater table was strongly orrelated to the water level in the river channel. When all examples were considered, river level accounted for 96% of the variance in the water table at a distance of 25 m from the river and still accounted for 90% of the variance in well 13 at a distance of 300 m from the river. When river stage is separated into flood, high flow within or near bank level, and low flow, additional information appears. Under low flow conditions this very slight increase in groundwater level occurred with increasing distance from the river. Under conditions of more rapid stream flow, the groundwater table in the land near the stream is depressed and the flow rate downstream creates a pressure deficit in the flood-plain wetland water system and water is being pulled into the stream flow faster than it is replaced from adjacent upland areas."

DISCUSSION OF PROJECT SUBAREAS

For the purposes of discussion it was necessary to divide the central and lower PRB into subareas, based on the type of modifications and their associated ecological impacts. Five "subareas" were considered, as follows:

1) Above Pequannock/Ramapo Confluence - effects of channelization and inlet placement on wetlands north of confluence;

2) Central Basin Levees - effects of levee placement and associated storage pond construction;

3) Great Piece Meadows - effects of Passaic channelization and Two Bridges inlet operation;

4) Pompton River - effects of both inlet structure and channelization on Pompton River wetlands; and,

5) Passaic River - effects of tunnel inlet construction.

WETLAND MAPS

A set of COE's maps (modified by the Service) depicting wetlands that would be impacted by project implementation (early Stage III plans) was provided in the 1985 PAR as Appendix D (Day et al., 1985). In regard to the selected plan, project related impacts to wetland mapped in 1985 remain the same for two subareas: 1) Above Pequannock/Ramapo Confluence; and 2) Pompton River. Revised assessments have been made for the following subareas: 1) Central Basin Levees; 2) Great Piece Meadows; and 3) Passaic River. Revised assessments were based upon project changes to levee systems and additional information on the Great Piece Meadows. The COE's maps originally used to illustrate project impacts on the one year floodplain were modified by the Service as follows:

1) Additional wetland to be adversely affected by project implementation had been added, and these areas were shaded in orange. Hydrophytic vegetation and hydric soils have been identified at these sites, as described under "Wetland Vegetation and Soils." Soil series symbols, as used by SCS, were provided on the maps in orange.

2) Urban areas included by the COE as "1 year floodplain lost" were indicated with black diagonal slash marks, and had not been considered as impacted wetland habitat. Much of this occurs in the Deepavaal area. Urban floodplain removed from consideration totaled 246.8 ac. for the dual inlet plan.

3) Wetland replaced with storage ponds was indicated on the COE's central basin levees' maps as shaded in orange. This situation has been updated and will be further described below.

4) Acreage had been measured and was provided on the COE's maps. Totals acreage was calculated from these figures.

SUBAREA IMPACTS

In order to assess the impacts of project implementation on wetlands, two scenarios were used. Scenario #1 is based upon the Service's identification of wetlands affected by project implementation. Scenario #2 is basically the same as #1, with additional wetland lost due to improper tunnel operation (i.e., diverting excessive flow from the channel). Improper tunnel operation would cause a drastic alteration in wetlands hydrology. Table 4 presents the wetland acreage that would be impacted under scenarios #1 and #2. The wetland subareas were previously highlighted and delineated on the COE's maps submitted as Appendix D in the 1985 PAR (Day et al., 1985).

Above Pequannock/Ramapo Confluence

Wetlands at and north of the confluence will be adversely affected by channelization of the Pequannock, Ramapo, and Wanaque Rivers and placement of the inlet structure. Channelization is described as follows: the Pequannock will be deepened an average of 6 ft. and widened (top width) from 100 ft. to 170 ft. The Ramapo will be deepened 6 ft. (average) and widened from 110 ft. to 150 ft. The Wanaque will be deepened 6 ft. (average) and widened from 90 ft. to 150 ft. As a result, wetlands in the floodplains will be deprived of periodic flooding and drained by lowering groundwater levels in the floodplain. Of these areas indicated as "1 year floodplain lost" by the COE, 11.2 ac. are already urbanized and not considered to be habitat affected by the project. These areas are marked with black slash marks, and the remaining yellow shaded "1 year floodplain lost" is wetland lost (dual inlet plan = 75.1 ac.). In addition, wetland not indicated by the COE will also be affected and has been added to the maps with orange shading. Those areas marked with diagonal orange slash marks exhibit hydrophytic plant communities and hydric soils, and soil symbols as used by SCS are included on the maps in orange (see soils descriptions). That portion of the Pequannock floodplain shaded in solid orange (along southwestern Pompton Lakes Boro boundary) exhibits a hydrophytic plant community and is flooded according to information provided by the COE.

Those areas described above will lose their wetland characteristics, and plant community composition will change toward a more mesic upland situation. Those "fringe" areas along channels, maintained at an early successional stage by deposition and flood "scouring" effects, will succeed toward an upland forested state. Furthermore, narrow channels of open water and old oxbows will be drained. These changes will occur in wetlands located on the river side of proposed levees. Much of the wetland lies outside of the levees and is expected to be adversely affected by future development once the threat of flooding is removed. This increased rate of development can be considered a direct result of levee placement. Where development does not occur, wetland will have been converted to upland. Therefore, under either situation wetland is lost.

The many islands at the confluence exhibit hydrophytic vegetation and hydric soil (Preakness) and are considered wetland by the Service. Channelization would lower groundwater levels necessary for Preakness soils and wetland plant communities to have developed. Changes in flooding characteristics will

Table 4. Total Amount of Wetland Adversely Impacted (acres).

LOCATION	DUAL INLET PLAN SCENARIO #1	DUAL INLET PLAN SCENARIO #2
ABOVE PEQUANNOCK/ RAMAPO CONFLUENCE	301.9	301.9
CENTRAL BASIN LEVEES	666.5	666.5
GREAT PIECE MEADOW	437.6	3113.0
PASSAIC RIVER	3.5	3.5
POMPTON RIVER	126.4	171.2
TOTAL WETLAND LOST	1535.9	4256.1

SCENARIO #1: BASED UPON FISH AND WILDLIFE SERVICE IDENTIFICATION OF WETLANDS AFFECTED WITH PROJECT IMPLEMENTATION (WITHOUT WEIR).

SCENARIO #2: SAME AS SCENARIO #1 WITH ADDITIONAL WETLANDS LOST DUE TO IMPROPER TUNNEL OPERATION.

influence the plant community composition by affecting understory and tree seedling survival. Species composition on the islands will change toward a more mesic upland community which would be noticeable in a few years in understory shrub and herbaceous layers. Most recent project plans indicate that the wetland forest community will be removed. In this case the islands will have been converted to an upland shrub or herbaceous community. The islands total 35.4 ac.

Under the selected plan, however, the COE's maps indicate that many of the islands will be flooded as a result of the immediate impounding or weir effect of the inlet levee, as they are shaded green. The duration of submergence is not explained in the COE's plans. Due to the erosive potential of large quantities/velocities of floodwater channeled to the inlet area, adverse and unpredictable impacts to these wetland plant communities are expected. Additional information on velocity and the potential for erosion is necessary to conduct a more specific assessment of this problem.
Under the selected plan, the areas shaded with brown slash marks on the COE's project plan maps (modified by the Service) will be adversely impacted due to the deepening/widening of the Pequannock and Ramapo River channels. Frequency, amount and duration of flooding will be altered if the channel were to be deepened an average of 6 ft. The extent and nature of the impounding effect of the inlet levee is unknown. As a result of changing the balance of these factors, plant species composition will change.

Much of what has been classified as "1 year floodplain gained" in the COE's plan descriptions is existing wetland, characterized by hydric soils and hydrophytic vegetation. These areas are to be considered as a qualitative change from valuable vegetated wetland habitat to open water channels. This qualitative change was measured as 15.6 ac. for the selected plan.

To summarize impacts upstream of the Pompton inlet structure, proposed channelization and changes in flooding frequency, amount and duration will result in successional changes in plant species composition and increased urbanization. In areas where the threat of flooding is removed, and where wetlands are protected behind levees, wetland and floodplain losses are inevitable due to high development pressures described under "Land Use Patterns." Potential for and rate of development is directly increased by effects of project implementation.

Central Basin Levees

Many of the levee systems have large drainage areas located behind them. Runoff from these areas, which would normally drain into the rivers by gravity, would now be collected and ponded. According to the COE, storage ponds will be located directly behind levees in the "naturally-occurring low areas." In comparison, areas supporting structural development are not suitable. The construction of storage ponds will eliminate wetlands on the "1-year floodplain" and wetlands located above the one-year flood event.

Passaic River Levee System #2A, with a drainage area of 4,111 ac., will require 389 ac. of storage ponds. The 389 ac. planned for conversion to ponding for levee #2A are classified as wetland, mostly PFO1 and PFO1/SS1, and

have been identified by NWI map information with recent (March 26, 1984) color infra-red aerial-photo updating and field inspection. Other storage pond areas identified as wetland habitat loss are located behind the following proposed levees: Passaic #10 (3.0 ac.); Rockaway #1 (16.5 ac.); Rockaway #2 (16.5 ac.); Rockaway #3 (12 ac.); and, Pinch Brook (4.5 ac.).

In wetlands indicated as "1 year floodplain lost" on the Central Basin Levee Maps provided by the COE (June 1985 PAR map set, used in conjunction with most recent levee placement map set), normal annual flow by the river will be prevented. Conversion from existing wetlands to upland plant communities will take place as a result of the change in hydrology. In many cases, the threat of annual flooding has prevented or at least discouraged development from occurring on existing "1-year floodplain" and associated wetlands (refer to "Land Use Patterns, Future Without Project"). Most floodplain that is inundated on a less frequent basis (e.g., 5, 10, 50-yr. floodplain) has been developed. Therefore, levee placement and the elimination of periodic inundation will encourage floodplain development.

Levee impacts on wetlands in the central PRB are presented in Table 5. Table 5 gives the following information for each of the 7 levee systems: wetland cover type; storage pond area; 1-year floodplain lost coincident with storage ponds; additional 1-year floodplain lost; total wetland losses by cover type; and, additional wetland losses. Overall, levees will necessitate 441.5 ac. of ponding area that will include 45.4 ac. of 1-year floodplain, separate 225 ac. of 1-year floodplain from the watercourse and result in 666.5 ac. of total wetland losses.

Great Piece Meadows

General Overview

It is difficult to accurately predict environmental impacts to Great Piece Meadows resulting from project implementation for the following reasons:

1) the removal of floodwater by means of a tunnel diversion system is a relatively new concept and there are no existing examples where biological impacts caused by the hydrologic changes can be directly observed; and,

2) There is a lack of scientific information on hydrologic changes that can be related to biotic communities.

Field inspection revealed hydric soils, plant communities and flood debris characteristic of annually flooded wetland in some areas higher than that indicated as one-year floodplain loss on the project maps provided by the COE. Although velocity/duration graphs are available, more information is needed on the frequency, amount, and duration of flooding. This information would allow a more specific analysis of plant community changes. Alteration of these hydrologic factors can adversely affect plant species composition.

In a study of the Raritan River floodplain, Wistendahl (1985) included detailed vegetational analysis, and stated that "slight differences in

Table 5. Levee Impacts on Wetlands in the Central Passaic River Basin.

Levee Systems	Wetland Cover Type	Impact Category (acres) Storage Pond Area[1]	1-yr. Floodplain Lost Coincident w/Storage Pond[2]	Additional 1-yr. Floodplain Lost[3]	Total Wetland Losses by Cover Type (ac.)	Additional Wetland Losses (ac.)[4]
Passaic #2A	PFO1	349.0	0	94.9	443.9	5.5
	PFO1/SS1	40.0	8.9	0	40.0	0
	PSS1/EM1	0	0	58.7	58.7	0
	POW	0	0	35.4	35.4	0
Passaic #2C	PFO1	0	0	4.7	4.7	0
Passaic #10	PFO1	3.0	3.0	6.4	9.4	0
Rockaway #1	PFO1	16.5	9.9	0	16.5	0
Rockaway #2	PFO1	0	0	3.0	3.0	0
	PFO1/SS1	16.5	16.5	8.8	25.3	4.0
Rockaway #3	PFO1	12.0	2.6	8.7	20.7	0
Pinch Brook	PFO1/SS1	0	0	2.8	2.8	0
	PSS1/EM1	4.5	4.5	1.6	6.1	0
	Totals:	441.5	45.4	225.0	666.5	9.5

1) Storage Pond: total wetland acreage in levee system.
2) 1-yr. Floodplain Lost Coincident With Storage Pond: included in storage pond acreage
3) Additional 1-yr. Floodplain Lost: floodplain not in storage pond area but separated from watercourse by levee.
4) Additional Wetland Losses: wetland areas located behind levee system and thus, subject to development.

topography and flooding effects have a marked influence on vegetation." The frequency, duration and timing of flooding were found to be the "master" factors controlling the vegetation pattern in the low floodplain of the Connecticut River (Metzler and Damman, 1985). Elevation above river level was described as an important factor determining the vegetation pattern of floodplains, primarily because it is correlated with flooding frequency and duration as well as soil aeration. Indications are that even slight changes in the frequency, amount and duration of flooding in the Great Piece Meadows will cause shifts in wetland plant species composition.

If the Two Bridges inlet structure is operated as proposed, floods greater than the "one-year event" would no longer be allowed to occur. The vegetational community composition of the Great Piece Meadows has evolved in response to greater than annual floods every few years, and if floods are discontinued, changes in plant species will occur. As explained earlier, flooding, however frequent, influences plant community composition by affecting understory and tree seedling survival.

An example of an unplanned, large-scale alteration of a pulse-stabilized ecosystem is the effect of the W.A.C. Bennett Dam project (on the Peace River) on the Peace-Athabasca Delta in the Canadian Province of Alberta (Edmonton Environmental Conservation Authority, 1973). This region was usually flooded in the spring by the Athabasca River that entered from the south. The Peace River, which passes to the north of the Delta to join the Slave River, contributed little to the actual flooding. For flooding to occur it was necessary for the level of the Peace River to be high enough to cause the water of the Athabasca to back up into the Delta. When the flow of the Peace River was regulated, the Delta began to transform from marshland to meadow. This was considered undesirable, because the local human inhabitants subsisted on trapping and fishing in the marsh. Therefore, a weir had to be built to hold back the water sufficiently to permit flooding, as occurred before project implementation.

The above problem (successional change due to a project) and solution (use of a weir) to maintain wetlands, illustrates how a weir in Great Piece Meadows could be used to maintain wetlands. If the project is implemented without the use of a weir, ecological changes to the existing wetlands are expected.

One-Year Floodplain Loss

In areas within the Great Piece Meadows identified by the COE as "1 year floodplain lost" the normal annual flooding will be removed as a direct result of project implementation. Of the 437.6 ac. of wetland converted to upland due to the change in hydrology, most acreage would be classified as palustrine forested wetland, with some shrub and some emergent dominated areas present. Mixed wetland cover types (e.g., SS1/EM) are also present (compare Figure 2 (NWI) with COE shaded "1 year floodplain lost"). This acreage is considered lost wetland (see Table 4). Plant community composition will shift from a wetland floodplain community type toward a more mesic upland situation, and this will begin to occur immediately after project operation begins. Vegetational changes will first be noted in the herbaceous and shrub layers. Upland tree species invasion will result over time due to seedling survival

rate changes. As an example, such changes have been noted along the lower Santee River in South Carolina, where damming/diversion for Lakes Marion and Moultrie have caused decreases or removal of floodplain flooding. Changes observed have indicated replacement of mixed bottomland hardwoods and cypress-gum forest with mesic species more characteristic of surrounding uplands. Initial plant changes occurred in the herbaceous and shrub understory.

According to the information that was provided by the COE "The water surface elevations for events of one year or less occurrence will be virtually the same for Great Piece Meadows under existing conditions and with the spur tunnel-dual inlet plan." This statement implies that water tables within Great Piece Meadows would remain the same for the entire growing season (i.e., once flood events have subsided). Under this assumption, no additional wetland acreage would be hydrologically impacted due to tunnel operation. Under this scenario, 437.6 ac. of wetlands would be lost due to project implementation if a weir is not incorporated into the project design. However, if inlet operating rules/procedures are not adhered to, the entire Great Piece Meadows complex will be adversely impacted. Improper tunnel operation as reflected under scenario #2 (Table 4) could result in a loss of 3,113 ac. of wetland.

The physical flood threat is a major reason why the Great Piece Meadows has not been developed. Removal of this flood threat could alter the development potential of this wetlands complex. Acquisition of Great Piece Meadows as proposed, would protect wetland and associated fish and wildlife habitats, provide natural storage for flood waters, and insure the functional capability of the tunnel system.

Impacts Due to Velocity Changes

Rivers adjust their slopes by meandering until they reach a nearly steady state, with sediment load balanced with water velocity and volume. The path of the water bends as uniformly as possible (conforming to a sine-generated curve), minimizing bank erosion and the expenditure of energy (Wharton et al., 1982). The greater the volume, velocity, or density the greater the force and the farther the river travels before it is turned back to form the next meander loop. The development of meanders occurs at bankfull (flood) stage.

River slope adjusts naturally to the velocity required to transport the load of water and sediment supplied by the drainage basin. As slope increases, a stream must degrade or develop a sinuous course. A meandering reach is more stable than a straight reach because it more closely approaches uniformity in the rate of work over the various riverbed irregularities than does the straight channel. In addition, the meandering river and its floodplain apparently present the most efficient geometry to accommodate the mean and extremes of flood variability that have occurred throughout its history.

During flooding conditions greater than the "1 year event" the gates on the Two Bridges inlet would be opened, causing changes in the existing flooding patterns. Vegetation will respond to these hydrologic changes, as previously discussed. A problem of a different nature will occur during flood events of larger magnitude. With the tunnel inlet in operation, it is apparent that

surface water gradients will become much steeper, and the result will be a marked increased in water velocity through the wetlands during flood conditions.

Table 6 illustrates velocities for various flooding event conditions at 4 stations along the Passaic (Figure 4). Under existing conditions the highest velocities generally occur during the 1 year event, due to the flow reversal effect that exists during larger magnitude flood events. It can be seen from the table that, under with-project conditions, velocities for the 1 year, 10 year, and 50 year events are much higher than the highest existing conditions (1 year) velocities.

The stable meander pattern described earlier, created by the Passaic River to accommodate its present sluggish flow, will be completely inappropriate for the much higher velocity. The resulting imbalance introduced into the ecoosystem will cause severe erosion of the channel and removal of vegetation, re-cutting through the existing meander pattern of new channels, and in general unpredictable destruction of wetland communities. The Passaic River will attempt to create a new stable meander pattern based on an artificial and temporary increased velocity. As a result, much sediment will be transported downstream to Dundee Lake and Newark Bay. Detrital accumulation rates may be affected by changes in flow-through and residence time of floodwater, altering food-chain dynamics.

In the "Comments on Velocity/Duration Graphs" provided by the COE in response to PAR requests (Appendix V.), the reach of the Passaic in the vicinity of station 1753+90 is described as follows.

> "Under improved conditions the velocities are definitely increased and indicate a need for design refinements in this reach to control velocities and their effects. These measures could include reshaping the channel to reduce velocities and/or stabilization through the use of riprap or other materials to protect against high velocities."

It is apparent that velocities increase significantly as far upstream as station 1940+00, where the highest existing condition velocity is just under 2 1/2 fps and the highest with-project velocity would be approaching 4 fps. The radii of meander turns that evolved over time in response to a maximum 2 1/2 fps velocity would not be suitable for an increased velocity of 4 fps. The result will be a potentially destructive situation, such that channel scour and bank/sheet erosion will alter plant communities.

The COE comment sheet further states that this far upstream into Great Piece Meadows "all improved conditions velocities are below 5 fps which is the threshold of being erosive." This so-called 5 fps "threshold" appears to be related more to materials (possibly in straight channels) than to the geometry and development of meander.

The potential zone for occurence of adverse impacts due to erosion, as estimated by the Service is illustrated in Figure 4. Total wetland acreage involved was area measured at 565 ac. This is obviously a matter in which much disagreement could be expected at this time, but one point is very clear: this problem needs to be addressed and evaluated further before project

Table 6. Velocity (Time = 95 Hours)
(Data taken from Corps of Engineers' velocity/duration graphs)

	Station (ft./sec.)			
Flood Event	1753+90	1841.70	1874+20	1940+00
Existing Conditions				
1-yr.	1.9	1.7	1.8	2.45
10-yr.	1.9	1.25	1.6	2.05
50-yr.	2.1			
With Project Implementation				
1-yr.	6.0	3.3	2.35	2.95
10-yr.	6.7	3.2	3.45	3.85
50-yr.	6.9	2.9	3.6	3.9

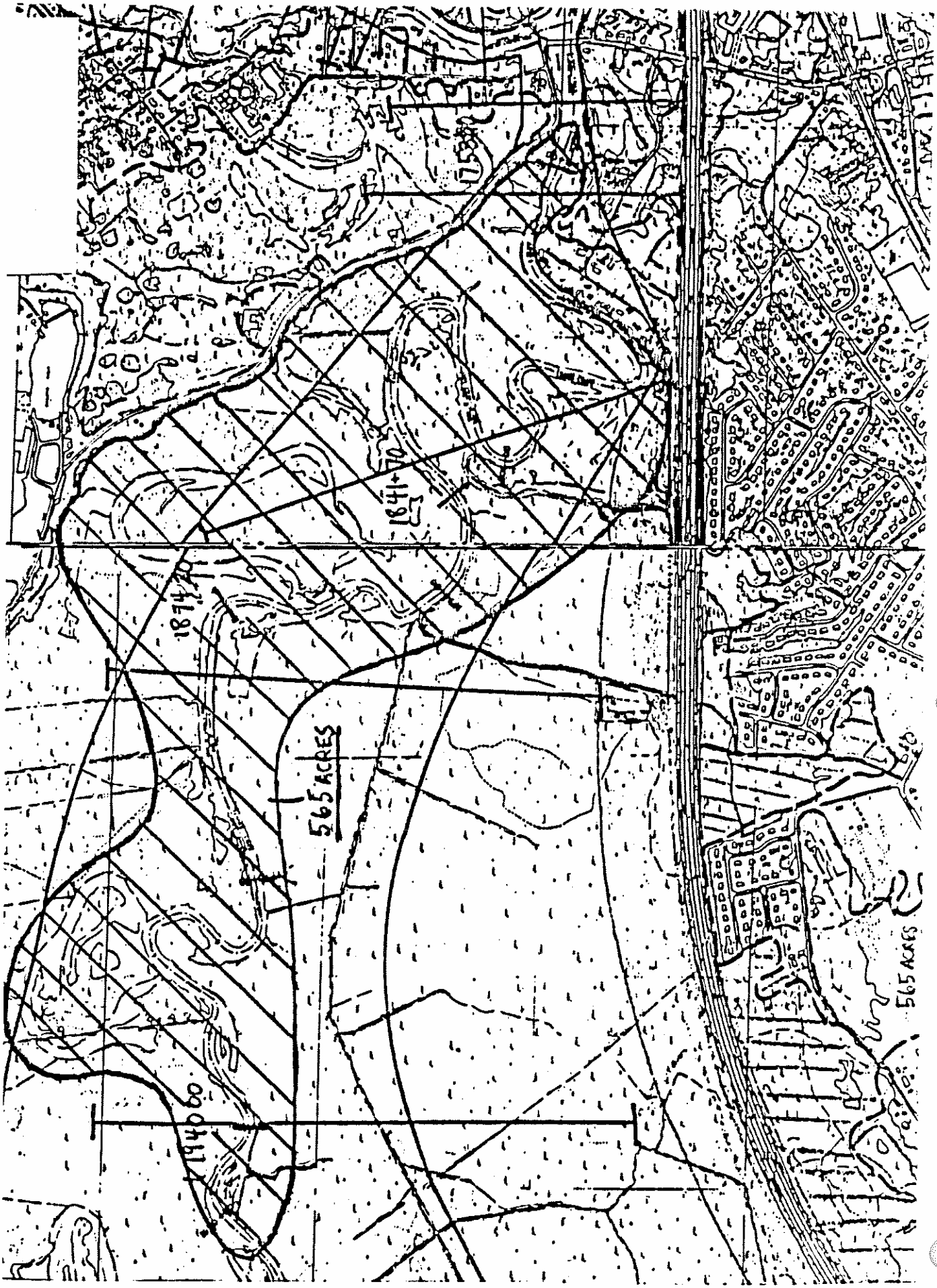


Figure 4. Potential Impacts Zone in Great Piece Meadows - Erosion

implementation can be considered. This is an extremely important point and further discussion can be found in the "Recommendations" section of this report. Please note that this acreage has not been included as "wetland adversely impacted" at this time, but may be considered impacted in future assessments, depending on the nature and results of the expected evaluation and the extent and type of "design refinements" being planned by the COE.

Pompton River

Although the Pompton floodplain wetlands would still be affected by one year flooding, they would be deprived of the "greater than one year" flood event that influences vegetational species composition by mechanical "scouring." Therefore, deprivation of the greater than one year flood event would result in changes to the community structure and degrade the existing wetland values. No direct wetland loss is indicated since such changes are subtle, occur over long time periods and are difficult to measure. Wetlands downstream of the Pompton inlet structure will be deprived of the periodic flushing and flooding necessary to maintain their existing character.

Adverse impacts will result to wetlands near the Passaic River's confluence with the Pompton River due to proposed channelization and resultant one year floodplain loss. The COE's "1 year floodplain lost" was measured at 153 ac., but 26.6 ac. are developed and under scenario #1 (Table 4) a total of 126.4 ac. would be adversely affected. Scenario #2 (Table 4) would adversely impact 171.2 ac., since additional floodplain and oxbow areas would be "dewatered." These areas would also be affected by changes in inundation frequency and duration under scenario #1, but this is difficult to assess without more detailed information, on predicted long-term hydrologic changes.

Passaic River

Three and one-half acres of PF01 will be directly destroyed as a result of tunnel inlet construction at Two Bridges.

SUMMARY

Project implementation could result in a loss of thousands of acres of wetlands. It is estimated that approximately 1,535.9 ac. of wetlands will be lost if the dual inlet plan is implemented without a weir structure in Great Piece Meadows. An additional wetland loss of 4,256.1 ac could result from improper tunnel operation. The conversion and/or loss of wetlands will decrease available habitat and hence, wildlife populations. Populations of herpetofauna, avifauna and mammals will be adversely impacted. Herpetofauna are completely dependent upon wetlands for reproduction, overwintering, food or essential habitat requirements. The conversion of wetland cover types will result in a corresponding change in available nesting and feeding sites to avifauna surface area. Interspersion, fragmentation and conversion of wetland cover types will determine the carrying capacity of wetlands for mammals. Overall, project implementation will greatly reduce and eliminate available wildlife habitat and decrease wildlife habitat suitability.

Overall, wetland areas indicated by yellow and orange shading on the maps submitted to the COE under the 1985 PAR (Day et al., 1985) will either experience vegetative community changes toward a more mesic upland situation, or succumb to development. It is expected that continued development would ultimately destroy existing wetland and floodplain areas and, thus, result in adverse impacts to wildlife populations. The acquisition of natural storage areas, including wetlands, as part of the selected plan will greatly curb future development in the central Passaic wetlands. Land use changes may be the most significant secondary impact resulting from low flows via project implementation, but probably the least quantifiable because such changes would occur over long periods of time.

TERRESTRIAL

Due to variations in terrestrial cover types and wildlife habitat suitability in the project area, the lower and central PRB are discussed separately.

LOWER PASSAIC RIVER BASIN - FUTURE-WITHOUT-PROJECT (1990 BASELINE CONDITIONS)

GENERAL EVALUATION

The Urban/Suburban/Industrial (UR) cover type is the major terrestrial, nonwetland cover type in the lower PRB. The urban component of this cover type includes "downtown" and commercial areas where habitat diversity is lowest, as well as public parks vegetated with ornamental species. The industrial component is generally characterized by either large expanses of lawns and plantings of ornamentals around buildings only, or ground covered by blacktop or vegetated by weeds. Examples of the UR and industrial components include Newark and Paterson. The suburban component provides the greatest habitat diversity in this cover type. Characteristically, the suburban component consists of lawns, shade trees and ornamental shrubbery around private residences, apartment complexes and in small parks. Haledon and Little Falls are examples of the suburban component. Riparian habitat in this cover type, other than in the Riverside Complex County Parks Complex, is best characterized as irregularly spaced, discontinuous, remnant areas usually no more than several feet wide.

WILDLIFE RESOURCES

Despite the preponderance of the urban and industrial components of the UR cover type in the lower PRB, the interspersion of cover types contributes to the diversity of the urban wildlife resources. Riverside parks (e.g., Riverside County Park Complex) and remnant riparian areas are particularly important because they are ecologically different from the otherwise similar UR components. These areas provide food, cover and transportation corridors for wildlife.

Avian

The number of bird species in an area is a function of tree canopy volume and cover type surface area (Foreman et al., 1976; Galli et al., 1976). An increase in either canopy volume or surface area results in a greater number

of nesting and feeding sites. However, under the future-without-project scenario, no substantial increases in the total surface areas of any cover type are expected in 1990. Thus, only avian species' populations may fluctuate in response to succession-related vegetation changes within UR components. Species commonly associated with the UR cover type include the house sparrow (Passer domensticus), blue jay (Cyanocitta cristata), song sparrow (Melospiza melodia), starling (Sturnus vulgaris), mockingbird (Mimus polyglottos) and American robin (Turdus migratorius). Additionally, the yellow warbler (Dendroica petechia), common yellow throat (Geothlypis trichas) and black-capped chickadee (Parus atricapillus) are species that occur primarily in the suburban component of the UR cover type.

Mammals

Changes in populations of small mammals species (e.g., shrews, mice, voles, rabbit) are generally related to the volume of ground cover and the habitat diversity in the horizontal plane. Population attributes include density, dispersion and reproduction rate. The controlling factors are microclimate diversity and food quality. Changes in larger mammal species (e.g., skunk, raccoon) are generally related to the amount and dispersion of cover types that provide travel corridors and escape cover relative to food and reproduction. The difference between the two groups of mammals, therefore, is based primarily upon mobility. Accordingly, relative cover type surface area sizes and interspersion are important considerations when assessing project-related impacts to larger mammals. Overall, surface area size and interspersion of cover types are not expected to change by 1990. However, accelerated flooding will result in an increase in the proportion of the mesic cover type (i.e., PF01) and thus, result in a greater increase in the carrying capacity of the wetland areas for small mammals. Species commonly associated with the UR cover type include rats (Rattus spp.), house mouse (Mus musculus) and gray squirrel (Sciurus carolinensis). Striped skunk (Mephitis mephitis), cottontail rabbit (Sylvilagus floridanus), raccoon (Procyon lotor), and eastern chipmunk (Tamias striatus) are other species that sometimes occur in the suburban component of the UR cover type.

Endangered, Threatened and Undetermined Status Species

The bald eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrinus) are the only species classified as "endangered" by both the Federal Government and the State of New Jersey that may occur in the lower PRB. The eagle and falcon are best characterized as incidental and are considered as occasional migrants only. The osprey (Pandion haliaetus), classified by the State of New Jersey as threatened, may also occur in the vicinity of the lower PRB during migration.

Seven species, classified by the State of New Jersey as being of undetermined status, are expected to occur in or be partially dependent upon the wetland or suburban components of the lower PRB for one or more life requisites. The

seven species are the Atlantic sturgeon addressed under "Aquatic," eastern smooth earth snake (Virginia valarie), ruby-throated hummingbird (Archilochus colubris), ruddy duck (Oxyura jamaicensis), black duck (Anas rubripes), Keen's myotis (Myotis keeni), and silver-haired bat (Lasionycteris noctivagans).

The status of the aforementioned species are not expected to change prior to 1990.

CENTRAL PASSAIC RIVER BASIN - FUTURE-WITHOUT-PROJECT (1990 BASELINE CONDITIONS)

GENERAL EVALUATION

The Urban/Suburban/Industrial (UR) cover type is the major terrestrial nonwetland cover type that occurs in the central PRB. The UR components include industrial and commercial areas where habitat diversity is lowest, as well as recreational parks vegetated with both indigenous and exotic ornamental plants. The industrial component is generally characterized by either large expanses of lawns and plantings or ornamentals around buildings, or ground covered by blacktop or vegetated by weeds. Examples of the industrial and commercial UR components include Pompton Lakes Boro and Lincoln Park Boro. The suburban component provides the greatest habitat diversity in the UR cover type. The suburban component consists of manicured lawns, shade trees and ornamental shrubbery around private residences or apartment complexes and in parks. Suburban areas are found throughout the central PRB. Riparian habitat in this cover type is more extensive in the central PRB in comparison to the sparsely vegetated banks further downstream in the lower PRB. The Wilderness Island Park, along the Wanaque River in Pompton Lakes, is a good example of indigenous riparian vegetation. However, there is a substantial annual loss of these riparian areas to development. This loss is expected to continue through 1990.

The upland hardwood forest (UH) cover type also exists in the central PRB. This is a mesic upland cover type where the soil retains a good supply of moisture throughout most of the growing season in most years. Site specific plant community species composition, however, varies as a function of relief, soil conditions and land use history. Dominant tree species in mature stands include red oak (Quercus rubra), white oak (Q. alba), black oak (Q. velutina), chestnut oak (Q. prinus), shagbark hickory (Carya ovata) and pignut hickory (C. glabra). Dominant canopy species in less mature stands include gray birch (Betula populifolia), black birch (B. nigra), bigtooth aspen (Populus grandidentata) and quaking aspen (P. tremuloides). Flowering dogwood (Cornus florida), ironwood (Capinus caroliniana) and infrequently, eastern red-cedar (Juniperus virginiana), are species that occur as part of the understory. Characteristic shrub species are maple-leaved viburnum (Viburnum acerifolium), spicebush (Lindera benzoin) and witch-hazel (Hamemelis virginiana). Most of the UH cover type in the study area has been developed or is zoned for development.

WILDLIFE RESOURCES

Many processes (e.g., land use conversion) and functions (e.g., hydrologic regime) shape and characterize the terrestrial cover types in the central PRB and thus, wildlife habitats. Unlike the extensive wetlands in the central PRB, the UH cover type is more stable and self contained. This difference exists because during the earlier portions of UH successional processes, the accumulation of organic matter exceeds losses. In the later successional stages, this difference diminishes until losses equal gains. When gains and losses are equal, a steady state (climax) situation exists. To maintain this steady state, local recycling of nutrients occurs (Darnell, 1978). Therefore, in comparison to wetlands, the UH cover type can be considered relatively stable and self contained. Wetlands are constantly receiving, processing and releasing organic matter and nutrients (open system), whereas the organic matter and nutrient transfer associated with the UH cover type generally remains more constant and is continuously recycled (closed system). The UH cover type greatly contributes to habitat diversity and supports single cover type users (e.g., gray squirrel) and provides important life requisites for multi-cover type users (e.g., white tailed deer). However, the UH cover type is rapidly being lost to development. In most cases, the UH cover type exists in the form of small woodlots or on the periphery of forested riparian and wetland areas.

The components of the UR cover type are artifacts of natural systems. Similar to the lower PRB, the UR cover type is the major terrestrial nonwetland cover type that occurs in the central PRB. The suburban component is predominant in the central PRB. The UR cover type is an artificially subsidized and open system. Without constant attention (e.g., mowing lawns, trimming trees and shrubs, insect control, clearing land) its composition would change. In general, the UR cover type is lacking in structural and temporal complexity and is deficient in species richness and equitability. However, the existing interspersion of the UR component cover types with other cover types (e.g., UH), contributes to an enriched wildlife resource. The UR cover type is expected to continue to increase by 1990.

Avian

Avifauna characteristic of the UR cover type components are similar to those species mentioned for the lower PRB. However, in the central PRB there is more interspersion of the UR cover type with other cover types, including UH, PFO1, PSS1, agricultural land and thus, a greater diversity of wildlife habitats. Previous Service PAR's (Conservation and Environmental Studies Center, 1980a) reported on numerous avifauna in the central PRB. The central PRB supports species such as scarlet tanager (Piranga olivacea), tufted titmouse (Parus bicolor), ovenbird (Seiurus aurocapillus), black-and-water warbler (Mniotilta varia), eastern bluebird (Sialia sialis), brown thrasher (Toxostoma rufum), ruffed grouse (Bonasa umbellus), great horned owl (Bubo virginanus) and barn owl (Tyto alba). It is expected that avian species equitability will change in response to successional vegetational changes and land use conversions.

Mammals

In the UR cover type, mammal species are identical to those listed for the lower PRB. Habitat diversity increases in the central PRB due to the interspersion of cover types and hence, mammalian species such as red fox (Vulpes vulpes), and white-tailed deer (Odocoileus virginianus) are more common. However, continued suburban and commercial encroachment on remnant farm land and UH cover types will greatly decrease habitat diversity and result in reduced mammalian populations. This trend will continue through 1990.

Endangered, Threatened and Undetermined Status Species

Similar to the lower PRB, the bald eagle and peregrine falcon, species classified as endangered by both the Federal Government and the State of New Jersey, occur coincident with their migratory movements. Additionally, the eastern timber rattlesnake (Crotalus horridus) and Cooper's hawk (Accipiter cooperii) are classified as endangered by the State of New Jersey. The osprey (Pandion haliaetus) is classified as threatened by the state. The occurrence of the osprey in the central PRB is suspected to be coincident with migration. However, the rattlesnake and hawk are species associated with the UH cover type. The red-shouldered hawk (Buteo lineatus) is a state-designated threatened species that may occur in or be partially dependent upon the UH cover types found in the central PRB. The continued loss of natural areas will eliminate wildlife habitats, including the habitats of state-designated endangered and threatened species.

LOWER PASSAIC RIVER BASIN - FUTURE-WITH-PROJECT (1990 PROJECT IMPLEMENTATION)

DUAL INLET TUNNEL DIVERSION PLAN

From Beatties Dam downstream to Newark Bay, the project would include 15 levee/floodwall systems, including 11 mi. of levees and 11 mi. of floodwalls. The construction of levees and floodwalls will require the removal of remnant riparian vegetation. Wildlife species using riparian areas will be eliminated. Overall, construction of levees and floodwalls will result in the irretrievable loss of existing riparian areas and portions of the UH cover type. Habitat destruction, direct and indirect mortality and reduced physiological functions of the wildlife resources are anticipated.

Indirect impacts to existing terrestrial cover types are expected to occur since implementation of the dual inlet tunnel plan will artificially stabilize hydrologic regimes. As a result, riparian areas remaining after project construction may change to more mesic conditions. Additionally, the control of flood waters will encourage development of some riparian areas and wetlands that will be periodically flooded. If not in public ownership, almost all undeveloped areas in the PRB are zoned for development.

Apart from the loss of riparian areas, the UR cover types are expected to remain similar to "future-without-project" projections for the lower PRB.

CENTRAL PASSAIC RIVER BASIN - FUTURE-WITH-PROJECT (1990 PROJECT IMPLEMENTATION)

DUAL INLET TUNNEL DIVERSION PLAN

Implementation of the dual inlet tunnel plan will result in adverse impacts to existing terrestrial cover types in the central PRB. Impacts to wildlife habitat will result from channel excavation and realignment, construction of levees and floodwalls and the removal of riparian vegetation.

Indirect impacts to existing terrestrial cover types are expected to occur since the tunnel system will artificially stabilize hydrologic regimes. As a result, riparian areas remaining after project construction may change to more mesic conditions. Terrestrial areas along the Pompton River (which are not purchased as part of the project to preserve natural storage) protected from flooding after project implementation will be more attractive for development. Flooding has discouraged development along the Pompton River and upon project completion, discharges will be limited to the one-year event. Therefore, areas that continue to flood annually will remain vegetated. Additionally, the conversion of existing riparian areas and terrestrial cover types to UR components is anticipated and will result in changes in wildlife populations. Wildlife changes will be related to elimination of shrub and tree canopy and herb layers. Overall, corresponding alterations in the wildlife community will include shifts in species equitabilities of the herpetofaunal, avifaunal and small mammal components. Following project completion, UR cover types and urban tolerant wildlife species will be predominant.

LOWER PASSAIC RIVER BASIN - FUTURE-WITHOUT-PROJECT (2040)

Wildlife populations will continue to be restricted by limited habitat. Land uses in the lower PRB will continue to remain highly industrialized and urbanized. Open areas such as the Riverside County Park Complex in Hudson and Bergen Counties will contribute to habitat diversity and thus, urban wildlife diversity. Continued flooding could result in additional mesic cover types and thus, increase the carrying capacity for some wildlife species.

Public uses of existing wildlife resources will continue to be nonconsumptive, including wildlife observation, feeding and photography. Remaining vegetated areas will provide open space for nonconsumptive opportunities. Resident wildlife will continue to be restricted to urban species. In comparison to existing wildlife populations, urban wildlife species are not expected to change in the year 2040.

CENTRAL PASSAIC RIVER BASIN - FUTURE-WITH-PROJECT (2040)

Wildlife populations will be limited by habitat availability. Terrestrial resources will continue to be lost to development. Residential, commercial and industrial development is expected to continue with favorable economic conditions. According to the information provided by the COE, Bergen County (69% developed) is expected to be 74% developed by 2040. Further, Somerset County (43% developed) is expected to be 58% developed by 2040. Development of terrestrial areas in the central PRB will continue to be encouraged by: 1)

municipal zoning; 2) location in the expanding New York metropolitan area; and, 3) being located in municipalities that are accessible by major transportation networks and thus, are under greater development pressure.

LOWER PASSAIC RIVER BASIN - FUTURE-WITH-PROJECT (2040)

Impacts on terrestrial resources in the lower PRB are not expected to be noticeable with project implementation since the subsurface diversion tunnel would not alter land use activities. Therefore, the future-with-project scenario would be similar to those comments stated under "future-without-project."

CENTRAL PASSAIC RIVER BASIN - FUTURE-WITH-PROJECT (2040)

Impacts on terrestrial resources in the central PRB would be similar to those under the "future-without-project" scenario since the subsurface diversion tunnel would not alter land use activities. However, tunnel operation could indirectly influence terrestrial areas. Some terrestrial areas are on floodplain near the watercourse and can be inundated. Tunnel construction would prevent flooding and thus, convert floodplain (not purchased as part of the project to preserve natural storage) to developable land. According to the information provided by the COE, development in these areas has been considered in designing the diversion tunnel system.

SECTION 5. RECOMMENDATIONS

GENERAL EVALUATION

Based upon the future-without and future-with-project scenarios presented in Section 4, the implementation of the selected dual inlet tunnel diversion plan as proposed would be destructive to existing fish and wildlife resources in the central and lower PRB. Implementation of this plan would require the construction of: 13.4 mi. of 39-ft. diameter tunnel and 1.3 mi. of 22-ft. diameter spur tunnel; 31 levees covering 225 ac.; 23 floodwalls covering 3.0 ac.; a series of storage pond areas; and, 6.0 mi. of channelization, including dredging and realignment.

Implementation of the dual inlet plan as proposed would eliminate 6.0 mi. of riverine habitat and 1,535.9 ac. of wetlands. A total of 4,256 ac. of wetlands could be lost due to improper tunnel operation. Additionally, backwater areas, islands, riparian vegetation and floodplains would either be eliminated or converted to non-wildlife uses. The measures proposed to reduce fish and wildlife losses resulting from project implementation are inadequate, particularly in the Pompton inlet area and in the Great Piece Meadows. The June PAR (Day et al., 1985) recommended a flow regulator such as a weir on the Passaic River to maintain habitat suitability in the Great Piece Meadows. According to the information provided by the COE, a weir structure is only "under investigation" at this time. Depending upon post-project conditions, including habitat suitability and vegetational succession, as well as tunnel operation, implementation of the plan could result in a permanent loss of fish and wildlife resources, including a portion of the central PRB wetlands.

The purpose of the selected tunnel diversion plan is to provide flood protection to the central and lower PRB. Flooding problems in the PRB will continue because local municipalities have zoned natural retention wetlands and floodplains for development. Project implementation will control current flooding and hence, will encourage wetland and floodplain development in areas not acquired for natural storage. To reduce project-related wetland damages, we recommend that the COE implement the following: 1) vigorous enforcement of regulatory authority under the Clean Water Act to regulate the filling of wetlands that provide natural retention of floodwaters in the PRB; 2) acquisition of floodplain and wetland areas that are important for retention; 3) reclamation of floodplains and wetland creation on a selected basis for reducing structural flood control measures; 4) formulation of a comprehensive wetlands management plan for the central Passaic wetlands; and, 5) development of nonstructural flood control/water management plans with adequate consideration given to fish and wildlife values and overall drainage basin management in comparison to invoking structural engineering concepts on the single criterion of water movements. The Service is highly supportive of the COE's land acquisition proposal to purchase 5,350 ac. of natural storage areas, including wetlands, in the central PRB.

Aquatic ecosystems are complex. Rivers and adjacent floodplain and wetlands change in response to channelization, hydrologic alterations and associated disturbances. Therefore, it is recommended that for future studies in the PRB the COE consider the Instream Flow Incremental Methodology (IFIM) to quantify

disturbances to a riverine ecosystem. The application of this scientific methodology would require a substantial commitment of time and funds. Recommendations formulated under IFIM would be based upon valid conclusions via sound biological data and direct observational evidence.

One of the responsibilities of the Service is to provide detailed assessment of project impacts to fish and wildlife resources. This impact assessment would be accomplished by utilizing HEP. The HEP is a habitat based approach to impact assessment and provides a scientific method for describing baseline conditions and predicting future habitat conditions in terms of both habitat quantity and quality. The baseline HEP for PRB terrestrial resources was accomplished about 6 years ago (Day and Bosenberg, 1980, 1981a). Therefore, additional baseline HEP would be conducted to identify data gaps (e.g., aquatic resources) and to extend the analysis into the lower PRB. With necessary updating, the HEP conducted in 1980 should provide sufficient baseline data for the central PRB, since the wetland cover types were adequately described by field investigations. The baseline data, along with future land uses, would be used to identify habitat changes at different time intervals and measure losses and gains associated with project implementation. The application of HEP in 1987 is needed to refine and quantify our recommendations in this report.

Other water management plans should be considered in the formulation of the proposed tunnel diversion plan. For example, the State of New Jersey is constructing an intake structure at the Pompton/Passaic confluence (Wanaque south pump station) that would, during droughts, pump water to the Wanaque Reservoir managed by the North Jersey District Water Supply Authority and to the Oradell Reservoir managed by the Hackensack Water Company, as well as to other reservoirs (Point View, Cedar Grove) managed by the Passaic Valley Water Commission. Approximately 250 mgd could be pumped from the intake to the Wanaque and 75 mgd to 100 mgd could be pumped from the intake to other reservoirs such as the Point View Reservoir. The COE's tunnel diversion intake would tap the river during high flows while the state's intake system would tap the river during low flows. Combined, this could accelerate water quality degradation. Additionally, several hydroelectric projects are proposed within the study area. The Passaic Valley Water Commission has proposed a hydroelectric project on Little Falls, the Paterson Municipal Utilities Authority and Great Falls Hydroelectric Company are now constructing a hydroelectric project on Great Falls and American Hydropower has a three-turbine hydroelectric project in operation at Dundee Dam. Upon completion, the American Hydropower project will operate nine turbines that can handle 2,300 cfs. The Federal Energy Regulatory Commission should be consulted about the compatibility of implementing the selected plan with present and future hydropower projects.

It is unclear how other proposed COE flood control plans relate to the formulation of the proposed tunnel diversion plan. For example, the Service assessed the COE's selected flood control plan for the lower Ramapo River (Day, 1984). This plan was based upon 1.7 mi. of channelization that would begin approximately 1.5 mi. upstream of the Pompton Lake Dam. Pompton Lake would be partially dewatered and bascule gates would be installed on the dam. Therefore, the beginning point of this Ramapo River plan, Pompton Lake Dam, is

also the starting point for channelization of the selected tunnel diversion project. The Service finds it difficult, particularly from a biological and ecological viewpoint, to conduct an assessment and formulate mitigation recommendations on two independent flood control projects designed to channelize and dredge the same river.

PLAN IMPLEMENTATION

OVERVIEW

After careful review and evaluation of the information provided by the COE, the Service approves the selected plan, with conditions. From a biological and ecological viewpoint, this flood control plan, particularly the acquisition of natural storage areas, is an improvement over previous alternative plans for the PRB (i.e., tunnel diversion, levee/floodwall, channelization, dual inlet and Beatties Dam inlet tunnel diversion). However, the Service requests that further planning and investigations be conducted to refine the selected plan for the purpose of minimizing potential adverse impacts to fish and wildlife resources.

The following recommendations should be investigated by the COE and, if feasible, should be incorporated into the selected plan prior to forwarding the plan for higher approval. The recommendations highlight the Service's major concerns for fish and wildlife resources in view of implementing the selected plan as proposed. Resolution of these concerns should be accomplished as soon as possible and prior to conducting a HEP analysis. Incorporating several of the following recommendations into the selected plan could greatly minimize habitat losses and thus, would influence the formulation of Service's final mitigation recommendations.

Recommendations for "plan implementation" are presented under the following subheadings that are named according to site location in the project area, proceeding from north to south: Pompton inlet area, Pompton River, Two Bridges inlet area, Great Piece Meadows, Rockaway River, Mainstem Passaic River, and acquisition areas throughout the PRB. Further comments and recommendations follow and are presented under "Mitigation Recommendations."

POMPTON INLET AREA

1. Redesign the Pompton inlet structure to eliminate or greatly reduce the proposed channelization and dredging on 2.6 mi. of the Pequannock, 1.3 mi. of the Ramapo and 1.0 mi. of the Wanaque Rivers. Dredging to 6.0 ft. in the Pequannock, Ramapo and Wanaque channels is proposed. Channel top widths on these rivers would be increased by 60 ft., 40 ft. and 60 ft., respectively. The proposed channelization and dredging is extensive, particularly if the purpose of channel work is to accommodate the morning glory inlet that will be contained in a basin that is lower in elevation than the river channel (the floor of the basin is 8 ft. below the crest of the morning glory inlet). The inlet structure is designed to prevent debris from entering the tunnel. However, this design would eliminate almost 5 mi. of riverine habitat in order to attain a change in elevation. Therefore, the Pompton inlet structure

should be redesigned to eliminate the proposed channelization as well as to prevent anything but floodwaters from entering the tunnel.

The magnitude of proposed channelization on these river segments may not offer an opportunity to incorporate basic stream-improvement techniques into project design. Post-project conditions, particularly habitat suitability and public accessibility to the watercourse, will determine what stream improvement techniques, if any, can be implemented and thus, recoup important recreational fishing opportunities.

2. Islands in the Ramapo River provide valuable wildlife habitat and should be retained. The project as proposed would eliminate the existing vegetational community structure supported on these islands.

3. Investigate the removal of the existing Ramapo River dam that is located near the proposed Pompton inlet site. This dam may contribute to raised surface water elevations and thus, contribute to back-up flooding along the river proposed for channelization, dredging, floodwalls and levees. Furthermore, if the selected plan is implemented as proposed, and the Ramapo River is channelized into the Pequannock River, it is unclear why the dam would be retained.

4. Channelization should not occur beyond the first major meander on the Ramapo River immediately upstream of the inlet structure. Islands, backwaters and riparian areas in this segment of the Ramapo River provide excellent wildlife habitat and should be retained.

5. Implementation of the project as proposed would divert the existing Ramapo channel into the Pequannock River. The left bank of the new channel should not prevent water from entering the former Ramapo channel. Construction of the left bank should include a weir or a low-headwall dam to allow for wetlands inundation, channel flushing and to maintain existing surface waters for fish and wildlife.

6. Excessive wetland vegetation would be removed from the Pompton inlet area. This vegetation is being removed to ensure that debris will not find its way into the inlet structure. Many of these wetlands are forested and provide valuable wildlife habitat. If it is necessary to remove forested wetlands, the successful establishment of emergent and scrub-shrub wetlands should occur during the first growing season following project implementation. For example, the areas on the river side of the Pequannock-Ramapo levee and along the right bank of the Pequannock River should be regraded for periodic inundation. Successful wetland establishment will require inundation and therefore, this segment of the Pequannock should not be channelized. Furthermore, it is unclear how water velocities (during tunnel operation) will impede the reestablishment of vegetation or cause bank erosion. A velocity/erosion study is recommended for the inlet area and on upstream reaches.

7. The Ramapo and Wanaque Rivers upstream of the Pompton inlet are important trout-stocked waters and provide recreational angling opportunities. Therefore, the project should be modified to allow for public access to these watercourses. The levee system proposed along the left bank of the Ramapo River does not make adequate accessibility possible. In fact, it is unclear why levees are needed when this segment of river is proposed for dredging and channelization. Implementation of the project as proposed would terminate existing trout management by the NJBFF on the Ramapo and Wanaque Rivers in the project area. Furthermore, future trout stocking plans being considered for the Pequannock River would cease.

8. Proper tunnel inlet operation is a very serious concern from a fish and wildlife viewpoint since volume can be regulated and thus, flushing, wetland and floodplain inundation, sediment deposition/erosion and flow regimes could be controlled. The one-year flood event at this location is approximately 4,300 cfs under existing conditions. Tunnel operation would reduce this to 500 cfs (representing approximate mean annual flow) with a peak of 4,000 cfs during storms. A one-year flood event (4,300 cfs not 4,000 cfs as proposed) may be the minimal discharge acceptable to maintain aquatic and wetland resources. However, it is recommended that the COE determine what flood event (i.e., maximum flood height) could bypass the tunnel intake structure and continue downstream while not requiring any channelization of the Pompton River in the Pompton inlet area. This flow is probably greater than the one-year flood event and could be further increased by floodplain reclamation. This may be a feasible nonstructural flood control method to incorporate into the project area since the COE's "1990 Base/2040 Projection Map" indicates a loss of natural storage areas.

9. Maintain existing channel meanders in the Pequannock, Ramapo and Wanaque Rivers.

10. Maintain adequate fish passage in the Pequannock, Ramapo and Wanaque Rivers.

11. Maintain public accessibility to the Pequannock, Ramapo and Wanaque Rivers for recreational angling opportunities.

12. In areas where levees are deemed necessary they should be set back from the watercourse and be constructed along the outer fringes of wetlands and floodplains. Levees should be vegetated with species indigenous to the immediate area. Levees should not prevent public accessibility to the watercourse.

13. Undertake a velocity/erosion study for river segments upstream of the Pompton inlet structure. It would be helpful for the COE to construct a miniature, physical flow model of the project impact area, particularly representing the upstream reaches from the Pompton and Two Bridges inlet structures. This model would be useful in conducting experiments on velocity changes that are expected to occur when the tunnel is in

operation. Velocity increases will cause channel bottom disturbance, sheet erosion, bank erosion, headcutting of channel meanders, water turbulence and sediment deposition. These physical changes resulting from velocity increases will greatly influence plant community structure and thus, the ability to retain or reestablish riparian and wetland areas.

POMPTON RIVER

1. Investigate the maximum flow that could bypass the Pompton inlet structure and continue downstream without channelization or dredging on the Pompton River in the inlet area.

2. Investigate the acquisition of developed floodplain areas for the purpose of floodplain reclamation.

3. Allow floodplain and wetland inundation, flushing of the channel and adequate flow regimes to continue, retaining existing biological and ecological conditions.

4. The amount of river channel capacity reduced over time should be determined. For example, a channel carrying the one-year event will eventually stabilize and thus, could be smaller than existing conditions.

5. Maintain adequate fish passage throughout the Pompton River.

TWO BRIDGES INLET AREA

1. Investigate the maximum flow that could bypass the Two Bridges inlet structure and continue downstream without channelizing the Passaic River. The one-year flood event at this location is approximately 6,100 cfs under existing conditions. Mean annual flow is approximately 1,100 cfs. Tunnel operation would reduce volume flow to 100 cfs with a peak flow approximating the one-year event during reciprocating discharge. Therefore, tunnel operation would decrease volume flow to 100 cfs and, during a storm event, increase flow to 6,000 cfs. First, this decrease and increase of flow rate is erratic and would adversely impact aquatic habitat. Second, the duration of time that the one-year flood event is permitted to flow downstream is unknown.

2. Approximately 1.1 mi. of the Pompton and Passaic Rivers is proposed for channelization. Redesign the proposed channel modification to accommodate basic stream-improvement techniques as deemed necessary by the NJBFF.

3. Design streambanks on the Passaic and Pompton Rivers to include filters and traps for petroleum products, road salt, sand and sediments wherever runoff drains into the watercourse.

4. Deposit riprap along streambanks on the Passaic and Pompton Rivers where

it is not possible to stabilize the bank with vegetation.

5. Reestablish natural substrate conditions.

6. Maintain adequate fish passage throughout the modified channel.

7. Undertake a velocity/erosion study for river segments upstream of the Two Bridges inlet structure.

GREAT PIECE MEADOWS

1. The proposed one-year flood event may be inadequate to maintain existing wetland characteristics, floodplain enrichment and flushing. It is recommended that the COE determine the specific hydrologic regimes, including inundation, necessary to maintain existing wetland cover types. Another important parameter that should be studied is residence time (the time that water remains over the floodplain floor and in associated depressions). The proposed one-year flood event is a good basis to understand the hydrological needs of the Great Piece Meadows. However, this "one- year event" hypothesis gives a priori preference for water regimes. Only valid conclusions via sound data should be used to resolve this crucial question about wetlands ecology. It is recommended that a model be used to determine anticipated wetlands conversion which could occur from hydrologic changes. Application of such a model could be effectively incorporated into the proposed HEP analysis since plant community succession, resulting from project implementation, will influence habitat suitability. The Service would like to discuss the feasibility of using plant community succession modeling during negotiations for fiscal year 1987 work. In the interim, the COE may wish to review studies of plant community succession modeling (Brody et al., 1986; Pearlstine and Kitchens, 1985; Pearlstine et al., 1985).

2. Once the threat of flooding is reduced, an accelerated loss of floodplain areas from development is expected. The COE's proposal to acquire up to 5,350 ac. of natural storage areas, including wetlands in the central Passaic basin is a commendable and important part of the selected plan. Preserving the flood storage function of wetlands will ensure that the diversion tunnel remains functional by controlling accelerated discharge resulting from continued development. Additionally, these natural storage areas will provide very important wildlife habitat. It is recommended that major landowners and agencies interested in the central Passaic wetlands coordinate the development of a comprehensive wetland management plan. Close coordination will be required between the COE, the Service, the New Jersey Green Acres Program and Wildlife Preserves, Inc. The New Jersey Green Acres Program has acquired several hundred acres, and Wildlife Preserves, Inc. owns almost 2,500 ac. of the central Passaic wetlands.

3. All wetland losses will be considered in formulating final mitigation recommendations. The HEP to be conducted would account for wetland values and losses and thus, compensation necessary to accomplish the

goals of the Service's mitigation policy. Certain hydrologic information would aid in the implementation of HEP. Therefore, it is recommended that the COE conduct studies on Great Piece Meadows to determine flooding volumes in terms of depths, frequency, seasonal periodicity, duration and soil saturation. Vegetational conversion and thus, habitat suitability could be determined from information and data obtained through such studies (refer to item #1 above).

4. Continue to investigate the feasibility of constructing a low-headwall dam or weir structure at the eastern discharge point of the Great Piece Meadows. This would insure continued flooding of the wetlands and thus, retain hydrophytic vegetation. This dam or weir should be designed as an adjustable structure to operate when the spur tunnel is open as well as during drought conditions. The weir should not make Great Piece Meadows a ponding area. The weir structure could confine wetland losses to those wetlands in the vicinity of the Passaic/Pompton Rivers confluence and along I-80.

5. The proposed I-80 levee system including associated ponding will result in a loss of forested wetlands. Blocking the existing culverts as proposed will interfere with the hydrologic regime. It is recommended that the ponding area be modified (refer to item # 2 under "Acquisition Areas") and the culverts remain open.

ROCKAWAY RIVER

1. The need to construct Rockaway River levee systems #1, #2 and #3 should be reevaluated and designed to follow the topographic contours. In the case of levees #1 and #3, proposed design will segregate wetlands from the watercourse.

2. Levees should be set-back from the watercourse and be constructed along the fringes of wetlands and floodplains. Further, levees should be vegetated with indigenous species and not prevent public accessibility to the watercourse.

3. Investigate the acquisition of developed floodplain areas for the purpose of floodplain reclamation.

4. Allow adequate floodplain and wetland inundation to continue.

MAINSTEM PASSAIC RIVER

1. Recreational boating on the lower Passaic River is limited due to a lack of accessibility to the watercourse. All existing public boat ramps should be identified and be incorporated into the final design of levee/floodwall systems. Municipal boat ramps are located in Kearny and Lyndhurst.

2. Allow flushing of the channel and adequate flow regimes to continue. Flushing levels should be maintained to help dilute polluted river waters in the Paterson/Clifton area. According to the information

provided by the COE, a minimum flow rate of 100 cfs during flood events will be maintained over Beatties Dam. This low volume flow may be periodically tolerated but is inadequate to maintain existing aquatic conditions. Mean annual flow at this location is approximately 1,100 cfs. The one-year flood event is approximately 6,100 cfs. The COE should also investigate the hydroelectric project that is being proposed by the Passaic Valley Water Commission in this area. The use of IFIM is recommended to quantify disturbances that are expected to result to the riverine ecosystem due to low flows.

3. The amount of river channel capacity reduced over time should be determined through monitoring.

4. Maintain adequate fish passage throughout the river.

5. Additionally, data regarding water velocities at the outlet structure should be submitted to the Service to assess potential adverse impacts to fishery resources.

ACQUISITION AREAS

1. The proposed acquisition of natural storage areas, including wetlands, is a very desirable part of the tunnel diversion plan. Continued loss of wetland and associated floodplain areas will result in greater flood frequencies and peaks. The purpose of acquiring and maintaining these areas is to insure the functional ability of the tunnel diversion system. In addition to accommodating the long-term operation of the tunnel, the acquisition of wetlands would provide for the protection of valuable wildlife habitat. It is unclear, however, what criteria were used by the COE to determine proposed acquisition areas, and why some important areas were omitted. For example, areas currently in public ownership, such as Green Acres' lands in Troy Meadows, should not be purchased before acquiring other natural storage areas now in private ownership and under development pressures. Wetlands at the confluence of the Pequannock/Wanaque/Ramapo Rivers are not being considered for acquisition. Ponding areas, except for the ponds associated with levee system #2A and the small acquisition area near the Passaic River in Essex County, are not, according to the delineation maps provided by the COE, being considered for acquisition. Additionally, all headwater regions of tributaries discharging into the central Passaic wetlands should be considered as important acquisition areas.

2. A section of the Great Piece Meadows south of I-80 is proposed for acquisition and major ponding. Ponding will require that existing forested wetlands be replaced with grass depressions. It is recommended that a ponding area be developed here, but incorporate wildlife concerns (game and nongame) to increase waterfowl productivity and protect important habitat. If a series of ponds (not one large catch basin) are created, water should be retained for waterfowl brooding during March through May. Water levels in the ponds should be up to a depth of 1.5 ft. Furthermore, each pond should be surrounded by cattails. The forested wetlands provide important wildlife habitat and should be

retained along borders of the cattail community. The series of ponds should be segregated by weir structures with some larger and deeper ponds intercepting the initial volume of water from flood events. The COE should coordinate closely with the New Jersey Division of Fish, Game and Wildlife (Bureau of Wildlife Management and Endangered and Non-game Species Program) in formulating a ponding design for this area. The state also has a concern for threatened and endangered species in this location.

3. The existing drainage culverts along I-80 should not be blocked as proposed since this would interfere with the hydrologic regime of the Great Piece Meadows.

4. It is unclear how the lands being considered for acquisition would be managed. It should be determined what lands in the central Passaic wet lands are currently in or are being proposed for state ownership or are in private ownership. The New Jersey Green Acres Program and particularly Wildlife Preserves, Inc., have considerable acreage that is either in their ownership or under investigation for purchase. These landowners should be closely coordinated with to formulate a comprehensive wetlands management plan for this area. These wetlands provide important wildlife habitat and should be retained. However, basic management techniques must be applied to improve the habitat quality and thus, the biological productivity of these wetlands. Invading common reed (Phragmites australis) and purple loosestrife (Lythrum salicaria), siltation, water quality, unauthorized filling and loss of open water are some major problems. The Service, therefore, recommends that in addition to acquiring sections of the central Passaic wetlands, a comprehensive wetlands management plan should be formulated as part of the overall tunnel project. The formulation of this plan would require the cooperation of the COE, the New Jersey Green Acres Program, Wildlife Preserves, Inc. and the Service.

5. Former wetland and floodplain areas under development and frequently inundated should be investigated as additional acquisition areas. Criteria used to identify these areas could include the following: 1) how much channelization and levee/floodwall construction could be eliminated by floodplain reclamation and wetlands creation; 2) frequency and duration of flooding; 3) flood storage potential; 4) current land use; 5) size; 6) wildlife value; 7) proximity to existing natural areas or other areas under consideration for acquisition; 8) cost benefit ratio of implementing nonstructural flood control methods; and, 9) municipal support for acquisition as natural storage areas. Although cost benefit analysis usually justifies structural flood control methods, it would be interesting to calculate annual flood damages and extrapolate the long-term gains derived by implementing non-structural methods. For example, annual flood damages in the PRB are estimated to be $76 million. How much of this cost would be repaid through floodplain reclamation and the purchase of floodplains and wetlands for natural flood storage?

6. Ponding areas are important to the operational function of the project. It is unclear whether or not the ponding areas (except the ponding areas along I-80 and the small ponding area near the Passaic River) are included under the acquisition proposal. Further, the long-term maintenance of the ponding areas is unclear. Grass-covered depressions may require minimal maintenance but in comparison to forested wetlands offer little value to wildlife. Therefore, it is recommended that wildlife habitat improvement techniques be incorporated into the design of the ponding areas. The COE should coordinate closely with the New Jersey Division of Fish, Game and Wildlife in formulating ponding designs (refer to item #2 under "Acquisition Areas").

7. The Black Meadows is one of the major wetland areas being considered for acquisition. The continued floodwater retention capability of this headwater wetland area is obviously important to the operation of the tunnel. Morristown Airport is within the Black Meadows. This airport was constructed on filled wetlands, is surrounded by the proposed acquisition lands on three sides, increases runoff and covers approximately 25% of the land surface area of Black Meadows. The airport should be evaluated as a site for wetlands creation, dependent upon bird-aircraft strike problems.

The concept of land acquisition for the purpose of compensation is addressed below under "Mitigation Recommendations."

MITIGATION RECOMMENDATIONS

MITIGATION PLANNING

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act [40 CFR Part 1508.20(a-e)] regulations to include the following:

(1) avoiding the impact altogether by not taking a certain action or parts of an action;

(2) minimizing impacts by limiting the degree or magnitude of the action and its implementation;

(3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

(4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and,

(5) compensating for the impact by replacing or providing substitute resources or environments.

The Service supports this definition of mitigation and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process.

Quantified mitigation, including specific mitigation recommendations, would be further determined through the use of the proposed HEP in 1987. The HEP would provide a scientific basis for determining fish and wildlife habitat compensation requirements. Additionally, in order to formulate accurate projections needed to conduct a future HEP scenario and to increase the scientific validity of the HEP analysis, a plant community succession model may be applied concurrently. Plant succession, resulting from hydrologic changes via project implementation, will influence habitat suitability. The proposed HEP report would present the findings and conclusions of the HEP analysis, including supporting technical data and final mitigation recommendations.

LAND ACQUISITION

In addition to insuring the functional ability of the tunnel diversion system, land acquisition is being considered to protect natural storage areas including wetlands. Land acquisition in fee title for the purpose of compensation will be recommended by the Service only under one or more of the following three conditions:

(1) when a change in ownership is necessary to guarantee the future conservation of the fish and wildlife resources consistent with the mitigation goal for the specific project area; or

(2) when other means and measures for mitigation (aforementioned mitigation elements) will not compensate for habitat losses consistent with the mitigation goal for the specific project area; or

(3) when land acquisition in fee title is the most cost-effective means that may partially or completely achieve the mitigation goal for the specific project area.

Service review of the wetlands being considered for acquisition, including mitigation planning goals via site specific resource category determinations, will be made on a case-by-case basis during the implementation of the HEP analysis in 1987.

GENERAL RECOMMENDATIONS

Prior to an implementation of a scientific habitat evaluation method such as HEP or the application of a mitigation technology, the following general recommendations are summarized below. These recommendations are based upon the Service's best professional judgment regarding the selected tunnel diversion plan as proposed:

(1) eliminate or greatly reduce the proposed channelization and dredging on the Pequannock, Ramapo and Wanaque Rivers;

(2) retain vegetated wetland, floodplain and riparian areas, islands and backwaters along the Pequannock, Ramapo and Wanaque Rivers;

(3) formulate a wetlands reestablishment plan for emergent and scrub-shrub wetlands in areas where forested wetlands will be eliminated;

(4) determine what volume flow could bypass the tunnel intake structures and continue downstream while not requiring channelization of the Pompton and Passaic Rivers;

(5) maintain existing channel meanders, adequate fish passage and public accessibility to the watercourse throughout the project area;

(6) the need for each levee system should be reevaluated and if constructed, levees should be set-back from the watercourse along the outer fringes of wetlands and floodplains;

(7) investigate the acquisition of developed floodplain and wetland areas for the purpose of floodplain reclamation and wetlands creation;

(8) allow floodplain and wetland inundation, flushing of the river channels and adequate flow regimes to continue;

(9) redesign the proposed channel modification for the Pompton and Passaic Rivers to accommodate basic stream-improvement techniques;

(10) determine anticipated plant community succession from hydrologic changes in the Great Piece Meadows;

(11) design a low-headwall dam or adjustable weir structure for the eastern discharge point of the Great Piece Meadows;

(12) present a descriptive analysis of tunnel inlet operation, particularly in regard to how and who will regulate volume flow and thus, river flow regimes;

(13) investigate the feasibility of acquiring headwater regions under the acquisition phase of the project;

(14) formulate ponding designs that are compatible with fish and wildlife management;

(15) formulate a comprehensive management plan for the central Passaic wetlands;

(16) undertake a velocity/erosion study for river segments upstream of the Pompton and Two Bridges inlet structures.

(17) identify contaminants (particularly dioxins and PCB's), concentrations and the extent of their transport downstream of the tunnel outlet structure that would result from increased water velocities during tunnel operations.

(18) continue project planning with close coordination with the New Jersey Division of Fish, Game and Wildlife and the Service.

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APPENDICES

APPENDIX A

DESCRIPTION OF THE SELECTED FLOOD CONTROL PROJECT BY THE CORPS OF ENGINEERS (Dual Inlet Tunnel Division Plan; and, undated letter from the COE responding to Service request for information regarding land use projections)

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, N. Y. 10278-0090

May 15, 1986

REPLY TO
ATTENTION OF:

Passaic River Basin and
Special Studies Branch

Mr. Charles Kulp
U.S Fish and Wildlife Service
Department of the Interior
Suite 322
315 South Allen St.
State College, Pennsylvania 16801-4832

Dear Mr. Kulp:

Enclosed is the information you requested at our meeting on 24 April 1986 to allow completion of your analysis of effects on the Fish and Wildlife resources for the Passaic River Basin proposed mainstem flood control project and the preparation of the Fish and Wildlife Coodination Act Report.

The information provided includes:

- A new narrative which contains; the spur tunnel inlet information, the operating rules including flow passage, and the water surface statement regarding existing conditions versus spur tunnel-dual inlet plan under non-flood conditions.

- Ponding area location and size information, for the levees and Pompton Inlet (Central Basin).

- Bank overflow elevations.

- Effective flow-area maps, with floodways, protected areas, and parks.

- Land use projections in natural storage areas for the future without the project for 1990, 2040.

Not included are information on the weir structure and the Third River which are still in formulation. For the purposes of FWS's analysis assume no weir structure. The Third River plans will be sent at a later date, as they are independent of the mainstem

Passaic plan. We look forward to continued close coordination as the FWCA report is prepared and the mitigation plan developed. This will ensure our ability to maintain the mid-summer due date.

If you should have any question or need further assistance please contact Robert Kurtz at FTS 264-3609 or x 3615.

Sincerely,

Richard J. Muraldo
for Samuel P. Tosi, P.E.
Chief, Planning Division

Enclosure

DUAL INLET TUNNEL DIVERSION PLAN

GENERAL

The key feature of the Pompton River/Beatties Dam Dual Inlet Tunnel Diverison plan Figure A, is a 13.4 mile-long, 40-foot-diameter tunnel from the Pompton River down to the Lower Passaic River. This plan includes an inlet and diversion works located in Wayne on the upper Pompton River below its confluence with the Pequannock, Wanaque and Ramapo Rivers. A second inlet would be provided by means of a 1.3 mile long, 30-foot diameter spur tunnel from Two Bridges to the main tunnel. The tunnel would divert floodwaters from the upper Pompton River and from the central Passaic River area to an outlet near the Third River/Passaic River confuence at the Clifton-Nutley border. The underground tunnel would be about 125 feet below ground level at the Pompton River Inlet, about 130 feet below the Two Bridges Inlet, and about 155 feet below the outlet see Figures P1 and P2. At its deepest point, under the Watchung Mountains in the area of the Little Falls-Clifton border, the tunnel would be 450 feet underground.

With the Pompton Inlet located where it will divert the bulk of the floodflow away from the major Pompton Valley flood damage area, no other structural flood control works will be required downstream along the Pompton River. Approximately 5.5 miles of levees and 0.6 miles of floodwalls and 4.9 miles channel modifications upstream of the Pompton Inlet would be required to direct floodflows into the tunnel, and to protect upstream areas. The Passaic River channel would be deepened for 0.7 miles from upstream of Two Bridges to the spur tunnel inlet to divert floodflows into the spur tunnel. Upstream of Two Bridges along the central Passaic River, a 100 year level of protection can be provided at intermittent locations by a system of set back levees and floodwalls. This system would consist of approximately 15 miles of levees and 0.5 mile of floodwall. The levees would range in height from 4 to 11 feet, with an average height of 7 feet.

From Beatties Dam down to Newark Bay, the dual-inlet plan calls for 22 levee/floodwall systems including about 13 miles of levee and some 12 miles of floodwall. Diverting floodwaters through the tunnel from both the Pompton Valley and the Central Passaic Basin would significantly reduce the need for structural flood protection from Beatties Dam down to just upstream of the Saddle River.

For the lower Passaic River downstream of Route 3, levees and floodwalls are required to provide protection against a 100-year tidal flood. Flows discharging from the tunnel would be safely contained within the lower Passaic River levee system that is already necessary to protect against tidal flooding with an average 1.5-foot increase in levee/floodwall heights between Wallington and North Arlington, and by expanding the extent of the system in the vicinity of the outlet. A tunnel diversion plan could not be constructed without the implementation of flood control measures to protect against tides as well as tunnel discharges in the outlet area.

The Pompton River/Two Bridges Dual-Inlet Tunnel Diversion Plan would provide protection up to a 100-year flood event in the Pompton Valley, Lower Valley and Central Basin. The cost of this plan is estimated at approximately $930 million with a benefit-to-cost ratio of 1.2-to-1. Its non Federal cost is $80 million.

TUNNEL ELEMENTS

The function of the two tunnel diversion inlets and spur tunnel is to divert floodflows from the Pompton River at the upper Pompton River and from the Passaic River at Two Bridges and then reintroduce the flow through a 13.6 mile 40-foot diameter tunnel into the estuarine portion of the Passaic River at its confluence with the Third River at Clifton and Nutley.

This plan was developed to make more efficient use of the Pompton Tunnel with the expectation that flows could be further reduced by a second inlet Two Bridges, while operating the tunnel with a priority diversion at the Pompton River inlet. The double inlet takes advantage of the difference in timing, approximately 2 days, of the floodflow peaks to make more effective use of the tunnel. The objective is to direct as much flow as possible at the Pompton River inlet and then, if the tunnel flow is operating at a level less than capacity, allow additional flow to enter the tunnel at Two Bridges by manipulating gates in the Two Bridges gated diversion spillway.

Pompton River Inlet

The location of the inlet portal is upstream of the Pompton Plains Cross Road (Jackson Avenue) in Wayne Township on the east bank of the Pompton River immediately downstream of the confluence of the Ramapo and Pequannock Rivers where they become the Pompton River. The site currently is part of a sand and gravel operation with these materials stock-piled on and adjacent to the site. The area around the site is generally undeveloped lowlying floodplain on the west and north and agriculture lands to the east. Stream slopes in the area are very flat.

Structures consist of a river flow restrictor, a river diversion spillway, and a morning glory tunnel inlet. The river flow restrictor is constructed across the Pompton River and consists of a concrete bridge-type structure with a 24 feet wide by 17.2 feet high permanent opening and four 30' wide by 17.2' high gated openings which are closed at all times except when flows exceed the 100-year design flow condition for the plan. Then the gates are opened in order to pass the larger flows and also maintain maximum diversion through the tunnel. Embankments are also located on both banks of the river to assure that the tunnel will function at design flow levels. Average heights will range from 4.5 to 6.5 feet and lengths will be 795 feet on the east bank and 765 feet on the west bank. Also there is a 7-foot high berm around the inlet basin perimeter (500 feet long).

The gated diversion spillway is located on the east bank of the river and its function is to open and allow floodwaters to enter the basin which contains the morning glory inlet. Seven 40-foot wide gates would be utilized to control these flows. These gates would be opened only when floodflow exceeds the 1 year event on the Pompton River and when flooding conditions were being predicted. These gates would be otherwise closed at all times and no diverison of flows would occur.

The morning glory inlet is contained in a basin lower in elevation than the river channel. This allows the diversion of flows without increasing flood stages, and, in fact, lowers flood stages upstream of the inlet site. The basin is 300 feet wide at its largest dimension and the floor is 8 feet below the crest of the morning glory inlet to assure that flows will enter the inlet in a hydraulically efficient manner.

Two Bridges Inlet and Spur Tunnel

The proposed inlet is located on the east bank of the Passaic River about 500 feet upstream of the Route 80 bridge, adjacent to Fairfield Road in Wayne. To utilize this site, a bridge for Fairfield Road would be built over the inlet structure. The surrounding area is lightly developed for residential use and mostly consists of undeveloped lowlying wetlands. The inlet structure, which is similar to the Pompton River tunnel inlet, would consist of a gated diversion spillway and morning glory tunnel inlet.

The diversion spillway would consist of gates which control the floodwaters which enter the basin containing the morning glory inlet. The morning glory inlet is contained in a basin similar to the Pompton Inlet. This inlet leads to a 30-foot diamter, 1.3 mile long spur tunnel which connects to the main tunnel route. The diversion spillway will have a spillway crest about elevation 151.0 feet NGVD (National Geodetic Vertical Datum) topped by eight 40 ft. wide x 19 ft. high gated openings which would open to allow the diversion of flood flows only. The morning glory tunnel inlet will begin diverting flows into the tunnel when waters ponded to elevation 151.0 feet NGVD. When floodflows are larger than the tunnel capacity, the excess flows would continue downstream.

Tunnel Outlet

The outlet location is on the left bank of the Third River at its confluence with the Passaic River in a wide portion of the Third River and in a well defined valley of the stream. Flows exiting the tunnel would be directed into the Passaic River through the Route 21 bridge. The outlet site is well away from residential development and is currently used as an equipment and materials yard for a construction company. The Passaic Valley Sewage Commission (PVSC) Yantacaw pumping station is located downstream of the site.

The diverted flows would exit the tunnel through an upshaft to the surface at sea level (greatly reducing water velocity) and then flow out the enlarged mouth of the Third River and under Route 21 into the Passaic River. The Route 21 bridge would be enlarged to accommodate the increased flows. Levees and floodwalls would be constructed on both banks of the Third River to protect those nearby areas from increased river stages estimated to be 13.9 feet NGVD as compared to 10.5 feet that would occur under today's conditions

for the 100-year design flows. Because the tunnel outlet is in the tidal portion of the Passaic River, levees and floodwalls are the only suitable measure mitigating the increased flood stages. To protect against hurricane surges and to mitigate for increased flood stages a total of 32,140 feet of levees averaging 9 feet in height and 11,350 feet of floodwalls averaging 8 feet in height would be required between the Second River and the Rutherford-East Rutherford boundary, a distance of 5.2 miles. These additional flows, however, would have no effects on river stages downstream of Rutgers Avenue Bridge because of the large flow capacity of the large navigation channel below that location.

CHANNEL ELEMENTS OF THE DUAL INLET TUNNEL DIVERSION PLAN

Channel modifications considered as part of this plan are required to direct floodflows into the tunnel inlets with the channel modifications on the Pequannock, Ramapo and Wanaque Rivers also required to provide protection to the areas upstream of the Pompton River tunnel inlet.

Passaic River and Pompton River

The channel transition along the Passaic River and Pompton River would extend from upstream of Two Bridges Road downstream for a distance of 0.7 miles to the Route 80 Bridge. This channel would have an average base width of 180 feet and would be deepened an average of 4-5 feet. The resulting top width of the channel would be approximately 260 feet. The top width of the existing channel averages approximately 220 feet.

Pequannock River

The channel modifications along the Pequannock River would extend from the location of the Pompton River tunnel inlet, just upstream of Pompton Plains Cross Road, upstream for 2.6 miles. The modifications would consist of deepening the existing channel by 14 feet and increasing the channel bottom width to an average 75 feet. The average top width of the modified channel would be approximately 170 feet. The top width of the existing channel is approximately 100 feet.

Ramapo River

The channel modifications along the Ramapo River extends from the Ramapo River-Pequannock River confluence upstream 1.3 miles to the Hamburg Turnpike Road. Ramapo River modifications consist of deepening the existing channel 6 feet and increasing the channel bottom width to an average 55 feet. The average top width of the modified channel would be approximately 150 feet. The top width of the existing channel in the reach is approximately 110 feet.

Wanaque River

The channel modifications along the Wanaque River extend from the Wanaque River-Pequannock River confluence upstream 1 mile to Hamburg Turnpike. The Wanaque River modifications consists of deepening the existing channel approximately 6 feet and increasing the channel bottom width to an average 75 feet. The average top width of the modified channel would be approximately 150 feet. The top width of the existing channel averages about 90 feet.

LEVEE/FLOODWALL ELEMENTS OF THE DUAL INLET TUNNEL DIVERSION PLAN

The first area to be protected is located at Kearny Point at the mouth of the Passaic River. The Kearny Point levee/floodwall system consists of 14,150 feet of earthen levee and 17,600 feet of floodwall protecting industrial structures on the left bank of the Passaic River, around Kearny Point and upstream along the right bank of the lower reaches of the Hackensack River in the Town of Kearny. The damages incurred in this area are predominately the results of tidal flooding. The levees in this area average 6.5 feet in height and 40.5 feet in base width. The floodwall is approximately 6 feet high. In order to provide a continuous line of protection, sections of Fish House Road and a nearby access road must be raised, and a gated structure would be needed across a railroad spur located in the northeastern corner of the system. Runoff from the 1,011 acre drainage area behind the system, which would normally drain into the river by gravity, would be collected by seven ponding areas ranging in size from 1.5 acres to 13 acres (totaling 42.9 acres) generally 4 feet in depth in combination with a 204 cfs pumping station.

Proceeding upsteam along the Passaic River the next area to be protected includes industrial structures within the area bounded by the Passaic River, Routes 1 and 9, and the Central Railroad of New Jersey in the City of Newark on the right bank of the Passaic River. The Doremus Avenue levee/floodwall system would protect against tidal and fluvial flooding. This system consists of 2,000 feet of levee with an average height of 5.5 feet and base width of 35.5 feet, and 2,120 feet of floodwall with an average height of 6.0 feet. This alternative requires that gated structures be provided at two openings underneath the Central Railroad of New Jersey in order to insure the line of protection. Runoff from the 329 acre drainage area would be collected by a 17.5 acre ponding area having a depth of 3.5 feet.

The area protected by the Turnpike levee/floodwall system, is bounded by the Passaic River, NJ Turnpike, and Routes 1 and 9 in the City of Newark on the right bank of the Passaic River. This system would protect industrial structures against tidal and fluvial flooding. This system consists of 1,200 feet of levee and 1,250 feet of floodwall. The levee averages 6.0 feet high and 38 feet wide at the base. The floodwall is 5 feet high. The 135 acre drainage area behind the system would be collected by a 4.0-foot deep ponding area covering 4.7 acres.

The Lister Avenue levee/floodwall system on the right bank of the Passaic River consists of 4,275 feet of levee and 3,300 feet of floodwall. The levee averages 5.0 high and 33 feet wide at the base. The floodwall is 6.5 feet high. This system protects industrial, commercial, and residential structures within the area bounded by the Passaic River, NJ Turnpike, Ferry Street and Freeman Street in the City of Newark. The 395 acres of drainage area behind the system would be collected by three ponding areas and a 159 cfs pumping station. The size of the ponding areas would be 4.5 acres, 6.6 acres, and 11.3 acres and would each be 4 feet deep.

In the Town of Harrison, on the left bank of the Passaic River, the Conrail levee system protects the industrial structures in the area bounded by the Passaic River, Conrail Railroad and 4th Street. The system consists of 2,750 feet of levee with an average height of 3.5 feet and 25.5 feet in base width. The runoff from 83 acres of drainage area will be collected by a ponding area which would cover 2 acres and be 4 feet in depth.

South 1st Street, Passaic Avenue #1 and Passaic Avenue #2 Levee/Floodwall Systems. The left bank of the Passaic River in the communities of East Newark, Harrison and Kearny would be protected from tidal and fluvial flooding from the South 4th Street Bridge upstream to Begen Avenue by 6,400 feet of levee with an average height of 4.5 feet and base width of 30.5 feet and 6,150 feet of floodwall averaging 5.5 feet high. Runoff from the 635 acres of drainage area behind the system would be handled by four ponding areas, ranging in sizes from 2.3 to 8.9 acres (total 27.2 acres), a 110 cfs pumping station and a 48" pressure interceptor. This levee/floodwall alternative can be separated into three independent systems at Interstate 280 and Conrail. A gated structure would be needed to block off the opening underneath Conrail north of Central Avenue in order to maintain the line of protection.

In the Borough of North Arlington, commercial and industrial structures along the left bank of the Passaic River within the area bounded by the Passaic River, Crystal Street, and Belleville Turnpike would be protected against tidal and fluvial flooding by 2,000 feet of levee with an average height of 7 feet and resulting base width of 43 feet, River Road System #1. Runoff from the 35 acre drainage area behind the system would be collected by a 3.2 acre ponding area 4 feet in depth.

The Riverside Avenue #1 levee/floodwall System located on the left bank of the Passaic River in Lyndhurst and North Arlington, consists of 5,000 feet of levee and 350 feet of floodwall and it protects the residential, commercial, and industrial structures bounded by the Passaic River, Route 3, Ridge Road, and Veteran Place in North Arlington and Lyndhurst from tidal and fluvial flooding. The levee in this area would have an average height of 12 feet and base width of 65 feet. The floodwalls would be 10 feet high. Runoff from the 577 acre drainage area behind the system would be handled by a 370 cfs pumping station and a 19.8 acre ponding area having a depth of 4 feet.

The right bank of the Passaic River, in the communities of Newark, Belleville and Nutley, would be protected from tidal and fluvial flooding from Verona Avenue in Newark to the Third River confluence in Nutley. In order to protect this area 9,500 feet of levees and 9,050 feet of floodwall would be needed, McCarter, Main Street and River Road #2 levee/floodwall systems. The average height of the levee and floodwalls would be approximately 6.0 and 8.0 feet, respectively. The width of the levee at its base would be about 38.0 feet.

Along the Third River at the location of the tunnel outlet approximately 2,750 feet of levees and 320 feet of floodwall would be required to contain the design flow discharging from the tunnel outlet. The levees and floodwalls would average 12.5 feet and 11 feet, respectively, with the base width of the levee averaging about 70.5 feet. The levees and floodwalls would be located on both banks of the Third River from its confluence with the Passaic River upstream to River Road, Yantacaw System.

On the left bank of the Passaic River in the Borough of Rutherford the Riverside Avenue levee system #2 would provide fluvial flood protection to the area from the Route 3 Bridge upstream to the abandoned railroad tracks at the East Rutherford border. To protect this area 4,340 feet of 8.5 feet levees, base width 50.5 feet, and 2,375 feet of floodwalls averaging 7 feet in height would be required.

In the Borough of East Rutherford, structures on the left bank of the Passaic River within the area bounded by the Passaic River, Maple Avenue Jackson Avenue and the abandoned Erie Railroad spur would be protected by the River Street levee/floodwall system. This system would consist of 3,370 feet of levee and 700 feet of floodwall. The levee would have an average height of 5 feet resulting in a base width of 33 feet. The floodwall would be 7 feet high. Runoff from the 344 acre drainage area would be handled by a 413 cfs pumping station.

Along the right bank of the Passaic River River Drive levee system #1, in the City of Passaic, structures within the area bounded by the Passaic River and Route 21 would be protected from fluvial and tidal flooding by 1,790 feet of levee and 1,660 feet of floodwall. The levee would have an average height of 6.5 feet and a base width of 40.5 feet. The floodwall would have an average height of 5 feet. A portion of River Drive would require being raised in order to insure a continuous line of protection. Runoff from the 36 acre drainage area would be handled by a 43 cfs pumping station.

The heavily developed area in the Borough of Wallington which is bounded by the left bak of the Passaic River and Main Avenue, Main Avenue levee system, would be protected from flooding by 2,730 feet of levee and 3,630 feet of floodwall. The levee would average 7.0 feet while the floodwall would have an average height of 7.5 feet. Runoff from the 178.5 acre drainage area behind levee/floodwall system would be handled by two pumping stations, 137 cfs and 44 cfs, and a 1 acre ponding area with a depth of 4 feet.

On the right bank of the Passaic River, in the City of Passaic, the area bounded by the Passaic River, First Street, and Monroe Street would be protected by 3,050 feet of levee and 10,170 feet of floodwall, 8th Street levee system. The levee would have an average height of 9 feet and a resultant base width of 53 feet. The floodwall would have an average height of 9.5 feet. One 3.5 acre ponding area, a pressure interceptor and two pumping stations would handle the runoff from the 207.5 acre drainage area behind the system.

On the left bank of the Passaic River, in the Borough of Wallington at Midland Avenue downstream of the Saddle River confluence, structures would be protected by the approximately 300 feet of levee and 1,300 feet of floodwall of the Midland Avenue systems. These levees would have an average height of 5 feet and resultant base width of 35 feet. The floodwalls would have an average height of 8.6 feet.

The Wagaraw Road levee system would protect areas in the Boroughs of Hawthorne and Fair Lawn bounded by the Passaic River, Maple Avenue, Diamond Bridge Avenue, and Goffle Brook. The system would consist of 1,860 feet of earthen levee, averaging 7.5 feet high, and 430 feet of floodwall, averaging 9.0 feet in height, and the raising of the E. 19th Street and Conrail bridge. Runoff within the 550 acres behind the system would be handled by 2 ponding areas (2.25 acres and 3.8 acres), a 241 cfs pumping station, and a 36" pressure interceptor.

The River Street #1 levee system would provide protection from fluvial flooding to the right bank of the Passaic River in the City of Paterson from the Conrail Railroad Bridge upstream to Broadway. To provide protection to this area 680 feet of levees and 2,250 feet of floodwalls would be required. The heights of the levees would average 4.5 while the floodwalls would average 4.0 feet. The base widths of the levees would be 30.5 feet.

Passaic River levee system #2A. This system consists of 48,000 feet of earthen levee (this includes blanket levee on the existing embankment for I-80) and 700 feet of floodwall which protects residential, commercial and industrial structures within the area bounded by the Passaic River, Route 80, Bloomfield Avenue, and the left bank of Deepevaal Brook in the Boroughs of Fairfield and West Caldwell. The levees would have an average height of 9.5 feet with a base width of 55.5 feet while the floodwalls would have an average height of 12.5 feet. As part of this system one gated structure, fourteen road raisings, two bridge raisings, and three bridge replacements are required and eight culverts need to be blocked off.

The 4,111 acres of drainage area beind the system are divided into sixteen subbasins, the local runoff from which is collected by a diversion ditch, a pressure interceptor, three pumping stations, and a series of ponding areas totalling approximately 310 acres.

Passaic River system #2C. The Passaic River #2C system is located along the right bank of Deepavaal Brook in the Borough of Fairfield and West Caldwell. This system would provide protection to the structures along Fairfield Place.

To protect this area 3,650 feet of levee and 1,000 feet of floodwall would be required. The levees and floodwalls would have an average height of 6.0 feet and 7.0 feet, respectively. The average base width of the levees would be 38.0 feet.

Passaic River system #10. This system would consist of 4,250 feet of levees located on the right bank of the Passaic River in the Township of Livingston. Protection would be provided to structures within the area bounded on the west by the Passaic River and on the east by Eisenhower Parkway.

The levees would be set back approximately 800 feet from the river to protect the existing wetlands in this area. The average height of the levees would be 8.5 feet and the base width would be 50.5 feet. Runoff from the 302.7 acre drainage area behind the levee would be collected by a 3.0 acre pond, 4 feet deep. A diversion ditch and culvert would also be provided to handle a portion of the runoff.

Rockaway River system #1. This system would consist of 3,600 feet of levees located on the right bank of the Rockaway River in the Township of Parsippany-Troy Hills. Protection would be provided to structures within the area bounded by the Rockaway River, New Road, Edwards Road and Vail Road.

The portion of the levee system that is upstream of Route 80 would be set back approximately 1,100 feet from the river. The levees downstream of Route 80 would only be set back approximately 200 feet from the river since structures are located closer to the bank in this area. The average height of the levees would be 8.5 feet and the base width would be 50.5 feet.

In order to maintain the line of protection it would be necessary to raise two segments of New Road. In addition, it would be necessary to block three culverts under Route 280 and two culverts under Route 80. Runoff from the 914.8 acre drainage area behind the system would be collected by three ponding areas. The ponding areas would consits of a 5.0 acre pond, 3 feet deep, a 1.0 acre pond, 3 feet deep, and a 10.5 acre pond, 4 feet deep.

Rockaway River system #2. This system is located on the left bank of the Rockaway River in the Township of Montville. This system is designed to protect structures in the area bounded by the Rockaway River, Barney Road, Walnut Drive, Kanner Avenue, Dogwood Circle and Change Bridge Road.

To protect this area from flooding from the Rockaway River, 5,400 feet of levees would be aligned along the river. The levees would have an average height of 7.5 feet with a base width of 45.5 feet. As part of this system, it would be necessary to raise the Vail Road Bridge. It would also be necessary to raise a portion of Vail Road, Barnet Road, and two areas of Change Bridge Road.

A 16.5 acre pond, 4 feet deep wold be required to collect surface runoff from the 1,097.3 acre draiange area behind the levee.

Rockaway River,system #3. This system would consist of 4,700 feet of levees and 470 feet of floodwalls located on the right bank of the Rockaway River in the Township of Parsippany-Troy Hills. Protection would be provided to structures within the area bounded by the Rockaway River on the east, River Drive, Mohawk Avenue and Sandalwood Drive on the west, Vail Road on the south and Knoll Road on the north.

Due to the close proximity of structures to the bank it would be necessary to align the levees and floodwalls along the stream. The average heights of the levees and floodwalls would be approximately 7.5 and 6.5 feet, respectively. The average base width of the levees would be 45.5 feet.

As part of this system it would be necessary to raise two areas of Lakeshore Drive and a segment of Hiawatha Boulevard.

Runoff from the 925. acre drainage area would be collected by two ponding areas, two pressure interceptors and two pumping stations. The ponding area would consist of a 0.5 acre pond, 2 feet deep and an 11.5 acre pond, 4 feet deep. The pressure interceptors would include a 32 inch and an 18 inch diameter pipe. The pumping stations would consist of an 11 cfs pump and a 132 cfs pump.

Whippany River system #2. This system is located on the left bank of the Whippany river in Hanover Township. This system provides protection to structures within the area bounded by Erie Lackawanna and Morristown and Erie Railroad south to Mt. Pleasant Avenue adjacent to the Whippany River.

In order to protect against flooding in this area 6,250 feet of levees would be required. The levee would have and average height of 8.0 feet and a base width of 48.0 feet. Internal drainage will be handled by pressure interceptors and/or pumping stations.

Whippany River system #3. This system is located on the right bank of the Whippany River in Hanover Township. This system provides protection to the structures downstream of Whippany Road Bridge on the right bank of the Whippany River.

In order to protect against flooding in this area approximately 2,900 feet of levee and 510 feet of floodwall would be required. The levee and floodwall would have an average height of 5.0 feet. The base width of the levee would be 33.0 feet.

In order to protect this structure 1,550 feet of levee would be required. This levee would have an average height of 7.0 feet and base width of 43.0 feet. Internal drainage will be handled by pressure interceptors and/or pumping stations.

Pinch Brook System. Located on the right bank of Pinch Brook in the Township of East Hanover, this system is bounded by Pinch Brook, Great Meadow Lane and Brentwood Drive. In order to protect against backwater flooding from the Whippany River in this area, 2,000 feet of levees would be required.

The levees, which would be aligned along the brook, would have an average height of 9.5 feet and a base width of 55.5 feet. A 4.5 acre pond, 4.0 feet deep would be required to collect runoff from the 96.5 acre drainage araa behind the levees.

Harrison Road William Street System. Located on the right bank of the Pequannock River in the Borough of Riverdale, this system would provide protection to structures in the area bounded by the Pequannock River, the Newark Pompton Turnpike and Riverdale Road.

This system would consist of 4,100 feet of levees to protect against backwater flooding from the Pompton River. The levees which would be aligned along the Pequannock River would have an average height of 5.0 feet with a base width of 33.0 feet. In order to maintain the line of protection it would be necessary to raise part of the Erie-Lackawanna Railroad and Riverdale Road. A 23.5 acre pond, 2 feet deep would be required to collect surface runoff from the 553 acre drainage.

Pequannock - Ramapo System. This system is located on the left bank of the Pequannock River and on the right bank of the Ramapo River in the Borough of Pompton Lakes. This system would provide protection to structures within the area bounded on the south and west by the Pequannock River, on the east by the Ramapo River and on the north by Riverview Road. Flooding in this area is caused by Pompton River flows backing up the Pequannock and Ramapo River. To protect against flooding, 10,200 feet of levees and 500 feet of floodwalls would be required. The levees would have an average height of 6.5 feet and base width of 40.5 feet.

It would be necessary to raise portions of Riverview Road, Riverdale Road, Willow Avenue and Dawes Highway in order to maintain the line of protection. To collect runoff from the 305.0 acre drainage area behind the system, three ponding areas would be required. The ponding areas would consist of an 11.0 acre pond, 4 feet deep, a 3.5 acre pond, 4 feet deep, and a 3.0 acre pond, 4 feet deep.

Shore Road System. This system would consist of 4,000 feet of levees and 625 feet of floodwalls located on the left bank of the Ramapo River in the Township of Wayne. Protection would be provided to structures within the area bounded by the Ramapo River and Black Oakridge Road.

This area is subject to backwater flooding from the Pompton River. The levees and floodwalls would be located along the river due to the close proximity of structures to the bank. Runoff from the 272 acre drainage area behind the levee/floodwall system would be collected by a 50 cfs pumping station and a 13.0 acre pond, 3 feet deep.

Albany Avenue System. Located on the left bank of the Wanaque River in the Borough of Pompton Lakes, this system is bounded by the Wanaque River on the east, Arcadia Road on the west, Riverview Road on the south and Hershfield Park Place on the north. Protection from backwater flooding from the Pompton River would be provdied to structures in this area by 2,500 feet of levee. The levees, which would be aligned along the bank, would have an average height of 7.0 feet and a base width of 43.0 feet.

Albany Avenue would be raised in order to act as the downstream closure for the levee system. A 1.5 acre pond, 4 feet deep would be provided to collect runoff from the 43 acre drainage area behind the system.

Turnpike Systems #1 and #2. These systems are located on the left bank of the Pompton River in the Borough of Wayne. These systems provide protection to the structures bounded by the Pompton River and Paterson-Hamburg Turnpike downstream of Pompton Lake Dam and upstream of Dawes Highway.

To protect against flooding in this area Turnpike Systems #1 and #2 would consist of 3,000 feet of levees and 450 feet of floodwalls. The levees and floodwall would average 4.0 and 5.5 feet, respectively, for the Turnpike 1 system and 8.5 and 8 feet, respectively, for the Turnpike 2 system. The base widths of the Turnpike #1 and #2 systems levees would average 28.0 and 42.5 feet, respectively. Internal drainage will be handled by pressure interceptors and/or pumping stations.

Stiles Court System. This system is located on the left bank of the Pequannock River in the Borough of Pompton Lake. This system would provide protection to the structures in the area bounded by the New York Susquehanna and Western Railroad on the north, Ringwood Avenue to the west and Hamburg Turnpike to the south. Flooding in this area is caused by the Pompton River flows backing up the Pequannock River. To protect against flooding 1,600 feet of levees would be required. The levees would have an average height of 8.0 feet and base width of 48.0 feet. Internal drainage will be handled by pressure interceptors and/or pumping stations.

Hill Court System. The Hill Court System is located on the right bank of the Wanaque River in the Borough of Pompton Lakes. The system provides protection to the structures along Menderson and Hill Courts. Flooding in this area is caused by the Pompton River flows backing up the Wanaque River.

To protect this area against flooding 1,250 feet of levees and 625 feet of floodwall would be required. The levees and floodwalls would have an average height of 8.0 feet and the base width of the levee would be about 48.0 feet. Internal drainage will be handled by pressure interceptors and/or pumping stations.

Wanaque Avenue System. The Wanaque Avenue System is located on the left bank of the Wanaque River in the Broough of Pompton Lakes. This system would provide protection to the structures bounded by the Wanaque River and Wanaque Avenue downstream of the NYSWRR to Pompton Avenue. Flooding in this area is caused by the Pompton River flows backing up the Wanaque River.

To protect this area against flooding 1,550 feet of levee and 125 feet of floodwall would be required. The average heights of the levees and floodwall would be 10 feet. The average base width of the levee would be 58 feet. Internal drainage will be handled by pressure interceptors and/or pumping stations.

OPERATIONAL DETAILS OF THE TUNNEL

The purpose of the two tunnel diversion inlets is to divert flood flows away from the major Pompton Valley and Passaic Lower Valley damages areas by making more effective use of the tunnel by taking advantage of the difference in timing in the floodflows along the Pompton and Passaic Rivers.

Pompton River Inlet

As previously discussed the Pompton River inlet consists of 3 major elements: (1) a river flow restrictor; (2) a gated diversion spillway; and (3) a morning glory diversion spillway. The river flow restrictor has 1 permanent opening and four gated openings. The purpose of the permanent opening is to permit a constant flow of water downstream during non-flood periods up to the 1 year event. When the one year event is exceeded the river flow restrictor would cause water to pond behind the structure. Once the ponded water obtains an elevation sufficient to flow into the morning glory inlet basin, the taintor gates on the diversion spillway are raised. These taintor gates would otherwise be closed at all times and no diversion of flows would occur. The morning glory diversion spillway is contained in a basin lower in elevation than the river channel. This allows the diversion of floodflows without increasing flood stages. Should floodflows exceed the 100-year event, the capacity of the tunnel, the four gated openings on the river flow restrictor would be opened in order to pass the larger flows and also to maintain maximum diversion through the tunnel.

Two Bridges Inlet

The major element of the Two Bridges Inlet consists of (1) a morning glory diversion spillway. When floodwaters begin to exceed the 1 year flow the gates on the diversion spillway would begin to open allowing flows to enter the morning glory inlet. When floodflows are larger than the capacity of the tunnel, the excess flows would continue downstream. This method of operation is necessary to approximate the water surface elevations in the Great Piece Meadows. When the 1 year flood is exceeded, the gates would be raised so that floodwater can be efficiently directed to the tunnel inlet via the upstream channel transition on the Passaic and Pompton Rivers.

CONSTRUCTION OF THE DUAL INLET TUNNEL

As previously discussed this plan combines: surface works consisting of channel modifications, levee/floodwall elements, inlet and outlet works and a river flow restrictor; and subsurface works consisting of tunnel excavation. The surface works will be constructed through traditional methods, while the tunnel construction would utilize specialized methods.

As shown on Figures P1 and P2, the tunnel would be constructed at an elevation lower than its outlet structure to a depth necesary to reach competent rock which would allow underground construction. In this situation, those occupants located above the route would not be physically aware of the tunnel construction except at the inlet, outlet and construction shaft locations. It has been determined that the most efficient way to construct the 13.6 mile, 40 feet diameter tunnel and the 1.25 mile, 30 feet diameter spur would be through the use of a tunnel boring machine (TBM). The TBM would be used throughout except in the excavation of the vertical inlets and outlet, and 2 construction shafts which will utilize conventional excavation methods.

One construction shaft would be located in an abandoned quarry site northeast of the Cedar Grove Reservoir. The other shaft would be located south of Preakness Valley Park in Wayne, in an area which is contiguous to a business and warehouse district. Both these shafts would be used as staging areas during construction and as maintenance access during the life of the project. It is estimated that approximately 4,100,000 cubic yards of rock would be excavated as part of the main and spur tunnels. There would be no problem in disposing of this material since it is highly marketable and non contaminated. As part of the surface works, approximately 1,500,000 cubic yards of earth would be excavated. A portion of this material would be marketable. Materials not marketable would have to be disposed of in suitable disposal areas.

Under these conditions, the construction time for this tunnel is estimated to be 77 months.

OPERATION AND MAINTENANCE OF THE DUAL INLET TUNNEL PLAN

After completion of the project, operation and maintenance of project facilities and related mitigation measures would be performed by the local cooperating agency in accordance with government regulations. Depending upon the project feature under consideration either periodic or annual maintenance would be required. As part of this plan periodic inspection of the tunnel structure, and testing of mechanical equipment at gated structures and pump stations would be required. Annual maintenance activities required to maintain the remaining project elements would consist of: debris removal at interior drainage facilities and tunnel inlets and outlet structures; shoal removal, riprap repair, trash pickup, brush and tree control in the modified channels; repair and patching of concrete structures; mowing, trash pickup, and weed control along levees and ponding areas.

The water surface elevations for events of one year or less occurrence will be virtually the same for Great Piece Meadows under existing conditions and with the spur tunnel-dual inlet plan.

The measures under consideration to mitigate the environmental effects of this plan include the following:

a. To maintain the wetlands along the Passaic, specifically the Great Piece Meadows, the operating rule as established will maintain a flow over Beatties Dam of 100 cfs and current water levels as it relates to tunnel operation. Additionally, a weir is being investigated for use in the Great Piece Meadows to maintain a water surface elevation of about a 164 feet (annual flood stage) during flooding event and possibly at other times to help maintain wetlands in these meadows.

b. Channel modification reaches will provide adequate water depths to maintain passage by fish.

c. Channel meanders in modified channel reaches will be maintained where compatible with sound engineering practices and design.

d. Channel modification reaches will provide for aquatic habitat structures where feasible.

e. Erosion control methods will be used during construction, using techniques similar to those utilized by the Soil Conservation Service.

f. Banks susceptible to erosion will be protected with riprap.

g. Riparian vegetation will be maintained where compatible with the project.

h. Areas disturbed during construction will have vegetation planted in the first growing season.

i. Topsoil will be replaced to levels present under existing conditions.

j. The diversion structures located at the Pompton and Two Bridges Inlets will be sized to pass non-flood discharges up to the 1 year flood.

k. Present modal flows will be maintained.

DUAL INLET
LEVEE/FLOODWALL PHYSICAL FEATURES TABLE (CONT)

System	Map #	Municipality	Bank	LEVEE Avg. Ht. (ft.)	LEVEE Avg. Base Width (ft.)	LEVEE Length (ft.)	FLOODWALL Avg. Ht. (ft.)	FLOODWALL Length (ft.)
CENTRAL BASIN								
Passaic R. #2A	9,10 34,11	Fairfield W. Caldwell	Right	9.5 11.0	67.0 76.0	46,000 2,000	12.5	700
Passaic R. #2C	34	Fairfield W. Caldwell	Right	6.0 6.0	46.0 46.0	2,000 1,580	7.0	1,000
Passaic R. #10	12	Livingston	Right	8.5	61.0	4,250		
Rockaway R. #1	21,11	Parsippany	Right	8.5	61.0	3,600		
Rockaway R. #2	21,11	Montville	Left	7.5	55.0	5,400		
Rockaway R. #3	21,22	Parsippany	Right	7.5	55.0	4,700		
Pinch Brook	38	E. Hanover	Right	9.5	67.0	2,000		
POMPTON-PEQUANNOCK-WANAQUE								
Shore Road	33,40	Wayne	Left	3.5	31.0	4,000	5.0	625
Turnpike #1	40	Wayne	Left	4.0	34.0	1,750	5.5	150
Turnpike #2	40	Wayne	Left	8.5	61.0	1,250	8.0	300
Stiles Ct.	40	Pompton Lakes	Right	8.0	58.0	1,600		
Harrison-William	40	Pequannock Riverdale	Right	5.0	40.0	4,100	8.5	1,000
Pequannock-Ramapo	40	Pompton Lakes	Peq-Left Wan-Right	6.5	49.0	10,200	7.5	500
Albany Ave.	40	Pompton Lakes	Left	7.0	52.0	2,500		
Hill Ct.	40	Pompton Lakes	Right	8.0	58.0	1,250	8.0	625
Wanaque Ave.	40	Pompton Lakes	Left	10.0	70.0	1,550	11.0	125

DUAL INLET
LEVEE/FLOODWALL PHYSICAL FEATURES TABLE

System	Map #	Municipality	Bank	Avg. Ht. (ft.)	Avg. Base Width (ft.)	Length (ft.)	Avg. Ht. (ft.)	Length (ft.)
LOWER VALLEY								
Kearny Point	1	Kearny	Left	8.5	61.0	14,150	8.0	17,600
Doremus Ave.	1	Newark	Right	7.5	55.0	2,000	8.0	2,120
Turnpike	1	Newark	Right	8.0	58.0	1,200	7.0	1,250
Lister Ave.	1,2	Newark	Right	7.0	52.0	4,275	8.5	3,300
South 1st St.	2	Harrison	Left	7.0	52.0	3,450	8.5	2,570
Main St.	3	Belleville	Right	7.5	55.0	3,250	10.0	4,950
River Road #1	3	N. Arlington	Left	8.0	58.0	2,000		
Riverside Ave. #1	3,4	Lyndhurst, NA	Left	13.0	88.0	5,000	11.0	350
River Road #2	3	Belleville Nutley	Right	7.5	55.0	5,750	9.0	4,100
River St.	4	E. Rutherford	Left	6.0	46.0	3,370	8.0	700
River Drive #1	4,5	City of Passaic	Right	7.5	55.0	1,790	6.0	1,660
Main Ave.	4	Wallington	Left	8.0	58.0	2,730	8.5	3,630
Yantacaw	4	Clifton	Third R.	13.5	91.0	2,750	12.0	320
Riverside Ave. #2	4	Rutherford	Left	9.5	67.0	4,335	8.0	2,375
8th St.	5	City of Passaic	Right	10.0	70.0	3,050	10.0	10,170

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, N. Y. 10278 -0090

REPLY TO
ATTENTION OF:
Passaic River Basin and Special Studies Branch

Mr. Charles Kulp
U.S. Department of Interior
Fish and Wildlife Service
Suite 322
315 South Allen Street
State College, Pennsylvania 16801-4832

Dear Mr. Kulp:

Reference is made to your letter of March 13, 1985, and the subsequent telephone communications between Mr. Cliff Day and Mr. Bill Zinni of your Absecon Sub-Field Office staff. That letter requested specific flood control, engineering and base year projection information.

We have sent your staff water surface elevation data for selected river points. The data are for existing conditions and future with the project conditions as requested in question 2 of your letter. We have also responded to item 7 by mailing the Hydraulics and Hydrology Appendices from the June 1983, Stage 2 Report to Dave Westerling in Newton Corner, Massachussetts. We will continue to respond to the balance of the issues you raised by telephone, with the exception of item 8 which is addressed below.

Item 8 is discussed in this letter in order to expedite the completion of the Planning Aid Report by May 15, 1985.

The following information for the 1990 base year is answered in the order in which the questions were presented in your letter.

- water quality deterioration - Water quality is expected to change by the base year due to continued development. Point source pollution including coliform bacteria, phosphates and nitrates are expected to decline as a result of sewage treatment improvements, however, continued development will lead to increases in non-point source pollution such as nitrates, phosphates, salts, petroleum products and sediment. The specific changes cannot be forecast.

- watershed runoff and watershed discharge - It is anticipated that both these elements will increase as a result of expected development.

- development - Development will continue to adversely affect wildlife habitat in various covertypes including wetlands.

- human population - Basinwide, human population will continue to increase at a rate of about 0.4%. This is a slower rate than the 1960's. In the Lower Valley little change is expected, but population increases in the Central Basin, which is relatively undeveloped will be at a higher rate than the basinwide average.

- land use development projections - The basinwide rate of increase will approach 1% per year, but as with human population, a proportionally larger amount will occur in the less densely developed Central Basin.

Our analysis of the trends in development indicates that an additional 500 acres of natural storage area will be lost by 1990. Furthermore, the "without project" projections between 1990 and 2040 indicate that an additional 3050 acres of natural storage will be developed, assuming current regulations (e.g., 20% fill rule) remain in effect.

If you require further details or information please contact Robert J. Kurtz of the Passaic River Basin and Special Studies Branch at 212/264-3609.

Samuel P. Tosi

Samuel P. Tosi, P.E.
Chief, Planning Division

APPENDIX B

COORDINATION BETWEEN THE FISH AND WILDLIFE
SERVICE AND THE NEW JERSEY DIVISION OF
FISH, GAME AND WILDLIFE
(Service letters of June 30, 1986 and September 19, 1986 and
Division reponse, dated October 23, 1986)

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
P.O. Box 534
705 White Horse Pike
Absecon, New Jersey 08201

June 30, 1986

Mr. Russell A. Cookingham, Director
New Jersey Division of Fish, Game
and Wildlife
P.O. Box CN 400
Trenton, New Jersey 08625

Dear Mr. Cookingham:

As you know, the Fish and Wildlife Service (Service) has been involved with a U.S. Army, Corps of Engineers' (Corps) flood control and water management project in the Passaic River basin for the past eight years. Under the Fish and Wildlife Coordination Act we are responsible for determining potential adverse impacts to fish and wildlife resources that could result from project implementation. Up to now we have submitted over 30 technical reports to the Corps regarding baseline aquatic and terrestrial resources and alternative and selected flood control plans. The New Jersey Division of Fish, Game and Wildlife has been extremely helpful in providing technical assistance during the assessment of these plans.

In 1985, we evaluated subsurface tunnel diversion systems and submitted a planning aid report to the Corps based upon our findings. This year the Corps has selected a modified version of the "dual inlet tunnel diversion plan." Overall, this plan would require the construction of over 14 miles of 30- and 40-foot diameter tunnels from the Pompton River down to the Passaic/Third River confluence. Additionally, plan implementation also requires the construction of levees and floodwalls. Obviously, we are concerned about the secondary impacts to the wetlands ecosystem that may result from project construction. A substantial amount of the central Passaic wetlands could be directly and indirectly impacted by project implementation since the normal flow regimes that inundate wetlands could be restricted. Our 1985 assessment of the dual inlet tunnel diversion plan identified approximately 4,200 acres of wetlands that could be adversely impacted. However, we expect less wetland impacts with the modified plan.

In order to fully evaluate the impacts to fish and wildlife resources that may result from project implementation, it will be necessary to have input from the Bureaus of Wildlife Management and Freshwater Fisheries, the Division's Office of Environmental Review and the Endangered and Non-game Species Program. As you know, Messrs. Andy Didun and Lee Widjeskog participated in a June 27, 1986 meeting with the Corps and along with other key Division staff (A. Bruce Pyle, Robert Papson, James Sciascia) have been provided with a complete set of project plans, including maps.

The mutual interest in the conservation of the fish and wildlife resources and their habitats of the Passaic River basin certainly warrants our cooperative effort to assess the environmental impacts associated with the proposed dual inlet tunnel diversion plan. Our continuing coordination will insure that habitat management objectives and decisions, including mitigation based upon project impacts, would be compatible with and reflect the objectives and interests of the Division. Additionally, by copy of this letter, we are also requesting that the Green Acres Program coordinate with us during project assessment since state owned lands in the central Passaic wetlands or lands under investigation for state acquisition may be impacted. As part of the selected plan the Corps is proposing acquisition of fringe wetland areas. Therefore, we would like to determine what land areas in the central Passaic River basin wetlands are currently in or are being proposed for state ownership or are in private ownership for conservation purposes (e.g., Wildlife Preserves).

As usual we are working under a time constraint. Due to the untimely death of Ms. Alice Nichols, who was the project biologist for the Passaic River basin study, I have been detailed to Absecon from our central office in Washington, D.C. in order to coordinate the Service's review of the dual inlet tunnel diversion plan. We must assess this plan and prepare a Fish and Wildlife Coordination Act report by the end of August, 1986. Therefore, I will be coordinating the review of the tunnel plan with your staff through the Division's Office of Environmental Review during the summer.

The Service has recommended to the Corps that Habitat Evaluation Procedures (HEP) be used to evaluate fish and wildlife losses and gains that are expected to result from project implementation. The HEP would provide a scientific basis for determining wildlife habitat compensation requirements and hence, the formulation of a mitigation plan. Mr. Charles J. Kulp (Field Supervisor, State College, Pa.) will be contacting you in the near future to discuss the planned HEP and the Division's participation.

Your Division's technical assistance and cooperation during the review of the dual inlet tunnel diversion plan is greatly appreciated. I look forward to working in the State of New Jersey with your staff during the forthcoming summer months. If you have any questions regarding this matter, please do not hesitate to contact me. I am available at (609)-646-9310.

Sincerely,

Clifford G. Day
Fish and Wildlife Biologist

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Suite 322
315 South Allen Street
State College, Pennsylvania 16801

September 19, 1986

Mr. Russell Cookingham, Director
New Jersey Division of Fish, Game
and Wildlife
P.O. Box CN 400
Trenton, New Jersey 08625

Dear Russ:

Four copies of the proposed draft Fish and Wildlife Coordination Act report on the Passaic River "Tunnel Plan" are enclosed for your review and comment. We would appreciate your views as soon as possible. Your letter of comment will be included in the report.

The report has been coordinated with your Bureaus of Freshwater Fisheries and Wildlife Management and the Endangered and Non-Game Species Program. As usual, your staff has been very cooperative and helpful. If you have any questions, please call us.

Sincerely,

Charles J. Kulp
Field Supervisor

Enclosure

DIVISION OF
FISH, GAME AND WILDLIFE
RUSSELL A. COOKINGHAM
DIRECTOR

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

PLEASE REPLY TO:
CN 400
TRENTON, NEW JERSEY 08625

October 23, 1986

Charles Kulp, Field Supervisor
U.S. Fish and Wildlife Service
Suite 322
315 South Allen Street
State College, PA 16801

Dear Mr. Kulp:

This letter serves to inform you that the Division of Fish, Game and Wildlife conceptually concurs with the information and recommendations provided in the "Draft - Section 2 (b) Report for the Passaic River Basin Study, Analysis of the Corps of Engineers' Selected Flood Control Project for the Central and Lower Passaic River Basin Study Area: Dual Inlet Tunnel Diversion Plan, by the U.S. Fish and Wildlife Service, September 1986". However, due to the potential adverse impacts this project could have on the central and lower Passaic Basin, we feel the need to emphasize certain points and provide additional comments/recommendations.

As a general evaluation, the Division considers the document to accurately reflect fish and wildlife resource information except for the following minor comments.

1. Page 25, Pompton River. The Division does not believe the two sample stations should be rated based on only one sample. Our regional fisheries biologist believes that the Jackson Avenue site is as good if not better than the Route 202 site relative to habitat/water quality.

2. Page 28, anadromous fish. The Bureau of Freshwater Fisheries points out that striped bass (Morone saxatilis) was also taken in this reach of the Passaic River in the referred study by Papson. Striped bass should be added to the list of anadromous species.

3. Page 40, Ramapo River. The text lists "white sucker, smallmouth bass and blue gill" as "fish typical of impounded areas". Although white sucker and smallmouth bass are found in impoundments, they are common lotic inhabitants also. We suggest the phase "fish typical of impounded areas" be omitted.

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4. Page 47, Pompton River. This section omitted mentioning that trout stocking of the Pompton River would be expected to continue in 2040 "future-without-project".

MAJOR ISSUES

While we fully concur with the specific and general recommendations of the document (pages 127 thru 151), the following comments are presented to emphasize and compliment the major topics that surfaced as a result of the current tunnel plan proposal.

Destructive to fish/wildlife resources

As indicated in the "General Evaluation of Section 5. Recommendations" (p. 127), the Division emphasizes and agrees that the proposal will be destructive to fish/wildlife resources. Significant negative impacts will result from 4.9 miles of channelization/levee construction/ commplete vegetation removal along the Pequannock, Ramapo and Wanaque Rivers above the proposed 39-foot diameter inlet. Destruction of the river channels and riparian areas will also create a loss of parklands already established along some reaches of the waterways (e.g. along the Ramapo River). Therefore, the Division concurs with the document's recommendations (pages 132,150) to redesign the proposal to reduce the linear upstream extent of impacts, retain more vegetative cover types and create emergent/scrub shrub wetlands where possible. Effected channelized areas should also be redesigned to incorporate in-stream fish habitat structures. In-stream habitat designs should also be considered in the channelized reaches above the spur tunnel inlet.

Other negative impacts will result from levee construction throughout the central/lower basin. The Divisions first concern is for the "ponding areas" and wetlands left segregated by the levees from the main body of wetlands/floodplain. It is recommended that they be acquired and managed for wildlife. Our second concern is that the levees be setback from the rivers to allow for a wildlife/vegetative community corridor and access by resource users. This concurs with recommendations on pages 141 to 150. In addition we note that not only should existing boat ramps be identified and incorporated in the final design of the levee/floodwall systems (page 142), but also that linear parks along the Passaic River be identified and maintained. Additional boat ramps, fishing piers and other access points should also be considered.

The Division also points out pages 94 and 127 of the document discuss the fact that thousands of acres of wetlands may be negatively impacted if tunnel operations are improperly handled. The Division would like to see designs that might be incorporated into the project scope which would insure proper tunnel operation. The Division concurs with recommendations (pages 127, 140-141) to construct a low-head weir to maintain water elevation and wetland habitat in Great Piece Meadows.

Acquisition of natural storage areas (approximately 5,350 acres)

The Division considers the acquisition and preservation of natural flood storage areas (pages 143 thru 147) in the Passaic Basin to be essential. In fact regardless as to whether the tunnel project is implemented these areas should be preserved. We agree with the USFWS that if acquisition of these areas does not occur, many of the areas would eventually be developed (p. 128).

As indicated on page 128, strict enforcement of the Clean Water Act, acquisition of flood storage areas, floodplain reclamation, development of a comprehensive wetland management plan and development of a non-structural flood/water management plans are all key elements in protecting fish/wildlife resources, reducing flooding problems and making the tunnel plan functionally viable. The Division would also like to add that an immediate moratorium on developing the proposed acquisition lands be recommended. Furthermore, developing wetlands and floodplains of all headwater areas of the Passaic River itself as well as its major sub-basins should also cease in order to not overload the central basin storage areas in the future. Such development could jeopardize the adequate functioning of the tunnels. Acquisition of these additional areas should be considered.

Floodplain reclamation

The Division notes that floodplain reclamation appears in various sections of "Section 5.0-Recommendations" (pages 128; 135, item #2; 137, item #8; 145,, item #5). We suggest that reclaiming floodplain areas may be a non-structural answer to reducing the scope of the tunnel plan/levee system when used to buy-out selected areas. We suggest that when used in conjunction with the acquisition of natural storage areas, acquiring the most flood prone areas would reduce flooding problems and provide open space easements for fish/wildlife and resource users. If done by using set-backs (off-channel) levees to protect the less flood-prone developments, this would help alleviate the annual burden of $76 million due to flood damage in the Passaic Basin. (We note that a DEP update of August 25, 1986 has the annual damage at $77.8 million). Considering these costs plus the cost to taxpayers and insurance companies over the years until the tunnel plan is implemented, we suggest that a positive cost/benefit may be achieved which would make a selective buy-out program feasible. We believe that this avenue should be further investigated.

Miscellaneous

1. The Division notes its agreement with the mitigation recommendations (pages 147-148).

2. We concur with the recommendations to have in-stream flow studies done on the channelized sections of the Pequannock, Wanaque, Ramapo, Pompton and Passaic Rivers. In addition, we agree that a Habitat Evaluation Procedure (HEP) be done to quantify habitat losses due to project implemention. However, we note that if the Division of Fish, Game and Wildlife is a participant of a HEP team, financial assistance from the Corps will be needed to fund the manpower/time used to participate in such an extensive survey.

3. The Division notes that acquisition areas and the destruction of some rivers/stream corridors will impact lands purchased with state acquisition and Green Acres monies. Close coordination with the state and municipal agencies involved will be necessary. We refer you the response letter in Appendix E.

We hope these comments are of service to you. Should you have any questions, feel free to contact us.

Very truly yours,

Russell A. Cookingham
Director

RAC/AD/sk

c H. Fenske
G. Howard
H. Lechner
A. Didun
L. Widjeskog
C. Day (USFWS)

APPENDIX C

LIST OF FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES IN NEW JERSEY

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

Common Name	Scientific Name	Status	Distribution
FISHES:			
Sturgeon, shortnose*	Acipenser brevirostrum	E	Hudson and Delaware Rivers plus other Atlantic coastal rivers
REPTILES:			
Turtle, green*	Chelonia mydas	T	Oceanic summer visitor coastal waters
Turtle, hawksbill*	Eretmochelys imbricata	E	Oceanic summer visitor coastal waters
Turtle, leatherback*	Dermochelys coriacea	E	Oceanic summer visitor coastal waters
Turtle, loggerhead*	Caretta caretta	T	Oceanic summer resident coastal waters rarely nests: Cape May and Atlantic Counties
Turtle, Atlantic ridley*	Lepidochelys kempii	E	Oceanic summer resident coastal waters
BIRDS:			
Eagle, bald	Haliaeetus leucocephalus	E	Entire state
Falcon, American peregrine	Falco peregrinus anatum	E	Entire state - re-establishment to former breeding range in progress
Falcon, Arctic	Falco peregrinus tundrius	E	Entire state migratory -
Plover, Piping	Charadrius melodus	T	no nesting Coastal beaches from Monmouth to Cape May Cour
MAMMALS:			
Cougar, eastern	Felis concolor cougar	E	Entire state - probably extinct
Whale, blue*	Balaenoptera musculus	E	Oceanic
Whale, finback*	Balaenoptera physalus	E	Oceanic
Whale, humpback*	Megaptera novaeangliae	E	Oceanic
Whale, right*	Eubalaena spp. (all species)	E	Oceanic
Whale, sei*	Balaenoptera borealis	E	Oceanic
Whale, sperm*	Physeter catodon	E	Oceanic
MOLLUSKS:			
None			
PLANTS:			
Small whorled pogonia	Isotria medeoloides	E	Bergen (Franklin Lakes, Closter), Mercer (Trenton), & Sussex (Montague, Sparta, Hainesville) Counties

*Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

APPENDIX D

U.S. FISH AND WILDLIFE SERVICE MITIGATION POLICYY
(Federal Register/Vol. 46, No. 15/January 23, 1981.
pp. 7656-7660)

U.S. FISH AND WILDLIFE SERVICE MITIGATION POLICY

I. PURPOSE

This document establishes policy for U.S. Fish and Wildlife Service recommendations on mitigating the adverse impacts of land and water developments on fish, wildlife, their habitats, and uses thereof. It will help to assure consistent and effective recommendations by outlining policy for the levels of mitigation needed and the various methods for accomplishing mitigation. It will allow Federal action agencies and private developers to anticipate Service recommendations and plan for mitigation measures early, thus avoiding delays and assuring equal consideration of fish and wildlife resources with other project features and purposes. This policy provides guidance for Service personnel but variations appropriate to individual circumstances are permitted.

This policy supersedes the December 18, 1974, policy statement entitled "Position Paper of the Fish and Wildlife Service Relative to Losses to Fish and Wildlife Habitat Caused by Federally Planned or Constructed Water Resource Developments" and the Service River Basin Studies Manual Release 2.350 entitled "General Bureau Policy on River Basin Studies."

II. AUTHORITY

This policy is established in accordance with the following major authorities: (See Appendix A for other authorities.)

Fish and Wildlife Act of 1956 (16 U.S.C. 742(a)–754). This Act authorizes the development and distribution of fish and wildlife information to the public, Congress, and the President, and the development of policies and procedures that are necessary and desirable to carry out the laws relating to fish and wildlife including: (1) ". . . take such steps as may be required for the development, advancement, management, conservation, and protection of the fisheries resources;" and (2) ". . . take such steps as may be required for the development, management, advancement, conservation, and protection of wildlife resources through research . . . and other means."

Fish and Wildlife Coordination Act (16 U.S.C. 661–667(e)). This Act authorizes the U.S. Fish and Wildlife Service, National Marine Fisheries Service (NMFS), and State agencies responsible for fish and wildlife resources to investigate all proposed Federal undertakings and non-Federal actions needing a Federal permit or license which would impound, divert, deepen, or otherwise control or modify a stream or other body of water and to make mitigation and enhancement recommendations to the involved Federal agency. "Recommendations . . . shall be as specific as practicable with respect to features recommended for wildlife conservation and development, lands to be utilized or acquired for such purposes, the results expected, and shall describe the damage to wildlife attributable to the project and the measures proposed for mitigating or compensating for these damages." In addition, the Act requires that wildlife conservation be coordinated with other features of water resource development programs.

Determinations under this authority for specific projects located in estuarine areas constitute compliance with the provisions of the Estuary Protection Act. (See Appendix A.)

Watershed Protection and Flood Prevention Act (16 U.S.C. 1001–1009). This Act allows the Secretary of the Interior to make surveys, investigations, and ". . . prepare a report with recommendations concerning the conservation and development of wildlife resources . . ." on small watershed projects.

National Environmental Policy Act of 1969 (42 U.S.C. 4321–4347). This Act and its implementing regulations (40 CFR Part 1500–1508) requires that the U.S. Fish and Wildlife Service be notified of all major Federal actions affecting fish and wildlife resources and their views and recommendations solicited. Upon completion of a draft Environmental Impact Statement, the Service is required to review it and make comments and recommendations, as appropriate. In addition, the Act provides that "the Congress authorizes and directs that, to the fullest extent possible . . . all agencies of the Federal Government shall . . . identify and develop methods and procedures . . . which will ensure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations."

III. SCOPE

A. Coverage

This policy applies to all activities of the Service related to the evaluation of impacts of land and water developments and the subsequent recommendations to mitigate those adverse impacts except as specifically excluded below. This includes: (1) investigations and recommendations for all actions requiring a federally issued permit or license that would impact waters of the U.S.; (2) all major Federal actions significantly affecting the quality of the human environment; and (3) other Federal actions for which the Service has legislative authority or executive direction for involvement including, but not limited to: coal, minerals, and outer continental shelf lease sales or Federal approval of State permit programs for the control of discharges of dredged or fill material.

B. Exclusions

This policy does not apply to threatened or endangered species. The requirements for threatened and endangered species are covered in the Endangered Species Act of 1973 and accompanying regulations at 50 CFR Parts 17, 402, and 424. Under Section 7 of the Endangered Species Act, as amended, all Federal agencies shall ensure that activities authorized, funded, or carried out by them are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. Mitigating adverse impacts of a project would not in itself be viewed as satisfactory agency compliance with Section 7. Furthermore, it is clear to the Service that Congress considered the traditional concept of mitigation to be inappropriate for Federal activities impacting listed species or their critical habitat.

This policy does not apply to Service recommendations for Federal projects completed or other projects permitted or licensed prior to enactment of Service authorities (unless indicated otherwise in a specific statute) or specifically exempted by them and not subject to reauthorization or renewal. It also does not apply where mitigation plans have already been agreed to by the Service, except where new activities or changes in current activities would result in new impacts or where new authorities, new scientific information, or developer failure to implement agreed upon recommendations make it necessary. Service personnel involved in land and water development investigations will make a judgment as to the applicability of the policy for mitigation plans under development and not yet agreed upon as of the date of final publication of this policy.

Finally, this policy does not apply to Service recommendations related to the enhancement of fish and wildlife resources. Recommendations for measures which improve fish and wildlife resources beyond that which would exist without the project and which cannot be used to satisfy the

appropriate mitigation planning goal should be considered as enhancement measures. The Service strongly supports enhancement of fish and wildlife resources. The Service will recommend that all opportunities for fish and wildlife resource enhancement be thoroughly considered and included in project plans, to the extent practicable.

IV. DEFINITION OF MITIGATION

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act regulations to include: "(a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments." (40 CFR Part 1508.20(a–e)).

The Service supports and adopts this definition of mitigation and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process. (See Appendix B for definitions of other important terms necessary to understand this policy.)

V. MITIGATION POLICY OF THE U.S. FISH AND WILDLIFE SERVICE

The overall goals and objectives of the Service are outlined in the Service Management Plan and an accompanying Important Resource Problems document which describes specific fish and wildlife problems of importance for planning purposes. Goals and objectives for Service activities related to land and water development are contained in the Habitat Preservation Program Management Document. The mitigation policy was designed to stand on its own; however, these documents will be consulted by Service personnel to provide the proper perspective for the Service mitigation policy. They are available upon request from the Director, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

A. General Policy

The mission of the U.S. Fish and Wildlife Service is to:

PROVIDE THE FEDERAL LEADERSHIP TO CONSERVE, PROTECT AND ENHANCE FISH AND WILDLIFE AND THEIR HABITATS FOR THE CONTINUING BENEFIT OF THE PEOPLE.

The goal of Service activities oriented toward land and water development responds to Congressional direction that fish and wildlife resource conservation receive equal consideration and be coordinated with other features of Federal resource development and regulatory programs through effective and harmonious planning, development, maintenance and coordination of fish and wildlife resource conservation and rehabilitation in the United States, its territories and possessions. The goal is to:

CONSERVE, PROTECT AND ENHANCE FISH AND WILDLIFE AND THEIR HABITATS AND FACILITATE BALANCED DEVELOPMENT OF THIS NATION'S NATURAL RESOURCES BY TIMELY AND EFFECTIVE PROVISION OF FISH AND WILDLIFE INFORMATION AND RECOMMENDATIONS.

Fish and wildlife and their habitats are public resources with clear commercial, recreational, social, and ecological value to the Nation. They are conserved and managed for the people by State, Federal and Indian tribal Governments. If land or water developments are proposed which may reduce or eliminate the public benefits that are provided by such natural resources, then State and Federal resource agencies and Indian tribal agencies have a responsibility to recommend means and measures to mitigate such losses. Accordingly:

IN THE INTEREST OF SERVING THE PUBLIC, IT IS THE POLICY OF THE U.S. FISH AND WILDLIFE SERVICE TO SEEK TO MITIGATE LOSSES OF FISH, WILDLIFE, THEIR HABITATS, AND USES THEREOF FROM LAND AND WATER DEVELOPMENTS.

In administering this policy, the Service will strive to provide information and recommendations that fully support the Nation's need for fish and wildlife resource conservation as well as sound economic and social development through balanced multiple use of the Nation's natural resources. The Service will actively seek to facilitate needed development and avoid conflicts and delays through early involvement in land and water development planning activities in advance of proposals for specific projects or during the early planning and design stage of specific projects.

This should include early identification of resource areas containing high and low habitat values for important species and the development of ecological design information that outlines specific practicable means and measures for avoiding or minimizing impacts. The former can be used by developers to site projects in the least valuable areas. This could possibly lower total project costs to development interests. These actions are part of good planning and are in the best public interest.

The early provision of information to private and public agencies in a form which enables them to avoid or minimize fish and wildlife losses as a part of initial project design is the preferred form of fish and wildlife conservation.

B. U.S. Fish and Wildlife Service Mitigation Planning Goals by Resource Category

The planning goals and guidelines that follow will be used to guide Service recommendations on mitigation of project impacts. Four Resource Categories are used to indicate that the level of mitigation recommended will be consistent with the fish and wildlife resource values involved.

The policy covers impacts to fish and wildlife populations, their habitat and the human uses thereof. However, the primary focus in terms of specific guidance is on recommendations related to habitat value losses. In many cases, compensation of habitat value losses should result in replacement of fish and wildlife populations and human uses. But where it does not, the Service will recommend appropriate additional means and measures.

RESOURCE CATEGORY 1

a. Designation Criteria

Habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section.

b. Mitigation Goal

No Loss of Existing Habitat Value.

c. Guideline

The Service will recommend that all losses of existing habitat be prevented as these one-of-a-kind areas cannot be replaced. Insignificant changes that do not result in adverse impacts on habitat value may be acceptable provided they will have no significant cumulative impact.

RESOURCE CATEGORY 2

a. Designation Criteria

Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section.

b. Mitigation Goal

No Net Loss of In-Kind Habitat Value.

c. Guideline

The Service will recommend ways to avoid or minimize losses. If losses are likely to occur, then the Service will recommend ways to immediately rectify them or reduce or eliminate them over time. If losses remain likely to occur, then the Service will recommend that those losses be compensated by replacement of the same kind of habitat value so that the total loss of such in-kind habitat value will be eliminated.

Specific ways to achieve this planning goal include: (1) physical modification of replacement habitat to convert it to the same type lost; (2) restoration or rehabilitation of previously altered habitat; (3) increased management of similar replacement habitat so that the in-kind value of the lost habitat is replaced, or (4) a combination of these measures. By replacing habitat value losses with similar habitat values, populations of species associated with that habitat may remain relatively stable in the area over time. This is generally referred to as in-kind replacement.

Exceptions: An exception can be made to this planning goal when: (1) different habitats and species available for replacement are determined to be of greater value than those lost, *or* (2) in-kind replacement is not physically or biologically attainable in the ecoregion section. In either case, replacement involving different habitat kinds may be recommended provided that the total value of the habitat lost is recommended for replacement (see the guideline for Category 3 mitigation below).

RESOURCE CATEGORY 3

a. Designation Criteria

Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis.

b. Mitigation Goal

No Net Loss of Habitat Value While Minimizing Loss of In-Kind Habitat Value.

c. Guideline

The Service will recommend ways to avoid or minimize losses. If losses are likely to occur, then the Service will recommend ways to immediately rectify them or reduce or eliminate them over time. If losses remain likely to occur, then the Service will recommend that those losses be compensated by replacement of habitat value so that the total loss of habitat value will be eliminated.

It is preferable, in most cases, to recommend ways to replace such habitat value losses in-kind. However, if the Service determines that in-kind replacement is not desirable or possible, then other specific ways to achieve this planning goal include: (1) substituting different kinds of habitats, or (2) increasing management of different replacement habitats so that the value of the lost habitat is replaced. By replacing habitat value losses with different habitats or increasing management of different habitats, populations of species will be different, depending on the ecological attributes of the replacement habitat. This will result in no net loss of total habitat value, but may result in significant differences in fish and wildlife populations. This is generally referred to as out-of-kind replacement.

RESOURCE CATEGORY 4

a. Designation Criteria

Habitat to be impacted is of medium to low value for evaluation species.

b. Mitigation Goal

Minimize Loss of Habitat Value.

c. Guideline

The Service will recommend ways to avoid or minimize losses. If losses are likely to occur, then the Service will recommend ways to immediately rectify them or reduce or eliminate them over time. If losses remain likely to occur, then the Service may make a recommendation for compensation, depending on the significance of the potential loss.

However, because these areas possess relatively low habitat values, they will likely exhibit the greatest potential for significant habitat value improvements. Service personnel will fully investigate these areas' potential for improvement, since they could be used to mitigate Resource Category 2 and 3 losses.

C. Mitigation Planning Policies

1. State-Federal Partnership

a. The U.S. Fish and Wildlife Service will fully coordinate activities with those State agencies responsible for fish and wildlife resources, the National Marine Fisheries Service (NMFS) and the Environmental Protection Agency (EPA) related to the investigation of project proposals and development of mitigation recommendations for resources of concern to the State, NMFS or EPA.

b. Service personnel will place special emphasis on working with State agencies responsible for fish and wildlife resources, NMFS and EPA to develop compatible approaches and to avoid duplication of efforts.

2. Resource Category Determinations

a. The Service will make Resource Category determinations as part of the mitigation planning process. Such determinations will be made early in the planning process and transmitted to the Federal action agency or private developer to aid them in their project planning, to the extent practicable.

b. Resource Category determinations will be made through consultation and coordination with State agencies responsible for fish and wildlife resources and other Federal resource agencies, particularly the National Marine Fisheries Service and the Environmental Protection Agency, whenever resources of concern to those groups are involved. Where other elements of the public, including development groups, have information that can assist in making such determinations, the Service will welcome such information.

c. All Resource Category determinations will contain a technical rationale consistent with the designation criteria. The rationale will: (1) outline the reasons why the evaluation species were selected; (2) discuss the value of the habitat to the evaluation species; and (3) discuss and contrast the relative scarcity of the fish and wildlife resource on a national and ecoregion section basis.

Note.—If the State agency responsible for fish and wildlife resources wishes to outline scarcity on a more local basis, U.S. Fish and Wildlife Service personnel should assist in developing such rationale, whenever practicable.

d. When funding, personnel, and available information make it practicable, specific geographic areas or, alternatively, specific habitat types that comprise a given Resource Category should be designated in advance of development. Priority for predesignation will be placed on those areas that are of high value for evaluation species and are subject to development pressure in the near future. Such predesignations can be used by developers or regulators to determine the least valuable areas for use in project planning and siting considerations.

e. The following examples should be given special consideration as either Resource Category 1 or 2:

(1) Certain habitats within Service-identified Important Resource Problem (IRP) areas. Those IRPs dealing with threatened or endangered species are not covered by this policy. (See Scope)

(2) Special aquatic and terrestrial sites including legally designated or set-aside

areas such as sanctuaries, fish and wildlife management areas, hatcheries, and refuges, and other aquatic sites such as floodplains, wetlands, mudflats, vegetated shallows, coral reefs, riffles and pools, and springs and seeps.

3. Impact Assessment Principles

a. Changes in fish and wildlife productivity or ecosystem structure and function may not result in a biologically adverse impact. The determination as to whether a biological change constitutes an adverse impact for which mitigation should be recommended is the responsibility of the Service and other involved Federal and State resource agencies.

b. The net biological impact of a development proposal (or alternatives) is the difference in predicted biological conditions between the future with the action and the future without the action. If the future without the action cannot be reasonably predicted and documented by the project sponsor, then the Service analysis should be based on biological conditions that would be expected to exist over the planning period due to natural species succession or implementation of approved restoration/improvement plans or conditions which currently exist in the planning area.

c. Service review of project impacts will consider, whenever practicable:

(1) The total long-term biological impact of the project, including any secondary or indirect impacts regardless of location; and (2) any cumulative effects when viewed in the context of existing or anticipated projects.

d. The *Habitat Evaluation Procedures* will be used by the Service as a basic tool for evaluating project impacts and as a basis for formulating subsequent recommendations for mitigation subject to the exemptions in the Ecological Services Manual (100 ESM 1). When the *Habitat Evaluation Procedures* do not apply, then other evaluation systems may be used provided such use conforms with policies provided herein.

e. In those cases where instream flows are an important determinant of habitat value, consideration should be given to the use of the Service's Instream Flow Incremental Methodology to develop instream flow mitigation recommendations, where appropriate.

f. Where specific impact evaluation methods or mitigation technologies are not available, Service employees shall continue to apply their best professional judgment to develop mitigation recommendations.

4. Mitigation Recommendations

a. The Service may recommend support of projects or other proposals when the following criteria are met:

(1) They are ecologically sound;

(2) The least environmentally damaging reasonable alternative is selected;

(3) Every reasonable effort is made to avoid or minimize damage or loss of fish and wildlife resources and uses;

(4) All important recommended means and measures have been adopted with guaranteed implementation to satisfactorily compensate for unavoidable damage or loss consistent with the appropriate mitigation goal; and

(5) For wetlands and shallow water habitats, the proposed activity is clearly water dependent and there is a demonstrated public need.

The Service may recommend the "no project" alternative for those projects or other proposals that do not meet all of the above criteria and where there is likely to be a significant fish and wildlife resource loss.

b. Recommendations will be presented by the Service at the earliest possible stage of project planning to assure maximum consideration. The Service will strive to provide mitigation recommendations that represent the best judgment of the Service, including consideration of cost, on the most effective means and measures of satisfactorily achieving the mitigation planning goal. Such recommendations will be developed in cooperation with the Federal action agency or private developer responsible for the project, whenever practicable, and will place heavy reliance on cost estimates provided by that Federal action agency or private developer.

c. The Service will recommend that the Federal action agency include designated funds for all fish and wildlife resource mitigation (including, but not limited to, Service investigation costs, initial development costs and continuing operation, maintenance, replacement, and administrative costs) as part of the initial and any alternative project plans and that mitigation funds (as authorized and appropriated by Congress for Federal projects) be spent concurrently and proportionately with overall project construction and operation funds throughout the life of the project.

Note.—Prevention of losses may necessitate expenditure of funds at an earlier stage of project planning. This is acceptable and preferred.

d. Service mitigation recommendations will be made under an explicit expectation that these means and measures: (1) would be the ultimate responsibility of the appropriate Federal action agency to implement or enforce; and (2) would provide for a duration of effectiveness for the life of the project plus such additional time required for the adverse effects of an abandoned project to cease to occur.

e. Land acquisition in fee title for the purpose of compensation will be recommended by the Service *only* under one or more of the following three conditions:

(1) When a change in ownership is necessary to guarantee the future conservation of the fish and wildlife resource consistent with the mitigation goal for the specific project area; *or*

(2) When other means and measures for mitigation (see Section 5 below) will not compensate habitat losses consistent with the mitigation goal for the specific project area; *or*

(3) When land acquisition in fee title is the most cost-effective means that may partially or completely achieve the mitigation goal for the specific project area.

Service recommendations for fee title land acquisition will seek to identify mitigation lands with marginal economic potential.

f. First priority will be given to recommendation of a mitigation site within the planning area. Second priority will be given to recommendation of a mitigation site in proximity to the planning area within the same ecoregion section. Third priority will be given to recommendation of a mitigation site elsewhere within the same ecoregion section.

g. Service personnel will fully support a variety of uses on mitigation lands where such uses are compatible with dominant fish and wildlife uses and, for Federal wildlife refuges, are consistent with the provisions of the Refuge Recreation Act and the National Wildlife Refuge Administration Act. However, it may be in the best public interest to recommend limiting certain uses that would significantly decrease habitat value for species of high public interest. In such cases, the Service may recommend against such incompatible uses.

h. Measures to increase recreation values will not be recommended by Service personnel to compensate for losses of habitat value. Recreation use losses not restored through habitat value mitigation will be addressed through separate and distinct recommended measures to offset those specific losses.

i. The guidelines contained in this policy do not apply to threatened or endangered species. However, where both habitat and endangered or threatened species impacts are involved,

Service personnel shall fully coordinate Environment efforts with Endangered Species efforts to provide timely, consistent, and unified recommendations for resolution of fish and wildlife impacts, to the extent possible. More specifically, Environment and Endangered Species personnel shall coordinate all related activities dealing with investigations of land and water developments. This includes full use of all provisions that can expedite Service achievement of "one-stop shopping," including coordinated early planning involvement, shared permit review activities, consolidated permit reporting, and consolidated flow of pre-project information to developers, consistent with legislative mandates and deadlines.

j. The Service will place high priority on and continue to develop and implement procedures for reducing delays and conflicts in permit related activities. Such procedures will include, but not be limited to:

(1) Joint processing of permits.

(2) Resource mapping.

(3) Early provision of ecological design information.

(4) Involvement in Special Area Management Planning.

k. The Service will encourage predevelopment compensation actions by Federal action agencies which can be used to offset future unavoidable losses for lands or waters not adequately protected by an existing law, policy, or program.

Banking of habitat value for the express purpose of compensation for unavoidable future losses will be considered to be a mitigation measure and not an enhancement measure. Withdrawals from the mitigation "bank" to offset future unavoidable losses will be based on habitat value replacement, not acreage or cost for land purchase and management.

5. Mitigation Means and Measures

Mitigation recommendations can include, but are not limited to, the types of actions presented below. These means and measures are presented in the general order and priority in which they should be recommended by Service personnel with the exception of the "no project" alternative. (See Section 4(a)).

a. Avoid the impact

(1) Design project to avoid damage or loss of fish and wildlife resources including management practices such as timing of activities or structural features such as multiple outlets, passage or avoidance structures and water pollution control facilities.

(2) Use of nonstructural alternative to proposed project.

(3) No project.

b. Minimize the impact

(1) Include conservation of fish and wildlife as an authorized purpose of Federal projects.

(2) Locate at the least environmentally damaging site.

(3) Reduce the size of the project.

(4) Schedule timing and control of initial construction operations and subsequent operation and maintenance to minimize disruption of biological community structure and function.

(5) Selective tree clearing or other habitat manipulation.

(6) Control water pollution through best management practices.

(7) Time and control flow diversions and releases.

(8) Maintain public access.

(9) Control public access for recreational or commercial purposes.

(10) Control domestic livestock use.

c. Rectify the impact

(1) Regrade disturbed areas to contours which provide optimal fish and wildlife habitat or approximate original contours.

(2) Seed, fertilize and treat areas as necessary to restore fish and wildlife resources.

(3) Plant shrubs and trees and other vegetation to speed recovery.

(4) Control polluted spoil areas.

(5) Restock fish and wildlife resources in repaired areas. Fish stocking or introductions will be consistent with the Service Fish Health Policy (January 3, 1978).

d. Reduce or eliminate the impact over time

(1) Provide periodic monitoring of mitigation features to assure continuous operation.

(2) Assure proper training of project personnel in the operations of the facility to preserve existing or restored fish and wildlife resources at project sites.

(3) Maintain or replace equipment or structures so that future loss of fish and wildlife resources due to equipment or structure failure does not occur.

e. Compensate for impacts

(1) Conduct wildlife management activities to increase habitat values of existing areas, with project lands and nearby public lands receiving priority.

(2) Conduct habitat construction activities to fully restore or rehabilitate previously altered habitat or modify existing habitat suited to evaluation species for the purpose of completely offsetting habitat value losses.

(3) Build fishery propagation facilities.

(4) Arrange legislative set-aside or protective designation for public lands.

(5) Provide buffer zones.

(6) Lease habitat.

(7) Acquire wildlife easements.

(8) Acquire water rights.

(9) Acquire land in fee title.

6. Follow-up

The Service encourages, supports, and will initiate, whenever practicable, post-project evaluations to determine the effectiveness of recommendations in achieving the mitigation planning goal. The Service will initiate additional follow-up studies when funds are provided by the Federal action agency.

In those instances where Service personnel determine that Federal agencies or private developers have not carried out those agreed upon mitigation means and measures, then the Service will request the responsible Federal action agency to initiate corrective action.

APPENDIX E

COORDINATION BETWEEN THE FISH AND WILDLIFE SERVICE AND THE NEW JERSEY GREEN ACRES PROGRAM
(Service letter of July 29, 1986 and Green Acres' response, dated July 30, 1986)

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
P.O. Box 534
705 White Horse Pike
Absecon, New Jersey 08201

July 29, 1986

Ms. Hermia Lechner, Administrator
New Jersey Green Acres Program
P.O. Box CN 404
1230 White Horse-Mercerville Road
Trenton, New Jersey 08625

Dear Ms. Lechner:

This is in further reference to the U.S. Army, Corps of Engineers' "dual inlet tunnel diversion project" that is proposed as a selected flood control plan for the Passaic River basin. You received information describing this project, including maps of central Passaic wetland areas being considered for acquisition by the Corps. The Corps is concerned about future land uses in these wetlands since continued development will accelerate flooding and thus, jeopardize the functional ability of the proposed diversion tunnel.

We appreciated Mr. Robert Beck of your staff participating in recent field inspections and meetings to discuss the proposed tunnel project. As I mentioned to Mr. Beck, we would like to receive written comments that summarize Green Acres' concerns in regard to project implementation. Furthermore, we would like to determine what land area in the central Passaic wetlands are currently in or are being proposed for state ownership and what future management plan, if any, Green Acres can recommend for this wetlands complex.

Again, the technical assistance and cooperation that we received from your staff during the review of this tunnel project is appreciated. If you have any questions regarding this matter, please do not hesitate to contact me. I am available at (609) 646-9310.

Sincerely,

Clifford G. Day

Clifford G. Day
Fish and Wildlife Biologist

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION

REEN ACRES PROGRAM

CN 404
TRENTON, N.J. 08625-0404

MEMORANDUM

DATE: July 30, 1986

TO: Clifford G. Day
US Fish and Wildlife Service

FROM: Hermia M. Lechner, Administrator
Green Acres Program

SUBJECT: Pompton River/Two Bridges Dual Inlet Tunnel Plan Review

The Office of Green Acres offers the following general comments after cursory review of the new proposed Dual Inlet Tunnel Plan by the Army Corps of Engineers.

The new plan represents a major reduction in the potential impacts to wetlands and rivers/streams of the Passaic Basin. The new location of the spur tunnel and inlet has eliminated considerable channelization related impacts on the Pompton River. The elimination of several levee systems will allow natural flooding of wetlands to continue and the proposed weir structure has the potential to minimize impacts to the Great Piece Meadows and may have beneficial management potential. In light of these changes which serve to reduce considerably the environmental impacts, this plan is preferred over the original dual inlet plan. The proposal to purchase approximately 4,800 acres of floodplain/wetlands in the basin is heartily supported by Green Acres and is in direct support of our land acquisition efforts both at the State and local level.

The tunnel plan as proposed, however, raises the following concerns which at this level of review must remain general.

1. Green Acres administers a bond-supported fund which is used to purchase land and build facilities for State Parks, Forests and Fish and Wildlife Management Areas. It is also used to assist municipalities and counties to purchase land and build facilities for outdoor recreation and conservation purposes.

Several State properties may be affected by the proposal at Great Piece Meadows, depending on the actual location of the Route 80 levee and the proposed weir structure. These affects will need to be analyzed in detail, once the actual block and lot location information is made available to Green Acres.

2. The potential impacts to municipal and county lands appear, from the initial comparison to readily available inventories, to be substantial. There has been a major effort by many of the local units to purchase the floodplains and wetlands of the basin for recreation and conservation purposes. Impacts to these areas will range from major loss of value to indirect impacts, through construction of levees/floodwalls, inlet structures, ponding areas and channelization.

   Bergen, Essex, Hudson and Passaic County parklands appear to be involved as well as parklands of the following municipalities:

   > Garfield, Kearny, Lyndhurst, Montville, North Arlington, Nutley, Passaic, Paterson, Pequannock, Pompton Lakes, Rutherford, Wayne

   A detailed analysis of the finalized plan in comparison to local inventories is necessary to identify all impacts both direct and indirect. Of particular concern are parklands within local units which have received Green Acres funding. Green Acres Rules and Regulations (NJAC 7:36-1.8(m)) states "Upon receipt of an acquisition or development grant, other lands owned, dedicated, or maintained for public recreation or conservation purposes by the local unit may not be diverted or disposed for uses other than those of public recreation or conservation without the prior approval of the Commissioner and the State House Commission". Such lands approved for diversion or disposal must be compensated for by replacement of land of equal or greater fair market value and recreation or conservation value.

3. Another general concern is that construction activities have been planned to occur on vacant land to avoid impacts to existing residential and commercial property uses, however, many of these "vacant" lands are public recreation/conservation lands. The buyout of inappropriate private development for construction sites should be pursued to the maximum extent as these public lands are most likely irreplaceable and the buyouts may prove to be more cost-effective and more consistent with floodplain management efforts.

4. The proposed acquisition of floodplain/wetland areas must be properly coordinated through our agency, local interests public and private, USF&WS, NJ Division of Fish, Game and Wildlife, and the NJ Division of Parks and Forestry to identify overlaps, conflicts and opportunities. The administration and management of these lands is also of prime concern.

Assuming these lands must be purchased to insure the prescribed level of flood protection by the tunnel plan, these lands should be secured as soon as possible since pressures may preclude this or prevent acquisition of key parcels because of significantly increased property values. These values, recently appraised and approved by our agency for similar type parcels, have been conservatively established at $25,000/acre. A rough calculation brings the total acquisition cost at $120,000,000. Parcels not so restrictively zoned may bring considerably higher values. This expense may have serious impacts on the stated cost/benefit ratio, since it now represents over 10% of the total project cost.

Green Acres appreciates the opportunity to provide input at this early stage of project review and will cooperate in future stages of review. It is essential that more specific information be forwarded to us relative to the specific locations of proposed constructions as well as detailed information on hydrologic conditions both with and without project. Specific locations should be identified by local unit, acreage to be affected and block and lot identification. Hydrologic conditions with and without project should include mapping of 1,2,5,10,25,50 and 100 year design storm events for the project area so impacts to recreation area facilities and conservation area habitats may be properly assessed.

H.M.L.

HML:RB:m
c: Helen C. Fenske, Assistant Commissioner
Andy Didun, Division of Fish, Game and Wildlife

APPENDIX F

COORDINATION BETWEEN THE FISH AND WILDLIFE SERVICE AND WILDLIFE PRESERVES, INC.
(Service letter of July 29, 1986 and Wildlife Preserves' response, dated August 29, 1986)

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

P.O. Box 534
705 White Horse Pike
Absecon, New Jersey 08201

July 29, 1986

Mr. Robert Perkins
Wildlife Preserves, Inc.
217 Davenport Drive
Stamford, Connecticut 06902

Dear Mr. Perkins:

This is in further reference to the U.S. Army, Corps of Engineers' "dual inlet tunnel diversion project" that is proposed as the selected flood control plan for the Passaic River basin. I appreciated the opportunity to discuss this project with you, particularly the potential impacts that project implementation may have on the central Passaic wetlands, and the wetland areas that are being considered for acquisition by the Corps. As I mentioned, the Corps is concerned about future land uses in these wetland areas since continued development will accelerate flooding and thus, jeopardize the functional ability of the proposed diversion tunnel.

As I mentioned during our discussion, we would like to receive general comments that summarize Wildlife Preserves' concerns in regard to project implementation. We are aware of the considerable land holdings that Wildlife Preserves has in the central Passaic wetlands complex.

If you desire to discuss this matter further, please do not hesitate to contact me. I am available at (609) 646-9310.

Thank you for your cooperation. I look forward to hearing from you.

Sincerely,

Clifford G. Day
Fish and Wildlife Biologist

WILDLIFE PRESERVES, INC.
P. O. BOX 260, PINE BROOK, N. J. 07058

DEDICATED TO THE PRESERVATION OF OPEN SPACE, NATURAL AREAS AND WILDLIFE

August 29, 1986

Mr. Clifford Day
Ecological Services
U.S. Dept. of the Interior
Fish & Wildlife Service
P.O. Box 534
Absecon, NJ 08201

Re: Passaic River Tunnel Plan

Dear Mr. Day:

A review has been made of information available to Wildlife Preserves, Inc. on the proposed plan of the U.S. Army Engineers for Passaic River flood control that uses a tunnel for much of the excess flood flow. In the long run such a plan is bound to have a very substantial effect on most of the wetlands in the Central Basin north of Chatham. In evaluating prospects for the tunnel plan it has been necessary to look at the overall situation. It is increasingly apparent that as a result of development, particularly as it affects water quantity and quality, there has been a rapid deterioration of the Central Basin's wetlands.

The Division of Ecological Services of the U.S. Fish & Wildlife Service is concerned with the impact both this tunnel plan and the area's development will have on the wetland and upland wildlife habitat in the Passaic's Central Basin. The Service also showed very considerable interest in the preservation of Troy, Piece, and Black Meadows as national wildlife refuges between the late 1930's and 1960.

Wildlife Preserves has been involved in attempts to preserve these areas for some 30 years. As part of this effort it has acquired land, primarily by purchase with donations. Currently it still has over 2000 acres in eight wetlands areas in the Central Basin, with main holdings in Troy and Piece Meadows. Wildlife Preserves has been interested in working with the Fish & Wildlife Service to protect the remaining areas of wildlife habitat in the Basin and would like to work out a plan to coordinate its efforts with those of the Service.

In view of the very rapid deterioration of the situation and of the extraordinary value and significance of some of these lands for wildlife, as well as for the enhancement of the quality of human life in the region, a special program seems called for which is capable of making an intense and prompt effort.

Although obvious, it is worth emphasizing that this Passaic Central Basin is markedly different from most other areas the Service is called upon to evaluate. Much of this Basin and the lands draining into it is in the process of becoming a city complete with highrise hotels and office buildings. It may even be the fastest growing portion of this country's largest and highest pressure metropolitan area. It is clear that something very different from the usual approach to river valley problems is needed.

As to the tunnel plan itself, there are many concerns and a need for more information. Among the primary concerns are the following:

1) The apparently drastic impact that the plan will have on areas along the Pompton and Ramapo Rivers as a result of channelization, etc.

2) The effect that reducing periodic flooding will have on most of the wetlands north of Chatham. It would appear that the habitat on these lands may be profoundly altered with the elimination of most of this flooding.

3) The rapid deterioration in the overall situation in the Central Basin as a result of the extensive development mentioned above. In order to prevent further damage, and the elimination of options for flood control, it is necessary to acquire the land in and adjacent to flood areas and wetlands quickly.

Particular attention should be given to this third area of concern. The suggestion for stabilization by acquisition has been made many times before particularly in a long statement submitted to the Army and the State at the time of flood hearings in 1968. Since that time development has reduced flood control options and greatly increased the costs of any sort of flood control program. This increased cost is many times the value of the land needed to stabilize the situation. Although it is too late to prevent much damage, there is still an opportunity to prevent a lot of additional deterioration.

Increased regulations do not provide the needed answer. In fact in some ways they create a worse situation by making regulated land more attractive to projects backed by the power of eminent domain or strong political support. Also, it is easier for developers outside regulated zones to ignore the adverse effects of the soil runoff and pollution they cause since their lands are not regulated effectively and the lands they damage have reduced economic value. As a result the damage claims they face can usually be regarded as negligible and not worth avoiding.

It would be hard to put too much emphasis on the need for prompt acquisition and a program to reduce the havoc caused by upstream construction.

Sincerely yours,

Robert Perkins, Jr.

Robert Perkins, Jr.
For Wildlife Preserves, Inc.

RP/js

PLEASE NOTE: Correspondence relating to this matter should be directed to Wildlife Preserves, Inc., c/o Meyner & Landis, One Gateway Center, Suite 2500, Newark, NJ 07102-5311

APPENDIX G

LIST OF PREPARERS AND CONTRIBUTORS

LIST OF PREPARERS AND CONTRIBUTORS

PREPARERS

PROJECT LEADER

Charles J. Kulp
Fish and Wildlife Administrator: U.S. Fish and Wildlife Service (29 years)
B.S., University of Miami
Certified Fisheries Scientist, American Fisheries Society

PROJECT BIOLOGISTS

Clifford G. Day (Principle Investigator)
Fish and Wildlife Biologist: U.S. Fish and Wildlife Service (9 years
B.S., M.S. West Virginia University
Certified Wildlife Biologist, The Wildlife Society
Certified Ecologist, The Ecological Society of America

Harvey M. Katz (under contract)
Fisheries Biologist: Great Swamp Research Institute, Envirosphere Company,
University of Massachusetts, U.S. Fish and Wildlife Service (22 years)
M.S., Ph.D., University of Massachusetts
B.S., Monmouth College

William Zinni, Jr.
Assistant Regional Wetland Coordinator (Region 5), U.S. Fish and Wildlife Service (3 years)
Wetlands Ecologist, University of Massachusetts, South Carolina Department of Wildlife and Marine Resources (5 years)
B.S., University of Rhode Island

CONTRIBUTORS

NEW JERSEY DIVISION OF FISH, GAME AND WILDLIFE

Bureau of Freshwater Fisheries
A. Bruce Pyle, Chief
Robert A. Papson Senior Fisheries Biologist

Bureau of Wildlife Management
Lee Widjeskog, Senior Wildlife Biologist
Endangered and Non-game Species
James Sciascia, Principle Nongame Zoologist
Office of Environmental Review
Andrew Didun, Principle Fisheries Biologist

NEW JERSEY GREEN ACRES PROGRAM
Robert Beck, Principle Environmental Planner

CORPS' RESPONSES TO THE FISH AND WILDLIFE SERVICE'S
MITIGATION RECOMMENDATIONS

PREFACE

CORPS' COMMENTS ON THE TRANSMITTAL LETTER

CORPS' COMMENTS ON THE FWCA REPORT

COMMENTS ON THE FISH AND WILDLIFE SERVICE'S TRANSMITTAL LETTER REGARDING THE SHORT-NOSED STURGEON:

The Corps has coordinated with the National Marine Fisheries Service (NMFS) regarding the short-nosed sturgeon (Acipenser brevirostrum). A letter from NMFS concluded that based on available information no Federally endangered species, including the short-nosed sturgeon, would be affected by the proposed flood control project.

CORPS' COMMENTS ON THE FWCA REPORT

Comment on Page 4 Paragraph 1 Regarding the Analysis of the Future Conditions Without the Project:

The Corps must analyze project effects over the project's life. We must, therefore, forecast what parameters will be influenced by the project, particularly environmental factors. While a supplemental report may be desired by the FWS, it must address future conditions in 1990 and 2040 both with and without the project in place. If this cannot be accomplished, then the analysis will be inadequate.

Comment on Page 50 Paragraph 1 Regarding Channel Capacity and Size:

The Pompton and Passaic Rivers will carry flows for an average of 360 days a year at existing rates. Only during flooding events (an average of 5 days per year) will flows be altered. Thus, project induced effects in the channel's morphology and water velocities are expected to be minimal.

SECTION 5. RECOMMENDATIONS

GENERAL EVALUATION

1 Based upon the future-without and future-with-project scenarios presented in Section 4, the implementation of the selected dual inlet tunnel diversion plan as proposed would be destructive to existing fish and wildlife resources in the central and lower PRB. Implementation of this plan would require the construction of: 13.4 mi. of 39-ft. diameter tunnel and 1.3 mi. of 22-ft. diameter spur tunnel; 31 levees covering 225 ac.; 23 floodwalls covering 3.0 ac.; a series of storage pond areas; and, 6.0 mi. of channelization, including dredging and realignment.

2 Implementation of the dual inlet plan as proposed would eliminate 6.0 mi. of riverine habitat and 1,535.9 ac. of wetlands. A total of 4,256 ac. of wetlands could be lost due to improper tunnel operation. Additionally, backwater areas, islands, riparian vegetation and floodplains would either be eliminated or converted to non-wildlife uses. The measures proposed to reduce fish and wildlife losses resulting from project implementation are inadequate, particularly in the Pompton inlet area and in the Great Piece Meadows. The June PAR (Day et al., 1985) recommended a flow regulator such as a weir on the Passaic River to maintain habitat suitability in the Great Piece Meadows. According to the information provided by the COE, a weir structure is only "under investigation" at this time. Depending upon post-project conditions, including habitat suitability and vegetational succession, as well as tunnel operation, implementation of the plan could result in a permanent loss of fish and wildlife resources, including a portion of the central PRB wetlands.

General Evaluation

The proposed project would include the acquistion of 5,350 acres of natural flood storage areas. This acquisition is for flood damage reduction purposes and is economically justified. Of the 5,350 acres, 5,200 acres are wetlands. Currently 4,800 acres are zoned for residential, commercial and industrial development and the balance under heavy pressure to be rezoned for development. The without project condition projects the loss of these acres between 1990 and 2040. Development includes both filling, (45% aerial extent) based on current NJDEP Flood Hazard Regulations and removal of natural cover including conversion to lawns and ornamental shrubs which have low wildlife values.

The Preservation of Natural Storage component of the plan would result in the protection of the wetlands, which would otherwise be lost. The number protected are significantly greater than the impacts of the project. For the above reasons the Corps considers loss of wetlands mitigated for by those elements included in the plan (land acquisitions, Central Basin weir, wetland plants, and nest structures).

This conclusion is based upon two factors: 1) existing information on the carrying capacity of these areas and 2) the fact that the flow regimes of all wetlands except Great Piece Meadows would remain at ambient levels. Great Piece Meadows' flow regime would be maintained for all but 100 acres by use of a weir which would permit the simulation of the existing 1 year flood in the meadow.

Paragraph 2. The impact on 1550 acres of wetland as stated is associated with this project, is without the implementation of the weir. This weir would allow continued inundation equivalent to an annual event of 350 of the 450 acres of wetlands in the downstream of Great Piece Meadows and would increase protection to wetlands further upstream. Ponding areas are under investigation for inclusion as wildlife management areas. The nature of the ponding areas would change from predominantly forested to emergent and open water. Inclusion of these ponding areas would restore, albeit as a different cover type, 200-600 acres of the 1550 impacted by the project. Additionally, the approximate 150 acres of wetland effected above the Pompton Inlet would be maintained, but as emergent and or shrub/scrub cover. Also the purchase of natural storage areas for the integral function of the tunnel would in effect hold safe from development substantial portions of wetlands now scheduled for development.

3 The purpose of the selected tunnel diversion plan is to provide flood protection to the central and lower PRB. Flooding problems in the PRB will continue because local municipalities have zoned natural retention wetlands and floodplains for development. Project implementation will control current flooding and hence, will encourage wetland and floodplain development in areas not acquired for natural storage. To reduce project-related wetland damages, we recommend that the COE implement the following: 1) vigorous enforcement of regulatory authority under the Clean Water Act to regulate the filling of wetlands that provide natural retention of floodwaters in the PRB; 2) acquisition of floodplain and wetland areas that are important for retention; 3) reclamation of floodplains and wetland creation on a selected basis for reducing structural flood control measures; 4) formulation of a comprehensive wetlands management plan for the central Passaic wetlands; and, 5) development of nonstructural flood control/water management plans with adequate consideration given to fish and wildlife values and overall drainage basin management in comparison to invoking structural engineering concepts on the single criterion of water movements. The Service is highly supportive of the COE's land acquisition proposal to purchase 5,350 ac. of natural storage areas, including wetlands, in the central PRB.

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Paragraph 3-1. Enforcement of regulatory authority has been and would continue to be executed by the Corps under the 404 program.

Paragraph 3-2. Acquisition of wetland areas 5,350 of which is included as an early implementation element in the recommended plan in order to preserve natural storage areas and minimize future increases in the flood hazards.

Paragraph 3-3. Certain small, select areas would be acquired and reclaimed as part of this project, mostly along the lower Pompton River.

Paragraph 3-4. If the project is authorized a management plan, for the central Passaic Basin would be quite beneficial and the Corps would assist in its development

Paragraph 3-5. Flood control management plan. The Corps has given consideration to biological and ecological values in the formulation of the flood control plans. For example, emphasis has been placed on maintaining the water levels in Great Piece Meadows, originally by use of gates on Beatties Dam and then, as plans changed, by use of a weir near the downstream terminus of the meadow. Additionally, the Corps' plan would preserve substantial tracks of wetlands, use instream habitat structures to hold fish, plant wetland flora in ponding areas, and provide cover and nesting structures for wildlife.

4 Aquatic ecosystems are complex. Rivers and adjacent floodplain and wetlands change in response to channelization, hydrologic alterations and associated disturbances. Therefore, it is recommended that for future studies in the PRB the COE consider the Instream Flow Incremental Methodology (IFIM) to quantify disturbances to a riverine ecosystem. The application of this scientific methodology would require a substantial commitment of time and funds. Recommendations formulated under IFIM would be based upon valid conclusions via sound biological data and direct observational evidence.

Paragraph 4. Use of Instream Flow Increme. . Methodology (IFIM) has, to present, been applied chiefly on western streams, where among the attributes, seasonal rain occurs. Possible use of this methodology would need to await proven use in eastern streams. In addition, it was mutually agreed that aquatic analysis would be conducted in the traditional way.

One of the responsibilities of the Service is to provide detailed assessment of project impacts to fish and wildlife resources. This impact assessment would be accomplished by utilizing HEP. The HEP is a habitat based approach to impact assessment and provides a scientific method for describing baseline conditions and predicting future habitat conditions in terms of both habitat quantity and quality. The baseline HEP for PRB terrestrial resources was accomplished about 6 years ago (Day and Rosenberg, 1980, 1981a). Therefore, additional baseline HEP would be conducted to identify data gaps (e.g., aquatic resources) and to extend the analysis into the lower PRB. With necessary updating, the HEP conducted in 1980 should provide sufficient baseline data for the central PRB, since the wetland cover types were adequately described by field investigations. The baseline data, along with future land uses, would be used to identify habitat changes at different time intervals and measure losses and gains associated with project implementation. The application of HEP in 1987 is needed to refine and quantify our recommendations in this report.

Paragraph 5 HEP. The use of HEP was to be based upon the field studies conducted in 1980. It was not until late (1986) in the planning process that the Corps was informed by FWS that the 1980 HEP data could not be used, but that a new field investigation using new species would be necessary to provide the quantified analysis. It was mutually agreed due to subsequent events and short time frame that FWS would use a non-HEP technique to assess plan impacts and provide the mitigation plan in the FWCA report to be submitted ot the Corps in time for inclusion with the draft Phase I GDM (September, 1986).

Use of HEP in the Lower Valley was eliminated for consideration by mutual agreement between FWS and the Corps. A similar agreement was reached regarding the use of aquatic techniques to be used.

6 Other water management plans should be considered in the formulation of the proposed tunnel diversion plan. For example, the State of New Jersey is constructing an intake structure at the Pompton/Passaic confluence (Wanaque south pump station) that would, during droughts, pump water to the Wanaque Reservoir managed by the North Jersey District Water Supply Authority and to the Oradell Reservoir managed by the Hackensack Water Company, as well as to other reservoirs (Point View, Cedar Grove) managed by the Passaic Valley Water Commission. Approximately 250 mgd could be pumped from the intake to the Wanaque and 75 mgd to 100 mgd could be pumped from the intake to other reservoirs such as the Point View Reservoir. The COE's tunnel diversion intake would tap the river during high flows while the state's intake system would tap the river during low flows. Combined, this could accelerate water quality degradation. Additionally, several hydroelectric projects are proposed within the study area. The Passaic Valley Water Commission has proposed a hydroelectric project on Little Falls, the Paterson Municipal Utilities Authority and Great Falls Hydroelectric Company are now constructing a hydroelectric project on Great Falls and American Hydropower has a three-turbine hydroelectric project in operation at Dundee Dam. Upon completion, the American Hydropower project will operate nine turbines that can handle 2,300 cfs. The Federal Energy Regulatory Commission should be consulted about the compatibility of implementing the selected plan with present and future hydropower projects.

Paragraph 6. Water management plans including Wanaque South and anticipated hydropower developments, both operating and proposed, have been considered and evaluated in relationship to the proposed flood control plan. The flood control plan would not adversely affect the operation of these facilities.

7 It is unclear how other proposed COE flood control plans relate to the formulation of the proposed tunnel diversion plan. For example, the Service assessed the COE's selected flood control plan for the lower Ramapo River (Day, 1984). This plan was based upon 1.7 mi. of channelization that would begin approximately 1.5 mi. upstream of the Pompton Lake Dam. Pompton Lake would be partially dewatered and bascule gates would be installed on the dam. Therefore, the beginning point of this Ramapo River plan, Pompton Lake Dam, is also the starting point for channelization of the selected tunnel diversion project. The Service finds it difficult, particularly from a biological and ecological viewpoint, to conduct an assessment and formulate mitigation

Paragraph 7. The relationship of Corps proposed interim plans to the Passaic main stem plan have been fully examined. One of the criteria for development of the tributary flood control plans, was that they are consistent and compatible with any mainstream flood control plan. If the other plans did not meet this criteria they did not qualify for early action. Further, the Pompton Lakes Dam acts as a barrier to prevent fish movement upstream. Therefore, biological and ecological assessment of these reaches as independent entities was possible and was accomplished in both these projects.

PLAN IMPLEMENTATION

OVERVIEW

After careful review and evaluation of the information provided by the COE, the Service approves the selected plan, with conditions. From a biological and ecological viewpoint, this flood control plan, particularly the acquisition of natural storage areas, is an improvement over previous alternative plans for the PRB (i.e., tunnel diversion, levee/floodwall, channelization, dual inlet and Beatties Dam inlet tunnel diversion). However, the Service requests that further planning and investigations be conducted to refine the selected plan for the purpose of minimizing potential adverse impacts to fish and wildlife resources.

The following recommendations should be investigated by the COE and, if feasible, should be incorporated into the selected plan prior to forwarding the plan for higher approval. The recommendations highlight the Service's major concerns for fish and wildlife resources in view of implementing the selected plan as proposed. Resolution of these concerns should be accomplished as soon as possible and prior to conducting a HEP analysis. Incorporating several of the following recommendations into the selected plan could greatly minimize habitat losses and thus, would influence the formulation of Service's final mitigation recommendations.

Recommendations for "plan implementation" are presented under the following subheadings that are named according to site location in the project area, proceeding from north to south: Pompton Inlet area, Pompton River, Two Bridges inlet area, Great Piece Meadows, Rockaway River, Mainstem Passaic River, and acquisition areas throughout the PRB. Further comments and recommendations follow and are presented under "Mitigation Recommendations."

Overview.

Paragraph 1 and 2 Further investigations (such as possible modeling) would require substantiation of successful use of the model including calibration, in order to determine their use.

POMPTON INLET AREA

1. Redesign the Pompton inlet structure to eliminate or greatly reduce the proposed channelization and dredging on 2.6 mi. of the Pequannock, 1.3 mi. of the Ramapo and 1.0 mi. of the Wanaque Rivers. Dredging to 6.0 ft. in the Pequannock, Ramapo and Wanaque channels is proposed. Channel top widths on these rivers would be increased by 60 ft., 40 ft. and 60 ft., respectively. The proposed channelization and dredging is extensive, particularly if the purpose of channel work is to accommodate the morning glory inlet that will be contained in a basin that is lower in elevation than the river channel (the floor of the basin is 8 ft. below the crest of the morning glory inlet). The inlet structure is designed to prevent debris from entering the tunnel. However, this design would eliminate almost 5 mi. of riverine habitat in order to attain a change in elevation. Therefore, the Pompton inlet structure should be redesigned to eliminate the proposed channelization as well as to prevent anything but floodwaters from entering the tunnel.
The magnitude of proposed channelization on these river segments may not offer an opportunity to incorporate basic stream-improvement techniques into project design. Post-project conditions, particularly habitat suitability and public accessibility to the watercourse, will determine what stream improvement techniques, if any, can be implemented and thus, recoup important recreational fishing opportunities.

POMPTON INLET AREA

1. The Corps has formulated many plans in order to determine the optimal balance of alternative elements. The proposed structures have been optimized to reduce the extent of levees and channels and have met the tests of economic justification. To lower the inlet would require deepening the channels further, to increase inlet elevation would necessitate raising levee heights in order to prevent the increased backwater from causing flood damages.

2. Islands in the Ramapo River provide valuable wildlife habitat and should be retained. The project as proposed would eliminate the existing vegetational community structure supported on these islands.

2. As proposed the project would lower standing water in the channel to depths of 1-2 feet. This is likely to cause changes to more mesic conditions on the islands in this channel. At the same time, however, the lowered water level would lead to an increase (15 acres) in emergent wetlands in the bypassed channel.

3. Investigate the removal of the existing Ramapo River dam that is located near the proposed Pompton inlet site. This dam may contribute to raised surface water elevations and thus, contribute to back-up flooding along the river proposed for channelization, dredging, floodwalls and levees. Furthermore, if the selected plan is implemented as proposed, and the Ramapo River is channelized into the Pequannock River, it is unclear why the dam would be retained.

3. There are two feeder dams in the project area one on the Ramapo River and another as the Pequannock River. Both are part of the Morris Canal System which is on the National Historic Register. The Corps has taken care to prevent the project from effecting these structures. The alternative as designed would work appropriately with the dams remaining as is.

4. Channelization should not occur beyond the first major meander on the Ramapo River immediately upstream of the inlet structure. Islands, backwaters and riparian areas in this segment of the Ramapo River provide excellent wildlife habitat and should be retained.

4. We concur that the natural areas upstream of the Pompton Inlet within the project are important wildlife habitat. Every effort has been taken to provide for the continuance of these areas. However, the channel modifications as proposed are necessary for proper operation of the tunnel plan.

5. Implementation of the project as proposed would divert the existing Ramapo channel into the Pequannock River. The left bank of the new channel should not prevent water from entering the former Ramapo channel. Construction of the left bank should include a weir or a low-headwall dam to allow for wetlands inundation, channel flushing and to maintain existing surface waters for fish and wildlife.

5. See 2 above.

6. Excessive wetland vegetation would be removed from the Pompton inlet area. This vegetation is being removed to ensure that debris will not find its way into the inlet structure. Many of these wetlands are forested and provide valuable wildlife habitat. If it is necessary to remove forested wetlands, the successful establishment of emergent and scrub-shrub wet lands should occur during the first growing season following project implementation. For example, the areas on the river side of the Pequannock-Ramapo levee and along the right bank of the Pequannock River should be regraded for periodic inundation. Successful wetland establishment will require inundation and therefore, this segment of the Pequannock should not be channelized. Furthermore, it is unclear how water velocities (during tunnel operation) will impede the reestablishment of vegetation or cause bank erosion. A velocity/erosion study is recommended for the inlet area and on upstream reaches.

6. Removal of trees from selected areas upstream of this inlet would be kept to the minimum needed in order to insure safe operation of the tunnel. Areas where trees are cut can have emergent and shrub-scrub flora planted as needed in order to mitigate for habitat impact.

The Corps concurs that a velocity study to evaluate erosion is important. Such a study would be conducted during the Corps Phase II General Design Memorandum as a basis for finalizing the operations and maintenance procedure associated with the tunnel.

7. The Ramapo and Wanaque Rivers upstream of the Pompton inlet are important trout-stocked waters and provide recreational angling opportunities. Therefore, the project should be modified to allow for public access to these watercourses. The levee system proposed along the left bank of the Ramapo River does not make adequate accessibility possible. In fact, it is unclear why levees are needed when this segment of river is proposed for dredging and channelization. Implementation of the project as proposed would terminate existing trout management by the NJBFF on the Ramapo and Wanaque Rivers in the project area. Furthermore, future trout-stocking plans being considered for the Pequannock River would cease.

7. Public access can be provided with the approval of the non-Federal sponsor (State of New Jersey).

8. Proper tunnel inlet operation is a very serious concern from a fish and wildlife viewpoint since volume flow can be regulated and thus, flushing, wetland and floodplain inundation, sediment deposition/erosion and flow regimes could be controlled. The one-year flood event at this location approximately 4,300 cfs under existing conditions. Tunnel operation would reduce this to 500 cfs (representing approximate mean annual flow) with a peak of 4,000 cfs during storms. A one-year flood event (4,300 cfs not 4,000 cfs as proposed) may be the minimal discharge acceptable to maintain aquatic and wetland resources. However, it is recommended that the COE determine what flood event (i.e., maximum flood height) could bypass the tunnel intake structure and continue downstream while not requiring any channelization of the Pompton River in the Pompton inlet area. This flow is probably greater than the one-year flood event and could be further increased by floodplain reclamation. This may be a feasible nonstructural flood control method to incorporate into the project area since the COE's "1990 Base/2040 Projection Map" indicates a loss of natural storage areas.

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8. The formulation of the tunnel plan was based upon extensive inventories of damageable properties and prior flood elevations for calibration purposes. The objective of the formulation was to develop the most cost-effective solution to the flood damage problem. The operating rules associated with the facility were modified to the maximum extent possible in an effort to minimize environmental effects.

9. Maintain existing channel meanders in the Pequannock, Ramapo and Wanaque Rivers.

9. Concur. In the majority of effected reaches channel modification would be within the channel meanders.

10. Maintain adequate fish passage in the Pequannock, Ramapo and Wanaque Rivers.

10. Concur. Also it should be noted that the new channel which would bypass the Pequannock feeder dam would actually facilitate fish passage.

11. Maintain public accessibility to the Pequannock, Ramapo and Wanaque Rivers for recreational angling opportunities.

11. Concur, with approval of the non-Federal sponsor.

12. In areas where levees are deemed necessary they should be set-back from the watercourse and be constructed along the outer fringes of wetlands and floodplains. Levees should be vegetated with species indigenous to the immediate area. Levees should not prevent public accessibility to the watercourse.

12. Concur, set-back levees have been incorporated wherever possible and replanting with native species would occur in the first growing season. Public access would be provided with the concurrence of the non-Federal sponsor.

13. Undertake a velocity/erosion study for river segments upstream of the Pompton inlet structure. It would be helpful for the COE to construct a miniature, physical flow model of the project impact area, particularly representing the upstream reaches from the Pompton and Two Bridges inlet structures. This model would be useful in conducting experiments on water velocity changes that are expected to occur when the tunnel is in operation. Velocity increases will cause channel bottom disturbance, sheet erosion, bank erosion, headcutting of channel meanders, water turbulence and sediment deposition. These physical changes resulting from velocity increases will greatly influence plant community structure and thus, the ability to retain or reestablish riparian and wetland areas.

13. A model would be utilized during the Corps Phase II GDM planning, to finalize operation and maintenance of the tunnel and can be utilized as an aid in revegetating areas.

POMPTON RIVER

1. Investigate the maximum flow that could bypass the Pompton inlet structure and continue downstream without channelization or dredging on the Pompton River in the inlet area.	POMPTON RIVER 1. See 8 above (Pompton River Inlet)
2. Investigate the acquisition of developed floodplain areas for the purpose of floodplain reclamation.	2. Acquisition has been investigated for the total 10 year floodplain, and for the flood plain defined by only those structures whose first floor would be inundated by a 10 year flood. They were found to be not economically justified.
3. Allow floodplain and wetland inundation, flushing of the channel and adequate flow regimes to continue, retaining existing biological and ecological conditions.	3. This has been reviewed and it has been determined that after the peak discharge associated with the flood passes flows up to the equivalent of the 1 year event can be allowed to continue downstream.
4. The amount of river channel capacity reduced over time should be determined. For example, a channel carrying the one-year event will eventually stabilize and thus, could be smaller than existing conditions.	4. With the plan, flow will likely change. Therefore, a monitoring system will be established to measure the channels carrying capacity.
5. Maintain adequate fish passage throughout the Pompton River.	5. Concur

TWO BRIDGES INLET AREA

1. Investigate the maximum flow that could bypass the Two Bridges inlet structure and continue downstream without channelizing the Passaic River. The one-year flood event at this location is approximately 6,100 cfs under existing conditions. Mean annual flow is approximately 1,100 cfs. Tunnel operation would reduce volume flow to 100 cfs with a peak flow approximating the one-year event during reciprocating discharge. Therefore, tunnel operation would decrease volume flow to 100 cfs and, during a storm event, increase flow to 6,000 cfs. First, this decrease and increase of flow rate is erratic and would adversely impact aquatic habitat. Second, the duration of time that the one-year flood event is permitted to flow downstream is unknown.

2. Approximately 1.1 mi. of the Pompton and Passaic Rivers is proposed for channelization. Redesign the proposed channel modification to accommodate basic stream-improvement techniques as deemed necessary by the NJBFF.

3. Design streambanks on the Passaic and Pompton Rivers to include filters and traps for petroleum products, road salt, sand and sediments wherever runoff drains into the watercourse.

4. Deposit riprap along streambanks on the Passaic and Pompton Rivers where it is not possible to stabilize the bank with vegetation.

TWO BRIDGES INLET AREA

1. The bypass flow at Two Bridges must be minimized early in a flood event. This is due to the nature of the flooding in the areas below Beatties Dam. The flooding in this area arises from three distinct peak conditions. The first peak, due essentially to the runoff and tributary streams below Beatties, occurs early in the flood event (hour 21), the second peak occurs when the Pompton River peak flow passes over Beatties Dam (hour 38), the third peak occurs near the end of the flood event (hour 98) and is caused by the arrival of the upstream Passaic River peak. Water flowing past the Two Bridges inlet must be minimized early in the flood to prevent worsening of the first peak. At no time will the tunnel operate to reduce any of these peaks below the first peak which is uncontrolled. During a 100 year flood event over 9000 cfs will bypass the Two Bridges Inlet. Since this is essentially non-damaging, the 1 year flows can be passed as long as the Pompton River peak has passed.

2. The channel modification for this area would basically be contained within banks. Also, some of the material excavated from the tunnel would be used in the channel, this would replace existing substrate and may actually increase habitat available.

3. This recommendation is not within the Corps purview. The proper responsibility lies with the state and local authorities.

4. Concur.

5. Reestablish natural substrate conditions.

6. Maintain adequate fish passage throughout the modified channel.

7. Undertake a velocity/erosion study for river segments upstream of the Two Bridges inlet structure.

GREAT PIECE MEADOWS

1. The proposed one-year flood event may be inadequate to maintain existing wetland characteristics, floodplain enrichment and flushing. It is recommended that the COE determine the specific hydrologic regimes, including inundation, necessary to maintain existing wetland cover types. Another important parameter that should be studied is residence time (the time that water remains over the floodplain floor and in associated depressions). The proposed one-year flood event is a good basis to understand the hydrological needs of the Great Piece Meadows. However, this "one-year event" hypothesis gives a priori preference for water regimes. Only valid conclusions via sound data should be used to resolve this crucial question about wetlands ecology. It is recommended that a model be used to determine anticipated wetlands conversion which could occur from hydrologic changes. Application of such a model could be effectively incorporated into the proposed HEP analysis since plant community succession, resulting from project implementation, will influence habitat suitability. The Service would like to discuss the feasibility of using plant community succession modeling during negotiations for fiscal year 1987 work. In the interim, the COE may wish to review studies of plant community succession modeling (Brody et al., 1986; Pearlstine and Kitchens, 1985; Pearlstine et al., 1985).

5. Concur.

6. Concur.

7. Concur, see 13 above under Pompton River Inlet.

GREAT PIECE MEADOWS

1. Plant community succession modeling has only recently been developed as a tool. Substantial use, calibration and applicability to the northeast United States would be needed for its inclusion in future Corps studies on the Passaic. The Corps believes that using this model for the present PHASE (I) of planning would not appreciably alter mitigation requirements. If models of this nature prove workable in a reasonable time frame the Corps would consider its inclusion in future, Phase II of the GDM. (See also Discussion under General Evaluation)

2. Once the threat of flooding is reduced, an accelerated loss of floodplain areas from development is expected. The COE's proposal to acquire up to 5,350 ac. of natural storage areas, including wetlands in the central Passaic basin is an important part of the selected plan. Preserving the flood storage function of wetlands in the future will ensure that the diversion tunnel remains functional by controlling accelerated discharge resulting from continued development. Additionally, these natural storage areas will provide very important wildlife habitat. It is recommended that major landowners and agencies interested in the central Passaic wetlands coordinate the development of a comprehensive wetland management plan. Close coordination will be required between the COE, the Service, the New Jersey Green Acres Program and Wildlife Preserves, Inc. The New Jersey Green Acres Program has acquired several hundred acres, and Wildlife Preserves, Inc. owns almost 2,500 ac. of the central Passaic wetlands.

2. Concur. Should the project be authorized, the establishment of a management plan would prove very beneficial.

3. All wetland losses will be considered in formulating final mitigation recommendations. The HEP to be conducted would account for wetland values and losses and thus, compensation necessary to accomplish the goals of the Service's mitigation policy. Certain hydrologic informa tion would aid in the implementation of HEP. Therefore, it is recommended that the COE conduct studies on Great Piece Meadows to determine flooding volumes in terms of depths, frequency, seasonal periodicity, duration and soil saturation. Vegetational conversion and thus, habitat suitability could be determined from information and data obtained through such studies (refer to item #1 above).

3. The Corps has extensively studied flood volumes, depths, stage-durations, velocity-durations, season periodicity, and soils. A substantial amount of this information has been forwarded to FWS for their analysis. Studies in Great Piece Meadows using the above information to determine habitat suitability and revegetational conversion to be used in a successional model referred to in recommendation 1 above, would await the detailed Phase II GDM planning. It should be noted however, that use of these models is not expected to appreciably alter mitigation as proposed by the Corps, since impact on wetlands is considered mitigated by preservation of natural storage areas, the placement of a weir, and revegetation.

4. Continue to investigate the feasibility of constructing a low-headwall dam or weir structure at the eastern discharge point of the Great Piece Meadows. This would insure continued flooding of the wetlands and thus, retain hydrophytic vegetation. This dam or weir should be designed as an adjustable structure to operate when the spur tunnel is open as well as during drought conditions. The weir should not make Great Piece Meadows a ponding area. The weir structure could confine wetland losses to those wetlands in the vicinity of the Passaic/Pompton Rivers confluence and along I-80.

4. Concur. The weir would be operated to prevent any permanent ponding of Great Piece Meadow.

5. The proposed I-80 levee system including associated ponding will result in loss of forested wetlands. Blocking the existing culverts as proposed will interfere with the hydrologic regime. It is recommended that the ponding area be modified (refer to item # 2 under "Acquisition Areas") and the culverts remain open.

5. Culverts must be closed during flooding events in order to insure the protection of the structures is Fairfield.

ROCKAWAY RIVER

1. The need to construct Rockaway River levee systems #1, #2 and #3 should be reevaluated and designed to follow the topographic contours. In the case of levees #1 and #3, proposed design will segregate wetlands from the watercourse.

2. Levees should be set-back from the watercourse and be constructed along the fringes of wetlands and floodplains. Further, levees should be vegetated with indigenous species and not prevent public accessibility to the watercourse.

3. Investigate the acquisition of developed floodplain areas for the purpose of floodplain reclamation.

4. Allow adequate floodplain and wetland inundation to continue.

ROCKAWAY RIVER

1. The Rockaway River levees were included to protect structures in the area. The alignment of the levees, which crosses some 12 acre wetland area is the most cost-effective alignment.

2. Concur. Where possible setback levees have been used and would be replanted. Access would be provided if desired by the non-Federal sponsor.

3. This has been investigated. The selected alternative at present includes all structures that can be economically justified for acquisition.

4. Except in the 12 acre wetland area the remaining wetlands would inundate as they do now.

MAINSTEM PASSAIC RIVER

1. Recreational boating on the lower Passaic River is limited due to a lack of accessibility to the watercourse. All existing public boat ramps should be identified and be incorporated into the final design of levee/ floodwall systems. Municipal boat ramps are located in Kearny and Lyndhurst.

2. Allow flushing of the channel and adequate flow regimes to continue. Flushing levels should be maintained to help dilute polluted river waters in the Paterson/Clifton area. According to the information provided by the COE, a minimum flow rate of 100 cfs during flood events will be maintained over Beatties Dam. This low volume flow may be periodically tolerated but is inadequate to maintain existing aquatic conditions. Mean annual flow at this location is approximately 1,100 cfs. The one-year flood event is approximately 6,100 cfs. The COE should also investigate the hydroelectric project that is being proposed by the Passaic Valley Water Commission in this area. The use of IFIM is recommended to quantify disturbances that are expected to result to the riverine ecosystem due to low flows.

3. The amount of river channel capacity reduced over time should be determined through monitoring.

4. Maintain adequate fish passage throughout the river.

5. Additionally, data regarding water velocities at the outlet structure should be submitted to the Service to assess potential adverse impacts to fishery resources.

MAIN STEM PASSAIC RIVER

1. Concur.

2. The flow over Beatties Dam would remain as is, at present, under non-flooding conditions which is an average 360 days per year. Only during flood events would flow over Beatties Dam be restricted.

3. See comment 4 above (Pompton River)

4. Concur.

5. As stated by FWS in this report, the Corps concurs that little impact on anadromous fish is likely to occur as a result of implementation of the project. Data on velocites is aw available and will be provided upon request, with the specific information desired (e.g. storm frequency versus velocity).

ACQUISITION AREAS

1. The proposed acquisition of natural storage areas, including wetlands, is very desirable part of the tunnel diversion plan. Continued loss of wetland and associated floodplain areas will result in greater flood frequencies and peaks. The purpose of acquiring and maintaining these areas is to insure the functional ability of the tunnel diversion system. In addition to accommodating the long-term operation of the tunnel, the acquisition of wetlands would provide for the protection of valuable wildlife habitat. It is unclear, however, what criteria were used by the COE to determine proposed acquisition areas, and why some important areas were omitted. For example, wetlands at the confluence of the Pequannock/Wanaque/Ramapo Rivers are not being considered for acquisition Ponding areas, except for the ponds associated with levee system #2A and the small acquisition area near the Passaic River in Essex County, are not, according to the delineation maps provided by the COE, being considered for acquisition. Additionally, all headwater regions of tributaries discharging into the central Passaic wetlands should be considered as important acquisition areas.

ACQUISITION AREAS

1. The land at the confluence of the Pompton/Wanaque/Ramapo Rivers would be purchased as part of the project, but it is not being purchased under the Preservation of Natural Storage Areas provision. Ponding areas associated with interior drainage portion of this project would be purchased. All areas currently undeveloped, would upon development contribute increased run off and decreased storage. Certain areas, specifically the natural flood storage areas from Chatham to Two Bridges on the Passaic, as well as the lower Rockaway and Whippany Rivers and adjacent to the Pompton River are considered essential for the development of the most cost-effective plan. The Corps model has taken into account development in headwater and upstream areas. An example is at the Chatham gage where development is expected to increase the runoff 4% between 1990 and 2040. This analysis was incorporated into the plan and affords appropriate protection.

The criteria used for acquisitions of natural storage areas include, the ability to store flood waters in substantial volume, their being contiguous to river sites, and their large size which would increase benefit to wildlife. For these reasons small, isolated areas far removed from the rivers were not included in the acquisition element of the plan.

2. A section off the Great Piece Meadows south of I-80 is proposed for acquisition and major ponding. Ponding will require that existing forested wetlands be replaced with grass depressions. It is recommended that a ponding area be developed here, but incorporate wildlife concerns (game and nongame) to increase waterfowl productivity and protect important habitat. If a series of ponds (not one large catch basin) are created, water should be retained for waterfowl brooding during March through May. Water levels in the ponds should be up to a depth of 1.5 ft. Furthermore, each pond should be surrounded by cattails. The forested wetlands provide important wildlife habitat and should be retained along borders of the cattail community. The series of ponds should be segregated by weir structures with some larger and deeper ponds intercepting the initial volume of water from flood events. The COE should coordinate closely with the New Jersey Division of Fish, Game and Wildlife (Bureau of Wildlife Management and Endangered and Nongame Species Program) in formulating a ponding design for this area. The state also has a concern for threatened and endangered species in this location.

2. Use of ponding areas for wildlife management (i.e. water fow nesting area) is presently under consideration. Their use for this purpose would be at least, in part based upon the suitability of each area and would need to be judged or an individua base. The Corps would coordinate with non-Federal sponsor to determine suitability to utilize these areas for wildlife management.

3. The existing drainage culverts along I-80 should not be blocked as proposed since this would interfere with the hydrologic regime of the Great Piece Meadows.

3. See Great Piece Meadows (#5).

4. It is unclear how the lands being considered for acquisition would be managed. It should be determined what lands in the central Passaic wet lands are currently in or are being proposed for state ownership or are in private ownership. The New Jersey Green Acres Program and particularly Wildlife Preserves, Inc., have considerable acreage that is either in their ownership or under investigation for purchase. These landowners should be closely coordinated with to formulate a comprehensive wetlands management plan for this area. These wetlands provide important wildlife habitat and should be retained. However, basic management techniques must be applied to improve the habitat quality and thus, the biological productivity of these wetlands. Invading common reed (Phragmites australis) and purple loosestrife (Lythrum salicaria), siltation, water quality, unauthorized filling and loss of open water are some major problems. The Service, therefore, recommends that in addition to acquiring sections of the central Passaic wetlands, a comprehensive wetlands management plan should be formulated as part of the overall tunnel project. The formulation of this plan would require the cooperation of the COE, the New Jersey Green Acres Program, Wildlife Preserves, Inc. and the Service.

4. The Corps has been in contact with NJ Green Areas Program regarding recently acquired state land. A management plan for the Central Basin, should the selected plan be authorized, would be beneficial and the Corps can help in formulating a plan

5. Former wetland and floodplain areas under development and frequently inundated should be investigated as additional acquisition areas. Criteria used to identify these areas could include the following: 1) how much channelization and levee/floodwall construction could be eliminated by floodplain reclamation and wetlands creation; 2) frequency and duration of flooding; 3) flood storage potential; 4) current land use; 5) size; 6) wildlife value; 7) proximity to existing natural areas or other areas under consideration for acquisition; 8) cost benefit ratio of implementing nonstructural flood control methods; and, 9) municipal support for acquisition as natural storage areas. Although cost benefit analysis usually justifies structural flood control methods, it would be interesting to calculate annual flood damages and extrapolate the long-term gains derived by implementing nonstructural methods. For example, annual flood damages in the PRB are estimated to be $76 million. How much of this cost would be repaid through floodplain reclamation and the purchase of floodplains and wetlands for natural flood storage?

5. The acquisition of floodplain land, both developed and undeveloped has been investigated. The acquisitions which is economically justified is included in the recommended plan. The investigations conducted considered the issues raised by FWS. The results of the 10 and 100 year buy-out plans revealed that they were not economically justified.

6. Ponding areas are important to the operational function of the project. It is unclear whether or not the ponding areas (except the ponding areas along I-80 and the small ponding area near the Passaic River) are included under the acquisition proposal. Further, the long-term mainte nance of the ponding areas is unclear. Grass-covered depressions may require minimal maintenance but in comparison to forested wetlands offer little value to wildlife. Therefore, it is recommended that wildlife habitat improvement techniques be incorporated into the design of the ponding areas. The COE should coordinate closely with the New Jersey Division of Fish, Game and Wildlife in formulating ponding designs (refer to item #2 under "Acquisition Areas").

6. Ponding areas are included as part of the project. The long term maintenance of the project is the responsibility of the non-Federal sponsor. Use of ponding areas for wildlife habitat management must be coordinated with the State of New Jersey (non-Federal sponsor).

7. The Black Meadows is one of the major wetland areas being considered for acquisition. The continued floodwater retention capability of this headwater wetland area is obviously important to the operation of the tunnel. Morristown Airport is within the Black Meadows. This airport was constructed on filled wetlands, is surrounded by the proposed acquisition lands on three sides, increases runoff and covers approximately 25% of the land surface area of Black Meadows. The airport should be evaluated as a site for wetlands creation, dependent upon bird-aircraft strike problems.

7. Purchase of Morristown Airport for wetland mitigation is not economically justified.

The concept of land acquisition for the purpose of compensation is addressed below under "Mitigation Recommendations."

MITIGATION RECOMMENDATIONS

MITIGATION PLANNING

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act [40 CFR Part 1508.20(a-e)] regulations to include the following:

(1) avoiding the impact altogether by not taking a certain action or parts of an action;

(2) minimizing impacts by limiting the degree or magnitude of the action and its implementation;

(3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

(4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and,

(5) compensating for the impact by replacing or providing substitute resources or environments.

The Service supports this definition of mitigation and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process.

X - Mitigation Recommendation

A - Mitigation Planning

The Corps recognizes the Services mitigation policy . The Corps has followed, to the extent practical, these criteria. Since the flood damages and loss of life are a given, some impact on fish and wildlife resources can be anticipated, therefore complete avoidance is not possible.

The Corps has endeavored to provide for FWS request to minimize impacts by providing for a weir placement in Great Piece Meadows and rectifying damage by replanting in easement areas. Further, impacts will be reduced with purchase of natural storage areas, a substantial portion of which is wetland. Compensation is also being provided in aquatic areas by use of pilot channels, use of cobble substrate, inclusion of aquatic habitat structures, and where possible, retaining trees which shade the river.

Quantified mitigation, including specific mitigation recommendations, would be further determined through the use of the proposed HEP in 1987. The HEP would provide a scientific basis for determining fish and wildlife habitat compensation requirements. Additionally, in order to formulate accurate projections needed to conduct a future HEP scenario and to increase the scientific validity of the HEP analysis, a plant community succession model may be applied concurrently. Plant succession, resulting from hydrologic changes via project implementation, will influence habitat suitability. The proposed HEP report would present the findings and conclusions of the HEP analysis, including supporting technical data and final mitigation recommendations.

See also,the Corps response under paragraph 5 of the General Evaluation Section regarding HEP,and the paragraph 3 of the section on Great Piece Meadows,regarding use of a plant sucession model.

LAND ACQUISITION

In addition to insuring the functional ability of the tunnel diversion system, land acquisition is being considered to protect natural storage areas including wetlands. Land acquisition in fee title for the purpose of compensation will be recommended by the Service only under one or more of the following three conditions:

(1) when a change in ownership is necessary to guarantee the future conservation of the fish and wildlife resources consistent with the mitigation goal for the specific project area; or

(2) when other means and measures for mitigation (aforementioned mitigation elements) will not compensate habitat losses consistent with the mitigation goal for the specific project area; or

(3) when land acquisition in fee title is the most cost-effective means that may partially or completely achieve the mitigation goal for the specific project area.

Service review of the wetlands being considered for acquisition, including mitigation planning goals via site specific resource category determinations, will be made on a case-by-case basis during the implementation of the HEP analysis in 1987.

B - Land Acquisition

The acquisition of land for this project is for accommodation of physical structures and any land needed to insure the integrity of the tunnel capacity to carry design flows. This includes the acquisition of substantial areas of natural storage, a large portion of which are wetlands. These wetlands would be held safe from development, thus they acquire protection with project implementation.

GENERAL RECOMMENDATIONS

Prior to an implementation of a scientific habitat evaluation method such as HEP or the application of a mitigation technology, the following general recommendations are summarized below. These recommendations are based upon the Service's best professional judgement regarding the selected tunnel diversion plan as proposed:

(1) eliminate or greatly reduce the proposed channelization and dredging on the Pequannock, Ramapo and Wanaque Rivers;

(2) retain vegetated wetland, floodplain and riparian areas, islands and backwaters along the Pequannock, Ramapo and Wanaque Rivers;

(3) formulate a wetlands reestablishment plan for emergent and scrub-shrub wetlands in areas where forested wetlands will be eliminated;

(4) determine what volume flow could bypass the tunnel intake structures and continue downstream while not requiring channelization of the Pompton and Passaic Rivers;

(5) maintain existing channel meanders, adequate fish passage and public accessibility to the watercourse throughout the project area;

(6) the need for each levee system should be reevaluated and if constructed, levees should be set-back from the watercourse along the outer fringes of wetlands and floodplains;

(7) investigate the acquisition of developed floodplain and wetland areas for the purpose of floodplain reclamation and wetlands creation;

General Recommendations:

1. The Corps plan formulation process has,and would continue to refine the project elements. These channel modifications which are included in the selected plan are essential to the proper functioning of the tunnel.

2. The vegetated wetlands, riparian habitat and islands would be retained to the maximum extent possible. Due to the need for levees, some 35 acres of riparian habitat would be lost and some islands would develop emergent vegetation around them.

3. Re-establishment and retainment of wetlands in the proposed project area, upstream of the Pompton Inlet, would be performed as appropriate.

4. This has been accomplished, that flow is 4,000 cfs. At present with limited buy-outs 4300 cfs (annual event) would be allowed to pass. Additional flows would require channel modifications downstream or economically unjustified (e.g. 0.6 B:C ratio) nonstructural measures.

5. Channel meanders would be maintained for a large majority (5.4 of 6 miles) of the modified channel. Adequate fish passage would be maintained as it now exists, except at the Pequannock feeder dam, where the new channel would actually facilitate fish passage. Public accessibility would not be blocked by the plans elements, however, accessibility must be approved by the non-Federal sponsor due to cost and liability constraints. Existing boat ramps would be continued.

6. Levees included in the final plan would be those which are economically justified and/or required for project integrity, setback levees have been used where possible.

7. This has been investigated and those areas that are justifie for acquisition and reclamation (5350 acres) have been incorporated into the plan.

(17) identify contaminants (particularly dioxins and PCB's), concentrations and the extent of their transport downstream of the tunnel outlet structure that would result from increased water velocities during tunnel operations.

(17) The State of New Jersey has done extensive bottom sampling and testing in the outlet area. Dioxin has been confirmed from this area. The State of New Jersey has committed to clean-up the river, with or without the implementation of the flood control project. This clean-up would be completed before the outlet would be functioning. Considering the above no further testing was deemed necessary.

(18) continue project planning with close coodination with the New Jersey Division of Fish,Game and Wildlife,and the Service.

(18) Close coodination with FWS and the State of New Jersey would continue now and in the future.

(8) allow floodplain and wetland inundation, flushing of the river channels and adequate flow regimes to continue;

8. Wetlands inundation has been accommodate to the maximum extent possible. This includes the proposed use of a weir near the downstream end of the Great Piece Meadows. Flushing of channels has been addressed and includes allowance for the passage of the one year event (4,300 cfs) immediately below the Pompton Inlet and 6100 cfs at Beatties Dam after peaks flows have occurred.

(9) redesign the proposed channel modification for the Pompton and Passaic Rivers to accommodate basic stream-improvement techniques;

9. Basic instream - improvement techniques such as meandered pilot channels, use of structures (e.g. single-wing, double-wing dam) and retaining of riparian cover where possible, would all be used to mitigate impacts.

(10) determine anticipated plant community succession from hydrologic changes in the Great Piece Meadows;

10. Specific anticipated plant community succession as a result of any hydrologic changes would require modeling, which has only recently available. Experience with early HEP usage have shown that substantial testing is necessary for new biological approaches before the tool can be used

(11) design a low-headwall dam or adjustable weir structure for the eastern discharge point of the Great Piece Meadows;

11. Concur, this feature of the plan is presently being designed.

(12) present a descriptive analysis of tunnel inlet operation, particularly in regard to how and who will regulate volume flow and thus, river flow regimes;

12. Concur, the final tunnel operating rule would spell out criteria for tunnel use.

(13) investigate the feasibility of acquiring headwater regions under the acquisition phase of the project;

13. This has been accomplished. Development of headwaters was included in our modeling effort. While runoff would increase and storage decrease, these increases and decrease have been included in the analysis of the plan and protection it affords. An example is at the Chatham Gage where development is expected to increase the runoff 4% between 1990 and 2040.

(14) formulate ponding designs that are compatible with fish and wildlife management;

14. The ponding areas are currently under investigation to use as wildlife management areas. Their inclusion as such would depend on the desires of the non-Federal sponsor (State of New Jersey).

(15) formulate a comprehensive management plan for the central Passaic wetlands;

15. A coordinated effort to formulate a comprehensive management plan for the central Passaic wetlands is recognized as very beneficial. Should this project be authorized the Corps would assist in setting up this plan.

(16) undertake a velocity/erosion study for river segments upstream of the Pompton and Two Bridges inlet structures.

16. Concur. A velocity erosion study for the river segments upstream of the Pompton, and Two Bridges Inlet would be undertaken during the Corps Phase II GDM studies to precisely define the operation and maintenance procedures for the project.