Making the Environmental Process Work: The Trenton Complex

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ABSTRACT

The Environmental Impact Statement on the Trenton Complex Highway System is a classic example of how, through extensive and meaningful coordination, a highly complex and controversial highway project can move through the process of the National Environmental Policy Act (NEPA) to implementation with the full support of all review agencies as well as those that issue permits. Throughout the NEPA process, the Trenton Complex received broad-based public support while simultaneously being shadowed by well-defined and intricately interrelated environmental concerns--mainly those related to cultural resources and wetlands. The challenge was to minimize or eliminate these and other environmental problems while simultaneously maintaining public support, keeping construction cost down, minimizing delays, and refraining from creating new environmental problems as a result of resolving existing ones. What finally evolved during the coordination process was an ingenious compromise, carefully integrated with the design efforts, which resulted in substantial cost savings while simultaneously protecting otherwise adversely impacted archaeological resources and wetlands areas. Many review agencies such as the Advisory Council on Historic Preservation have referred to the Trenton Complex project as a textbook case of how environmental studies on transportation and other development projects should be carried out. This praise illustrates that the team concept used for this project, with all participants pulling together toward a common goal, can succeed even in projects as environmentally challenging as the Trenton Complex.

Completion of the final links of the I-195/I-295, NJ 29, NJ 129 system near Trenton, New Jersey (commonly referred to as the Trenton Complex project), has long been a top-priority item for the New Jersey Department of Transportation (NJDOT) and FHWA. Without the Trenton Complex project, the partially completed Interstate highway and freeway system in and around Trenton could not meet the Interstate and regional transportation needs for which it was designed (Figure 1). Without the Trenton Complex project, local roads would have to continue serving Interstate and regional traffic movements and, as a result, would continue experiencing severe congestion and high numbers of traffic accidents. Clogged roads in the Trenton area would continue to act as an impediment to the economic revitalization plans of the city.

PROJECT DEVELOPMENT

Planning for the highway project proposed for Trenton began in the late 1950s. During the ensuing years, numerous configurations of roadway links were considered with several different proposals reaching advanced levels of planning and design. Public hearings were held in the early 1960s and alignment approvals were obtained in the mid-1960s. Final design was completed and certain property acquisitions, relocations, and clearings were accomplished in the late 1960s, before enactment of the National Environmental Policy Act (NEPA) in 1969.

With the enactment of NEPA, the proposed project underwent review to check for compliance with the new law. Comprehensive environmental studies began in 1974, leading to a Draft Environmental Impact Statement (EIS) issued in 1976. After extensive consultation and coordination with review agencies and affected communities, the Final EIS was approved in 1981. This document included commitments for new final design for almost the entire project. In accordance with the Final EIS, comprehensive mitigation programs have been or will be implemented, and the entire project is currently in various stages of final design, construction, or both.

OVERVIEW OF ENVIRONMENTAL ISSUES

The Trenton Complex project was characterized by a large number of potentially severe adverse impacts for which creative solutions and mitigation measures had to be developed before approval for proceeding with construction. These potential impacts included:

- Infringement of the highway on major portions of the Abbott Farm National Historic Landmark, one of the most significant and valuable archaeological resources in the eastern part of the United States, and loss of portions of other archaeological districts and sites.
- Infringement on significant portions of the Crosswicks Creek Wetlands system, considered one of the most valuable wetlands in the Upper Delaware Estuarine System.
- The taking of 7 park and recreational facilities in Trenton.
- Significant aesthetic impact through loss of more than 75 mature shade trees along a principal urban street.
- Significant noise impacts to residential areas adjacent to the roadway.

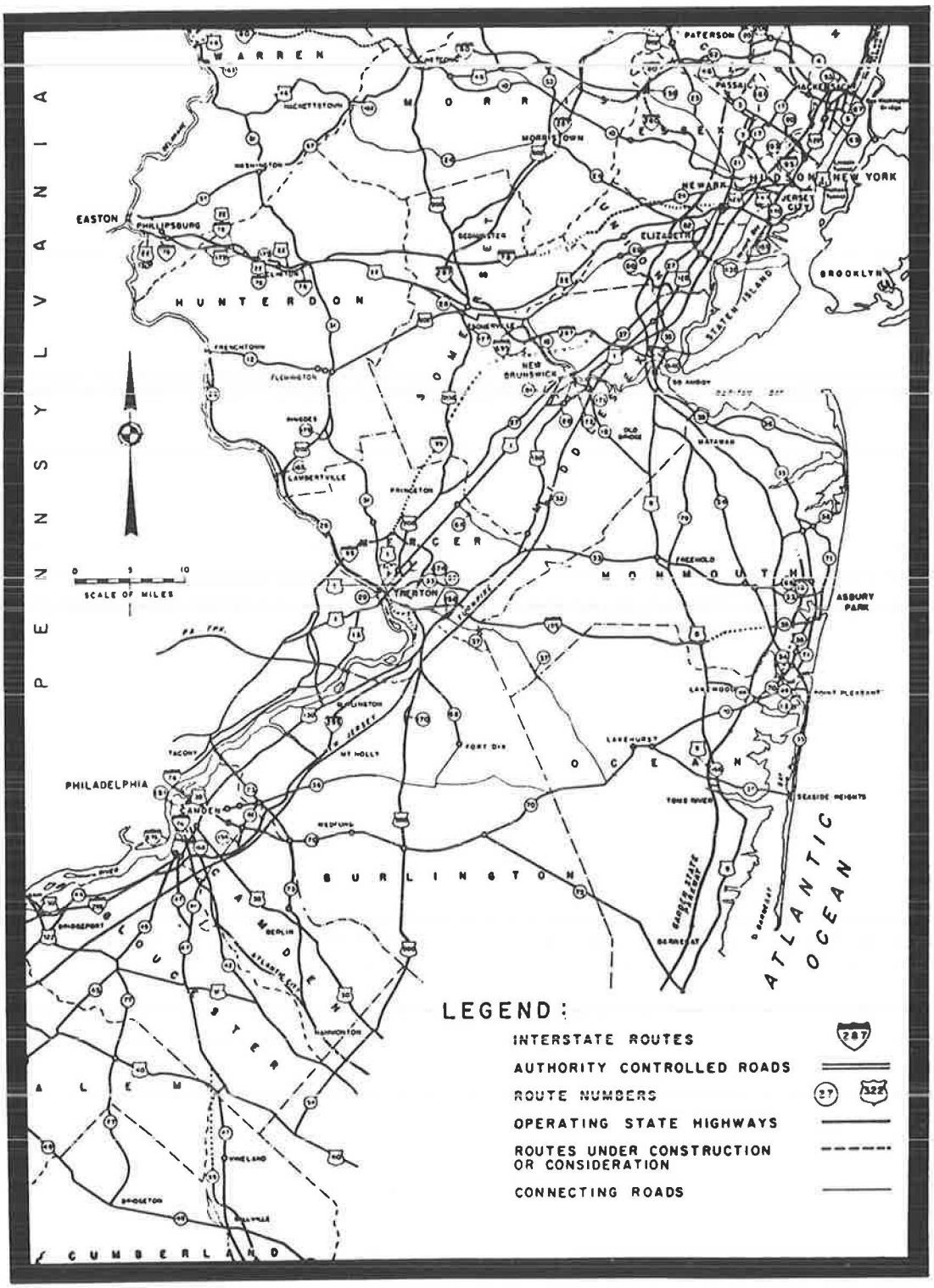


FIGURE 1 Regional highway systems.

Because the project involved construction of relatively short links (each between 1 and 6 miles long) to an otherwise completed Interstate highway and freeway system, there were no easy solutions to these environmental problems, such as might have been entailed in a major shift or roadway alignment (Figure 2). Moreover, potential mitigation measures to address one environmental issue had to be considered in terms of their own possible adverse effect on other environmental issues. For example, in the major interchange area between the I-195 and I-295 links, a shift of the alignment away from

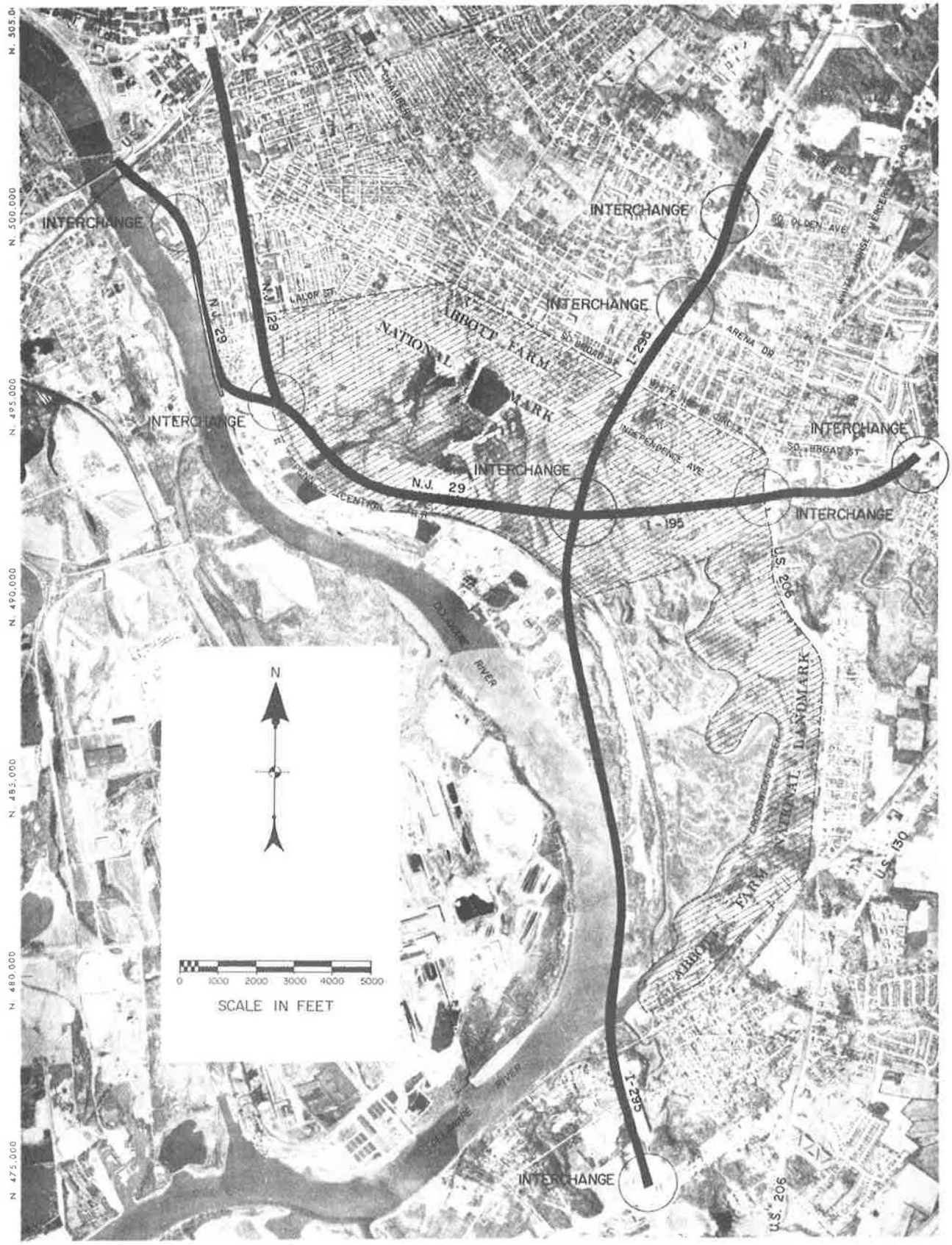


FIGURE 2 Recommended alternatives for I-195/I-295, N.J. 29, N.J. 129.

prime archaeological resources within the Abbott Farm National Historic Landmark could result in the taking of more wetlands and vice versa.

As a result of the complexity of interrelationships among environmental issues, a wide range of alternatives were posited and examined in the preparation of the Draft EIS. These alternatives included 11 system configurations for the 6 major links of the project, 5 location alternatives for 1 link, and a total of 13 design alternatives for 2 links and the major I-195/I-295 interchange. In combination, this array of alternatives resulted in 125 separate and discrete design-location alternatives for the entire project. It was only through continual coordination and consultation with federal, regional, state, county, and municipal agencies--both during the environmental studies and throughout the subsequent mitigation programs--that consensus was reached that both satisfied the regional transportation needs and protected and preserved to the maximum extent possible important environmental features and resources in the project area.

The extensive coordination for the Trenton Complex project can be conveniently divided into two basic stages:

Stage I: Consultation during the preparation of the Draft EIS and Final EIS
Stage II: Consultation after approval of the Final EIS in 1981 on the major mitigation programs for the Abbott Farm National Historic Landmark and the Crosswicks Creek Wetlands system

A summary of Stages I and II and a more detailed description of Stage II are presented in the following sections. This focus has been selected because

- The archaeological impacts and the wetlands impacts presented the greatest obstacles to the implementation of the highway project.
- Archaeological features and wetlands resources were spatially fused, thereby creating additional impediments to developing an environmentally acceptable mitigation program.
- The archaeological and wetlands mitigation program developed was one of the most comprehensive ever undertaken for a highway project.
- The success of the archaeological and wetlands mitigation program has been hailed as a classic example of how the needs for both transportation improvement and environmental protection can be met despite formidable challenges and constraints.

STAGE I: CONSULTATION DURING PREPARATION OF DRAFT AND FINAL EISs

Abbott Farm National Historic Landmark

Background

The Abbott Farm National Historic Landmark is a 2,000-acre site located generally southeast of Trenton and includes both wetlands and upland terrace areas. The Abbott Farm area was first brought to prominence through the work of Dr. C.C. Abbott in the late nineteenth century. His theories about the antiquity of man in the New World, based on research in the Trenton area, subsequently inspired a number of professional excavations in and around Abbott Farm during the past 100 years.

Abbott's pioneering efforts and subsequent excavations have made the Abbott Farm site one of the best known areas of prehistoric habitation along the eastern seaboard of the United States. Archaeological evidence has been underscored for the entire known span of human occupation in the New World ranging from Paleo-Indian (about 10,000 B.C.) through late Woodland (about 1400 A.D.). In addition, Abbott Farm contained important historic sites from the eighteenth and nineteenth centuries. Ironically, despite its national prominence, the cultural resources within the Abbott Farm National Historic Landmark had never been definitely determined before the Trenton Complex project.

Impacts

The original design of the Trenton Complex project during the 1960s was completed before Abbott Farm was declared a national historic landmark. The original design would have resulted in loss of approximately 400 acres of the landmark and an indeterminate loss of cultural resources. As part of the Draft EIS, in consultation with the State Historic Preservation Officer (SHPO), the Advisory Council on Historic Preservation (Advisory Council) and the U.S. Department of the Interior, it was agreed that extensive archaeological investigations would be performed to identify the degree of potential impact of the proposed roadway project on Abbott Farm and other nearby cultural resource sites. As a result, a Phase I Archaeological Investigation, consisting primarily of a surface reconnaissance with minimal subsurface testing, was carried out for the potentially affected portions of the landmark. These studies were sufficient for determining a reasonable and prudent alternative that achieved a 33 percent reduction in areal loss compared with that of the original alternative; however, many questions about the full impact of encroachment on buried archaeological resources in the Abbott Farm district and adjacent historic areas were still left unanswered.

During negotiations with the SHPO, the Advisory Council, and the U.S. Department of the Interior, a compromise was reached whereby it was agreed that:

1. Based on the Phase I studies of the Draft EIS, NJDOT and FHWA would be allowed to proceed to a decision on alignment approval.
2. In return, NJDOT firmly committed to pursue more detailed Phase II studies, and based on those further studies, to prepare a comprehensive mitigation plan before construction in the areas in which cultural resources would be affected.

Within the scope of this comprehensive mitigation plan, NJDOT also committed to conducting specific archaeological studies in the I-195/I-295 interchange area and surrounding areas of alignment to determine if access to significant cultural resources would be preserved by placing additional portions of the highway system or interchange on structures rather than embankment. This compromise was put in the form of a Process Memorandum of Agreement among the Advisory Council, the SHPO, NJDOT, and FHWA. This agreement essentially allowed the project to proceed to approval and final design without further delay while at the same time it provided for necessary protection of Abbott Farm.

The Crosswick Creek Wetlands

Background

All but a small amount of the tidal marshland once present along the Delaware River Estuary north of Philadelphia has been replaced by development. Of the marshland remaining, the Crosswicks Creek Wet-

lands is the largest single tract, covering approximately 2,900 acres of tidal and nontidal areas. Although not an undisturbed area, the Crosswicks Creek Wetlands is still an extremely valuable component of the Upper Delaware Estuarine System. It functions as a source of food organisms for its own food web and for those of the estuary and beyond, as a breeding and nursery area for resident and migratory fish, and as a habitat for a variety of birds, including some that are considered threatened or endangered (chiefly the Ospry and the Bald Eagle).

Impacts

The impacts of the proposed roadway project on the tidal portions of the Crosswicks Creek Wetlands were analyzed by using two criteria: the first criterion was a measure of actual areal loss resulting from the project and the second criterion was a determination of functional value loss associated with actual areal loss. A grid structure was superimposed over the wetlands and each cell (approximately 50 acres) of the grid was evaluated on the basis of characteristics such as the actual amount of tidal wetland it contained, the type and condition of vegetation, and the extent of tidal circulation (Figure 3). This grid system was designed to provide a rapid means of assessing the impact of construction on the single most important attribute of the Crosswicks Creek Wetlands--its ability to continue functioning as a productive tidal wetlands. Impacts on tidal portions and on terrestrial habitat were analyzed separately to avoid undue complication of the grid-system analysis.

Under the design concept prepared in the early 1960s for the highway project, construction of the Trenton Complex project would have resulted in a loss of 40 acres of tidal wetlands and a functional value loss of 11 percent. Working in close coordination with the New Jersey Department of Environmental Protection (NJDEP) and the U.S. Department of the Interior, a proposed mitigation scheme was developed that reduced the areal loss to only 1 acre of tidal wetlands and the functional loss to only 1 percent. This mitigation program included the following three major steps:

1. Alignment of one of the I-295 links was shifted out of the Crosswicks Creek Wetlands on an upland area known as Duck Island. In the original design in the 1960s, the wetlands alignment had been selected for construction to preserve the Duck Island area for future industrial development. The shift in alignment to the Duck Island alternative resulted in an estimated savings of $20 million in construction cost of the highway. Extensive multidisciplinary coordination was necessary in assessing this alignment shift to ensure that intact cultural resources would not be adversely affected by this action.
2. A commitment was made to construct the major I-195/I-295 interchange on a structure over the 24 acres of tidal wetlands in the interchange area. This would result in only 1 acre of designated wetlands being lost, with 23 acres of designated wetlands spanned by structure. In the Final EIS, this design was estimated to cost an additional $60 million more than the original design concept of embankment construction for the entire interchange.
3. The I-195 route link crosses a wetland or tidal flat at the confluence of Crosswicks Creek and the Delaware River. If the roadway link were built on an embankment over the tidal flat, 8.8 acres of wetlands would be filled. A commitment was made by NJDOT to undertake a study of the feasibility of creating compensatory wetlands in the project area to replace the 8.8 acres that would be lost if the road link were built on an embankment over the tidal flat. Based on the results of this study, a decision would be made to build either the extended bridge alternative or the short bridge alternative with compensatory wetland replacement. The cost of the first alternative would add at least an additional $7.0 million to the construction cost of the project.

Park and Recreational Facility Impacts

Background

The northern and western corridors of the Trenton Complex project pass through a section of the urban core of Trenton. The land use mix in this section of the city consists of densely settled neighborhoods; a key industrial employment center; and municipal facilities such as parks, recreational facilities, and a large cemetery. Most of the neighborhoods are ethnic communities, some with a long history of community cohesion and stability.

Impacts

Because of existing dense development patterns, it was impossible to locate the new highway links without affecting existing park and recreational facilities. Extensive design and location studies were undertaken to minimize the level of impact. Some of these studies were undertaken in the 1960s, before the beginning of the studies for the Draft EIS. Where impacts were unavoidable, extensive consulting and negotiations were undertaken with the municipalities of Trenton, Hamilton, and Bordentown as well as the Mercer County Parks Commission and NJDEP to reach mutually agreeable resolutions concerning mitigation. As a result of these extensive efforts, agreement was reached on the mitigation program, which included the following:

- Construction of new ball parks and playgrounds in the same neighborhood areas as the five such facilities lost as a result of the project.
- The building of an additional playground in the project area.
- The upgrading of a ball field slightly affected by the project.
- Modification of the alignment adjacent to the proposed Delaware Raritan Canal State Park to allow for towpath activity, a scenic overlook, and increased pedestrian access to the proposed new park.

Through these extensive mitigation commitments, agreement was reached with all of the municipalities and agencies concerned and the Section 4(f) plan (Department of Transportation Act of 1966) was approved.

Aesthetic Impact

Background

Lamberton Field is a 6-acre linear walkway that is tree-lined and unpaved, located in Trenton along the eastern bank of the Delaware River. The most important characteristic of the field is the large number of mature sycamore trees. There are 118 such trees, most of them forming two parallel rows along the field. These trees contribute significantly to the aesthetic setting of the area and to the scenic view of the Delaware River from residences along Lamberton Street.

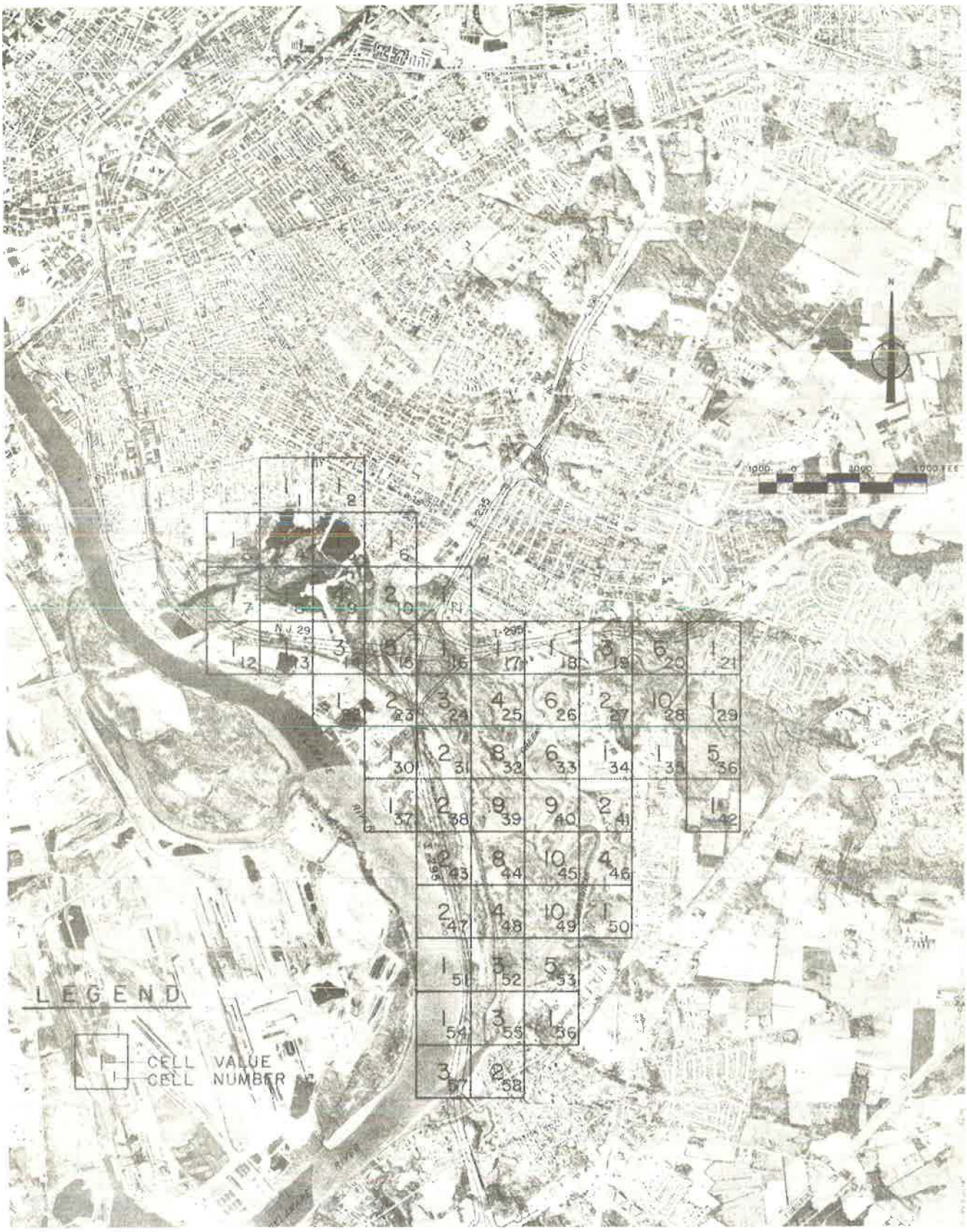


FIGURE 3 Grid analysis map of Crosswicks Creek Wetlands.

Impacts

The original design of the NJ 29 link of the Trenton Complex project would have necessitated the removal of more than 75 of the 118 sycamore trees in Lamberton Field. Moreover, the profile of the roadway would also have acted as an aesthetic barrier to viewsheds along the Delaware River. As part of the studies undertaken for the Draft EIS, extensive consultations were held with the city of Trenton and NJDEP to develop an alternative scheme for mitigating this potentially significant adverse impact. As a result of these consultations, a new alignment was developed that required the removal of less than 50 trees, and the roadway immediately adjacent to the river was redesigned with a depressed profile thereby making it barely visible from the Lamberton Street residences. Coupled with elimination of the severe traffic congestion along Lamberton Street that would result from the construction of the Trenton Complex project, this new scheme--developed through the consultation process--ensured that the aesthetic setting for the residents of Lamberton Street would, on balance, be improved by the project.

Noise Impacts

Background

The existing noise levels in the area of the Trenton Complex project were those characteristic of urban-suburban settings. As is true with most such settings, the predominant background noise was created by vehicular traffic. The L10 noise level in the project area averaged 65 dB except in those areas of high traffic volume and traffic congestion, where levels in excess of 70 dB, and in some instances 80 dB, occurred.

Impacts

As a result of the Trenton Complex project, it was determined that noise levels would be substantially reduced along existing roadways from which traffic would be diverted. There would, however, be significant noise impacts to about 200 dwelling units along the new alignment. In accordance with FHWA procedures, noise abatement measures were investigated as part of the Draft EIS. Aesthetically pleasing noise barriers were found to be feasible along all noise-impacted sections of the roadway with the exception of the NJ 29 link where, because of engineering constraints, the noise barrier would have also resulted in an unattractive visual obstruction of the Delaware River viewsheds currently afforded the neighborhoods along the proposed NJ 29 route. Adverse noise impacts would occur to 40 residences along NJ 29 and would result in an increase in noise level from 3 to 5 dBA higher than current levels. Because existing noise levels were already at or above the 70-dBA design noise level, this 3- to 5-dBA increase in noise due to the building of the new alignment was determined to be an adverse impact; however, in reality this level of increase is only slightly higher than the threshold of noise increase perceptible by the human ear.

NJDOT consulted with residents along Route 29 and with the city of Trenton to determine their preferences with respect to the noise barrier. Because of the visual obstruction that would have resulted from the barrier and because actual noise levels would only rise slightly above current levels, both the affected neighborhoods and the city of Trenton opposed construction of any noise barriers. As a result, NJDOT obtained approval from FHWA for an exception to the design noise levels in this area. In all other areas where adverse noise impacts would occur, aesthetically pleasing noise barriers were designed as part of the project.

STAGE II: CONSULTATION AFTER APPROVAL OF THE FINAL EIS IN 1981: ARCHAEOLOGICAL AND CULTURAL RESOURCES

Mitigation of Abbott Farm National Historic Landmark

With the publication of the Final EIS in 1981 and approval of the proposed Interstate complex the same year by FHWA, the question of the archaeological resources within the alignments assumed critical importance. Archaeological studies in support of the Draft EIS (1976) indicated that the right-of-way purchased by NJDOT for the project would significantly affect the Abbott Farm National Historic Landmark. The historic archaeological studies also located a number of historic properties comprising a mill, early residences, industrial remains, and portions of the Delaware River and Raritan Canal that appeared to be in the impact areas (Figure 4).

A substantial number of the sites initially reviewed by the Keeper of the National Register were located within portions of the right-of-way that lay outside of the boundaries of Abbott Farm National Historic Landmark. Responding to questions raised by the keeper of the National Register for these sites was seen as crucially important for the planning of Phase II testing to be coordinated with engineering design, and was structured to collect the necessary information in the same sequence as in the planned construction schedule. By providing archaeological information early in the final design phase, it was anticipated that cultural resource concerns could be incorporated into the final designs, thereby reducing the adverse impact to archaeological sites and minimizing the requirements for data recovery. Concomitant with Phase II testing for Determination of Eligibility was the requirement to conduct archaeological testing to develop mitigation plans for sites already determined eligible for the National Register.

With construction planned to begin in 1983, there was enormous pressure to complete the Phase II studies, mitigation plans, and the actual archaeological mitigation. Assembling the required documentation, securing the reviews, responding to questions, and obtaining the necessary state and federal approvals within the compressed time frame required extremely close and continual coordination of the consultant team, NJDOT, FHWA, the SHPO, the National Register, and the Advisory Council.

Phase II Testing and Mitigation Planning: 1981 to 1982

The proposed highway complex was divided into 7 sections for archaeological testing and mitigation planning. Three closely related prehistoric archaeological sites (the Shady Brook Complex) were located on the northernmost section of I-295. This section was scheduled for construction in fall 1983. From an archaeological perspective, the Shady Brook Complex was considered to be an outlier site because it was located more than 1 mile northeast of the main

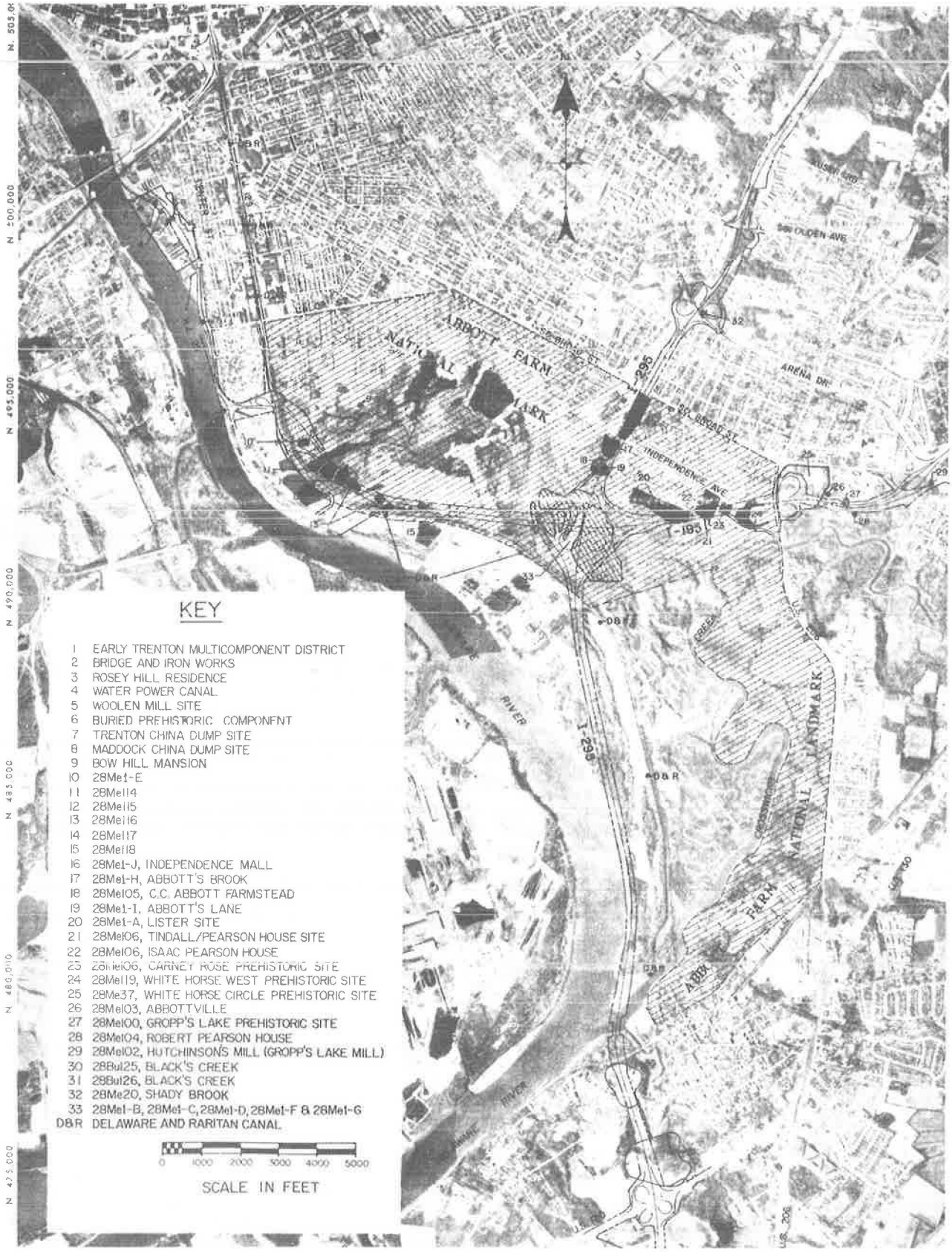


FIGURE 4 Archaeological sites of the Trenton Complex.

complex of sites in the Abbott Farm National Historic Landmark.

Consultations with the SHPO and representatives of the Advisory Council resulted in the decision to break out this section of the project as a separate compliance action. Allowing the Phase II research, report, Determination of Eligibility, and mitigation to proceed independently of the remainder of the project provided the necessary lead time for the Shady Brook Complex to be mitigated within the tight design and construction schedule while the remainder of the Phase II studies were being conducted. Phase II testing of this site began in June 1981; the report of the testing, Determination of Eligibility, and mitigation plan were prepared during the winter and all necessary approvals were in place by May 1982; mitigation fieldwork was conducted and the site released for construction on schedule in August 1982.

Successful completion of all requirements for the Shady Brook Complex in advance provided an invaluable preview of the challenges and requirements for the remainder of the project. Moreover, the data recovered provided an advance look at the types and quantities of artifacts that could be expected from the remainder of the sites in the corridors and provided an opportunity to test the pre-field hypotheses being developed for the large-scale mitigation. The Shady Brook Complex also allowed a complete run-through, on a manageable scale, of all phases of analysis, laboratory work, graphics, and report production.

Immediately following the conclusion of Phase II testing at the Shady Brook Complex, two additional field crews were brought in to begin testing sites along the rights-of-way on the remainder of the Trenton Complex. At the peak of Phase II testing, crew size numbered more than 50 persons working on three sites simultaneously. The work involved close coordination among prehistoric and historic archaeologists, informant interviewers, an architectural historian, a historian, and museum researchers working with the collections from the Works Progress Administration excavations on Abbott Farm.

As testing progressed, however, it became clear that the majority of the prehistoric cultural materials scattered throughout the corridors lacked integrity, having been disturbed by more than 100 years of plowing, erosion, and land modifications associated with residential construction. Results of the extensive testing revealed 5 prehistoric sites within the I-195 corridor that would require mitigation before construction (Figure 5). Prehistoric archaeological materials from the remainder of this 6,000-ft segment were determined to be in a context too disturbed to provide data useful for understanding the prehistory of the area.

The Black's Creek Prehistoric Archeological District was initially viewed as a manageable problem because the two sites had been determined eligible for the National Register and testing was designed only to establish the basis for mitigation. As testing progressed, however, it became apparent that both sites were badly disturbed and that no intact site areas had survived within the proposed right-of-way (Figure 6)--the only site fragment that was intact was located on a bluff edge well outside of the right-of-way. Therefore, NJDOT, in consultation with FHWA, the SHPO, and the Advisory Council, modified the original evaluation of the significance of the Black's Creek District, and recommended no mitigation and a reevaluation of its National Register status. This obviated the need for what would have been a major archaeological excavation effort.

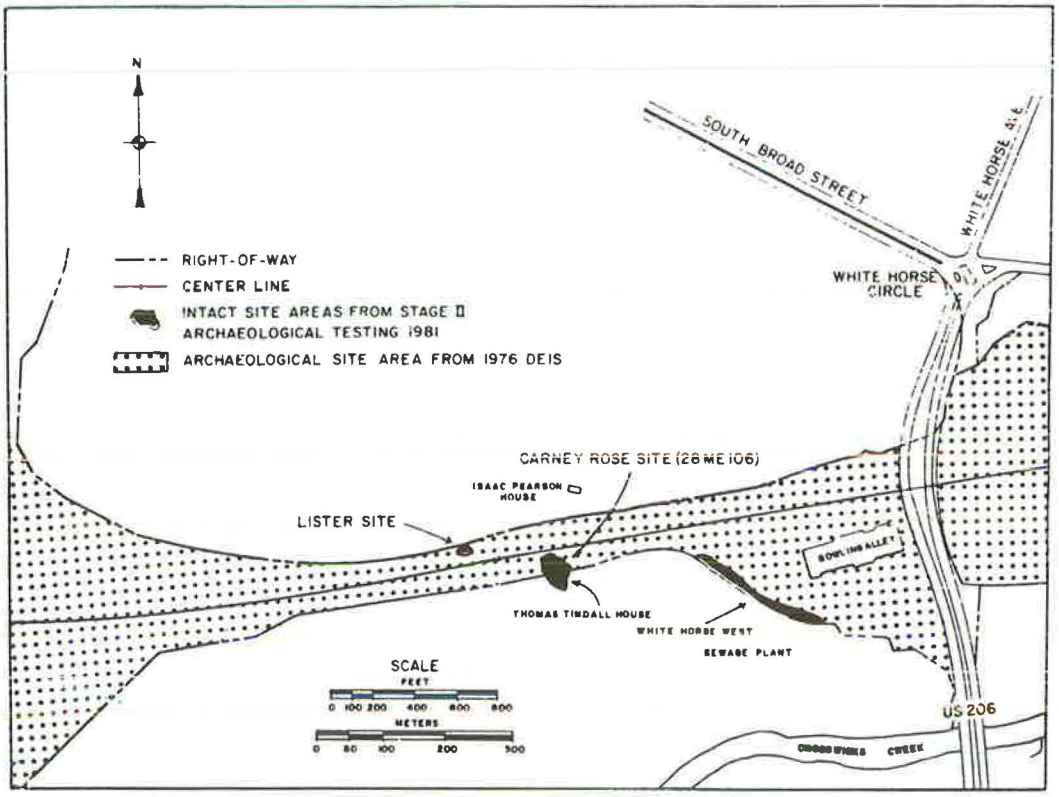
Work in the Wetlands Interchange began during late fall 1982. This interchange, comprising approximately 80 acres, was initially thought to consist of a single major prehistoric site partially bifurcated by the wetlands. Intensive testing throughout the 80-acre area located two major archaeological concentrations (Figure 7): one site consisted of a linear configuration more than 2,000 ft long and was narrow, averaging less than 100 ft wide; the second site was located on a major wetland finger immediately adjacent to an area excavated in the late 1800s. Both of these sites, although of immense scientific importance, were clearly definable and were much more limited in area than postulated in the 1976 report. A number of smaller disturbed sites were investigated on the remaining wetlands fingers.

While testing the water power canal and industrial foundations on the Route 29 segment, the crew encountered an intact prehistoric component deeply buried beneath the terrace. The survival of prehistoric materials in a heavily used industrial and residential area was considered so significant that the Advisory Council and the SHPO met with FHWA and NJDOT representatives to evaluate options for the site. This discovery of a prehistoric component demonstrated that extensive testing would be required to determine the extent of the prehistoric materials present and to develop a mitigation plan sensitive to the needs of both prehistoric and historic resources. However, the duration of testing for prehistoric resources would require significantly more time than was available if construction delays on other sections were to be avoided. Consultation resulted in the decision to break out the New Jersey Route 29 segment of the project as a separate compliance action to allow the remainder of the project to move ahead; this segment is scheduled to be completed last (about 1990), allowing adequate time for testing and mitigation planning without jeopardizing the remainder of the project.

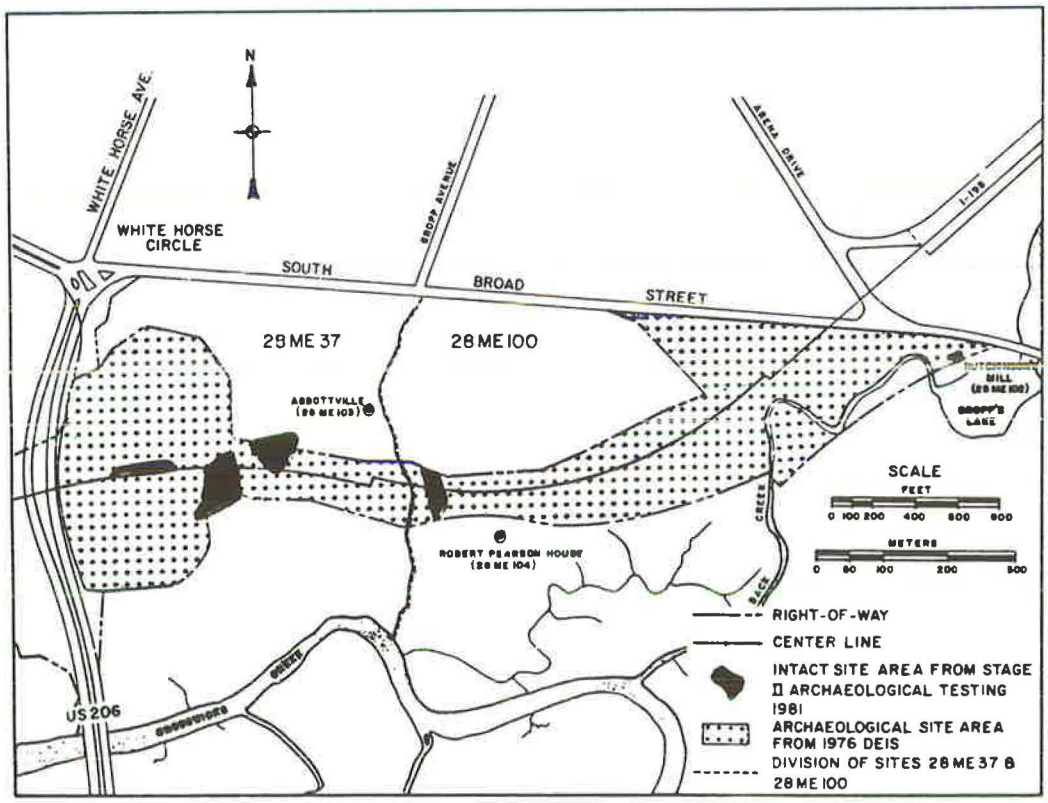
A review of the fieldwork results demonstrated that designing a workable mitigation of prehistoric resources in the Trenton Complex could be accomplished in an archaeologically sound and cost-effective manner. To collect the necessary site data, slightly more than 3,000 posthole-size windows and 200 2.5 x 2.5-m units and 13 backhoe trenches had been excavated within the 13 miles of highway corridor. For the first time, NJDOT, FHWA, the SHPO, and the Advisory Council had an accurate assessment of the size, depth, and nature of the cultural resources located throughout the highway corridors in the Trenton Complex. These data and reports clearly revealed that the impact on cultural resources, although substantial, could be mitigated by careful excavation planning and through coordination with engineering design.

Review and Mitigation Planning: 1983

During development of the reports, constant coordination was maintained with NJDOT archaeologists, FHWA, the SHPO, and the Advisory Council archaeologists. Their interaction was beneficial because it kept all parties working at a good pace as the analysis proceeded. Advance reviews also provided valuable feedback and removed the element of potential surprises in the documents as they were being developed. By maintaining complete familiarity with the



I - 195 Wetlands Interchange to U.S. Route 206



I-195 U.S. Route 206 to Arena Drive Interchange

FIGURE 5 Estimated and actual intact archaeological site areas.

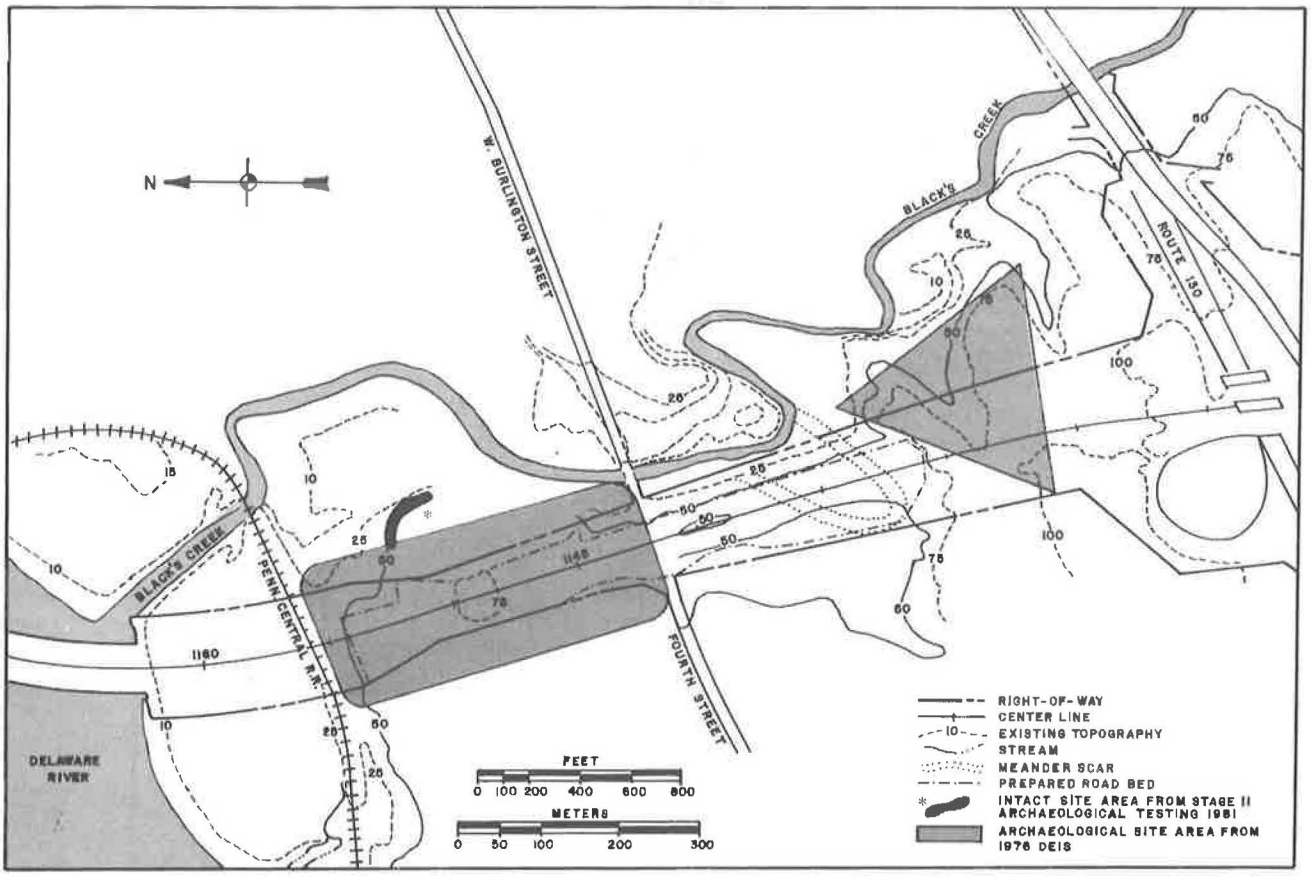


FIGURE 6 Black's Creek prehistoric archaeological district.

study throughout, review time for the massive quantity of documents was minimized, which allowed for a quick turnaround time after they were submitted.

After the determination was made of those sites eligible for the National Register, all proposed mitigation plans were submitted to the Advisory Council for review. The formal review required less than 2 months because of the continuing coordination throughout the project. A Memorandum of Agreement (MOA) was coordinated among all parties (the Advisory Council, FHWA, NJDOT, the SHPO), with every recommendation in the mitigation plan being evaluated before it was included in the MOA.

During the review and development of the MOA, mitigation planning for the I-195 segment was initiated. This segment was designated for letting of the construction contract in late fall 1983 and for construction in spring 1984. To complete the excavation of 4 prehistoric and 1 multicomponent (prehistoric and historic) site within the time frame remaining, 3 of the sites had to be under excavation simultaneously. This level of excavation required a large number of archaeologists to be in the field and an increase in laboratory staff. By beginning planning for this segment during the review, start-up time was reduced to less than 1 week.

After completion of the MOA, it was decided that an official signing ceremony would be held at the Advisory Council in Washington, D.C., with representation from the SHPO, FHWA, NJDOT, the consulting firm, and the Advisory Council. On September 28, 1983, the MOA was signed with all parties present, an unprecedented cooperative effort that saved 2 to 3 months over the normal process of routing, review, and signature by each agency.

Mitigation: 1983 to 1984

Within 1 week of the signing of the MOA, fieldwork began on the I-195 segment. Approximately 40 archaeologists and support personnel were involved in this work. Excavation of the Gropps Lake prehistoric site was the most complex, involving construction of a half-mile access road and removal of 3 to 5 ft of overburden with a dragline. Preservation in this site was excellent because of the overburden placed in the early 1800s. Hearths, projectile points, tools, lithic debitage, and a large pottery collection were recovered from the site. Most important, the site contained datable organic remains, a rarity in upland archaeological sites.

The historic house foundation at the Carney Rose site yielded a major ceramic collection that will contribute to the understanding of early historic settlement and trade patterns throughout the Delaware Valley. The prehistoric component also provided a major collection of materials that are undergoing analysis and interpretation.

Fieldwork continued until January 1984. In the last months, work was conducted in heated shelters because of bitter winter conditions. Completion of the fieldwork on the I-195 segment ahead of construction removed the last potential impediment to

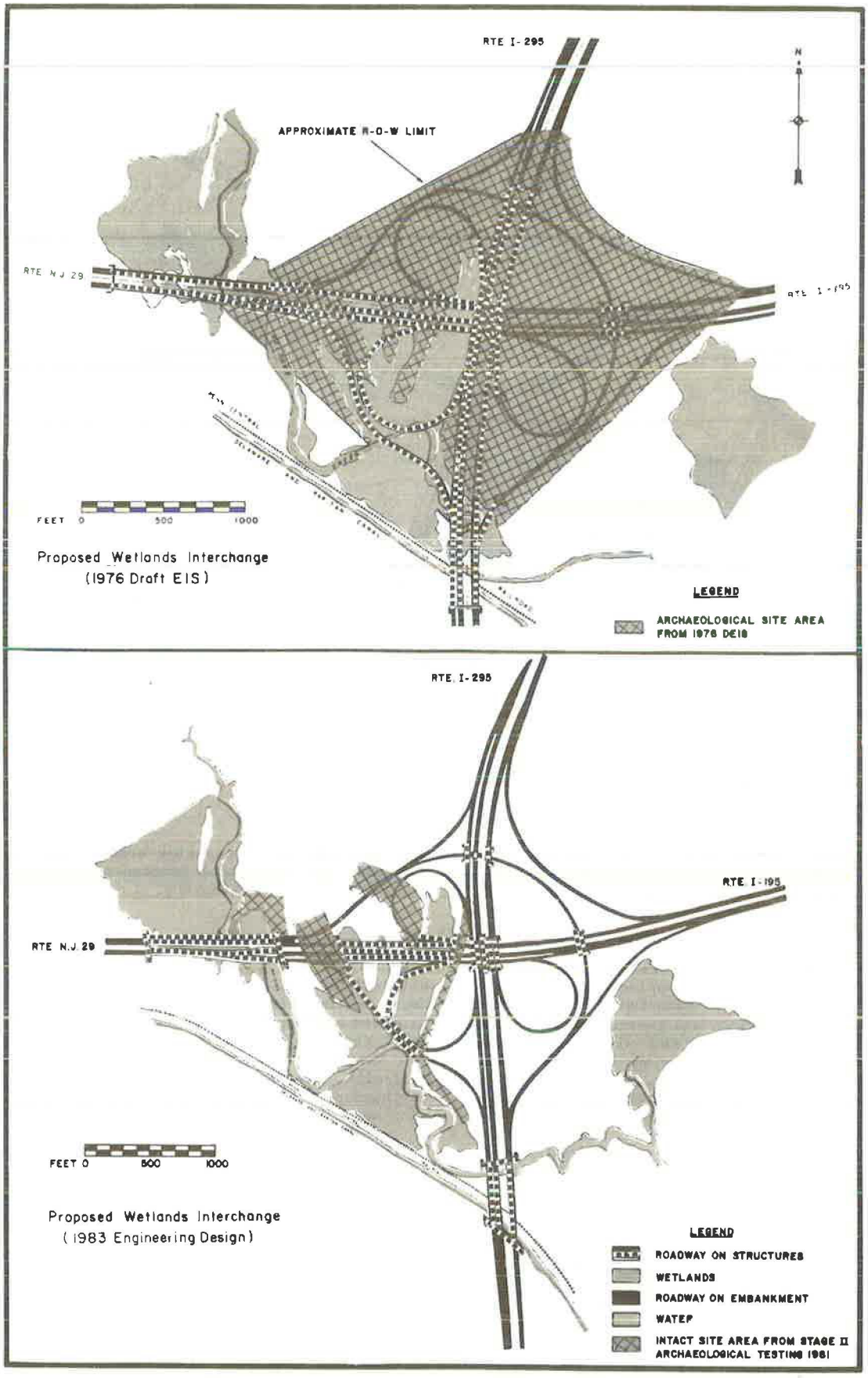


FIGURE 7 I-195/I-295/N.J. 29 wetlands interchange.

completion of the entire Trenton Complex within the original schedule. The design and letting sequence for the remaining sections is such that excavations will be completed a minimum of 1 to 4 years ahead of construction.

STAGE II: CONSULTATION AFTER APPROVAL OF THE FINAL EIS IN 1981--WETLANDS AND ECOLOGY

The Mudflat

The purposes of the special studies of the Crosswicks Creek crossing (Figure 8) were fourfold.

First, the functional characteristics, both ecological and hydrologic, and the uniqueness of the wetland area at the mouth of the Creek (known as the Mudflat) were documented so that the feasibility of replacing the affected area could be determined for both land area and functional value.

Second, an assessment was undertaken for two proposed bridge schemes: constructing the short bridge and embankment and constructing the extended bridge. Implicit in the comparison of these two schemes was the understanding that implementing the short-bridge-and-embankment alternative would result in the loss of a greater percentage of the Mudflat area than would implementing the extended-bridge alternative. Of additional concern with this short-bridge-and-embankment alternative was the effect it would have on the physical tidal flow regimes in Crosswicks Creek; that is, whether the additional constriction at the mouth of the Creek, due to an extension of the embankment into the channel, would cause significant adverse backwater impacts.

Third, having determined the functional characteristics and physical acreage of the Mudflat, other areas in the Crosswicks Creek study area were evaluated to determine their potential as replacement wetland areas. A plan was then proposed to create suitable wetland acreage.

Fourth, preliminary engineering was conducted on the two bridge schemes for cost comparison. In addition, information was generated on location of the embankment for the hydraulic modeling, construction methods (to assess the length of construction), and the associated impacts to the wetland area.

Both quantitative and qualitative studies of the biological and ecological values of the Mudflat were undertaken. Officials from NJDOT, FHWA, NJDEP, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Delaware River Basin Commission, and the U.S. Coast Guard participated from the outset with the consultant in these field studies in review and advisory capacities. This participation facilitated the formal review process later in assessing the feasibility of replacement alternatives. In the field studies, the flora and fauna present (macrophytes, algae, invertebrates, and fish) were documented. The importance of the habitat and food chain production were studied, as well as the Mudflat's role in erosion control, flood moderation, recreation, and aesthetics.

Based on the various investigations and studies performed, NJDOT, FHWA, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers concurred in the finding that the Mudflat functions as:

- An active, healthy, and productive wetland component of the Crosswicks Creek estuarine system.
- A buffer between the waters of the Delaware River and Crosswicks Creek, attenuating both wave energy and tidal currents.
- A nourishment center for fish because of its rich macroinvertebrate fauna and planktonic flora.
- An important habitat area for fish, especially as a nursery area for immature species (bass, pickerel, herring) and as a feeding area for adults (including the shortnosed sturgeon, an endangered species).
- A feeding and resting site for many species of waterfowl and seabirds.
- A significant area in primary productivity and nutrient cycling; however, because of its size, this area is not a crucial component of the overall capacity of the Crosswicks Creek wetlands system for these biological activities.
- A moderating force against adverse effects of flooding.

The key element of the hydrologic studies was to document whether the Mudflat could be partially filled without causing backwater effects upstream from the embankment. The first phase of the determination of the Crosswicks Creek hydrologic characteristics involved data collection and review. All available models and supporting data describing the hydraulic and hydrologic characteristics of Crosswick Creek were sought. Direct contact was made with the appropriate technical and management personnel at the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Federal Emergency Management Administration, NJDEP, and the Delaware River Basin Commission.

Information existed on the nontidal portion of Crosswicks Creek and on tides in the Delaware River 9 miles downstream from the mouth of Crosswicks Creek. Unfortunately, no information about the cyclical nature of the tides at the confluence of Crosswicks Creek and the Delaware River was available.

Because of the influence of wetlands and nontidal inflow in the Crosswicks Creek basin, hourly elevations at the mouth of the Creek could not be interpolated from other Delaware River stations. To augment the information available, it was necessary to collect field data concerning floodplain and river profiles, stream flows, and velocities. The location and extent of this supplemental data collection was closely coordinated with NJDOT.

Based on a review of the ecological and hydrological values and characteristics of the Mudflat, it was decided--in consultation with NJDOT, NJDEP, FHWA, and the U.S. Fish and Wildlife Service--that any proposed replacement acreage had to satisfy two general criteria:

1. The acreage had to be located, to the extent possible, either within or adjacent to the area of the Crosswicks Creek mouth.
2. Replacement of the acreage had to at least maintain and, at best, enhance and improve the overall ecological function of the Crosswicks Creek estuarine system.

The short-bridge-and-embankment alternative required 7.4 acres of the Mudflat, 0.2 acres of the sandbar, and 1.7 acres of open water, totaling 9.3 acres of wetlands. It was determined, in consultation with the resource agencies, that the recommended replacement acreage should be in this same general range, depending on the site. This amount of acreage, suitably located and properly vegetated, would result in replacement of the habitat elements lost in the Mudflat, and with the adoption of certain schemes, would increase the nutrient cycling and primary productivity of the overall system.

Based on a review of aerial and topographic mapping and on-site field investigations, various sites were primarily screened as potential areas for wetland replacement activities in coordination with

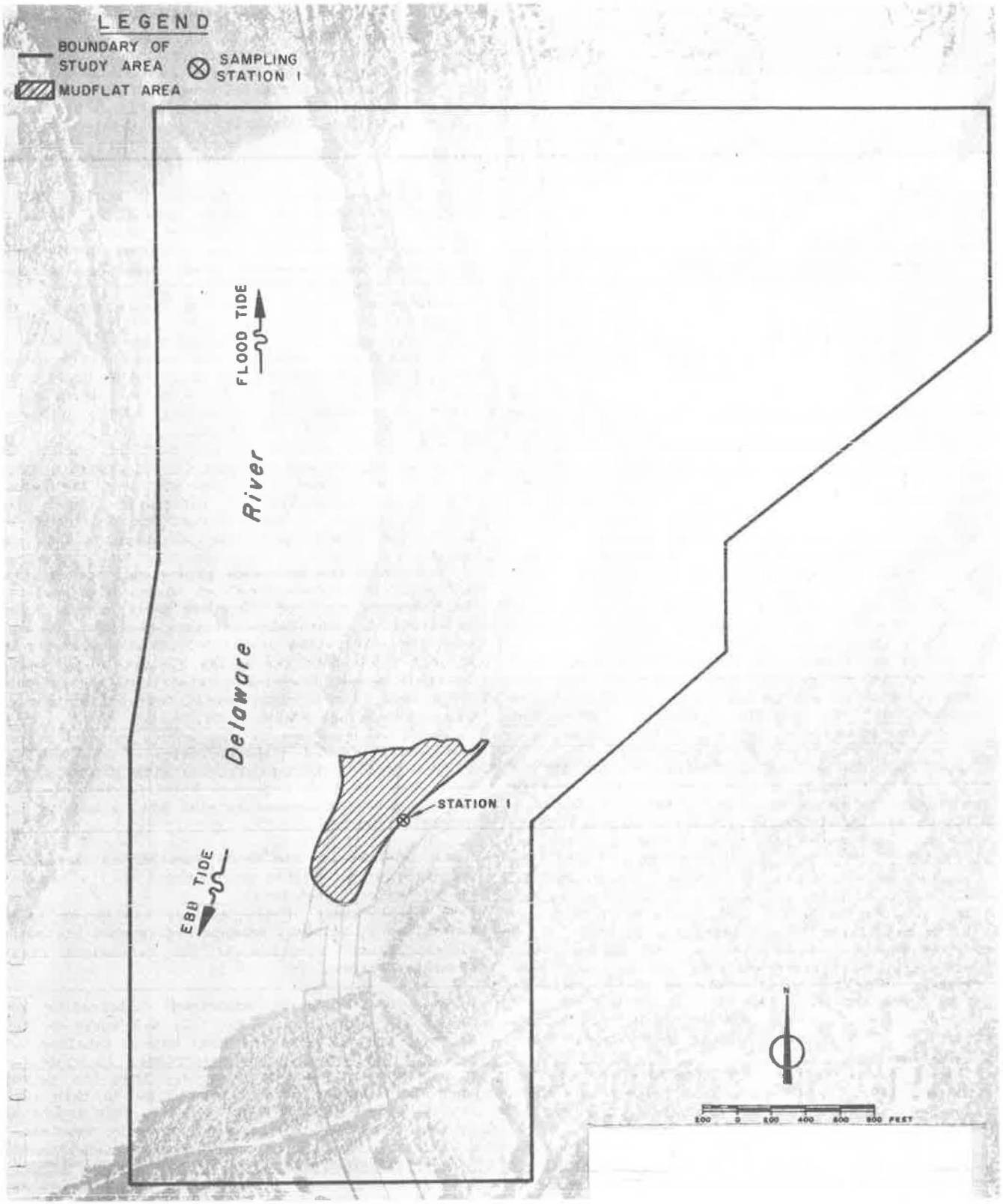


FIGURE 8 Study area of Crosswicks Creek Wetlands replacement.

NJDOT. Although the Crosswicks Creek estuarine system is large, the focus for replacement sites was localized within an approximately 4,000-ft radius of the Mudflat. The major purpose of this focus was the desire to position the replacement site as near as possible to the Crosswicks Creek and Delaware River confluence. In this manner, it became more feasible for a replacement site to function as a buffer between the two water bodies, thus duplicating a significant functional characteristic of the Mudflat.

The following guidelines, jointly developed in consultation with NJDOT, FHWA, and the U.S. Fish and Wildlife Service, were considered in determining the overall suitability of the replacement sites:

- The site selected would, optimally, have a low current ecological value that would clearly benefit from conversion to wetlands. Currently developed areas were excluded.
- It was necessary that the site be subject to tidal action and not require additional periodic maintenance to provide adequate water circulation. However, it was recognized that initial excavation or fill might be required to render a site acceptable for emergent wetland vegetation to thrive.
- Sites located within the boundaries of the Abbott Farm National Historic district would be avoided. The location of potential sites was coordinated with the archaeological team performing the ongoing investigations, and the probability of impacts on cultural resources was noted.

Four potential sites were identified. After coordination with NJDOT, one site was selected and a wetlands replacement scheme developed, which included a grading plan showing the final elevation in the site, number of plants, amount of fertilizer, and estimated cost of planting the vegetation.

Preliminary engineering was performed to estimate construction costs of the two Crosswicks Creek crossings alternatives. It was estimated that the extended-bridge alternative would cost $24 million. The short-bridge-and-embankment alternative was estimated to cost $17 million, including the $3 million estimated cost of wetland creation, making a $7 million cost difference between the two alternatives. The ultimate decision about which alternative will be selected for construction is recognized to be one requiring high-level consultation and coordination among concerned agencies, with consideration given to the cited technical background.

Wetlands Interchange

Further studies in the I-195/I-295 interchange area were more straightforward, but no less important in minimizing the cost of construction. There had been a commitment in the EIS not to fill any tidal wetlands in the interchange; that is, any tidal wetlands would be spanned by structure (Figure 9). As the project proceeded further into design, two things became clear: one, the amount of the interchange to be built on a structure was significant; and two, the mapping of the tidal wetlands was not of sufficient detail and accuracy to propose and evaluate design modifications.

Thus, a substantial amount of supplemental field work was conducted by the consultant and NJDOT biologists to stake the boundaries of tidal and nontidal wetlands. Slopes throughout the wetlands area were slight; therefore, it was important to be in the field at high tide to observe the areas of inundation and correlate the type and density of vegetation in the tidal areas. Survey crews then followed to map the boundaries exactly. After this information had been mapped, the consultant's engineers were able to make slight shifts in the location and shape of the Wetlands Interchange that obviated the need for most of the construction on structure originally anticipated.

SUMMARY AND CONCLUSION

A mitigation program of the magnitude of the Trenton Complex--which involves adhering to tight deadlines, coordinating multidisciplinary studies of ecology, cultural resources, and engineering, and working in harmony with the funding and review agencies--created a series of challenging management problems. From the viewpoint of the cultural resources and wetlands, four key problems existed: ensuring the quality of work, coordinating with the review agencies, incorporating study findings into the engineering design in a cost-effective manner, and keeping the project on schedule.

Modification of engineering design to preserve priceless cultural resources and critically important wetlands proved difficult on the Trenton Complex project because the right-of-way had been purchased almost 20 years previously and engineering was locked in. Nevertheless, through extensive coordination of the wetlands and archaeological investigations with engineering design considerations, creative mitigation programs were developed to protect these environmental resources without compromising engineering design requirements; an example of this was the Wetlands Interchange. At the time the Final EIS was approved in 1981, NJDOT and FHWA had agreed to build the entire interchange on a structure to minimize impacts on cultural resources and wetlands. Tight definition of wetlands, combined with accurate mapping of the archaeological sites, allowed the engineers to slightly rotate the interchange configuration to avoid or minimize the impact on cultural resources and wetlands. Through this modification in alignment--a direct result of coordination of the disciplines--80 percent of the structure could be built on fill, resulting in a savings of $40 million compared with the original EIS design concept.

Many review agencies, such as the Advisory Council, referred to the Trenton Complex project as a textbook case of how environmental studies on transportation and other development projects should be carried out. This praise illustrates that the team concept used for this project, in which all participants pulled together toward a common goal, can succeed, even in the case of projects as challenging as the Trenton Complex.

The Trenton Complex Interstate highway project might easily have gone uncompleted, had it not been for the enormous public need that otherwise might have gone unsatisfied and the perseverance of project sponsors to see this need fulfilled. Throughout the NEPA process, this project enjoyed broad-based public support while simultaneously being shadowed by well-defined and intricately interrelated environmental concerns--mainly those related to cultural resources and wetlands.

Faced with a range of comments from governmental agencies, comments that covered the spectrum from general acceptance and support for the project to disbelief that it would ever be approved and expression of unalterable opposition, NJDOT and FHWA had to separate the legitimate issues from the rhetoric. This was accomplished by dividing the concerns into logical categories, including impacts on cultural resources, ecological impacts, as well as other environmental impacts; coordinating as appropriate on a continuing basis; and seeking solutions for valid concerns. Extensive alternative locations and

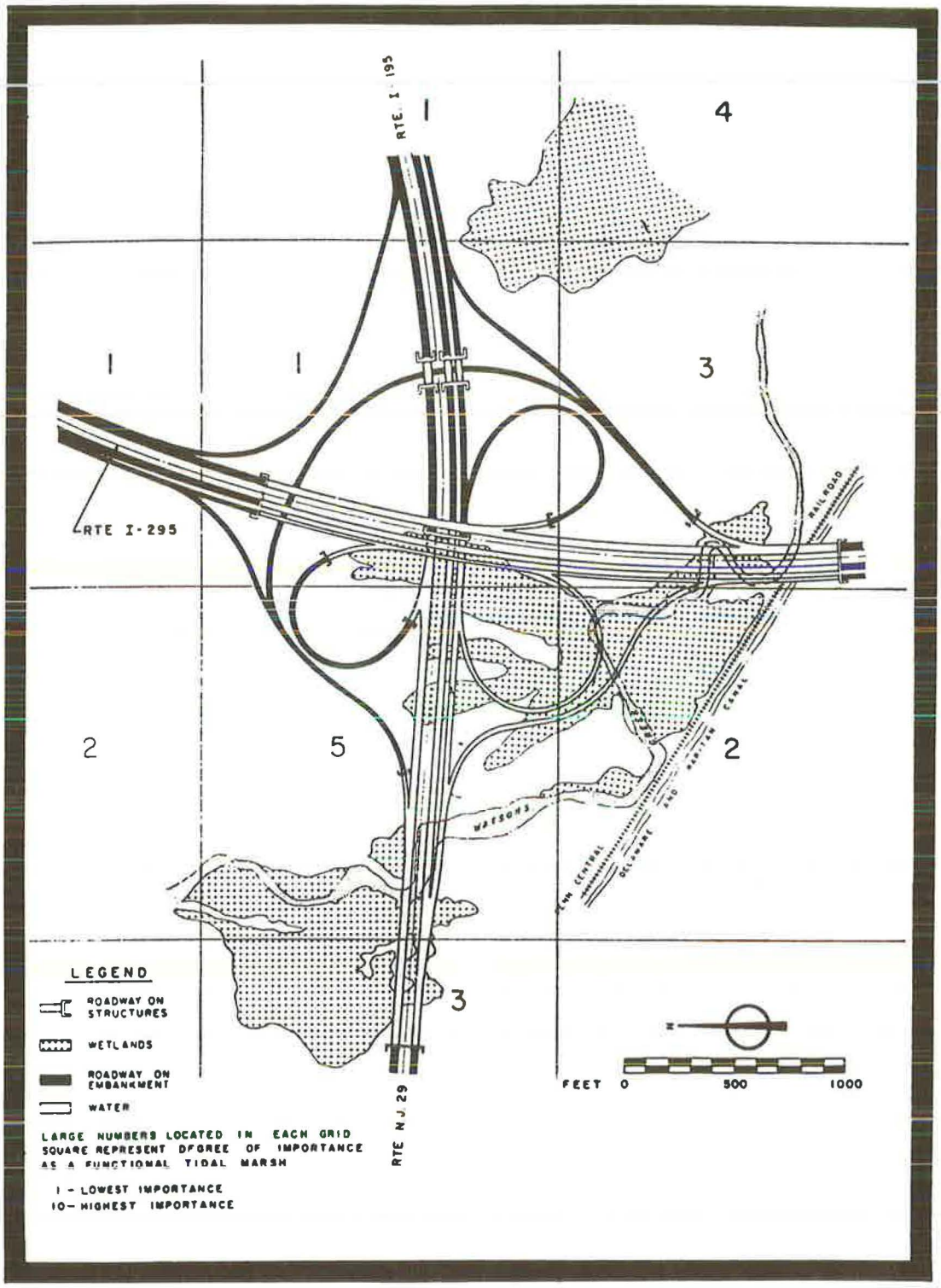


FIGURE 9 Proposed I-195/I-295/N.J. 29 interchange.

design treatments, and combinations thereof, were studied as means to this end. The challenge was to minimize or eliminate problems while simultaneously maintaining public support, keeping construction costs down, minimizing delay, and refraining from creating new environmental problems as a result of resolving existing ones.

In the final analysis, the cultural resources and ecological issues would be the most challenging to resolve, not only because of their individual significance but also because of the potential for the solutions related to one adversely affecting the other, thereby increasing costs. Through the process of coordination an ingenious compromise evolved, carefully integrated with the design efforts, which resulted in substantial cost savings while simultaneously protecting archaeological and wetland areas that were otherwise adversely affected.

Portions of the Trenton Complex are now under construction, another contract is soon to be let,

and several other portions are in the advanced stages of design. Even though the Final EIS has been approved, the MOA signed, and several construction permits granted, the environmental work continues and will continue into the future. In the early 1970s, approval of a Final EIS was viewed as the end of the NEPA process. However, the Trenton Complex project, perhaps more than any other, has demonstrated that although approval of the Final EIS yields the decision about location, environmental work must continue during the design process to meet specific environmental needs such as fulfilling the requirements of the MOA, and to provide solutions to environmental problems that arise during the process of securing construction permits. The realization that approval of a Final EIS is not the end of the NEPA process and that environmental work must continue during the final design phase has developed over an extended period of time and has not come without some frustrations. Ahead lie substantial amounts of work in completing archaeological investigations to gain ultimate acceptance; additional work has to be completed on wetlands mitigation, including major decisions about project design and methods of construction to secure needed construction permits. Even now, almost 15 years after NEPA and almost 5 years after Final EIS approval, expenditures of time and cost for environmental mitigation and coordination are substantial. Although much of this was unforeseen in the beginning, it has become clearer over time--particularly as new and unforeseen issues arose and new regulations were introduced during the approval process--that Final EIS approval is not the end of environmental involvement for the project, but rather the beginning of a new and more issue-related environmental phase demanding more and better coordination than previously.

The Trenton Complex has evolved dramatically during the years since enactment of NEPA in 1969. In many ways and by nearly any standard, the Trenton Complex project has been improved for those who will live within its proximity and for mankind in general, as a result of the environmental coordination process. It must be remembered, however, that it did not come without substantial costs in manpower and money invested in studies and that it did not come without postponing other needed transportation improvements for the many years during the process.

Perhaps one of the greatest benefits of the environmental coordination carried out on the Trenton Complex project is that it has been a learning experience for all those who have been associated with it during the past 15 years. During those years, as the NEPA process itself matured, so did those who worked with it and served it. Many who originally thought the Trenton Complex should not and could not be built have, through the extensive coordination efforts, come to believe this project is beneficial not only to regional and local needs, but also to environmental preservation and enhancement. Staff members from NJDOT and FHWA who once sat across the table from representatives of environmental agencies opposed to the project have long since reconciled their differences and cemented relationships that will serve to expedite future projects. This reconciliation resulted from considerable discussion and coordination among the interested communities and agencies, leading to a mutual understanding and respect for the various positions taken on the many sensitive environmental issues involved in the Trenton Complex project. The Trenton Complex being built in a manner more environmentally compatible than some ever believed possible is perhaps reward enough for the years of effort spent. For some of those who worked on the project, however, the learning experience with respect to coordination and reconciliation of differences among those who hold different views is perhaps even more satisfying.

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