DRAFT

US Army Corps
of Engineers
New York District

General Design Memorandum

Passaic River
Flood Damage Reduction Project

Main Report and Supplement 1 to the Environmental Impact Statement

April 1984 Flood

September 1995

US Army Corps
of Engineers®
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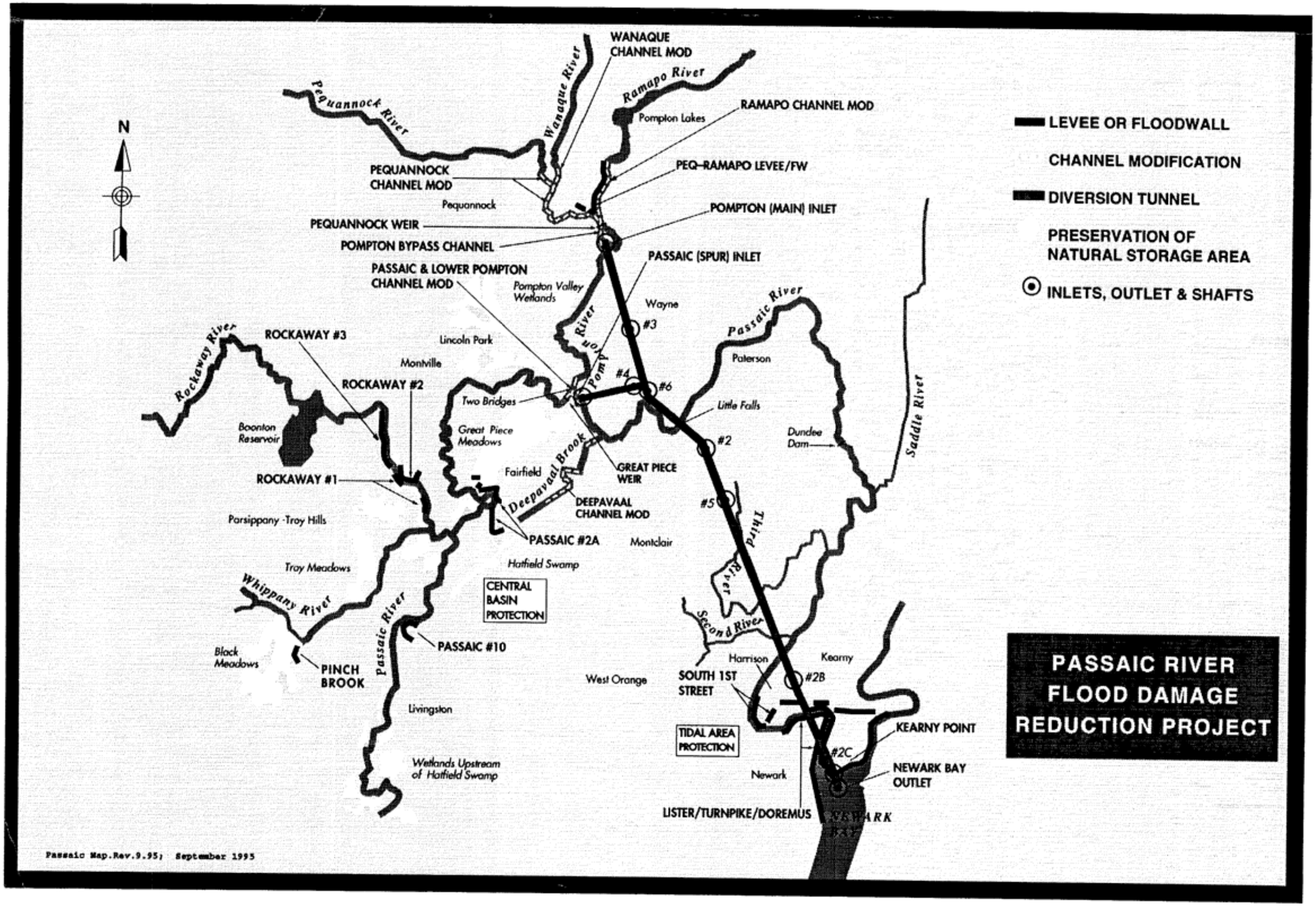
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PASSAIC RIVER FLOOD DAMAGE REDUCTION PROJECT

GENERAL DESIGN MEMORANDUM
Main Report and Supplemental Environmental Impact Statement

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SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1 OBJECTIVE

This General Design Memorandum[1] provides the information necessary for implementation of the authorized Passaic River Flood Damage Reduction Project. The authorized project is a product of the Phase I Advanced Engineering and Design studies conducted in response to Section 101 of the Water Resources Development Act of 1976. The objectives of this report are to:

- Establish the project details for each project element as the basis for Feature Design Memoranda (FDM) and construction plans and specifications.

- Establish a current project cost estimate.

- Detail the entire implementation process through construction.

- Establish the Federal and local sponsor responsibilities for construction, operation and maintenance.

1.2 CONTENT

While the main purpose of this report is to advance project implementation, it is also intended to meet the needs of everyone involved in the implementation process including decision makers, concerned public, and agency reviewers at all levels of government. Therefore, extensive information is included from the disciplines of engineering, economics, environmental sciences, and real estate appraisal. Also documented is the cooperation of numerous government agencies with whom the project was coordinated at every step.

1.3 FORMAT

The report is divided into a main report, the Supplemental Environmental Impact Statement and appendices. The main report and the Supplemental Environmental Impact Statement are for

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[1]Prepared in accordance with ER 1110-2-1150, Engineering and Design for Civil Works Projects, dated March, 1994 and EC 1110-2-268, Engineering Design for Civil Works Projects, dated 1 July 1991.

readers who desire a comprehensive view of the entire project. Readers wanting detail on all the technical studies and the coordination efforts with the various agencies may refer to the appendices to be found in report volumes as shown in **Table 1.**

Table 1: Report Organization

Contents
Main Report Supplemental Eis
Appendix A - Public Involvement Appendix B - Environmental Resources Appendix C - Hydrology and Hydraulics Appendix D - Cost Engineering Appendix E - Geotechnical Appendix F - HTRW Appendix G - Structural Appendix H - Real Estate Appendix I - Economics Appendix J - Passaic #10 Levee/Floodwall

MAIN REPORT

SECTION 2

PROJECT STATUS

2. PROJECT STATUS

2.1 AUTHORIZING LEGISLATION

The Passaic River Flood Damage Reduction Project was authorized for design and construction by Section 101(a)(18) of the Water Resources Development Act (WRDA) of 1990 (Public Law 101-640) on 28 November 1990 and amended by Section 102(p) of the Water Resources Development Act of 1992 (Public Law 102-580). A copy of Section 101(a)(18) as modified by WRDA 92 is included as **Figure 1.** This section of the Act authorized a variety of flood related measures under three major subsections as follows.

- Subsection A authorized the flood control project elements, defined as the cost-sharing, operation and maintenance responsibilities, particularly the Federal responsibility to operate the tunnel feature, and credits to be allowed for non-Federal work already in place in terms of specified in-kind services and flood protection works. It also authorized the establishment, operation and maintenance of a flood warning system at full Federal expense, before the tunnel system is completed.

- Subsection B authorized the construction of streambank restoration measures in the City of Newark, NJ, requiring construction to begin before other project elements.

- Subsection C authorized the establishment of a wetlands bank whereby the State of New Jersey would establish a Passaic River Central Basin Wetlands Bank, comprised of natural flood storage areas in the Central Basin. The purpose of this subparagraph is to evaluate and demonstrate, for application on a national basis, the feaibility and methods of obtaining an interim goal of no net loss if the Nation's wetlands base and a long-term goal to increase the quality and quantity of the Nation's wetlands. The lands in the bank would be available for mitigation purposes required under Federal or state law with respect to non-Federal activities in the state, which would continue to own and operate the lands consistent with project purposes. In addition, the state may acquire additional lands related by drainage or stream flow to protect the integrity of the bank; such lands can include transition and buffer areas adjacent to the Central Basin wetlands and other Passaic River Basin areas including the Rockaway, Pequannock, Ramapo, and Wanaque watershed area. The law also provides for the Non-Federal sponsor to be credited with the fair market value of these lands, aquired before, on, or after enactment of this act, as well as costs incurred in converting any of these lands to wetlands, toward its share of the cost of this project and any other flood damage reduction project in the Passaic River Basin.

2.2 PROJECT UNDER IMPLEMENTATION

This report focuses on the flood damage reduction project authorized in subsection A of the authorizing legislation and addresses the cost-sharing credits related to the wetlands bank and additional watershed lands described in subsection C. The streambank restoration measures authorized in subsection B are the subject of a separate report and are, therefore, not addressed in this report.

The authorized flood damage reduction project under implementation is based on the report of the Chief of Engineers, dated February 3, 1989, except that the main diversion tunnel was rerouted to discharge into Newark Bay. The project was authorized at a total cost of $1.2 billion, with an estimated Federal cost of $890 million and an estimated cost of $310 million, all at October 1989 price levels. That project has undergone a number of design refinements that are discussed in Section 6 - Changes, of this main report.

The project under implementation involves the construction of a tunnel flood diversion system and associated works consisting of channel modifications, gated weirs, levees and floodwalls, and the preservation of natural storage areas. Other project features include recreation facilities, environmental mitigation and a wetlands bank.

2.3 STATUS

Upon completion, and with the support of the non-Federal sponsor, this General Design Memorandum will accompany a project cooperation agreement in support of a request that construction funds be included in the Corps of Engineers budget. If Congress acts favorably and appropriates funds, the engineering and design will continue and actual construction may begin. The implementation process is described in detail in Section 14 - Implementation, of this main report.

SUBJECT: Passaic River Main Stem, New Jersey and New York, -Water Resources Development Act of 1990, Section 101 (a)(18) - Modified by WRDA 1992

SECTION 101 (a)(18)(A) FLOOD CONTROL ELEMENTS

(i) IN GENERAL. - The project for flood control, Passaic River Main Stem, New Jersey and New York: Report of the Chief of Engineers, dated February 3, 1989, except that the main diversion tunnel shall be extended to include the outlet to Newark Bay, New Jersey, at a total cost of $1,200,000,000, with an estimated first Federal cost of $890,000,000 and an estimated first non-Federal cost of $310,000,000.

(ii) DESIGN AND CONSTRUCTION. - The Secretary shall design and construct the project in accordance with the Newark Bay tunnel outlet alternative described in the Phase I General Design Memorandum of the District Engineer, dated December 1987. The main diversion tunnel shall be extended approximately 6 1/2 miles to outlet in Newark Bay, the 9 levee systems in Bergen, East Essex, and Passaic Counties which were associated with the eliminated Third River tunnel outlet shall be excluded from the project, and no dikes or levees shall be constructed along Passaic River in Bergen County in connection with the project. With respect to the Newark Bay tunnel outlet project, all acquisition, use, condemnation, or requirement for parklands or properties in connection with the excluded 9 levee systems and the eliminated Third River tunnel outlet works, and any other acquisition, use or condemnation, or requirement for parkland or properties in Bergen County in connection with the project, is prohibited. The Secretary shall certify to the Committee on Public Works and Transportation of the House of Representatives and the Committee on Environment and Public Works of the Senate that no detrimental flood impact will accrue in Bergen County as a result of the project.

(iii) APPLICABILITY OF COST SHARING. - Except as otherwise provided in this paragraph, the total project, including the extension to Newark Bay, shall be subject to cost sharing in accordance with section 103 of the Water Resources Development Act of 1986.

(iv) OPERATION AND MAINTENANCE. - The non-Federal sponsor shall maintain and operate the project after its completion in accordance with the regulations prescribed by the Secretary; except that the Secretary shall perform all measures to ensure integrity of the tunnel, including staffing of operation centers, cleaning and periodically inspecting the tunnel structure, and testing and assuring the effectiveness of mechanical equipment at gated structures and pump stations.

(v) CREDIT FOR NON-FEDERAL WORK. - In recognition of the State of New Jersey's commitment to the project on June 28, 1984, all work completed after such date by the State or other non-Federal interests which is either compatible with or complementary to the project shall be considered as part of the project and shall be credited by the Secretary toward the non-Federal share of the cost of the project. Such work shall include, but not be limited to, those activities specified in the letter of the New Jersey Department of Environmental Protection, dated December 9, 1988, to the Office of the Chief of Engineers. However, only the portion of such work that meets the guidelines established under section 104 of the Water Resources Development Act of 1986 shall be considered as project costs for economic purposes. In applying such section 104 to the project, the Secretary shall likewise consider work carried out by non-Federal interest after June 28, 1984, and before the date of the enactment of this Act that otherwise meets the requirements of such section 104.

(vi) FLOOD WARNING SYSTEM. - The Secretary is authorized to establish, operate, and maintain, at full Federal expense, the Passaic River flood warning system element of the project before completion of construction of the tunnel element of the project.

(B) STREAMBANK RESTORATION MEASURES. - The project shall include the construction of environmental and other streambank restoration measures (including bulkheads, recreation, greenbelt, ~~and scenic overlook facilities~~ and public access to Route 21) on the west bank of the Passaic River between Bridge and ~~Jackson~~ Brill Streets in the city of Newark, New Jersey, at a total cost of ~~$6,000,000~~ $25,000,000. The project element authorized by this subparagraph shall be carried out, in cooperation with the city of Newark, so that it is compatible with the proposed reconstruction plans for Route 21 and the proposed arts center. The non-Federal share of the project element authorized by this subparagraph shall be 25 percent. The value of the lands, easements, and rights-of-way provided by non-Federal interests shall be credited to the non-Federal, share. Construction of the project element authorized by this subparagraph ~~may be undertaken~~ shall be undertaken in advance of the other project features and may not await implementation of the overall project.

(C) WETLANDS BANK. -

(i) PURPOSES. - The purposes of this subparagraph are to evaluate and demonstrate, for application on a national basis, the feasibility of and methods of obtaining an interim goal of no overall net loss of the Nation's remaining wetlands base and a long-term goal to increase the quality and quantity of the Nation's wetlands; of restoring and creating wetlands; of developing public and private initiatives to search out opportunities of restoring, preserving, and enhancing wetlands; and of improving understanding of the function of wetlands ecosystems in order in improve the effectiveness of the Nation's wetlands program, including evaluating the functions and values wetlands,

assessing cumulative impacts and the effectiveness of protection programs, and wetlands restoration and creation techniques.

(ii) ESTABLISHMENT. - The State of New Jersey shall establish a Passaic River Central Basin Wetlands Bank (hereinafter in this paragraph referred to as the "Wetlands Bank") to be comprised of lands which are acquired before, on, or after the date of the enactment of this Act by the State or any other non-Federal interest and which lie within the Passaic River Central Basin, New Jersey, natural storage area discussed in the report of the Chief Engineers and the Phase I General Design Memorandum.

(iii) USE. - The Wetlands Bank shall be available for mitigation purposes required under Federal or State law with respect to non-Federal activities carried out in the State.

(iv) COMPENSATION. - The State may receive compensation for making lands available under clause (iii).

(v) STATE OWNERSHIP AND OPERATION. - The State shall continue to own and operate, consisted with the purpose of the project authorized by this paragraph, lands made available for mitigation purpose under clause (iii).

(vi) ACQUISITION OF ADDITIONAL LANDS. - The State or other non-Federal interests may acquire for the purpose of assuring the integrity of the Wetlands Bank additional lands which are in, adjacent to, or provide drainage for runoff and streamflows into the storage area described in clause (ii) and may use funds provided by sources other than the State for such purpose. Such lands shall include transition and buffer areas adjacent to the Central Basing natural storage wetlands and other Passaic River Basin areas, including the Rockaway, Pequannock, Ramapo, and Wanaque River watershed areas.

(vii) CREDIT. - The fair market value of lands acquired by the State or other non-Federal interests in the Storage area described in clause (ii) before, on, or after the date of the enactment of this Act, the fair market value of the additional lands acquired for the integrity of the Wetlands Bank under clause (vi) before, on, or after such date of enactment, and the costs incurred by the State or other non-Federal interests in converting any of such lands to wetlands shall be credited to the non-Federal share of the cost of the project authorized by this paragraph, and any other flood control project in the Passaic River Basin.

(viii) TREATMENT OF ACQUIRED LANDS. - Lands acquired by the State ~~for the Wetlands Bank~~ in accordance with clauses (ii) and (vi) shall not be treated as a project cost for purposes of economic and financial evaluation of the project.

(ix). EFFECTS ON OTHER LAWS. - Nothing in this subparagraph shall be construed as affecting any requirements under section 404 of the Federal Water Pollution Control Act (33 U.S.C. 1344) or section 10 of the Act of March 3, 1899 (33 U.S.C. 403).

MAIN REPORT

SECTION 3

DEVELOPMENT OF THE PROJECT

3. DEVELOPMENT OF THE PROJECT

3.1 OVERVIEW

Major flood damage has occurred frequently since before the turn of the century and has continued to increase as the basin developed. The problem has been studied extensively at both the State and Federal level and many solutions have been proposed but none have been built due to lack of support. The project under implementation is the product of extensive planning that considered the diverse concerns in the Passaic River Basin.

3.2 PLANNING BY NEW JERSEY

Many reports on the development of water resources in the Passaic River Basin have been completed. These reports date back to colonial times when the main emphasis of the studies was on irrigation of the Central Basin, flood protection and navigation in the Lower Valley. The most comprehensive of these reports, published in 1931 by the New Jersey State Water Policy Commission, considered several alternative plans and made an inventory of the total flood control benefits which might be delivered in the Passaic River Basin from each plan. 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.

3.3 PLANNING BY THE CORPS OF ENGINEERS

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 plagued by controversy and indecision. In the 60 years since the Corps of Engineers was first directed to plan solutions to the Passaic Basin's flood problems, lack of consensus has prevented the implementation of any of the six plans that were recommended. This strong opposition centered on: 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. Opposition, based on environmental, economic and social factors, was expressed by various Passaic River Basin interests, including government agencies, organizations and individuals. The many levels of political jurisdiction in the basin has further complicated the resolution of the numerous issues surrounding flood control planning. As a result, the people of the Passaic River Basin remain threatened by economic losses, hazards to health and the threat of injury and loss of life. Following are major events in the history of Corps planning in the Passaic River Basin.

- 1939. As a result of the 1936 Act, a survey report was submitted to the Chief of Engineers in March, 1939. The report recommended a plan consisting of a dry flood detention reservoir on the Pompton and Passaic Rivers at Two Bridges and channel modifications in the Passaic River from Two Bridges to Little Falls. Local interests in the Passaic Basin consumed considerable time in reviewing the report in attempting to resolve their differences, and in April, 1945 it was returned to the District Engineer for updating of changed conditions.

- 1948. In October 1948, a revised report was submitted. It recommended a dam and reservoir at Two Bridges for flood control and water supply, channel modifications downstream of the reservoir, and local flood protection projects at Passaic, Clifton, Lodi and Haledon. This report was returned to the District Engineer in March, 1950 for further study because of the divergent views of local interests.

- 1962. In June 1962, the District Engineer responded to the Governor of New Jersey's expressed desire for a comprehensive plan by submitting an updated and revised draft report. It recommended favorable action on an alternative plan that provided for flood detention reservoirs at Oakland and on the Whippany River, a multiple purpose reservoir on the Passaic River at Millington, channel improvements from these reservoirs to Beatties Dam and along the lower Passaic River, and a 45-foot diameter diversion tunnel from Little Falls to an outlet on the Passaic River at Nutley. This draft report was returned to the District Engineer in October 1962 for further study because of the divergent views of local interests.

- 1969. The 1969 survey report responded to the governor's request for a plan that emphasized conservation storage for water supply in conjunction with flood detention. It recommended a multiple purpose dam and reservoir at Two Bridges for flood control, water supply, hydropower and pollution abatement. The plan also included levees and floodwalls on the Pompton River, and local protection works in the Central Basin and Lower Valley.

- 1972. The most recent survey report prepared by the Corps of Engineers was issued in June 1972 and recommended a plan consisting of a multiple purpose reservoir at Two Bridges for flood control, water supply and water quality in addition to a smaller multiple purpose dam and reservoir at Myers Road on the Upper Passaic in Millington, NJ. It also included channel improvements along the Passaic, Pompton, Pequannock, Wanaque and Ramapo Rivers, and local protection projects at Lodi, Oakland, Denville, Mahwah and Haledon in New Jersey, and at Sloatsburg, New York. The Board of Engineers for Rivers and Harbors, reviewing the report, responded to local concerns by requesting the District Engineer to develop a new alternative to maximize flood protection with minimum environmental impact.

- 1973 The supplemental report identified a flood control plan consisting of a dry detention reservoir at Two Bridges, N.J., which would also include recreation; diversions, channel modifications and local protection works on the Passaic and Pompton Rivers; and tributary local protection works on Molly Ann's Brook at Haledon, NJ; Saddle River at Lodi, NJ; Ramapo River at Oakland, NJ; Mahwah River at Suffern, NY; Nakoma Brook at Sloatsburg, NY; and Rockaway River at Denville, NJ. This became the first Corps of Engineers plan to reach Congress for action, which was ultimately to authorize the Corps to conduct a Phase I Advanced Engineering and Design study.

Subsequent to the completion of the 1972 report as supplemented in 1973, the basin underwent major change that reduced the options available for flood protection. Development occurred on the site of the proposed dry detention reservoir, greatly increasing the cost of acquiring residential, commercial and industrial properties, rendering reservoir plans highly uneconomical.

An alternative to reduce acquisitions would have been to extend the lengths and increase the heights of the proposed levees and floodwalls in order to protect existing development from the ponded waters of the detention reservoir during periods of flooding. However, this alternative was also found to be prohibitively expensive and economically infeasible. The futility of considering reservoir alternatives any further had been confirmed.

3.4 PHASE I ADVANCED ENGINEERING & DESIGN STUDY

Section 101(a) of the Water Resources Development Act of 1976 (Public Law 94-587) authorized the Passaic River Basin Phase I Advanced Engineering and Design Study. The Study followed Congressional guidelines included in the U.S. House of

Representatives Report No. 94-1702, which is the House Public Works and Transportation Committee's 27 September 1976 report on the 1976 Water Resources Development Act. This guidance precluded further consideration of any plan that relies on extensive use of dikes, dams and levees such as those proposed in previous studies.

Under the Phase I study, solutions to the flood problems in the Passaic River Basin, along with allied purposes, were considered for the Passaic River and its tributaries. Studies of all areas were conducted to a level of detail necessary to determine whether flood control solutions have the potential for feasibility as Corps of Engineers projects. Reports recommending Federal flood control were completed for several problem areas in the basin. The Final Report on Flood Protection Feasibility, Remaining Tributaries, was published in January 1990, and summarized all investigations under the Phase I authority.

Flood problems were investigated in 46 municipalities in the Lower Valley and Central Basin. The problem area included the Main Stem Passaic River from its mouth upstream to Millington, N.J., the Pompton River, the lower Ramapo, Wanaque, Pequannock, Whippany and Rockaway Rivers, and numerous small tributaries affected by backwater flooding from the Passaic River, such as Fleischer's Brook, Peckman River, Singac Brook and Deepavaal Brook. The following reports were prepared on the Passaic River and Major Tributaries.

- Feasibility Report. The Phase I Advanced Engineering and Design study authorized in the Water Resources Development Act of 1976 resulted in the Phase I General Design Memorandum, or feasibility report, that included an environmental impact statement (EIS) for the Main Stem Passaic River. It was completed in December, 1987. The report recommendations were concurred in by the Board of Engineers for Rivers and Harbors in July, 1988 and by the Chief of Engineers in February, 1989. The Assistant Secretary of the Army transmitted the report to the Office of Management and Budget for review in October, 1989. The recommended plan consisted of a 39 foot diameter, 13.5 mile long main tunnel; a 22 foot diameter, 1.2 mile long spur tunnel; 5.9 miles of channel modifications; 37.3 miles of levees and floodwalls, and preservation of 5,350 acres of flood storage, 5,200 of which are wetlands. This plan would protect flood-prone areas along the Passaic, Pompton, Pequannock, Wanaque, Ramapo, Rockaway and Whippany Rivers, and Deepavaal and Pinch Brooks.

Three measures identified as possible basin-wide interim projects were also studied under the overall Passaic River Basin Phase I Advanced Engineering and Design authorization.

- Emergency preparedness. A study on flood emergency preparedness including a flood warning system was conducted under the continuing authority for small projects (Section 205 of the 1948 Flood Control Act). It resulted in the Detailed Project Report that recommended a project for authorization. The low Federal first cost of the recommended plan and the relatively short implementation period made the small project program most effective to the need for implementing this flood warning system in the Passaic River watershed. The plan was to improve the timeliness, accuracy and reliability of flood warnings throughout the Basin. It included the establishment of local self-help programs, increased rain and stream gage density and automation, flood warning, flood hazard mapping, improved computer software and flood warning hardware facilities, and enhanced local response programs. The report was approved by the Chief of Engineers in September, 1984 and plans and specifications were subsequently completed by the New York District. The Secretary of the Army approved the recommended plan for construction and signed a Local Cooperation Agreement with the State of New Jersey on 30 October 1986. The installation was completed in 1988 and the project is now operational. The project will be the primary data source governing the operation of the Passaic River Flood Damage Reduction Project.

- Preservation of Natural Flood Storage. The study resulted in a recommendation for no interim action, but for further consideration as an early action measure in conjunction with the overall Main Stem Passaic River Study. The authorized flood damage reduction project contains preservation of key Central Basin natural flood storage areas as a nonstructural project element.

- Snagging and clearing. These measures were investigated as a potential basin-wide interim action as part of the channel clearing feasibility study for the Passaic River and tributaries. However, such measures were determined to be economically infeasible.

3.5 SUMMARY

The flood emergency preparedness project is in place and has since been updated with newer computers and software by the Federal Government. No further action was taken on the snagging and clearing plan. With regard to the Main Stem feasibility plan, it is worthwhile to note that the authorized project evolved from more than 150 plans presented in public meeting in the early 1980's consisting of combinations of channel modifications, levees and floodwalls, upstream reservoirs, flood plain evacuation (buyout), floodproofing of structures, raising structures, diversion tunnels, and other measures. In June 1984, of the State of New Jersey through its NJDEP Commissioner Hughey developed criteria for plan selection and determined that the a dual inlet tunnel plan best met those criteria and asked the Corps of Engineers to proceed into feasibility design of this plan in 1988, Governor Kean committed the State to working with the Corps on the project to ensure project authorization and resolve fine-tuning decisions during the design of the plan. The project was authorized by the Water Resources Development Act (WRDA) of 1990 and WRDA 1992. These authorizations are the basis for the current project.

MAIN REPORT

SECTION 4

BASIN DESCRIPTION

4. BASIN DESCRIPTION

4.1 OVERVIEW

This section briefly describes the physical features of the Passaic River Basin that produce floods and govern design of the plan of protection. A brief discussion of the flood damage potential in the basin is included along with historical data on flood damages.

4.2 PHYSICAL CHARACTERISTICS

The Passaic River Basin, shown in **Figure 2**, drains an area of 935 square miles of which 787 are in New Jersey and 148 are in New York. Seven major tributaries bring water into the main stem of the Passaic River. They are the Whippany, Rockaway, Pompton, Pequannock, Wanaque, Ramapo and Saddle Rivers. See **Table 2** for data on the characteristics of the Passaic River and its major tributaries.

Of primary significance to the flood problem are the three distinctly different regions that comprise the basin, as delineated in **Figure 3.** The mountainous and heavily wooded Highland Area is 500 square miles in extent, 13 miles wide and 38 miles long. It has steep sided narrow valleys and rushing streams and many natural and artificial lake areas. Development is mostly rural in character and there is much open land. The Ramapo, Wanaque and Pequannock Rivers join to form the Pompton River, which flows into the Passaic River.

The Central Basin is 262 square miles in extent, 9 miles wide and 30 miles long. Low lying and marshy lands adjacent to the various streams form extensive frequently inundated floodplains totaling 21,000 acres above Little Falls. These floodplains include the Great Piece Meadows, Hatfield Swamp, Troy Meadows, and Black Meadow as well as the Bog and Vly Meadows adjacent to the Pompton River. The Passaic River passes out of the Central Basin through the narrow rock gorge restriction at Little Falls. Although the Whippany River and Rockaway River tributaries flow as rapidly as streams in the Highland Area, the flood effect is greatly dampened by broad floodplains in their lower reaches and the slow rising of the Passaic.

Table 2 - Passaic River Basin Descriptive Data

CLIMATIC DATA

Annual temperature; 48 F at Charlottesburg and 57 F at Newark
Average rainfall: 48.0 inches
Winds, prevailing direction: Northwest
Average number of rainy days: 121
Average annual snowfall: 33.7 inches
Mean annual relative humidity: 67 - 73%
Average growing season: 171 days

STREAM DATA

Stream	Location	Distance above mouth in miles	Drainage area in square miles	Length in miles	Slope in feet per mile
Passaic River					
At mouth	Newark	0.0	935.0	87.6	7.9
At Dundee Dam	Clifton	17.40	809.9	70.2	8.9
At Beatties Dam	Little Falls	29.7	762.2	57.9	8.5
At Two Bridges	Lincoln Park	33.0	740.8	54.6	9.0
Pompton River	At mouth	0.0	378.1	44.8	21.0
Pequannock river	At mouth	0.0	192.6	30.8	35.2
Wanaque River	At mouth	0.0	108.1	25.0	33.0
Ramapo River	At Pompton Lakes	0.0	160.0	35.8	25.1
Rockaway River	At mouth	0.0	205.7	43.0	26.8

The Lower Valley is 173 square miles in extent, about 7 miles wide and 24 miles long. Heavily urbanized and densely populated, the valley has rolling sides and a comparatively wide rolling bottom land that narrows down to about three-quarters of a mile below Dundee Dam. The major tributary in the Lower Valley is the Saddle River which joins the Passaic about 15.5 miles upstream of Newark Bay. Areas downstream of Dundee Dam are subject to high water levels from tidal events as well as from flow in the Passaic River.

Significantly, the three regions play different roles in producing floods. The rapidly flowing streams in the Highland Area are the greatest flood producers, the effects of which are suffered in the floodplains of flat and slower flowing streams in the Central Basin. In basin-wide floods, the Pompton River peaks at Two Bridges one to two days sooner than the Passaic River. Flooding in the Central Basin upstream of Two Bridges is aggravated by very flat stream slopes of the Central Basin area and the restriction upstream of Little Falls. This promotes the storage of flood waters in those areas thus reducing the flood peaks in the Lower Valley. Flashy tributaries in the Lower Valley below Little Falls peak earlier than the Passaic because of the large runoff from their urbanized watersheds. Flood stages in the Lower Valley are also aggravated by high tides, northeasters and hurricanes. Portions of the Lower Valley floodplain are also affected by coincident flows from the Hackensack River. However, the flooding impact of the Hackensack River is insignificant in comparison to damage caused by tidal events.

4.3 SOCIOECONOMIC FACTORS

The patterns of development and land use in the Passaic River Basin are products of the post-World War II trend of urbanization 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 basin, the Passaic River Basin displays all the characteristics 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 extent, 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.

Suburban development 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 acres (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 less expensive land and the 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. The extensive relocation of commerce and industry, and the jobs they provide to the suburbs, have made commutation feasible from new residential suburbs.

4.4 FLOOD DAMAGE POTENTIAL

Major economic activities and land uses in the basin are related to residential, commercial and industrial development. Numerous highways and railroads traverse the area. Communities in the eastern portion of the basin are older with high density multi-family housing and a large industrial base. Such is the case in cities as Newark, Kearny, Harrison, Passaic and Paterson. Near the mouth of the Passaic River there are many port-related activities devoted to the transfer of goods and materials.

With respect to flood-prone communities, the project area consists of 35 communities whose boundaries are partially or entirely within the flood plain. The 35 communities cover a land area of 246 square miles and had a 5.52% reduction in population to 1,068,000 between 1980 and 1990. The area that would be inundated by the 100-year flood is shown on **Figures 93** through **134.**

The Passaic River basin has a long history of flooding dating back to the early 1800's. The flood of October, 1903 is the worst flood on record for most of the basin while the flood of July, 1945 produced record effects on several tributaries. If the 1903 flood were to recur under current conditions of development, the expected damages would amount to about $2,492,000,000 at October, 1994 prices. The most devastating recent flood occurred in April, 1984, when three lives were lost and about $493 million in damages were incurred by about 6,400 properties. Over 9,000 people were evacuated from their homes. The 1984 flood can be expected to be equalled or exceeded once every 25 to 50 years. The basin was most recently declared a major disaster area in lower Essex and Hudson counties during the storm surge from Newark Bay in December, 1992.

The three areas in the basin that are subject to the most serious flooding are:

- The highly developed business, industrial and residential area in the Lower Valley along the Passaic River from Newark upstream to Little Falls.

- The Pompton River Valley.

- The Central Basin, along the Passaic River from Little Falls upstream to Chatham, and the lower reaches of the Rockaway and Whippany Rivers.

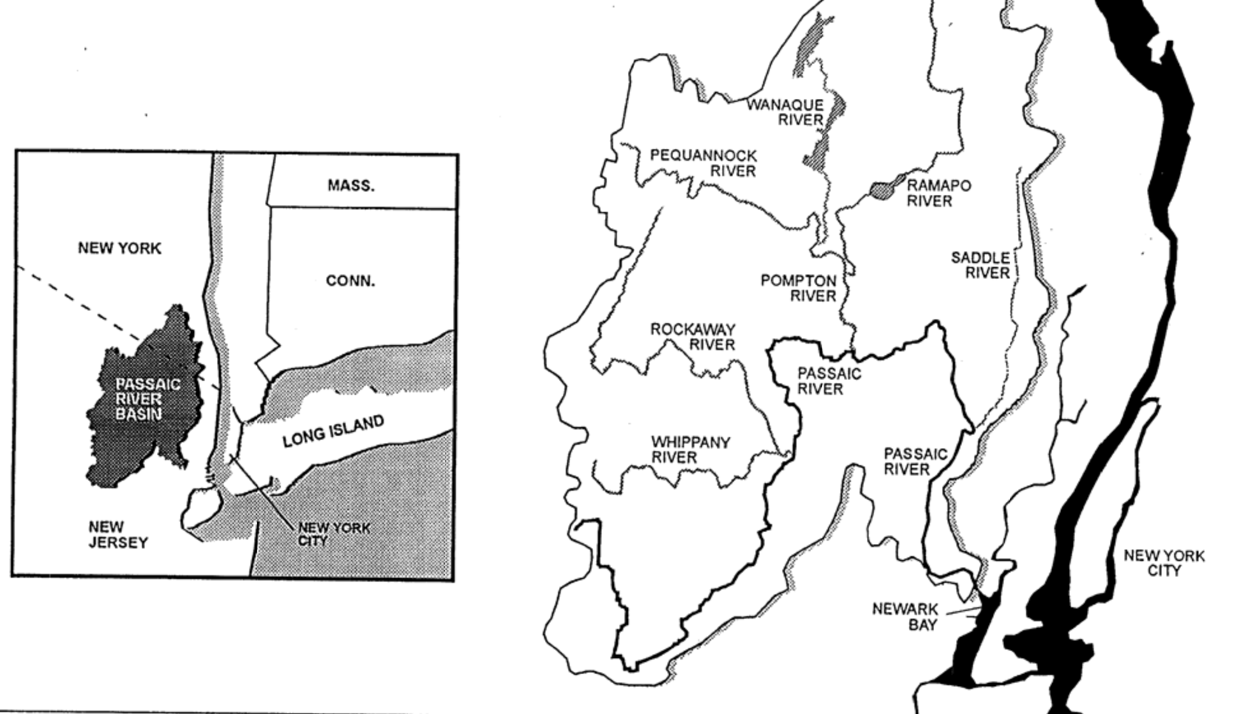
The total average annual damages in the basin are estimated at $116,016,000 at October, 1994 prices, of which $49,164,000 is in the Lower Valley, $33,501,000 is in the Central Basin and $33,351,000 is in the Pompton Valley. Damages are expected to increase due to continued urbanization and development of natural flood storage areas. About 23,000 structures and places of business would be flooded by the 500-year event, causing about $3.2 billion in damage. For the 100-year flood the structures affected would number about 19,500 and suffer about $1.6 billion in damage. See **Table 3** for pertinent data on flood damages.

Table 3 - Flood Damages in the Passaic River Basin
(In October, 1994 dollars)

MAJOR RECENT FLOODS	
Event	Damages
May, 1968	$98,800,000
November, 1977	240,000,000
April, 1984	462,007,000
AVERAGE ANNUAL DAMAGES	
Category	Annual damages
Residential	$28,335,400
Commercial	27,310,800
Industrial	38,978,700

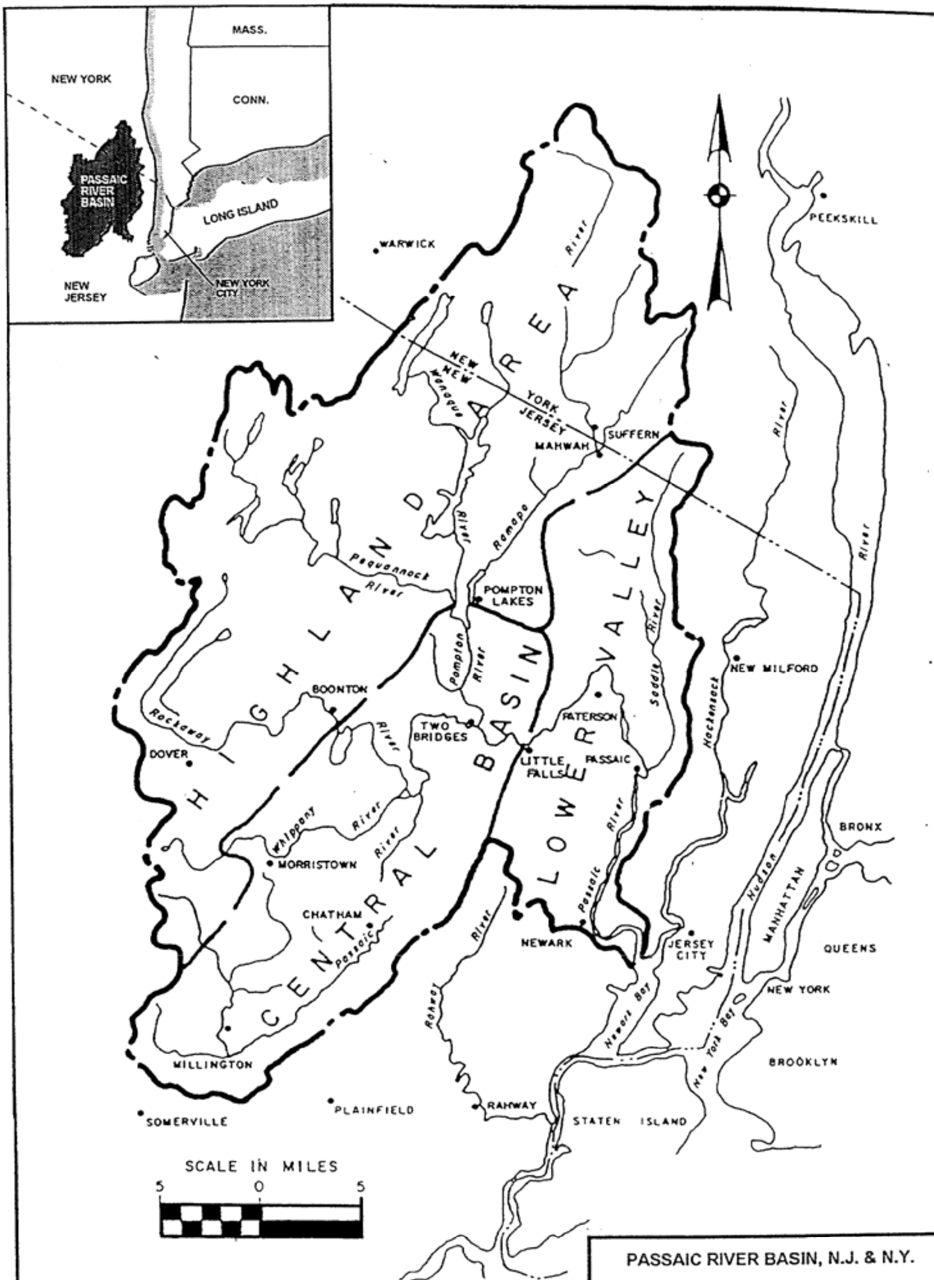
Utilities	1,126,200
Municipal	20,264,700
Total	116,016,000

PASSAIC RIVER BASIN



mapmain.cdw/9-6-95

FIGURE 2



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

TOPOGRAPHIC REGIONS

FIGURE 3

MAIN REPORT

SECTION 5

PROJECT DESCRIPTION

5. PROJECT DESCRIPTION

5.1 OVERVIEW

The Passaic River Flood Damage Reduction Project comprises structures and land management measures to establish and maintain a high level of flood protection in the Passaic River Basin. The project will reduce the average annual flood damages by 89%. The main protective feature of the plan, a large underground diversion tunnel system, will be supplemented with levees, floodwalls, channel modifications and preservation of natural flood storage. The project will reduce flood levels at major damage areas in the Pompton River Valley, the Central Passaic Basin and the Lower Valley of the Passaic River Basin. Beautification and recreational features are included with certain elements of the project. This section includes a brief description of the project as well as details on each element of the project. An overview of the entire project is shown at the front of this book and on **Figure 4** in the accompanying volume of figures. The area that would be inundated by the by the 100-years flood with the project in place is shown on Figure 93 through 134. Summary data on the project are displayed in **Table 4**.

5.1.1 Tunnel System. The tunnel system, shown in **Figures 5** through **30**, will consist of two parts. The main tunnel will be 20.4 miles long and 42 feet in diameter; it will carry floodwaters from an inlet on the upper Pompton River to an outlet in Newark Bay, 1,850 feet offshore of Kearny Point. The second tunnel will be a 1.3-mile long spur tunnel, 23 feet in diameter, that will convey Central Basin floodwaters from an inlet on the Passaic River, just downstream of the confluence of the Passaic and Pompton Rivers at Two Bridges, to an underground connection with the main tunnel. The tunnel system is designed to protect against the 100-year flood event. Eleven shafts will be built at various locations for construction access, removal of material and other purposes.

To direct the floodwaters into the inlets, 5.5 miles of channels in the Passaic, Pompton, Pequannock, Wanaque, and Ramapo rivers will be modified. A levee/floodwall system, consisting of 0.4 miles of levee and 0.6 miles, of floodwall will be provided to prevent flooding by water as it flows to the Pompton Inlet. In addition, gated weirs will be built on the Passaic and Pequannock Rivers to prevent upstream headcutting, minimize erosion potential and protect existing wetlands.

5.1.2 Central Basin Protection. Seven local systems, shown in **Figures 31** through **71**, consisting of levees, floodwalls and channel modifications, will protect flood problem localities on the Passaic River and tributaries. Each system includes interior flood damage reduction facilities, such as culverts, ponding areas and pumping stations, to either hold or safely pass runoff from protected areas during floods. Recreation and beautification features are included at various locations. These features include such items as hiking trails, bicycle trails and aesthetic treatment of levees and floodwalls. The Central Basin Systems are as follows:

- Passaic River Levee/Floodwall System #2A
- Passaic River Levee System #10
- Deepavaal Brook Channel Modification
- Rockaway River Levee/Floodwall System #1
- Rockaway River Levee System #2
- Rockaway River Levee/Floodwall System #3
- Pinch Brook Levee/Floodwall System

5.1.3 Tidal Area Protection. Three local systems, shown in **Figures 72** through **91**, consisting of levees and floodwalls, will protect flood problem localities in the Lower Valley from tidal flooding. Each system includes interior flood damage reduction facilities, such as culverts and pumping stations, to dispose of runoff from protected areas during floods. Recreation and beautification features are included at various locations. The tidal protection systems are as follows:

- Kearny Point Levee/Floodwall System
- Doremus/Lister/Turnpike Levee/Floodwall System
- South 1st Street Levee/Floodwall System

5.1.4 Preservation of Natural Storage. The project includes the preservation of 5,350 acres of natural storage in the Central Basin to prevent increases in flood flows caused by the loss of such areas to development. Of that area, 5,200 acres are wetlands. The area to be preserved is shown in Figures 111-114, 120-125, 128-131, 133 and **134**.

5.1.5 Fish and Wildlife Mitigation. Wherever possible, adverse impacts were mitigated by including environmental measures into the design of each channel modification, levee, floodwall or other structure. In those cases where impacts could not be addressed in the design of specific elements, mitigation measures were provided separately from the project elements.

5.1.6 The remainder of this section describes each element of the project in detail.

Table 4 - Project Data

Authorization	Water Resources Development Act of 1990 as modified by the Water Resources Development Act of 1992.
Location	State of New Jersey in the Counties of Bergen, Essex, Hudson, Morris, and Passaic
Streams	Passaic, Rockaway, Pompton, Pequannock, Wanaque and Ramapo Rivers; Deepavaal and Pinch Brooks
Project purpose	Flood damage reduction and hurricane protection
Project features	Tunnel diversion system consisting of a main tunnel 42 feet in diameter and 20.4 miles long, a spur tunnel 23 feet in diameter and 1.3 miles long, two inlets, an outlet, two weirs and associated river works comprised of 0.42 miles of levee, 0.55 miles of floodwall and 7.0 miles of channel modification. Central Basin flood damage reduction works consisting of 4.15 miles of levee, 1.84 miles of floodwall and 1.4 miles of channel modification. Lower Valley flood damage reduction works consisting of 2.13 miles of levee, and 10.82 miles of floodwall. Preservation of 5,350 acres of natural wetland storage. Environmental mitigation measures and recreational and beautification features at various locations.
Construction cost	First cost as of October, 1994 prices $1.4 billion Federal cost $1,040 million Non-Federal cost $360 million* Operation and maintenance $3.15 million* Fully funded construction cost, with inflation $1.87 billion *Basic project cost sharing from WRDA 1986 does not include modification to cost sharing by WRDA's 1990 and 1992.
Design flood	Design flood: - 100-year event for Tunnel system, Central Basin Protection Area, Tidal Protection Area.
Flood stage reduction for 100-year flood	Flood stage reduction for 100 year flood: Pompton River at the mouth: from 173.5 to 165.2

Municipalities protected	Passaic County: Clifton City, Little Falls, Passaic City, Paterson City, Pompton Lakes Borough, Totowa Borough, Wayne Township, West Paterson City Essex County: Belleville Town, Fairfield Borough Livingston Township, Newark City, Nutley Town, North Caldwell, Roseland Borough, West Caldwell Morris County: Parsippany-Troy Hills Township, East Hanover Township, Florham Park Borough, Hanover, Lincoln Park Borough, Montville Township, Pequannock Township, Riverdale Borough Bergen County: Elmwood Park Borough, East Rutherford Borough, Fair Lawn Borough, Garfield City, Lyndhurst Township, North Arlington Borough, Rutherford Borough, Wallington Borough Hudson County: East Newark Borough, Harrison Town, Kearny
Economic justification	Annual charges: $127,295,200 Benefits: $173,923,500 Benefit-cost ratio: 1.4
Construction schedule	Begins: September, 1998 Completion: June, 2009

5.2 TUNNEL SYSTEM

The major element of the project is the tunnel diversion system that includes, in addition to a main tunnel and a spur tunnel, a variety of works to support their operation and minimize adverse effects. The tunnel system will bypass flood waters from the major damage areas and discharge them into Newark Bay. Included in the system are:

- Two tunnels.

- An inlet structure at the upstream end of each tunnel.

- An outlet structure in Newark Bay.

- Vertical shafts to the tunnel at various locations for construction access and other purposes.

- Gated weirs on the Passaic and Pequannock Rivers and control erosion of channels and preserve existing wetlands.

- Levees, floodwalls and channel modifications on the Pequannock, Ramapo, Wanaque, Lower Pompton and Passaic Rivers to direct flood waters safely and efficiently to the inlet.

Each of the tunnel system components is described in detail in the following paragraphs. Summary details are provided in **Table 5**.

Table 5 - Tunnel System

Component	Type and location	Description
Main Tunnel	Tunnel, from Wayne to Newark Bay	42 feet in diameter, 20.4 miles long
Spur Tunnel	Tunnel, from Wayne to Main Tunnel intersection in Totowa	23 feet in diameter, 1.3 miles long
Pompton inlet	Structure, in Wayne on Pompton River	In a semi-circular basin about 220 feet in diameter. 11 vertical lift gates each 60 feet wide and 12 feet high. 216-foot radius semi-circular access basin
Passaic inlet	Structure, in Wayne on Passaic River	5 vertical lift gates each 50 feet wide and 13 feet high. 150-foot by 300-foot access basin., Inlet channel. Bridge across Fairfield Road
Outlet	Structure, in Newark Bay 1,850 feet offshore of Kearny Point	3 vertical lift gates each 26 feet wide and 30 feet high. Upshaft 42-45 feet in diameter and 380 deep. Outlet structure about 25 feet high above sea level.
Shafts	Structures at various locations	11 shafts, see Table 6
Pequannock Weir	Structure on right bank of Pequannock River within 200 feet of existing weir.	4 gates each 50 feet wide and 15 feet high
Great Piece Weir	Structure on Passaic River 600 feet upstream of Two Bridges Road	5 gates each 30 feet wide and 10 feet high
Passaic and Lower Pompton Rivers	Channel modification at confluence of Pompton and Passaic Rivers.	Deepen Passaic over distance of 0.4 mile, and Lower Pompton over a distance of 0.3 mile , by 4 to 5 feet. Create 1.2 mile pilot channel in Passaic downstream of Spur Inlet.

Ramapo River	Channel modification from the proposed Pequannock Weir to Paterson-Hamburg Turnpike	Over a distance of 1.3 miles, deepen by up to 10 feet, and increase bottom width to range from 60 to 100 feet and top width to 150 feet.
Wanaque River	Channel modification from mouth to just south of Paterson-Hamburg Turnpike	Over a distance of 0.8 mile, deepen by up to 7 feet, and increase bottom width from 50 to 74 feet and top width to 125 feet.
Pequannock River	Channel modification from Pompton inlet to just downstream of Paterson-Hamburg Turnpike.	Over a distance of 2.4 miles, deepen by up to 10 feet, and increase bottom width to range from 34 to 100 feet and top width to range from 135 to 160 feet.
Bypass channel	New channel in conjunction with the Pequannock Weir excavated on the right bank of the Pequannock River	0.3 mile long, 120 to 250 feet wide, and 2 to 14 feet deep. Create 0.3 mile long pilot channel in Pompton downstream of Main Tunnel Inlet.
Pequannock-Ramapo Levee/Flood System	Levee and floodwall on the right bank of the Ramapo River where it joins the Pequannock River to form the Pompton River.	2,200 feet of levee, 7.0 average height and 52 feet average bottom width. 2,910 feet of floodwall, 6.0 average height. Interior Flood damage reduction facilities consisting of 4 ponding areas, 8.5, 0.3, 0.4 and 5.0 acres in extent, and a 3-cfs pump providing protection varying from 80- to 200-year.

5.2.1 Tunnels. The 42 foot diameter main tunnel will carry floodwaters from an inlet at the upper Pompton River in Wayne to an outlet in Newark Bay. A 1.3-mile long, 23-foot diameter spur tunnel will convey Central Basin area floodwaters from an inlet on the Passaic River just downstream of Two Bridges, also in Wayne, to an underground connection with the main tunnel. Plans and profiles of the tunnel are shown in **Figure 4, 5, 13 and 14.**

The tunnels will be entirely in bed rock, about 175 feet from the surface to the tunnel invert at the Pompton Inlet, about 170 feet at the Passaic Inlet, and approximately 400 feet at the outlet. The intersection of the main and spur tunnel inverts will be about 185 feet below ground level. At its deepest point, under the Watchung Mountains in the vicinity of the Little Falls-Clifton border, the main tunnel invert will be 480 feet underground. Excavation will be performed mostly by a tunnel boring machine (TBM), but some drilling and blasting will be done where necessary for shaft construction. The tunnel will be lined with 15 inches of cast-in-place concrete.

The system will significantly lower flood stages even when the tunnel capacity is exceeded. The largest areas benefiting from the system will be the Passaic River from Dundee Dam in Clifton to the Rockaway River confluence, the entire Pompton River and the lower Ramapo, Pequannock and Wanaque Rivers. Reductions in the 100-year flood will be as high as 8 feet on the Passaic and as much as 10 feet on the Pompton, Ramapo, Pequannock and Wanaque Rivers.

Several locations in the tunnel were selected to vent air out of the tunnel during flow diversion. The two primary locations are the tunnel inlets each of which will have a de-aeration chamber. Air will be entrained at each inlet by hydraulic jumps that occur when water levels in the tunnel are low and by plunging flow when water levels are higher. The diameters of the chambers will be larger than the diameter of the tunnel to provide additional area when the flow is "bulked up" with air. A vertical air vent will be placed at the optimum location in each de-aeration chamber. At the Pompton inlet, the chamber will be 500 feet long, 52 feet in diameter and will have a 15-foot diameter vent shaft. The Passaic inlet de-aeration shaft will be 420 feet long, 30 feet in diameter and will have a 12-foot vent shaft.

5.2.2 Pompton (Main) Inlet. As shown in **Figure 11**, the inlet portal will be upstream of the Pompton Plains Cross Road (Jackson Avenue) Bridge in Wayne Township on the east bank of the Pompton River. The site is immediately downstream of the confluence of the Ramapo and Pequannock Rivers. Currently, this area is occupied by a topsoil manufacturing operation with material stockpiled on the site as well as adjacent to it. The area around the site is generally an undeveloped low lying floodplain to the west and north, and agricultural to the east. Stream slopes in the area are very mild.

Details of the Pompton inlet are shown in **Figures 17, 18 and 19.** The surface structures consist of a semi-circular gated diversion spillway, access basin, inner weir and a sloping tunnel inlet. The inlet will be located in a basin that is approximately 480 feet in diameter and excavated to a depth of about 20 feet. There will be 11 vertical lift diversion gates, 60 feet wide and 12 feet high. The gates will divert and regulate flow into a 216-foot radius semi-circular access basin that will be excavated to a depth of about 20 feet. The inner weir will be the highest point on the sloping drop into the main tunnel. The drop inlet will slope and converge from the 125-foot radius semi-circular inner weir to the 26-foot radius circular main tunnel chamber, about 170 feet below. The configuration of the inlet is a semi-cone shape.

The semi-cone inlet design limits flow to only one side of the inlet while permitting air to escape the other side, producing superior performance in both flow capacity and safety. This design will be model-tested during later stages of follow-on engineering and design work. Also, a 0.3 mile long pilot channel will extend downstream from the Pompton Inlet deepening the existing channel by 2 to 4 feet.

5.2.3 Passaic (Spur) Inlet. The Passaic spur inlet, shown in Figure 12, is located on the east bank of the Passaic River, about 500 feet upstream of the Interstate Route 80 bridge crossing, adjacent to Fairfield Road in Wayne. To utilize this site, a bridge for Fairfield Road will be built across the approach channel to the inlet structure. The surrounding area is lightly developed for residential use and mostly consists of undeveloped low lying wetlands.

Details of the Passaic Inlet are shown in **Figures 20, 21 and 22.** The inlet structure, which is similar to the Pompton River tunnel inlet, will consist of a straight gated side channel diversion spillway, an access basin, a semi-circular inner weir and a sloping tunnel inlet. There will be 5 vertical lift diversion gates, 50 feet wide by 13 feet high, to regulate the diverted flow into a 300-foot wide access basin that will be excavated to a depth of about 20 feet. The inner weir will be the highest point on the sloping drop into the spur tunnel. The drop inlet will slope and converge from the 75.5-foot radius semi-circular inner weir to the 15-foot radius circular spur tunnel chamber about 160 feet below, directing water into the 23-foot diameter, 1.3-mile long spur tunnel which connects to the main tunnel at a deep underground connection. The inlet will also use the semi-cone design but it contains a straight approach access basin.

5.2.4 Tunnel outlet. The tunnel outlet, shown on **Figure 5,** will be located about 1,850 off shore in the upper end of Newark Bay where the Passaic and Hackensack Rivers meet. The diverted floodwaters will flow through an upshaft from a depth of 399 feet vertically into the outlet structure which extends from a depth of about 26 feet below mean sea level to about 25-feet above mean sea level. The outlet will contain three 26-foot wide by 30-foot high vertical lift gates to distribute flow into Newark Bay. The outlet is not expected to have an adverse impact on navigation. To confirm this, however, both a physical model and a ship simulation study will be conducted during later stages of engineering and design work.

5.2.5 Shafts. As shown in **Figure 4**, there will be a total of 11 vertical shafts along the tunnel alignment for various purposes, such as the entrance and exit of construction equipment and materials, muck removal, dewatering and venting. Work shaft 2, located at Montclair State College, will function as the Tunnel Operations Center. Workshaft 2C, located at Kearny Point will house the equipment that will dewater the tunnel for inspection and maintenance purposes. The pumping station and equipment are shown in **Figure 15 and 16.** The purposes and locations of the various shafts are shown in **Table 6.**

5.2.6 Pequannock Weir. The new Pequannock weir is designed to supplement the existing Morris Canal feeder dam system. Its purpose is to assist in the passage of flood flows in excess of the 1-year event and to preserve the existing wetlands by maintaining existing water levels at a normal elevation of 177 NGVD. The new weir, details of which are shown in Figures 25, 26 and **27** will be placed on the right side of the Pequannock River within 200 feet of the existing weir. It will consist of 4 tainter gates each 50 feet wide by 15 feet high. The gate sill elevation will be set at elevation 164.0, which is 3 feet above the new upstream channel invert. The tainter gates will normally be operated in the down position (closed) and will only operate during flood events greater than the annual flood. The weir will be directly linked to the main tunnel inlet by a new bypass channel, described below.

A maintenance access bridge will be located at the top of the weir and will span each gate opening. An access road will be provided to the site from the end of Garden Place Road.

5.2.7 Great Piece Weir. The Great Piece Weir, shown in Figure 11, will be situated in the Town of Fairfield and the Borough of Lincoln Park. Its purpose is to prevent upstream headcutting, minimize erosion potential, and maintain the viability of the wetlands; an incidental benefit will be the prevention of channel erosion upstream of the Passaic Inlet. The weir is approximately 600 feet upstream of the Two Bridges Road that crosses over the Passaic River just upstream of the Passaic River and Pompton River confluence. The weir structure, details of which are on Figure 28, will incorporate five 30-feet wide gates providing a total river opening of 150 feet. The five torque tube bascule gates will rest on a gate sill set at elevation 156, approximately 6 feet above the proposed river bottom elevation.

The gates will have a total height of 10 feet and will be capable of creating a backwater pool to elevation 166, thereby maintaining water levels in the Great Piece Meadows upstream of the weir.

The weir will be provided with an overhead operating deck which will be supported by the weir abutments and four 10-foot wide intermediate piers. The operating deck will provide access for operation and maintenance from both the south and north banks of the river. The south access will be provided from a driveway that will branch off from an existing office complex. The weir will also have access from a short driveway to the north which ties into Two Bridges Road.

5.2.8 Passaic and Lower Pompton Rivers Channel Modification. A modified transition channel, shown in **Figures 11** and **12**, which will direct flows into the Passaic (Spur) Inlet, will extend along the Passaic River about 0.4 mile upstream of Two Bridges down to the Route 80 Bridge, and for about 0.3 mile along the lower Pompton River. This channel will have a maximum base width of 240 feet and will be deepened an average of 4 to 5 feet. The resulting cut of the new modified channel will be approximately 260 feet. The new channel cut will be entirely within the existing channel, which has an average top width of approximately 280 feet. In addition, a small pilot channel 20 feet wide, 3 feet deep, will extend past the spur inlet for a distance of 6,500 feet. The purpose of this pilot channel will be to prevent sediment from accumulating directly in front of the inlet. Thus the pilot channel will convey the suspended sediment and smaller bedloads down river, and therefore maintain the improved channel at the spur inlet.

5.2.9 Ramapo River Channel Modification. The Ramapo River channel modifications, shown in **Figures 9** and **10**, will extend for 1.3 miles from the newly proposed Pequannock Weir to just upstream of Paterson-Hamburg Turnpike near Pompton Lakes Dam. The modification includes deepening the existing channel up to 10 feet and widening the channel bottom to an average of 60 to 100 feet. The average top width of the modified channel will be approximately 150 feet. The top width of the existing channel averages approximately 110 feet. Almost the entire length of the modified channel will be protected with riprap. As a beautification measure, the river bank will be stabilized based on bioengineering techniques, a developing technology that involves the use of plant material or a combination of plant and inert material to improve plants over time as they become better established. About 5,415 feet of riprap will be used to protect this channel.

5.2.10 Wanaque River Channel Modification. The Wanaque River channel modification, shown in Figures 6 and 7, will extend from its mouth for 0.8 mile upstream to just below the Paterson-Hamburg Turnpike. The proposed modification includes deepening the existing channel by as much as 7 feet and increasing the channel bottom width from 50 to 74 feet. The resulting average top width will be approximately 125 feet. The existing channel top width averages approximately 90 feet. About 650 feet of riprap and 2,650 feet of crushed stone will be used to protect the channel from erosion. As a beautification measure, the river bank will be stabilized using bioengineering techiques.

5.2.11 Pequannock River Channel Modification. The Pequannock River channel modification, shown in Figures 6, 7 and 8, will extend from the Pequannock Weir, upstream for 2.4 miles. The modification includes deepening the existing channel up to 10 feet and increasing its bottom width to an average of 34 to 100 feet. The top width of the modified channel will range from 135 to 160 feet. The top width of the existing channel averages approximately 100 feet. About 2,000 feet of the proposed channel will be protected with riprap and about 150 feet of crushed stone. As a beautification measure, the river bank will be stabilized using bioengineering techniques.

Table 6 - Shafts

Shaft	Location	Size	Purposes
Workshaft 2C (Pump Station)	Near sewage treatment plant at Kearny Point	42 feet in diameter, 400 feet below the ground surface	Muck removal, dewatering, personnel and equipment access, concrete placement and house pump station facilities
Workshaft 2c (Vent shaft)	Near sewerage treatment plant at Kearny Point	15 feet in diameter, 400 feet below ground surface	Ventilation
Workshaft 2B	Keegan landfill, Bergen Avenue, Kearny	42 feet in diameter, 390 feet below the ground surface	TBM access, muck removal, construction support, concrete placement, ventilation

Vent/hook hole shaft 5	Broad Street near the Garden state Parkway and interchange, Bloomfield	15 feet in diameter, 170 feet below the ground surface	Concrete delivery. Disassemble TBM head to enable backout. To be retained as vent.
Workshaft 2 (Tunnel Operations Center)	Montclair State College	42 feet in diameter, 349 feet below the ground surface	TBM access, muck removal, construction support. concrete placement, maintenance access. Operations Center.
Vent shaft 6	East of Routes 80, 46 and 23 interchange	15 feet in diameter, 140 feet below the ground surface	Vent air entrained by highly turbulent flow at the junction.
Workshaft 3	Near Wayne Department of Public Works Yard	42 feet in diameter, 167 feet below the ground surface	Removal of two TBM's. To be retained as vent shaft.
Pompton (Main) Inlet	Downstream of confluence of the Ramapo and Pequannock Rivers	Sloping semi-circular inlet with a 15 foot diameter shaft, 160 feet below ground surface	Main Tunnel inlet, TBM access, muck removal, maintenance access. Ventilation shaft
Passaic (Spur) Inlet	Upstream of Route 80 bridge on east bank of the Passaic River	Sloping semi-circular inlet with a 12 foot diameter shaft, 156 feet below ground surface	Spur Tunnel inlet, TBM removal. Ventilation shaft.
Newark Bay Outlet	1,850 feet offshore in upper end of Newark Bay	42 feet in diameter, 380 feet below mean sea level	Tunnel discharge, sediment removal
Workshaft 4	East of Route 80, 46 and 23 interchange	23 feet in diameter, 160 feet below the ground surface	TBM access, muck removal, construction support. concrete placement

5.2.12 Pompton Inlet Bypass Channel. A new bypass channel, shown in Figure 10, approximately 0.3 mile in length, will be built in conjunction with the landside-based Pequannock Weir, described previously. The relocated channel will extend from the Pequannock Weir to the Pompton Inlet. It will vary from 130 to 230 feet in width, be cut to a depth of 2 to 14 feet into an existing field for a length of 1,830 feet and hydraulically connect flood waters to the Main Pompton Inlet. As part of the bypass channel, 400 feet of the Upper Pompton River and 600 feet of the lower Ramapo River (just downstream of the Old Morris Canal Ramapo Feeder weir) will be modified to allow flood flows to enter into the Pompton Inlet. The Pompton River channel improvements will be confined to the immediate area of the inlet above the existing low water weir (just upstream of the Jackson Avenue bridge). The channel will be deepened up to 3 feet and will have a new channel bottom width of about 100 feet. Although the bypass channel will be used rarely, it will generally be maintained wet due to downstream tailwater levels. A pilot channel, 0.3 mile long, will extend downstream from the Pompton Inlet.

5.2.13 Pequannock/Ramapo Levee/Floodwall. This levee/floodwall shown in Figure 9, will be located on the right bank of the Ramapo River and provide protection to existing structures in Pompton Lakes. To significantly reduce fluvial flooding, 2,200 feet of levee and 2,910 feet of floodwall will be required. The levees will have an average height of 5.9 feet and base width of 45 feet. The floodwalls will have an average height of 6 feet. To assure that local drainage in the protected area is maintained, new gravity outlets will be provided, along with four ponding areas, 0.3 acre, 0.4 acre, 8.5 acres and 5.0 acres in extent, the latter two being part of the natural storage areas to be preserved. A 3-cfs capacity pumping station will be provided to improve drainage. Profiles of the system are shown on Figures 29 and 30.

For recreation, a riverside trail will be provided. Access to the trail will be from Riverview Road. A platform for sitting, fishing and small boat launching will be located in Stiles Park. For beautification, the levees will be seeded with native wildflowers. Where the floodwall passes through residential rear yards, it will be hidden by a solid wood fence. Both sides of floodwalls passing through borough-owned property will be provided with growing vines.

5.3 CENTRAL BASIN PROTECTION

To supplement the tunnel system, protection will be provided in the Central Basin at seven localities by means of levees, floodwalls and channel modifications. The Central Basin systems are described below and summary details are provided in Table 7. Recreation and beautification features are included where they apply. Interior flood damage reduction facilities consisting of gravity culverts, sluice gates, flap gates, ponding areas and pumps, as appropriate for each system, will convey surface runoff from the protected areas to the river in times of flood.

Table 7 - Central Basin Protection
(Dimensions in Feet)

LEVEE-FLOODWALL SYSTEMS								
System	Location	Levee Average			Floodwall Average		Interior facilities	Deg. of prot in yrs
		Height	Base	Length	Height	Length		
Passaic #2A	Passaic River right bank in Fairfield and West Caldwell	7	52	6,216	5.5	3,082	Culverts; 5 ponds 42.5, 117, 53.3, 26.0 and 3.9 acres; 4 pumps; 5, 3, 1, and 2 cfs	100
Passaic #10	Passaic River right bank in Livingston	8	60	4,853	11	97	Culverts; 10 acres pond, 2 - 3 cfs pumps	100
Rockaway #1 -Downstream -Upstream	Rockaway River right bank in Parsippany-Troy Hills	 5.9 10.3	 45 72	 818 2,421	 3.3 ----	 521 -----	Downstream: Culverts; 3 ponds; 7.5, 15.0 and 16.6 acres Upstream: Culverts; 2 ponds; 30.1 and 7.4 acres, 1 cfs pump	100
Rockaway #2	Rockaway River left bank in Montville	10	70	3,172	----	-----	Culverts; 41.8 acre pond, 10 cfs pump	100

Rockaway #3	Rockaway River right bank in Parsippany-Troy Hills	7	45	1,850	8.5 5.1[1]	5232 1470[1]	Uses existing facilities	100
Pinch Brook	Pinch Brook right bank in East Hanover	2 8	25 60	2,397	9.4	415	Culverts, 10.5 acre pond, 1 - 3 cfs pump	100
CHANNEL MODIFICATION								
	Location	Length		Top width		Bottom width		
Deepavaal Brook	Deepavaal Brook in Fairfield and West Caldwell	7,660		60 to 85		30		100

(1) Floodwall to be placed on existing levee.

5.3.1 Passaic River Levee/Floodwall System #2A. This element of the plan, shown on **Figures 31** through 42, comprises four separate segments situated along the Passaic River in the southeastern portion of Fairfield Township and northwestern portion of West Caldwell Township. The total length of levee and floodwall is 9,298 feet of which 6,216 feet are levee and 3,082 feet are floodwall. The Interstate Route 80 embankment is integral to the overall line of protection. The system protects residential, commercial and industrial development in an area bounded by the right bank of the Passaic River, Interstate Route 80, Bloomfield Avenue and the area adjacent to the left bank of the Deepavaal Brook. The levees will average approximately 7 feet in height with an average base width of 52 feet. The floodwalls will have an average height of approximately 5.5 feet. Interstate Route 80 is an integral part of the line of protection. To prevent flanking of the system, numerous culverts under Interstate Route 80 will require sluice gates and flap gates. A closure structure will be required at the Route 80 bridge over Horseneck Road, tying into the bridge abutment.

The northern segments, located entirely in Fairfield, will start approximately 2,400 feet north of the intersection of Interstate Route 80 and the Passaic River. The levee proceeds east adjacent to an abandoned borrow pit filled with water, then curves gently to the southeast where it ties into high ground. The levee starts again at the southwestern boundary of the Fairfield Industrial Park between the industrial park and a large surface water body, then continues southeast to the rear of an industrial building on Evans Drive. A floodwall will then be constructed at the top of bank of a portion of a former oxbow meander of the Passaic River and end at the Route 46 embankment.

Proceeding southward, the next segment, a proposed levee and floodwall, will begin at Route 46 approximately 1,000 feet south of the end of the northern levee and run south along the eastern banks of the Passaic River in Pio Costa Commercial Park to Bloomfield Avenue in Fairfield.

The southern segment continues from Bloomfield Avenue and extends in a southerly then easterly direction through woodlands and wetlands between the Passaic River and Broadway Lane and ends east of Broadway Lane in West Caldwell.

Interior flood damage reduction facilities will be provided by supplementing existing culverts with new gravity outlets, sluice gates, flap gates and 5 ponding areas, 42.5, 117.0, 53.3, 26.0 and 3.9 acres in extent. Four pumping stations with capacities of 5, 3, 1, and 2 cfs will also be provided.

The Passaic #2A system provides excellent opportunities for recreational enhancements. The northern portion will be provided with a parking area at the end of Evans Street, a boat launch at the man-made lake, a picnic area near the boat ramp, an interpretive display and a trail system. A second trail system will begin at Bloomfield Avenue and connect to one of the roads in the small residential area. Site beautification will be provided by planting the levees with native wild flowers. The river sides of floodwalls will be beautified by vines growing up the wall. The portion of the land side of the floodwall visible from Bloomfield Avenue will be finished with a textured surface.

5.3.2 Passaic River Levee System #10. This element, shown on **Figures 43** through **49**, consists primarily of 4,853 feet of levees located on the right bank of the Passaic River in the Township of Livingston. A 10-foot length of floodwall founded by a 42 foot and 45 foot I-wall transitioning into the levee on both sides of the closure wall will be provided where an existing elevated sanitary sewer passes through the levee. Protection will be provided to structures in the area bounded on the west by the Passaic River and on the east by Eisenhower Parkway.

The levees will be set back approximately 800 feet from the river to avoid existing wetlands. The height of the levees will average 8 feet and the base width will be about 60 feet. They will be planted with native wildflowers as a beautification feature.

Interior flood damage reduction facilities will be provided by new culverts with sluice gates, flap gates and a 10.0-acre ponding area, contained in the natural storage area to be preerved, and two 3-cfs pumping stations.

Passaic River #10 will be the first element of the project to be placed under construction and is described in greater detail in Appendix J - Passaic #10 Feature Design Memorandum.

5.3.3 Deepavaal Brook Channel Modification. This channel modification element of the plan, shown on **Figures 50** through **54**, provides flood protection in the areas of West Caldwell and Fairfield. It begins at about 500 feet south of the Jersey City water supply aqueduct right-of-way and extends to the area of Long Meadow Lane and the Fairfield-West Caldwell boundary. The 7,660 feet of existing channel, which borders the Essex County Airport, will be enlarged by increasing its bottom width to 30 feet and its top width from 60 to 85 feet, compared to the existing top width that varies from about 30 to 50 feet. An additional 560-foot long modification will be constructed farther downstream in the vicinity of the Fairfield Office Center. This consists of increasing the bottom width to 50 feet upstream and downstream of the building and deepening the channel.

5.3.4 Rockaway River Levee/floodwall System #1. This system, shown on **Figures 55** through **60**, will consist of two sections on the right bank of the Rockaway River in the Township of Parsippany-Troy Hills. The total length of the system will be 3,760 feet.

The downstream portion includes 1,339 feet of levee and floodwall to protect the area bounded by the Rockaway River, New Road, Edwards Road and Vail Road. The levees downstream of Route 80 will be set back approximately 200 feet from the river. This S-shaped system begins with a floodwall at the Route 46 east embankment and continues about 521 feet adjacent to the Rockaway River, a service station and a shoppng mall. At that point the levee will begin and extend about 818 feet where it will tie into existing grade south of a commercial building on New Road. The average heights of the levee will be about 5.9 feet for the levee and range up to 5 ft in height for the floodwall.

The upstream portion is a levee 2,421 feet long north of Route 80 in the Township of Parsippany-Troy Hills. The levee will be set back approximately 1,100 feet from the river. The average height of the levee will be about 10.3 feet and the base width will be about 72 feet. The southern tie-out of the levee will be about 200 feet north of an existing gravel road parallel to Route 80.

The northern end will be slightly northeast of the intersection of Edwards Road and Larkspur Drive. The upstream portion of Rockaway #1 will be protected from flanking by the Rockaway #3 system, which consists of raising in place the existing Lake Hiawatha levee/floodwall system.

Interior flood damage reduction facilities for the downstream portion will be provided by new gravity culverts, sluice gates, flap gates and 3 ponding areas, 7.5, 15.0 and 16.6 acres in extent, the first two being in the natural storage area to be preserved.

Interior flood damage reduction facilities for the upstream portion will be provided by a new culvert, sluice gate, flap gate and 2 ponding areas, 30.1 and 7.4 acres in extent, both in the natural storage area to be preserved. In addition, a 1-cfs pumping station will be provided.

Recreational features will be included in the system. A trail will be provided on the upstream levee, extend beyond it and meet the dirt road for access. A short trail will be provided in the downstream portion along the river side of the wall and levee. Beautification measures include the planting of native wildflowers on the levees, planting of vines on the river side of the wall and texturing the concrete face on the land side.

5.3.5 Rockaway River Levee System #2. This system, shown on **Figures 61** through **63**, will be located on the left bank of the Rockaway River in the Township of Montville. It is designed to protect a residential area bounded by Change Bridge Road and Konner Avenue. The proposed levee system is an open U-shaped system approximately 3,172 feet in length with an average height of 10 feet and an average base width of 70 feet.

The levee will begin approximately 500 feet east of the Lancaster Avenue/Change Bridge Road intersection and proceed southeast behind residences along Change Bridge Road for approximately 650 feet. The levee will then proceed due east immediately adjacent to the Change Bridge Road right-of-way for approximately 600 feet where it changes direction to northeast for 400 feet. The levee will proceed east and tie in to high ground behind residences along Dogwood Circle.

Interior flood damage reduction facilities will be provided by a 41.8 acre ponding area, contained in the natural storage area to be perserved; it will discharge into the Rockaway River by means of a new 24-foot wide, 6-foot high box culvert to supplement the existing facilities. In addition, a 10-cfs pumping station will be provided.

The recreational feature of the system will be a trail constructed with an extension over the levee to connect it with Change Bridge Road. For beautification, the levee will be planted with native wildflowers. The side facing the road and residences will have shrubs close by. Where the levee passes residences, the toe of the levee will be planted with small ornamental flowering shrubs.

5.3.6 Rockaway River Levee/Floodwall System #3. This system, shown in **Figures 64** through **69**, will consist of 8,552 feet of levees and floodwalls located on the right bank of the Rockaway River in the Township of Parsippany-Troy Hills. Protection will be provided to residential structures in 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 the northern terminus of River Drive to the north.

Rockaway #3, which will augment the existing Lake Hiawatha levee/floodwall system, will consist of 5,232 feet of floodwall, 1,850 feet of levee and 1,470 feet of floodwall placed on existing levee. The average height of the existing levees will be increased by approximately 7 feet and the average base width increased by approximately 45 feet. The average floodwall height will be approximately 8.5 feet, while the average floodwall height above grade on top of the existing levees will be approximately 5.1 feet. The existing levee system in the area of the Rockaway #3 project has levee elevations ranging from elevation 177.5 to 179.5, compared to the new levels ranging from 183.6 to 184.6.

The new construction will consist of approximately 1,025 feet of new floodwall at the northern portion of River Road, 376 linear feet of new floodwall at the north and south ends of the existing levee. The existing levee will have additional fill placed on its land side over a distance of 825 feet. The remaining portions are existing floodwalls that will be replaced and small areas of levee that will have their heights extended by constructing a floodwall on top of the levee.

Currently, the existing levee contains five closure structures. The new levee/floodwall system will contain four closures, two closures will maintain access to the clubhouse area, one closure at the end of Hiawatha will be replaced for channel maintenance purposes, and one will be constructed adjacent to the Tenneco gas transmission lines which presently has two closures. The existing closure in the area of Chesapeake Avenue will become a floodwall. Also associated with the existing levee are interior flood damage reduction facilities that include a pump station with a capacity of 183 cfs located near the end of Wilbur Avenue.

Interior flood damage reduction facilities for the existing project are expected to be adequate for the modification, subject to further studies that will be performed for the feature design memorandum.

For recreation, a path will be provided on the river side of the levees and floodwalls. A number of beautification features are included. On the land side, the treatment of floodwalls will include shadowbox fencing to hide the walls in residential rear yards, and the provision of shrubs by the small park. The river side of the floodwalls will be planted with vines. The river side of levees will be planted with native wildflowers. Because the land side is close to the backs of residences, lawn grass will be planted.

5.3.7 Pinch Brook levee/floodwall system. This system, shown on **Figures 70** and **71**, will be located on the right bank of Pinch Brook in East Hanover Township, Morris County, New Jersey. It is bounded by Pinch Brook, Great Meadow Lane and Brentwood Drive. This open U-shaped levee/floodwall system will be approximately 2,812 feet in length, consisting of 2,397 feet of levee and 415 feet of floodwall and will protect the existing commercial and residential properties against floodwaters backing up from the Whippany River.

The southern levee will have an average height of approximately 8 feet and a base width of approximately 60 feet while the floodwall will have an average height of 9.4 feet. The northern levee will have an average height of 2 feet with an approximate base width of 25 feet.

The upstream end will be in the vicinity of Sheldon Court and proceed behind the residences on Brentwood Drive. As the levee proceeds downstream, it will change to a floodwall in the area of the industrial park. After a distance of approximately 415 feet, the floodwall will change back to a levee and proceed parallel to the Jersey Central Power and Light Company high voltage transmission lines for approximately 1,122 feet to its termination near the end of Great Meadow Lane at the rear of the residential area.

Interior flood damage reduction facilities will be provided by two 36-inch diameter culverts with flap gates and sluice gates, and a 10.5-acre ponding area contained in the natural storage area to be preserved. In addition, a 3-cfs pumping station will be provided.

Beautification measures include planting the levee with native wildflowers. Also, on the portion facing the residences, small shrubs will be added at the levee toe. The floodwall will have vines on the wetland side.

5.4 TIDAL AREA PROTECTION

In the Lower Valley, no structural features are included from Beatties Dam downstream to the Second River. The tunnel will divert portions of the damaging flood flows away from flood problem localities in this reach. From the Second River downstream to Newark Bay, intermittent levees and floodwalls are required to protect against flooding from coastal flood events. They will provide protection against both fluvial flows and storm surges in Newark Bay. These systems include about 2.1 miles of levees and 10.8 miles of floodwalls. Interior flood damage reduction facilities will be required behind these levees and floodwalls in order to carry surface runoff from the protected areas to the rivers and bay. These facilities will include gravity culverts and pumping stations. Summary data on the tidal protection systems are displayed in **Table 8**. Plans and profiles are shown on **Figure** 72 through 89 and typical details are shown on **Figures** 90 and 91.

Table 8 - Tidal Protection
(Dimensions in feet)

System	Location	Levee Ht.	Levee Base	Levee Length	Floodwall Ht.	Floodwall Length	Interior facilities	Deg. prot.
Kearny Point	Hackensack right bank and Passaic left bank in Kearny and Harrison	5.2	41	3,908	7.4	33,771	Culverts; 1-75 cfs pump	100+
Lister/Turnpike/Doremus	Passaic River right bank in Newark	5.5	44	5,599	8.1	17,657	Culverts; 1-100 cfs pump 1-50 cfs pump	100+

South 1st Street	Passaic River left bank in Harrison	6.5	50	1,750	6.2	5,700	Culverts; 1-75 cfs ump 1-70 cfs pump 1-30 cfs pump	100+

5.4.1 Kearny Point Levee/Floodwall System. This system, shown on **Figures** 72 through 80, consists of approximately 3,908 feet of earthen levee and approximately 33,771 feet of concrete floodwall. It will protect an industrial area from tidal flooding on the left bank of the Passaic River around Kearny Point and upstream along the right bank of the Hackensack River in Kearny. Also included in this system are floodwalls and closures to protect the Port Authority Trans-Hudson (PATH) line from tidal flooding that will occur from both the Hackensack and Passaic Rivers. The levees have an average approximate height of 5.2 feet and approximate base width of 41 feet. The average floodwall height is approximately 7.4 feet.

PATH Line protection will begin in Harrison and consist of a small floodwall to protect the north PATH tracks. Another segment will be required in Kearny to protect the north track. Protection of the south PATH track will begin approximately 2,200 feet east of the NJ Turnpike bridge and continue east to the Conrail embankment.

The Kearny Point segment will begin at the Conrail embankment approximately 500 feet east of the NJ Turnpike bridge, continue south along the left bank of the Passaic River, proceed around Kearny Point, north along the right bank of the Hackensack River, and tie into a containment berm on Public Service Electric and Gas Company property. The floodwall will begin again on the north side of the containment berm and continue east to Fish House Road, which will be raised. The floodwall will resume on the north side of the raised road, cross the Transco Gas pipelines and proceed east. The floodwall will change direction to the north, cross an existing roadway and tracks with gated structures and terminate in the Conrail embankment. The final segment of floodwall will proceed west for approximately 905 feet to high ground adjacent to the Conrail tracks. A floodside clay blanket or concrete pavement will be provided for the Conrail embankment to control through seepage. Present and future access to the river will be maintained by gated structures.

Interior flood damage reduction facilities will be provided by new gravity culverts with flap gates and sluice gates, along with a 75-cfs pumping station.

5.4.2 Lister/Turnpike/Doremus Levee/Floodwall System. This system, shown on **Figure 81** through **87**, lies on the right bank of the Passaic River and will consist of floodwalls, levees and associated closure structures in the City of Newark to protect industrial structures against tidal flooding. The protected area is bounded by the Passaic River, Ferry Street and Freeman Street, the N.J. Turnpike, Routes 1 & 9, and the Conrail yards adjacent to Port Newark. The total system consists of approximately 5,599 feet of levee, averaging approximately 5.5 feet in height with a base width of approximately 44 feet and approximately 17,657 feet of floodwall (including gated structures) averaging approximately 8.1 feet in height.

The floodwall will begin approximately at the intersection of Raymond Boulevard and Oxford Street in the City of Newark and continue on the right bank of the Passaic River to the Conrail embankment, approximately 1,300 feet north of the New Jersey Turnpike extension Newark Bay Bridge. Closure structures will provide access for existing and future docking facilities as well as protection from flanking.

Protection from flanking of the levee system requires additional measures within the interior of the protected area. The tie-out at the Conrail embankment will continue along the Conrail embankment to the New Jersey Turnpike embankment where a small levee will be required between the two embankments. A 3-foot high closure about 45 feet wide will be required at the Wilson Avenue overpass to prevent flanking. An unnamed overpass 700 feet north of Wilson Avenue will be eliminated and fill will be placed to bring the area up to existing N.J. Turnpike road grade as part of the Turnpike widening project. An additional small closure or track raising may be needed at the Conrail underpass at Route 1 and 9 to the New Jersey Turnpike embankment to complete the line of protection.

Interior flood damage reduction facilities will be provided by new gravity outlets along with two pumping stations with capacities of 50 and 100 cfs.

The Joseph G. Minish Waterfront Park and Historic Area, planned by the Corps of Engineers and the State of New Jersey, will lie to the west of the project in the City of Newark. This system, which is not part of the project, will include a public boat basin with a boat ramp, and a promenade along the bulkhead. At the western end of this floodwall in the park, the promenade will be sloped so that the wall functions as a 3-foot high railing while permitting river views. The path will continue beside the existing storage tanks and on top of the levee behind the apartments. For beautification, the western 1,000 feet of the floodwall will be cast with a textured concrete face. All floodwalls will have vines planted on the river side; the levees will be planted with native wildflowers.

5.4.3 South 1st Street Levee/Floodwall System. This system, shown on **Figure 88** and **89**, is situated on the left bank of the Passaic River in the Town of Harrison. The levee/floodwall system will provide protection to residential, commercial and industrial structures from tidal floods from the South 4th Street bridge up to the New Jersey Transit rail bridge just south of the Route 280 bridge.

A total of approximately 7,450 linear feet of levee and floodwall with eight closure structures will be required. The levees will total 1,750 feet in length with an average height of about 6.5 feet and an average base width of 50, feet while the 5,700 feet of floodwall will have an average height of 6.2 feet. A continuous line of protection will be provided by gated structures across Passaic Avenue and adjacent to South 4th Street. River access and access to property on the east side of South 4th Street will be provided through gated structures at several sites adjacent to the Passaic River and South 4th Street.

The South 1st Street floodwall system will begin on the east side of Passaic Avenue just south of the New Jersey Transit rail line bridge structure and cross Passaic Avenue with a closure about 40 feet wide. A levee will continue parallel to the Passaic River for approximately 650 feet up to the Harrison Street bridge just beyond the Hess Station, where it ties into the north embankment. The floodwall will begin again on the south embankment of the Harrison Street bridge and continue onto the Tenneco manufacturing Refining Companies property where two 30-foot closures will be provided. The floodwall will proceed adjacent to an existing baseball field approximately 250 feet to the site of J. Supor Trucking along the Passaic River and the site of Diamond Shamrock Chemical Co. The floodwall will continue along the Passaic River adjacent to the Hartz Mountain Industries site where a closure about 30 feet wide will be provided. The floodwall will then continue and tie into the Amtrak/Conrail rail line embankment.

The floodwall will extend south from the Amtrak/Conrail line embankment adjacent to Public Service Electric and Gas Company's (PSE&G) Harrison plant facilities along the Passaic River where two 30-foot closures are provided. The rest of PSE&G's frontage will be protected with a floodwall and tie into the South 4th Street bridge embankment. An additional section of floodwall to prevent flanking runs north from high ground, adjacent to Cape May Avenue, to the Conrail bridge embankment. This section of floodwall will be approximately 1,425 feet in length and contain two 30-foot closures, one for Tri-Chem line, and one for an adjacent parking lot.

Interior flood damage reduction facilities will be provided by new gravity culverts with flap gates and sluice gates, along with three pumping stations with capacities of 75, 70 and 30 cubic feet per second.

As a beautification measure, the side of the floodwall facing the river and the side facing the athletic field will be decorated with vines.

5.5 PRESERVATION OF NATURAL STORAGE

The preservation of 5,350 acres of natural storage areas in the Central Passaic Basin is a significant flood damage reduction element in the project. The acquisition of these lands will insure the long term maintenance of the project's degree of protection by preventing increases in flood flows that might be caused by the loss of these areas to new development. This acquisition, in conjunction with nearly 16,000 acres already protected under existing Federal and state programs, will preserve the flood storage and environmental characteristics of the Central Basin wetlands. In addition, the project also requires that the existing floodways in the areas of acquisition be maintained at their present widths. The wetland areas to be preserved are shown on **Figures 111-114, 120-125, 128-131, 133** and **134.**

Tables 9 and **10** list the acres proposed for acquisition by municipality and major wetland area.

As previously stated in the descriptions of the local protection systems, certain portions of these lands will also be used for ponding as elements in interior flood damage reduction facilities.

Table 9 - Natural Storage Areas to be Acquired, by municipality

System	Wetland	Acres
East Hanover	Black Meadows Troy Meadows Upstream Passaic	143 215 2
Fairfield	Hatfield Swamp Great Piece Meadows Long Meadows	12 1,014 46
Florham Park	Upstream Passaic Black Meadows	22 370
Hanover	Black Meadows	684
Lincoln Park	Bog and Vly Meadows Pompton Valley Wetlands Great Piece Meadows	393 16 774
Livingston	Upstream Passaic	85
Montville	Great Piece Meadows Hatfield Swamp Bog and Vly Meadows	69 6 36
Parsippany-Troy Hills	Troy Meadows Hatfield Swamp	978 104
Wayne	Pompton Valley wetlands Great Piece Meadows	18 9
Chatham	Upstream Passaic	8
Pequannock	Pompton Valley wetlands	94
Pompton Lakes	Pompton Valley wetlands	11
Riverdale	Pompton Valley wetlands	10
Roseland	Upstream Passaic wetlands	2
West Caldwell	Hatfield Swamp	256
Total		5,350

Table 10 - Natural Storage Areas to be Acquired, by Wetland area

Wetland	Municipality	Acres
Great Piece Meadows	Wayne Lincoln Park Montville Fairfield	9 774 69 1,014
Bog and Vly Meadows	Lincoln Park Montville	393 36
Pompton Valley Wetlands	Pequannock Lincoln Park Wayne Riverdale Pompton Lakes	94 16 18 10 11
Hatfield Swamp	West Caldwell Fairfield Parsippany-Troy Hills Montville	256 12 104 6
Long Meadows	Fairfield	46
Troy Meadows	Parsippany-Troy Hills East Hanover	978 215
Black Meadows	East Hanover Hanover Florham Park	143 684 370
Upstram Passaic	Chatham Roseland Livingston East Hanover Florham Park	8 2 85 2 21
Total		5,350

The preservation of natural storage under this plan involves the following considerations:

- The retention by the State of New Jersey of existing approved Federal Insurance Administration Floodways at their current limits in the areas to be acquired;

- A realistic determination, based on New Jersey Department of Environmental Protection estimates for final delineations, of floodways in communities where they have not yet been adopted, without attempting to take this plan into account; and

- The retention of current state no "netfill" in the Central Basin and storm water management regulations.

5.6 FISH AND WILDLIFE MITIGATION

The engineering and design effort included thorough consideration of opportunities to mitigate known and potential impacts of the project. Wherever possible, such impacts were addressed in the design of each element as part of standard engineering practice. In those cases where impacts could not be addressed in the design of specific elements, mitigation measures were included separate from the project features. Mitigation features include measures at degraded wetland sites, hydraulic controls and pumps to regulate site hydrology and instream structures. Both kinds of mitigation features are described in Section 8 - Environmental Analysis.

5.7 PROJECT OPERATION

The tunnel system allows the existing natural channels in the Central Basin and the Highland Area (Pompton Valley) to function as they would today until floods are expected. The system is not expected to operate for events approximately less than the 1-Year flood. A floodwarning and forcast system will advise when floods are expected to exceed the 1-Year event, whereupon the project will be activated.

The design of the tunnel system will take advantage of the flood hydrograph timing relationship between the Passaic and the Pompton Rivers. For example, should the 100-Year flood occur, the Pompton will peak about 40 hours earlier than the Passaic River. With this in mind, the spur tunnel gates will operate based on stages at the Pompton Inlet.

Control structures will open and cause the diversion of flood waters into the tunnels and allow the water to be managed with minimum impact on existing conditions.

5.7.1 Pompton Inlet. The plan of operation at the Pompton Inlet is to permit a continuous bypass flow for all flood events ranging from 4,300 to 7,000 cfs. Such operation will keep the peak flow at Pompton Plains from exceeding what now corresponds to approximately the one-year flood event. The gate operation will be designed to release flows approximating bankfull capacity for all floods between the one-year and 100-year events. At the mouth of the Pompton River, the 100-year flow will be reduced from 28,500 to 7,420 cfs.

5.7.2 Passaic Inlet. Under non-flood conditions, normal flows will continue to remain within the Passaic River and flow over Beatties Dam. When floods greater than the one-year event are anticipated, the gates on the diversion spillway will open to divert Passaic flows into the tunnel. The Central Basin flow into the lower valley must be minimized early in the storm to prevent or reduce flooding in the Lower Valley caused by concurrent peaks.

5.7.3 Tunnel flows. Since the Pompton River's input to the main tunnel peaks first and is the main contributer to flooding, the water allowed into the spur tunnel will always depend on conditions in the Pompton. This rule will generally give priority to diverting Pompton River flows into the tunnel over those of the Passaic. Thus, for flows between 50- and 500-year, the Passaic inlet will be closed for a period of time to permit only flow from the Pompton inlet. During a 100-year event, the tunnel will carry only Pompton water for about 11 hours as the Pompton peaks. No water will be allowed into the tunnel from the Passaic Inlet. The maximum bypass flow at the Passaic Inlet will be approximately 9,000 cfc during the 100-year event. The Lower Valley will not be affected because at this time the peaks in that reach will have passed.

During the later portion of the rainfall/runoff event, after Pompton peaks have passed, the Passaic Inlet will open to allow the peaks from the Passaic to enter the tunnel. These flows could arrive up to two days later then the Pompton flows. In more frequent storms from 1- to 50-year, the tunnel will have sufficient capacity to allow inflow from both inlets simultaneously.

The Passaic inlet will continue to divert flow until the rain stops, peak stages downstream of Little Falls recede, and Passaic River stages downstream and upstream of the inlet fall to below non-damaging levels. Then the Passaic spillway diversion gates will be gradually closed.

MAIN REPORT

SECTION 6

CHANGES

6. CHANGES

6.1 OVERVIEW

Since authorization of the Passaic River Flood Damage Reduction Project, preconstruction engineering and design studies have been performed. This, in addition to further coordination with state and other Federal agencies, has resulted in various design refinements made using by current engineering, economic and environmental conditions. As an example, four levee/floodwall systems in the Pompton Valley are no longer included because of the more efficient hydraulic design of the inlets and channels that will convey floodwaters to the Pompton Inlet. A revision, as the term is used here, will mean any change from the project authorized in the Water Resource Development Act of 1990, as modified by the Water Resource Development Act of 1992.

6.2 REVISIONS

Table 11 displays the revisions to the authorized project along with the reasons why they were made.

Table 11 - Project Revisions

Project element	Revision	Reason
TUNNEL SYSTEM		
Tunnel	Main tunnel increased in length from 20.0 to 20.4 miles; diameter from 40 to 42 feet. Spur tunnel increased in length from 1.2 to 1.3 miles; diameter from 22 to 23 feet.	Tunnel lengthened to move outlet closer to existing navigation channel to minimize dredging. Diameters enlarged to compensate for greater friction losses caused by increase in length at outlet for approximately the same design flow.
Pompton Inlet	Inlet changed from morning glory type to semi-circular sloping inlet. Pompton River flow restructure eliminated.	Improve hydraulic performance, safety, and reduce air entrainment.

Passaic Inlet	Inlet changed from morning glory type to semi-circular sloping inlet. Buyout of three structures now required.	Improve hydraulic performance, safety, and reduce air entrainment.
Outlet	Moved to 1,850 feet offshore of Kearny Point.	To direct discharges into Hackensack River Navigation Channel so as to minimize erosion of existing mudflats. Also to minimize disposal of potentially contaminated sediment.
Shafts	Number of work shafts increased from 4 to 8. One access shaft and one vent/hook hole shaft added. Work shaft 2 to be used as control center.	To accommodate tunnel route changes made to allow tunnel boring machine to bore predominantly uphill. Air vent added at critical location to avoid potential "slug flow" phenomenon.
Passaic and Lower Pompton Rivers Channels	Length of deepening shortened from 1.1 to 0.7 mile. Average top width increased from 235 to 280 feet; bottom width increased from 175 to 240 feet. Pilot channel added, extending past inlet for a distance of 6,500 feet	Channels were slightly redefined to accommodate new inlet design. Added sediment bypass channel to prevent sediment from accumulating at entrance of Passaic Inlet.
Pequannock River Channel	Length of deepening decreased from 2.6 to 2.4 miles; deepening increased from 7 to 8 feet.	Channel redesigned to accommodate new Pompton Inlet configuration.
Bypass Channel	Enlarged bypass channel to 0.5 mile long, 2 to 14 feet deep, and 130 to 230 feet wide.	To accommodate redesign of the Pequannock Weir and its new siting on the land side of the Pequannock River, thus allowing access during flood events for emergency equipment.
Wanaque River Channel	Length of deepening increased from 1.0 to 1.1 mile; maximum deepening increased from 6 to 7 feet; added 2,000 feet of riprap and 600 feet of crushed stone.	Channel redesigned to accommodate new Pompton Inlet configuration.

Ramapo River	Length of deepening increased from 1.1 to 1.3 mile; deepening increased from 4 to 10 feet. Almost entire length to be lined with riprap.	Channel redesigned to accommodate new Pompton Inlet configuration.
Pequannock/Ramapo levee/floodwall	Length of levees decreased from 9,230 to 2,200 feet; average height decreased from 9.4 to 5.9 feet; average bottom width decreased from 66 feet to 45 feet. Length of floodwalls increased from 1,500 to 2,910 feet; average height decreased from 10.8 to 5.7 feet.	Levee shortened due to redesign of channels and main inlet based on updated topographic mapping. Some levee replaced by floodwall to minimize disturbance to existing structures.
Shore Road	Deleted	No longer needed due to channel and inlet redesign.
Stiles Court	Deleted	No longer needed due to channel and inlet redesign.
Hill Court	Deleted	No longer needed due to channel and inlet redesign.
Wanaque Avenue	Deleted	No longer needed due to channel and inlet redesign.
Pequannock Weir	Relocated for land side access and changed from two 85-foot bascule gates to four 50-foot wide and 15-foot high tainter gates. Raised gate sill to elevation 164.0.	To provide emergency access during large flood events and ease maintenance requirements. Raised gate sill to alleviate sedimentation in weir area.
Great Piece Weir	Relocated weir downstream. Placed c. 17,000 cy of fill and raised 6-7 existing residences and 1,000 LF of roadway; gates changed from single 100' bascule to 5-30' torque tube basque gates.	Reduce impacts on wetlands and eliminate need for overbank levee. Provide accessibility to structure gate during flood events.

CENTRAL BASIN PROTECTION		
Passaic River #2A	Total length shortened from 20,660 to 9,298 feet. For the 6,216 feet of proposed levee the average height decreased from 8.6 to 7.0 feet, base width decreased from 61.6 to 52 feet; For 3,082 feet of floodwall, with average height decreased from 9 to 5.5 feet. Eastmost section eliminated. Westmost section realigned to north.	Levees along Deepavaal Brook were replaced by Deepavaal Brook channel improvement. Westernmost section realigned to minimize impacts to open water and wetland habitat.
Passaic River #10	No significant change.	
Rockaway River #1	Average height of downstream protection decreased from 8.7 feet to 5.9 feet. Downstream portion changed by replacing part of levee with 521 feet of floodwall having average height of 3.3 feet and an 818-foot long levee section with an average height of 5.9 feet.	Refinements in hydraulic design based on updated site information.
Rockaway River #2	Length of levees decreased from 3,300 to 3,172 feet. Average height increased from about 8 to 10 feet. Bottom width increased from 60 to 70 feet.	Refinements in hydraulic design based on updated site information.
Rockaway River #3	Total length of works increased from about 6,320 feet in length to 8,550. Length of new levee decreased from 6,320 to 825 feet with average height reduced from 10.3 to 7.0 feet, and bottom width decreased from 72 to 52 feet. Floodwall continues for 6,702 feet of which 1,525 feet is new and 4,282 feet will replace existing floodwall or be driven into existing levee.	Refinements in hydraulic design based on updated site information. Most of levee replaced with floodwall to minimize disturbance to existing structures.

Pinch Brook	Shortened from 3,380 feet of levee to 2,812 feet (2,397 feet in two sections and 415 feet of intervening floodwall). Average height of levee increased from 6.6 to 8 feet and the base width increased from 49.6 to 60 feet. Average height of the added floodwall would be 9.4 feet.	Redesigned levee alignment to shorten overall length and reduce footprint of the system.
Deepavaal Brook	Levee eliminated and replaced by 7,660 feet of channel improvement to increase the bottom width to 30 feet, and the top width to vary from 60 to about 85 feet.	Channel improvements are more effective in conjunction with tunnel drawdown during basin-wide flood events. Also, complex interior damage reduction facilities works were voided by eliminating levees.
TIDAL AREA PROTECTION		
Kearny Point	Total length increased from 34,520 feet to 37,679 feet, 33,771 ft of floodwall and 3,908 ft of levee. Levee average height decreased from 8.8 to 5.2 feet; bottom width decreased from 63 to 41 feet. Floodwall average height decreased from 8.0 to 7.4 feet. Elevations of tops of levees and floodwalls have not changed.	Lengthened to protect north and south tracks of the PATH line and to protect from Hackensack River flooding. Some levee replaced by floodwall to minimize impact on existing structures. Changes were also affected by updated topographic mapping.
South First Street	Lengthened from 5,930 to 7,450 feet, 1,750 feet of levee and 5,700 feet of floodwall. Average height of levee decreased from 7.9 to 6.5 feet, base width decreased from 57.4 to 50 feet. Average height of floodwall decreased from 8.3 to 6.2 feet. Elevations of tops of levees and floodwalls have not changed.	Southern portion of system at South 4th Street Bridge and along South 4th Street extended to prevent flanking. Some levee replaced by floodwall to minimize impact on existing structures. Changes were also affected by updated topographic mapping.

Lister/Turnpike/ Doremus	Three original separate systems, totalling 14,470 feet of levees and floodwalls are now combined into one continuous system 23,256 feet long. System includes 5,599 ft of levee and 5,700 ft of floodwall. Average height for levee decreased from minimum of 7.4 to 5.5 feet, and base width decreased from minimum of 54.4 to 44 feet. Average height of floodwall changed from varying between 5.5 and 10.3 feet to an average of 8.1 feet. Elevations of tops of levees and floodwalls have not changed.	To prevent flanking of the systems. Extended approximately 8,000 feet in City of Newark Area to tie in to existing railroad embankment and provide added protection to heavily urbanized area. Some levee replaced by floodwall to minimize impact on existing structures. Changes were also affected by updated topographic mapping.
PRESERVATION OF NATURAL STORAGE		
Land acquisition	Minor changes in location of the designated 5350 acres were made.	To reflect developmental changes and to address geographical and ecological efficiencies.
FISH AND WILDLIFE MITIGATION		
At various localities	Incorporation of wetland hydrology in ponding site criteria in accordance with good engineering design resulted in reduction of impacted wetlands from 905 acres to 94 acres. Remaining wetland impacts are addressed specifically by restoration of disturbed wetlands.	To compensate for adverse impacts.

MAIN REPORT

SECTION 7

ENGINEERING DESIGN

7. ENGINEERING DESIGN

7.1 OVERVIEW

The Passaic River Flood Damage Reduction Project was developed by various engineering disciplines to alleviate flood problems in the basin. An understanding of the flood-producing characteristics was achieved by analyzing the hydrology of the basin including the hydraulic capacities of its valleys, lakes and streams. The elements of the plan have been designed to manage the water resources of the basin by providing the maximum flood relief consistent with economy of construction. Geotechnical analysis, testing and modeling were done in connection with structural design studies to the level of detail that assures the works remain stable, reliable and functional throughout the project life. Thus the cost estimate of the project reflects a soundly engineered project. This section summarizes the engineering design studies performed for this design memorandum. Further detail on the various disciplines may be found in the technical appendices as noted in the discussion.

7.2 SURVEYS AND MAPPING

Aerial photography and field control surveys performed in 1988 and 1989 were employed to develop topographic mapping and stream cross-sections for the project area. The topographic mapping was prepared at a scale of one inch equals 30 feet and one inch equals 200 feet, with one- and two-foot contour intervals respectively, utilizing the National Geodetic Vertical Datum (1929 adjustment) as established benchmarks. The mapping coordinates are referenced to North American Datum (NAD) 27 and are in feet based on the New Jersey State Plane Coordinate System (SPCS) 27. Stream cross-sections were prepared through a combination of field surveys for the channel and bridge sections, and photogrammetric procedures for overbanks. A utility survey was also performed in conjunction with the topographic survey. The digital mapping, in connection with computer-assisted design techniques, provided a high degree of flexibility in the design of the project components.

7.3 HYDROLOGY AND HYDRAULICS

Starting with existing conditions, the hydrologic and hydraulic studies focused on the conditions that would exist both with and without the project in the Passaic River and Newark Bay.

Consideration was also given to the Hackensack River as it affects conditions in the Passaic River and Newark Bay. The hydrologic and hydraulic studies graphically illustrate how the plan will work as an integrated system. Accurate modeling tools were used to reproduce existing conditions. With the existing conditions firmly calibrated and verified, it was possible to compare future conditions with and without the project. Full details on the investigational studies performed are in Appendix C - Hydrology and Hydraulics.

7.3.1 Modeling The 935 square mile basin was subdivided into 189 subbasins, ranging in size from 0.46 to 50.9 square miles. The flood-producing characteristics of the basin were considered, including natural physiographic and manmade effects such as urbanization, reservoirs, and water supply diversions.

7.3.1.1 UNET model. A modeling tool, not formerly applied to previous Passaic River studies, was used to more accurately predict the complex flood behavior in the basin. The model had to be capable of reproducing flows and flood stages over large geographical regions and time periods. It also had to be capable of simulating unsteady and network flow. A review of available models resulted in the selection of the UNET model developed by the Army Hydrologic Engineering Center (HEC). This model has been in use and under development for over 10 years. With this tool, one model would capture the basin's response to rainfall and produce a stage-frequency-relationship. Information necessary to drive the UNET model was obtained by linking it to the physical characteristics of the subbasin in the HEC-1 model that simulates basin rainfall runoff. Following a rigorous calibration and verification process, the UNET and HEC-1 models were accepted as being capable of reflecting both historical and hypothetical events, and thus appropriate for project design.

7.3.1.2 Tidal surge modeling. The lower 17.7 miles of the Passaic River downstream of Dundee Dam are subject to occasional flooding due mainly to storm surges. Therefore, the stages of the Passaic from Newark Bay to Dundee Dam are influenced by a combination of fluvial and tidal flooding.

The outlet structure and tidal area protection levees adjacent to Newark Bay will affect flow patterns in the upper end of the bay. A storm surge analysis was conducted to determine the extent of this change. The primary objective of the study was to relate the stages and frequencies (stage-frequency curves) for tidal events in the lower Passaic and Hackensack Rivers and Newark Bay. The curves are based on the combined effects of hurricanes and northeasters for conditions expected to exist in the year 2050.

All future condition analysis assumed a 0.5 foot future sea level rise by the year 2050. The added sea level rise was used in the design of the height and extent of the tidal levees overtopping and flanking. The study also determined the correlation between tidal surge levels and peak river flows, which was not addressed in previous studies. Factors such as separation of residual storm surges from observed tidal heights, time lags and correlation factors were addressed. Another objective of the study was to determine if the tunnel and/or tidal levees would raise water levels in Newark Bay and the tidal reaches of both rivers. No significant impact on Newark Bay is expected as a result of the project.

7.3.1.3 Discharge-frequency analysis. The effectiveness of the project in reducing flood damages required a statistical analysis of historical flood events. By relating the damages caused by such events along with hypothetical ones, it was possible to estimate the benefits of a project. For this project, a frequency analysis was performed on six stream flow gages with long periods of records. Annual series frequency analyses were performed using computer program HECWRC, Flood Frequency Analysis, dated April, 1987, which incorporates procedures from EC 11102-249 "Hydrologic Frequency Analysis," and "Water Resources Council Bulletin 17B, Guidelines for Determining Flood Flow Frequency." All statistical computations were performed on gage data through Water Year 1994, as adjusted for partial duration and urbanization.

7.3.1.4 Hydrodynamic Models. In the estuary portion of the study area that includes Newark Bay, Passaic River to Dundee Dam and Hackensack River to Oradell Reservoir, 2- and 3-dimensional numerical models were developed to assess project impact. Models were used to predict changes in salinity, temperature and circulation patterns in and around the bay and outlet structure. Data collection efforts were performed to calibrate and verify models to a known set of historical information. Hypothetical events were then evaluated with and without the project in place, with model output providing the hydrodynamic response to both the sediment transport and water quality models for further analysis.

This effort included the evaluation of a series of variables that consisted of:

- Tunnel Water: empty or partially filled tunnel.
- Time of Year: cold or warm receiving bay waters.
- Flood magnitude: hypothetical 2-, 25- or 100 year with and without the project.

Model results indicated that the effect of the tunnel diversion on circulation patterns is very localized and would basically be a zone around the outlet structure. Generally, impacts are not significant due to the outlet citing in an area that already has high currents during existing flood events. However, cross currents to shipping with the project in place are more likely and this will be more accurately assessed during the FDM when a physical model would be built and a ship simulation study performed.

7.3.1.5 Sediment Transport. As part of this study effort, sediment evaluations were made for the upland riverine areas on the Passaic River upstream of Dundee Dam, a 2-dimensional sediment transport model in the Newark Bay area, and a trapping efficiency study of tunnel discharges. For the upland areas, a limited sediment assessment study was conducted by the Corps of Engineers Waterways Experiment Station in 1990 to test for potential adverse impacts of the project. The study made recommendations that resulted in the establishment of a sediment data collection program. Four data collection sites have been selected where data was collected for two minor flood events. The sites are 1) the Pompton River at Pompton Plains, 2) Passaic River at Little Falls and 3) Passaic River at Pine Brook, and 4) the Hackensack River at New Milford. After data collection was completed, the sediment transport process was evaluated; the primary goal will be to assess sediment movement in and around the tunnel inlets and to determine the impacts of the tunnel on sediment transport capabilities and changes on the Passaic River, its tributaries and Newark Bay. In addition, an evaluation was made of the effect of sediment on the operation and maintenance of the tunnel. Model results indicated some areas of potential deposition and erosion may occur.

7.3.1.6. Water Quality. A water quality model was created to help determine the impacts of the project on water quality in Newark Bay, the lower Passaic River and the lower Hackensack River. The model was developed at the Corps of Engineers Waterways Experiment Station (WES) in Vicksburg Mississippi. A computer program which simulated flow in three directions was developed for the analysis. To insure the proper movement of the tides, the model included the Hudson River up to Troy, NY, Sandy Hook, NJ and a large portion of Long Island Sound. The model simulated salinity, water temperature, and dissolved oxygen levels with and without the tunnel project. The water quality analysis was fully coordinated with the National Marine Fisheries Service (NMFS) along with other environmental agencies.

7.3.2 Tunnels. The analyses and procedures were performed in accordance with standard Corps of Engineer design guidance. With a systematic 54-year period of record dating back to 1940, and an historical extension to October, 1903, ample data are available to determine reliably the flow for the 100-year design flood event. Appropriate statistics were developed to allow the determination of peak flow-frequency curves in accordance with Bulletin 17B of the United States Water Resources Council. The Corps' standard computer program was used to calculate the expected probabilities for the frequency curves. Existing condition computations were used to determine the curves for future conditions in the year 2050, with the tunnel system in place. Having established existing conditions (1992) and 2050 conditions, based on the expected probability, adjustments were made to the UNET peak flows. This permitted the design flow for the tunnel to be established at approximately 29,000 cubic feet per second (cfs).

Tunnel size was determined by study of elevation-discharge curves in relation to a range of values for the roughness of the tunnel. Given tunnel diameters were then applied to maximum design head of 175.0 at the Pompton Inlet and downstream tailwater elevation of 6.2, National Geodetic Vertical Datum, allowing for future sea level rise and storm surge in Newark Bay. The result of this analysis, supplemented by statistical reliability estimates, demonstrated that the 100-year flow of 29,000 cfs could be most effectively conveyed with minimal damage by a pipe 42 feet in diameter.

7.3.2.1 Pompton Inlet. The location of this inlet is absolutely critical to the establishment of design flow, diameter and overall cost of the tunnel element. Floodwaters entering the tunnel at this point will travel 20.4 miles to Newark Bay. The Pompton Inlet will skim up to 29,000 cfs of excess floodwaters allowing between 4,300 and 7,000 cfs, representing the range of the 1- and 2-year frequency events, to be bypassed. Generally, the bypassed flow will increase as the size of the storm increases. These flows will be out of bank but will not cause significant damages. A risk and uncertainty analysis was performed at this inlet. Hydraulic studies allowed the elevation of the inlet to be low enough to significantly reduce the need for extensive upstream levee/floodwall systems.

7.3.2.2 Passaic Spur Inlet. This inlet will divert up to 13,400 cfs of excess floodwaters out of the river into the spur tunnel. Between 5,550 and 6,500 cfs, representing the range of the 1- and

1.5-year frequency events, will be allowed to bypass the inlet. Generally, these bypassed flow will increase as the size of the storm increases, but will remain within the banks.

7.3.2.3 Outlet. The diverted floodwaters will flow from a depth of 399 feet vertically into the outlet structure, which will extend from a depth of about 26 feet below sea level to about 25 feet above sea level. It will contain three 26-foot wide by 30-foot high vertical lift gates that will distribute flow through an angle of about 70 degrees and across the full channel depth of 30 feet. If one or more of the gates were to fail to open during a major flood event, flow will still be able to exit the tunnel through a 140-foot long overflow section located at the back of the outlet.

7.3.3 Channel modifications. All channel modifications were designed in accordance with the Corps of Engineers manual on the Hydraulic Design of Flood Control Channels[1]. Areas considered for erosion protection included locations to be modified and unimproved locations where channel velocities are expected to increase by at least 25% as a result of the project. Channel velocities used to determine erosion potential were obtained from the UNET model for improved conditions.

7.3.4 Levees and floodwalls. For the Central Basin and Pequannock-Ramapo levee/floodwall systems, heights were determined by adding an allowance for uncertainties to the water surface elevations for the 100-year flood event. The uncertainties associated with flow, channel roughness, debris obstruction at bridges and blockage of tunnel inlet gates, were estimated. Sensitivity analyses were performed for various conditions. The combined effects of uncertainties in discharge, blockages and other conditions were used to set the minimum design water surface profiles.

Since all levee/floodwall systems provide limited protection, consideration was given to overtopping which can be expected to occur at some time. To minimize the hazard of overtopping, the design calls for it to occur at the least hazardous location, which could be either at the downstream-most end of the levee/floodwall systems or at a ponding site in a protected area. The flowline that overtopped the levee at the least hazardous location was then determined and superiority height was added along the remaining locations.

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[1]EM 1110-2-1601

7.3.5 Interior Flood Damage Reduction Facilities. Each levee-floodwall system was designed to provide for the drainage of storm water from the protected area during and after flood events. Facilities will include culverts, sluice gates, flap gates, pumps and ponding areas. In no case will drainage be less effective than without the project. Accordingly, facilities to assure the current level of effectiveness were considered as well as enhanced facilities in areas where residual flooding occurs. As sound engineering design, small pump stations were included in some instances due to a combination of factors including the reduction of overall project footprint, New Jersey rules on Green Acres and wetlands replacement ratios, and the need to evacuate ponding areas in a reasonable time period. In other cases, interior facilities were enhanced because it was economically feasible to do so.

The design of the interior flood damage reduction facilities considered events of seven frequencies ranging from the 2- to 500-year. Conditions exterior to each system were compared to interior conditions behind the levee. Hypothetical events of the same frequency based on UNET modeling, for both interior and exterior conditions, were assumed to occur simultaneously to determine interior ponding elevations. Seepage through the levee/floodwalls was not included in the interior analysis, except for Passaic #10, where it was found to be negligible. Data on interior flood damage reduction facilities are shown in **Table 12.**

Table 12 - Interior Flood Damage Reduction Facilities

System	Facilities to match without project condition	Facilities provided as sound engineering design	Enhanced facilities
Pequannock/Ramapo	Culverts with sluice gates and flap gates Four ponding areas	3 cfs pump	
Passaic #10	Culverts with sluice gates and flap gates One ponding area	two 3-cfs pumps	
Pinch Brook	Culverts with sluice gates and flap gates One ponding area		3 cfs pump
Passaic #2A	Culverts with sluice gates and flap gates Five ponding areas	5 cfs pump 3 cfs pump	2 cfs pump 1 cfs pump
Rockaway #1	Culverts with sluice gates and flap gates Five ponding areas	1 cfs pump	
Rockaway #2	Culverts with sluice gates and flap gates One ponding area	10 cfs pumping station	
Rockaway #3	Existing facilities are used		
Lister/Turnpike/ Doremus	Culverts with sluice gates and flap gates		1000-cfs pump 50-cfs pump
Kearny Point	Culverts with sluice gates and flap valves		75-cfs pump

South First Street 1st	**Culverts with sluice gates and flap valves**		**75-cfs pump** **70-cfs pump** **30-cfs pump**

With respect to tidal protection area interior flood damage reduction facilities, exterior conditions are controlled by tidal stages. Study showed that there is a low degree of coincidence between peak tidal stages and high Passaic River runoff events. It was found that a normal tide plus a 1.5- to 2.0-foot surge could be adopted as coincident within the Passaic River Basin. Seepage rates were found to be negligible. Ponding areas were not used in this area because of the lack of space in these heavily urbanized areas for either natural or excavated ponding areas. Various levels of pumping capacity beyond that necessary to match non-project conditions were evaluated to determine the optimum protection. As a result of the optimization process, additional pumping was found to be justified at all three of the tidal protection areas as shown in **Table 12.** Interior flood damage reduction facilities for the tidal levee/floodwall systems consist primarily of gravity culverts with sluice gates, flap gates, and pumping stations.

7.3.6 Improved conditions Implementation of the project will reduce flood damages in numerous localities in the Passaic River basin. Tunnel diversions will result in the largest flood level reduction, although individual levee/floodwall systems, and channel modifications will provide high levels of protection at their respective locations. Generally, the project will reduce the 100-year flood to non-damaging or low level residual flooding in the principal damage areas of the Central Basin and Lower Valley. Areas upstream and downstream of the tunnel inlets will have water level reductions as a result of the tunnel's operation. In the Lower Valley tidal areas, where the tunnel diversion will have little to no impact, the levee/floodwall systems will provide protection for the heavily urbanized areas in the vicinity of Newark Bay.

The effect of these systems on flood elevations of the project at various locations is displayed in **Table 13** .

Table 13 - Project Effects
Reduction in Water Level, (In feet)

River	Location	Flood event 1-yr.	10-yr.	100-yr.	500-yr.
Passaic River	Pine Brook	0.1	0.3	1.2	2.1
Wanaque River	At Mouth	5.2	6.2	5.7	4.4
Pequannock River	Near proposed Pequannock Weir	1.8	6.1	6.9	5.8
Ramapo River	1.5 mile above mouth	1.8	6.1	4.9	3.8
Pompton River	Above inlet	0.6	7.7	10.7	6.6
Pompton River	At mouth	0.4	5.3	8.3	6.0
Deepavaal Brook	At mouth	0.3	4.8	7.8	5.9
Passaic River	Little Falls	0.1	4.8	8.1	5.8
Passaic River	Dundee Dam	0.1	1.6	1.7	2.0

7.4 GEOTECHNICAL

A preliminary type of geotechnical design was performed for each project feature to ensure a reasonable, sound cost estimate. Diverse geotechnical studies were conducted in support of the design of the tunnels, inlet and outlet works, levees, floodwalls and other elements of the project. These included geotechnical analyses and studies of groundwater, construction materials, subsurface explorations and laboratory testing. However, it should be noted that a subsurface exploration and testing program of much greater magnitude along with more detailed geotechnical analyses will be necessary for feature design memorandum studies. Full details are in Appendix E - Geotechnical.

7.4.1 General Geology A substantial amount of exploration is needed to assure that a project of this magnitude is compatible with the geological conditions expected over the 21.7 miles of tunneling, and other works. For this General Design Memorandum, over 40,000 linear feet of borings were made for tunnel design including almost 34,000 linear feet of rock coring. Prior to preparation of plans and specifications, another 40,000 to 80,000 linear feet of borings are planned. The more detailed the explorations, the less risk there will be to the government and the contractors who bid for construction. At the heart of the exploration program is the need to assure that the location and definition of all buried valleys that may exist along the tunnel alignment have been determined. For the tunnel boring machine (TBM) to encounter unconsolidated soil deposits in a buried valley will be unacceptably hazardous and costly.

7.4.2 Groundwater Studies. A comprehensive groundwater study was performed because of the importance of the potential impact of tunnel construction on groundwater resources. The study results will be the basis for follow-on design studies of the various project elements over the implementation stage of the project. Quantitative studies were made for the tunnels and Great Piece Meadows and qualitative evaluations were made for other project features. Groundwater conditions were observed by means of a boring program, as part of which some borings were converted to observation wells that allow monthly measurements to be made.

A hydrogeologic investigation was performed along the alignment of the tunnel elements. The purpose of the investigation was to estimate the potential effects of groundwater on tunnel design, and the effects of tunnel construction and operation on the regional groundwater conditions. Six field pumping tests were performed at shaft locations and groundwater modeling was performed for seven areas along the tunnel alignment. The objectives were to:

- Evaluate existing groundwater conditions along the length of the tunnels.

- Evaluate potential seepage into the tunnel during and after construction.

- Estimate the drawdown in local aquifers and nearby water wells.

- Assess the potential for contaminants to accumulate as a result of tunnel construction.

The groundwater modeling indicates that drawdown of groundwater in shallow overburden areas is not expected along the tunnel alignment as a result of tunnel construction or operation. Many bedrock wells are located within 5,000 feet of the tunnel along the southern end of its route. They could experience drawdowns ranging from 10 to 50 feet during construction. After construction is complete, well drawdowns due to tunnel seepage will be significantly reduced by grouting and tunnel lining. The lower tunnel will operate in a wet condition such that long-term well drawdown will not exist. Thereafter, the wells will only be affected to a lesser degree for short periods during dewatering and maintenance activities.

The groundwater studies provided the basis for developing a procedure to limit seepage into the tunnel to acceptable levels during and after construction. Reduction of seepage will be accomplished by cement grouting and concrete liner placement. Grouting ahead of the tunnel boring machine will be performed in the most pervious rock zones, determined by probe holes drilled radially and ahead of the TBM. After placement of the tunnel liner, grouting will again be performed to fill any voids between the liner and the rock. These grouting and liner procedures will minimize groundwater drawdowns. It estimated that long term steady state seepage into the fully grouted and concrete lined tunnel will be on the order of 1,000 to 2,000 gallons per minute (gpm) or similar to the discharge from single high capacity municipal or commercial wells. Since drawdown in overburden aquifers will be negligible, no damaging settlement of structures above the tunnel is expected. During excavation of the tunnel shafts through the overburden soils, slurry/concrete walls or freeze walls will be used to control seepage.

7.4.3 Tunnels The preconstruction engineering and design phase exploration program, while designed primarily for the tunnels, also provided information for shafts, inlets and outlet. In rock, the coring and pressure permeability testing was performed in all boreholes, and video surveys and geophysical testing were performed in selected boreholes. In the overburden, split spoon and undisturbed sampling were performed in selected borings. For the geotechnical exploration a total of 119 borings have been drilled for the main tunnel and 10 for the spur tunnel.

The geology of the tunnel route was analyzed as to its suitability for tunnel construction and the associated inlets and shafts. The need to drive the tunnel through competent rock was considered a basic requirement for the alignment of the tunnels. Information for the entire route of both tunnels was obtained. Areas of weakness such as buried valleys and discontinuities were identified and considered in the design.

A laboratory rock and soils testing program was conducted to determine the significant design characteristics of the tunnel route such as compressive strength of soil and rock. Design parameters were selected and stability analyses performed.

With regard to construction, alternative ways to construct the tunnel were considered including conventional excavation procedures using drilling and blasting techniques. It was concluded that a tunnel boring machine is the most economical approach for construction of the tunnel. TBMs have been used to bore 40' diameter tunnels in Europe and it has been determined to be well within the ability of manufacturers to produce TBMs to bore the proposed 44-1/2 foot diameter tunnel. Geologic conditions along the tunnel alignment are considered to be suitable for use of a TBM, which has high productivity, requires little temporary support, and minimizes concrete lining. It is expected that several TBM's will be required to work concurrently in view of the size of the project.

The muck produced by the TBM will have to be removed to a place of disposal. It is probable that a horizontal tunnel and vertical shaft conveyor system will be used in conjunction with the TBM-driven tunnel for muck removal. The tunnel muck will be transported to the disposal sites either by train, barge or truck. The disposal of the tunnel muck is not expected to be a problem as there is known to be interest in using it as engineered fill and quarry owners have expressed interest in obtaining this material for quarry fill.

7.4.4. Shafts. The project provides for 11 shafts serving varying purposes such as muck removal, dewatering, personnel and equipment access, concrete placement and ventilation, as described in Section 5 - Project Description. Subsurface explorations were conducted for each shaft. Structural support for shaft excavation through the overburden soils will be provided by slurry/concrete or freeze walls. Rock support for the shafts will be provided by resin encapsulated rock bolts, where necessary. For added protection from rock falls, welded wire mesh will be used between the bolts as determined by the size of the shafts.

7.4.5 Inlets. The geotechnical design for the Pompton Inlet was based on foundation design and settlement, excavation, water and seepage control. Design features include:

- Control of surface water and groundwater by a cellular sheet pile cofferdam and sheet pile wall.

- A large diameter slurry/concrete wall for advancing the shaft through the overburden. Backfilling of excavations with structural concrete to create its semi-cone shape.

- Founding of the gate structure and access basin on H-piles

- A concrete wall will be utilized for the back retaining wall, incorporated into the back portion of the structure and tied into rock.

- A 15-foot diameter air vent located 200 feet along the alignment of the tunnel.

The Passaic Inlet is similar to the Pompton Inlet except that it is smaller and has a straight control weir instead of a circular one. The Passaic Inlet design includes:

- Control of surface water and groundwater by a combination slurry wall and berm around the structure excavation.

- Use of a large diameter slurry/concrete wall for semi-cone shaft excavation and construction.

- Founding of the gate structure and access basin on H-piles.

- A tied back retaining wall.

- A 12-foot diameter air vent located 200 feet along the alignment of the tunnel.

7.4.6 Fairfield Road Bridge and Passaic Inlet Approach Channel. The geotechnical design features associated with the bridge and the approach channel generally include: anchored sheetpile retaining walls to support the bridge approach roadway embankments; the approach roadway embankment and new pavement section, pile foundations for the bridge abutment and piers, anchored sheetpile retaining walls to support inlet approach channel walls, and the temporary road to allow Fairfield Road to remain open during construction.

The bridge will be a multi-span reinforced concrete structure. The superstructure will be supported by abutments and piers constructed within braced sheetpile excavations and founded on H-piles driven in to the dense natural glacial soils or to the underlying bedrock. The Passaic Inlet approach channel will be rectangular in shape and 300 feet wide. It will be lined with stone and riprap and be supported by vertical anchored sheetpiling. The anchoring system will be a series of tie-rods connected to continuous concrete deadmen embedded in the natural soil.

7.4.7 Tunnel Outlet. The exploration program, conducted from a floating platform in Newark bay, consisted of drilling and sampling, borehole geophysical investigations and a pumping test to observe hydrogeology. The outlet structure will be of reinforced concrete with three vertical lift gates. The significant geotechnical design features are as follows:

- Construction of a circular sheet pile cofferdam around the inlet shaft. After the cofferdam is filled with sand, a freeze wall will be constructed to advance the shaft excavation into rock.

- The reinforced concrete gate structure will be constructed concurrently offsite in a dry dock.

- A concrete shaft liner will be placed and keyed into rock. The freeze wall will thaw and the cofferdam will be removed. The site will be excavated for the structure and outlet channel and then a pile foundation driven under water.

- The gate structure will be floated in and sunk into position onto leveling pads. A sheet pile skirt will be driven around the structure and grout injected for connection to the pile foundation.

7.4.8 Great Piece Weir. The site geology was derived from the boring programs conducted in the vicinity of the site. Laboratory soil testing was performed on selected samples. Appropriate soil design parameters were selected for geotechnical design based on the laboratory soil testing and the standard penetration test blow counts from the borings. The weir will be constructed in the existing Passaic River channel using a two-stage cellular sheetpile cofferdam. The gate structure and wing walls will be founded on steel pipe piles driven to refusal in glacial till or rock.

7.4.9 Pequannock Weir. Subsurface explorations were performed at the site of the weir and soil parameters were based on the standard penetration blow counts. The weir will be constructed in a new channel adjacent to the existing Pequannock River channel and weir. An earthen cofferdam will surround the excavation and a slurry wall will be utilized to control seepage into the excavation. A pile foundation was selected for the gated weir and the four adjoining wing walls to provide adequate bearing capacity, sliding stability, and erosion resistance. Levees, required to provide closure between the new weir and high ground to the west and the existing weir to the east, will be constructed of semi-pervious material with riprap armoring on the upstream face.

7.4.10 Tidal Area Protection. For each of the three tidal protection systems, consisting of over 11,000 linear feet of levee and 57,000 linear feet of floodwall, studies included a limited boring and laboratory testing program, development of design parameters, and geotechnical analyses. The subsurface soil conditions at all three system areas are generally considered as poor for support of levees or floodwalls. The soft organic and laucustrine soil deposits affect stability for levees and require pile support for floodwalls. Accordingly, levees, with side slopes of one vertical to three horizontal and a-10 foot crown, are located in areas where adequate land is available along the waterfront for stability; floodwalls are used where space is constrained by existing structures or utilities along the river; floodwalls comprise 84% of the tidal area protection. For stability, the river side toe of levees must be at least 80 feet from the edge of any existing bulkhead structure, and at least 30 feet from the top edge of banks without bulkheads or other structures. Fill material will be obtained either from commercial sources or from tunnel excavation. Floodwalls will generally consist of continuous cantilever PZ-27 steel sheetpiling with a reinforced concrete cap. The sheet piling will penetrate the ground to a depth at least three times the wall height, with a minimum depth of 10 feet. In isolated areas, box pile and cellular sheetpile floodwalls will also be used. In all instances where existing embankments or walls are used as part of levee and floodwall systems, Corps of Engineers criteria will be applied during feature design memorandum studies to assure stability.

7.4.11 Central Basin Protection. The levee and floodwall designs in the Central Basin are similar to those described under paragraph 7.4.10. Geotechnical analyses were performed on the Central Basin elements using limited existing subsurface information. No soil or rock testing was performed for the Central Basin elements. Additional borings will be made as part of the follow-on engineering and design phases.

7.4.12 Pequannock/Ramapo Levee/Floodwall and Channel System. Studies included a design of the levee and floodwall structures, a soil analysis to evaluate existing site conditions based on limited existing boring data, and a check on seepage and slope stability. Levees will have a 10-foot crown with side slopes of one vertical to three horizontal. One alternative for levee fill is to utilize the tunnel muck in conjunction with a river side clay blanket to limit through seepage. It was determined that one vertical to two and one-half horizontal channel slopes are adequate based on low water and sudden drawdown analyses.

7.4.13 Passaic River Levee System #10. This system is scheduled to be the first element of the plan constructed. Therefore, a detailed geotechnical design was performed as a basis for preparation of plans and specifications. All required subsurface investigations and laboratory soils testing were performed. Appendix J - Feature Design Memorandum contains full details. The levee will generally have one vertical on three horizontal side slopes, a 10-foot wide crown, and will be constructed of on-site borrow.

7.5 STRUCTURAL

A preliminary type structural design was performed for each project feature to ensure a reasonably sound cost estimate. In general, external project stability was analyzed but detailed design such as that necessary to design reinforcing steel and connections was not performed. All elements of the project were designed on the basis of sound engineering practice and design principles and in accordance with Corps of Engineers design manuals for each type of structure. Additional details on each structural element are located in Appendix G - Structural.

7.5.1 Tunnel Liners. Design of the 42-foot diameter main tunnel and the 23-foot spur tunnel considered both rock and hydrostatic loads. The rock surrounding the tunnels will be self-supporting thereby transmitting no load to the concrete tunnel liner; thus, the concrete liner was designed to withstand full hydrostatic pressure. Since the tunnels will be driven by tunnel boring machines, varying the liner thickness will not be possible. Therefore, the liner will be held constant at 15 inches. The only variable in the liner design is the compressive strength of the concrete; for the main tunnel it will vary from 3,000 pounds per square inch (psi) to 6,500 psi, and for the spur tunnel it will be 3,000 psi. The concrete liners will have no expansion joints due to the interlocking strength of the concrete liner and the rough rock surface.

7.5.2 Tunnel Shafts. Eleven shafts will serve as air vents and/or maintenance and equipment access ways to the tunnel. During construction, five shafts will serve as TBM access and muck removal points. After construction, one shaft at Kearny Point will serve as a housing for a pump station for the tunnel. The shafts will vary in diameter from 12 to 45 feet with their liner thicknesses varying from 12 to 24 inches. Compressive strength of the concrete will vary from 3,000 to 4,500 psi. It was assumed that the rock surrounding the shafts would be self-supporting thereby transmitting no load to the concrete shaft liner. The hydrostatic and soil pressure, which increase with depth, determined the sizing of the concrete shaft walls and liners.

7.5.3 Pompton (Main) Inlet. This component of the project includes a variety of structural elements. The inlet will be radial and consist of a concrete spillway with 11 hydraulic lift gates attached to reinforced concrete piers supported on H-piles to resist horizontal and vertical loads. The piers will also support gate-lifting equipment and a maintenance bridge, and provide guideways for gates and maintenance bulkheads. An unregulated weir and chute floor will control flow into the tunnel. Tie-back, rock anchored basin walls and pile founded T-Walls surrounding the inlet will serve to retain exterior soil and groundwater pressures. The design of each structural element was based on combinations of headwater and tailwater elevations and forces induced by earthquakes, uplift and ice. The concrete compressive strength will be 3,000 psi and the structural steel will conform to ASTM A36 steel.

Eleven 60-foot wide vertical lift gates will be located over each spillway section to control the flood flow. Each gate will be operated hydraulically, and consist of a skin plate and four wide flange beams designed to resist water pressure as well as ice pressure. Each gate will weigh approximately 63,000 pounds.

The unregulated weir will be a concrete gravity structure that would control the inflow to the tunnel. It was designed to resist uplift, lateral water and earthquake pressures, and vibrations caused by a sudden flood discharge. The chute floor is located below the unregulated weir and provides a smooth transition into the tunnel. Drain holes tying into drain pipes running radially behind the chute floor will serve to minimize water pressure thus reducing uplift forces on the chute floor and the instability of rock wedges and joint blocks.

The approach channel wall will be a reinforced concrete T-wall supported by H-piles driven to refusal, and designed to resist overturning and sliding forces exerted by floods and the surrounding soil. The design considered a range of flooding and soil conditions. The basin wall is a reinforced concrete L-shaped wall with counterforts and tie-back rods, and will rest on rock and be as high as 66 feet above the rock. High strength rods grouted into rock will resist soil and water pressure applied behind the wall. The counterforts will resist water pressure applied in front of the wall. A rock-anchored basin wall, one foot thick, will lie just under the tie-back basin wall with drain holes installed behind the wall to reduce water pressure.

Three maintenance bulkheads consisting of two girders and a skin plate were designed to resist water pressure on its skin plate face and will weigh approximately 20,000 pounds each. The maintenance bridge will be built for access and inspection and to allow for a crane to install and remove the maintenance bulkheads. The bridge will consist of three 4-foot by 4-foot prestressed concrete box girders, supporting a reinforced concrete deck and steel guardrail.

Electrical and mechanical systems to operate the gates and support equipment will be located at the Pompton Inlet. The gates could be controlled locally on-site or from the Operations Center at Workshaft 2.

7.5.4 Passaic (Spur) Inlet. This component of the project will also include a variety of structural elements similar to that of the Main Inlet. The inlet will consist of a straight spillway regulated with five hydraulic lift gates attached to reinforced concrete piers, a basin floor, an unregulated weir, and a sloped chute floor which leads into the tunnel. The spillway will be of reinforced concrete supported by H-piles driven to refusal to resist horizontal and vertical loads. The piers will also support the gate-lifting equipment, a maintenance bridge and provide guide ways for gates and maintenance bulkheads. The design of each structural element was based on combinations of headwater and tailwater elevations and forces induced by earthquakes, uplift and ice. The concrete compressive strength will be 3,000 psi and the structural steel will conform to ASTM A36 steel.

Five 50-foot wide vertical lift gates will be located over each spillway section to control the flood flow. Each gate will be operated hydraulically, and consist of a skin plate and four wide flange beams designed to resist water pressure as well as ice pressure. Each gate will weigh approximately 45,000 pounds.

The unregulated weir is a concrete gravity structure that will control the inflow to the tunnel. It was designed to resist uplift, lateral water and earthquake pressures, and vibrations caused by a sudden flood discharge. The chute floor is located below the unregulated weir and provides a smooth transition into the tunnel. Drain holes tying into drain pipes running radially behind the chute floor will minimize water pressure thus reducing uplift forces on the chute floor and the instability of rock wedges and joint blocks.

The approach channel wall is a 28-foot high reinforced concrete T-wall supported by H-piles driven to refusal, which are designed to resist overturning and sliding forces exerted by floods and the surrounding soil. The design considered a range of flooding and soil conditions. The basin wall is a reinforced concrete L-shaped wall with counterforts and tie-back rods, and will rest on rock and be as high as 67 feet above the rock. High strength rods grouted into rock will resist soil and water pressure applied behind the wall. The counterforts will resist water pressure applied in front of the wall. A rock-anchored basin wall, one foot thick, will lie just under the tie-back basin wall with drain holes installed behind the wall to reduce water pressure.

Three maintenance bulkheads consisting of two girders and a skin plate were designed to resist water pressure on its skin plate face and will weigh approximately 17,000 pounds each. The maintenance bridge will be built for access and inspection purposes and to allow for a crane to install and remove the maintenance bulkheads. The bridge will consist of three 4-foot by 4-foot prestressed concrete box girders, supporting a reinforced concrete deck and steel guardrail.

Electrical and mechanical systems to operate the gates and support equipment will be located at the Passaic Inlet. The gates could be controlled locally on-site or from the Operations Center at Workshaft 2.

7.5.5 Newark Bay Outlet. Located 1,850 feet south of Kearny Point, in Newark Bay, the outlet will consist of pile supported reinforced concrete structure with three vertical hydraulic lift gates to regulate flow from the vertical tunnel outlet shaft. The outlet structure will be built off-site and floated into position over the vertical outlet shaft and pile supports. Allowable unit compressive strength of reinforced concrete will be 4,000 psi and the specified yield strength of reinforcement steel will be 60,000 psi. Structural steel will have a yield strength of 36,000 psi and conform to ASTM A36.

Flow from the outlet will be controlled by three steel-framed gates, each having a continuous steel skin plate. Each gate will be 26 feet wide and 30 feet high with a 25-foot opening height from the gate sill elevation of -20 feet, and will be operated by two hydraulic cylinders. Each gate was designed to withstand a 30-foot hydrostatic load from the bay side with the interior dry, and a maximum interior water elevation and low tide bay water elevation. The design of the foundation was based on a range of conditions that would be encountered during construction, operation, storms, floods and earthquakes.

Electrical and mechanical systems to operate the gates and support equipment will be located at the Newark Bay Outlet. The gates could be controlled locally on-site or from the Operations Center at Workshaft 2.

7.5.6 Fairfield Road Bridge. The Fairfield Road Bridge will be built approximately 200 feet upstream of the Passaic Inlet to replace the existing roadway and to allow for Fairfield Road to cross over the 300-foot wide Passaic Inlet approach channel. It will serve to ensure project integrity during flood events by minimizing the obstruction to river flow while providing continuous local access to the surrounding areas.

The bridge consists of five simply supported spans, each approximately 85 feet long to produce a total length of 430 feet between abutment backwalls. The bridge will support a 40-foot wide two-lane roadway on a reinforced concrete deck slab supported by prestressed concrete I-beams set on reinforced concrete piers and abutments founded on H-Piles. The bridge will also support a 60-inch diameter aqueduct line set on prestressed concrete I-beams adjacent to the deck slab. As part of the bridge construction, I-wall retaining walls will channel floodwaters to the Passaic Inlet after it passes under the bridge. The bridge was designed in accordance with current American Association of State Highway and Transportation Officials (AASHTO) and New Jersey Department of Transportation (NJDOT) criteria.

7.5.7 Great Piece Weir. This weir, located downstream of the Great Piece Meadows in the Central Basin Area, will be built to prevent upstream headcutting, minimize erosion potential and to maintain the existing upstream wetland habitat. The weir includes five 30-foot wide torque tube bascule gates resting on a gate sills 6 feet above the Passaic River bottom; an operating deck supported by the weir abutments and four 10-foot wide intermediate piers; and a short access driveway. Wingwalls will retain the embankments of river adjacent to the weir. The abutments and piers are set on a reinforced concrete continuous slab founded on concrete-filled steel pipe piles. The design of the foundation was based on a range of conditions including construction, normal and flood flow, and maintenance.

Electrical and mechanical systems to operate the gates and support equipment will be located at the Great Piece Weir. The gates could be controlled locally on-site or from the Operations Center at Workshaft 2.

7.5.8 Pequannock Weir. The Pequannock Weir will be located in a new channel just southwest of an existing weir. The existing weir is located on the Pequannock River at its confluence with the Ramapo River in Pompton Plains New Jersey. A new channel will be constructed just to the west of the Pequannock River to provide sufficient capacity to pass flood flow efficiently. The new Pequannock Weir has two functions. During flood conditions, the new weir would reduce damaging flood elevations upstream and permit the bypass of flows around the Old Morris Canal Feeder Dam. During normal conditions (approximately 97% of the time) it would preserve the existing wetlands by maintaining the water levels that exist today.

The weir consists of a concrete monolith footing founded on a timber pile foundation. The footing will support four spillway sections with tainter gates set between five piers, and a maintenance access bridge with three 8-foot deep girders spaced at eight feet supporting a 20-foot wide reinforced concrete deck. A wheeled 45-ton crane will be stored on the bridge for maintenance purposes and to install stoplogs. Critical load cases for the foundation and tainter gates were analyzed including 100-year flood flow, ice loading, gate lifting, earthquake, and cable break.

Electrical and mechanical systems to operate the gates and support equipment will be located at the Pequannock Weir. The gates could be controlled locally on-site or from the Operations Center at Workshaft 2.

7.5.9 Tidal Area Protection Floodwalls. As part of the authorized project, three levee/floodwall systems will be required to protect existing industrial areas along the Passaic and Hackensack Rivers from tidal flooding near the Newark Bay. The systems include approximately 57,128 feet of floodwall. Floodwalls were chosen at locations where space constraints prevented the use of levees and where it was desirable to minimize disturbance to suspected hazardous, toxic and radioactive waste sites. Standard Corps I-wall sheet pile floodwalls will be located at the top of the riverbanks, box pile I-wall floodwalls will be constructed in the river where existing structures are located in close proximity to the river's edge, and cellular cofferdam structures will be built at the Kearny Point system to close off two abandoned boat basins along the right bank of the Hackensack River. Specified design stresses will be 3,000 psi for concrete, 60,000 psi for reinforcement steel and 38,500 psi for steel sheet piling.

7.5.10 Central Basin and Pompton River Floodwalls. As part of the authorized project, approximately 13,630 feet of floodwall will be required as part of six levee/floodwall systems to protect existing commercial and residential properties from flooding along the Passaic, Rockaway, and Ramapo Rivers. All of the Central Basin and Pompton River floodwalls will be standard Corps I-walls consisting of a steel sheet pile foundation with a reinforced concrete cast-in-place cap. I-Wall floodwalls were chosen where space constraints limited the use of a levee.

The design of Rockaway #1 and #3, Pinch Brook, and Passaic #2A floodwalls was performed using the conventional method. The design of the Pequannock/Ramapo floodwall was performed using the Corps engineering manuals and computer design programs. All sheet piles will be standard regular carbon grade steel with a specified design bending stress of 38,500 psi. The reinforced concrete cap will consist of 3,000 psi concrete and grade 60 steel reinforcement.

7.5.11 Passaic #10 Floodwall. The Passaic #10 Levee/Floodwall System will protect several industrial properties in Livingston Township from flooding. As part of the system, a 10-foot closure wall with adjoining I-Wall floodwalls transitioning into the adjacent levees will maintain the line of protection across the alignment of an existing exposed 52-inch diameter sanitary sewer line. The design was based on Corps engineering manuals and computer design programs. As this project element would be the first constructed, complete design details are provided in Appendix J - Passaic #10 Feature Design Memorandum.

7.5.12 Closure Structures. Closure structures will be needed at several locations along the Tidal Area Protection levee/floodwall systems and Central Basin and Pompton River levee/floodwall systems. Several types of gates were studied and swing gates were selected because of their economy, simplicity of making the closure, and mechanical reliability. The swing gates will be supported by top and bottom hinges attached on one side to a reinforced concrete vertical support member tied into a footing founded on timber piles. The gates will be closed by latches attached to the supporting structure on the opposite side of the opening. Two types of closure structures are presented with varying closure widths, a pedestrian/vehicular and railroad closure. The gates and foundation were designed to resist maximum hydrostatic pressures from a 100-year flood. Design of the gates was performed in accordance with Corps of Engineer design manual on load and resistance factor design criteria for local protection project closure gates.

7.5.13 Pumping Stations. Pumping stations behind levees and floodwalls of the Tidal Area Protection levee/floodwall systems will be needed to remove storm runoff from the protected areas. Conceptual drawings for six pump stations were developed. Wall and floor slab thicknesses were computed and the flotation stability of each station was determined. The pump stations are essentially large concrete box structures constructed in the ground housing pumps to remove interior drainage from the protected areas. Bearing and rotation calculations were performed treating the pump stations as spread footings. The thicknesses of walls and floor slabs were designed to resist full hydrostatic pressure when the pump station is empty.

7.6 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

Investigations were conducted to determine the potential effects of existing hazardous, toxic and radioactive waste contamination on construction and operation of the project and the potential effects of the project on existing HTRW contamination. All project elements were investigated including the main and spur tunnels and associated inlets, shafts, river channel modifications, weirs, levees and floodwalls.

Field investigations were conducted at the tunnel inlet and outlet locations, at several proposed shaft locations, and at one proposed levee location. Environmental records were also searched to identify HTRW sites in the vicinity of each project element. Based on the field investigations and records search data, qualitative analyses were performed to determine occupational exposure to risk from contaminated soil, groundwater or surface water generated during construction activities. Alternatively, the potential risk of adverse effects of construction activities on existing contamination were also assessed. In addition, the collected data were compared to the regulatory criteria established by the United States Environmental Protection Agency (USEPA) and the New Jersey Department of Environmental Protection (NJDEP). Response alternatives were evaluated based on these criteria. The alternatives addressed whether soils to be excavated or groundwater to be pumped during construction or operation will require special handling due to the presence of contaminants. Special handling for soils includes disposal or beneficial reuse; special handling for pumped groundwater includes removal of contaminants prior to its discharge to surface water. Conservative cost estimates for special handling of excavated soil and discharged groundwater, and for additional investigations where current data are incomplete, were developed for each feature.

In summary, there are proposed project features that may impact or be impacted by the presence of HTRW. There are several sites where further intrusive investigations are required. The total cost of construction and investigation for remediation of HTRW impact for the flood damage reduction project is estimated at about $29,000,000 of which $1,900,000 are for additional investigations. As discussed in Section 14 - Implementation, any project costs that are incurred as a result of the presence of HTRW contamination are the responsibility of the local sponsor. Full details on HTRW considerations are provided in Appendix F - Hazardous, Toxic and Radioactive Waste.

7.7 COST ENGINEERING

Each component of the project was engineered to assure the minimum cost of construction consistent with project effectiveness, reliability and safety. Alternative means of accomplishing the objectives of each component were considered. The project cost estimate was further minimized by providing for effective management and timing of each project element throughout the construction phase. The overall cost estimate is comprised of 36 individual M-CACES[2] estimates, all of which are included in Appendix D - Cost Engineering. Cost engineering for levees, floodwalls, channel modifications, weirs and pumping

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[2]Microcomputer-Aided Cost Engineering System

facilities was in accordance with standard Corps of Engineers manuals for such works. For the tunnel system components, special cost engineering studies were performed.

7.7.1 Main Tunnel. Several factors influenced the selection of the main tunnel's location. The availability of work shaft locations and proximity to roads and railroads suited to the transportation of the tunnel muck was critical in this highly urbanized area. Another important consideration was the minimization of the length of tunnel that had to be driven through rock. Curves in the tunnel alignment had to be limited to a minimum radius of 1,500 feet to accommodate the maneuverability of the tunnel boring machine. The need to avoid deep buried valleys in the lower portion of the tunnel resulted in the lowering of the tunnel invert to elevation -409 feet, N.G.V.D. A minimum of one tunnel diameter of sound rock above the crown of the tunnel was allowed to ensure that there will be an adequate thickness of sound rock over the tunnel crown. To facilitate dewatering, a low point was provided at work shaft 2C. Four separate contracts will be required for the construction of the tunnel by three tunnel boring machines, as follows:

Contract A	From the outlet to workshaft 2B
Contract B	From workshaft 2B to hook hole shaft 5
Contract C	Between workshaft 5 and hook hole, workshaft 3
Contract D	From Pompton Inlet to Workshaft 3

The spur tunnel will be built under a separate Contract E. Its alignment is the shortest distance between the Passaic Inlet and the main tunnel that will accommodate the construction of a work shaft.

7.7.2 Shafts. Cost engineering performed for each shaft reflects the specific conditions and requirements at each location, such as tunnel boring machine access, clearing of trees, switchyard to facilitate rail transportation of muck, security fencing, and protection of drainage courses. Work shaft 2, will be provided with facilities consistent with its use as a master control center for the entire tunnel system.

7.7.3 Inlet and Outlet Structures. The Pompton Inlet will be used as work shaft for muck removal during the tunnel construction period. The Passaic Inlet will be used to remove the tunnel boring machine after the tunnel excavation. The Newark Bay Outlet will be a single purpose structure having no additional use during the tunnel construction period.

7.7.4 Tunnel Boring Machine. The use of tunnel boring machines for tunnel excavation was selected because of their high production, low level of required temporary support, and reduced concrete lining as the result of reduced overbreak.

7.7.5 Materials. An investigation was performed of commercial sources of materials required for construction including concrete tunnel lining, inlet and outlet structures, weirs, floodwalls, levees and embankments. Its purpose was to determine probable availability and cost of: ready-mix concrete, portland cement, concrete aggregates, fly ash, riprap, graded stone, earth borrow and clay, steel, sheet piling, H-piles and reinforcing steel. Estimated quantities are about 950,000 cubic yards of ready-mixed concrete, 300,000 cubic yards of earth fill, 200,000 lineal feet of steel H-piles, 900,000 square feet of steel sheet piles, 90,000 cubic yards of riprap and graded stone and 50,000 tons of reinforcing steel. All materials were found to be locally available over the construction period. Appendix E - Geotechnical, summarizes the results of the study.

7.7.6 Disposal of Excavated Materials. Construction of the project will produce significant quantities of soil and rock that require disposal. A study was made on the character, transportation and disposal of material excavated during construction of the main tunnel, spur tunnel, shafts, inlet and outlet structures and channel excavations. Considered were quantity and nature of the materials, possible means of on-site disposal, potential disposal sites, HTRW factors and the economics of disposal. The total amount of material excavated for these works is about 10,000,000 cubic yards (loose measure) of rock and 2,000,000 cubic yards (loose measure) of soil.

The following conclusions and recommendations resulted from the study:

- Adequate capacity exists for the disposal of anticipated quantities of excavated materials at sites generally within 10 miles of the production shafts.

- Highway, rail and water routes are available within the project area. Highways, however, appear to have the lowest capital costs of the three modes of transportation.

- Prospective recipients have been found who are willing to accept excavated materials at no cost, but not to compensate for it.

- Environmentally, it might be more acceptable to use railway transportation to minimize effects on air, noise and transportation.

- There is a strong likelihood of HTRW contamination at shafts 2B, 2C, and 3 and that contaminated sediment may be encountered during construction of the outlet. In accordance with NJDEP guidelines, some contaminated materials that are excavated may be reused on site.

7.8 PROJECT SECURITY

Although the project involves no classified information or related facilities, the design calls for security measures to prevent vandalism and terrorist acts. Structures will be secured by the use of fencing, signs, lighting and alarm systems. Operation equipment will be set up to prevent unauthorized operation of the gates. Specific measures will be presented in the plans and specifications. Provisions will also be made to provide safety features protecting the general public from potentially unsafe or dangerous conditions.

MAIN REPORT

SECTION 8

ENVIRONMENTAL ANALYSIS

8. ENVIRONMENTAL ANALYSIS

8.1 OVERVIEW

This section covers environmental effects and environmental design aspects. Extensive studies of environmental resources in the basin were conducted for the Phase I General Design Memorandum. Because that document was prepared to establish feasibility it did not comprehensively treat environmental design factors. For implementation purposes, additional studies have been done to assure that each aspect of the project responds to the principles of GOOD environmental design. Additional effort has also been applied to identifying and addressing the environmental impacts of the project and mitigating them as fully as possible. Full details are described in Appendix B - Environmental Resources. In addition, the Final Supplemental Environmental Impact Statement (SEIS) accompanies this report.

8.2 ENVIRONMENTAL EFFECTS

The natural environment affected by the project is limited to the Central Basin and the tunnel outlet area. As noted in Section 4, there are three distinct hydrologic regions, the Highland Area, the Central Basin and the Lower Valley. At present about 14% of the Central basin is recognized as wetlands, but it continues to develop although it remains basically suburban. The project's effects on fish and wildlife are related to aquatic and terrestrial changes. Most of the impacts are associated with construction and will be temporary, but some effects of a more enduring nature will occur and will be mitigated. Environmental effects of the project are comprehensively addressed in the Supplemental Environmental Impact Statement; summarized below are those impacts that are of most significance.

8.2.1 Newark Bay The freshwater outflows from the tunnel will be received by Newark Bay, which is about 5.7 miles long, 0.75 mile wide, and 3,200 acres in extent. It has two distinct depths; shallows ranging from 0.5 to 11 feet at mean low water, and dredged ship channels of depths ranging up to 30 feet and covering an area of about 750 acres. Newark Bay is surrounded primarily by industrial and commercial development but some residential development as well. Virtually all of the shoreline has been impacted by bulkheading or riprap so that the extent of natural shore line is limited. Some of the industries located on the bay produce or handle materials that are suspected of being toxic. Biological sampling was performed by agreement between the Corps of Engineers and the National Marine Fisheries Service. Positive as well as negative effects will result from the project based on the following facts.

- The amount of water entering Newark Bay will be the same but the timing of its entry will be different. This condition is expected to create minor short term changes in the Bay's water quality in the immediate vicinity of the outlet.

- The floodwaters entering Newark Bay will be cleaner than at present or in the future without the project. This condition is expected to reduce pollution entering of the Bay.

- The tunnel will be mostly full of water between flood events. This condition is expected to create temporary degradation of dissolved oxygen levels in the immediate vicinity of the tunnel outlet due to back up of stored tunnel water that would become anoxic with time.

The total impact is expected to be insignificant. The resulting drop in salinity due to the rapid inflow of fresh water, will rarely exceed 24 hours in duration and will be similar in effect to what occurs in the without project conditions. Other impacts may occur as a result of: Changes in the chemical and physical properties of the floodwaters; the extent to which floodwaters remain in the tunnel before the next flood; disturbances of bottom sediment; and changes in water temperature.

Positive effects of the tunnel include reduction of pollutants entering the river during floods. The tunnel relieves this problem for all but the most severe flood events.

8.2.2 Wetlands. The loss of habitat near the remaining freshwater wetlands in the Central Basin is expected to continue with the project in place. However the project includes features to mitigate project-related losses.

The Central Basin contains about 24,000 acres of wetlands of which 13,700 are within the project area. The project will cause direct loss of 95 acres of wetlands as a result of levees and sideslopes associated with channel modifications.

The basic tool used to quantify wetland impacts and to formulate a mitigation plan was the Habitat Evaluation Procedure (HEP) developed by the United States Fish and Wildlife Service, (USFWS). The species guilding concept was employed with HEP to choose species to be used. Other species, not chosen for HEP, but within the same habitat, were also considered during mitigation planning. The goal was to offset all adverse impacts where they cannot be avoided. Where possible, alternative mitigation measures were considered at the areas directly affected by the project works. If that could not be done, off-site alternatives were considered such as wetlands creation and land restoration, regrading of land, restoration and habitat improvement.

8.2.3 Aquatic Resources Aquatic impacts will vary within specific reaches on the individual streams. Impacts will include some loss of shade, increased water temperatures and decreased dissolved oxygen. Effects on the aquatic biota will be greatest in areas where the physical measures will be placed. The Pequannock, Wanaque, and Ramapo River complex, where channel modifications provided and a levee/floodwall system will be provided, will be the adequate resources most affected by the tunnel system. These areas contain the highest diversities of fish and benthic invertebrate species. Thus, this combination of greatest instream and bank manipulation in the area of the greatest diversity will cause the greatest impact on the aquatic environment.

The types of effects include: (1) reconfiguration of the stream morphology; (2) elimination of substantial tree shade and, therefore, an increase in water temperature, coupled with a decrease in dissolved oxygen; (3) removal of aquatic flora and fauna during construction; and (4) entrainment increasesas a result of adaption of the Pequannock Weir to direct flows to the main inlet and; (5) caused by loss of riffle/run species.

Anadromous fish are found in limited numbers in Newark Bay and the Lower Passaic River. Generally, they spawn in April and May, seeking low salinity or fresh waters. Offspring reside in the river from May until September. They will not be affected by the project for the majority of the year. The effects of tunnel operation in April and May are expected to be minimal because it mimics natural conditions.

8.2.4 Wildlife. The project's primary impacts on wildlife will be due to the loss of wetland habitat mostly by the placement of levees in the Central Basin. Some of these areas have already declined in value because of activities of man. A total of 95 acres of wetland habitat will be adversely affected or lost by project construction.

8.2.5 Endangered Species. A review of the project area was conducted in consultation with the USFWS, NMFS, and their state counterparts, in accord with the requirements of the Endangered Species Act. No species on the Federal endangered list will be adversely affected by the project based on the latest consultation with the Federal agencies concerned, as reported by Federal law (Section 7). Most species on the state list, especially those in the Great Piece Meadows, are likely to be beneficially affected due to lowering of maximum floodwater depth. Continued monitoring and sighting will alert the Corps to any need for follow-up action that may be required as part of the project. The National Marine Fisheries Service advised that the project will not affect endangered species under its jurisdiction. Recent sightings indicated in the summer of 1995, raising a concern to be addressed in future studies.

8.2.6 Groundwater. It is not expected that construction or operation of the tunnel or other project features will have any significant impact on groundwater quality. During construction, slurry trenches or freeze walls will be used to prevent seepage from the overburden soils into the excavations for shafts and surface structures. If deep groundwater contamination is encountered during tunnel excavation, the dewatering effluent will have to treated prior to discharge.

During operation, water will be maintained in the tunnel to elevation 0.0. This will, in effect, balance internal with external pressures and significantly reduce seepage of groundwater into the tunnel. Groundwater inflow into the entire tunnel will be limited by grouting of the rock and placement of a concrete tunnel liner.

With respect to groundwater quantity, through the use of engineering controls during construction and operation, it is not anticipated that the tunnel will have any significant impact on groundwater resources. Seepage into the completed tunnel, after grouting and liner installation, is estimated to be in the range of 1,000 to 2,000 gallons per minute (gpm). This flow for the entire 20.4 mile tunnel length is about equal to the output of a single high capacity municipal or commercial well. Since drawdowns in the overburden aquifer are estimated to be minimal, no significant impact on shallow wells is expected.

8.2.7 Water Quality. Floodwaters instead of flowing into Newark Bay from its channel and gradually diluting the salinity of the water, will enter Newark Bay as a freshwater plume that would drop salinity rapidly in the immediate vicinity of the tunnel outlet. At the 100 year event this effect essentially replicates natural conditions during a flood. Thus, the operation of the tunnel does not increase stress to the resident organisms. Nor are there expected to be any significant adverse effects in water temparture or dissolved oxygen in Newark Bay.

8.2.8 Air Quality. The project is within the State of New Jersey's Implementation Plan in accordance with the Clean Air Act National Ambient Air Quality Standards (NAAQS) for the majority of constituents. The evaluation of air quality impacts will depend upon the final determinations of significant factors such as construction schedule, construction equipment and hours of operation. If the expected air emissions exceed any of the NAAQS rates established for non-attainment areas, a full scale conformity analysis will be completed and subjected to the established Federal review process.

8.2.9 Aesthetics. The main inlet and shafts will be placed in industrial zones so as to avoid significant aesthetic impacts. Aesthetic treatments will be applied to levees and floodwalls as a standard feature if they are located in residential areas, parks or within view of parks. Levees will be beautified with plantings that are native to the area. In residential yards, turf grass will be planted and shrubs will be provided along the lower edges of levees.

8.2.10 Noise. Most of the noise generated by the project will occur deep underground and be totally imperceptible. There will be no noise or vibrations felt at the surface as the tunnel boring Machine cuts through the rock from 150 to 500 feet below the surface Short term construction-related noise, generated at the inlets, shafts and tidal area protection structures, are in areas that already experience such noises from highways and industrial activities. In the Central Basin residential areas, there will be short term noise during the construction of levees, floodwalls and channel modifications. This noise will be heard by those who directly benefit from the project.

8.2.11 Cultural Resources. The Corps is party to a Programmatic Memorandum of Agreement with the New Jersey State Historic Preservation Office (NJSHPO)and the Advisory Council on Historic Preservation. In accordance with that agreement, cultural resource investigations were performed for several project elements, the purpose being to identify properties within or adjacent to the project area that are listed, or potentially eligible for inclusion, in the National Register of Historic Places. All phases of the investigation and the review process have been coordinated with the NJSHPO.

8.3 ENVIRONMENTAL DESIGN

Environmentally sound objectives were pursued throughout the entire design effort. Opportunities for environmental enhancement were considered, as well as for mitigation of unavoidable project impacts to the extent possible. Environmental preservation has been incorporated as a standard feature into the design of each element, including the channel modifications, levees, floodwalls and other structures. In addition, specific sih and wildlife measures, separate from the project components, were included in the design specifically to mitigate unavoidable project impacts.

8.3.1 Mitigation of Estuarine Impacts An intensive sampling, strategy, provided the baseline conditions supported by extensive experimentation and model studies of water quality with which to compare project impacts. This allowed a mitigation needs of the plan to be developed that considered the following measures:

- Re-aeration of tunnel water

- Creation of estuarine marsh habitat

- Creation of fish habitat in Newark Bay away from the outlet

These efforts indicate the Bay would function with little or no change between a with project or with-out project condition.

8.3.2 Mitigation of Wetlands Impacts. The mitigation plan includes maintenance of wetlands in ponding areas by use of pumps, sluice gates and flap gates to control site hydrology. To offset unavoidable wetland losses, techniques to be used include such measures as creation of wetlands from burrow areas, restoration of disturbed to wetlands, construction of blind ditching and earthen banks to create emergent scrub communities, and maintaining wetlands hydrology according to a planned program planned program. In addition, mitigation measures will be used at sites apart from the project elements including: restoring disturbed areas of the Lincoln Park gravel pits.

8.3.3 Mitigation of Aquatic Impacts. A plan was developed to mitigate changes in stream morphology, and the loss of tree shade, leading to increased water temperature and decreased dissolved oxygen. The measures include: maintaining shade on southern and western banks to the maximum extent possible; using stockpiled stream material and tunnel cobble material to restore existing stream substrate; using instream structures, as well as offstream velocity refuge embayments, to increase habitat in tributaries upstream of the tunnel inlet and in the Pompton River. Wing dams and other instream structures will be used to replace riffle/run pool morphology.

8.3.4 Mitigation of Wildlife Impacts. All project elements affecting wildlife resources were examined in detail to minimize their impacts, mainly limited to wetlands. Wetland mitigation incorporate wildlife concerns in addressing functional equivalency of mandated ratios for impacted acreage.

8.3.5 Great Piece Weir. The weir location and design was coordinated with the USFWS. To assure that this weir, as well as the Pequannock weir, effectively protect upstream wetlands, the USFWS Habitat evaluation Procedure and a plant recessional model were used. Wetlands within the 2-year floodplain will be thus protected.

8.3.6 Pompton River. The reach downstream of the Pompton Inlet provides opportunities to mitigate the upstream impacts on the Pequannock, Wanaque and Ramapo Rivers. Habitat mitigation techniques will be used to offset the upstream losses. Also, flow in this reach will be allowed at bankfull capacity of 4,300 cfs to increase the flushing of the bottom during flood events. This flow will also allow continued natural sediment transport and scouring, while helping to reduce contaminants in the river from overland sources.

8.3.7 Recreation and Aesthetic Enhancement Each project element was considered for the addition of recreational facilities and aesthetic treatment. These measures are described in Section 5 - Project Description.

8.3.8 Recreational Mitigation. Land that is part of the New Jersey Green Acres Program and diverted from recreational use to flood damage reduction purposes requires replacement with land of equal or greater value. Lands included in the easements for the project are considered to be diverted from recreational purposes. All the land in this project, so affected, consists of undeveloped woodland in the floodplain and could be replaced by similar passive recreation sites. These include Passaic County Park Department lands in Wayne Township and the Borough of Pompton Lakes, and Essex County Park Department lands in the Borough of Fairfield and Livingston Twonship. It is expected that by the time project construction begins, the Town of Harrison, which has applied for the Green Acres Program, will have lands affected as part of the South 1st Street System.

In all areas where recreational land or open space is taken, either for narrow strips lost to channel widening, or where levees will cover parks or open space, the areal extent of the taking was calculated and will be offset with either direct land purchases or replaced with cash payment as mitigation for the loss.

8.3.9 Beneficial use of Excavated Materials The estimated quantity of rock excavation from tunnel construction is over 10 million cubic yards, loose. Soil materials will be excavated in the construction of shafts, channel modifications, inlets and outlet structures comprising an estimated quantity of 2 million cubic yards, loose. Potential uses of these excavated materials vary. Granular soils will provide excellent materials for both compacted and uncompacted fills and embankments. Some of the granular material may be adequate for processing into fine aggregate for concrete. The clays may be used for embankments and levees or for cover on landfills. Basalt rock could be processed into coarse aggregate for concrete or asphalt and used as stone base for roadways or for compacted embankments. The shale/sandstone material could be used for compacted embankments and levees, uncompacted embankments and underwater fills.

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SECTION 9

REAL ESTATE REQUIREMENTS

9. REAL ESTATE REQUIREMENTS

9.1 OVERVIEW

A gross appraisal was completed to estimate the cost of acquiring the lands and easements for the construction of each element of the Flood Damage Reduction Project. The estimates were based on determining for each element the type of real estate interest required and applying the fair market values of properties as determined by surveys of market conditions and recent real estate transactions.

9.2 BASIS FOR LAND REQUIREMENTS

For those project elements that preclude any other use, acquisition is needed in fee simple, which signifies ownership of all the rights in a parcel of real property.

For those lands required for project elements that may be used by the property owner for other purposes, permanent easements will be acquired. This will allow the government to construct, maintain and operate the project facilities and allow the owners to use the property as long as such use does not interfere with the project purpose.

Temporary easements will be acquired to allow for use of property needed only for the construction of the project, including staging areas and transportation of supplies and equipment.

Fair market value is the amount in cash, or terms reasonably equivalent to cash, for which in all probability the property would be sold by a knowledgeable owner willing but not obligated to sell to a knowledgeable purchaser who desires but is not obligated to buy.

9.3 REAL ESTATE REQUIREMENTS FOR PROJECT ELEMENTS

The total acreage required for the project is 5,378 acres in fee simple, 468 acres in permanent easement and 123 acres in temporary. Table 14 displays these needs by project element.

Table 14 - Real Estate Requirements
(In acres)

Category	Fee simple	Permanent easement	Temporary easement
TUNNEL SYSTEM			
Pompton Inlet	4.1	0.4	6.5
Passaic Inlet (1)	5.6	0.8	6.37
Tunnel	0	218	0
Pequannock-Ramapo	0	4.06	2.96
Work shaft #2	1.02	0.48	2.5
Work shaft #2B	0.52	0	3.8
Work shaft #2C	1.5	1.37	1.13
Work shaft #3	0.18	0.08	0.38
Work shaft #4	0.14	0.41	2.5
Vent/hook hole shaft #5	0.02	0.1	0.35
Vent shaft #6	0.12	0.08	0.5
Newark Bay Outlet	1.7	0	2
Fairfield Road Bridge	0	0.2	0.23
Pequannock Channel	0	41.5	11.48
Wanaque Channel	0	14.3	5.2
Ramapo Channel	0	24.84	6.08
Pompton Bypass Channel	0	16.32	2.6
Passaic Channel	0	26.9	5.08
Great Piece Weir	0.77	1	7.75
Pequannock Weir	2.25	0	3.76
CENTRAL BASIN PROTECTION			
Passaic #2A	0	9.41	6.04
Passaic #10	0	27.81	1.76
Deepavaal Brook		15.98	6.72
Rockaway #1	0	5.47	2.7
Rockaway #2 (2)	0	4.98	2.05

Rockaway #3	0	3.47	7.15
Pinch Brook	0	2.95	1.97
TIDAL AREA PROTECTION			
Kearny Point	0	21.48	13.35
Lister/Turnpike/ Doremus	0	21.48	6.02
South 1st Street (3)	10	4.49	1.43
PRESERVATION OF LAND			
Land acquisition	5350	0	0.00
Total	5377.92	467.56	123.35

(1) 3 single-family homes (1 used as a business office).
(2) 4 multi-family structures, 1 single-family home.
(3) 2 Business properties, parking lot and storage yard

MAIN REPORT

SECTION 10

COORDINATION

10. COORDINATION

10.1 OVERVIEW

Throughout the development of the project an active program has been pursued to obtain the views of all interests external to the Corps, including the other Federal agencies, state and local governments and their resource agencies, groups and individuals. Issues have been surfaced and steps have been taken toward resolution. Full details are provided in Appendix A - Public Involvement.

10.2 PUBLIC INVOLVEMENT PROGRAM

The public involvement program pursued the following objectives:

- To build public confidence and trust in the project implementation process.

- To reflect the needs and preferences of the people of the Passaic River Basin within the bounds of Federal, state, county and local programs, laws, regulations and authorities.

- To resolve issues and solve problems through public involvement.

These objectives were met by:

- Developing an information program to make the public knowledgeable about the region's water resource problems, needs, objectives, alternatives and priorities.

- Creating a mechanism by which the public could express its views on any aspect of the process.

- Providing opportunities for the public to participate directly in reaching decisions pertinent to project implementation.

- Actively promoting effective coordination among federal, state, county and local agencies.

Three scoping meetings for the Supplemental Environmental Impact Statement (SEIS) were held in June, 1993 to provide a forum for the broad range of public and political views to be aired. The meetings permitted an open exchange of ideas, information and opinions particularly with respect to the revisions in the project as authorized by the Water Resources Development Act of 1990. The chief purpose of the scoping meetings was to gather and document information on issues identified by the various interests so they could be properly reflected in this General Design Memorandum and the SEIS.

10.3 OTHER FEDERAL AGENCIES

Federal agencies with resource management responsibilities have provided opportunities to participate in the formulation and implementation of the project at every stage of the process. They have contributed their expertise and cooperated in the resolution of issues of significance to their missions.

10.3.1 The Environmental Protection Agency and the Corps of Engineers signed a memorandum of agreement for the development of a comprehensive wetlands mitigation plan, which has been incorporated into the project. EPA also applied its expertise in the areas of air and water quality, and hazardous, toxic and radioactive wastes.

10.3.2 The National Marine Fisheries Service provided research and sampling data from Newark Bay needed to determine potential impacts due to the construction and operation of the tunnel outlet.

10.3.3 The Geological Survey collected data and created groundwater models for both tunnel inlets. These models were integrated with a model of the entire tunnel to replicate existing conditions and forecast project impacts on groundwater resources and hazardous, toxic and radioactive wastes.

10.3.4 The Fish and Wildlife Service provided extensive assistance regarding projection of future conditions with and without the project and inventories of the various fish and wildlife resources. It assisted in the establishment of baseline conditions for the proper application of the Habitat Evaluation Procedure. Over 50 technical reports discussed qualitative impact assessments that enabled the Corps to identify adverse impacts on fish and wildlife and minimize them by means of appropriate mitigation measures.

The goal of the Fish and Wildlife Service was to assure that the adverse environmental effects of the project are minimized to the maximum extent possible are incorporated. The Service provided the following recommendations toward that end.

1. The Corps must continue consultation with the Service throughout the next study phase regarding potential project-related effects to the Indiana bat. The Corps should coordinate with the Service regarding any studies necessary to determine the suitability of the project area for Indiana bats.

2. The Corps must coordinate with the National Marine Fisheries Service regarding potential project-related effects to the Federally-listed threatened or endangered marine species.

3. The Corps should coordinate with the New Jersey Natural Heritage Program for current information regarding candidate species in the project area.

4. The Corps should coordinate with the New Jersey Division of Fish, Game and Wildlife, Endangered and Nongame Species Program regarding potential project-related effects to any state-listed species.

5. The Corps should coordinate with the Service to develop site specific plans to offset unavoidable adverse impacts to palustrine forested wetlands through the restoration of former wetlands within the Passaic River Basin.

6. The Corps should coordinate with the Service to develop site specific plans to offset unavoidable adverse impacts to palustrine scrub-shrub wetlands through the restoration of former wetlands within the Passaic River Basin.

7. The Corps should coordinate with the Service to develop site specific plans to offset unavoidable adverse impacts to palustrine emergent wetlands through the improvement of existing emergent wetlands within the Passaic River Basin.

8. The Corps should incorporate the in-stram structure recommended by Garline et al (1995) into the selected plan to offset the adverse impacts of the proposed channel modifications.

9. The Corps should coordinate with the Service to develop plans for off-channel velocity refuges along the river reaches to be affected by the proposed channel modifications.

10. The Corps should coordinate with the Service to develop plans for additional studies to examine the effects of the proposed project on water temperature regimes in the river reaches affected by channel modifications.

11. The Corps should take necessary steps to minimize the disturbance of contaminated sediments during construction of the tunnel outlet.

12. The Corps should identify suitable upland sites for the disposal of any contaminated sediments excavated during the construction of the tunnel outlet.

13. The Corps should coordinate with the Service, and the New Jersey Division of Fish, Game and Wildlife regarding the development of comprehensive management of plans for the proposed acquisition areas, Great Piece Meadows Weir, and the wetlands mitigation areas.

Corps responses to these recommendations are as follows:

Recommendation 1. Concur. The Corps will maintain informal consultation with the Service regarding project-related effects on the Indiana bat. Should continuing informal consultation indicate biological assessments are necessary, one will be prepared in accordance with the 50 CFR Part 42. Studies required to support the biological assessment will be coordinated with the Service.

Recommendation 2 through 4. Concur. Similar consultation will be initiated with the National Marine Fisheries Service.

Recommendation 5 through 7. Concur. Ongoing consultation will be maintained regarding these resources.

Recommendation 8 and 9. Concur. The Corps New York District will actively pursue incorporation of these features into the selected plan.

Recommendation 10. Concur. Additional temperature studies regarding reaction of fishery species to increasing water temperatures will be conducted in final design stages.

Recommendation 11. Concur. Engineer controls for sediment disposal are incorporated in project plans.

Recommendation 12. Concur. Upland disposal will be considered consistent with regulatory controls regarding on-site re-use of sediments, ocean disposal and other options designed to meet regulatory criteria and state agreements for the disposal of contaminated sediments.

Recommendation 13. Concur. Resource management plans developed for proposed acquisition areas will be coordinated with the Service and the New Jersey Department of Fish, Game and Wildlife to ensure any plan development meets Service and state management criteria, goals and objectives.

10.4 STATE AND LOCAL AGENCIES

The staff of the non-Federal sponsor, the New Jersey department of Environmental Protection provided consultation, data collection, and assistance in mitigation planning.

MAIN REPORT

SECTION 11

COST ESTIMATE

11. COST ESTIMATE

11.1 OVERVIEW

This section provides information on the cost of building the project, including construction labor, equipment and materials, and real estate acquisition. Also discussed are the costs of operation and maintenance over the project life. The cost estimate is broken down with respect to the various elements of the project.

11.2 MANAGING THE COST ESTIMATE.

The total authorized project cost estimate as stated in Appendix D - Cost Engineering set the target for managing and controlling costs during implementation. The estimate has been and will continue to be updated as necessary. As the design is refined the cost of each feature becomes more accurate with fewer uncertainties. The estimate is made current for each major milestone in the implementation process.

11.3 FIRST COST OF CONSTRUCTION

First cost includes charges arising from the construction of the project including engineering and design, construction management and contingencies. The estimated project cost of the authorized plan of improvement is $1,400,000,000, of which $1,040,000,000 is Federal and $360,000,000 is non-Federal. The cost is estimated at October 1994 price levels. The Federal and non-Federal costs are summarized in Table 15. A detailed cost estimate of the plan of improvement is contained in Appendix D, Cost Engineering. Also shown are the estimated fully funded costs, which are the funds needed for the project accounting for price escalations due to inflation over the construction period.

Table 15 - Cost Estimates
(October, 1994 price level)

Project element	First cost	Fully funded
TUNNEL SYSTEM		
Tunnels (including shafts	1,094,254,000	1,455,679,973
Inlets	73,172,046	102,439,320
Outlet	32,791,234	44,270,329
Weirs	23,384,185	32,231,104
Levees, walls, channels	35,139,731	51,660,563
Subtotal	1,258,741,896	1,686,281,289
CENTRAL BASIN PROTECTION		
Passaic #2A	8,771,911	10,929,229
Passaic #10	2,797,507	3,222,175
Deepavaal Brook	3,196,402	3,952,184
Rockaway System	21,070,596	25,824,853
Rockaway #1	3,856,781	4,712,997
Rockaway #2	3,667,721	4,460,377
Rockaway #3	13,546,094	16,651,479
Pinch Brook	1,850,156	2,251,854
Subtotal	37,685,572	46,180,295
TIDAL AREA PROTECTION		
Kearny Point	46,472,848	59,510,799
Lister/Turnpike/Doremus	36,668,234	45,686,478
South First Street	12,739,377	15,629,043
Subtotal	95,880,459	120,826,320
PRESERVATION OF NATURAL STORAGE		
Land acquisition	5,755,235	6,658,315
FISH AND WILDLIFE		
Mitigation	7,06,116	10,488,427
Total cost of project	1,400,000,000	1,870,000,000

11.4 COMPARISON WITH PREVIOUSLY APPROVED ESTIMATE

Differences between the current cost estimate and the current approved Project Cost Estimate (DA form PB-3 effective 1 October 1994) are presented in detail in Appendix D. The basis of the PB-3 estimate is the cost contained in the authorizing legislation, updated to current price levels using the Office of Management and Budget inflation factors.

The current fully funded approved Project Cost Estimate (with allowance for inflation through construction) is $1,870,000,000. The fully funded estimate as developed for this General Design Memeorandum, is $1,870,000,000, unchanged.

11.5 OPERATION AND MAINTENANCE COSTS

The operation and maintenance (O&M) costs are the estimated average annual economic costs necessary to maintain the project at full operating efficiency to obtain the intended benefits.

Upon completion of construction the Federal Government will be responsible for performing all measures to ensure the integrity of the tunnel, including staffing of operation centers, cleaning and periodically inspecting the tunnel structure, and testing and assuring the effectiveness of mechanical equipment at gated structures and pump stations. The non-Federal sponsor will be responsible for: operating, maintaining, repairing, rehabilitating and replacing the remaining project features, including existing highway and railroad embankments used as levees and tie-outs for levees; and recreational and environmental mitigation features.

Operation and maintenance costs are based on experience that provided information on actual practices for various types of projects. The only project facilities that will require continuous operation will be the pump stations. However, test operation of the gates at the inlet and outlet structures together with periodic maintenance will be required.

The major task associated with the project will be the annual maintenance required for the channels, levees and floodwalls. These tasks will include but not be limited to: inspection, maintenance, repair and replacement of riprap; clearing of debris from the channel and bridges, sediment removal as needed; shoal removal, brush and tree control; trash pickup cutting of grass along the channel banks, levees and ponding areas; and the repair of concrete structures together with the painting of miscellaneous metal parts.

Fish and wildlife mitigation features have been designed to be self-maintaining, as recommended by the United States Fish and Wildlife Service and the New Jersey Bureau of Freshwater Fisheries. The wetlands will be self-perpetuating once established, and the nesting boxes designed to replace the loss of reproductive cover from trees are expected to degenerate over time. They are not scheduled to be maintained or replaced since new trees and nesting niches will become available as the riparian corridor becomes reestablished.

The major activities required for tunnel operation and maintenance are as follows:

- Periodic pump-out. The tunnel will have to be pumped out to make a visual inspection and allow sediment to be removed. Pump-outs will be scheduled periodically and after each major flood event.

- Responsibilities of on-site personnel. Qualified personnel will receive flood warning messages and operate the gates when flood events are ex[ected. Other personnel will perform routine daily tasks such as general inspection and guarding against vandalism to the inlets, outlet, and gates. They will also ensure proper working order of the related electrical components and hydraulic machinery. An annual testing program of the entire system should be initiated along with a training program to provide for additional qualified operational personnel in case of a flood emergency.

- Mechanical maintenance. A yearly maintenance program will be initiated for the gates at the Pompton Inlet, the gates at the Passaic inlet and the gates at the outlet.

- Maintenance of inlet and outlet structures. An annually scheduled maintenance program will be established for inlets and the outlet.

- Cleaning of tunnel. Clean outs of the tunnel will occur at least ten times during the 100 year life of the structure, though others may occur after major flood events.

Average annual operation and maintenance costs, as shown in **Table 16.** are estimated to be $3,150,000.

Table 16 - Operation and Maintenance Costs
(In dollars)

Item	Annual costs
Tunnels system	1,907,000
Central Basin Protection	622,000
Tidal Area protection	421,000
Preservation of natural storage	200,000
Fish and wildlife mitigation	0
Total cost	3,150,000

MAIN REPORT

SECTION 12

ECONOMIC ANALYSIS

12. ECONOMIC ANALYSIS

12.1 OVERVIEW

Federal participation in the project requires a demonstration of economic feasibility, which is established by determining whether the benefits exceed the annual economic charges. Benefits were determined based on detailed investigations of the economic impacts of flooding in the basin. Annual charges were based on the application of economic principles to all the costs of constructing, operation and maintenance of the project. The economic analysis is summarized in Table 17 and discussed in detail in Appendix I - Economics.

12.2 ANNUAL ECONOMIC CHARGES

The annual charges as summarized in **Table 17** were computed on the basis of the following factors:

- Interest and amortization were determined using a discount rate of 7-3/4% and a project economic life of 100 years, which is the period of time over which the project is expected to yield its benefits.

- Interest during construction is the cost of construction money invested before benefits are derived from the project. It is added to the construction cost to determine the total investment in the project. Interest during construction is determined by adding compound interest at the applicable project discount rate from the date the expenditures begin to the beginning of the year in which benefits begin to accrue. Construction of this project is estimated to take 10 years 10 months as discussed in Section 14 - Implementation and Appendix - D, Cost Engineering.

- Costs for the operation and maintenance are discussed in Section 11 - Cost Estimate.

12.3 BENEFITS

Flood control benefits are based primarily on the damages that will be prevented by the project and averaged over the 100 year project life. Damage reduction estimates were based on studies of historical floods, projections of development in flood plain areas and statistical analyses relating damage potential to the hydrologic characteristics of the basin with and without the project.

Historical data on flood damages in the Passaic River basin have been compiled since the 1903 flood and researched in newspaper and Federal post-flood reports. To the extent possible the data were analyzed as specifically as to the stream, location and category of damage. While the flood of record is the event of 1903, major floods have occurred frequently since then. Ten major floods have occurred since in 1968.

Interviews were conducted to obtain first-hand data on damages resulting from actual flood events. This process has been ongoing since 1980. Over 3,000 interviews have been conducted to obtain information on residential, commercial, industrial, utility and public damage in the 214 damage reaches that were identified. This information, brought up to date by means of new surveys and interviews, permitted firm relationships to be established between depth of flooding and resulting damage. Extensive assessments of land use have also recently been performed to assure the validity of damage estimates.

Only tangible damages are used in the estimate of benefits for this project. Estimates were made for: Residential, commercial, industrial, and public property (schools, recreation areas); municipal facilities (streets, highways, utility lines); and municipal emergency costs. Where applicable, damages were categorized as to structures and contents.

All the benefits accruing to the flood damage reduction project are shown in Table 17. The total equivalent annual benefits over the period of analysis are estimated at $174,466,500. This is the value of flood damage reduction resulting from the tunnels, channels, levees and floodwalls including benefits in advance of the base year. Benefits are also credited to greater investment in existing properties due to the project (future affluence), preservation of natural storage areas, reduction in delays to vehicular traffic and railroads, reductions in Federal Flood Insurance Administration costs, more beneficial use of residences (intensification) and growth in industrial contents. These latter two benefit categories refer to more intense utilization of an existing structure as a result of less frequent flooding. For instance residents may intensify the use of their homes by finishing the basement if the flood hazard is reduced.

Detailed information on the benefits is contained in Appendix I, Economics.

12.4 ECONOMIC JUSTIFICATION

Total annual benefits for the plan of improvement are $174,466,500. Total annual charges are $127,295,000 (October 1994 price level). Any costs already incurred on flood damage reduction efforts are excluded from the annual charges. A comparison of average annual benefits and annual charges results in net benefits of 47,171,500, and a benefit-to-cost ratio of 1.37 to 1.0 for the Passaic River Flood Damage Reduction Project.

Table 17 - Economic Justification
October, 1994 price levels, 7-3/4% interest rate, 100 year project life

ANNUAL CHARGES	
First cost, interest and amortization	108,560,000
Interest during construction	18,570,000
Total investment	127,130,000
Operation and maintenance	3,150,000
(Minus GDM cost)	38,500,000
Total annual charges	127,295,000
BENEFITS	
Flood damage reduction	116,002,700
Affluence	3,697,200
Preservation of natural storage	2,592,800
Reduction of traffic delays	1,666,700
Advance of base year	41,493,100
Reduction in flood insurance costs	890,000
Residential intensification	520,400
Growth in industrial contents	8,683,100
Recreation	1,764,800
(Minus Residual induced damages)	(252,000)
Total benefits	174,466,500

FEASIBILITY	
Net benefits	47,177,500
Benefit-cost ratio	1.4

A breakdown of this benefit/cost analysis by separable project elements is presented in Table 18. Separable elements are those components that can function independently without the presence of other project elements to reduce flood damages. These are economically justified elements of the authorized project that have been incorporated into the overall project design to augment the flood damage reduction provided by the primary project element, the tunnel, beyond its area of beneficial influence. The benefits and costs of those elements that are integral to the functional role of the tunnel are included in the tunnel element. They include the 7 miles of channel work, tunnel inlets and pilot channels, Pequannock and Great Piece Meadow Weirs, Deepavaal Channel, and the Pequannock-Ramapo Levee floodwall system.

Table 17a - Incremental Benefits of Separable Project Elements

(October, 1994 price levels, 7-3/4% interest rate, 100yr project life)

INCREMENTAL BENEFITS				
System	Total Benefits*	Annual Cost	B/C	Net Benefits*
Pinch Brook	$2,391,700	$172,274	13.88	$2,219,426
Passaic 10	$577,100	$288,070	2.00	$289,030
Rockaways	$3,539,600	$1,930,589	1.83	$1,609,011
Passaic 2A	$8,860,100	$1,118,510	7.92	$7,741,590
Lister, etc.	$24,735,800	$3,484,766	7.10	$21,251,034
S. First St.	$4,001,500	$1,164,190	3.44	$2,837,310
Kearny	$10,763,700	$4,655,310	2.31	$6,108,390
Preservation	$5,014,500	$728,584	6.88	$4,285,916
Deepavaal Channel	$1,025,100	$352,707	2.91	$672,393
Tunnel	$114,582,500	$113,752,707	1.01	$829,793
Total	$175,491,600	$127,647,707	1.37	$47,843,893

* Benefits reflect reductions for residual induced damages.

MAIN REPORT

SECTION 13

COST SHARING

13. COST SHARING

13.1 OVERVIEW

The project is a joint undertaking of the Federal government and the non-Federal local sponsor. Federal law requires that the costs be apportioned in accordance with the benefits to be realized. The sponsor's percentage varies with the type of benefit. Since the project serves the multiple purposes of flood damage reduction, hurricane damage reduction and recreation, the costs were allocated to each purpose to provide the basis for apportioning cost.

13.2 APPORTIONMENT OF COSTS.

The apportionment of Federal and non-Federal costs, based on the Water Resources Development Act of 1986, is given in **Table 18.** The Federal share of the project's fully funded construction costs is $1,390,000,000. The non-Federal costs are estimated at $480,000,000, of which lands, damages, rights-of-way and relocations are estimated at $52,500,000, and the required minimum 5% cash contribution is estimated at $87,100,000. The remaining estimated non-Federal cost of $340,000,000 can be paid in cash or credits as stated in the authorizing legislation.

13.3 CREDIT PROVISIONS

The water Resources Development Act of 1990 authorizes credits for The non-Federal sponsor against its share of the project cost. Credits are allowed for real estate purchased for the wetlands bank and additional watershed lands as well as for the costs of activities that contribute to flood damage reduction. Such activities must meet the criteria stated in Section 104 of The Water Resource Development Act of 1986. These measures may include any flood damage structures, reduction or conversion of acquired lands to wetlands, compatible acquisition of floodplain properties and lands, easements and rights-of-way.

Table 18 - Cost Apportionment
(Fully funded amounts)

	Federal	Non-Federal	Total
FIRST COSTS			
Flood damage reduction	1,311,450,000	437,150,000	1,748,600,000
% share	75	25	
Hurricane protection	78,520,000	42,280,000	120,800,000
% share	65	35	
Recreation	300,000	300,000	600,000
% share	50	50	
Total	1,390,000,000	480,000,000	1,870,000,000

MAIN REPORT

SECTION 14

IMPLEMENTATION

14. IMPLEMENTATION

14.1 OVERVIEW

The implementation process will carry the project through the remaining design phases, preparation of feature design memoranda for the various elements of the project, development of plans and specifications, and construction. Funds must be budgeted by the Federal government and non-Federal sponsor to support these activities, which include the preparation of financial plan. A schedule has been developed to identify the steps and financial requirements.

14.2 SCHEDULE

Construction will begin in September 1998 with the Passaic #10 system and be completed in June, 2009. **Figure** 135 shows the planned construction sequence of the project elements.

14.3 FINANCIAL REQUIREMENTS

Initiation and completion of the project on schedule will require annual budgeting and commitment of funds by the Federal government and the local sponsor in accordance with the financial developed as [part of the Project Cooperation Agreement] described in Section 14. Table 19 displays the estimated annual financial requirements over the construction period. A range of annual non-Federal expenditures is shown reflecting potential credits as discussed in Section 13, and the 5% cash contributes required by law for flood damage reduction projects. If the State of New Jersey were to take full advantage of credit provisions, the financial cost to the State would be the cash contribution. Shown in the last column of Table 19.

TABLE 19 - Financial Rquirements for Construction
(in thousands of dollars)

		NON-FEDERAL		
FISCAL YEAR	TOTAL FUNDING	WRDA 1986	WRDA 1990 POTENTIAL CREDITS	REQUIRED CASH
1998	$ 20M	5	4	1
1999	35	9	7	2
2000	59	15	12	3
2001	144	37	30	7
2002	175	45	37	8
2003	311	80	65	15
2004	331	85	69	16
2005	350	90	73	19
2006	320	82	67	15
2007	94	24	20	4
2008	24	6	5	1
2009	7	2	1	1
TOTAL	$1870M	$480M	$390M	$90M

TABLE 19 - Financial Rquirements for Construction
(in thousands of dollars)

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FISCAL YEAR	TOTAL FUNDING	WRDA 1986	WRDA 1990 POTENTIAL CREDITS	REQUIRED CASH
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1999	35	9	7	2
2000	59	15	12	3
2001	144	37	30	7
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2003	311	80	65	15
2004	331	85	69	16
2005	350	90	73	19
2006	320	82	67	15
2007	94	24	20	4
2008	24	6	5	1
2009	7	2	1	1
TOTAL	$1870M	$480M	$390M	$90M

MAIN REPORT

SECTION 15

PROJECT COOPERATION AGREEMENT

15. PROJECT COOPERATION AGREEMENT

15.1 OVERVIEW

The Federal Government and the non-Federal sponsor have certain obligations which they must meet for this project. The major obligations for each party, as defined at this time, are presented below.

Guidance from HQUSACE, regarding the interpretation of the authorizing legislation has been incorporated into the Federal and non-Federal sponsor obligations listed below as applicable. Highlights of the significant provisions include the following:

- The project will be cost-shared in accordance with Section 103 of WRDA 1986;

- No levees will be constructed in Bergen County, NJ in conjunction with the project;

- The operation, maintenance, repair, rehabilitation and replacement of the tunnel works, including the flood warning system will be performed and paid for by the Federal Government.

- Credits to offset the non-Federal share of the project cost will be provided for real estate purchased for the wetlands bank and additional watershed lands. Such credits must be identified in the PCA. The real estate purchased after PCA execution would be creditable, so long as its intended purchase was identified in the PCA.

- As required in the project authorization, the credits also will include the costs of activities identified in the December 9, 1988, letter of the New Jersey Department of Environmental Protection (NJDEP) as well as any other work that meets the criteria for credit under Section 104 of the 1986 Water Resources Development Act. All costs incurred between June 29, 1984, and the date of execution of the PCA will be eligible for credit and the PCA itself will include a specific statement of this amount.

15.2 FEDERAL OBLIGATIONS

The Federal Government, acting through the New York District, U.S. Army Corps of Engineers, will be obligated to:

- Design and construct the Federal components of the project;

- Approve real estate credits and ensure non-Federal components are compatible with the project;

- Inform the non-Federal sponsor when significant design or constructed portions of the project are completed;

- Perform at Federal expense all operation, maintenance, repair and rehabilitation and replacement measures to ensure integrity of the tunnel, including staffing of operation centers, cleaning and periodically inspecting the tunnel structure, and testing and assuring the effectiveness of mechanical equipment at gated structures and pump stations.

- Provide Operation and Maintenance (O&M) Plans for the local protection project components to the sponsor as construction in completed;

- Retain the right to enter project lands after construction completion for the purpose of inspection under terms specified in the O&M Plan. The terms will also be clarified in the PCA.

15.3 NON-FEDERAL SPONSOR OBLIGATIONS

The Non-Federal sponsor, the State of New Jersey, will be required to:

- Provide, to the United States, all lands, easements, and rights-of-way, including all borrow, ponding, and disposal areas, including lands required for fish and wildlife mitigation, determined suitable by the Chief of Engineers and necessary for construction, operation, and maintenance of the project;

- Provide cash payment equivalent to 5 percent of the cost assigned to structural flood control elements, to be paid during construction, or expend cash for lands during construction to offset the 5 percent non-Federal cash contribution requirement.

- Provide additional cash contributions or credits for lands as are necessary so that the non-Federal contribution for structural flood control is not less than 25 percent nor more than 50 percent of the cost of structural flood control, to be paid during construction;

-Provide additional cash contributions or credits for lands as are necessary so that the non-Federal contribution for nonstructural flood control is not less than 25 percent of the cost of nonstructural flood control;

- Provide additional cash contributions or credits for lands as are necessary so that the non-Federal contribution for hurricane and storm damage reduction is not less than 35 percent of the cost of hurricane and storm damage reduction, to be paid during construction;

- Share the cost of separable fish and wildlife mitigation features in the same proportion as the non-Federal share of the costs of project features which require mitigation;

- Provide fifty percent of the cost of separable recreation facilities for which there would be Federal participation, to be paid during construction;

- Provide a Financial Plan to the Government. The Financial Plan is to be prepared by the sponsor and submitted to the Corps at the earliest possible date. The Plan will define how the sponsor will finance its share of the costs of the project and must demonstrate the sponsor's ability to meet its obligations. The Plan will be reviewed by the Government with the PCA before construction funds are appropriated.

- Perform all necessary design and construction activities relating to alterations and relocations of buildings, highways, railroads, bridges (except railroad bridges and approaches), and utilities including storm drains, water supply lines, and sanitary sewers, other than those portions which pass under or through the project's structures, and other structures and improvements made necessary by construction, operation, and maintenance of the project;

- Hold and save the United States free from damages due to the construction, operation, maintenance, and replacement of the project, except where such damages are due to the fault or negligence of the United States or its contractors; This clause will require the agreement of the sponsor, the State of New Jersey, since it may result in an indemnification which violates New Jersey sovereign immunity.

- Upon completion of each project feature, operate and maintain, replace and rehabilitate the works, including existing highway and railroad embankments used as levees and tie-outs for levees, and recreation and environmental mitigation features, in accordance with regulations prescribed by the Secretary of the Army; except for operation, maintenance, repair, rehabilitation and replacement of the tunnel works, as noted in item IV.2(4) above.

- At least annually, inform affected interests regarding the limitations of the protection afforded by the project. Limitations, affected interests and procedures for informing affected interests will be as defined in the operation and maintenance manual.

- 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 insure compatibility between future development and protection levels provided by the project;

- Prior to initiation of construction, prescribe and enforce regulations to maintain existing pre-project New Jersey Department of Environmental Protection Central Basin floodway delineations in the areas of natural flood storage acquisition;

- Prior to initiation of construction, prescribe and enforce regulations or other floodplain management techniques to prevent obstructions or encroachments on lands acquired for natural flood storage, floodplain storage, channels, interior drainage and ponding areas, and rights-of-way, which would reduce their flood-carrying and flood storage capacity, or would interfere with the operation and maintenance of the project, and control development in the project area to prevent increases in flood damage potential;

-Pay all investigatory and construction costs incurred due to the presence of regulated contaminated materials encountered on project sites, and hold and save the United States free from any future clean-up of hazardous waste sites on which project features are constructed.

- Administer and assure access to the recreation facilities and other project lands to all on an equal basis;

- Comply with all applicable Federal and state laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964 (PL 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; and

- Comply with the applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, 84 Stat 1894, 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.

DRAFT SUPPLEMENT 1 TO THE ENVIRONMENTAL IMPACT STATEMENT (SEIS 1)

Supplement 1 to the Environmental Impact Statement for the Authorized Flood Damage Reduction Project for the Passaic River, which drains parts of Passaic, Bergen, Morris, Essex and Hudson Counties in New Jersey.

The responsible lead agency is the U.S. Army Corps of Engineers, New York District.

Abstract: Congressional authorization of the recommended Passaic River Project extended the project's tunnel outlet from an upriver terminus to Newark Bay. As a result, this SEIS has been prepared.

The authorized Passaic River Flood Damage Reduction Project consists of two underground tunnels: a 20.4 mile-long main tunnel, about 42 feet inner diameter, and a 1.3 mile-long 23-foot inner diameter spur tunnel. These tunnels carry floodwaters from inlets on the upper Pompton River and the Central Passaic River to Newark Bay. Seven miles of channel modifications are associated with the tunnel inlets. Seven miles of levees/floodwalls, in seven distinct systems, and a 1.4 mile channel element augment tunnel protection upstream of its area of influence. Thirteen miles of levees and floodwalls provide storm surge protection to the Lower Valley. The project includes the acquisition of 5,350 acres of natural flood storage to limit increased future flooding and preserve wetland systems. Mitigation includes wetlands restoration at degraded sites, regulation of site hydrology at wetland-ponding areas, construction of instream fishery structures, data recovery for cultural resources, and recreation and beautification measures for levees and floodwalls.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENTS IS 60 DAYS FROM THE DATE ON WHICH THE NOTICE OF AVAILABILITY OF THIS DRAFT SEIS 1 APPEARS IN THE FEDERAL REGISTER.

If you would like further information on this statement, please contact:
Mr. John S. Wright
U.S. Army Engineer Dist, N.Y.
80 River Street; Hoboken, N.J.
Telephone: (201) 656-4749

An updated Clean Water Act Section 404(b)(1) Evaluation and Compliance Determination is included to meet Section 401, State Water Quality Certification, and Section 404(r) exemption provisions.

NOTE: Information, figures and maps discussed in the Main Report and Appendices, as well as the 1987 Feasibility Report and FEIS are incorporated by reference into this SEIS 1.

PASSAIC RIVER FLOOD DAMAGE
REDUCTION PROJECT

SUPPLEMENT 1 TO THE ENVIRONMENTAL IMPACT STATEMENT

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PASSAIC RIVER FLOOD DAMAGE
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CHAPTER 1

SUMMARY

MAJOR CONCLUSIONS AND FINDINGS

AUTHORIZED PLAN AS CURRENTLY DEFINED IN THE GENERAL DESIGN MEMORANDUM

1.00 The Passaic River Flood Damage Reduction Project consists of two underground tunnels: a 20.4 mile-long main tunnel, with a 42-foot internal diameter, and a 1.3 mile-long, 23-foot diameter spur tunnel. These tunnels supplement river capacity by diverting floodwaters from inlets on the upper Pompton River and the Central Passaic River to Newark Bay. About 5.5 miles of channel modifications direct flows into the tunnel inlets and, 7.1 miles of levees/floodwalls, in seven distinct systems, augment tunnel protection outside of the tunnel's area of influence. Thirteen miles of levee/floodwalls in three systems provide storm surge protection to the Lower Valley. One and a half miles of channel modifications provide additional local protection and 2.8 miles of pilot channels maintain sediment transport at the inlets. The project acquires 5,350 acres of natural flood storage to prevent increased future flooding and to preserve natural ecological systems. Mitigation features will offset adverse project effects on wetlands, cultural and recreational resources, and marine and freshwater fisheries through the use of wetland restoration at degraded sites, hydraulic controls to regulate site hydrology, instream structures for fisheries, data recovery for cultural sites, and recreation and beautification features for levees and floodwalls.

RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

1.01 The recommended plan was critically reviewed by appropriate State and Federal agencies and, after modification, was authorized by Congress. The Phase I General Design Memorandum (GDM), which described the original plan, was completed in December 1987. The Final Environmental Impact Statement (FEIS), which accompanied that report, was filed with the Environmental Protection Agency (EPA) on January 17, 1989. Its Record of Decision was signed on March 8, 1990. Congressionally mandated modifications required lengthening the tunnel which in turn necessitated new studies.

1.02 Table 1 "Relationship of Plans to Environmental Statutes," summarizes the project's compliance with all applicable environmental laws. The publishing of the Final Environmental

Impact Statement and its filing with the Environmental Protection Agency will bring the project into full compliance with the statutes set forth in Table 1. In the special case of hazardous and toxic waste regulations, i.e., the Comprehensive Environmental Response, Compensation and Liability Act and the Resource Conservation and Recovery Act, responsibility and procedural compliance lies with the non-Federal sponsor. Documentation addressing those issues which affect project planning is addressed in the DSEIS.

TABLE 1

RELATIONSHIP OF PLANS TO ENVIRONMENTAL STATUTES	
● FEDERAL LAWS AND EXECUTIVE ORDERS	COMPLIANCE STATUS
Archaeological and Historic Preservation Act of 1974, as amended.	PARTIAL COMPLIANCE
Clean Air Act, as amended.	PARTIAL COMPLIANCE
Clean Water Act of 1977 (Federal Water Pollution Control Act), as amended.	PARTIAL COMPLIANCE
Coastal Zone Management Act of 1972, as amended.	PARTIAL COMPLIANCE
Comprehensive Environmental Response, Compensation and Liability Act of 1980	PARTIAL COMPLIANCE
Endangered Species Act of 1973, as amended.	PARTIAL COMPLIANCE
Fish and Wildlife Coordination Act of 1934, as amended.	PARTIAL COMPLIANCE
Marine Protection, Research, and Sanctuaries Act of 1972, as amended.	PARTIAL COMPLIANCE
National Environmental Policy Act of 1969, as amended.	PARTIAL COMPLIANCE
National Historic Preservation Act of 1966, as amended.	PARTIAL COMPLIANCE
Resource Conservation and Recovery Act	PARTIAL COMPLIANCE
Rivers and Harbors Appropriation Act of 1899, as amended: Section 10.	PARTIAL COMPLIANCE
Rivers and Harbors Act of 1970, Section 122.	PARTIAL COMPLIANCE
Wild and Scenic Rivers Act, as amended.	PARTIAL COMPLIANCE
Executive Order 11593, Protection and Enhancement of the Cultural Environment	PARTIAL COMPLIANCE
Executive Order 11988, Floodplain Management	PARTIAL COMPLIANCE
Executive Order 11990, Protection of Wetlands.	PARTIAL COMPLIANCE
● STATE LAWS AND LOCAL POLICIES	PARTIAL COMPLIANCE
Coastal Area Facility Review Act (N.J.S.A. 13:19-1 et seq).	PARTIAL COMPLIANCE
New Jersey Green Acres Land Acquisition Act of 1961, N.J.S.A. 13:8 A - 47 (a) and (b).	PARTIAL COMPLIANCE
Waterfront Development Law (N.J.S.A. 12:5-3).	PARTIAL COMPLIANCE
Wetlands Act of 1970 (N.J.S.A. 13:9 A-1 et seq).	PARTIAL COMPLIANCE
Waterfront Harbors Facilities Development Law of 1914	PARTIAL COMPLIANCE

REQUIRED STATE-ADMINISTERED PERMITS
Clean Water Act of 1977, Section 401: State Water Quality Certificate
Clean Water Act, Section 402 Permit under National Pollutant Discharge Elimination System Permit for Exploratory Drilling
Freshwater Wetlands Permit
Stream Encroachment Permit
Green Acres Permit

1.03 Table 2, "Effects of the Authorized Plan on Natural and Cultural Resources," summarizes the effects of the authorized plan. Table 2 indicates the degree to which project construction and operation will affect the significant wetlands, aquatic and estuarine habitats, and cultural resources of the Basin. In response to the public concern regarding the presence of surface features, refinements in project design have significantly reduced the scope and size of surface features since project authorization. For example, the number of levee flood wall systems has been reduced from fifteen to ten.

TABLE 2

EFFECTS OF THE AUTHORIZED PLAN ON NATURAL AND CULTURAL RESOURCES	
TYPES OF RESOURCES	EFFECTS
Wetlands	95 acres converted to flood control would be replaced in disturbed sites within Central Basin wetlands.
Newark Bay	Tunnel releases mimic natural conditions. No significant change in Bay resources with project operation.
Freshwater Fisheries	17 acres of riffle/pool/run habitat destroyed; replaced by 17 acres of constructed riffle/pool/run system in Pompton River.
Water Quality	Water quality improves as pick-up and transport of floodplain contaminants resulting from overbank flooding are reduced.
Groundwater	A few wells in the immediate vicinity of the tunnel may experience drawdown during construction. Grouting and a 15-inch tunnel liner prevent effects upon completion of construction.
Historic and Cultural Resources	Impacts fully mitigated in accordance with agreements with State Historic Preservation Office.
Wild & Scenic River	Nominated stretch of Passaic River in Great Piece Meadows is not affected.
Recreation	38 acres of undeveloped open space and parkland will be replaced in kind or with a cash payment.

AREAS OF CONTROVERSY

1.04 Federal planning for flood control in the Passaic River Basin has taken place in an issue-charged atmosphere since its inception in 1936. A summary of this history is presented in Section 3.3 of the main report. Issues include floodplain buyouts, tax rateables, impacts to wetlands, stream fisheries and groundwater, surface flood control structures, community life, and project costs both at the Federal and local levels. These issues have generated serious and extensive discussions at numerous public hearings and meeting as described in the Public Involvement Appendix A. Of particular note has been the continued interest in a buyout of homes in the Passaic River Basin floodplain.

UNRESOLVED ISSUES

1.05 The buyout remains the dominant unresolved issue in the project's long planning history. Several environmental issues persist either because of a public reluctance to accept technical analyses and conclusions drawn by Federal and state agencies with statutory responsibilities for specific resources, or as a result of the level of detail of the analysis conducted for the 1987 report.

1.06 Buyouts and evacuation plans for floodplain structures were examined with great care for the 1987 Report. However, these plans were eliminated because of their high implementation costs, unacceptable residual effects, such as continued flooding of highways and infrastructure, and economic and social impacts in the affected communities.

1.07 As a measure of the continued interest in buyouts, Congressman Gallo in 1994, in response to New Jersey Governor Christine Todd Whitman, requested an update of the previous buyout study. As a consequence, an update of this nonstructural approach has been added to the analyses conducted for the authorized project. The Passaic River Buyout Study offers an accurate, current and consistent comparison of flood protection costs for 35 flood prone communities within the basin.

1.08 The balance of issues have been resolved by the ongoing planning process. Of primary interest were concerns raised by EPA which viewed the level of detail of wetlands mitigation plans as being too generalized. This issue is the subject of a Memorandum of Agreement (MOA) developed with EPA for continued planning of wetland mitigation. Continued coordination with EPA and other regulatory agencies is being maintained to ensure resolution of any lingering questions about wetlands or other environmental issues.

TIERING OF THE FEIS

1.09 Tiering is a method of organizing information "to eliminate repetitive or redundant discussions and focus on information specific to project features requiring environmental review"

(National Environmental Policy Act (NEPA), Sec. 1502.20). Thus the FEIS entitled "Flood Protection Feasibility Main Stem Passaic River", dated December 1987 , and filed with the EPA on January 17, 1989, is incorporated with this document by reference under the tiering concept. Section 2.3 summarizes the issues discussed in the FEIS. Information and data from the original document are incorporated by reference where necessary, allowing this current document to concentrate on information that is either specific to the subsequent authorization, or resulting from continued planning since publication of the 1987 report.

1.10 The original FEIS, is available in library repositories located throughout the Passaic River Basin. Libraries and their addresses are included in the Main Report and at the beginning of the Appendix A - Public Involvement.

CHAPTER 2

PURPOSE OF AND NEED FOR ACTION

STUDY AUTHORITY

2.00 The Water Resources Development Act (WRDA) of 1990 Public Law 101-640, dated 28 November 1990, Section 101(a)(18)(A), authorized the Secretary of the Army to carry out plans described for the Passaic River Main Stem New Jersey and New York in the report of the Chief of Engineers dated February 3, 1989, "except that the main diversion tunnel shall be extended to include the outlet to Newark Bay, New Jersey." That authorization initiated the refinements of the feasibility plan presented in the December 1987 report for flood damage reduction in the Passaic River Basin. Authorization modified the plan selected by the non-Federal sponsor by relocating the tunnel outlet to Newark Bay from its initial terminus in the Passaic River near Nutley, New Jersey, thereby lengthening the tunnel by six miles and eliminating nine levee/floodwall systems in East Essex and South Bergen counties.

2.01 Guidance for the update of a range of floodplain evacuation plans originally described in the December 1987 report is provided by the Department of the Army's Director of Civil Works in a letter dated 15 March 1994. This direction provides for a special buyout and floodplain evacuation report entitled "Passaic River Buyout Study" prepared in tandem with this GDM and DSEIS.

PROBLEMS AND OPPORTUNITIES

2.02 Table 3 in the FEIS, "Summary of the Problems and Needs of the Passaic River Basin," outlined the planning for flood damage reduction in the Passaic River Basin. Their relationship to traditional Corps of Engineers' water resources responsibilities and the Congressional guidance for the Passaic River Basin were developed as Problem and Opportunity statements for the project and itemized in the FEIS in Table 4, "Statements of Problems and Opportunities."

2.03 The primary need for this project is to address flooding in the Passaic River Basin and its major tributaries in five counties and 35 municipalities.

PUBLIC CONCERNS

2.04 Public concerns to solve persistent and recurrent flooding in the Passaic River Basin reach back to colonial times. A list is presented in Table 3 of the December 1987 report. The concerns can generally be characterized as diverse and often divisive and have contributed to the prolonged planning process. Six Federal flood control plans and reports failed to achieve consensus among divergent interests in the basin. This impasse provided the final impetus for Federal action articulated in the Water Resource Development Act of 1976. The Act provided guidelines for the development of various alternatives from which the State of New Jersey selected a plan that was subsequently authorized, with modifications, in 1990.

2.05 One of the more controversial issues raised repeatedly throughout the planning period has been the feasibility of a buyout of the floodplain. It persists as an issue of significant interest to the public, as documented in press articles in Appendix A - Public Involvement.

2.06 Recurring proposals for the buyout of homes in the Wayne-Lincoln Park area are evidence of this interest and the driving force for continued study of a buyout of the floodplain. While a buyout of these structures would remove them from the flood hazard, it would not offer a basin-wide solution to the flood problem. This fact is recognized by proponents who concede that some additional, as yet undetermined structural features, would be needed to provide basin-wide protection.

SCOPING MEETING CONCERNS

2.07 Three scoping meetings were held in 1993 to gain public input in the identification of environmental issues resulting from the relocation of the tunnel outlet to Newark Bay and other plan modifications to the recommended plan. The New Jersey meetings were held on June 9 in Little Falls (88 people attended), June 16 in Lyndhurst (78 people), and June 22, 1994 in Trenton (37 people). Representatives of the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the New Jersey Department of Environmental Protection (NJDEP) and the U.S. Environmental Protection Agency (USEPA) participated in the meetings.

2.08 Three issues directly related to the extension of the tunnel outlet to Newark Bay were identified:

a. A possibility that disease-causing bacteria could reproduce and multiply in the moist darkness of the tunnel and contaminate Newark Bay upon discharge of floodwaters.

b. A possibility that rats might migrate through the tunnel from the Newark area to start colonies miles away from their origin, and;

c. A possibility that storm surges in Newark Bay would be augmented by the discharge of upstream floodwater into the Bay.

2.09 A response to these concerns was provided in a published documentation of scoping results. These documents are included in Appendix A - Public Involvement. In summary they indicate:

a. Bacterial contamination is unlikely because conditions favoring bacteria in the tunnel would be far different from those in Newark Bay. For example, bacteria in a freshwater and potentially anaerobic environment (par.5.16) would likely be destroyed upon contact with the oxygenated, brackish water of the Bay. Additionally, the similarity of conditions in the proposed tunnel to those in existing storm sewers, which do not presently exhibit significant health related bacterial contamination, suggests the potential is minor.

b. At the time of the scoping meetings, rodents were a suspected vector in the transmission of a fatal respiratory disease in the Southwestern United States. Since the 1992 meeting, a report in the journal *Science*, "Hantavirus Outbreak Yields to PCR [Polymerase Chain Reaction]" in the November 5, 1993 issue, "identified a previously unknown strain of hantavirus -- a family of viruses long known in Asia and Europe...", as the cause of the disease in the American southwest. Thus, while newly diagnosed here, it appears to be a virus that can occur worldwide. The Center for Disease Control and Prevention in Atlanta, Georgia, indicates many rodent species are capable of disease transmission and can be expected to occur in the natural and developed habitats in the Passaic River Basin. However, tunnel designers have determined that the tunnel will remain approximately 70 percent filled with water between flood events thus preventing any rodents from using it as a migration route.

c. Concern over whether the discharge of upstream floodwaters into the Bay could aggravate storm surges in Newark Bay has been the subject of a major research effort. A coincidence storm analysis determined that river flood flows are unlikely to coincide with hurricane surges from the New York Bight. While hurricanes cause the majority of surge events in Newark Bay, they usually pass through in a matter of hours, generally producing surges that peak and return to normal before their rainfall reaches the bay. Usually it takes about two days for rain falling on the Lower Basin to reach Newark Bay, and five to six days for rain on the Upper and Central Basins to peak at the Bay. Further, computerized, numerical, hydraulic models calibrated to historic storms, indicate that 100-year floods discharging normally into Newark Bay increased normal high tides by about two inches. By contrast, operation of the tunnel would increase normal high tides by only about two and one-tenth inches. Unlike rapidly passing hurricanes, northeasters cause storm surges that last for several days, presenting a greater potential for coincidental flooding. But even under this scenario, the tunnel's incremental addition to storm surges in Newark Bay remains at one-tenth of an inch - an amount that would not significantly aggravate Bay flooding (Appendix C - Hydrology and Hydraulics - Section 25).

2.10 The scoping meetings also revisited many other concerns that were addressed in the 1987 report, including plan formulation, environmental concerns, property values and loss of tax bases, construction details and the buyout of floodplains. While the meetings afforded valuable opportunities for information exchanges, most of the issues raised were outside the scope of the SEIS or had been addressed previously (Appendix A - Public Involvement Section 3 - Scoping Meetings).

STUDY OBJECTIVES

2.11 This study seeks to meet three objectives: first, it documents authorized changes in the recommended plan presented in the 1987 report pursuant to the National Environmental Policy Act. Second, it documents that continuing engineering studies have significantly reduced the project's footprint. Third, it addresses previously unresolved issues related to environmental concerns raised during the review of the FEIS and records new information generated during this phase of study for: wetlands, fisheries, cultural resources, geohydrology, hazardous, toxic and radioactive wastes, air quality, and coastal zone consistency determinations.

Chapter 3

ALTERNATIVES

INTRODUCTION

3.00 Alternative flood control plans considered in the original plan formulation included an array of management measures in different scales, extents and combinations as specified by the House of Representatives in HR 94-1702. They included (1) structural measures acting directly on floodwater to change its direction, area of inundation, volume, stage or depth, and (2) measures to increase the river's conveyance by enlarging river channels, raising bridges, augmenting groundwater recharge or constructing tidal barriers, reservoirs, tunnels, concrete floodwalls or earthen levees.

3.01 Non-structural measures primarily directed at moving floodplain occupants out of harm's way included floodproofing and/or raising structures, permanent evacuation (buyout of structures), flood warning, flood preparedness, floodplain zoning and preservation of natural flood storage areas. It is noteworthy that the two non-structural elements which were cost effective for the Passaic River Basin were the Emergency Preparedness Plan, which is already in place, giving basin residents up to four extra hours of notice to prepare for impending floods; and the preservation of 5,350 acres of flood storage land through public acquisition, which is an integral element of the authorized plan.

3.02 A complete description of the systematic evaluation of 150 different flood control plans which utilized these approaches is in the December 1987 Report - Appendix C - Plan Formulation. Alternatives considered in this supplement include: (1) a no-action alternative, defined as the most probable alternative absent implementation of the authorized plan; (2) the Federal alternative authorized by the Water Resources Act of 1990, as amended; and (3)actions by others, which includes buyouts of floodplain structures by the State of New Jersey and the Federal Emergency Management Agency.

NO-ACTION ALTERNATIVE

3.03 In the absence of the authorized Federal action, 20,000 residences and businesses and 35 municipalities in the Passaic River Basin will continue to be subject to flood damage.

3.04 Over the 100-year life of the project the basin population of two-and-one-half million is expected to increase by 800,000.

Associated increases in development, especially paved surfaces, will contribute to increased runoff and non-point source pollution, thereby increasing the frequency, duration, depth and extent of flooding. These increases will adversely affect water quality and fish and wildlife. To the extent regulatory license allows, the natural flood storage wetlands of the Central Passaic Basin will remain at risk for development with potential reduction in their floodwater storage capacities. By 2040, over 69,400 acres are expected to be developed basin-wide of which about 3,000 acres would be basin wetlands and their fringes. With such development, a 6% increase in the two-year storm discharge and a 3% increase in the 100-year discharge at Little Falls can be expected. See Appendix C - Hydrology and Hydraulics, Table C-31.

3.05 The No-Action alternative would result in substantial physical damage, monetary losses, associated environmental and social effects and degradation of water quality in the Passaic River and its major tributaries. The health and safety of floodplain residents would continue to be jeopardized during floods.

3.06 Flood damage mitigation measures would likely consist primarily of monetary compensation for losses through the National Flood Insurance Program, and the acquisition of a limited number of structures through State and local programs. Continued flooding would generate costs for municipal and county taxpayers. Repair of flood damages would require expenditures of time and money by municipalities, public service providers, and property owners.

3.07 In addition, floodplain residents would continue to pay for flood insurance. Reccuring impacts of flooding would continue to cause residential and non-residential public and municipal structural content and property damages. Adverse effects on highways and commuter railroad lines and the disruption of sanitary, water, gas, electrical, and communication networks would continue to force the relocation of affected families and disrupt daily routines. Federal and local governments would continue to incur costs associated with evacuation, reoccupation, flood fighting, fire disaster relief and other emergency actions caused by flooding.

3.08 Should significant flooding result in a major natural disaster deemed by the President to be beyond the capabilities of the State and local communities, the Federal Emergency Management Agency (FEMA) would provide post-flood assistance to cover up to 75 percent of the cost of eligible damages. The State would be required to provide the remaining 25 percent share. If, for example damages eligible for Federal assistance following a 100-year storm in the Passaic River Basin amounted to $1 billion, FEMA would cover 75 percent of these costs ($750 million). The State would be responsible for the remaining 25 percent share ($250 million), in addition to any other costs not covered by FEMA.

3.09 A Presidential Disaster Declaration would also authorize implementation of the Hazard Mitigation Grant Program (HMGP), under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended. An additional 15 percent of the Federal disaster expeditures with state matching funds on a 75/25 scale could be available for hazard mitigation measures.

3.10 Hazard mitigation measures include property acquisition and relocation assistance. Potential measures may also include elevating or floodproofing structures to comply with National Flood Insurance Program (NFIP) standards. To be eligible, the State and the affected local governments must meet specific NFIP procedural requirements.

3.11 Following the Flood of 1984, both the Federal Emergency Management Agency and the State of New Jersey offered buyouts to 500 homeowners in the Pompton River valley. Despite vigorous efforts to induce owners to sell, only 61 homes in Pequannock, Lincoln Park and Wayne were ultimately bought by the State. Surveys attributed the low participation rate to the perceived below market level of purchase prices, and the unavailability at those price levels of comparable housing in the basin. Others expressed reluctance to leave homes, that in some cases, had been lived in by families for generations.

ACTIONS BY OTHERS

3.12 Governor Whitman, sensitive to the severe and recurrent flood problem in the Passaic Basin has expressed a continued interest in a buyout of floodprone structures. As a consequence, she requested an update of the buyout plan presented in the 1987 Feasibility Report so as to compare the merits and shortcomings of floodplain buyouts with the merits and shortcomings of the flood tunnel plan. That study explores in depth the relative impacts of the two alternatives upon 35 flood prone communities.

3.13 The new buyout evaluation has been developed in accordance with the 1965 Flood Control Act's National Economic Development Procedures prepared by the Water Resources Council and promulgated as the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies, Chapter

II - National Economic Development (NED) Benefit Evaluation Procedures March 10, 1983. These same guidelines are used to evaluate the authorized plan.

3.14 The criteria for buying or floodproofing structures susceptible to flood damages relate to flood depths at or below a structure's first floor elevation. Those structures with low levels of inundation potential would be floodproofed and steps would be taken to provide main floor and basement protection and prevent sewer backup to minimize or eliminate the risk of damage. Landmark structures -- substantial public or private buildings of significant public recognition -- would be floodproofed regardless of flood damage potential. Those structures exhibiting significant damages would be bought out. Selection criteria and their application are discussed in the "Passaic River Buyout Study".

3.15 The removal of floodprone structures from the floodplains has the potential to reduce non-point pollution, expand natural habitats and provide increased open space opportunities for the remaining basin residents. However, it can do so at significant fiscal and social costs to the affected communities. The loss of tax rateables and the effects on community cohesion, in addition to basic costs for acquisition, demolition and disposal, have been major reasons for the failure of past buyouts. Other complications related to buyout efforts include relocation costs and assigned acquisition values that are often lower than homeowner expectations.

3.16 Results of the Buyout Study indicate that the initial direct project costs and fully funded project costs (inflated to the middle of construction) are: $3.9 and $5.5 billion for the 100-year floodplain; $2.8 and $4 billion for the 50-year floodplain; $2.3 and $3.2 billion for the 25-year floodplain; and $1.6 and $2.3 billion for the 10-year floodplain. These costs are for current acquisition, demolition, disposal, remediation, floodproofing, relocation and administration. A 15 year project implementation period is anticipated. Benefit to cost analysis does not indicate feasibility or Federal interest for buying floodplain structures.

3.17 Beyond the direct costs other costs have emerged. There are no costs associated with: 1) the loss of large portions of local tax bases, 2) removing infrastructure (sewers and water systems or streets), 3) removing public buildings, or 4) developing sites for public use. The infrastructure would continue to flood during flood events, and unless ignored, certain additional state costs would be high for raising or floodproofing highways and commuter rails; these could add another half billion dollars. Without public involvement it is not possible to gauge local acceptance of any buyout plan. But heightened awareness of adverse effects on rateables, housing units, business and community cohesion resulting from a buyout suggests the public would reject these alternatives. The Buyout Study confirms the earlier conclusion that the most likely Federal alternative to the authorized plan is "No Action". No further analysis is included for the buyout alternative.

AUTHORIZED ALTERNATIVE

3.18 The Passaic River Flood Damage Reduction Project, employs two tunnels as major flood control elements. Their dimensions are summarized in Table 3 along with other project features. Details are presented in the Main Report in Section 5.

TABLE 3

PROJECT FEATURES		
TUNNEL ELEMENTS		
• Main inlet in the Pompton River just upstream of Pompton Plains Cross Road/ Jackson Avenue Bridge. This inlet has a diversion spillway and stilling basin.		
• A spur inlet on the Passaic River just downstream of the confluence with the Pompton River. This inlet incorporates a berm and a diversion spillway.		
• A main tunnel 20.4 miles long, 42 feet internal diameter extending from Wayne to Newark Bay.		
• A spur tunnel, 1.3 miles long with a 23-foot diameter extending from Wayne to the main tunnel intersection in Totowa.		
• Outlet 1,850 feet South of Kearny Point in Newark Bay.		
LEVEE/FLOODWALL SYSTEMS *(in feet)*		
• **Lower Valley**	LEVEE	FLOODWALL
Lister/Turnpike/Doremus	5,599	17,657
Kearny Point	3,908	33,771
South First Street	1,750	5,700
• **Central Basin**		
Pinch Brook	2,397	415
Passaic Levee #10	4,853	97
Passaic Levee 2A	6,216	3,082
Rockaway Levee 1 Lower	818	521
Rockaway Levee 1 Upper	2,421	—
Rockaway Levee 2	3,172	—
Rockaway Levee 3	1,850	6,702
• **Pompton Valley**		
Ramapo-Pequannock Levee	2,200	2,910
WEIRS		
• Great Piece Meadows weir 600 feet upstream of confluence of the Pompton/Passaic Rivers		
• Pequannock River weir gate modification on west end of weir		

TABLE 3 *(continued)*

CHANNEL MODIFICATION REACHES
• Passaic River - 0.4 mile, upstream from Route 46 Bridge
• Passaic River pilot channel - 1.2 miles, downstream of the spur inlet
• Pompton River - 0.3 mile, from confluence with Passaic River upstream
• Pompton River pilot channel - .3 miles, downstream of main tunnel inlet
• Pequannock River - 2.4 miles, upstream from its confluence with the Pompton River
• Pequannock River Bypass Channel - 0.3 mile, just upstream of main tunnel inlet
• Wanaque River - 0.8 mile, upstream from its confluence with the Pequannock River
• Ramapo River - 1.3 miles, upstream from its confluence with the Pequannock River
• Deepavaal Brook - 1.4 miles, from confluence with Passaic River

ENVIRONMENTAL ENGINEERING AND DESIGN

3.19 Good engineering and design have significantly reduced the scope and extent of adverse project effects on the Basin's resources. Adverse effects to 810 acres of wetlands have been avoided by lowering the elevation of the main inlet eliminating four upstream levee and floodwall systems on the Pequannock and Wanaque Rivers, and reducing their overall length on the Ramapo Rivers. Tunnel operation has been designed to permit the one-year flood to bypass the inlet. These flows will inundate and nourish wetlands and scour downstream channels, maintaining river ecosystems and aesthetic values.

3.20 The project utilizes weirs to maintain wetland hydrology on lands influenced by the drawdown of overbank flooding. Channel modifications are generally restricted to one side. Wetlands converted to ponding areas would be maintained through the use of pumps and controlled release outfall pipes to support wetland vegetation. Erosion-susceptible areas will be protected with riprap (stone protection). Areas disturbed during construction will be restored.

3.21 Pequannock Weir The purpose of the Pequannock weir gates is to direct flood flows into the bypass channel leading to the tunnel inlet. Under normal flow conditions the gates are closed to allow the weir to maintain existing adjacent wetlands hydrology. The weir will be provided with 4 vertical lift gates, each 50 feet wide by 15 feet high. The sill elevation will be 164 feet at mean sea level (msl), three feet above the proposed upstream channel's bottom. The gates would normally be operated in the down position (closed) and would only operate during flooding events greater than the annual flood. The existing Pequannock overflow structure would remain as it is today (Appendix C - Hydrology and Hydraulics, Figures C-96 a through d).

3.22 Great Piece Meadows Weir The Great Piece Meadows Weir, included to prevent erosion upstream of the spur tunnel inlet and to maintain viability of wetlands, has been relocated closer to the inlet, about 600 feet upstream of the Pompton-Passaic River confluence. The redesigned weir will incorporate five 30-foot-wide gates providing a river opening of 150 feet. The five torque tube bascule gates will rest on the river bed where a gate sill will be set at 156 feet msl, approximately six feet above the proposed river bottom elevation. The gates would be 10 feet high and create a backwater pool to elevation 166 feet, thereby maintaining inundation of the Great Piece Meadows upstream over 4.5 miles to Horseneck Road (Appendix C - Hydrology and Hydraulics, Figure C-98).

3.23 Deepavaal Channel Weir Sheetpile weirs will be installed in intermittent drainage ditches entering Deepavaal Brook. The weirs will prevent headcutting and subsequent lowering of water table levels in adjacent wetlands after the Deepavaal dredging is complete. Steel sheetpile approximately 10 feet long will be driven across the drainage ditches. Riprap will be added at the base of each weir to prevent erosion (Appendix C - Hydrology and Hydraulics, Figure C99a).

3.24 Levee/Floodwall Interior Drainage Ponds Six hundred acres of wetlands were to be used as interior drainage ponds as proposed in the 1987 report; they were planned to be excavated to increase their storage volume. The ponds were to have been replanted with wetland vegetation at their new, lower elevations as mitigation. The Corps developed site operation changes during the current phase of planning that would retain existing wetland vegetation. This was presented at the interagency mitigation workshop of November 16, 1994, for agency comment, which approved of this step reducing acres of ponding area loss from 599 to six acres.

3.25 A coincidental rainfall analysis was performed to determine if the wetlands could be maintained in their existing conditions with a levee and floodwall system in place, which would eliminate their periodic inundation by the river. The analysis of actual rainfalls and river stages determined that wetland hydrology at the ponding sites could be maintained consistently with the interior hydrological requirements of a levee/floodwall system through the combination of larger culverts, pumps, flap gates and sluice gates to provide positive hydraulic control of the available interior rainfall. This conclusion avoided the need to disturb 599 wetlands acres. The coincidental rainfall analysis is detailed in Appendix C - Hydrology and Hydraulics, Section 35.5.

MITIGATION PLANS

3.26 Fish and wildlife mitigation features include placing instream aquatic habitat structures and upgrading the wildlife carrying capacity of up to 190 acres of project lands as an offset to project impacts. A Programmatic Memorandum of Understanding with the State Historic Preservation Office guides the assessment of cultural resources and associated mitigation. The mitigation plans described in this section are the result of a multi-tiered approach which emphasized avoiding or minimizing project impacts through good engineering and design. Any residual impacts were then rectified through mitigation plans designed to restore all disturbed resources.

3.27 Replacing the Resource Riffle/pool/run sequences removed by channel modifications on the Wanaque, Pequannock and Ramapo Rivers will be replaced by constructing rock dikes, and chevrons on the Pompton River. Existing fishery refuge from storm velocities provided by the Pequannock Weir will be replaced by constructing in-stream and off-channel refuges upstream of the tunnel inlet to prevent the possible entrainment of fish. Eighteen acres of Green Acres-funded properties diverted to flood control purposes will be replaced with equivalent properties. Up to 190 acres of wetlands and 3,500 feet of structural fishery habitat will be constructed. Recreation, including river access, is provided in residential areas for levee and floodwall systems. Aesthetic measures include native wildflower plantings on levees and vines on floodwalls, and covering floodwalls with wood fencing in residential areas. Specific mitigation designs are presented in the Appendix B - Environmental Resources, Sections 2.4 and 6.2.

3.28 Compensation Mitigation for Green Acres Program funded properties includes cash compensation for diverted properties when requested by municipalities.

COMPARATIVE EFFECTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

3.29 A summary of the environmental effects of alternative plans is presented in Table 4. The table compares the Authorized Plan with Existing Conditions, a "No Action Plan" which describes the future in the basin without flood protection and "Actions by Others". Comparisons include economic, social and natural and cultural resource effects of project implementation.

TABLE 4 (a)

COMPARATIVE EFFECTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

SIGNIFICANT RESOURCES		ALTERNATIVES			
		EXISTING CONDITIONS	NO ACTION PLAN	AUTHORIZED PLAN	ACTIONS BY OTHERS: FLOODPLAIN BUYOUT
FISHERIES	Estuarine	50+ species. Poor nursery. Fish advisories regarding consumption. Species concentrated in navigation channels.	No change.	Potential improvement due to improved water quality.	Improvements consistent with gains in water quality as floodplain is evacuated.
FISHERIES	Freshwater	10-20 species. Upstream coldwater riffle/run/pools become warmwater pools downsteam. Pollution-tolerant species dominate benthic populations.	No change.	Pool habitats increase. Values improve for trout, bluegill and smallmouth bass. Riffle species decline. Rock deflectors placed in the Pompton River to offset losses in upstream channel reaches.	Improvements consistent with gains in water quality as floodplain is evacuated.
WETLANDS	Newark Bay	Limited emergents and 30 acres of intertidal and subtidal mud flats exist off Kearny Point.	No change.	Outlet structure and riprap channel replace 2 acres of subtidal mudflats with reef environment.	No change.
WETLANDS	Central Basin	Encompasses 24,000 wetland acres of which 13,735 (9,000 forested; 1,700 scrub/shrub; and 3,035 emergent) are in the project area. Invading exotics and flood inundations ranging from 2' to 10', stress wetland systems.	Development of up to 3,000 acres estimated for year 2040 resulting in increases in depth and duration of flood events.	5, 200 wetland acres protected by acquisition of natural storage areas. Herbaceous vegetation promoted by limiting inundation extremes.	Natural succession of evacuated floodplains will produce fields of varying degree consistent with state/ local management goals and hydrology at evacuated sites.

TABLE 4 (b)

COMPARATIVE EFFECTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

SIGNIFICANT RESOURCES		ALTERNATIVES			
		EXISTING CONDITIONS	NO ACTION PLAN	AUTHORIZED PLAN	ACTIONS BY OTHERS: FLOODPLAIN BUYOUT
Wildlife		Habitat subject to inundation extremes. Food, water and cover limiting for evaluation species.	Continued depression of wildlife populations due to development and inundation.	Wildlife protected on 5,350 acres of natural storage area. Stress from extremes in inundation reduced.	Expansion of wildlife in evacuated floodplain habitats offset by location of resettled evacuees.
WATER QUALITY	Newark Bay	Bay becomes freshwater bay during floods. Temperature, dissolved oxygen and salinity are within normal ranges.	No change	Minor temporary localized changes in salinity, temperature and oxygen during tunnel operation. Bay water is cleaner due to reduced out-of-bank pollutant pick-up.	Pollution contribution by the Passaic River declines consistent with evacuation of floodplain population.
WATER QUALITY	Riverine	Moderate upstream tributaries to poor downstream (Passaic River). Improvement occuring upstream due to relocation of sewage treatment plants	Improving trend limited by watershed development. Contamination from toxic and human wastes occurs during overbank flooding.	Water quality improves as a result of curtailed non-point loading due to reduced flooding.	Improvement as pollution discharges decline with floodplain evacuation; tempered by locale of resettled basin population.
WATER QUALITY	Groundwater	Presently adequate. Overburden and lower valley deep aquifer not suitable for drinking.	No change.	Wells in immediate vicinity of tunnel may experience drawdown during construction.	No change.
Cultural Resources		National Register sites and potential register sites occur throughout the Basin.	Potential loss of cultural sites on lands suitable for development.	Impacts fully mitigated in accordance with agreements with State Historic Preservation Office.	Potential impacts if historic structures are evacuated.
Hazardous, Toxic and Radioactive Wastes (HTRW)		Numerous regulated sites in 100-year floodplain and along tunnel alignment, especially in Lower Valley. Continued source of contamination in floodwaters from industrial sources.	Continued risk from HTRW being spread by floods.	Non-regulated and non-hazardous contaminated excavated soil to be reused on-site in accordance with NJDEP agreements. Hazardous soil to be managed in accordance with State regulations. Groundwater & surface water to be treated, if necessary, prior to discharge.	Some possible improvement due to clean-up associated with demolition of floodplain structures (includes HTRW sites).

TABLE 4 (c)

COMPARATIVE EFFECTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

SIGNIFICANT RESOURCES	ALTERNATIVES			
	EXISTING CONDITIONS	NO ACTION PLAN	AUTHORIZED PLAN	ACTIONS BY OTHERS: FLOODPLAIN BUYOUT
Public Health & Safety	8 National Disaster declarations since 1968. Substantial health and safety risks. Potential loss of life from drowning.	Flood hazard continues. Possible FEMA action in event of Presidential Declaration of Natural Disaster.	Flood hazard eliminated below 100-year design level at tunnel inlets.	Flood hazards eliminated only in areas below elevations of flood-plain evacuation only. Hazards continue for all remaining structures in the floodplain.
Recreation	Demand for outdoor recreation exceeds existing opportunities throughout the basin.	National Disaster declaration could lead to expansion of open space resulting from a FEMA buyout. Evacuation of structures incurring damage in excess of 50% possible.	Provides trails, river access and recreation with flood control features.	Increases in outdoor recreational opportunities on evacuated lands consistent with land-use goals and State and local management policies.
Aesthetics	Extensive urban/suburban residential, commercial and industrial centers. Interspersed wetlands totaling 24,000 acres plus open green acres and parkland.	No change.	Provides aesthetic treatments for project features.	Increase in open space consistent with land use goals and State and local management policies.
Community Cohesion	Strong local interest in local community, major factor in flood prevention planning.	Populations in 35 municipalities stressed by continued flooding. Potential evacuation impacts resulting from relocation in event of post-flood disaster declaration	Eliminates flood-related stress. Maintains community cohesion.	Disrupts community cohesion consistent with level of evacuation and extent and location of relocated flood-plain populations.
Air Quality	Passaic River floodplain currently in non-attainment for several Clean Air Act parameters.	No change.	Minor, local adverse impacts during construction. Elimination of flood-related traffic delays and clean-up actions.	Adverse air quality impacts during demolition phase. Air quality improvements in post-demolition phase.

TABLE 4 (d)

COMPARATIVE EFFECTS OF ALTERNATIVES ON SIGNIFICANT RESOURCES

ECONOMICS	ALTERNATIVES			
	EXISTING CONDITIONS	NO ACTION PLAN	AUTHORIZED PLAN	ACTIONS BY OTHERS: FLOODPLAIN BUYOUT
Tax Base	Strong economy, stable workforce and reliable tax base support extensive developing infrastructure.	Tax revenues limited by drain of flood emergencies. Potential evacuation impacts in event of National Disaster declaration.	Creation of 5,000 construction jobs and elimination of flood costs promote economic expansion and increased tax base.	Reduces tax base consistent with extent of evacuation.
Project Cost	NA	NA	$1.4 billion initial costs. $1.9 billion fully-funded cost.	INITIAL COSTS / FULLY FUNDED 100-year - $3.9 B $5.5B 50-year - $2.8 B $4.0B 25-year - $2.3 B $3.2B 10-year - $1.6 B $2.3B
Federal Cost	FEMA support in case of large flood events and National Disaster declarations. None for frequent nuisance flooding.	No change. Undetermined cost of FEMA buyout and/or floodproofing actions.	$1.4 billion with $1 million in annual costs for operation and maintenance.	NA
State/Local Costs	Periodic local flood rescue and relief costs. State revenues utilized to support flood emergency and mitigation costs.	No change.	$90 million with $390 million in credits. $2 million operation and maintenance costs for levee/ floodwalls and natural storage areas. HTRW remediation costs of about $29 million.	Full State and local funding under current policy and legislation.
Flood Damage Costs	Average of $100 million annually.	Flood damages increase to $130 million annually by the year 2040.	Flood damage costs eliminated for all floods less than the 100-year event.	Flood costs eliminated at flood levels below evacuation elevation. Damage continues for all remaining structures in floodplain.

CHAPTER 4

AFFECTED ENVIRONMENT

INTRODUCTION

4.00 Chapter 4 describes the significant resources of the areas that would be affected by the project. The level of detail presented for each resource is commensurate with its relative importance. Each of the resources described in this chapter is significant based on legislation listed in Table 1, Relationship of Plans to Environmental Statutes. For additional detail cross-references are made to the main report, its appendices and, where appropriate, to the 1987 final environmental impact statement.

STUDY AREA PHYSIOGRAPHY AND LAND USE

4.01 The Passaic River Basin occupies a 935-square-mile area in northeastern New Jersey and southeastern New York. Parts of eight New Jersey and two New York counties, containing 132 municipalities, are in the basin. The basin is located completely within the Appalachian Province. The waters of the Passaic River originate within the highlands and pass through two sub-provinces, the Central Basin and the Lower Valley, on their journey to Newark Bay. Three physiographic regions: the Highlands, the Central Basin, and the Lower Valley, are shown on Figure 1 in this supplement.

4.02 Highlands The 500 square mile highlands, located in the northwestern portion of the basin, are characterized by thin, rocky soils and long narrow valleys which promote rapid run-off and flash flooding. The extensive forests within the highlands hold major watersheds which provide high-quality water supplies to the basin. The highlands are also major recharge areas for basin aquifers.

4.03 Central Basin The Central Basin, located entirely in New Jersey, is an oval 262-square-mile depression consisting of low, rolling hills with flat, wet meadowlands, and freshwater swamps. Extensive and expanding residential and commercial development is typical although tracts of undeveloped land still remain.

4.04 Lower Valley The Lower Valley, a relatively flat area covering 173 square miles, is located in the southeastern part of the basin near New York City. The Lower Valley, from Newark upstream to Paterson, is the most densely populated and heavily industrialized of the three regions. Very few areas of natural vegetation remain and wetlands, once common, have been dramatically reduced.

4.05 Geomorphology and Topography The Piedmont Province, which encompasses the Central Basin and the Lower Valley, is topographically low and smooth in relief except for the three generally northeasterly-southwesterly trending ridges known as the Watchung Mountains. The undulating plain of the Piedmont Province attains its highest elevation along the Ramapo Fault at the western margin of the province and generally slopes southeastward. The rolling and undulating topography of the plains has developed from glacial material which covers the area. The Watchung Mountains, which result from differential erosion around resistant beds of basalt, are 200 to 300 feet higher in elevation than the surrounding plain and reach elevations which range from 450 to 870 feet mean sea level at High Mountain north of Paterson.

SEISMOLOGY

4.06 The Passaic project is located in a moderately active seismic area that is subject to strong shaking from infrequent earthquakes (See Appendix E - Geotechnical Design, Volume 1 - Section 1.4, Seismic Study, and Figures 1 and 2.)

REGULATED SUBSTANCES

4.07 An environmental records search was conducted in 1993 and 1994, using various environmental databases to inventory those sites along the project's linear extent, which could potentially affect project construction and worker's health. For a full presentation of the sites which were evaluated refer to Appendix F - Hazardous, Toxic and Radioactive Waste Sites (HTRW). A brief summary of site evaluations follows.

4.08 Sites classified were in the vicinity of project features having either known contamination, a high potential for contamination, or a low potential for contamination. Selected project sites where construction activities are planned were sampled and chemically analyzed to determine the presence of contaminants. The study area was limited to 1,500 feet on either side of the tunnel alignment and 300 feet on either side of levee and floodwall systems.

4.09 Eighty-five (85) sites were identified as having known contamination. Of these, three were National Priority List (Superfund) sites, and 42 were State Priorities List sites. The remaining 40 sites are regulated by the New Jersey Department of Environmental Protection. One hundred twenty-four (124) sites were identified as having a high potential for contamination. Three hundred ninety (390) sites were identified as having a low potential for contamination.

4.10 Of the known contaminated sites, various constituents have been identified in select media, from fairly benign levels to higher, more environmentally deleterious levels. There are a number of known contaminated sites which are equally distributed between the southern half and the northern half of the project area. The majority of the known contaminated sites in the southern half were identified in Newark, Harrison and Kearny, but in the upper half were fairly evenly distributed throughout. Contaminants identified were heavy metals, base neutral analyses (BNAs), volatile organic compounds (VOCs), Polychlorinated biphenyls (PCBs), and polychlorinated dibenzo-p-dioxins (dioxins).

4.11 The information gathered was used as a baseline for the subsequent hazardous, toxic and radioactive wastes sites investigations (HTRW), and is available for review at the Passaic River Division during normal business hours. This baseline data was used to: 1) determine those sites where additional HTRW intrusive investigations would be subsequently conducted; 2) quantify the potential risk-based exposure assessment using the currently available analytical data obtained; and 3) for comparisons with existing applicable or relevant and appropriate requirements (ARARs).

GROUNDWATER RESOURCES

4.12 Groundwater quality and supplies are major concerns to residents of the Passaic River Basin. For a detailed description of geology and groundwater resources, see Appendix E - Geology Groundwater, Sections 1 and 2. A general summary is provided below.

4.13 Regional Hydrogeology Three types of water bearing strata can generally be defined in the project area. These include sedimentary rocks of the Newark Group, basalt flows of the Newark Group, and unconsolidated sediments. The sedimentary rocks of the Newark Group contain both confined and unconfined aquifers. Unconfined conditions generally occur in upland areas where overlying unconsolidated deposits are thin or absent. Confined and semi-confined conditions (Artesian) exist in lowland areas, especially where clay beds in the unconsolidated Quaternary deposits mantle the underlying rock units. Confined conditions may also occur directly beneath the basalt flows of the Newark Group, as well as beneath zones of low hydraulic conductivity within the sedimentary rocks themselves.

4.14 The sedimentary rocks of the Newark Group generally have low intergranular hydraulic conductivities. However, fractures are capable of transmitting significant amounts of water. The most productive wells in Essex County, for the most part, occur in sedimentary rocks and are between 300 and 400 feet deep.

4.15 The basalt flows of the Newark Group generally have low hydraulic conductivities. However, these rocks often contain abundant fractures. Wells drilled into the basalts produce small quantities of water, generally from depths of less than 300 feet. The basalt flows locally serve as confining units between higher hydraulic conductivity zones of the sedimentary rocks of the Newark Group.

4.16 The unconsolidated glacial sediments of the region include glacial and non-glacial deposits of great variety and complexity. These deposits are classified as till, lake-bottom sediment, deltaic and lacustrine fan sediment, fluvial over lacustrine sediment, and fluvial sediment.

4.17 Unconsolidated deposits have extremely varied hydrogeologic characteristics. Till consists of non-stratified and non-sorted deposited glacial material. It is generally composed of silt, sand, gravel, and boulders. Units composed of till may serve as unconfined aquifers where they are thick and sandy. In many areas, deposits of till are discontinuous and of limited significance. Lake bottom sediments are generally made up of stratified clay, silt, and fine-grained sand deposited on the bottoms of glacial lakes. Lake bottom deposits do not yield a significant quantity of water, and usually act as a water barrier. In some areas, lake bottom sediments are underlain by stratified glacial deposits which are highly-productive aquifers.

4.18 Fluvial sediments were deposited by meltwater streams and rivers on alluvial plains or in stream beds. Generally, they consist of stratified sand. Fluvial deposits which overlie lacustrine sediments are typically unconfined and are hydraulically connected to nearby bodies of surface water. Deltaic and lacustrine fan sediments are composed of stratified sands and gravel that were deposited in glacial lakes, usually near ice-water contacts.

4.19 The unconsolidated deposits in the project area reach their greatest thickness and significance in buried bedrock valleys. At least six buried valleys are traversed by the proposed tunnel alignment. From the southeast to northwest they include: (1) a lacustrine deposit over 250 feet thick in the Newark area, (2) a fluvial deposit over 50 feet thick in the valley of the Passaic River just north of Newark; (3-4) a deltaic and lacustrine fan deposit over 50 feet thick a few miles west of Belleville and one between 50 and 100 feet thick that fills a valley carved into the Feltville Formation along the Peckman River; (5) a lacustrine valley fill deposit over 100 feet thick which overlies the Towaco Formation; and (6) an extensive lacustrine deposit over 250 feet thick overlying the Boonton Formation near the northern end of the proposed tunnel.

4.20 Although it is difficult to generalize on the basis of limited data, it has been widely assumed that significant hydraulic interaction occurs, at least locally, between the buried valley deposits and the bedrock aquifers.

4.21 A conceptual model suggests that groundwater in the area is topographically driven, with recharge at higher elevations and discharge at lower elevations. In the surficial unconsolidated deposits, most groundwater recharge occurs where sands and gravels are exposed at the ground surface. Where bedrock aquifers crop out near the surface, recharge can occur through fractures to other zones of high hydraulic conductivity. After entering the subsurface in recharge areas, groundwater flows downward, then laterally, to discharge at lower elevations (i.e., stream channels).

4.22 Groundwater discharge in the area can occur through several mechanisms. Buried valley aquifers are often considered to be discharge areas. Groundwater in buried valley aquifers may be discharged directly to surface waters or through evapotranspiration. Groundwater may also be locally discharged from the bedrock aquifers directly to surficial aquifers which do not lie in buried valleys. Once groundwater enters these surficial aquifers, discharge may occur directly to surface waters or through evapotranspiration. Groundwater withdrawals by production wells also constitute a major regional source of groundwater discharge.

4.23 <u>Groundwater Resources Along Tunnel Alignment: Sources and Capacities</u> Groundwater is used for municipal, commercial, industrial and individual domestic water supplies. Groundwater is derived from both glacial and alluvial materials as well as from fractured bedrock. Where the unconsolidated materials consist of thick stratified sand and gravel deposits in buried glacial valleys, high-capacity wells, capable of pumping more than 1,000 gallons per minute, are not uncommon, especially in the southern part of the Central Passaic River Basin. However, except for the extreme northern section, high-capacity wells in the unconsolidated deposits have not been permitted in the immediate vicinity of the tunnel alignment.

4.24 The fractured bedrock produces small to moderate and sometimes large water supplies. However, the most productive surficial wells yield more groundwater than the most productive bedrock wells. Nonetheless, bedrock wells, producing several hundred gallons per minute in places throughout the Newark Basin, are not uncommon.

4.25 The Newark Group is the most important aquifer in the southeastern third of Passaic County which encompasses the north-central alignment of the tunnel. Reported yields of public supply and industrial wells range from 50 to 510 gallons per minute and the median yield is 130 gallons per minute. Most of these wells are 200 to 400 feet deep. The median yield of all public supply and industrial wells over 300 feet deep and eight inches or larger in diameter is 230 gallons per minute.

4.26 Groundwater Quality In the existing state, chemical quality of groundwater from both the unconsolidated and bedrock aquifers is usually good for drinking. However, groundwater from the unconsolidated deposits overlying the bedrock, commonly contains excessive iron or manganese that must be treated to comply with secondary drinking-water standards. High hardness is also common, causing excessive soap consumption problems.

4.27 Groundwater from the bedrock of the Newark Group, through which the tunnel will traverse, may contain some constituents that exceed drinking-water standards rendering the water undesirable for potable use without treatment. Deeper rock wells (more than 250 feet deep) would be expected to generally yield poorer quality water than shallower rock wells having unacceptable sulfate and very high hardness. Chemical analyses of 169 water samples from 150 wells in the bedrock of the Newark Basin show water to be generally fresh, somewhat oxidizing, slightly alkaline, non-corrosive, and hard. They are predominantly calcium-magnesium-sodium bicarbonate type waters of good natural quality, but locally they may require treatment for undesirable characteristics and constituents.

4.28 Groundwater in the lower area of the Hackensack River Basin is hard to very hard and highly mineralized. Here the water quality in both the Passaic Formation and unconsolidated deposits is influenced by the Hackensack River and Newark Bay. Heavy pumpage has induced recharge of water high in chloride from these sources. Both surface and groundwater quality in the lower

Hackensack River Basin may be influenced by the disposal of large quantities of sewage and industrial wastes into the Hackensack Meadowlands.

4.29 Groundwater Contamination In conjunction with the Hazardous Toxic and Radioactive Waste (HTRW) investigation, a hydrogeologic investigation included field studies at proposed workshaft locations 2B, 2C, 2, and 3; evaluation of local and regional hydrogeology; and groundwater-flow modeling. The modeling study evaluated the inter-connection of overburden materials with bedrock aquifers and the potential for interference with existing groundwater contamination. The results of those models are discussed under Groundwater Quality Effects beginning with Section 5.09.

4.30 Shallow groundwater contamination, including separate-phase contaminants in some cases, has been reported at several known HTRW sites along the tunnel alignment. The separate-phase contaminants were not reported for any proposed work locations and deep groundwater contamination appears limited.

4.31 Groundwater Use In the southern portion of the area, many industries rely on groundwater for their processes. At the northern end of the tunnel alignment, most high-capacity wells are used for public supply. Several communities rely entirely on groundwater to supply their residential population. Other communities have residents with their own private wells.

4.32 There are 203 industrial supply wells in the vicinity of the tunnel center alignment. Their combined potential is approximately 38 million gallons per day. Public supply from another 30 wells accounts for an additional 5 million gallons per day.

4.33 In Morris County, the towns of Riverdale and Pequannock rely entirely on groundwater. They each have their own well field and all residents have hook-ups. Pequannock has a backup hook-up with the City of Newark. Approximately five percent of the population of Lincoln Park do not receive municipal water. Therefore, it is assumed that these persons rely on residential wells.

4.34 In Passaic County, the communities of Pompton Lakes and Little Falls rely on groundwater. Pompton Lakes' population is totally hooked-up to the town well field. Little Falls has a small percentage of residential well users who are not hooked up to municipal supplies. The rest of the town is supplied by municipal wells located in Essex Fells. Approximately two percent of the population of Wayne Township are not served by municipal water. Therefore, it was assumed that they rely on residential wells.

4.35 Essex County has three communities along the alignment that have a small percentage of residential well users who are not hooked up to municipal supplies.

SURFACE WATER QUALITY

4.36 Riverine Surface water quality varies from moderately good in the freshwater reaches upstream of the major tunnel inlet in the Pequannock, Wanaque and Ramapo Rivers to degraded in the Passaic River reach upstream of the spur tunnel inlet. The final environmental impact statement's Section 4.35 - 4.65 describes surface water quality conditions as of 1987. Changes in water quality and factors influencing it are discussed in 4.47 Fishery Resources.

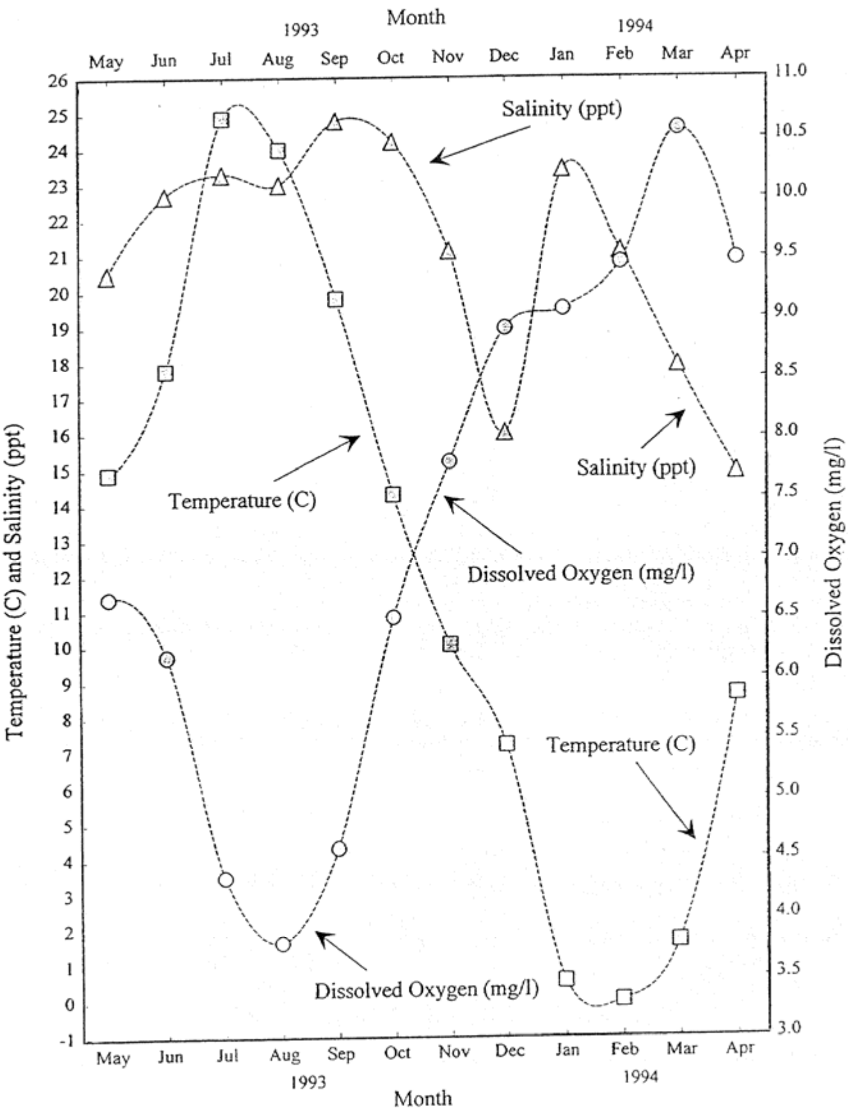
4.37 Newark Bay Existing water quality conditions in Newark Bay are considered to be good based on existing STORET (water quality) data, observations taken by the National Marine Fisheries Service, and the Stevens Institute of Technology. Both Newark Bay and the Passaic River below Dundee Dam are tidal. The bay and the Passaic about up to Second River are estuarine. The dissolved oxygen levels generally range from three milligrams per liter up to 11 milligrams per liter, and the temperatures range from 34°F to 82°F. Average salinity in Newark Bay is normally 20 parts per thousand (Figure 1). It normally drops to zero during 25- to 100-year flood events

4.38 Water quality models were created by the Corps' research laboratories at the Waterways Experiment Station to predict the effect of tunnel discharge on water quality in Newark Bay. Studies were also conducted by Stevens Institute of Technology on the chemical and biological oxygen demand of river water having the potential for storage in the tunnel. The hydrodynamic model which drives the water quality model, and the experiments performed by Stevens are described more fully in Appendix C - Hydrology and Hydraulics, Section 31.

COASTAL ZONE RESOURCES

4.39 Addendum 2 to this SEIS contains the Coastal Zone Act's Consistency Determination. The Final Environmental Impact Statement included a Coastal Zone Management Consistency Determination. This supplement revises that Determination to be consistent with the relocation of the tunnel's outlet to Newark

FIGURE 1 - NEWARK BAY EXISTING CONDITIONS: RELATIONSHIP BETWEEN TEMPERATURE, DISSOLVED OXYGEN AND SALINITY



Bay. New Jersey's Coastal Management Plan was approved in September 1978 pursuant to Section 306 of the Federal Coastal Zone Management Act (CZMA) of 1972. The Coastal Management Area extends inland for 500 feet along the entire Lower Valley of the Passaic River, from Dundee Dam, 17 miles upstream, to its mouth, and along Newark Bay.

4.40 The City of Newark is designated as a "Special Urban Area" that falls within the Northern Waterfront Region of the Coastal Zone of New Jersey. This designation qualifies Newark for the receipt of State aid to enable it to maintain and upgrade municipal services and offset local property taxes. This designation also encourages development aimed at restoring the city's economic and social viability. Newark's levees and floodwalls, designed to protect land use, which is predominantly industrial, would contribute to that designation.

4.41 In addition to special urban areas other "Areas of Coastal Zone Management Concern" are detailed in Addendum 2 and elsewhere within the document where comparable subjects are discussed.

FISH AND WILDLIFE STUDY METHODS

4.42 The Habitat Evaluation Procedures (HEP) and a plant successional model developed by the U.S. Fish and Wildlife Service (USFWS) were selected to assess effects on the fish and wildlife resources of the Passaic River Basin. These selections were made in coordination with the USFWS and New Jersey Department of Environmental Protection. Extensive sampling of Newark Bay was conducted by the National Marine Fisheries Service.

4.43 The plant successional model is designed to predict the composition and abundance of tree species, as well as tree size and canopy closure. The model was used to predict project effects on successional trends in the basin's wetlands. It is called FORFLO and was developed by the USFWS, National Ecology Research Center in Fort Collings, Colorado.

4.44 The HEP model utilizes selected species to act as representatives of vegetative cover-type, or habitats present in a project area. HEP provides a measure of the capacity of a given area to support species of fish and wildlife. Once subject species have been chosen, models are selected incorporating elements essential to their existence which are termed life requisites. The models utilize variables related to those life requisites that are susceptible to measurement using various data collection techniques. Data such as stream velocity, stream depths and substrate type for an aquatic HEP and cover type, number of mast producers, and crown closure for a terrestrial HEP, are some of the types of data that can be utilized.

4.45 Species models were selected and constructed at a 1990 HEP workshop held for the Passaic River project. The workshop and HEP team responsible for assessing project resources included representatives from USFWS, species experts, and biologists from NJDEP, and the Corps' project biologist. The species selected for the aquatic portion of the analysis were smallmouth bass, bluegill, and 'stocked' trout. These species are known to occupy the aquatic reaches of the project area and are of significant interest to anglers. Species selected for the terrestrial wetland HEP included the green heron, muskrat, and the wood frog.

4.46 The field data were used to quantify the variables supporting a Habitat Suitability Index (HSI) for the selected species for the subject site. Indices range from perfect habitat at 1.0 to no habitat at 0.0. Moderate or average habitat would be 0.5 with readings below or above being characterized accordingly. When the HSI is multiplied by the impacted acres, expressed as habitat acres (HA's), the results are Habitat Units (HU's). These units provide a measure of the value of the existing habitat at that site. When changes to the site are predictable, then a similar analysis provides estimates of future value of the site for the selected species. Gains and losses in HU's were used to gauge project effects and develop mitigation plans addressing them. Details of these analyses are presented in Appendix B - Environmental Resources, Section 2.

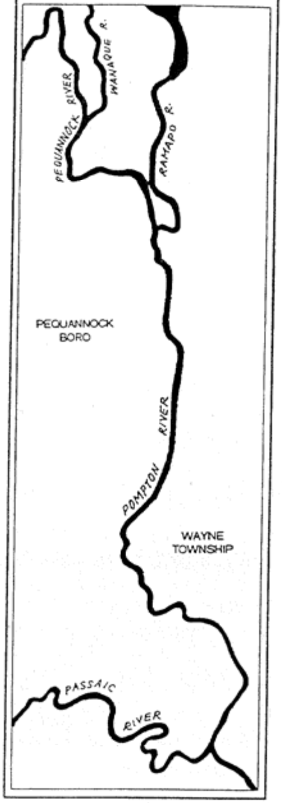
FISHERY RESOURCES

4.47 Fishery resources were sampled in 1980 by NJDEP in support of the December 1987 FEIS. Generally, species numbers and age structure were better on the Pompton River's three tributaries (Pequannock, Wanaque and Ramapo) than on the Pompton itself. The Passaic River in the project area yielded only four species of pollution-tolerant fish. Figure 2 displays the rivers affected by the project.

4.48 The Pequannock River's aquatic community was composed of 13 fish species. However, community structure was poor due to the lack of predatory species and the presence of only two species of sunfish. And while macroinvertebrate diversity was moderate, it was dominated by pollution-tolerant species. Since 1987, the Bloomingdale Sewage Treatment Plant, located on the banks of the Pequannock River, has closed and sewage is non-conveyed to a

FIGURE 2

FISHERY RESOURCES STUDY AREA



modern regional facility located downstream of the Pequannock River. This has improved water quality due to less nutrient and chlorine loading and increased fish diversity, leading the state to change the designation for a portion of the river in the project area from a warmwater fishery to trout maintenance status. Water quality is expected to remain good in the future.

4.49 Sampling on the Wanaque River yielded 17 species of fish and 12 invertebrates including Gammarus sp. Three predatory species, smallmouth bass, rock bass and brown trout, were collected. The presence of holdover brown trout reflect conditions capable of supporting a cold water fishery. Subsequent surveys by New Jersey's Bureau of Freshwater Fisheries indicate that water quality in the project area has improved so that a change in classification from a warmwater fishery to trout maintenance is also likely here. These conditions are forecast to remain stable.

4.50 The Ramapo River in the project area contained a limited but relatively balanced warmwater fishery in 1987 which included three predatory species, three sunfish and three forage species. The benthic macroinvertebrates, totaling 19, represented broad diversity and included oligochaete worms, Gammarus and gastropods species. All indications are that the fisheries found at the time of the sampling would remain as is, that is, each would retain its designation as a warmwater fishery.

4.51 The sampling of the Passaic River in the project area conducted for the 1987 report, revealed the presence of pollution tolerant fish and macroinvertebrates. Upstream discharges from municipal and private sources constitute significant pollutant sources. However, although future improvement in water quality as a result of reductions in point source discharge is possible, no substantial changes along the project reach are known to have occurred since the 1987 FEIS. No measurable changes in the river's status is foreseen.

4.52 No substantial changes along the Rockaway and Whippany Rivers in the project area are known to have occurred since the 1987 FEIS. The future conditions of these rivers is expected to approximate existing conditions.

4.53 Aquatic HEP Results The HEP analysis confirms the general zonation presented in the 1987 report. A review of the data reveals a segmented fishery with an upstream coldwater fishery being replaced in downstream reaches by a warmwater one. Habitat Suitability Index (HSI) values illustrate moderate support for brown trout (a coldwater fish) on the Pequannock and Wanaque Rivers and smallmouth bass (a coolwater fish) on the Ramapo River, but relatively low value (0.3+) on the Wanaque River. This relationship on these two rivers also held for smallmouth bass spawning. The bluegill, a warmwater species, had a low HSI (<0.2) for adults on the Ramapo River. However, the Ramapo had a relatively high HSI (0.7+) for bluegill spawning habitat. Because the Ramapo River is a slow-moving stream with shallow sandy areas, it provides good spawning habitat for the bluegill. The Rockaway, Whippany and Passaic Rivers were not included in the evaluation due to minimal project influence.

WETLANDS

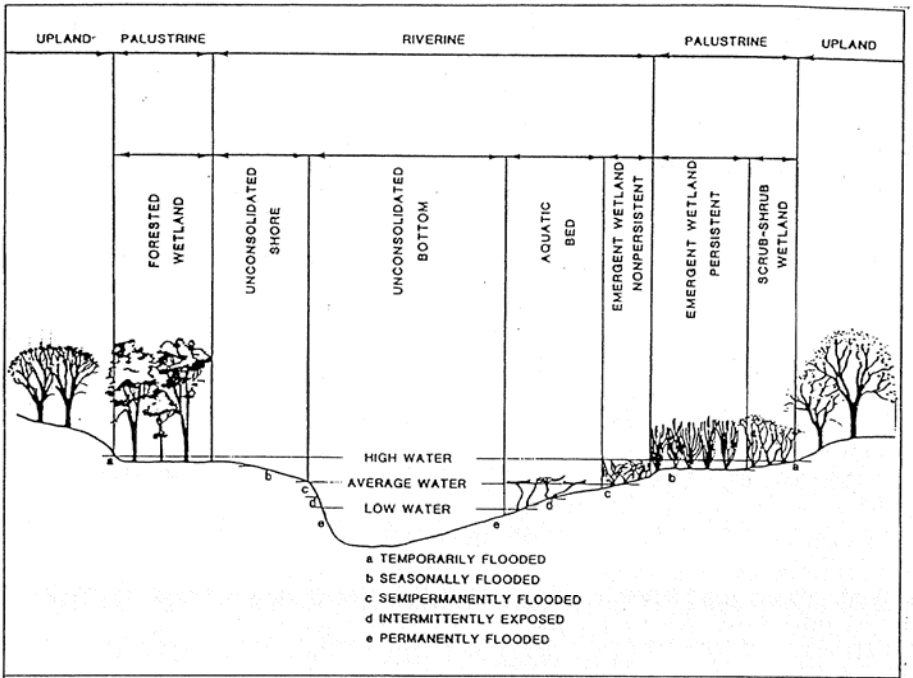
4.54 The vast majority of the wetlands associated with the project are located in the Central Basin. Figure 3 of the Main Report illustrates their location. Approximately 24,000 acres of wetlands exist, of which some 13,700 are in the project area. Most are designated as palustrine wetlands "bottomland hardwoods" by the U.S. Fish and Wildlife Service.

4.55 The major freshwater wetlands include Great Piece Meadows, Hatfield Swamp, wetlands upstream of Hatfield Swamp to Canoe Brook, Black Meadows, Troy Meadows, Bog and Vly Meadows, and the Pompton-Three Rivers wetlands. These lands exhibit a continued slow filling that is due to siltation which is not directly noticeable. A more complete description of the freshwater wetlands is found in the 1987 report, sections 4.73 through 4.97. Figure 3 displays typical riverine (palustrine) wetlands.

4.56 Small amounts of vegetated estuarine edge exist in Newark Bay along with a tidal flat just south of Kearny Point. Shallow water estuarine habitat is located on the east side of the bay where water depths range from 0.5-10 feet at mean low water.

4.57 Wetlands Composition Freshwater wetlands occur in riverside floodplains as (1) forested swamps, (2) scrub-shrub,

FIGURE 3 - WETLAND HABITATS IN RIVERINE SYSTEM



Source: Classification of Wetlands and Deepwater Habitats of the United States, L.M. Cowardin, et al., U.S. Fish & Wildlife Service, 1979.

dominated by small trees and bushes, or (3) emergent, with seasonally flooded herbaceous or non-woody plants. The predominant ground cover-type is the palustrine forested wetland (61%), followed by palustrine forested scrub-shrub (3%) and palustrine emergent (2%). The second largest component is the emergent wetland which constitutes 22 percent of the ground cover-type. Emergent wetlands dominate Troy Meadows and Black Meadows (49% and 44% respectively). Wetland cover maps are included in the Appendix B - Environmental Resources, Section 2, in Figures 2.3 - 2.22.

4.58 <u>Vegetation</u> Forested wetlands are dominated by red maple, silver maple, swamp white oak, pin oak, sweet gum, slippery elm, and white ash. Understories contain spicebush, poison ivy, viburnums, and dogwood species. Ground cover varies from very sparse to lush. Various grasses, herbs, and forbs are encountered. Scrub/shrub wetlands are dominated by sapling red maple, various willow species, button bush and common alder. Emergent wetlands are dominated by broadleaf and narrowleaf cattails, sedges (three-square, Carex), duck potato, arrow arum, pickerelweed, Phragmites, purple loosestrife, and reed canary grass. The latter three species tend to crowd out other plants and have increased in extent over the last 15 years. Mixtures of these vegetation species often induce a patch work appearance termed interspersion.

4.59 Continued development of upland habitats in and near the Central Basin will further stress wetland habitats. This is reinforced by the general lack of management, due at least in part to the multiple ownership of these areas.

4.60 Passaic Levee #10 Wetlands The Passaic Levee #10 site is surrounded in three directions (north, west and south) by palustrine forested wetlands, although an area on the south side contains a palustrine emergent marsh. There is also an area of scrub/shrub on the south side of the development as well as a few scattered emergent wetland pockets in the area. The project area affected consists of 75% palustrine forested wetland. Habitat Evaluation Procedure results have limited application at this site due to the small size of the area and the few samples available. They do, however, provide some background information for impact analysis and subsequent mitigation planning.

WILDLIFE RESOURCES

4.61 The wildlife within the Central Basin is diverse although it is stressed by the encroachment of humans. Development has greatly reduced the number of individuals of most species not fully tolerant of human activities. With regulation, wetland development has slowed, but still continues. Development of upland sites continues and adverse effects, such as increases in siltation, have affected the Central Basin's wetland ability to support wildlife.

4.62 Natural upland habitats include deciduous and coniferous woodlands and old fields which range from grassland to pole stage stands. These habitats have become scarce in the last three decades because of development.

4.63 A faunal survey of major wetlands was conducted. Most wildlife sightings were of birds since they were the most visible and vocal of the four terrestrial vertebrate classes. The wetlands of the Central Basin form an important migrant rest and feeding area for avian species during spring and fall and also provide substantial breeding habitats. The total number of species that can be expected to use the Central Basin wetlands is at least 120. This number is reached when totals from sampling conducted in May, June and July are combined with the expected number of migratory species which normally appear in late fall or the winter. Declines in numbers and breeding of certain groups of waterbirds have been recorded. Notable are the reduction in waterfowl and rails. The reduction in these types of birds is based upon observations made by naturalists and historic anecdotal information and, more recently, upon the scientific investigations carried out as part of this project.

4.64 The large contiguous blocks of wetlands in the Passaic River Central Basin constitute the critical wildlife habitat in the basin, so the HEP methodology emphasized these resources. They are discussed under wildlife because the model uses wildlife species as indicators of the wetlands' habitat values.

4.65 Model Results The species selected to evaluate the project wetlands are the wood frog for the palustrine forested wetlands; the green heron for the palustrine scrub/shrub, and scrub/shrub-emergent wetlands; and the muskrat for the emergent wetlands. These species were selected because they were known to occupy the wetlands in the project area. It was believed that their needs would reasonably represent the cover-type along with other associate species. They also had already been used in the study area in 1980.

4.66 Refinements in the habitat evaluation procedures since 1980 have led to the validation of many models, helping to insure that they provide optimal and accurate information for the species evaluated. A further regionalization of the models to be used in the project was an objective of a 1990 workshop. A review of the models indicated that the wood frog model was valid as assembled. However, refinements to the green heron and muskrat models were possible and desirable. To this end, experts for these species were selected and joined the HEP team to refine the models. Once developed, the models documentation was performed by the National Ecology Research Center of the USFWS (now the National Biological Service) and circulated for review and comments.

4.67 Wetlands cover-types measured within the project area of the Central Basin include 8,365 acres of Palustrine forested wetlands, 400 acres of forested-scrub/shrub wetlands, 220 acres of forested-emergent, 920 acres of scrub/shrub, 780 acres of scrub/shrub-emergent, and 3,035 acres of emergent for a total of 13,720 acres. Appendix B - Environmental Resources - Section 2 describes the ground-cover types in named wetlands and its Table 2.1 gives their acreages by wetland.

4.68 Seventy-six sites were randomly selected from stratified cover-types within the wetlands to insure that: 1) all were represented, 2) enough sites were available to allow a reasonable degree of confidence that the information gathered reflected the ability of the various habitats to support the selected species. All sites were rated using the selected species models. This included measurements of the variables for each life requisite to determine its value.

4.69 The areal extent of the various wetlands and cover-type composition presented in the FEIS still remain valid (1987 Report, Appendix B - Natural Resources (Volume III), Table 26. Refinements in cover-type acreage and vegetative composition were made based on field studies.

4.70 Species and site-specific findings in the project's major wetlands are presented by species in the Appendix B - Environmental Resources, Section 2.1.3.2.1. The data collected within the Great Piece Meadows, including information on the HEP species, are discussed in greater detail than results from the other area wetlands because these wetlands are closest to the Passaic tunnel inlet. Hence, adverse effects of reduced flood stage and duration would most likely occur here.

4.71 Life Requisites-Limiting Factors The analysis of the life requisites for the evaluation species are summarized as follows: (1) Wood Frog - two life requisites -- cover and water -- were identified; (2) Green Heron - two life requisites -- nesting and food -- were identified (two measurements - square yards of cover for nesting, and linear yards of forage habitat, were identified to determine suitable habitat) and (3) Muskrat - two life requisites -- food and water regime -- were identified.

4.72 Wood Frog: A synopsis of the HEP findings for the evaluation species indicates that the samples were generally comparable. Great Piece Meadows was typical of the project area regarding HSI's for wood frog. The difference in the mean Suitability Indeces (SI) for cover between Great Piece Meadows and the project area as a whole, was not significant.

4.73 The mean SI for the water variable for the entire project area and for Great Piece Meadows approximate each other. Generally, the comparison of the water life requisite between the other wetlands in the project area were not statistically significant, with the exception of Hatfield Swamp.

4.74 Generally, comparisons of the other meadows revealed they were similar to each other except Hatfield Swamp where the water HSI was significantly less than Troy Meadows, likely due to the ground elevation of Hatfield Swamp which allows water to drain off faster. Hatfield Swamp contained substantially more cover when compared to Black Meadows or the Pompton Valley wetlands.

4.75 Green Heron: Due to the relative scarcity of scrub/shrub habitat, only eight sites could be randomly selected for analysis. As a result, only the Great Piece Meadows met the criterion of three sample sites to allow in depth evaluation.

4.76 The limiting factor for this species is the lack of forage zone. This greatly reduces its reproduction value for the green heron. Other limitations include limited water regime stability during the nesting season.

4.77 Generally, the other sites exhibited the same conditions as the Great Piece Meadows. That is, both life requisites were low, and foraging habitat was very limited compared to nesting habitat.

4.78 Muskrat: Generally, the values for these species are low throughout the Great Piece Meadows. In this wetland, the water regime value is virtually the same as the value for the entire project area, while the value for food is lower than the average for the project area wetlands as a whole.

4.79 The water regime of Great Piece Meadows and the food life requisites are nearly equal (0.23 vs 0.26). Both would require equal attention in order to improve the carrying capacity for this species.

4.80 The greater occurrence of the emergent wetland cover-type in other wetlands allowed the sampling of a larger number of sites. Four wetlands: Troy Meadows, Black Meadows, Great Piece Meadows, and wetlands upstream of Hatfield Swamp, met sampling criteria for data analysis. Generally, the results indicated that the carrying capacity is low throughout project wetlands. It is best in Troy Meadows where more water and preferred food are present. The other wetlands scored substantially lower but reasonably close to each other. The water value in each of these wetland areas was limiting mainly because of rapid fluctuations of water levels, the depth of floodwaters, and the limited number of banks for refuge burrows.

4.81 Values for food were substantially higher than those for the water regime, especially in Black Meadows and the wetlands upstream of Hatfield Swamp. However, since the values for both life requisites are low, both should be addressed in any plans to improve the carrying capacity for the green heron and other species characteristic of the emergent wetlands.

ESTUARINE RESOURCES

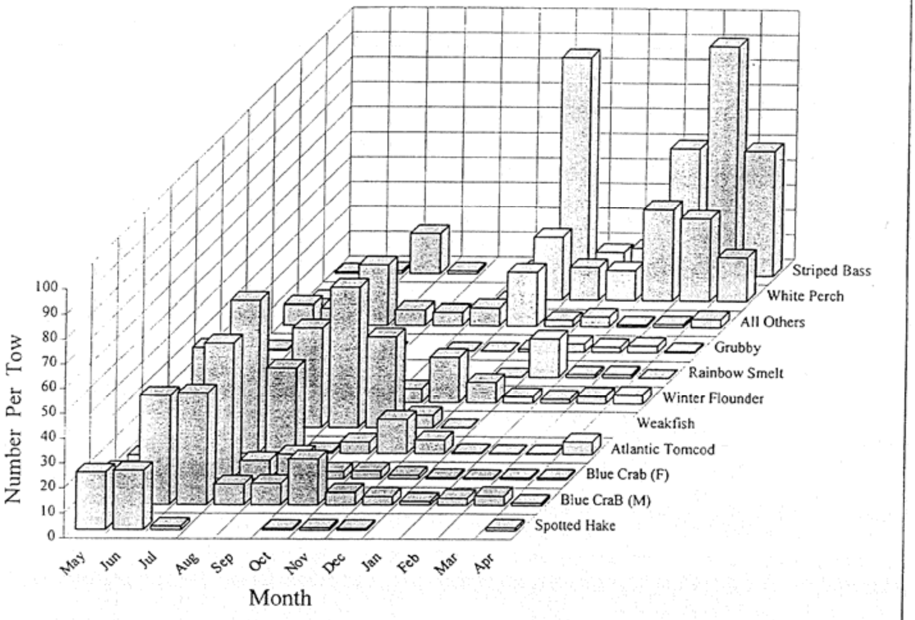
4.82 The change in outlet location necessitated collecting information regarding Newark Bay. The National Marine Fisheries Service (NMFS) intensively sampled Newark Bay for one year from May 1993 to April 1994. The results indicated that the bay contains a good array of finfish. Additionally, a substantial population of blue crab is present. Currently, due to pollution in the sediment, and possible contamination of the resident shellfish and finfish, there is an advisory against eating fish and shellfish caught in Newark Bay.

4.83 The survey yielded 56 species of fish and benthic macro invertebrates, 20 species of larval fish, and 54 species of benthic organisms. The majority of the fish were found in the bay's navigation channels. Diversity was good. Seasonal variations in species age and composition generally reflected expected findings for an estuary in the New York Bight. Striped bass and white perch dominated from November through March, while Atlantic tomcod and blue crab (both male and female) dominated in June and July. Substantial numbers of spotted hake were taken in July from the channels. Weakfish were most abundant from August through October. The ichthyoplankton community is characterized by 20 species of larval fish. Larvae are most abundant from June through September. Anchovy and goby made up the majority of the larvae fish collected. Figure 4 displays the "Ten Most Abundant Fish and Megainvertebrates in Newark Bay".

4.84 Benthic populations varied with season. Numbers were dominated by polychete worms but also included oligochate worms, and several species of mollusks and crustaceans.

4.85 Anadromous Fish - Finfish Migratory Pathways Most tributaries within northern New Jersey have had historic runs of anadromous fish. These populations have dwindled over time because of pollution and habitat loss. Remnant populations exist in the Passaic River up to the base of Dundee Dam. Due to pollutant loading, dam weirs, bulkheading, and a lack of substrates available, spawning areas for anadromous fish are very limited.

FIGURE 4 - TEN MOST ABUNDANT SPECIES OF FISH AND MEGAINVERTEBRATES IN NEWARK BAY



Monthy individual catch, in number, of the 10 most abundant species of fish and megainvertebrates collected with an 8.5-m otter trawl during a biological and hydrographical characterization of Newark Bay, NJ; May 1993 - April 1994.

4.86 In recent years anadromous fish have been observed on the Passaic River downstream of Dundee Dam. Blueback herring were observed in the Third River in 1977, and three species of clupeids (blueback herring, alewife, and American shad) were captured in 1981. Subsequently, the most recent sampling by NMFS revealed that this bay contains a substantial population of striped bass. It is dwarfed by the populations within the Hudson River, but is noteworthy when considering the relative size of the bay.

4.87 Also worthy of note is the relative lack of herrings (bluebacks, alewives and American shad) in the NMFS sampling. The populations have dwindled to the point that either (1) they are being missed by the sampling, or (2) they are no longer present in any but remnant numbers. Future sampling can be designed to increase gear selectivity for herring.

4.88 Marine Fisheries Results of the sampling by NMFS revealed that true marine fish, (e.g. tuna) do not directly use Newark Bay. However, fish which utilize the ocean but come into estuaries to feed (e.g. bluefish) are present.

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

4.89 The Federally-listed endangered Indiana bat (Myotis sodalis) is known to occur in the Passaic River Basin. In February 1993, an Indiana bat hibernaculum was identified in Morris County by USFWS and NJDFGW personnel. Indiana bats hibernate in caves and abandoned mine shafts from October to April, depending on climatic conditions.

4.90 In the summer of 1995, post-lactating female Indiana bats were discovered within the Passaic River Basin, confirming the presence of breeding Indiana bats in the area. Female Indiana bats occupy summer maternity roosts under loose tree bark along riparian and floodplain forests and have also recently been confirmed to utilize upland forested areas as summer maternity roosts. Indiana bats, as with all eastern United States bat species, feed almost exclusively on insects. Studies have indicated that Indiana bats forage in air space near the foliage of streamside and flooplain trees. Thus, the floodplain forest is an important habitat component for the Indiana bat. The abundance of mature trees within the floodplain and upland forests in the vicinity of the project area provide suitable maternity, summer, and foraging habitats for the species. Except for the Indiana bat, and an occasional transient bald eagle or peregrine falcon, no other Federally-listed or proposed threatened or endangered flora or fauna under U.S.F.W.S. jurisdiction are known to occur in the project area.

4.91 Section 7 consultation with the National Marine Fisheries Service (NMFS) indicated some potential for the presence of endangered species on Newark Bay. Sampling by the National Marine Fisheries Services in Newark Bay during 1993-94 did not detect the presence of endangered marine species.

4.92 State Listed Endangered Species There are a substantial number of state listed species within the project area; most that are listed are found in the wetlands.

4.93 The Corps' concern about New Jersey State endangered and threatened species of flora and fauna was initiated in 1979 with a faunal survey of wetlands potentially affected by the project.

State flora which were designated as endangered, threatened or of concern were examined via literature search and field surveys.

4.94 A list of species that are known to reside in the project area at present or have been recorded in the area in the recent past, and species with the potential to reside in the area can be found in Appendix B - Environmental Resources, Section 3, Table 3.1.

SOCIOECONOMIC CONDITIONS

4.95 Demographic Characterization The Passaic River Basin consists of 132 communities whose boundaries fall in a five county region that, wholly or in part, lies within the Passaic River's 500-year recurrence interval floodplain. The 1990 census indicated a population loss in this region from 3,110,674 to 3,033,088. The older, more densely developed portions in the Lower Valley lost population to the newer, more affluent suburbs in the Central Basin and beyond. Thus, Essex, Hudson and Bergen Counties lost population while Passaic and Morris Counties grew. For more economic data see Appendix I - Economics of the Buyout Report.

4.96 Housing Trends in housing construction parallel the shift in population away from high density inner suburban rings to the newly developing outer suburban areas, particularly along transportation arteries. Since 1987, major interstate linkages (I-287 with the New York State Thruway) have been completed, which allow easy automobile access to formerly remote land that is now readily accessible to urban centers and employment. In the five-county region, 451,778 households moved between 1985 and 1990. The total number of housing units in the five-county area rose by 2.5 percent over the last decade to 1,171,466. Morris County saw the largest increase in the number of housing units (13 percent), while Essex County lost 18,520 units, many of which were in older urbanized areas like Newark.

4.97 Per Capita Income Incomes in the five-county region increased from $13,166 to $19,569 per capita over the last decade. This income is higher than in the project area and in the floodplain, where the per capita income is $15,867. This low figure is due to large unemployed populations in Newark and Paterson which pull the averages down. Communities with the highest per capita incomes include Livingston with $34,174, and North Caldwell with $40,848.

4.98 Labor Force The communities in the Central Passaic River Subbasin had a total labor force of 144,572 in 1990. Their unemployment rate was 3.2 percent. The Lower Passaic Subbasins' total Labor Force in 1990 was 467,954, which is much larger than that of the Central Basin and Pompton River subbasins. However, the unemployment rate, at nine percent, is the highest of the three subbasins due largely to the higher rates found in Lower urban areas.

4.99 The Pompton River Subbasin has the smallest total labor force with 87,725 people. Its unemployment rate was almost four percent. The census tracts intersected by the 500-year floodplain combine for a total labor force of 259,230 in 1990 and an unemployment rate of approximately 7%. Occupation types and other details are presented in the Appendix I - Economics.

4.100 Community Cohesion Community cohesion as an indicator of community stability within a given area is reflected by population changes. Statistical analyses of individual census tracts intersected by the 500-year floodplain of the Passaic River Basin were performed to characterize social composition. Population density in the basin is high, with 3,000 people per square mile, although populations have decreased slightly during the last decade, from 478,027 in 1980 to 474,804 in 1990. This change in population was one of the smallest decreases when compared to the metropolitan region, indicating a stable area.

4.101 Looking at the census data by subbasin determined that the Central Basin Subbasins have a higher percentage of households than either the project area or the region. In 1980, 82% of the households were made up of families, a relatively high figure. This is another indicator of stability. And while the Pompton River Subbasin has the smallest number of families and households among the three subbasins its, 36,383 families have risen in number by 4% and its 45,596 households have risen by 11% since the 1980 census. Thus, not only is this area stable, it is a target location for people who are seeking to relocate to affordable housing.

HISTORIC AND PREHISTORIC CULTURAL RESOURCES

4.102 Cultural Resources As an agency of the Federal Government, the Corps has certain responsibilities concerning the protection and preservation of cultural resources within the project area. The Federal statutes and regulations authorizing the Corps to undertake these responsibilities include Section 106 of the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969, Executive Order 11593; and the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800).

4.103 To assist the Corps in fulfilling these responsibilities, a Programmatic Memorandum of Agreement (PMOA) developed among the Corps, the New Jersey State Historic Preservation Office (NJSHPO) and the Advisory Council on Historic Preservation (ACHP) was signed by the ACHP on March 30, 1993. In accordance with this document, cultural resources investigations were initiated for several project elements to identify properties located within or adjacent to the project area that are listed or potentially eligible for listing on the National Register of Historic Places (NRHP).

4.104 The PMOA stipulated that individuals and groups be designated to participate as interested parties in the cultural resources review. These parties include the Archaeological Society of New Jersey, the State Archaeologist and Registrar, the Roebling Chapter of the Society of Industrial Archaeology, the Canal Society of New Jersey, the North Jersey Highlands Historical Society, the Newark City Historian, the Passaic County Historian, the Wayne County Historic Preservation Commission, and the Pompton Lakes Historic Preservation Commission.

4.105 Investigations for the tunnel systems/upper basin elements were carried out in 1994 by Boston Affiliates Inc., the Rutgers University Center for Public Archaeology, and Historic Conservation and Interpretation Inc. Investigations of the central basin protection elements were limited to the Passaic River Levee System #10. These were carried out by the Rutgers University Center for Public Archaeology and Kittatinny Archaeological Research Inc. during 1993. Investigations of the remaining central basin protection elements and of the tidal area protection elements will be carried out in accordance with the procedures outlined in the PMOA during the Feature Design Memorandum (FDM) and Plans and Specifications Phases of the project.

4.106 Cultural resources investigations were conducted at the sites of the main and spur tunnel inlets; levees, floodwalls and channel modifications on the Pequannock, Ramapo, Wanaque and Passaic Rivers; work shafts and associated staging area; and the Pequannock and Passaic River weirs.

4.107 Detailed accounts of the investigations and their findings are presented in Appendix B - Environmental Resources, Section 5. A summary description of identified cultural resources follows.

4.108 <u>Cultural Resources Investigations</u> Cultural resource surveys consisted of documentary research, geomorphic research, and site inspections limited to a surface reconnaissance and selective augering of landforms.

4.109 Five previously identified prehistoric sites are located within or immediately adjacent to the project's surface features. One is potentially National Register-eligible. More research will be required to determine the eligibility status of the others. Ranking of project impact zones for archaeological sensitivity found some to be moderately to highly sensitive.

4.110 The section of the project area adjoining the confluence of the Passaic and Pompton Rivers contains three known prehistoric sites: Sites 28-Ex-23, 28-Mr-156, and 28-Mr-157. The Passaic/Pompton confluence area also contains locations where geomorphic analysis and fieldwork indicate that unidentified archaeological sites may be present. Most of the confluence area has a high to moderate potential for prehistoric site preservation.

4.111 All three known sites are located west of the confluence. Site 28-Mr-157 and Site 28-Mr-156 adjoin the project area on the Passaic River's northern bank, separated by a terrace area identified as having a high potential for prehistoric remains. Site 28-Mr-157 is on a high terrace, approximately 10 feet above the river. Located at the Passaic/Pompton confluence, its margins may extend to the latter waterway as well. Artifacts recovered here suggest that it was occupied during the Archaic (8,000-1,000 B.C.) and Woodland (1,000 B.C.-1,600 A.D.) periods. Portions of this site are believed to be well preserved. Prehistoric site 28-Mr-156, located slightly to the west, is in the floodplain at the edge of Great Piece Meadows. Its temporal association has not been determined. The preservation of this site is uncertain due to the possibility of channel meandering. Prehistoric site 28-Ex-23 is also located west of the confluence, on a high terrace on the south shore of the Passaic River. Again, artifacts suggest Archaic and Woodland Period occupations. Large portions of the site are probably preserved along the slope and on the upper part of the terrace. The amount of artifactual material recovered indicates that site 28-Ex-23 may be NRHP-eligible.

4.112 Much of the northern and southern banks of the river, east of the confluence and upstream of the Route 80 crossing, were determined to be moderately to highly sensitive for prehistoric archaeological remains. On the southern bank, the easterly extension of the terrace containing site 28-Ex-

23, contains areas of intact soils and has been identified as having a moderate potential to contain prehistoric sites. Two areas on the northern bank exhibit geomorphic conditions suggesting a high potential for prehistoric site preservation. These included a small terrace immediately adjacent to the Passaic/Pompton confluence and a natural levee backslope just upstream from the Route 80 crossing.

4.113 The area located between the Ramapo River's confluence with the Pequannock River and the project's terminus at the Paterson-Hamburg Crossing, just south of Pompton Lake, contains a well-documented series of prehistoric sites, as well as areas along the river's banks identified as having moderate to high potential to contain previously unknown prehistoric sites.

4.114 Of the known Ramapo River project area Site 28-Pa-146 (the Graham-Kuhn Site) is the only one adjoining the river. Located just east of the Pequannock confluence, along the river's western bank, near the Pompton Plains Cross Road, it contains evidence of Middle Archaic through Late Woodland occupations. Geomorphic conditions favor the preservation of this site.

4.115 Two areas designated as moderately sensitive for prehistoric materials were identified in the reach of the Ramapo River upstream of the confluence. They include a narrow stretch along the river's western bank between the Pompton Lakes Sewage Treatment Plant and the Dawes Avenue Bridge, and a second location, also on the western bank, just south of Riverview Road, composed of a narrow terrace leading into a meander - shaped depression. Selected, undisturbed locations within these areas have moderate potential for prehistoric site preservation.

4.116 The section of the project area adjoining the Pequannock River, north of its confluence with the Ramapo River and south of the Riverdale Road crossing, contains one known prehistoric site as well as areas of moderate to high archaeological sensitivity. Prehistoric site 28-Pa-87 is located on the northern and eastern banks of the river, in a low lying area enclosed by a broad meander. Although no artifacts were found here this area and the high terrace bordering it to the north, have been identified as having a moderate to high potential for site preservation. Geomorphic analysis and fieldwork identified areas possessing moderate to high potential for site preservation on the river's northern and eastern banks, both upstream and downstream from site 28-Pa-87.

4.117 Lands within and immediately adjacent to impact zones of work shafts, access shafts, and the tunnel outlet were the subject of reconnaissance level literature review and field inspections. These investigations formed the basis of evaluations of each area's potential to contain prehistoric cultural resources. For those sites determined sensitive, further investigations are planned during final design stages.

4.118 Workshafts 3, 4 and 4 Alternate are located in close proximity to known sites. Their environmental settings and the presence of undisturbed soils suggest that there is a high potential here for encountering prehistoric remains within the actual project impact zones. Based upon similar geomorphic and environmental conditions, Workshaft 2B alternate and Workshaft 2A have also been determined to be sensitive.

4.119 Central Basin Levee Floodwall Systems and the Passaic #10 Levee System Cultural resources investigations have been conducted at the site of Passaic River Levee #10. This study consisted of a literature review, field testing, and geomorphic analysis. A NRHP-eligible prehistoric archaeological site is contained within the bounds of the Passaic Levee #10. The site, designated Site 28-Ex-78, is located on a terrace which projects westward into the wetlands adjoining the Passaic River. Artifacts recovered here suggests that it dates to the Late Archaic Period (4000-2000 B.C.). In addition, landforms determined to be sensitive for prehistoric sites are located within the wetlands portion of the Passaic Levee #10 project area. Investigations of the impact zones of the remaining elements -- Passaic River Levee/Floodwall System 2A; Rockaway Levee Systems 1, 2 & 3; Pinch Brook Levee/Floodwall System, and Deepavaal Brook channel modifications -- will be carried out in accordance with the procedures outlined in the PMOA during the Feature Design Memorandum Phase and Plans Specifications Phase of the project.

4.120 Historic Sites and Structures Of the twenty historic properties surveyed during these investigations, eight are National Register of Historic Places (NRHP)-listed, eligible, or are contributing elements to an NRHP-listed historic district. Of the remainder, five have been determined ineligible and seven will require further evaluation. More detailed field inspections and compilation of relevant literature were also undertaken for many properties. Archaeological testing was performed at the Morris Canal's Pompton Feeder Lock and the Locktender's House Site as well as at the Ludlum Steel Company Dumpsites. The following properties are located within or are immediately adjacent to, project impact zones. See Figures 5.1 and 5.2 in Appendix B - Environmental Resources - Section 5, Cultural Resources.

4.121 Historic Property #1: The Schuyler Colfax House, 2343 Paterson - Hamburg Turnpike, Wayne (Ramapo River) This structure, a portion of which is said to date to 1696, is listed on the National Register of Historic Places. The lot to the rear of the structure, which backs onto the Ramapo River, as well as the embankment itself, may contain archaeological and landscape resources that contribute to the property's eligibility. The Colfax Cemetery is located along the river approximately 100 yards to the north of this property.

4.122 Historic Property #7: The Dawes Avenue Bridge, Ramapo River, Wayne The Dawes Avenue bridge was constructed in 1928 as part of the 1924-1928 closure of the Morris Canal. Designed by Cornelius Vermeule, director of the closure, and constructed by Winston and Company, it has been found eligible for listing on the National Register of Historic Places by the New Jersey Department of Transportation. That agency's survey form for the structure describes it as "an elliptical deck arch bridge with a vertical crest to the roadway and paneled parapets set between massive end posts." It is considered a late example of the bridge type.

4.123 Historic Property #8, Ramapo River Embankment, Paterson-Hamburg Turnpike, Wayne A series of structures, some which may have dated to the early 18th century, are depicted on historic maps of the reach of the Ramapo River which extends from the Schuyler Colfax House to the Paterson-Hamburg Turnpike. The Colfax Cemetery was also located here, approximately one hundred feet north of the Schuyler Colfax House. Modern structures and asphalt parking lots now occupy the entire area. Further research, including subsurface testing, would be necessary to establish the eligibility status of these properties.

4.124 Historic Property #9: Van Ness House, 2 Riverdale Boulevard, Pompton Lakes The National Register-eligible Van Ness House in the Borough of Pompton Lakes is a circa (ca.) around 1790 farmhouse considered to be one of the best examples of its type. The rear yard appears to contain undisturbed portions.

4.125 Historic Property #11: Beam House, 62 Riverdale Road, Riverdale The National Register-eligible Beam House was constructed ca. early 1850s. It is located on the north side of Riverdale Road, approximately four hundred feet from the west bank of the Pequannock River. No evidence of remains associated with occupation of this structure was found during a search along the river's shoreline. The lot immediately surrounding the house appears undisturbed and may contain subsurface archaeological deposits.

4.126 Historic Property #5: Two Bridges Road Bridge, Pompton River, Lincoln Park Borough The Two Bridges Road Bridge was built in 1887 as a crossing over the Pompton River. It has been found eligible for the National Register of Historic Places by the New Jersey Department of Transportation. A riveted pony truss, the bridge is significant as the only surviving two-span truss and the only double - intersection Warren truss within the county. It was manufactured by a small local fabricator, J.P. Bartley & Co. of Morris County.

4.127 Historic Property #13, Budd/Campbell House, 70 Fairfield Road, Wayne This structure was probably constructed 1860. Further research would be necessary to determine its eligibility for the National Register. There is no apparent modern disturbance within its surrounding lot.

4.128 Historic Property #14, Ryerson House Site, Fairfield Road at Two Bridges A ca. mid-19th century structure was located on the east side of Fairfield Road, directly opposite the bridge. It is labelled "Ryerson" on historic maps. Archaeological remains may be associated with it.

4.129 Historic Property #15, Van Ness/Dormus House Site, Two Bridges Road, Fairfield A ca. mid-19th century structure was located near the Passaic River, immediately west of Two Bridges Road at the bridge. Remains that may be associated with it were noted along the river bank at this location. This is also the location of prehistoric site 28-Ex-23.

4.130 Historic Property #17, Dey/Post House Sites, Two Bridges Road, Lincoln Park The area located to the northwest of the Passaic/Pompton confluence, on both sides of Two Bridges Road, may contain archaeological remains associated with eighteenth and nineteenth century residences, early industrial activities, a burial ground, and a Revolutionary War encampment.

4.131 Morris Canal's Pompton Feeder Lock Site and Locktender's House Site The northern terminus of the Morris Canal's Pompton Feeder is located on the east bank of the Ramapo River approximately two hundred feet upstream of the Pompton Dam. The Lock Site consists of the buried remains of the feeder lock. Adjacent to it are remains of the Locktender's House. The Morris Canal is listed on the National Register. The Pompton Lock Feeder Site and the Locktender's House Site should be considered as contributing to the Canal's eligibility as a historic district.

4.132 Ramapo River Slackwater Canal: Guardbanks, Towpath, Wall Remnants, and Related Features From its entrance at the Feeder lock, to the falls at the site of the Pompton Ironworks, the feeder canal occupies the engineered channel of a natural waterway -- the Ramapo River. The Morris Canal, of which the Pompton Feeder is a part, is listed on the National Register. The landscape features and other structures associated with the Slackwater Canal should be considered elements contributing to the Morris Canal's eligibility as a historic district. These would include remnants of masonry retaining walls, the abutment to the ca. 1836 Colfax Bridge, as well as a series of earthwork features comprised of guard banks, the towpath, and sections of altered channel. Former meanders, including those known as "the Slank," "the Punch Bowl," and "Doctor's Island," mark sites where the natural waterway was modified during the Feeder's construction. Finch Island, located at the confluence of the Pequannock and Ramapo Rivers, appears to be another site of significant canal-associated terrain-altering activity. As with the Feeder proper, the Slackwater section also contains structures associated with the 1920s dismantling, such as the Pequannock Spillway and the Pompton Feeder Dam.

4.133 The Pompton Ironworks Historic District, Ludlum Steel Dumpsites #1 and #2 Pompton Falls on the Ramapo River powered iron and steel works during the 18th, 19th and early 20th centuries. The northern terminus of the project area, including both banks of the Ramapo River, in the vicinity of the Paterson-Hamburg Turnpike crossing, contains the remains of a series of historic iron and steel making operations. This site, which includes the remains of a charging tower and hydropower system, is considered NRHP-eligible as an historic district. Two dumpsites, containing artifacts associated with early iron and steel production processes, are located within the project impact zone. The dumpsites should be considered contributing elements to the eligibility of the area as a historic district. Project impact zones upstream of the Turnpike crossing may also contain portions of the Ironworks which have not yet been evaluated.

4.134 Historic Sites and Structures Based on historical accounts of the Kearny Point area, the potential exists for historically significant submerged resources in the Tunnel Outlet site/Workshaft 2C area. Workshaft 2 is located within a quarry that was worked during the late 19th and early 20th Centuries. Some mechanical elements and structures associated with this historic facility may survive.

4.135 Tidal Area Protection Investigations of the impact zones of the following elements -- Kearny Point Levee/Floodwall System, Lister/Turnpike/Doremus Floodwall System, and South 1st Street Levee/Floodwall System -- will be carried out in accordance with the procedures outlined in the PMOA during the Feature Design Memorandum Phase and Plans and Specifications Phase of the project.

RECREATION

4.136 This section addresses the existing conditions at specific sites where surface project elements could affect recreational open space and parks. Assessments are used on the State SCORP.

4.137 Recreational opportunities in the Lower Valley are scarce. Demand greatly exceeds the supply of parks. Harrison and Kearny are in Hudson County which satisfies about one-fifth of its population's recreational demands. There are no residences in the vicinity of Kearny Point, so there is very little demand for recreation there.

4.138 Just across the Passaic River, Essex County has a small recreation deficit at the county level, but most of its parks and open space are located on the Watchung Mountains, resulting in local deficits in other parts of the county. In Newark, the Terrell Homes of the Ironbound neighborhood have expressed concern regarding riverside access. South of Ironbound, industrial land uses predominate and extend all the way down to Port Newark, where there is limited residential demand for recreation. Most waterfront industries are located there to facilitate waterborne transportation, and generally have built their facilities right up to dockside or the water's edge. As a result, there is limited access and limited space by which to provide additional access to the river.

4.139 The Central Basin, compared to the Lower Valley, has many more existing recreational resources and opportunities. Many of the existing lands were acquired through New Jersey's Green Acres Program. Aquatic Park, for example, is just upstream of the tunnel inlet and its land extends upstream along three rivers: the Ramapo, Pequannock and Whippany. The park is owned by Passaic County along with the right-of-way for the tow path from the old Morris Canal which follows up the east side of the Ramapo River. Municipally-owned parkland also exists in the inlet area in Pompton Lakes and includes Feinbloom Field, Wilderness Island Carlo Field, Snodgrass Park and Hirschfield Park, in addition to numerous acres of open space. The specific acreages affected and their Block and Lot numbers are found in Appendix B - Natural Resources, Section 7 Recreation, Tables 1 and 2.

4.140 In the Borough of Fairfield, sand and gravel excavation has created a 50 acre lake, surrounded by land that is badly degraded, with portions covered by roads, derelict structures, and barren, drifting sand. Some residual wetlands remain.

4.141 Other recreational open space in Essex County which was acquired with Green Acres Program funding includes the West Essex Park in the Borough of Fairfield and Livingston Township.

AESTHETICS AND SCENIC RESOURCES

4.142 The aesthetics in the basin are as varied as its land uses. In the Lower Valley, existing aesthetics would most please industrial archaeologists -- as most scenes are predominated by old industrial structures, many of which are derelict. Overall, aesthetics are sterile, man-made, industrial landscapes lacking vegetation. Views improve near the waterfront where one can capture more of the sky and water. The industrial setting at the workshafts and most levee/floodwall systems are not deemed significant aesthetic resources.

4.143 Odors are a negative attribute of the physical setting at the mouth of the Passaic River where levees and floodwalls are planned for Kearny Point and Newark's industrial sections from downstream of the Ironbound Neighborhood to Port Newark. The industrial emissions combined with the odors from the Passaic Valley Sewage Treatment Plant create a negative ambient atmosphere around the mouth of the river and in northern Newark Bay.

4.144 In the Central Basin, where residential land use predominates, aesthetics become more important. The vistas there can be rather bucolic, particularly if the view into wetlands excludes man-made features.

4.145 Noise levels are fairly high throughout the project area because of its intense urbanization. Higher noise levels are found near major transportation routes and industrial and commercial complexes. These levels are significantly lower in residential areas, especially where trees are present in large numbers since they dampen noise levels.

AIR QUALITY

4.146 In accordance with the Clean Air Act and New Jersey's State Implementation Plan (SIP) various regions within the Passaic River Floodplain are designated 'non-attainment areas (NAA)". Non-attainment areas are those regions identified by the Environmental Protection Agency as exceeding the National Ambient Air Quality Standards (NAAQS) for specific criteria pollutants: Ozone (NO_x and VOC/HC), Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Particulate Matter (PM-10), and Lead (Pb).

4.147 The proposed Passaic River Flood Damage Reduction Project is located within a five (5) county are in northeastern New Jersey: Passaic, Morris, Bergen, Essex, and Hudson. The following table identifies those regions currently in non-attainment status for specific criteria pollutants:

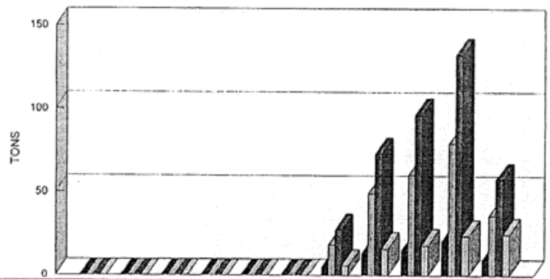
Table 5. Regional Extents in NAAQS/SIP Non-Attainment Status

County	Ozone (No_x or VOC)	CO	SO_2	PM-10	Lead
Hudson	x	x	N/A	x	N/A
Essex	x	x	N/A	Newark Kearny Harrison only	N/A
Bergen	x	x	N/A	N/A	N/A
Passaic	x	Clifton Paterson Passaic only	N/A	N/A	N/A
Morris	x	Morristown only	N/A	N/A	N/A

N/A - Not Applicable. Currently in attainment for specified parameter.

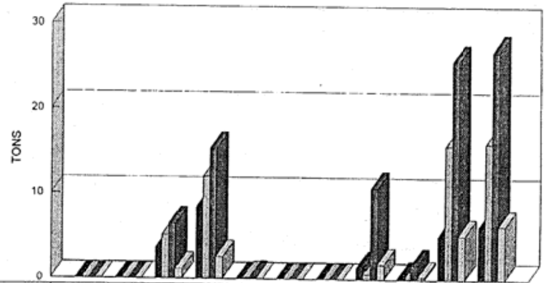
FIGURE 6 - AIR QUALITY PREDICTIONS (BY COUNTY)

SEIS - AIR QUALITY
PASSAIC COUNTY



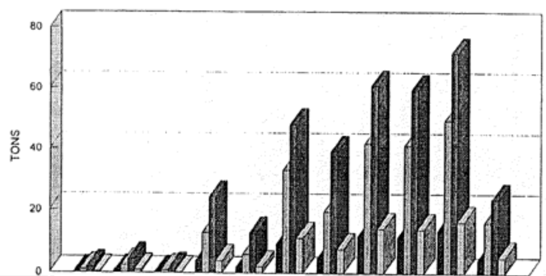
YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
■ HC	0	0	0	0	0	0.007	5.05	13.2	15.2	20.4	9.6
▫ CO	0	0	0	0	0	0.03	18.3	49.2	60.5	79.5	35.8
■ NOx	0	0	0	0	0	0.055	26.9	73.3	96.5	132.8	57.9
□ PM	0	0	0	0	0	0.008	5.82	15.9	18	23.5	24.4

SEIS - AIR QUALITY
MORRIS COUNTY



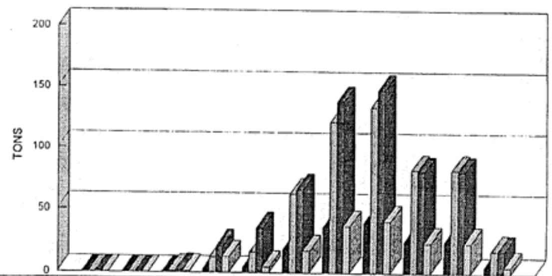
YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
■ HC	0	0	3.63	8.37	0.03	0	0	1.42	0.23	5.1	6.15
▫ CO	0	0	5.14	12.01	0.14	0	0	0.64	0.1	15.77	16.05
■ NOx	0	0	6.44	15.36	0.19	0	0	10.7	1.74	25.69	26.86
□ PM	0	0	1.17	2.57	0.03	0	0	1.76	0.29	5.16	6.24

SEIS - AIR QUALITY
ESSEX COUNTY



YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
■ HC	0.252	0.58	0.17	3.89	1.81	9.06	4.61	11.6	11.4	13.6	4.4
▫ CO	1.02	2.34	0.76	12.86	5.98	32.99	19.43	41.8	41.2	49.5	16.2
■ NOx	1.86	4.27	1.17	24.19	12.67	48.05	39.17	60.9	59.5	71.7	23.6
□ PM	0.375	0.86	0.17	3.82	1.93	11.08	7.642	14.1	13.9	16.3	5.1

SEIS - AIR QUALITY
HUDSON COUNTY



YEARS	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
■ HC	0	0	0.27	2.78	4.14	18.5	36.1	39.6	25.03	25.03	5.6
▫ CO	0	0	1.22	12.25	16.1	62.3	121.9	134.2	82.4	82.4	18.3
■ NOx	0	0	1.81	20.98	35.22	65.7	138.4	147.8	81	81	17.9
□ PM	0	0	1.23	12.74	4.41	17.3	36.9	40.9	24.1	24.1	5.4

FIGURE 6

INTRODUCTION

5.00 This chapter presents the effects of the Passaic River Flood Damage Reduction Project on the environmental resources described in Chapter 4. The focus is on the environmental effects of the realigned tunnel on Newark Bay, and updated evaluations based on studies performed since the 1987 report was published. The interested reader is referred to appropriate appendices for more details.

SEISMOLOGY

5.01 The surface works have been designed to resist an appropriate level of shaking including an earthquake load case using the pseudo-static method and an acceleration of one tenth the force of gravity. Experience with more seismic areas of the world has shown that underground structures are very resistant to earthquakes.

REGULATED SUBSTANCE SITES

5.02 Qualitative analyses were performed as to the magnitude of risks that would occur from occupational exposure to contaminated soil, groundwater, or surface water. The results were used to evaluate potential health risks during the construction and operation of each project feature. The data were also compared with New Jersey Department of Environmental Protection (NJDEP)and U.S. Environmental Protection Agency (EPA) criteria for contaminant levels in environmental media. The soils data were also compared to NJDEP criteria governing soil reuse and disposal. Groundwater data were analyzed as to NJDEP and EPA regulations for water quality and effluent discharges to surface water. The results of the substantive evaluation of regulated sites are included in Appendix F of the Main Report - Hazardous Toxic and Radioactive Waste.

5.03 The comparisons allowed for an evaluation of requirements for special handling due to the presence of contaminants. Special handling for soils would include disposal or restrictions on reuse. Handling for pumped groundwater would include removal of contaminants prior to its discharge to surface water. The results of these evaluations are included in Appendix F - Hazardous, Toxic and Radioactive Waste.

5.04 The project features were designed to minimize excavation of soils and seepage into the tunnel and thus reduce the possibility of contaminated soil disposal and/or groundwater effluent treatment. Excavation of soil beneath levees will be minimized and I-type sheetpile floodwalls will be used to minimize excavation. Contaminated soils with values above the most stringent soil cleanup criteria, but below Toxic Characteristics Leaching Procedure (TCLP) will be reused on the site, if possible. Soils with contamination levels above the TCLP are characterized as hazardous as defined by the Resource Conservation and Recovery Act and will be managed as such. Disposal, reuse and treatment of NJDEP regulated materials were discussed and agreed to by NJDEP and USACE in a November 24, 1994 meeting (See Appendix F - Hazardous Toxic and Radioactive Waste - Section F-1 for a Memorandum for the Record of that meeting.

5.05 Occupational exposure cancer risks and non-cancer health hazard index values were estimated for several of these regulated sites, including the intrusive field-investigation locations. The calculated values suggest that dermal-contact exposure to contaminants at the investigated work sites would pose low to negligible cancer and non-cancer health risks. Nonetheless, during further investigations and/or construction activities, the appropriate personal protective equipment shall be worn, removing any potential health risks.

5.06 Once the contaminant evaluations were determined to require special handling, an incremental cost estimate for special handling and further investigation was calculated for each feature. The estimates include costs for sampling and analysis, treatment, transportation, and disposal, as required. The incremental costs for each feature were summarized to yield a total incremental cost for the project of 28 million dollars. The detailed estimate is in Appendix F - Hazardous Toxic and Radioactive Waste Report, Section F-1.

5.07 The evaluation of this data indicates that several features may require additional field investigations to further characterize potential contamination: i.e. Workshafts 2A, 2B, 2C, and 3; Pinch Brook Levee; Doremus Avenue, Kearny Point, Lister Avenue, and Newark Bay Levee Systems; and Great Piece Weir and Pequannock River Channel Modifications. The recommended site-specific investigations will be performed during future design studies to fully assess the impact of contamination. These focused investigations would provide the basis for more accurate cost estimates that would be attributable to the presence of contamination at each feature location.

5.08 The hazardous substance effects discussed above were developed primarily in accordance with agreements reached at the November meeting with NJDEP. See Appendix F - Geotechnical Design for a Memorandum for the Record of this meeting.

GROUNDWATER QUALITY EFFECTS

5.09 It is not anticipated that the construction or operation of the tunnel or other project features will have any significant adverse effects on groundwater quality.

5.10 Construction The groundwater models indicate that there would be negligible induced drawdown effects in overburden groundwater during tunnel construction and/or operation. Therefore, existing shallow groundwater contamination is not expected to affect the project and the project is not expected to affect the existing contamination, unless the contamination has already migrated downward into bedrock.

5.11 Known groundwater contamination discovered near Workshaft 2B exists in a highly permeable zone along a bedding plane fracture in the soft bedrock. The tunnel and workshaft would intersect this zone. Groundwater that does enter the workshaft or tunnel will be treated if necessary, prior to discharge to a surface water body. The full extent of the issue cannot be estimated because the source of contamination is unknown. All other shaft and inlet locations where groundwater samples were collected showed minor or no contamination. During construction, sheet piling, slurry trenches or freezewalls would be used to prevent seepage from the overburden soils into the excavation for shafts and surface structures.

5.12 Operation Once the tunnel is built, water would be maintained in the tunnel at sea level. This will, in effect pressurize the lower half of the tunnel and reduce the inflow of groundwater. Groundwater inflow into the entire tunnel will be limited by grouping and placement of a 15 inch thick concrete liner.

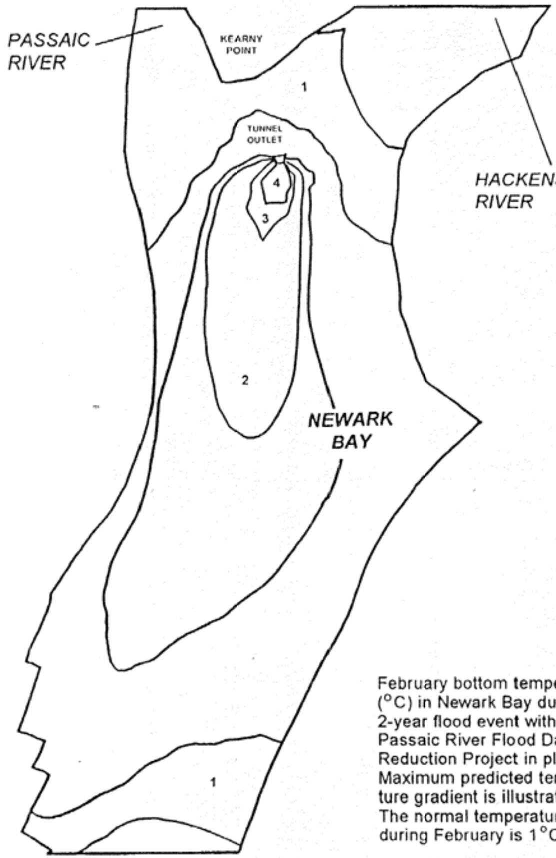
5.13 Groundwater Quantity Effects Through the use of engineering controls during construction and operation, it is not anticipated that the tunnel would have any significant adverse effects on groundwater resources. Seepage into the completed tunnel, after grouping and liner installation, is estimated in the range of 1,000 to 2,000 gallons per minute or 1,440,000 to 2,880,000 million gallons per day. This flow, for the entire 20 mile tunnel length, is about equal to the output of a single high capacity municipal or commercial well and not deemed significant. Since drawdowns in the overburden aquifer are estimated to be minimal, no significant adverse effects to the capacity of shallow wells would be expected. See Appendix E - Geotechnical Design - Section 2.

SURFACE WATER QUALITY EFFECTS

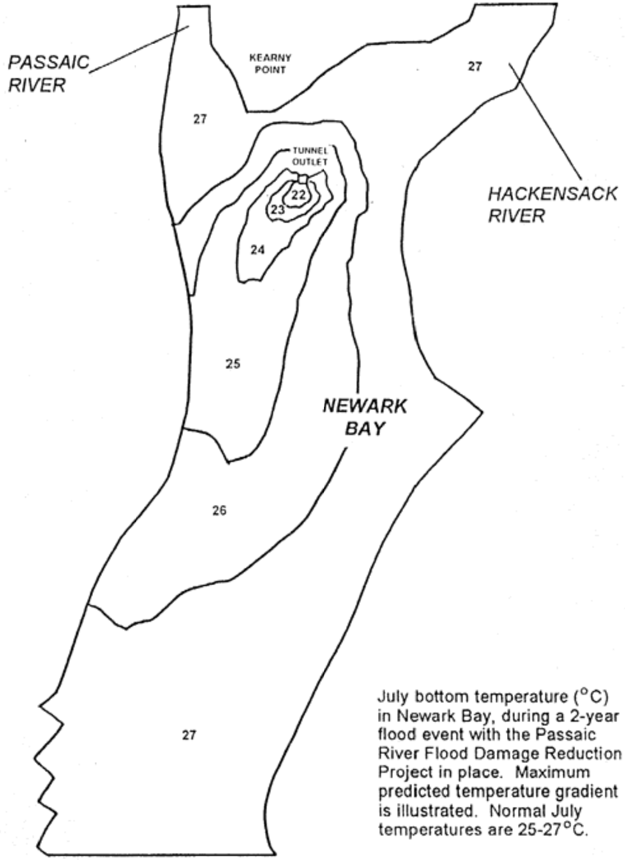
5.14 An evaluation of the effects of the discharge of fill material, necessary for project construction, into the surface waters of the Passaic River Basin (including wetlands) is consistent with guidelines promulgated through the Clean Water Act Section 404(b)(1) concluded that: (1) the majority of areas where channel cuts are proposed have no identified or suspected contaminants, therefore, no adverse impacts to the water bodies are expected; (2) in areas where contaminants are suspected, engineering controls such as cofferdams, silt screens and soil filter fabrics will be used for its management, in accordance with its classification; (3) State regulations and agreements would eliminate potential contamination of State waters; and, (4) the use of appropriate and practicable discharge conditions which would minimize unavoidable adverse effects of discharges on the aquatic ecosystem, would include the use of habitat replacement or restoration of wetlands and aquatic resources, as appropriate.

5.15 Tunnel Water Quality The Stevens Institute's experiments focused on the quality of the water in the tunnel during the estimated two year interval between storm events. Results of the stormwater experiments carried out under anaerobic conditions indicate dissolved oxygen concentrations of floodwaters were adequate to meet ultimate oxygen demand for stored tunnel water. During the course of the experiments, attempts were made to measure the immediate oxygen demand. However due to the low BOD of the stormwater, no immediate drop in the dissolved oxygen could be detected. The time history of pH and BOD of the reaction medium indicate that there is initially a drop in BOD_5 during the first month of operation. However, thereafter the BOD_5 remains essentially constant within the experimental error associated with its measurement. The pH drops initially from 8.7 to 6.8-6.9 and then remains fairly constant. These data indicate, that initially (during the first month) some aerobic biodegradation took place, but after the initial time period, no biodegradation under reduced oxygen atmosphere (anaerobic situation) occurred. Additionally, there was no noticeable gas production under anaerobic conditions. Gas analyses on samples confirmed that H_2S and CH_4 were not detected. This indicates that the collected stormed water did not undergo any anaerobic biological transformation during the duration of the study. Similarly, there was no noticeable gas production by the experiments used to simulate the effect of ocean water seepage. The data indicated the supply of biodegradable material in flood water, isolated in the tunnel between flood events, would be consumed before dissolved oxygen is depleted. As a result, anaerobic degradation and the chemically-reduced end products, such as sulfide or methane are not expected.

FIGURE 5 (a) - BOTTOM TEMPERATURES OF NEWARK BAY WITH PROJECT (2-YEAR FLOOD EVENT)



February bottom temperature (°C) in Newark Bay during a 2-year flood event with the Passaic River Flood Damage Reduction Project in place. Maximum predicted temperature gradient is illustrated. The normal temperature during February is 1°C.



July bottom temperature (°C) in Newark Bay, during a 2-year flood event with the Passaic River Flood Damage Reduction Project in place. Maximum predicted temperature gradient is illustrated. Normal July temperatures are 25-27°C.

FIGURE 5 (b) - SALINITY LEVELS IN NEWARK BAY WITH AND WITHOUT THE PROJECT (2-YEAR FLOOD EVENT)

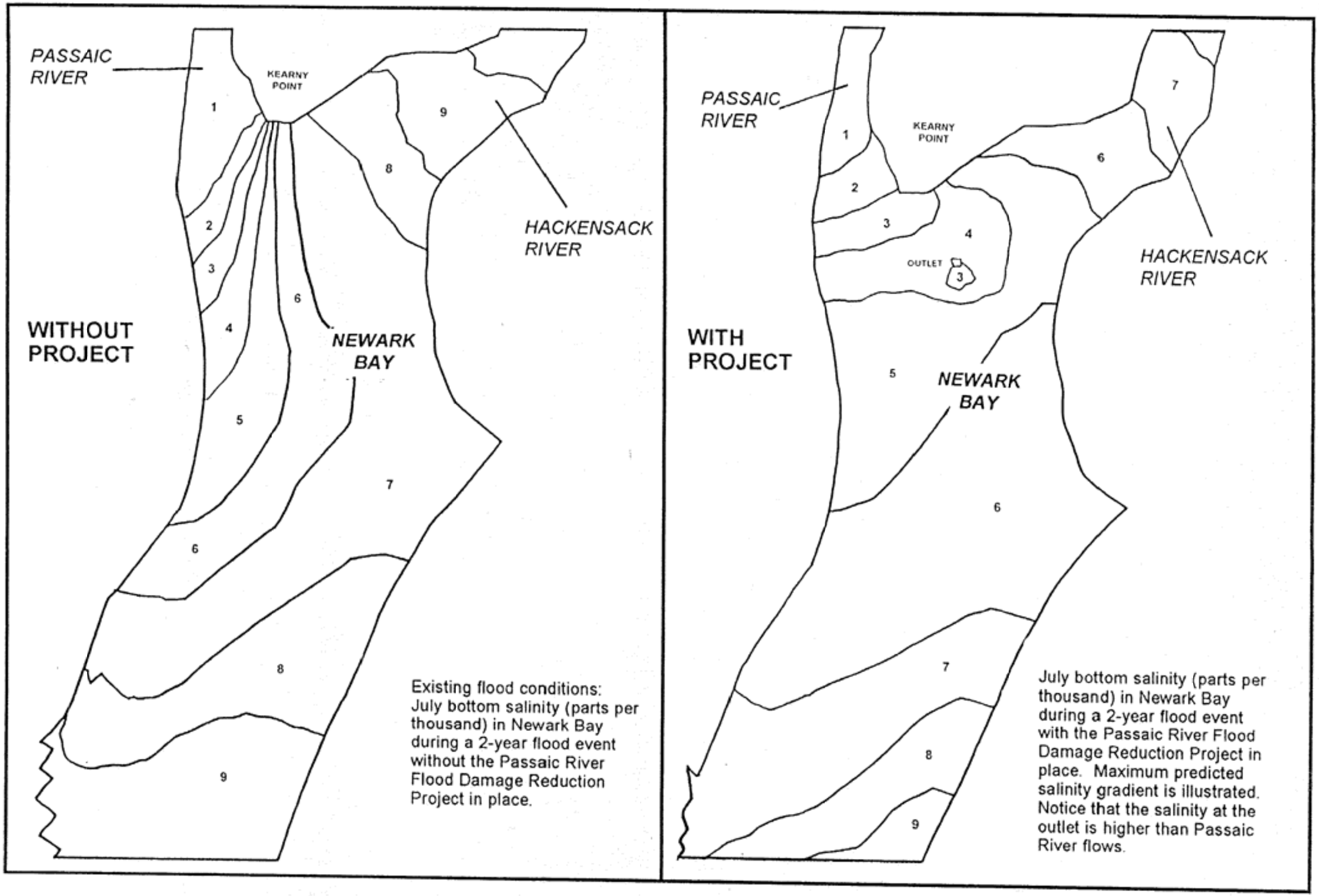
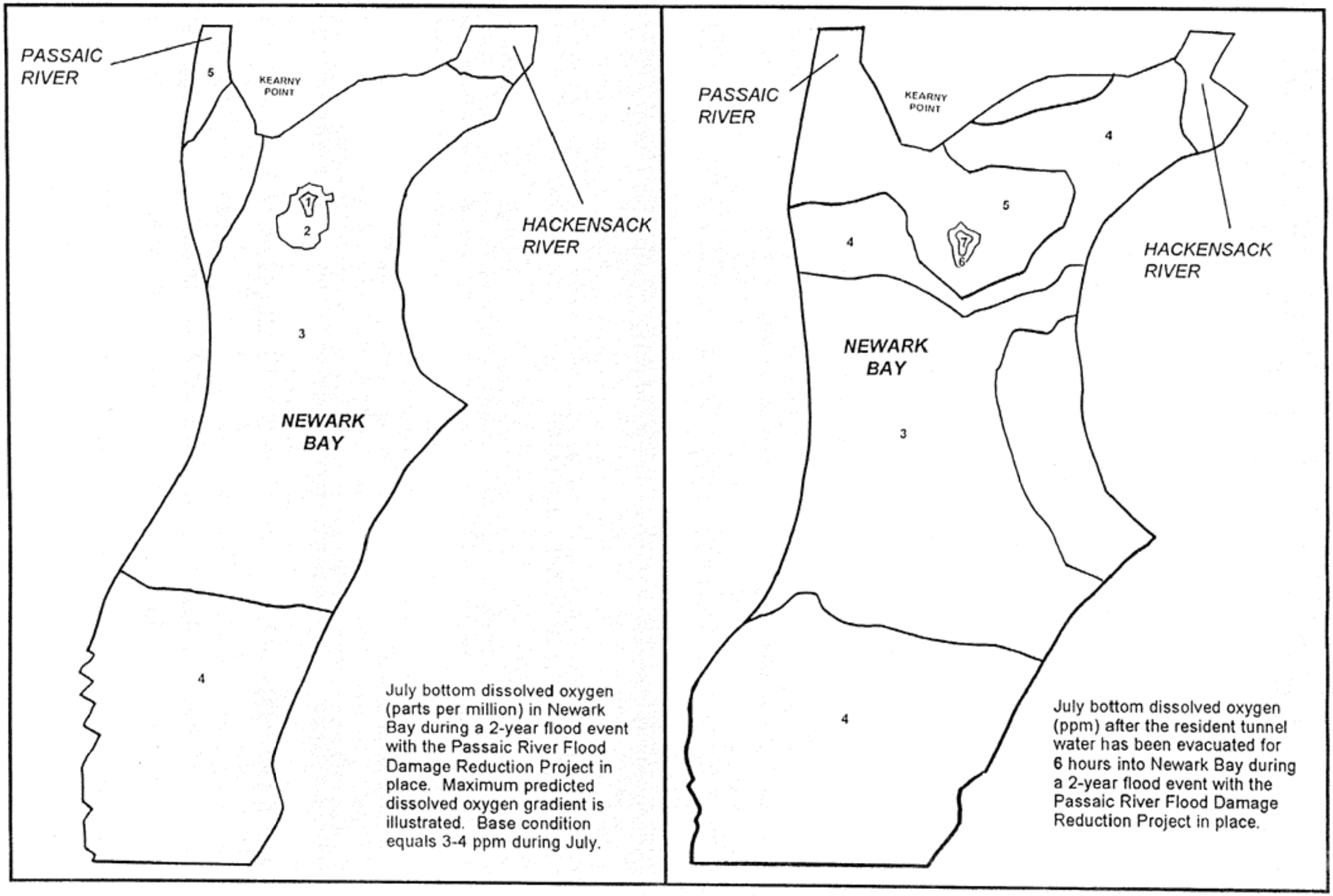


FIGURE 5 (C) - DISSOLVED OXYGEN IN NEWARK BAY WITH THE PROJECT (2-YEAR FLOOD EVENT)



July bottom dissolved oxygen (parts per million) in Newark Bay during a 2-year flood event with the Passaic River Flood Damage Reduction Project in place. Maximum predicted dissolved oxygen gradient is illustrated. Base condition equals 3-4 ppm during July.

July bottom dissolved oxygen (ppm) after the resident tunnel water has been evacuated for 6 hours into Newark Bay during a 2-year flood event with the Passaic River Flood Damage Reduction Project in place.

5.16 Newark Bay Water Quality Water quality analyses evaluated a two-year storm, the minimum storm which will cause operation of the tunnel a 25-year and a 100-year storm to examine the effects of the tunnel discharge on the receiving water. Analyses emphasized February and July, to provide worst-case conditions for examination of temperature shock from water stored in the tunnel at 12.7 degrees Centigrade (55°F). The model results for salinity, temperature and dissolved oxygen predictions are detailed in the Appendix C - Hydrology and Hydraulics, Section 31.

5.17 The results indicate the effects of the discharged water is limited to the immediate vicinity of the tunnel outlet. The worst case conditions are presented in Figures 5a-c for temperature, salinity and dissolved oxygen. During July, minimum dissolved oxygen with the tunnel in place will equal or exceed minimum dissolved oxygen conditions within half a kilometer (about 1,600 feet) of the outlet (Figure 5c). During February, minimum dissolved oxygen depression due to the tunnel is more excessive than July, due to ambient concentrations, but the severe oxygen depletion 2 mg per litter, is limited to the outlet itself. The models' predictions indicate the effect due to the discharge of oxygen-depleted water stored in the tunnel is limited in extent and duration, with the oxygen levels dropping below two parts per million only in the immediate vicinity of the outfall and persisting for about six hours. This is due to the effects of dilution and reaeration. The volume of stored water -265,000,000 cubic meters -- is small relative to the volume of Newark Bay, which consists of approximately 11,600,000,000 cubic meters. Consequently, the oxygen-depleted water effectively disappears when mixed with the much larger bay volume. The duration is minimized by the large volumes of additional dilution flood water that follows the discharges. Areas over which the maximum temperature differences would occur are also small, and would last for less than four hours (Figure 5a). It is noted that 25-year and 100-year storms generate volumes of fresh water that are so great that salinity dips to 0, and the tunnel would produce no significant change from existing flood conditions. Models indicate that a 2-year July flood, considered worst-case, for salinity, would reduce, salinity to 0 for about two hours in a very small area (Figure 5c).

COASTAL ZONE

5.18 No significant adverse effects will occur as a result of the flood control plan. Please see the Coastal Zone Act Consistency Determination in Addendum 2. Resources which would not be affected by the project but are of special interest to those managing coastal resources are discussed in Addendum 2 - Determination of Compliance. In addition to those discussions, other natural resources within the domain of coastal resources which could be potentially affected by the project, but also have a wider sphere of interest are discussed in this Supplement 1 to the environmental impact statement. These include recreational resources, open space and public access to the waterfront, and the Bay's biological and cultural resources.

5.19 There would be no significant adverse effects in Newark as a result of the project. The tidal levees and floodwalls, designed to protect predominantly industrial land, would limit access to the river. Recreational access would be maintained in areas adjacent to residential development in Newark's Ironbound Neighborhood, and in Harrison adjacent to the South 1st Street levee/floodwall where a fishing and boat launching platform would be built. Industries requiring waterfront access would have it provided through special floodwall openings.

FISHERY RESOURCES EFFECTS

5.20 Project effects on fishery resources have not changed significantly during Preconstruction Engineering and Design (PED) studies. Redesign of the inlet and its approach channels, at a lower elevation cause changes primarily in location rather than in magnitude. Water levels in modified channels would increase as a result of the lowered inlet structure and channel excavation.

[redacted]

5.23 Channel deepening would remove 6,600 feet riffle/pool sequences reducing structural diversity and stream aeration. The addition of riprap to armor modified river channels will provide 2,200 feet of benthic invertebrate habitat, minimizing these losses. Fishery community exchanges of riffle/run species such as the tesselated darter with pool species, such as sunfish, are considered a direct project losses.

5.24 The loss of streambank vegetation and undercut banks forecast in the 1987 FEIS has been reduced by restricting construction cuts to the north and east sides thereby minimizing shade loss and increasing summer water temperatures. This realignment of channel modifications, where possible, to maintain riparian vegetation on west and south banks minimizes effects on shade and food sources. Studies planned for the Final Design Memorandum (FDM) phase of planning will include an in depth analysis of any in temperature increase to sensitive species (e.g. trout) to determine if lethal thresholds are reached and, if so, additional mitigation designs to offset the increase.

5.25 The Habitat Evaluation Procedures, analysis of the evaluation species, did indicate significant changes in expected carrying capacity with project implementation. The habitat units for the brown trout increased from 7.0 units to 15.2 as the mean habitat scores remain approximately the same and wetted habitat expanded from about 17 acres to over 33 acres. A review of the life requisites for the brown trout indicates it can do well in pool environments. Thus, physical effects from channel modifications and placement of riprap are projected to have no net adverse impact on the species selected for evaluation.

5.26 Wanaque River Design refinements on the Wanaque are similar to the Pequannock. The elimination of the Hill court levee/floodwalls and restriction of channel work reduces loss of shade on the river. Temperature and community change concerns are the same as for the Pequannock River. However, losses of riffle communities are expected to be severe. Channel modification would remove 4,000 linear feet of riffle/run habitats. Methods to address these concerns are similar.

5.27 Channel depths would increase with project refinements. However, these changes do not substantially increase the length of river that would become pool-like. Instead, the slope of the river bottom, from its upstream terminus to its confluence with the Pequannock River, is increased to allow the channel to meet the lowered Pequannock River.

5.28 Habitat Analysis Procedures for the Wanaque fishery indicate no adverse effects to the selected species as a result of structural work on the stream. The fishery was represented by the adult brown trout, adult smallmouth bass, and spawning smallmouth bass. Brown trout exhibited a negligible increase in habitat units from 3.9 to 4. This was the result of the increase in total habitat available, which offset the loss in the mean habitat suitability score.

5.29 The analyses for the adult and spawning smallmouth bass, indicate that the total mean habitat score for both life stages increase -- 0.3 to 0.4 and 0.2 to 0.5 respectively. Likewise, the habitat area available also increases from 7.5 to 10.2 acres. This combination of increases in habitat score and wetted area raises the habitat units from 2.5 to 4.1 for adult smallmouth bass, and from 1.7 to 4.8 for spawning smallmouth bass. A review of the life histories of this species an explains these increases. As with the trout, bass does well in a pool environment. The addition of 330 feet of riprap to the excavated reach also augments structural preferences of the bass.

5.30 <u>Ramapo River</u> Effects in the Ramapo River would be less severe than the Pequannock or Wanaque Rivers because the Ramapo is slower-moving except in the 800 feet downstream of the Paterson-Hamburg Turnpike bridge. Therefore, effects associated with channel deepening would be minimal. Since 1987 the elimination of the Shore Road Levee System reduced the adverse effects to natural areas and shade.

5.31 The Habitat Evaluation Procedures for the Ramapo River indicates no adverse effects to either smallmouth bass adults or bluegill adults. In fact, the results show that the mean habitat score for adult smallmouth bass and adult bluegill remain virtually unchanged. Small increases in habitat units are a result of habitat expansion from 12 to 14 acres for both species as a result of deepening and widening the stream.

5.32 Spawning, habitat units for both of the smallmouth bass and bluegill, decreases in from 0.5 to 0.4 and 0.7 to 0.6, respectively. The smallmouth bass decrease is a result of dredging beyond optimal depths. Riprap would be used to armor the Ramapo channels; 5,500 feet, lessening the spawning value for bluegill. This is not deemed significant due to the small change in HEP values.

5.33 <u>Pompton River</u> Since the 1987 FEIS, changes in structural work in the Pompton River now includes approximately 1,600 feet of channel which will be modified within banks to insure efficient flow of water into the Passaic spur tunnel inlet. The Pompton River also contains sections which provide mitigation sites for unavoidable project-related impacts in the three upstream rivers.

5.34 Secondary project effects will occur during the tunnel's operation. During floods, 4,300 cubic feet per second (cfs) will bypass the main inlet and flow down the Pompton River. The 1987 plan bypassed only 500 cfs downstream. The larger volume reflects refined hydraulic design which promotes natural scouring and sediment transport within the system to enhance fishery habitats. However, some sediment accumulation will occur upstream of both inlets on the Ramapo and Passaic Rivers. There will also be some minor reduction of scouring in the Pompton River. Operating details are presented in the Hydrology and Hydraulics, Appendix C, Section 28.

5.35 Passaic River Additional flow of up to 8,800 cubic feet per second (cfs) during the 100-year event passing by the spur inlet would minimize adverse effects in the Passaic River. A 6,600 foot pilot channel now included for the Passaic River to move sediment from the spur inlet would have no adverse effects due to its relatively small size and the low quality of the fishery at this site. Rather, it provides increased structural diversity to a relatively uniform channel.

5.36 Rockaway River and Whippany River The levee and floodwall systems along the Rockaway River have not changed since the 1987 report. Aquatic systems are not significantly impacted by these structures. The Whippany River, in the Borough of East Hanover, would receive minor impacts from construction of a levee/floodwall ponding area. Adverse effects are limited because riparian vegetation consisting of emergent species does not provide significant shade to the stream.

5.37 Limitation of HEP Predictions The Habitat Evaluation Procedure (HEP) was based on a relatively small number of variables and emphasized species of to anglers, interest i.e. trout, bass and other sunfish. These constraints entail a number of assumptions that need to be carefully considered. Because results were species-specific, they should not be used to make inferences about how the larger fish community would respond to the project's large-scale habitat changes. Construction will convert about 95% of the Wanaque River and 80% of the Pequannock River in the project area from a system of riffle\pool\run habitats to near lakelike conditions. This effect is likely to result in reductions or near-elimination of riffle species such as the tesselated darter, cutlips minnow and, perhaps, the blacknose dace. In contrast, species that can do well in slow-moving or standing water would probably increase as indicated by the HEP increase as substrate size increase with the lining of the channel with cobble-sized rock. The expanded pool area also played an important part in affecting scores for these species, illustrating how large changes in a single variable can influence overall habitat scores when models consist of a relatively small number of variables. Thus, while habitat values actually increased for some species substantial changes in the composition of the fish community are likely.

WETLAND RESOURCE EFFECTS

5.38 The adverse effects described in the 1987 report have been significantly reduced during this design phase from over 905 acres to 95. This was achieved through redesign and lowering of the tunnel's inlet, thereby eliminating levees originally required upstream of the inlet along the Pequannock and Wanaque Rivers. Ponding areas in wetlands behind levees and floodwalls have been equipped with pumps and closures for drainage culverts to control interior hydrology allowing regulation of wetland inundation while retaining evacuation capability to prevent interior flood damages. Other reductions were accomplished by relocating the Great Piece Meadows weir closer to the spur tunnel inlet and by expanding hydrological control in Great Piece Meadows wetlands through the raising of the weir to elevation 166 above sea level. Comparison of 1987 and 1995 Project Effects on Wetlands Acres by project element is in Appendix B Natural Resources, Table 2.14.

5.39 Remaining wetland losses include 67 acres of forested wetlands, 18 acres of palustrine scrub/shrub and palustrine scrub/shrub-emergent wetlands, and 10 acres of palustrine emergent wetlands. These direct losses are related to structural elements while indirect effects are occurring due to changes in inundation.

5.40 Specific Areas of Concern: Great Piece Meadows The Great Piece Meadows is the wetland closest to the spur tunnel inlet and the one which would potentially suffer the greatest adverse effects from the tunnel's operation. During a large flood, when the tunnel inlet is open, the wetlands could, theoretically, be drained, thereby preventing their required periodic flooding. For this reason, as well as for engineering concerns, the Great Piece Meadows weir was included in the 1987 report to control stream hydrology during tunnel operation.

5.41 The weir location and design was coordinated with resource agencies, especially the U.S. Fish and Wildlife Service. As part of the design effort, the Service and the Corps conducted a plant successional model for the Meadows. It was performed to determine potential impacts and if the weir could protect upstream wetlands.

5.42 Modeling indicated minor changes to understory plant species that exist around the edge of Great Piece Meadows within the one-year floodplain. Due to the flat nature of Great Piece Meadows, the one-year floodplain encompasses about 60% of the area. The influence of the weir, as proposed in the 1987 report, was lost about halfway between Two Bridges and Horseneck Road. In order to increase the weir's influence, additional studies were conducted to determine if the weir's height could be raised without creating damaging water levels in the Horseneck Road community. The results indicated that the weir could be raised to a height of 166 feet and allow expansion of wetland inundation to the vicinity of Horseneck Road to insure the integrity and productivity of Great Piece Meadows -- or an increase to 80% of the meadows.

5.43 Ponding Area Wetlands Project ponding areas are mainly forested wetlands. The 1987 report called for these wetlands to be excavated to increase storage capacities. Redesign reduced wetlands adversely affected by interior drainage ponds from 599 acres to 6 acres. A coincident rainfall/runoff/river stage analysis in conjunction with the use of pumps and operating methods associated with the closure structures (flap valves and sluice gates) enabled redesign to insure that vegetation in the interior drainage ponds would be maintained in its existing condition (Appendix C- Hydrology and Hydraulics, Section 35.5).

5.44 Tunnel Inlets and Workshafts Wetlands destroyed by the inlets and workshafts comprise 19 acres. They include 6 acres at the Passaic Inlet and 13 acres at tunnel access sites. They consist of 12 acres of palustrine forested, and 7 acres of palustrine scrub/shrub wetlands.

5.45 Non-Tunnel Elements Elements not integral to the tunnel account for the balance (32 acres) of the wetlands affected, including 3 acres at the Pinch Brook levee system, 12 acres at Passaic Levee 2A, 10 acres at the Rockaway levees, and 7 acres at Passaic Levee 10. Habitats affected for these elements include 22 acres of palustrine forest, 4 acres of palustrine scrub/shrub, and 6 acres of palustrine emergent wetland.

5.46 Passaic Levee 10 Wetlands The flood protection provided by the spur tunnel falls off upstream of Great Piece Meadows, so levees are needed to provide flood protection upstream of that point. The Passaic 10 levee system will cover about 18 acres. The levee footprint covers 8 acres, of which 4.8 acres are wetland. In addition, another 2.2 acres of adjacent wetlands will be lost due to construction activities. Impacted wetland cover-types include 5.5 acres of palustrine forested, 0.7 acres of palustrine scrub/shrub and 0.8 acres of palustrine emergent wetlands.

5.47 Channel Modifications Thirty-eight acres of wetlands would be lost upstream due to the construction of the main inlet structure specifically, 15 acres would be lost to channel widening and deepening; 6 acres lost to levees and 17 acres lost to a new bypass channel (specific cover-types are identified in Table 5.7.a.5.).

WILDLIFE RESOURCES EFFECTS

5.48 Wildlife resources in the Basin are considered to be critical because of their relative scarcity due to degree of basin development. A reduction in project effects on the wildlife resources coincides with elimination of some ponding areas, retention of ponding site vegetation, and maintenance of wetland hydrology associated with reduction of wetland impacts since the 1987 report. Affected wildlife resources consists primarily of palustrine wetland. Coordination with the New Jersey Forest Service revealed that no known specimen trees will be affected by the project.

5.49 Primary impacts to the resources ability to support species's occurs to wood frog habitat as a result of project conversions of 67 acres of forested wetlands. Calculated over the construction period and the life of the project, this loss equates to reduction of 7,035 units of wood frog forested wetlands habitat. The green heron and muskrat losses occur from impacts to 18 acres of palustrine scrub/shrub and scrub/shrub emergent wetland and 10 acres of palustrine emergent wetland for a total of 28 acres. These translate into 1,890 units of green heron and 1,050 units of muskrat habitat over the construction period and the life of the project. These units provide a measure of the value of the habitat that must be acquired in wetland mitigation plans to meet wildlife needs. Those plans are presented in the Environmental Resources Appendix B, Section 3.

ESTUARINE RESOURCES EFFECTS

5.50 The project will not adversely effect coastal resources. Effects on Newark Bay from project construction will convert about 3.2 acres of bay bottom to a reef community.

5.51 Anadromous Fish - Finfish Migratory Pathways Effects on migratory fish will not be felt under normal circumstances with the project in place. Tunnel operation has a potential to affect these species during their movements in the bay prior to upstream mitigation to the spawning area. However, bay circulation during tunnel operation mimics natural hydraulic conditions during a flood. Therefore, this impact is not considered to be significant based upon an intensive biological survey of the bay and extensive modeling results.

5.52 Marine Fisheries The appearance of marine fish which utilize this estuary linked to the seasonal cycle to which they are adapted. Adverse effects will not occur during normal circumstances. Only when the tunnel operates will the potential for effects exist and, even then, ensuing flood conditions mimic those that would occur under natural flood conditions. Therefore, effects to marine fish from operation of the tunnel are not considered significant (NMFS).

5.53 Newark Bay Fisheries Resources Analyses of model results was based on the 2-, 25- and 100-year floods to provide a full range of impact contrasts. The evaluation of effects on biota in the water column is complicated by considerations of mixing. As species are entrained into the tunnel effluent, the tunnel water, by conservation of mass constraints, is diluted. Maximum effect will be felt by sessile or structure oriented organisms over which the undiluted tunnel water will flow. Further, the assumption was made that the maximum impact will occur when anoxic water residing in a wet tunnel (55° F) is released and the temperature differential with ambient is greatest; i.e., 34°F and 82°F for February and July, respectively.

5.54 Many of the species of Newark Bay are highly mobile and will usually be able to avoid deleterious conditions. However, strictly demersal and structure oriented species may be unable to escape adverse hydrological conditions, e.g., grubby, Myoxocephalus aenaeus; tautog, Tautoga onitis; cunner, Tautogolabrus adspersus; rock gunnel, Pholis gunnellus; goby, Gobiosoma sp; winter flounder, Pleuronectes americanus; hogchoker, Trinectes maculatus; American oyster, Crassostrea virginica; softshell clam, Mya arenaria; horseshoe crab, Limulus polyphemus; mantis shrimp, Squilla empusa; etc.

5.55 Ichthyoplankton will be entrained into the tunnel effluent as mixing (dilution progresses), thus mortality is difficult to quantify.

5.56 The benthic community within a possible zone of impact will be exposed to the maximum gradient. Longer lived species are generally molluscs and can withstand short-lived gradients by "clamming up". Short-lived species (worms and crustaccea) should be able to quickly recolonize areas experiencing mortality.

5.57 The floodwater, instead of pushing down the Passaic and gradually diluting the salinity of the water, will enter as a freshwater plume that would drop salinity rapidly in the immediate vicinity of the tunnel outlet. At the 100-year event this effect essentially replicates natural conditions during floods. Thus, the operation of the tunnel does not increase osmotic stress to the resident organisms. The two year existing event does not; however, completely remove salinity from the bay, and with the tunnel, the area effectively reduced to 0 parts per thousand is small and the duration is short. (Figure 5(b)). Since this is a naturally occurring phenomenon, species occupying the estuary either are tolerant of such occurrences or die, and later recolonize the area after a return to normal conditions. The tunnel effects in this regard essentially mimic existing conditions.

5.57 It is assumed that rainfall temperature is the same as ambient water temperature, i.e., 34.0°F and 82.0°F for February and July, respectively. Thus there is no temperature change in the absence of the tunnel. Model results for the project are therefore net results. Maximum magnitude and areal coverage of bottom temperature gradients for February and July due to the project are illustrated in Figure 5(a). Areas over which the temperature difference is greater than 7.0°C are small. Such gradients last less than four hours. Major components of the biota living in Newark Bay, especially in the vicinity of the outfall, are adapted to sharp changes in environmental parameters and are therefore unlikely to be adversely affected by such a small, short-lived change in temperature.

5.58 According to the model results, dissolved oxygen levels drop below 2.0 parts per million (ppm) only in the very immediate vicinity of the outfall (Figure 5 (c)). The low DO conditions persist for about six hours - the time it takes to empty the resident tunnel water. As soon as the tunnel water is evacuated, the area in the vicinity of the outfall experiences above ambient DO (Figure 5 (c)).

5.59 <u>Newark Bay Water Quality Effects Conclusions</u> Assuming the veracity of the model, it is unlikely that the tunnel will cause any substantial mortality of fish or ichthyoplankton and very little mortality to benthic fauna.

RARE, THREATENED AND ENDANGERED SPECIES EFFECTS

5.60 Literature searches, coordination with Federal agencies responsible for these species, and biological sampling did not reveal the presence of any of these species in project areas. However, given that evidence of breeding Indiana bats in the project area is a recent discovery (Summer, 1995), and substantial additional investigation will be necessary to determine the potential effects of the proposed project on Indiana bats. The Corps will continue consultation with the Service, throughout the next study phase. This will allow time to conduct the additional studies necessary to determine the suitability of the project area for Indiana bats, and if necessary to identify measures to avoid adverse impacts.

5.61 State Endangered Or Threatened Species Thirty-six rare plant and animal species on the state list have been identified in the general project area. Twenty-four exist relatively close to project elements. Only the yellow lampmussel is expected to be adversely affected during channel modifications.

5.62 Generally, the project as configured will have only minor impacts on listed species. Some of the changes would be beneficial. Tunnel reduction of depths of wetland inundations can have a positive impact on the wildlife. These effects include the elimination of drowning and the need for various species to migrate to higher ground. Such migration often involves traversing roadways where species are subject to being hit by vehicles. Both of these occurrences can depress various species of wildlife including endangered ones such as the bluespotted salamander (*Ambystoma laterale*).

SOCIOECONOMIC EFFECTS

5.63 Nine houses would be adversely affected by the project. Three houses near the spur inlet tunnel on Fairfield Road in Wayne would be removed for the inlet structure. On Camp Road in Wayne, six other houses would be raised to allow the annual flood to bypass the tunnel's inlet and flow down the Pompton River without flooding.

5.64 A significant beneficial effect of the project would occur during construction as project expenditures would generate economic activity. Because Federal funds would provide most of the funds to construct the project, regional construction effects alone outweigh the burden of financing the non-federal share of costs. Project construction will generate an annual average of approximately 1,450 jobs in the State of New Jersey and Southern New York. Annual output will increase by more than $154 million including wages of $41 million -- again with almost all of the impact in the twelve-county region.

EFFECTS ON HISTORIC AND CULTURAL RESOURCES

5.65 Primary impacts resulting from the actual excavation of the tunnels are not foreseen because the work is being conducted many feet below the surface. Primary impacts to cultural resources resulting from the construction of the two tunnels are anticipated only at elements constructed to conduct floodwaters into the inlets (such as levee/floodwall systems and channel modifications), at the tunnels' inlets and outlets, and at work (or vertical) shafts. There should be no impacts associated with the creation of ponding areas and pumping stations so long as excavation of the ground surface does not occur. Secondary impacts from tunnel systems/upper basin elements may be associated with access roads and staging areas. Impacts associated with upper basin levee borrow pits have not been evaluated.

5.66 Main Tunnel Inlet The land surface at the location of this element has been completely destroyed. This area has no potential for prehistoric site preservation. No impacts to prehistoric cultural resources are anticipated.

5.67 Spur Tunnel Inlet Historic properties adjoining the Pompton Inlet include structural and landscape elements contributing to the eligibility of the NRHP-listed Morris Canal. These are the Pompton Feeder Lock Site, the Locktender's House Site, the Feeder Dam, the towpath, Finch Island guardbank, and a small section of engineered channel that forms part of the Ramapo River Slackwater Canal. As presently positioned, the inlet will have no direct impact on these. Secondary impacts could occur as a result of placement of staging areas or access roads.

5.68 The construction of this element will adversely affect an area determined to have high potential for archaeological site preservation and will adversely effect Historic Property #13, the Budd/Campbell House. Project plans call for the structure's removal. Associated ground disturbance would impact intact historic archaeological deposits that may be associated with the structure. Although the house dates to circa 1860, its NRHP-eligibility has not yet been determined.

5.69 Passaic and Lower Pompton Rivers Channel The two locations where cuts to the bank are proposed have been designated as having high potential for archaeological site preservation. Cuts to the western bank of the Pompton River would impact the margins of prehistoric site 28-MR-157. On the eastern bank of the Passaic, immediately downstream of the confluence, an area of high archaeological sensitivity would be impacted by channel cuts. Prehistoric site 28-EX-23 is located on the southern bank of the Passaic River, immediately upstream of its confluence with the Pompton River. Project plans do not presently involve cuts to this portion of the bank, thus, impacts are not anticipated.

5.70 Historic Sites and Properties The proposed channel cut to the Pompton River's west bank is located within an area that may contain significant historic archaeological remains associated with Historic Property #17, the Dey/Post House Sites. The exact location of these properties and their NRHP-eligibility has not yet been established. Impacts may occur here. Channel modifications associated with structural alterations to the abutments of Historic Property #5, the Two Bridges Road Truss Bridge, could be considered adverse effects to that property.

5.71 Archaeological remains associated with Historic Property #15, the Van Ness/Dormus House Site, may survive along the southern bank of the Passaic River, immediately west of the Two Bridges Road Truss Bridge. The site's NRHP status has not yet been evaluated. Project plans do not call for channel cuts at this location. However, any changes in project plans involving more extensive cuts may impact archaeological deposits here.

5.72 Pequannock River Channel Modifications Cuts to the eastern banks of the Pequannock River may impact a series of areas designated as having a moderate to high potential for archaeological site preservation. Channel modifications are planned for an area adjacent to prehistoric site 28-Pa-87, as well as in three highly sensitive locations immediately upstream. Other modifications are planned within a continuous area of moderate sensitivity, located downstream of the site, to the south and west of the Sewage Treatment Plant.

5.73 Historic Property #9, the Van Ness House, a NRHP-eligible late 18th century house, may be adversely affected by cuts to the banks of the Pequannock River. Any truncation of the rear yard could permanently alter the house's setting and its relationship to the river, and may impact potential historic archaeological resources.

5.74 Pompton Inlet Bypass Channel Modifications This area was not evaluated for prehistoric resources during the investigations. Construction of this project element will not affect historic properties. Although the Pompton Feeder Dam and the Pequannock Spillway adjoin the zone of impact, project plans indicate that they will not be affected. However, other Pompton Feeder and Slackwater Canal associated properties are located immediately to the east of its zone of impact. Secondary impacts could result from staging areas and access roads.

5.75 Wanaque River Channel Modifications No areas of archaeological sensitivity have been delineated within the zones of impact for the proposed channel modifications. Thus, no adverse effects are foreseen. As no historic properties are located here, no impacts are anticipated.

5.76 Ramapo River Channel Modifications Cuts may occur in sections of the Ramapo River's banks designated as having moderate potential for archaeological site preservation. At some of these locations, impacts would also occur as result of construction of the Pequannock/Ramapo levee floodwall system. A large area of moderate archaeological sensitivity extends along the western bank of the river in the northernmost portion of the project area, near Mathes Avenue. Another area of moderate sensitivity extends from Dawes Avenue on the north downstream to the southern end of River Edge Drive.

5.77 Historic cultural resources located on both banks of the Ramapo River may be impacted by cuts to the bank. The abutments of the NRHP-eligible Dawes Avenue Bridge are located on the banks. The entire structure could be adversely affected if its abutments are altered. Portions of the rear lot as well as aboveground and subsurface structures associated with the NRHP-listed Schuyler- Colfax House may fall within the impact zone of the channel modifications. Features on the bank include a stairway, remains of former landings, landscaping, and a refuse deposit. The backyard contains evidence of a privy or cistern as well as subsurface remains of former gardens and earthfast buildings. Terrain alterations and the removal of vegetation would have an adverse effect upon these properties. Any substantial truncation of the backyard will permanently alter the house's setting and its relation to the river.

5.78 Historic Property #8, Ramapo River Embankment, will not be affected by the project. However, this determination should be re-evaluated should project plans call for more extensive cuts to the eastern bank of the river. Portions of the Ramapo River Slackwater Canal, an element contributing to the eligibility of the NRHP-listed Morris Canal, may be impacted by cuts to the bank. The towpath hugs the river's eastern bank south of the Dawes Avenue Bridge. A series of retaining walls, bridges, culverts, and storm drains are associated with it. The river's eastern bank also contains landscape features that are evidence of 19th century efforts to change the course of the river as part of the construction of the Slackwater Canal. These include two former meander channels which were dammed and bridged by the towpath. The eastern bank also contains the surviving abutment of the ca. 1836 Morris Canal Bridge 115. Sections of retaining wall continue along the eastern bank as far upstream as the Paterson-Hamburg Turnpike Bridge. Near the project's northern terminus, the western bank contains a section of altered channel. This channel replaced the old meander channel that enclosed Doctor's Island. Many of these elements fall within the channel modifications project impact zone and may be adversely affected.

5.79 Channel cuts may also affect portions of the Ironworks located upstream of the Turnpike Bridge. These location have not been evaluated.

5.80 Pequannock Weir As the area has been found to have low potential for prehistoric remains and does not possess historic properties, no impacts are not anticipated.

5.81 Great Piece Meadows Weir Construction of the Great Piece Weir may adversely affect a previously identified prehistoric archaeological site. Portions of prehistoric site 28-Ex-23 have been detected on the slope and top of a riverfront terrace located on the southern bank of the Passaic at the same location as the proposed weir's southern terminus. An area characterized as having moderate potential for site preservation is located immediately upstream of the southern terminus. No historic properties are located here, no impacts are anticipated.

5.82 Pequannock/Ramapo Levee/Floodwall System Construction of the Pequannock/Ramapo levee/floodwall system may adversely affect an area designated as having moderate potential for archaeological site preservation located along the Ramapo's western bank. It extends inland in the vicinity of Mathes Avenue, near the project's northern terminus at the Paterson-Hamburg Turnpike crossing. An additional area of moderate potential is located on the northern bank of the Pequannock, to the south of the Sewage Treatment Center.

5.83 If not appropriately placed, construction of the Pequannock/Ramapo levee/floodwall system may adversely affect portions of Ludlum Steel Dumpsites #2. This site, along with adjacent Dumpsite #1, are considered contributing elements to the NRHP-eligible Pompton Ironworks Historic District. They are located on the western bank of the Ramapo River, in the vicinity of Mathes Avenue and Riverview Road, near the project's northern terminus at the Paterson-Hamburg Turnpike crossing. Dumpsite #1, the more southerly of the two, is located inland from the river, closer to Mathes Avenue. It appears to be outside of the present zone of impact. Dumpsite #2, the northernmost, is constricted on a narrow and steep slope, between the riverbank and Riverview Road. Given the present design of the levee/floodwall system, it will be adversely affected by project construction.

5.84 Work Shafts and Tunnel Outlet The six vertical shafts listed here; workshaft 3 (Wayne Municipal Yard), workshaft 4 (Interstate Route 80 Interchange, Borough of Totowa), workshaft 4 alternate, workshaft 2A (Joralemon Road, Belleville), and workshaft 2B (Bergen Avenue, Kearny) are located in areas that have a high potential for archaeological site preservation. Their construction may impact buried prehistoric remains. Secondary impacts could occur as a result of placement of staging areas or access roads. No prehistoric archaeological or historic impacts are expected to occur at the tunnel outlet or workshaft 2C.

5.85 Passaic River Levee System #10 The project's upland component, as it is presently designed, will destroy all of site 28-Ex-78. The northern levee tie-in will impact the southern portion of the site, nearest to the industrial park. The six-acre borrow site, located to the northeast of the levee, will impact the remaining areas of the site. The wetlands component may impact additional resources.

RECREATION RESOURCES EFFECTS

5.86 Recreational access to the river in the Lower Valley and in the Central Basin would be cut off by the construction of levees and floodwalls. In the Central Basin a total of twenty acres would be impacted as narrow strips of local parks and undeveloped open space along riversides which would be widened or have their banks raised with the construction of levees in Pompton Lakes, Livingston, Parsippany-Troy Hills, Montville and East Hanover. Another 18 acres of Green Acres - lands would be converted to flood control purposes from Passaic County Parks in Wayne and Pompton Lakes, as well as Essex County parkland in Fairfield and Livingston. Harrison would also be affected. Appendix B - Environmental Resources, Section 7, Table 1 provides affected acreages in the Green Acres Program, and Table 2 provides Municipal Parkland acreages. Block and lot numbers are also given.

NOISE

5.87 Noise impacts are not expected to differ significantly from those described in the FEIS. Reduction in the project footprint, particularly in the Pompton Lake community where levee system are no longer planned, will significantly reduce noise levels in those areas.

AESTHETICS

5.88 Effects on aesthetics were discussed in the December 1987 report. In summary, the main inlet and workshafts have been located in industrial areas so as to minimize adverse effects. However, engineered structures will replace those landscapes. Levee and floodwall construction in residential communities will replace river views with a more structured, uniform man-made view.

AIR QUALITY CONFORMANCE DETERMINATION RESULTS: EFFECTS OF CONSTRUCTION AND OPERATION AT SURFACE FEATURES

5.89 The results of the expected total annual emissions for HC/VOC (Hydrocarbons/Volatile Organic Compounds) and NO_x (Oxides of Nitrogen), CO (Carbon Monoxide), and PM (Particulate Matter) are graphically provided in Figure 6 for Hudson, Essex, Passaic and Morris Counties. The above constituents were evaluated since they were the only pollutants which fell within the extents of the proposed project's non-attainment areas.

5.90 All NAAQS non-attainment area pollutants (Ozone, CO, and PM) are within the allowable Conformity Determination criteria, with exceptions as noted in Tables 7-9. The Conformity Determination threshold for Hydrocarbons/VOCs is 25 T/yr, for Carbon Monoxide is 100 T/yr, and for No_x is 25 T/yr for severe non-attainment areas, the proposed project's characterized extents.

5.91 Those HC/VOC, CO, and NO_x emissions which exceed the NAAQS Conformity Analyses threshold for Hudson, Essex, and Passaic Counties for the project's expected construction phase are listed in Tables 7-9.

5.92 AIR QUALITY CONFORMITY DETERMINATION CONCLUSIONS The proposed Passaic River Flood Damage Reduction Project is within the State of New Jersey's Implementation Plan (SIP), in accordance with the Clean Air Acts National Ambient Air Quality Standards (NAAQS) for the majority of constituents. The Hydrocarbon/Volatile Organic Compound, Carbon Monoxide, and Oxides of Nitrogen (NO_x) concentrations exceed the regulatory criteria for select periods during the proposed construction schedule, indicating non-compliance.

5.93 Since much of the data used to perform this analysis are expected to be modified, the results illustrated herein should be viewed as preliminary. When the final construction schedule and necessary equipment are determined, the air emissions will be re-evaluated. Should the expected air emissions exceed any of the NAAQS rates established for non-attainment areas, a full scale Conformity Analysis shall be completed and circulated for comment and review in accordance with 40 CFR Part 51, Subpart W.

TABLE 7 Estimated Hydrocarbon (HC)/Volatile Organic Carbon (VOC) Air Emissions for Proposed Project in Excess of State Implementation Plan for Expected Construction Period

Year	HC/VOC (T/yr)			
	Hudson	Essex	Passaic	Morris
1998	N/A	N/A	N/A	N/A
1999	N/A	N/A	N/A	N/A
2000	N/A	N/A	N/A	N/A
2001	N/A	N/A	N/A	N/A
2002	N/A	N/A	N/A	N/A
2003	N/A	N/A	N/A	N/A
2004	N/A	N/A	N/A	N/A
2005	N/A	N/A	N/A	N/A
2006	25.03	N/A	N/A	N/A
2007	25.03	N/A	N/A	N/A
2008	N/A	N/A	N/A	N/A

N/A- Not Applicable-within NAAQS

TABLE 8 Estimated Carbon Monoxide (CO) Air Emissions for Proposed Project in Excess of State Implementation Plan for Expected Construction Period

Year	CO (T/yr)			
	Hudson	Essex	Passaic	Morris
1998	N/A	N/A	N/A	N/A
1999	N/A	N/A	N/A	N/A
2000	N/A	N/A	N/A	N/A
2001	N/A	N/A	N/A	N/A
2002	N/A	N/A	N/A	N/A
2003	N/A	N/A	N/A	N/A
2004	121.9	N/A	N/A	N/A
2005	134.2	N/A	N/A	N/A
2006	N/A	N/A	N/A	N/A
2007	N/A	N/A	N/A	N/A
2008	N/A	N/A	N/A	N/A

N/A- Not Applicable-within NAAQS

TABLE 9 Estimated Oxides of Nitrogen (NO_x) Air Emissions for Proposed Project in Excess of State Implementation Plan for Expected Construction Period

Year	NO_x (T/yr)			
	Hudson	Essex	Passaic	Morris
1998	N/A	N/A	N/A	N/A
1999	N/A	N/A	N/A	N/A
2000	N/A	N/A	N/A	N/A
2001	N/A	N/A	N/A	N/A
2002	35.2	N/A	N/A	N/A
2003	65.7	48.05	N/A	N/A
2004	138.4	39.17	26.9	N/A
2005	147.8	60.9	73.3	N/A
2006	81	59.5	96.5	N/A
2007	81	71.7	132.8	25.7
2008	N/A	23.6	57.9	26.9

N/A- Not Applicable-within NAAQS

LOCAL SHORT TERM USES OF HUMAN ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

5.94 The over all productivity of the State of New Jersey and the New York Metropolitan Region would be advanced with the construction of a flood protection plan which would eliminate the frequent and recurring flood problems in the Passaic River Basin. While there would be short-term expenditures of basin resources during its construction -- electricity, steel, air and water resources, for example -- they would be offset many times by preventing major flood-related productivity losses which occur during flood periods.

5.95 During construction, there will be short-term disruptions to the efficient functioning of portions of certain natural systems -- streams, wetlands or parklands -- but all of their adverse effects would be mitigated, and in the long term, their productivity would be maintained by the restoration of disturbed systems.

5.96 The long-term productivity of the people in the Passaic River Basin would be significantly enhanced with the elimination of flood-related impacts. The resources of the Passaic River

Basin either from natural systems or those developed by man, all contribute to the long-term productivity of the region. Flooding disasters stress both natural and man-made systems. As noted in Chapter 4 and 5 inundation appears to effect herbaceous production within the Central Basin wetlands. Similar effects are more obvious in man-made systems. One example is the average withdrawal of 100 million dollars annually from the basin's production necessary to address flood disasters and recovery.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE PROPOSED ACTIONS

5.97 Irreversible or irretrievable commitments of resources for the construction of the authorized plan include human and natural resources. The human resources include the time, labor and capital required to complete its planning and construction. Expenditures total 47 million dollars at the current stage of project design and can be expected to reach 1.4 billion dollars by the time construction is completed. Natural resources include fuel and oil, steel, concrete, wood, asphalt, stone, clay, soil, erosion control fabrics, plants and seeds and certain land areas. An analysis of the necessary resources and material to construct the project estimates quantities of 860,000 cubic yards of ready-mixed concrete, 260,000 cubic yards of earth fill, 170,000 linear feet of steel H-piles, 1,310,000 square feet of steel sheet piles, 100,000 cubic yards of riprap and graded stone, and 10,000 tons of reinforcing steel, and plant materials necessary to vegetate 100 acres of disturbed wetland and terrestrial sites. The assembly of the materials through construction of project features would require an additional 3,067,000 gallons of petroleum products for the operation of heavy equipment necessary to do so. Once assembled, these materials must be considered, from practicable perspectives, to be irretrievable.

5.98 Twenty seven riffle/pool/run reaches in the Pequannock, Wanaque and Ramapo Rivers would be lost. Mitigation actions in the Pompton River, improve fishery habitat there but cannot exactly duplicate the lost habitat, because the Pompton is of a warmer nature. As a result certain riffle/pool species could be eliminated from the area or have populations greatly reduced include the tesselated darter, cutlips minnow, and blacknosed dace.

ENERGY IMPACTS AND CONSERVATION POTENTIAL

5.99 In the context of the Passaic River Basin and its flood problem, energy may be expanded to reduce flood damages or recover from the effects of floods. Annually, flood costs average 100 million dollars in the Basin. Although not readily convertible to energy equivalents, this sum represents significant expenditures for energy as well as a drain on the basin's natural and fiscal resources. The construction of a flood damage reduction project would have a conservative effect by eliminating this annual debit.

5.100 Use of energy to excavate the tunnel, build surface elements, and reclaim disturbed lands would also be significant. As noted in paragraph 5.116, 3,067,000 gallons of fuel would be required for earth moving and heavy equipment use alone. In addition, electrical energy necessary to operate the tunnel boring machine in the construction of 20.4 miles of tunnel would expected to approach 93,000,000 kilowatt hours of energy. This is a substantial amount; however, it would be a one-time expenditure which must be balanced against annual expenditures necessary to address continual flooding in the basin. Although not calculable using current data, an indication of the ultimate conservation relationship can be generated from the benefit to cost comparison for the project. At 127,295,000 annual costs, for construction are exceeded by the benefits. It follows that net energy use over the life of the project could be expected to be less with the project than without it.

MITIGATION MEASURES AND THEIR EFFECTS

5.101 The two resources most affected by the project, wetlands and aquatic, are the focus of separate mitigation plans. These plans are presented in the Appendix B - Environmental Resources, Section 2. Results of the intensive biological survey and extensive modeling indicate changes to Newark Bay would be minor, shortlived, and of small areal extent, and thus not significant enough to warrant an estuarine mitigation plan. Project refinement concentrated on reducing or avoiding adverse effects through good environmental design. Mitigation plans were subjected to this refinement process. Where avoidance or minimization of project effects was not possible, appropriate plans have been developed. Plans associated with the Feature Design Memorandum (FDM) for Passaic Levee #10 are more refined than the plans for the balance of this report which is a General Design Memorandum (GDM); therefore, the Passaic #10 plans is more detailed and includes planting specifications as well as design elevations.

5.102 The remainder of the project features are not refined at the same level of detail. The detail provided, however, is substantially increased from the FEIS. Sites for mitigation have been selected. Methods to be employed include restoration of forested wetland sites, construction of instream structures; "blind" ditches, and the use of approved insect vectors to control areas of purple loosestrife. The mitigation measures that will be used in addressing aquatic and wetland losses follow.

5.103 Aquatic Mitigation Concerns with the loss of riffle/pool/run communities and the potential for increased entrainment of fish at the Pequannock Weir. No quantifiable technique exists for measuring these losses. The removal of 2,100 square feet of refuge that now exists at the base of the weir will be replaced in refuge areas incorporated in project designs for stream reaches upstream on the Pequannock, Wanaque and Ramapo Rivers. The Environmental Resources Appendix contains additional and more detailed information on these mitigation measures.

5.104 The Pompton River was surveyed during 1991 and 1992 to assess its use for mitigation. Several areas were found which could be improved to offset losses in upstream reaches where channel modification eliminates riffle/pool/run habitats. Twenty-seven wing-dam structures will be placed in the Pompton River in three reaches. One area downstream of the Jackson Avenue bridge will contain 6 structures; 600' further downstream, 4 structures would be located, and 17 structures would be placed just below the Newark-Paterson Turnpike for 2,300 feet. The Environmental Resources Appendix contains detailed information including figures of the configuration of the wing-dams.

5.105 Wetland Mitigation Wetland mitigation plans developed for the Passaic Levee 10 will serve as a prototype for wetland mitigation plans for other elements. Its efficiency analysis and level of detail provide planning efficiencies for similar sites. Mitigation for these plans is guided by regulatory mandates at the Federal and state levels for a one to one functional replacement of lost value. Functional equivalency is gauged by HEP analysis to insure wildlife values are replaced and serve to dictate acreage requirements above a minimum one to one ratio.

5.106 Forested Wetlands A loss of 67 acres of palustrine forested wetlands will occur with project implementation, which represents some 7,035 units of habitat. This loss occurs during construction and the life of the project. This type of wetland requires a substantial amount of time to acquire the characteristics of a forest. As a result, in order to offset losses within the framework of the project life, the creation/-re-creation of 99 acres of forested wetlands is included in the project. This will be accomplished by: (1) excavation of filled lands next to existing wetlands, (2) contour grading to reproduce pre-existing wetland elevations including low areas for ephemeral water necessary for wood frog reproduction, (3) revegetation with trees indigenous to the area, including surveying of tree, understory and forest floor species to replicate adjacent wetland habitats, (4) monitoring of sites during restoration and for a minimum of four years after completion mitigation goals are met, and (5) convening of a workshop to develop strategies for successful attainment of the goals if problems develop.

5.107 Scrub/Shrub, Scrub/Shrub-Emergent, and Emergent Wetlands Improvement of existing wetlands for the green heron, and the muskrat will be the objective in replacing losses of these cover-types. Extensive amounts of invasive monotypic vegetation, purple loosestrife, occur in these wetlands. Controlling this plant with approved insect vectors will be used at selected sites. This measure, and where appropriate, plantings with cattail, bulrush and three square will be used to improve food supply for muskrat. Blind, or closed non-draining ditches will be used to provide habitat for foraging green heron and increased water habitat for the muskrat. In the case of the green heron, the key limiting factor is finding foraging habitat that supplies enough food for successful nesting. Standing water 12 inches or more at the nest site also decreases predation on green heron eggs and nestlings. For the muskrat, severe water level fluctuations and lack of banks for refuge burrows has greatly limited the carrying capacity for this species. Water is also its primary means for moving from site to site. When water levels are relatively stable, mortality from drowning is reduced. Additionally, some of the material excavated from the created ditch can be mounded to provide opportunities for the muskrat to have refuge burrows during times of high water.

5.108 Passaic Levee 10 Wetlands Contours will be graded at the borrow site to wetland elevations and replanted with wetland vegetation. A total of 5.1 acres of wetland will be created at this site. Further, reclamation of 7.7 disturbed acres will be performed to offset upland losses. The ponding area wetlands required for interior drainage will be maintained in natural conditions through the use of pumps, sluice gates and flap valves, to maintain wetland hydrology. See Appendix C - Hydrology & Hydraulics and Appendix B, Section 6, Environmental Resource for details.

5.109 Cultural Resources Avoiding impact is the preferred mitigation measure. In instances where that is not possible, additional measures will be coordinated with the State Historic Preservation Office. Additional research is planed for sites with potential national register eligibility or for which additional data is required to assess their significance or project effects. A summary of those measures, by project feature follow.

5.110 Pompton and Passaic Measures will be taken to demarcate these properties during construction to ensure that they are avoided. Subsurface testing will be conducted to determine the presence or absence and NRHP-eligibility of sites. Mitigation in the form of data recovery will be undertaken if NRHP-eligible sites are identified.

5.111 Project plans call for the removal of Historic Property #13, the Budd/Campbell House, a house that may be eligible for the NRHP. The preferred alternative would be a project design that avoids impacts to the house and grounds. If this is not feasible, an assessment of the structure's NRHP-eligibility will be undertaken. This would include subsurface testing to determine if an archaeological component is present. If the house is determined eligible, then mitigation measures will be considered. Feasible measures would include relocation to another site and recordation.

5.112 Passaic and Lower Pompton Rivers Subsurface testing will be undertaken to determine whether evidence of site 28-Mr-157 extends to this area and whether such remains are NRHP-eligible. If so, mitigation in the form of data recovery, will be implemented. Subsurface testing for historic remains is also recommended as is additional documentary research. If deposits here are determined NRHP-eligible, mitigation in the form of data recovery, will be implemented. Recordation of the Two Bridges Road Truss Bridge is recommended. Additional geomorphic analysis and subsurface testing is also planned for an archaeologically sensitive terrace on the Passaic's eastern bank.

5.113 Pequannock River Channel Modifications Subsurface testing will be undertaken in impacted areas in order to confirm the presence or absence of prehistoric artifactual remains and to assess the NRHP-status of any identified sites. The same procedure is recommended at a location designated as moderately sensitive adjoining the southern Pequannock River in the vicinity of the Sewage Treatment Center. The results of these studies will determine the necessity and scope of any mitigation measures.

5.114 An assessment of the Van Ness House NRHP-eligibility will be undertaken. This would include additional research to determine the exact date and history of the structure. Subsurface testing is also recommended at this site. Mitigation plans will be based on the results of these evaluations.

5.115 Pompton Inlet Bypass Channel Field inspection and geomorphic analysis of the bypass channel's zone of impact will be undertaken in order to determine its archaeological sensitivity. If the area is determined sensitive, subsurface testing will also be undertaken. Properties associated with this zone may be affected by secondary impacts. Measures will be taken to demarcate the Pompton Feeder and Slackwater Canal during construction to ensure that they are avoided.

5.116 Wanaque River Channel Modifications No mitigation measures are required for this feature.

5.117 Ramapo River Channel Modifications Geomorphic analysis is recommended as a means of detecting intact soils at impact sites. Such soils would then be tested to assess the presence or absence of prehistoric remains. Any encountered prehistoric sites will be assessed for their NRHP-eligibility. The results of these studies will determine the necessity and scope of any mitigation measures. Recordation of the Dawes Avenue Bridge is recommended.

5.118 Further subsurface testing and research will be undertaken at the Schuyler Colfax House in order to locate all features, including the cemetery. Mitigation measures include data recovery, recordation, monitoring of the structure during construction, and reconstruction of portions of the original landscape.

5.119 Further research and field evaluation will be undertaken to completely assess the Ramapo River Slackwater Canal. Mitigation measures include recordation and reconstruction of the original landscape.

5.120 Those portions of the Pompton Ironworks or Ludlum Steel Dumpsite #2 that may be affected by channel cuts will be researched to assess the extent of the resources. If significant features are identified, a program of recordation and data recovery would be implemented as a mitigation measure

5.121 Pequannock Weir No mitigation measures are required for this feature.

5.122 Great Piece Meadows Weir Archaeological testing will be undertaken to determine the limits and extent of the site 28-Ex-23. Data recovery would then be implemented as a mitigation measure.

5.123 Pequannock/Ramapo Levee/Floodwall System Geomorphic analysis is recommended at the more northern location, located along the western bank of the Ramapo River, in the vicinity of Mathes Avenue. If results here indicate the presence of intact soils, then subsurface testing will be undertaken. Any encountered prehistoric sites will be assessed for

NRHP-eligibility. The results of these studies will determine the necessity and scope of any mitigation measures. The same procedure is recommended for the remaining area of moderate sensitivity which is located along the northern bank of the Pequannock River, near the sewage treatment center.

5.124 Tunnel Outlet/Workshaft 2C. Further research and remote sensing is recommended to determine the presence or absence of anomolies. Ultimately, evaluation of the NRHP-eligibility of any encountered shipwrecks and development of mitigation measures will be undertaken.

5.125 Workshaft 3 (Wayne Municipal Yard), Workshaft 4 (Interstate Route 80 Interchange, Borough of Totowa), Workshaft 4 alternate, Workshaft 2A (Joralemon Road, Belleville), and Workshaft 2B (Bergen Avenue, Kearny),Workshaft 2. . Field evaluation and subsurface testing are recommended in order to confirm the presence or absence of NRHP-eligible sites. If any NRHP- sites are identified, mitigation measures will be developed. Confining work to the already excavated portions of the quarry at workshaft 2 is recommended. If this is not feasible, further visual evaluation and subsurface testing of foundation remains will be undertaken.

5.126 Passaic River Levee System #10. Mitigation, in the form of a complete archaeological excavation of Site 28-Ex-78 will be undertaken. Additional testing in the wetlands project impact zone will be undertaken to determine the presence or absence and NRHP- eligibility of prehistoric sites. If NRHP-eligible sites are encountered, mitigation in the form of data recovery will be undertaken.

5.127 Mitigation needs for the remaining Central Basin elements and for the tidal protection elements will be determined during the FDM phases and plans specifications phase for the project.

RECREATION

5.128 Lower Valley. Recreation is incorporated into project plans at other Lower Valley sites where residences are nearby. Riverside trails are integrated into the levee that will protect the Terrell Homes in the Ironbound neighborhood of Newark providing waterfront and recreation access. This part of Newark is just downstream of the Performing Arts Center and Joseph G. Minish Waterfront Park and Historic Area where a marina and a promenade which will be connected to the recreational trail on the levee. The Waterfront Park is a separate Corps of Engineers project which is being built in coordination with the State of New Jersey and the City of Newark. Across the river in Harrison at the 1st Street Levee/Floodwall. picnic facilities will be provided along with a small boat launching/fishing platform.

5.129 The central basin offers more opportunities for satisfying the demand for recreational open space. Lost recreation land will be replaced in-kind, both in specific municipalities and for Green Acres acquisitions at county and local levels. In all areas where recreational land or open space is taken, either for narrow strips lost to channel widening, or where built levees will cover parks or open space, the extent of the taking will be offset with either direct land purchases, or, if desired by the local entity, will be replaced with a cash payment as mitigation for the loss. Most of the concerned "landowners" -- the counties and municipalities -- have not yet reached a decision as to whether they would prefer to have the taken land replaced in-kind, by purchase, or by a cash payment in lieu of the land. These details will be resolved in the next planning phase. Two tables displaying the lost acreage and their lot and block numbers are in Appendix B - Environmental Resources, Section 10, Table 1 "Lands in the Green Acres Program", and Table 2 "Municipal Parkland and Undeveloped Open Space."

5.130 In addition, efforts to replace the lost opportunities on-site or nearby are limited by the densities of development in the basin. The Fairfield site for the 2A levee system does however present an opportunity to create new recreational opportunities and facilities. The northern end contains land that will be revegetated as a park with trees and shrubbery. A parking area would be located at the end of Evans Street, a boat launch at the man-made lake, a picnic area near the boat ramp, an interpretive display and a trail system, which would wind around the lake and wetlands within the levee and floodwall. An easy portage stretch would allow for the transfer of small boats or canoes from the lake to the river. The proposed facilities are shown in Figures 12 and 13 of the Environmental Resources Appendix. A second trail system will begin at Bloomfield Avenue and continue beside the levee across from West Essex Park. The end of the trail will connect to one of the roads in the small residential area south of the levee system.

AESTHETICS

5.131 Impacts to aesthetics in the Lower Valley at the workshafts or levee and floodwall sites are not been deemed significant due to the industrial nature of the sites. Standard engineering practices call for aesthetic treatments which would be applied to levees and floodwalls located in residential areas, parks, or within the view of parks as standard engineering practice. Levees will be beautified with plantings which are native to the area to make then fit into each setting. In residential yards, turf grass is appropriate, with flowering shrubs to be planted along the lower edge of the levees in clusters of three to seven to add interest. Recommended shrubs that would be planted in wetter locations include Summersweet, Clethra alnifolia, red osier dogwood, Cornus sericea, compact inkberry Ilex glabra compacta, virginia sweetspire Itea virginica, and mountain laurel Kalmia latifolia, while drier site yards would have dwarf varieties of azaleas, forsythia and spireas planted. The levees would be planted with nonaggressive grasses such as sheep fescue, Festuca ovina, along with several types of wildflower seed mixes which will provide a progression of seasonal blooms and control erosion. Near the bottom of the levees, wildflowers would include the dog-tooth violet, Erythronium americanum, toothwort, Dentaria diphylla, foamflower, Tiarella cordifolia, deciduous wild ginger, Asarum canadense, atamasco lily, Zephranthes atamasco, and stonecrop Sedum ternatum. On levee sides, taller species would include moss pink, phlox subulata, green and gold, Chrysogonum virginianum, crested dwarf, Iris cristata, coreopis, Coreapsis auriculata, wine-leaf cinquefoil, Potentilla tridentat, and other daisies and asters. Drawings of these plants, specific seed mixes and their flowering months are detailed in the Appendix B Natural Resources Section 7 entitled: "Recreational Impacts and Beautification."

5.132 Standard engineering practices call for aesthetic mitigation in the Lower Valley calls for covering the concrete floodwalls with vines planted to make the walls appear more natural and blend with the strip of opportunistic vegetation which usually establishes itself along the riparian edge. With this mitigation, the floodwalls would create more landscape uniformity than appears today, but the shoreline would have a more natural appearance.

LIST OF PREPARERS

5.133 Table 9 presents a list of the people who were primarily responsible for Supplement 1 to the environmental impact statement, as well as those primarily responsible in Federal agencies and scientific consultant firms whose work was integrated into this document.

TABLE 9 (a)
LIST OF PREPARERS

The following people were primarily responsible for preparing this Supplement #1 to the Environmental Impact Statement:

Name and Role in Preparing SEIS	Discipline and Expertise	Experience
John S. Wright, M.S. Environmental and Economic Study Management, Chief, Director SEIS	Biology/Limnology Environmental Planning NEPA Review	3 Years, PRD, New York District, COE 7 Years, Ohio River Division 6 Years, Huntingdon District 1 Year, Memphis District 5 Years, MCAS, Cherry Point, NC
M. Lou Benard, M.A. SEIS Editor and Coordinator for Environmental Resources Studies Recreation Mitigation	Physical Science Environmental Studies and Water Resources Planning	17 Years, PRD, New York District, COE
Robert J. Kurtz, M.S. Estuarine & Freshwater Fisheries, Wildlife and Wetlands Assessment	Biology Fisheries Biology Water Resources Planning	17 Years, PRD, New York District, COE
Cornell Pippens, B.A. Economic Assessments Economic Effects	Regional Economist	12 Years, Regional Economist PRD, New York District, COE
Richard Jackson, M.S.C.E., PE Hazardous and Toxic Waste and Groundwater Investigations, Geotechnical Chief	Geotechnical Engineer	21 Years, COE 2 Years, Geotechnical Consultant 3 Years, Naval Facilities Engineer 1 Year, Illinois Highway Department
Joseph P. Deery, B.S.C.E M.S. - Environ'l. Engineering Candidate Hazardous, Toxic & Radioactive Wastes, Air Quality Analysis	Environmental Engineer	1 Year, PRD, New York District, COE 2 Years, U.S. Coast Guard 4 Years, Private
John Bianco, M.S. PE Hydrology & Hydraulics, Chief Coincidental Rainfall & Runoff Analysis Project Layout, Hydrodynamics Software Development	Civil Engineering Hydrology & Hydraulics	1 Year, Tulsa District, COE 7 Years, Baltimore District, COE 5 Years, North Atlantic Division, COE 5 Years, New York District, COE
Raymond Schembri, M.S., PE Hydraulic Modeling & Design, Topographic and Storm Surge Evaluations, Sediment Transport, Water Quality	Civil Engineering Hydraulics	15 Years, New York District, COE Engineering, Planning and Passaic River Divisions
Henry F. Kiefer , A.A.S. Construction Cost Estimates Real Estate Costs Coordinator	Cost Estimator Civil Works/Tunnel Cost Engineering	10 Years, Civil Engineering/Surveyor-Private 18 Years, Technical/Cost Engineering, New York District, COE
Wendy Harris, M.A, M. Phil. Archaeological Resources	Archaeology Cultural Resources Mgmt.	5 Years, New York District, COE 10 Years, Private Consultant
Thomas A. Fontana, B.A. Public Involvement Appendix Editorial Review, Graphics Preparation	Public Affairs Journalism	3 Years, Public Affairs, MBL Insurance Co. 7 Years, New York District, COE

TABLE 9 (b)
LIST OF PREPARERS

The following people were primarily responsible for preparing reports which support this Supplement #1 to the Environmental Impact Statement:

Name and Role in Preparing SEIS	Discipline and Expertise	Experience
Peter S. Benjamin, M.S. Effects on Fish and Wildlife Resources Coordination Act Report	Fishery and Wildlife Biologist	4.5 Years, U.S. Fish & Wildlife Service 1 Year, U.S. Forest Service 1 Year, Indiana Dept. of Natural Resources
Robert Papson, B.A. Fishery Survey/HEP Evaluations	Principal Fisheries Biologist	16 Years, NJ Bureau of Freshwater Fisheries
Stewart Wilk Newark Bay Biological Characterization	Marine Fisheries	35 Years, Chief, Research Scientist, National Marine Fisheries Service
Robert F. Carline, Ph.D HEP Fishery Analysis	Fishery Biologist	28, Years, National Biological Service-Pennsylvania Cooperative Fish & Wildlife Research Unit
Carl F. Cerco, Ph.D., P.E. Newark Bay Water Quality Model	Hydrologist, Water Quality and Hydro-Dynamic Modeling	8 Years, Waterways Experiment Station, COE 10 Years, Virginia Institute of Marine Science
David Abraham., M.S., River Sediment Transport	Hydraulic Engineer	5 Years, Waterways Experiment Station, COE
Joseph V. Letter Jr., M.S., Newark Bay Hydrodynamics and Sedimentation, Numerical Modeling	Estuarine Hydrodynamics and Sedimentation Numerical Modeling	Years, Waterways Experiment Station, COE 15 Years,Physical Modeling 19 Years,Numerical Modeling
Thomas A. King, P.G. Groundwater Modeling, Geology	Hydrogeologist	1 Year, North Atlantic Division, COE 2 Years, Baltimore District, COE 15 Years, Private Consultant
Herbert Buxton Groundwater Modeling & Study Oversight	Hydrogeologist	United States Geological Survey Assistant District Director, NJ Office
George F. Pinder, Ph.D. Groundwater Modeling	Consulting Hydrogeologist	Dean of Engineering and Mathematics, University of Vermont
Donal Furlow, M.S. Passaic Levee #10 Wetlands Mitigation Plan	Certified Professional Wetlands Scientist	33 Years, Private Professional Practice

CHAPTER 6

PUBLIC INVOLVEMENT

PUBLIC INVOLVEMENT

6.1 Chapter 6 of the FEIS details the Public Involvement program up to 1987. The Water Resources Development Act of 1976 (P.L. 94-587) authorized a new Passaic River Basin study for which public involvement was initiated in December 1977 inviting all to participate in the reconnaissance phase of plan formulation and to share information.

6.2 During the planning stage, when over 150 different flood control plans were developed, public involvement concentrated on the Passaic River Basin Study's Subbasin Coordination Groups, which served as focus groups. Environmental concerns were also gathered at numerous coordination meetings and public information meetings, and during presentations for all levels of government. The information gathered at these meetings was used to eliminate plans which were not publicly acceptable. After the flood of 1984, The Corps submitted the seven best solutions to the State of New Jersey's Department of Environmental Protection. On June 28, 1984, following a series of public meetings, the State selected the dual inlet tunnel plan for detailed study.

6.3 Plan refinements produced a Phase I Advanced Engineering and Design Study or feasibility report and Environmental Impact Statement (EIS) for the selected plan in December 1987. This plan was authorized by the Water Resources Act of 1990.

6.4 However, Congress, sensitive to residents' objections regarding the location of levee systems and the plan's tunnel outlet in the Lower Valley, responded by modifying the plan, extending the tunnel to an outlet in Newark Bay and eliminating the need for nine levee systems, 13.5 miles in length in south Bergen and east Essex Counties. Authorization directed the continued planning, engineering and design (PED) for refinement of the project's design.

6.05 Over 150 coordination meetings have been held since authorization, including 56 meetings with municipalities and county officials and 28 with State of New Jersey officials. Other meetings involved environmental groups, the media, professional societies, business and union groups, academia, and the general public. This level of activity was and is still indicative of the ongoing high level of public interest. In order to formalize and focus that interest towards the required evaluation of project changes, scoping meetings were held on June

9, 16, and 22, 1993 in Little Falls, Lyndhurst, and Trenton, New Jersey, respectively. The dual purpose of those meetings was to document issues identified by the public related to project changes and provide updates of the project planning, engineering and design process. A summary of the information gathered at the scoping meetings can be found in the Appendix A - Public Involvement, Section 3.2.

6.6 In the 1987 report, an Environmental Advisory Board (EAB) was envisioned as a committee of environmental experts from the private sector and government agencies whose mission would provide the forum in which a consensus on environmental issues could be reached. However, the Federal Advisory Committee Act (P.L. 92-463; 86 Stat. 770, October 6, 1972) generally limits such groups to the national level. The purpose of the proposal -- to establish a forum for public input and to achieve inter-agency cooperation among the public resource agencies -- has instead been achieved through National Environmental Policy Act's (NEPA) provisions for scoping and the incorporation of cooperating agencies into the planning process.

COOPERATING AGENCIES

6.7 Federal agencies were formally invited to become cooperating agencies and to join the Corps' planning team. The U.S. Department of the Interior's Fish and Wildlife Service, U.S. Department of Commerce's National Marine Fisheries Service and the U.S. Environmental Protection Agency agreed to participate as cooperating agencies. The Fish and Wildlife Service worked with Corps biologists to implement Habitat Evaluation Procedures, which are required to ascertain existing conditions, predict project effects, and assist in mitigation designs.

6.8 The National Marine Fisheries Service provided a biological characterization of Newark Bay via periodic catches to inventory existing fisheries, predict project effects and assist in mitigation design.

6.9 Before the coordination process had been formalized, the Environmental Protection Agency (EPA) and the Corps signed a Memorandum of Agreement for the Development of a Comprehensive Wetlands Mitigation Plan. Subsequently, EPA assisted the Corps and other cooperating agencies in selecting a consulting firm for wetlands mitigation planning. EPA also contributed in other areas of expertise including hazardous, toxic and radioactive wastes, air, and water quality, and provided surface water quality data which was used to inventory existing water quality in Newark Bay, and the EPA designated sole-source aquifers.

6.10 Cooperating Federal agencies were joined by the New Jersey Department of Environmental Protection (NJDEP)as the non-Federal partner for the project. NJDEP's professional staff have provided consultation, data collections, and analyses and assisted in mitigation planning. Specific meetings related to green acres properties, aquatic, wetland and estuarine resources were conducted in that effort. The state's Division of Engineering and Construction was always available as the State's technical point of contact for meetings with local interests or other State professionals. Field-level assistance was provided by the NJDEP Division of Fish, Game and Wildlife in the Fish and Wildlife Service's habitat evaluation procedure's field evaluation of habitats and mitigation designs. At the administrative level, the Corps coordinated with the Governor's staff through the Director of Legislative Affairs. Consultation and coordination was provided in arenas for which the State has assumed primary responsibility for its resources, such as with hazardous, toxic and radioactive waste, coastal zone management and marine resources, and land use planning which oversees the Green Acres Program, freshwater wetlands, floodplain management and stream encroachment regulations. In addition, the Programmatic Agreement among the U.S. Army Corps of Engineers, the Advisory Council on Historic Preservation and the New Jersey State Historic Preservation Office guided the Corps regarding its handling of cultural and historic resources. The U.S. Geological Survey in West Trenton cooperated on an informal basis by collecting data and assisting the Corps in the creation of ground-water models supporting the evaluation of the project's effects on groundwater resources.

6.11 Coordination was also implemented at county levels, whether with the engineers for the County Department for Parks, Recreation and Cultural Affairs or with the County Soil Conservation Districts working under the auspices of the New Jersey Natural Resources Conservation Program.

VIEWS AND RESPONSES

6.12 Public input has had a significant effect on project planning. Section 6.11 through 6.16 of the FEIS describes its influences on the 1987 report. During the PED process, public influence continued to identify issues and focus PED design efforts. This was especially true in the development of plan refinements that decreased environmental impacts originally forecast in 1987. For example, the number of affected wetlands has been reduced from over 900 acres in 1987 to less than 100 acres. This was accomplished in part by lowering the tunnel inlet's elevation which limited upland levee/floodwall requirements there by reducing wetlands required as ponding areas and minimizing surface levee/floodwall intrusion in community affairs. It has stimulated creative engineering analyses supporting alternative hydraulic controls to meet ponding requirements for remaining floodwall/levee systems. Concerns about the sole-source aquifers generated extensive groundwater modeling studies which targeted resource impacts allowing for development of methods to limit those impacts. Each of these plan refinements evolved to address agency and public concerns and exhibit a continuation of the initial coordination process documented in the 1987 report.

6.13 Finally, the ongoing interest in a buyout of floodplain structures to limit flood damages has resulted in the update of studies documented in the 1987 report. That report is presented in a separate document to this General Design Memorandum.

6.14 A list of agencies and environmental groups which were sent copies of the draft Supplement 1 to the Environmental Impact Statement follows:

<u>Federal Offices</u>

Advisory Council on Historic Preservation
Environmental Protection Agency, Region II Administrator
Department of Agriculture
- Eastern Regional Forester
- Soil Conservation Service, State Conservationist

Department of Commerce
- National Oceanic and Atmospheric Administration, Research Director

Department of Energy, Area Manager
Department of Health and Human Services, Regional Director
Department of Housing and Urban Development, Region II
Department of the Interior
- U.S. Geological Survey, Regional Hydrologist
- U.S. Fish & Wildlife Service, Administrator
- National Park Service - Planning, Development and Engineering
- Bureau of Indian Affairs, Eastern Area Director

Department of Transportation
- Federal Highway Administration
- Federal Railroad Administration

Federal Emergency Management Agency, Region II

<u>State Offices</u>

Governor Christine Todd Whitman
New Jersey Department of Environmental Protection
- Division of Fish, Game & Wildlife
  - Bureau of Environmental Review

Bureau of Freshwater Fisheries
Bureau of Marine Fisheries
Bureau of Wildlife Management
Division of Parks & Forestry
State Historic Preservation Office
Division of Engineering & Construction
Bureau of Floodplain Management
Division of Solid and Hazardous Waste
Division of Water Quality
Division of Communications, Legal Services and Legislative Affairs
Public Information Officer
Green Acres
New Jersey Department of Transportation
New Jersey State Archaeologist
Bureau of Archaeology and Ethnology

Environmental Groups and Commissions

Advisory Council on Historic Preservation
American Fisheries Society
American Littoral Society
Archaeological Society of New Jersey
Bergen County Soil Conservation Service
Canal Society of New Jersey
Division of Cultural and Historical Affairs
Essex/Hudson/Passaic Counties Soil Conservation Service
National Audubon Society
New Jersey Audubon Society
New Jersey Conservation Foundation
New Jersey Highlands Historical Society
New Jersey Historical Society
North Jersey Historical Society
Nature Conservancy
Passaic River Coalition
Passaic County Historian
Pompton Lakes Historic Preservation Commission
Princeton University, Center for Environmental Studies
Rutgers School of Law, Environmental Law Council
Sierra Club
Society for Industrial Archaeology
Wayne Historic Preservation Commission
Wetlands Institute

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ADDENDUM 1

ADDENDUM 1

NEWARK BAY AND THE PASSAIC RIVER FLOOD DAMAGE REDUCTION PROJECT PRECONSTRUCTION ENGINEERING DESIGN

CLEAN WATER ACT'S SECTION 404(b)(1) EVALUATION AND THE FINDING OF COMPLIANCE

In order to implement the requirements of Section 404 of the Clean Water Act, an exemption was sought under Section 404(r) as part of the authorization process by including a Section 404(b)(1) evaluation in the 1987 Phase I General Design Memorandum. Subsequently, Congress changed the recommended plan in the Water Resources Development Act of 1990 (P.L. 101-640, dated November 28, 1990). This Finding of Compliance updates the earlier 404(b)(1) Evaluation and brings it into conformance with the realigned tunnel which elminated 13.5 miles in nine levee systems in the Lower Valley. It discusses the changed condition and incorporates new information developed during post authorization planning, engineering and design (PED) activities.

The updated 404(b)(1) analysis and Compliance Determination is being provided to meet state water quality certification in accordance with section 401 of the Clean Water Act and the exemption provisons of section 404(r) as appropriate for Congressional consideration in the budget process.

FINDING OF COMPLIANCE FOR
THE PASSAIC RIVER FLOOD DAMAGE REDUCTION PROJECT

1. No significant adaptation of the guidelines were made relative to this evaluation.

2. The majority of areas where channel cuts are proposed have no identified or suspected contaminants, therefore, no adverse impacts to the water bodies are expected.

3. In areas where contaminants are suspected, engineering controls such as cofferdams and silt screens would be used to mitigate potential suspension of sediment. Sediment would be managed in accordance with its classification (i.e. below regulatory concern, non-hazardous contaminated, hazardous). Based on our environmental records searches most sediments are not expected to be contaminated.

4. Disposition of all sediment will be coordinated with NJDEP. Disposal sites were selected so as not to harm endangered species nor their critical habitats.

5. The proposed dredged material and placement of riprap will 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. The life stages of aquatic life and other wildlife will not be permanently adversely affected.

6. Appropriate and practicable discharge conditions that would minimize unavoidable adverse effects of discharges on the aquatic ecosystem include the use of: 1) silt screens, 2) soil filter fabrics, and 3) habitat replacement or restoration of wetlands and aquatic resources, as appropriate.

7. On the basis of the guidelines, the proposed disposal site for the discharge of dredged material as specified in compliance with the guidelines with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to aquatic ecosystems.

TABLE 1

PROJECT FEATURES		
TUNNEL ELEMENTS		
• Main inlet in the Pompton River just upstream of Pompton Plains Cross Road/ Jackson Avenue Bridge. This inlet has a diversion spillway and stilling basin.		
• A spur inlet on the Passaic River just downstream of the confluence with the Pompton River. This inlet incorporates a berm and a diversion spillway.		
• A main tunnel 20.4 miles long, 42 feet internal diameter extending from Wayne to Newark Bay.		
• A spur tunnel, 1.3 miles long with a 23-foot diameter extending from Wayne to the main tunnel intersection in Totowa.		
• Outlet 1,850 feet South of Kearny Point in Newark Bay.		
LEVEE/FLOODWALL SYSTEMS *(in feet)*		
• **Lower Valley**	LEVEE	FLOODWALL
Lister/Turnpike/Doremus	5,599	17,657
Kearny Point	3,908	33,771
South First Street	1,750	5,700
• **Central Basin**		
Pinch Brook	2,397	415
Passaic Levee #10	4,853	97
Passaic Levee 2A	6,216	3,082
Rockaway Levee 1 Lower	818	521
Rockaway Levee 1 Upper	2,421	—
Rockaway Levee 2	3,172	—
Rockaway Levee 3	1,850	6,702
• **Pompton Valley**		
Ramapo-Pequannock Levee	2,200	2,910
CHANNEL MODIFICATION REACHES		
• Passaic River - 0.4 mile, upstream from Route 46 Bridge		
• Passaic River pilot channel - 1.2 miles, downstream of the spur inlet		
• Pompton River - 0.3 mile, from confluence with Passaic River upstream		
• Pompton River pilot channel - .3 miles, downstream of main tunnel inlet		
• Pequannock River - 2.4 miles, upstream from its confluence with the Pompton River		
• Pequannock River Bypass Channel - 0.3 mile, just upstream of main tunnel inlet		
• Wanaque River - 0.8 mile, upstream from its confluence with the Pequannock River		
• Ramapo River - 1.3 miles, upstream from its confluence with the Pequannock River		
• Deepavaal Brook - 1.4 miles, from confluence with Passaic River		
WEIRS		
• Great Piece Meadows weir 600 feet upstream of confluence of the Pompton/Passaic Rivers		
• Pequannock River weir gate modification on west end of weir		

404 (b)(1) EVALUATION

I. PROJECT DESCRIPTION

1.A. Location

The Passaic River drains 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). The watershed is elliptical in shape, 56 miles long and 26 miles wide, with its long axis running in northeast-southwest. The basin's major river is the Passaic and its seven major tributaries include the Saddle, Pompton, Ramapo, Pequannock, Wanaque, Rockaway and Whippany Rivers (Figure 2 in the Main Report). Their floodplains encompass more than 85 square miles and falls within 50 municipalities.

1.B. General Description: This flood damage reduction project is water dependant and no practicable alternative exists to the unavoidable effects which may be induced by its construction and operation. Alternatives to the recommended plan were described in the Chapter 5 of the 1987 Main Report. Table 11 in the Main Report displays changes in project features related to design refinements since the 1987 report was published.

All of the construction for this project would be in New Jersey. There would be no significant long term adverse effects from the project's construction and operation.

The major element of the project is its tunnel system, located underground away from water courses; therefore, it is not a part of this evaluation. Most of the surface elements interact with waters and are addressed in this evaluation. Table 11 in the Main Report summarizes the project's design refinement since the 1987 report.

Table 1 in this Addendum summarizes the project features. Chapter 5 in the Main Report fully describes each of the features.

1.C. Authority and Purpose

1. The Passaic River Basin Study, was authorized for study in the Water Resources Development Act of 1976 (P.L.94-587). Subsequently, Congress changed the Recommended Plan in the Water Resources Development Act of 1990 (P.L. 101-640, November 28, 1990) realigning the tunnel to outlet into Newark Bay and authorizing its construction.

2. The purpose of the project is to reduce flood induced damage to approximately 20,000 structures in the Central Basin and Lower Valley.

1.D. General Description of Materials

1. General Characteristics of Materials: Fill materials would consist of concrete, clean fill, commercial rock, tunnel rock and drilling mud (Bentonite). The excavated material would consist of gravels, sands, silts, and clays and stream cobble. (See Appendix E - Geotechnical, Section 8 for construction techniques and for the content of excavated materials.)

2. Quantity of Material: About 300,000 cubic yards of clean fill would be necessary to construct the levees. About 20,000 cubic yards of concrete would be used for floodwalls, 1,500 cubic yards for the Pompton River diversion spillway, 2,400 cubic yards for the spur tunnel diversion spillway, 2,500 cubic yards for the outlet structure, 205 cubic yards for the Great Piece Meadows Weir and 335 cubic yards for the Pequannock River Weir. Approximately 80,000 cubic yards of riprap and crushed stone would be placed as armoring for channel stabilization. The quantity of drilling muds which would be required for exploratory drilling muds discharge water resulting from geological exploration.

In addition, 200 cubic yards of riprap, rock wing-dams, and boulders would be placed at intervals in the Pompton River for fishery habitat creation.

3. Source of Material: The source of the riprap and bedding to line the channel would be from: 1) local stone quarries, 2) sand and gravel pits, and 3) excavated tunnel material. Fill material needed for constructing levees in wetlands would be from: 1) commercial sources, 2) on site borrow areas, and 3) tunnel excavation material.

1.E. Description of the Proposed Discharge Sites

1. Location:

a. Riprap:

Passaic River at its confluence
 with the Pompton River) ....1,775 feet
Pequannock River (upstream of weir)..........575 feet
Pequannock River.(downstream of weir)......1,680 feet
Wanaque River .... 3,385 feet
Ramapo River ....5,385 feet
Newark Bay Outlet ....150 feet

b. Instream habitat structures would be placed in the project area an: 1) the Pompton River from the Pompton Cross

Roads/Jackson Avenue Bridge downstream along a 13,550 feet long reach to the New York Susquehanna and Western Railroad Bridge; 2) the Pequannock River to Riverdale Road, (an area which is designated as trout maintenance); and 3) the Wanaque River to its confluence with the Pequannock (another area which is under consideration for designation to trout maintenance).

c. Excavated Material: Most uncontaminated material excavated from the channels will likely be hauled to commercial sand and gravel suppliers for resale. Some uncontaminated material that meets engineering specifications could be used to construct levees. Uncontaminated material from the outlet's channel in the Bay will likely be disposed of offshore. Based on our environmental records searches most sediments are not expected to be contaminated. Excavated materials which do not pass the chemical analyses would be disposed of upland or in capped disposal areas offshore in accordance with Federal, State and local regulatory policy. Upland disposal sites would be located during the next planning phase.

d. Levees and floodwalls: Specific locations of levees and floodwalls which would receive reused construction fill materials would not be developed until the next planning phase.

e. Drilling muds: The discharge of investigatory drilling fluids would occur (bentonite and cuttings) into storm drains, onto the ground surface, and into surface waters along the tunnel route.

2. Size of disposal sites

a. Approximately 89 acres of wetlands would be filled during construction as follows: levees and floodwalls (32 acres), inlets (6 acres), workshafts (13 acres) and channel modified side slopes would be excavated and rip-rapped or filled in 38 acres.

b. The channel bottoms which would receive rip-rap or crushed stone is approximately: 1.8 acres on the Pequannock, 12.6 acres on the Wanaque, 10 acres on the Ramapo River, and 7.0 acres on the Passaic River. Refer to their plan drawings for specific locations See Section I.1.B. above.

c. About 11,000 square feet of the Pompton River bottom would receive rock and crushed stone for fish constructing habitat structures.

d. Approximately 89 acres of wetlands would be filled by structural elements:

- o Inlets and workshafts.............. 19 acres
- o Channel modification-sideslopes.... 21 acres
- o Levees/Floodwalls.................. 32 acres

o Pequannock Weir.................... 17 acres

e. Approximately 3.2 acres of bay bottom would be affected by the construction of the outlet structure in a transitional area between the tidal flats lying due south of Kearny Point and west of the Hackenbsack navigation channel. Addendum 2, the Coastal Zone Consistency Determination, Section 7:7E-3.7 describes the outlet stucture and 7:7E-3.39describes the bay bottom.

f. Drill muds - Not calculable at this time. Dependent on drilling location and available disposal conditions.

3. Type of Disposal Site: Disposal would occur in the open water of the rivers, streams and Newark Bay both at confined and unconfined sites, upon terrestrial sites subject to sufficient periodic inundation to qualify them as "waters of the United States" or wetlands, and in storm drains and surface drainages leading to water of the United States.

4. Type(s) of Habitat:

a. Wetlands - Over sixty-five per cent of the wetlands effected are palustrine forests dominated by red maple, pin oak, sweet gum, and white ash. The rest are nearly equal amounts of palustrine scrub/shrub, a mix of scrub/shrub-emergent, or emergent wetlands. Scrub/shrub wetlands contain sapling red maple, common alder, buttonbush, swamp rose, and willows. Emergent wetlands contain cattail, bulrush, pickerel weed, three square, Carex, purple loosestrife, reed canary grass, and phragmites.

b. Riverine - The area of the river where riprap placement would occur varies from riffle-pool complexes to very slow moving (lentic) waters associated with backwater created by the Ramapo and Pequannock Weirs. Stream slopes are given in Section II.A.1. The upper portion of the Pequannock River in the project area is designated as trout maintenance, and the rest as a warmwater fishery. The Wanaque River contains the most diversity, and is under consideration by NJDEP to be designated as trout maintenance for its entire length in the project area. The Ramapo River in the project area is designated as a warm water fishery and is likely to remain so due to its lentic characteristic.

c. Estuarine - Bay bottom (below the photic zone). The bay bottom at the outlet site currently consists of a sand and silt mixture.

d. Catch basins and storm water sewers located in various minicipalities over the tunnel route.

5. <u>Timing and Duration of Discharge</u>:

The entire project would take 7.5 years to complete. Various project element's construction time follow:

Passaic Levee 10................................2Y.O.M
Hurricane Levees-South 1st Street, Turnpike, Doremus,Lister) Kearny Point...................2Y.9.M
Two Bridges Channels..........................2Y.0.M
Tunnel (Tunnel, Inlets, Outlets, Workshafts)....4Y.5.M
Pompton Trib Channels..........................2Y.3.M
Pinch Brook.......................................7.M
Passaic 2A.....................................2Y.1.M
Rockaway 1 ....6.M
Rockaway 2 .... 10.M
Rockaway 3 ....1Y.3.M

Actual timing and duration of fill activities associated with these elements is not yet available.

F. Description of Disposal Method: Fill methodology will vary with the purpose of the specific project element:

o Levees would be constructed with earthen material, which will be placed with earth moving equipment.

o Stones to armor the bottom against erosion would be placed by back hoe and by hand or offloaded from barges.

o Concrete would be poured into forms for intake structures and ancillary features at inlets as well as at permanent work shafts. The outlet structure would be pre-cast and floated into place and lowerd onto piles founded in the bedrock.

o Drilling muds will be recycled for continued used. Excess water will be seperated and discharged by way of a discharge hose.

II. FACTUAL DETERMINATIONS - Relate to impacts See 40CFR 230.11

A. Physical Substrate Determinations:

1. *Substrate Elevation and Slope.*

The Pequannock River elevation ranges between 182 and 162 NGVD in the project area of 14,300 feet with a slope of 7.4 feet per mile.

The Wanaque River elevation ranges between 184 and 174 NGVD in the project area of 1.1 miles with a slope of nine feet per mile.

The Ramapo River elevation ranges between 164 and 174 NGVD in the project area of 1.9 miles with a slope of five feet per mile.

2. <u>Sediment Type:</u> a. Physical substrate changes in the project area:

River	Existing	With-Project
Pequannock River(downstream of weir-bypass channel in existing Pequannock reach)		

Stone/Rip-rap	0.0%	46.5%
Gravel	0.0%	0.0%
Sand	97.5%	48.5%
Silt/Clay	2.5%	1.0%

Pequannock River(2,000 feet upstream of the weir)

Stone/Rip-rap	0.0%	0.0%
Gravel	0.0%	0.0%
Sand	81.9%	82.0%
Silt/Clay	18.1%	18.0%

Pequannock River (Riverdale Road Bridge)

Stone/Rip-rap	0.0%	0.0%
Gravel	67.6%	68.0%
Sand	32.4%	32.0%
Silt/Clay	0.0%	0.0%

Pequannock River(1,200 feet downstream of Paterson-Hamburg Turnpike)

Stone/Rip-rap	0.0%	100.0%
Gravel	1.4%	0.0%
Sand	92.9%	0.0%
Silt/Clay	5.7%	0.0%

Wanaque River(MIn the middle of the channel modification)

Stone/Rip-rap	0.0%	0.0% (1)
Gravel	46.7%	47.0%.
Sand	53.3%	53.0%
Silt/Clay	0.0%	0.0%

(1) Stream will contain rip-rap from 0'-2,645', and 4,700'-5,620'. In these reaches the current make-up of the river bed will change to 100% stone/rip-rap.

Ramapo River (In the middle of the channel modification) (2)

Stone/Rip-rap	0.0%	100.0%
Gravel	39.0%	0.0%
Sand	61.0%	0.0%
Silt/Clay	0.0%	0.0%

Pompton River(near Pompton Inlet, just downstream of Jackson Ave. Bridge) (3)

Gravel	59.3%	59.0%
Sand	40.7%	41.0%
Silt/Clay	0.0%	0.0%

Pompton River(just upstream of its confluence with the Passaic River)

Gravel	0.0%	0.0%
Sand	94.3%	94.0%
Silt/Clay	5.7%	6.0%

Passaic River(1000 feet upstream of its confluence with the

Pompton River)		
Stone/Rip-rap	0.0%	0.0%
Gravel	0.9%	1.0%
Sand	93.5%	93.0%
Silt/Clay	5.6%	6.0%
Passaic River(1000 feet downstream of its confluence with the Pompton River)		
Stone/Rip-rap	0.0%	0.0%
Gravel	1.5%	1.0%
Sand	90.9%	91.0%
Silt/Clay	7.6%	8.0%
Newark Bay(1950 feet South of Kearny Point in Newark Bay)		
Stone/Rip-rap	0.0%	100.0% (3)
Gravel	0.0%	0.0
Sand	60.0%	0.0
Silt/Clay	40.0%	0.0

Legend of size of material Stone/Rip-Rap=6-30", Gravel=>0.19", Sand=0.0029-0.19", Silt/Clay=<0.0029"

(2) The Ramapo-Pompton River confluence will contain a concrete section for the inlet to the tunnel,

(3) Rip-rap will be for the area of flow contiguous to the tunnel outlet structure itself

The locations of the rip-rap and rock is shown on plan sheets in Appendix C - Hydrology and Hydraulics Figures ___ through ___. Specific figures for features are in I.1.B.

o Change in the substrate of the channels as shown on the above referenced plan sheets includes armoring with rip-rap which will provide a hard substrate and interstitial space for habitats for bottom dwelling organisms. It is likely that the with project substrate will provide greater refuge for these organisms than exists at present.

o In areas where no rock or rip rap would be added to the substrate, after excavation the river is expected to return to its present conditions, based on sampling conducted during the planning phase.

3. Dredge/Fill Material Movement: Cofferdams, silt screens and soil filter fabrics would be used to limit material movement. However, some displacement into the affected rivers and Newark Bey would be unavoidable during construction. Effects are expected to last over most of the construction phase in the affected reaches.

4. Physical Effects on Benthos: Some change in organisms will occur in those reaches where water flows would change from lotic to lentic with the project in place (see II.A.1.). Placing pre-cast concrete for the outlet structure and

riprap to prevent erosion of the bay bottom during outlet use, will alter the substrate. The change would result in the loss of soft substrate organisms and the gain in hard substrate species. Recolonization of affected reaches is expected to return benthic communities to pre-project conditions in upstream freshwater rivers.

5. Other Effects: Excavation effects associated with modifying the channels includes the loss of benthics, especially sessile organisms, from the modified reaches. With-project conditions would also effect flow regimes and river bottom morphology in the Pequannock, Wanaque, and Ramapo Rivers. Part I.1.B details the linear extent affected. See also effects on Necton.

6. Action Taken to Minimize Impacts: Part III.H. details the Actions Taken to Minimize Impacts.

II.B. Water Circulation, Fluctuation and Salinity Determinations:

1. Water Quality:

(a) Salinity - minor temporary change with the tunnel's operation, but it would be similar to existing conditions as shown by the water quality models.

(b) Water Chemistry - No change. Fill material is uncontaminated rock and stream-cobble with some concrete and commercial benonite. The uncontaminated materials would not alter stream chemistry.

(c) Clarity - Water clarity would be reduced temporarily during channel excavation, placing riprap and constructing mitigation structures.

(d) Color - The water would become opaque and brown. See II.B.1.(c) above.

(e) Odor - No adverse effect is expected.

(f) Taste - No effect on potable water supply. The discharges are downstream of public water intakes, except for placement of rip-rap, crushed stone and concrete placement. The concrete will be placed using cofferdams, thus preventing exposure to open waters.

(g) Dissolved Gas Levels - Dissolved oxygen levels will decrease during construction due to the rise in biological and chemical oxygen demand associated with resuspending channel sediment. In addition, the loss of shade resulting from removal of riparian vegetation would increase water temperature, especially critical during the summer month, decreasing the ability of water to hold oxygen. Conversion of riffle habitats to pool habitats will reduce aeration potential and may lead to reduced dissolved oxygen levels on Pequannock and Wanaque Rivers.

The Ramapo River levee and floodwall, located on the west bank of the river, would reduce the river's shade. However, because the area is residential, shade is imcomplete now, and the project's river widening would create a greater volume of water, which would be deeper than it is today. Thus, dissolved oxygen decreases from existing conditions are expected to be small. Short reaches of the Pequannock and Wanaque Rivers would also loose shade.

(h) Nutrients - Fill materials are composed of uncontaminated rock, stream cobble and bentonite clays. No increase in nutrients is expected.

(i) Eutrophication - Expansion of lentic waters would be expected to increase retention times with potential increases in eutrophication of the Ramapo, Pequannock, and Wanaque Rivers.

2. Current Patterns and Flow:

(a) The following streams will experience a change from lotic to lentic conditions in the affected reaches.

- o Pequannock River
- o Wanaque River
- o Ramapo River
- o Pompton River
- o Passaic River

Newark Bay's current patterns at the outlet location will change temporarily during flood events.

(b) Velocities. With project velocities in channelized reaches will be reduced where lotic waters are converted to lentic conditions. In the Newark Bay, the outlet's velocities will be held to 2-3 cubic feet per second and should have limited effects on the Bay because it would only occur on average about 5-10 days each year. The following table gives velocities for: a frequent flood event (2-year), a moderately infrequent event (25-year flood), and a rare event (100-year event) with and without the tunnel in operation. This is for the Pequannock River upstream of the Pequannock Weir, the Pequannock Bypass channel, Wanaque River, and the Ramapo River at three selected stations.

Pequannock R. upstream	2 yr.	25 yr	100yr storm
	Velocities in feet per second		
Near Upstream terminus			

Existing	2.4	6.0	3.6
With project	2.4	6.0	4.6
Approx. Midpoint			
Existing	3.7	6.8	4.3
With project	2.4	8.0	5.6
Near Downstream terminus			
Existing	3.4	3.0	4.8
With project	1.5	1.7	5.6

Pequannock River bypass	2 yr.	25 yr	100yr
Near Upstream terminus			
Existing	0.4	0.4	0.3
With project	1.8	4.8	5.8
Approx. Midpoint			
Existing	4.3	4.2	4.3
With project	2.5	8.4	10.9
Near Downstream terminus			
Existing	4.7	4.8	4.5
With project	1.1	3.5	4.7

Wanaque River	2 yr.	25 yr	100yr
Near Upstream terminus			
Existing	3.4	4.2	4.8
With project	3.4	4.2	5.2
Approx. Midpoint			
Existing	2.9	4.0	6.0
With project	4.7	4.9	7.8
Near Downstream terminus			
Existing	2.7	4.8	5.3
With project	3.7	4.0	4.5

Ramapo River	2 yr.	25 yr	100yr
Near Upstream terminus			
Existing	5.3	5.5	6.0
With project	3.9	3.5	7.0
Approx. Midpoint			
Existing	3.8	4.5	7.7
With project	4.2	3.2	11.3
Near Downstream terminus			
Existing	4.7	3.5	8.0
With project	2.5	8.0	9.7

(c) Stratification - none

(d) Hydrologic Regime - No significant effects

3. Normal Water Level Fluctuation - Stages:

The overbank flooding under existing conditions, varies at different points along the river. The operation of the project will allow those level fluctuations to be reduced on average 3-5 feet restricting fluctuations to those of the annual event. Examples of those levels at selected river stations are provided in the following table:

Location	River Station	Water Height Annual event
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
	River Station	100 yr event
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

4. Salinity Gradients:

Gradients would remain the same when tunnel is not operating (on average from 355 to 360 days per year). Minor temporary reductions will occur at the tunnel outlet, lasting for about two hours, but a similar condition occurs during floods now.

5. Action Taken to Minimize Impacts: Actions to minimize impacts are addresses in III.H.

II.C. Suspended Particle/Turbidity Determinations

1. Changes in suspended particulates and turbidity in the vicinity of dredging for channel modifications are expected to increase during construction. No adverse long term changes are expected. Long term beneficial effects include less pollutants entering the river from overland flooding with the project, since floodwaters would be maintained in-banks with the excess water entering the tunnel.

2. Effect (degree and duration) on Chemical and Physical Properties of the Water Column:

(a) Light Penetration - light penetration would be reduced during construction since some suspension of materials is inevitable.

(b) Dissolved Oxygen - Since some streambank vegetation would be removed, the loss of shade and resultant increases in temperature would decrease oxygen's solubility. In Newark Bay, the discharge of oxygen depleted water would be limited in extent and duration, with dissolved oxygen levels dropping below two parts per million in the immediate vicinity of the outfall and persisting for about six hours. See the SEIS section 5.5.

(c) Toxic Metals and Organics - No long-term effects are expected, but increases in organics would occur temporarily during construction.

(d) Pathogens - none known

(e) Aesthetics - Riparian habitat replacement with a combination of riprap and landscape plantings would change the the riverside aesthetics. Temporary turbidity increases would reduce the aesthetic appeal of the river during construction.

3. Effects on Biota:

(a) Primary Production, Productivity - Limited short term effects due to turbidity and suspended materials' effects on phytoplankton and photosynthesis. The outlet structure and riprap channel would create a reef community in Newark Bay which would increase diversity and productivity.

No significant long term adverse effects on the biota of Newark Bay were forecast by the National Marine Fisheries based on the water quality models for Newark Bay.

(b) Suspension/Filter Feeders - No long-term adverse effects, but organisms would be removed during sediment excavation, others would be buried, or have filter mechanisms clogged as a result of increased sediment transportat during construction. Changes in community organizations could occur in stream sections where substrates riverine conditions change from lotic to lentic. During the construction of the outlet many molluscs and polychate worms will likely be lost. Recolonization after construction would be affected by the change in substrate composition. The diversity in bay bottom structure created by outlet would lead to a more diverse invertebrate population.

(c) Sight feeders - No long-term adverse effects, but sight feeders would have reduced fields of vision caused by increased turbidity during construction. These species should reestablish themselves after construction is completed.

(d) Fish

i. Generally, the effects of the project will yield an increase in habitat for: brown trout, adult smallmouth bass, and to a lesser extent spawning smallmouth bass. On the Ramapo River adult bluegill habitat would increase by more than 14%, but spawning habitat would decrease by about 6%. Fish that prefer riffle and pool habitats in the project area in the Pequannock and Wanaque Rivers reaches will suffer significat decreases.

ii. In the estuarine waters of Newark Bay, adult fish are not expected to be adversely affected, but their eggs and larvae would be more susceptible to loss. Losses would in large part be based on the time of year when the tunnel would operate, with the winter likely to have less harmful effects since many of the fish species leave the bay at that time. Actual losses are expected to be minor.

3. Normal Water Level Fluctuations: Stages:

No effects on normal water level fluctuations because of fill.

4. Action Taken to Minimize Impacts:

Part III, Section H discusses the Actions Taken To Minimize Impacts.

II.D. Contaminant Determinations:

No long-term adverse effects are expected.

II.E. Aquatic Ecosystem and Organism Determination:

1. Effects on Plankton: Temporary adverse effects in Newark Bay would occur due to turbidity changes during construction which will effect phytoplankton photosynthesis. Based on the water quality models of Newark Bay, the National Marine Fisheries Service has predicted that the tunnel effects on plankton would not differ significantly from existing flood conditions.

2. Effects on Benthos:

Benthic organisms in the freshwater sections of the project area would be adversely affected during construction. They may be temporarily eliminated from excavated and rip-rapped channel reaches. After completion of the project these organisms would reestablish themselves.

Permanent changes would occur at the outlet site. Sessile organisms requiring soft substrate would be eliminated, with organisms adapted to hard substrate colonizing the site. Benthic organisms at the outlet would be destroyed during construction. Placement of the outlet fill will produce a substrate change from sand and silts to concrete and large rock.

Colonizing benthic organisms would be different species than are now present. The structure of the outlet would increase substrate for organisms that attach themselves to hard surfaces such as barnacles and mussels. A reef community would become established.

3. Effects on Necton:

Construction would cover some spawning areas for freshwater fish species, eliminate a portion of their protective cover, and eliminate most of the aquatic organisms from the construction area. After project completion, they would recolonize the areas. Due to some riparian shade loss, ambient water temperatures will be higher with the project from May through September. The effect would be greater on the Pequannock and Wanaque Rivers because more temperature sensitive fish occur in these reaches. A marginal coldwater fishery may be reduced if temperature changes are severe.

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. These losses would have a temporary and minimal effect on the available food within the aquatic system.

5. Effects on Special Aquatic Sites:

(a) Sanctuaries and Refuges:

No Federal sanctuaries or refuges occur in the project area. A New Jersey State aquatic site is present in the vicinity of the Pompton inlet on the Ramapo and Pequannock Rivers. However, no adverse effcts are expected at this site.

(b) Wetlands - About 53 wetlands acres would be permanenetly lost due to fill associated with the project: levees would account for 34 acres, the spur tunnel for 6 acres, and workshafts for 13 acres. Another 32 acres of wetland would be lost due to dredging and cutting into the channels' sideslopes. Isolation of wetlands in smaller areas would effect another 5 acres.

(c) Mud flats - none

(d) Vegetated Shallows - none

(e) Coral Reefs - N/A

(f) Riffle and Pool Complex - Significant losses would occur as a result of channel modifications.

6. <u>Threatened and Endangered Species:</u>

No threatened or endangered species are known to be adversely affected. Reports of recent discoveries of lactating Indiana Bats will be evaluated during the FDM.

7. <u>Other Wildlife:</u>

The fill used to create levees on wetlands would directly impact wildlife. The carrying capacity of the surrounding areas, which have appropriate habitat are not known; however, the displaced wildlife would be expected to die or replace individuals present in surrounding areas.

8. <u>Action Taken to Minimize Impacts</u>. See Section III H. for details.

II.F. <u>Proposed Disposal Site Determinations</u>

1. <u>Mixing Zone Determinations</u>:

(c) Current Velocity/Degree of Turbulence - the use of cofferdams during construction would eliminate turbulence and sediment transport from some excavation sites and areas where concrete would be poured, simultaneously restricting ambient current velocities which would effect the mixing zone. Cofferdams would be used at the Pompton Inlet, Pequannock Weir, and Great Piece Meadows Weir. The concrete at the tunnel outlet would be pre-cast and dropped into place. In open water sites where channel stabilization takes place these factors would expand the mixing zone.

(d) Stratification Attributable to Causes at Disposal Site - None. Sample data indicates homeothermic conditions in Newark Bay.

(e) Discharge vessel speed and direction - Not Applicable.

(f) Rate of Discharge - Not Applicable

(g) Ambient concentration of constituents of interest/Fill material characteristics:

No significant adverse effect. Fill materials would be from: on site, commercial sources, or tunnel construction and are considered devoid of toxic or hazardous constituents.

(h) Discharge actions/unit of time: Not determind at this time.

2. <u>Determination of Compliance with Applicable Water</u>

Quality Standards:

(a) EP Toxicity Test (See the 1987 Report's Appendix B - Natural Resources, Table B-47.) All constituents passed this test.

(b) Elutriate Tests ((See the 1987 Report's Appendix B - Natural Resources, Table B-47.) All constituents passed this test.

3. Potential Effects on Human Use

(a) Municipal and Private Water Supply. Effect temporary - 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

i. Recreational fisheries effects are expected to be adverse during the project construction period (2-3 years in duration upstream of the Pompton Inlet). For about 2 years after the construction ends, fishing effort would be minimal, until the fishery becomes reestablished.

ii. Commercial Fisheries - none in project area.

(c) Water Related Recreation - See recreational fishery above. Little other water recreation other than some canoeing occurs. During construction this activity would be eliminated. It could however expand with increase in channel depths following construction.

(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 dams are located along the Ramapo and Pequannock Rivers. The Ramapo dam is 800 feet upstream of the confluence with the Pequannock River, while the Pequannock dam is 1600 feet upstream of its confluence with the Ramapo River. The Ramapo Dam is 250 feet wide and 10 feet high. The Pequannock Weir is also 250 feet wide and 9 feet high. The project plan has been designed to avoid adverse impact on these historic dams. Placing the Pequannock gated weir and channel just west of this dam, will avoid adverse effects.

G. Determination of Cumulative Effects on the Aquatic Ecosystem. A change in fishery communities will favor pool species at the expense of riparian species. Creation of a reef community and going in water quality will increase overall production.

H. Determination of Secondary Effects on the Aquatic Ecosystem

The Pequannock, Wanaque, Ramapo and Pompton Rivers would be changed significantly during the project's operation. Floods greater that the 2 year event will bypass the inlet with a resultant decreases in the depths and velocities from existing conditions. First the gated weir on the Pequannock River will open, increasing velocities upstream and leading to possible intrainment of fish. In such instances, the Pequannock River velocities with the project would be less than without the project. The same is generally true for most of the reach of the Ramapo River. During floods, flows on the Pompton and Passaic Rivers would increase, but not to the magnitude they now do because most of the excess flood water would be diverted into the tunnel. Flows would be limited to bank full condition. These reductions in volume and velocity would effect sediment transport with potential minor effects on bottom slope and contours. Minor increases in sedimentation would occur upstream of the inlets on the Passaic and Ramapo Rivers and some reduction in scour on the Pompton River downstream. Such chances could have minor effects on riverine ecosystems. The species composition of aquatic community in the affected freshwater reaches are expected to change due to change in flow from a lotic to a lentic regime and due to warmer summer water temperatures caused by loss of riparian shade.

Tunnel discharges would increase current flows in the vicinity of the outlet on the Droyer's Reach of the Hackensack River channel. The outlet has been designed to reduce velocities to 2 feet per second for the 100-year event by the time it reaches the navigation channel. Modeling indicates that the flows would be below the threshold that would increase sediment transport over existing conditions. Aquatic conditions within Newark Bay would mimic natural conditions with the tunnel in operation.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

III.A. Adaptation of the Section 404(b)(1) Guidelines to this Evaluation:

Project is in compliance - under Part 230 II, Subpart A 230.12.

III.B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Sites, Which Would Have Less Adverse Impact on the Aquatic Ecosystem.

No available practicable alternatives to the use of riprap in the river bed for prevention of erosion, was found.

Investigation of alternatives to the placement of levees in the wetlands revealed that none were practicable.

Alternative solutions for tunnel inlets, work shafts, and outlet construction were analyzed in the 1987 Feasibility Report and determined to be uneconomical or more expensive than the current project. A futher update of nonstructural buyout of the floodplain is included in this GDM which also reached the same conclusion.

III.C. Compliance With Applicable State Water Quality Standards

Project is in compliance; no long-term effects are expected.

III.D. Compliance With Applicable Toxic Effluent Standards or Prohibition Under Section 307 of the Clean Water Act.

The project is in compliance.

III.E. Compliance With Federal Endangered Species Act 1973

The project is in compliance; no federally endangered marine species or habitats for these species have been identified in the project area or at the disposal sites. Section 7 Consultation with USFWS has been completed.

III.F. Compliance With Specific Protection Measures for Marine Sanctuaries Designed by the marine Protection, Research and Sanctuaries Act of 1972

The project is in compliance; the federally endangered Indiana Bat has been reported in the project area. Additional USFWS studies will be initiated during the FDM stage.

III.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) Commercial Fisheries - No effect; none present

2. Significant Adverse Effects on Life Stages of Aquatic Life and Other Wildlife Dependent on Aquatic Ecosystems

(a) Plankton - No significant effect.

(b) The Pequannock River to Riverdale Avenue has been redesignated as trout maintenance from non-trout warmwater. The Wanaque River, has a marginal coldwater fishery and may be designated as trout maintenance in the project area. In addition it has a good warmwater fishery. This river may lose its marginal coldwater fishery as a result of project implementation. The Ramapo River, because of its current lentic nature, is likely to change in designation from a non-trout warmwater fishery. See II.C.3.

(e) Shellfish Species - No significant effect; no effect on human health and welfare.

(f) Wildlife - No significant effect. See - for wetland impact discussion.

(g) Special Aquatic Sites - State Gravel Bar Site in the area of the Pequannock, and Ramapo Rivers near the Pompton Inlet may be impacted.

3. <u>Significant Adverse Effects on Aquatic Ecosystems Diversity, Productivity and Stability</u>

Effects are not significant in the long term. Short term construction effects would be severe, however.

No significant effects on balance with use of aquatic habitat mitigation. The Pequannock, and Wanaque Rivers are likely to lose their trout maintenance fishery. Part II, Section C.3.(d) discusses changes for species monitored. Section E3 also provides fishery information.

4. <u>Significant Adverse Effects on Recreational, Aesthetic and Economic Values</u>.

(b) Recreational Fisheries - adverse impact during construction (2.0-3 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 will help mitigate adverse effects.

III.H. <u>Appropriate and Practicable Steps taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem</u> Redesign/re-engineering during the PED phase reduced impacts by avoidance or minimization wherever practicable. This effort has greatly reduced structural elements, thus avoiding many impacts. Redesign of Project elements reduces wetland impacts as follows:

- o Interior drainage ponds from .... 600 acres to 6 cres
- o Near inlet effects from .... 95 acres to 19 acres
- o Channel sideslopes from ....45 acres to 38 acres

o Levee/floodwall footprint from ....37 acres to 32 acres

Redesign of the Pompton tunnel inlet has allowed a reduction in levee/floodwall systems upstream of the Pompton Inlet from 5 to 1, and the remaining system has been reduced in size. Also the river flow restrictor just above Jackson Ave./Pompton-Crossroads has been eliminated.

Pumps, sluice valves, and flap gates will be employed to insure wetland ponding areas' integrity in the interior of levees. The Great Piece Meadows Weir maintains the wetlands integrity for those areas of the meadows which would have been adversely impacted by operation of the tunnel. Silt screen, soil fabrics, and cofferdams will be used to reduce or eliminate spillage of material during construction. Instream habitat structures, cobble placement and riprap will be used to offset project related instream habitat losses. Wetland mitigation plans utilize restoration actions on previous disturbed wetlands to offset project impacts.

Confining the channel cuts to the north and east side of channels wherever possible will reduce the loss of shade and increased stream temperature. Use of habitat structures will replace substrates lost to channel excavation and allow benthic organisms to reestablish themselves. Further reduction are obtained by placement of channel to one side allowing one natural bank to remain. Riprap will be placed as necessary on bank slopes to prevent erosion and will also enhance aquatic habitats.

Wetland impacts have been greatly reduced from the former plan. The PED phase reexamined the procedure to be used for the storage of water (interior drainage) associated with the levees. This lead to a dramatic reduction in the impacts. Adversely effected wetland ponding areas were reduced from 600 acres to 5 acres. Redesign near the tunnel outlet reduced impacts there from 95 acres to 19 acres. Small reductions in wetland impacts were also achieved for the reductions in levees (37 acres to 32 acres) and channel sideslopes changes (45 to 34 acres).

Erosion and siltation will be controlled by the use of silt fences and retention basins will be utilized for levee and floodwall construction to retard translocation of suspended material. Cofferdams will be used to contain the effluent from poured concrete for inlet and outlet structures and weirs. Cellular sheetpile cofferdams will be used to form dry areas to construct structures in channels.

III.I. <u>On the Basis of the Guidelines, the Proposed Disposal Site(s) for the Discharge of Dredged or Fill Material</u>

Specified as complying with the requirements of these guidelines.

ADDENDUM 2

ADDENDUM 2

NEWARK BAY AND THE PASSAIC RIVER FLOOD CONTROL PROJECT'S PRECONSTRUCTION ENGINEERING AND DESIGN

CONSISTENCY DETERMINATION
FOR THE
FEDERAL COASTAL ZONE MANAGEMENT ACT'S SECTION 302
AND
NEW JERSEY'S COASTAL AREA FACILITY REVIEW ACT

The Federal Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.), Section 306, requirements and the New Jersey Coastal Management Plan's procedures for a Consistency Determination were addressed in the 1987 report. A consistency determination was filed, with a copy of the letter documenting the determination of consistency of compliance included as Attachment A21 of Appendix A - Public Involvement and the Division of Coastal Resources, reply is included as Attachment A21, New Jersey State letter of January 11, 1988.

Subsequently, Congress changed the recommended plan in the Water Resources Development Act of 1990 (P.L. 101-640, dated November 28, 1990). This Consistency Determination updates the earlier Determination and brings it into conformance with the realigned tunnel which eliminated nine levee systems which would have covered 13.5 linear miles in the Lower Valley.

This updated Determination of Compliance is provided to meet Federal and State requirements under the Coastal Area Facility Review Act (CAFRA, N.J.S.A. 13:19-1 et seq.), the Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et seq.) and the Waterfront Development Law (N.J.S.A. 12:5-3). These procedures also seek a state Water Quality Certificate pursuant to Section 401 of the Federal Clean Water Act, 33 USC 1251 et seq. This approval is sought in conjunction with the foregoing permit applications.

There will be no adverse effects on coastal resources caused by the project. This applies to Newark, as a city in the Northern Waterfront Region as well as to natural resources and man-made structures itemized in the guidelines and this Addendum.

FINDING OF COMPLIANCE FOR NEWARK BAY AND
THE PASSAIC RIVER NEW JERSEY FLOOD REDUCTION PROJECT

1. No significant adaptation of the guidelines were made relative to this evaluation.

2. No significant adverse impacts are foreseen relative to the "Special Urban Area" of Newark, New Jersey or other "Areas of Coastal Zone Management Concern" including anadromous fish, wetlands, historic and archaeological sites, hazardous and toxic substance sites, scenery (aesthetics), or traffic (transportation).

3. No significant adverse effects will result from the flood control plan.

4. On the basis of the published guidelines: "Rules on Coastal Zone Management", N.J.A.C. 7:7E, as amended July 18, 1994, the Passaic River Flood Reduction Project is in compliance with the Federal and State Coastal Zone Management Plan.

COASTAL AREA FACILITY REVIEW ACT, ET AL.
CONSISTENCY DETERMINATION

Pursuant to the Federal Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.), Section 306, the New Jersey Department of Environmental Protection is tasked with the management of the coastal zone under the State's Coastal Management Plan, approved in September 1978, as amended to 7/18/94. The principal authorities that govern the procedures addressed with this Consistency Determination are the Coastal Area Facility Review Act (CAFRA, N.J.S.A. 13:19-1 et seq.), the Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et seq.) and the Waterfront Development Law (N.J.S.A. 12:5-3). These authorizations also govern the review of Water Quality Certificates issued pursuant to Section 401 of the Federal Clean Water Act, (33 USC 1251 et seq.), when approvals are sought in conjunction with the foregoing permit applications for work in the coastal zone. In meeting this requirement this Determination is cross referenced with the 404(b)(1) evaluation presented as Addendum 1 and prepared for the freshwater of the project.

Chapter 4 of Supplement 1 to the Environmental Impact Statement documents the existing conditions for significant resources which include some of the parameters which fall within the domain of the legislation listed above. The project's environmental effects on significant resources are documented in Chapter 5. This addendum describes parameters which could be affected by the project and describes potential project effects.

The organization of the consistency determination parallels the guidance offered in the New Jersey Department of Environmental Protection (NJDEP) "Rules on Coastal Zone Management, N.J.A.C. 7:7E, as amended July 18, 1994", and emphasizes the relevant portions identified in consultation with NJDEP staff as follows.

7:7E-3.5 Finfish Migratory Pathways Finfish surveys in the Lower Passaic River and Newark Bay documented the existence of alewife or river herring (Alosa pseudoharengus), blueback herring (Alosa sapidissima), American shad (Alosa aspidissima), striped bass (Monroe saxatillis), and American eel (Anguilla rostrata). The tunnel outlet in Newark Bay will not adversely effect finfish migratory pathways (NMFS, 1995).

7:7E-3.6 Submerged Vegetation Habitat Not applicable. These habitats are not present in Newark Bay in the vicinity of the project.

7:7E-3.7 Navigation Channels Two navigation channels exist in northern Newark Bay. The Passaic River Channel would not be affected by the plan because it lies to the west of the tunnel outlet. The Hackensack River Channel, named the "Droyers Point Reach", would be adjacent to a transitional area leading easterly and away from the tunnel outlet. These channels are maintained by the U.S. Army Corps of Engineers and marked by U.S. Coast Guard buoy numbers 38 and 39 on National Oceanic and Atmospheric Administration National Ocean Survey Chart Number 12327.

The tunnel outlet will be built in Newark Bay in the transitional area between the tidal flats lying due south of Kearny Point and west of the Hackensack River's navigation channel. A gated fan-shaped outlet structure and channel designed to convey tunnel water away from the inlet toward the Hackensack Channel will also be dredged. Navigation will not be hindered by the location of the tunnel outlet. See Appendix C - Hydrology and Hydraulics, Figure ____ for the outlet's location relative to the Hackensack Navigation Channel.

Velocities of two feet per second as the discharge enters the Hackensack Navigation Channel are designed to minimize impacts on navigation traffic.

7:7E-3.10 Marina Moorings Marine moorings do not occur within the geographic limits of this flood control plan.

7:7E-3.11 Ports Port Newark is located about 5,000 feet south of Newark's levee systems and more than one and a half miles southwest of the tunnel outlet. The project would not interfere with activities in Port Newark.

7:7E-3.12 Submerged Infrastructure Routes Sumberged infrastructure will be accommodated and not adversely affected by the project. Appendix G - Structural, Section 10, Tidal Area Protection Floodwalls lists all utilities crossing by project feature. Section 10.3.5 describes the construction sequence which would be followed to accommodate the submerged routes.

7:7E-3.13 Shipwrecks and Artificial Reefs These special areas include "all permanently submerged or abandoned remains of vessels which serve as special marine habitat or are fragile historic and cultural resources". There are no reefs or shipwrecks in the navigation channel near where the tunnel outlet would be located, as the channel is periodically dredged to maintain navigation.

7:7E-3.15 Intertidal and Subtidal Shallows There will be no direct project impact on subtidal shallow flats in Newark Bay. The outlet structure's gate sill would be at -21 feet mean sea level (msl) and the fan shaped channel would transition to -30 msl at the Hackensack Channel.

Additional information related to intertidal and subtidal shallows is in_______.

7:7E-3.23 Filled Water's Edge Filled water's edge characterizes the lower Passaic River and Newark Bay. Historic wetlands maps and verbal description of the first European settlers document that wetlands originally fringed the entire estuary. Current drilling logs verify that mixed rubble and other unconsolidated landfill is located along the riverbanks where walls and levees are planned for flood control. The flood protection structures are water dependents Public waterfront access is addressed in 7:7E-8.11.

7:7E-3.25 Flood Hazard Area The entire flood project area falls within the Federal Emergency Management Agency's and New Jersey's designated flood hazard areas. The project will not induce unwise development or related flood losses. The planned levees and floodwalls would provide up to a 500-year level of protection for the existing intensely developed industrial area.

7:7E-3.27 Wetlands Almost all of the wetlands in the Passaic River's lower valley have been filled and/or destroyed, as documented by historic maps and verbal accounts. None of the remaining acreage would be affected by the project. See SEIS 1, Section 4.8.

7:7E-3.28 Wetland Buffers Not applicable. See above.

7:7E-3.34 Steep Slopes Not applicable. No slopes exist since original landscape was wetlands.

7:7E-3.36 Historic and Archaeological Resources A Programmatic Agreement among the U.S. Army Corps of Engineers New York District, the Federal Advisory Council on Historic Preservation, and the New Jersey State Historic Preservation Officer dated March 31, 1993 governs the treatment of these resources. Cultural Resources Surveys indicate no significant cultural resources exist in the project area within the coastal zone.

7:7E-3.38 Endangered or Threatened Wildlife or Vegetation Species Habitats No species listed as endangered or threatened were found to occur within the Coastal Zone Area by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

7:7E-3.39 Critical Wildlife Habitats There are a series of spartina alternatives which fringe Newark Bay around the south tip and east side of Kearny Point that totals about 5.5 acres. Beyond this is a tidal flat of approximately 30 acres. In addition two abandoned boat slips, approximately 220 feet by 100 feet and 200 feet by 640 feet are located on the right/west side of Kearny Point in the project area.

The Spartina fringe is on the bay side of where levees and floodwalls are planned and will be effected by the project. The total flat lies closer to the Kearny Point than the tunnel outlet. Further, the outlet wastes are directed toward the Droyers portion of the Hackensack navigation channel and therefore away from the tidal flats.

The two boat slips areas will be effected by the project. As now proposed they will be blocked-off as part of the project. This will have the benefit of project reducing costs substantially for the State of New Jersey and Federal Government. There is however, the potential that these sites may act as holding areas for various fish species, such as stripped bass. Since this features has only been recently designed to minimize costs, full study of possible fishery impacts await the next Feature Design Memorandum, phase.

7:7E-3.40 Public Open Space Limited public open space exists within New Jersey's Coastal Zone in Newark Bay that would be affected by the tunnel plan. The largest site is at the John F. Kennedy athletic field in Harrison along the Passaic River's eastern bank. The athletic field is surrounded by a very high chain link fence that separates the field from the river and prevents access to it. The project calls for a floodwall between the field and the river that would obstruct river views. Recreation mitigation at the field includes a waterfront opening in the wall and the construction of a platform for small boat launching and fishing. Vines would be planted to add a natural touch. Other levee and floodwall systems would limit the use of the river in industrial reaches, however, where there are residences such as in Harrison, recreational facilities including picnic tables, grills, and trash baskets along with fishing access would also be provided just north of Harrison Street at the South First Street System where an undeveloped open space exists on the east bank. Across the river in Newark, adjacent to the Ironbound neighborhood, a promenade providing waterfront access is planned.

7:7E-3.41 Special Hazard Areas Various regulated sites, are located throughout the Lower Valley's floodplain within the regional coastal zone area's domain. Sites range from national

Priorities' List (Superfund) status to New Jersey Department of Environmental Protection sub bureau classifications. Each regulated site was conservatively evaluated for its occupational health risks. In addition, all sites were evaluated for environmental impacts based upon Federal, State and local regulatory criteria. The risk-based calculated values indicate that dermal-contact exposure to contaminants at most worksites would pose low to negligible cancer and non-cancer health risks in an occupational exposure scenario.

The only site where cancer risk estimates indicate potentially serious occupational health concerns is the Maxxus/Henkel/Diamond Alkali property, a know dioxin site on Lister Avenue in Newark. An approved remediation plan calls for creating an impermeable cap and wall surrounding the site. The Environmental Protection Agency is requiring Maxxus Corporation to construct floodwalls at the Diamond Shamrock site to U.S. Army Corps of Engineers design specifications. The toxicological and ecological assessments are elaborated upon in Appendix F - Hazardous, Toxic and Radioactive Waste Investigation.

In all instances where any intrusive activities or construction will be conducted at known or suspected HTRW sites (based on knowledge of past usage) the Corps will develop Health and Safety Plans which will be certified by industrial hygienists. Additional information is in 4.3 and 5.3 Regulated Substance Sites.

7:7E-3.43 Special Urban Areas The City of Newark has been designated as a "special urban area" qualifying it to receive State aid for upgrading municipal services and offsetting local property tax losses. Levees and floodwalls would limit the use of the river in some industrial reaches, but a promenade providing waterfront recreational and fishing access will be provided adjacent to the Ironbound neighborhood. Industries that require waterfront access will have that option made available through special openings in the floodwalls. The high level (500-year recurrence interval) of flood protection afforded by the plan will assist the restoration of Newark's waterfront by increasing property values and redevelopment potential.

Another special hazard area is the dioxin contaminated sediments in the Lower Passaic River, with floods today dioxins are scoured from sediments in the Lower Valley and carried into Newark Bay. With the tunnel, high volume scouring will not occur in the most polluted reaches of the Passaic River and relatively clean water emerging from the Highland province will be captured by the tunnel's inlet and removed from the basin before they have the opportunity to flow across flood plains picking up contamination.

7:7E-3.47 <u>Geodetic Control Reference Marks</u> The project will not move, raise, lower or disturb any geodetic control reference marks to accommodate construction.

7:7E-4.2(g)(1) <u>New Dredging</u> New dredging of previously undreged areas would be required to construct the tunnel outlet structure with a coffer dam and to dredge the fan-shaped spillway which will convey tunnel water away from the outlet.

Refer to the Appendix G - Structural, Section____ for details of the construction methodology for the tunnel outlet. In summary: the tunnel outlet will be built in Newark Bay in the transitional area between the tidal flats south of Kearny Point and the Hackensack River's navigation channel. The tunnel outlet shaft will be constructed within an 80 feet diameter circular sheet pile cofferdam. The cofferdam will be filled with sand and a freeze wall constructed to advance the shaft into the bed rock. The outlet's gate structure will be floated and founded on piles driven into bedrock. The gated fan-shaped outlet structure and channel designed to convey tunnel water away from the inlet will also be dredged to remove sediments. The upper 5 to 10 feet of recent deposits of organic silts and sands may be contaminated and the excavated soils may require special disposal in accordance with NJDEP standards. No contamination is expected in the underlying pleistocene soils which can be disposed of in a conventional manner.

7:7E-4.2 The reader is referred to Addendum 1 for the Supplemental 404(b)(1) Evaluation, Section _____ for details of disposal of dredged material in accordance as with the Federal Guidelines for the Specification of Disposal sites for dredged or fill material (40CFR 230).

7:7E-4.2(q) <u>Outfalls and Intakes - Stormwater Effluent</u> Today flood water sweeping out of the channels picks up a host of contaminants from the floodplains. Fifty hazardous, toxic and radioactive waste sites in the 100-year floodplain in the Central Basin and Lower Valley contribute pollution to floodwater, along with home heating oil, gasoline and other automobile solvents which become waterborne during floods. On-site sewage cesspools contribute to the mix, and municipalities combined sewage treatment plants usually become overwhelmed during floods so they must discharge raw sewage into floodwater. These are the sources of contaminated floodwater today.

With the project in place, relatively clean floodwater would be diverted from Wanaque, Pequannock and Ramapo River basins before it would leave its channels. It would be conveyed directly to Newark Bay before it had an opportunity to become contaminated in the floodplains along the Central Basin and Lower Valley. Therefore, the quality of the stormwater effluent entering Newark Bay would be higher than the polluted slug entering the bay under existing flood conditions.

7:7E-6.3 Secondary Impacts Secondary impacts, defined here as additional development likely to be constructed as a result of the approval of a particular proposal, would occur with this project in place and is considered to be beneficial in this urbanized setting. With the flood protection afforded by the project's levees intensification of land uses and levees project's in the "Special Urban Area" of the City of Newark, redevelopment would occur in accord with Newark's redevelopment plans, increasing property values appropriate to their plans.

7:7E-7.11 Coastal Engineering Coastal engineering is defined as a variety of structural and non-structural measures to manage water areas and shorelines for natural effects of erosion, storm and sediment movement. No structures are being built exclusively for constant engineering purposes. However, approximately 2,700 linear feet of floodwall would be constructed from open water at the Kearny Point Levee/Floodwall and the Lister/Turnpike/Doremus/Levee Floodwall System.

7:7 E-8.2 Marine Fish and Fisheries Based on the National Marine Fisheries Services fisheries surveys performed for this project in Newark Bay, the Corps' Waterways Experiment Station's mathematical modeling of the water quality in the Bay, and the Steven's Institute of Technology's modeling of water quality in the tunnel, the effects on marine fish and fisheries is not deemed to be significant (WES, NMFS, 1995).

The flood Control project will not exacerbate any of the criteria under consideration when compared with the existing flood conditions when a host of pollutants is carried from the floodplains into Newark Bay. The tunnel outlet will not interfere with finfish spawning runs, or reduce the critical capacity of estuaries to function as finfish nursery areas, nor reduce the summer dissolved oxygen below ambient existing conditions. Heavy metal loads carried into the Bay will be less than occurs with floods today.

7:7E-8.4 Water Quality The flood control project will not exacerbate any of the CZM criteria under consideration when compared with the existing conditions. Water quality is addressed in Addendum 1, Supplemental 404 (b)(1) Evaluation

Section _____ and in 4.5 and 5.5.

7:7E-8.6 Groundwater Use The infiltration of groundwater into the tunnel will be minimized by: 1) grouting during construction, 2) placing a 15 inch thick lining of concrete, and 3) retaining water in the tunnel at sea level.

7:7E-8.7 Stormwater Management Although the guidelines for stormwater management do not apply to this project, the tunnel would, in fact, achieve the overall goal stated in the guidelines of the "post-construction...reduction from the pre-development level of total suspended solids and soluble contaminants in the stormwater". Section (c) Standards relevant to stormwater management system design,again, do not apply to the magnitude of this project. In fact, the Passaic River Flood Reduction Plan is the designated "Regional Stormwater Management Plan" to which the guidelines require builders should conform. All calculations related to runoff and discharges related to storms are detailed in Appendix C - Hydrology and Hydraulics.

7:7E-8.8 Vegetation The project will have no impacts on vegetation in the coastal zone.

7:7E-8.11 Public Access to the Waterfront Site plans include integrating riverside trails into levee and floodwalls designs were ever feasible. However, in most locations they have not been included for the following reasons: 1) insufficient space between floodwalls and existing industrial buildings and the shoreline, 2) the industrial nature of existing development creating an ambiance that is not compatible with recreational or aesthetic uses; 3) the large number of hazardous, toxic, and radioactive waste sites through most of the leveed reaches; 4) contaminated fish and shellfish, in the Passaic River and Newark Bay, which are under a State Department of Environmental Protection Advisory not to eat finfish or shellfish taken from or the lower Passaic River; 5) the malodorous emanations from the industries and the Passaic River Sewerage Commission's sewage treatment plant and 6) the absence of residences and potential users. Trails would be provided adjacent to residential areas in Newark's Ironbound neighborhood and in Harrison at the South First Street Levee system. Harrison will also have a small boat launching and fishing platform built adjacent to the John F. Kennedy Athletic Stadium, which would be accessible through an opening in the floodwall.

7:7E-8.12 Scenic Resources and Design Scenic resources include views of natural and/or built landscape. This refers to new developments. Nonetheless, landscape architects were employed to integrate wooden fences to screen floodwalls in residential areas. Floodwalls will be aesthetically improved by planting native vines and native plants to improve the levees of aesthetics.

7:7E-8.13 <u>Buffers and Compatibility of Uses</u> Buffers are natural or man-made areas, structures, or objects that serve to separate distinct uses or areas. The surface elements of the project have integrated aesthetics with the use of landscape architectural elements including native plants on levees and wooden fencing to screen floodwalls in residential areas. Floodwalls in industrial areas would be beautified with native vines.