DELAWARE HISTORIC BRIDGE SURVEY UPDATE

Abstract

The Delaware Historic Bridge Survey Update was undertaken under contract with DelDOT by Lichtenstein & Associates from 1995 to 1998. The purpose of the project is to review, update, and supplement the 1988-1989 Delaware statewide historic bridge survey and the 1991 publication of Delaware Historic Bridge Survey and Evaluation, which evaluated bridges constructed prior to 1946. The project objective was to research and compile information that supports and justifies recommendations as to which of the state's bridges constructed prior to 1956 meet the criteria for inclusion in the National Register of Historic Places and which do not. The effort augments the 1988-89 survey effort, and the two serve as a significant component of the Section 106 review process for both eligibility and determinations of effect. Additionally, the survey findings serve as the database for planning and preservation activities.

The work included documenting and evaluating the National Register eligibility of bridges built from 1946 to 1956, verifying that the 80 bridges previously evaluated were still eligible for the National Register, reviewing and revising the criteria for determining significance and historic contexts based on new research and updated information, and compiling the documentation and findings into a camera-ready bound report.

The final report consists of (1) methodology, (2) criteria for determining significance, (3) historic contexts and select bibliography, (4) 76 survey forms for bridges that were reported from the National Bridge Inspection Standards (NBIS) database to have dates of construction from 1946 to 1956, (5) updated survey forms for 80 bridges previously evaluated as eligible, (6) two survey forms for bridges on the state-owned Milton-Ellendale rail line (7) and summary of recommendations and survey findings. As a final product, the survey findings will be compiled in a revised and updated version of the Delaware Historic Bridges publication. The revised publication serves as an important means to convey the survey information to a variety of users.

The survey methodology presents the project objectives, approach, and work plan. It defines the survey parameters, describes the content of the survey forms, lists bridge types found in Delaware, presents information on how the criteria for determining significance and historic contexts were developed, the approach to field work and historical research, and the synthesis of the information into final National Register recommendations.

The criteria for determining significance apply the National Register criteria for evaluation as enumerated in 36 CFR 60.4. The criteria for determining significance describes specifically how National Register evaluation procedures have been applied to the state's bridges. It defines areas of significance for individual bridges, considers how the criteria are applied to bridges in listed and potential historic districts, and explains what is meant by integrity.

The historic contexts place Delaware's roads and bridges in their economic, political, social, and engineering contexts. They provide the background history necessary to making sound judgements about which bridges have historical and/or technological significance and which do not. Three contexts have been prepared in order to address the specific needs of the survey update. Two of the contexts, Delaware's Roads and Bridges 1946-1956 and Delaware's Bridge Technology 1946-1956, are designed to take the historic contexts that were prepared for the previous survey through the decade from the end of World War II to the beginning of the interstate highway era in 1957. The third context, Railroad Development in Delaware, 1827-1997, traces the growth and development of the state's railroads from 1827 to 1996 and was prepared to amplify upon a critical aspect of the state's transportation history and offer a more advanced framework for evaluating the state's railroad-related resources, including bridges.

Survey forms for 1946-1956 bridges consist of a summary short form, long form, black and white photographs, USGS map, and sketch map. The survey forms for bridges previously evaluated consist of a summary short form, reinspection narrative, black and white photographs, and sketch map. The survey forms are the heart of the survey. They serve to document the bridges and then justify a National Register recommendation of eligible or not eligible through specific application of the criteria and contexts.

A summary of recommendations and findings is presented with a list of all of the surveyed bridges broken down by National Register recommendation and grouped by bridge material and type. Sixty two (62) of the 80 previously eligible bridges have been recommended as still eligible for the National Register. An additional six (6) bridges with dates of construction from 1946 to 1956 have been recommended eligible bringing the state's total of extant eligible highway bridges to 68.

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DELAWARE HISTORIC BRIDGE SURVEY UPDATE

Methodology

Definition of Survey Objectives And Parameters

The 1995-1998 Delaware Historic Bridge Survey Update was undertaken by Lichtenstein & Associates for the Delaware Department of Transportation (DelDOT) in response to the Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA). The primary goal, mandated by STURAA, is to evaluate the National Register eligibility status of the state's bridges.

DelDOT requested that the survey update work plan include an approach that would revise and supplement the previous 1988-1989 historic bridge survey. That effort inventoried all known pre-1946 bridges in the state, including 405 highway bridges and 205 railroad bridges. Data had been compiled on Historic American Engineering Record (HAER) cards. As a result of the 1988-1989 survey, 80 highway bridges were recommended eligible for the National Register.

Lichtenstein and DelDOT in consultation with the Delaware State Historic Preservation Office (SHPO) agreed that the survey update would provide eligibility recommendations for 76 highway bridges with dates of construction from 1946 to 1956. In addition, evaluations would include two (2) railroad bridges on the DelDOT-owned Milton-Ellendale line. It was felt that the highway bridges built between the end of World War II in 1945 and the beginning of interstate highway construction in 1957 shared a common historical and technological context that facilitated their complete assessment as a group of alike cultural resources. To achieve that goal, each bridge was assessed for its potential engineering and historic significance. Lichtenstein compiled and recorded the findings on standardized survey forms, and the data was evaluated against the National Register of Historic Places criteria. The National Register-eligibility recommendations were forwarded to the DelDOT Location & Environmental Studies Office which consulted with the DE SHPO. Concurrence with the recommendations will become a significant part of the interagency Section 106 consultation process.

It was also agreed to reinspect the 80 previously eligible bridges to determine which still met the National Register of Historic Places criteria for evaluation. It was understood that since the earlier survey, many of the eligible bridges had been replaced or rehabilitated. Eligibility reassessments were based on current field inspections and a review of department plans and records. The eligibility reassessments were compiled on the summary short forms with attached inspection narratives that chronicle changes since the previous survey. The narrative justifies the eligibility recommendation.

Throughout the project, Lichtenstein personnel met with an advisory committee including representatives of DelDOT and the Delaware SHPO. The committee brought together a wide range of experience and expertise that assisted with guiding the project and making decisions about its layout and content. The committee reviewed all submissions.

In order to efficiently assess each of the bridges, the survey was divided into two phases. Phase I consisted of a review of existing survey material and transfer of data into an electronic format. A computerized database of the 80 previously eligible bridges and 76 bridges with dates of construction from 1946 to 1956 was developed and the data entered on draft survey forms. The criteria for evaluation were reviewed and revised by the advisory committee. Draft historic contexts based on secondary and primary literature research were prepared. SHPO files were reviewed for relevant data, including whether a bridge was located in a listed or eligible historic district. The Phase I goal was to establish base line data for the field inspection and subsequent research into each bridge's significance.

Phase II consisted of field inspections and eligibility evaluations of each of the 1946-1956 highway bridge's historic significance, context, setting, and historic integrity. Each bridge was documented with black & white photographs and color slides. USGS Quad maps with locations were completed for each bridge. Additional research was done as needed to justify and support the eligibility recommendations. A long form with an expanded physical description, statement of historical and technological significance, boundary description, and a select bibliography was prepared for each 1946-1956 bridge. The survey was from the historical, not structural, perspective, so condition and functional adequacy were not evaluated.

Phase II also consisted of field reinspections and reevaluations of the 80 previously eligible pre-1946 bridges. Reinspections focused on an assessment of the bridge's historic integrity, as well as photo documentation. Additional research was done in DelDOT's bridge plans and maintenance records to determine what alterations, if any, had occurred to each bridge since the previous survey. In some cases, further research was required to answer new questions about an individual bridge's historical and technological significance or history of alterations. The reinspection information was compiled on survey forms with a second page, or inspection narrative, including an expanded physical description and evaluation of significance and historic integrity.

Final copies of the completed survey forms and reevaluations were deposited with DelDOT's Location and Environmental Studies office.

PHASE I

Review Existing Survey Material & Transfer into Electronic Format

Materials from the previous survey including HAER cards, photo negatives and slides were reviewed by Lichtenstein to determine what could be reused and thus eliminate duplication of effort on both the survey portion and the production of the bound report. Since no electronic copy of the bound report or the survey data was found, the text portion of the 1991 publication was entered into a WordPerfect for Windows 6.1 format.

To facilitate easy retrieval and sorting of the survey data, bridge data was compiled in Microsoft Access 2.0 software running under MS Windows compatible with IBM PS/2 equipment and able to run a laser printer. DelDOT's bridge maintenance unit provided a computer file that contained records on all the 1946 to 1956 bridges on the state's bridge management database that is part of the National Bridge Inspection Standards (NBIS). A second computer file was provided for the 80 bridges that had been evaluated eligible by the prior survey. The database files included data such as bridge number, location, length, width, owner, facility carried, feature intersected, DelDOT district, bridge type, material, and year built. The data was decoded and reformatted for Microsoft Access 2.0.

In addition to the data retrieved from the NBIS system, data fields were added to the database for information specific to the historic bridge survey, such as bridge designer/builder, date of alterations, source of date of construction, setting, summary, current National Register status, and National Register recommendation. Data was entered into these fields during the course of the survey.

Survey Form

A survey form was developed to convey information about each bridge in a clear and concise manner, including types of information most useful to potential survey users in several DelDOT departments and the Delaware SHPO. The form layout and content were approved by the advisory committee. The adopted survey form conveyed relevant information in an easily retrievable format on one page (Figure 1). The MS Access 2.0 software generates the survey forms, as well as maintains the database.

A list of bridge types, designs, and primary materials (Figure 2) was developed to ensure that physical descriptions on the survey forms would be standardized.

DELAWARE DEPARTMENT OF TRANSPORTATION — A. G. LICHTENSTEIN AND ASSOCIATES, INC.

DELAWARE HISTORIC BRIDGES SURVEY

BRIDGE NUMBER: OWNER: CRS #:

COUNTY: HUNDRED: ZONE:

LOCATION: SPO MAP:

ROAD NUMBER: MILEPOST: USGS QUAD:

FACILITY CARRIED:

NAME/FEATURE INTERSECTED:

TYPE: DESIGN:

MATERIAL:

SPANS: LENGTH: WIDTH:

DATE OF CONSTRUCTION: ALTERATION: SOURCE:

DESIGNER/BUILDER: DOT DIST:

SETTING:

Current NR Status:

NR Recommendation:

SUMMARY:

PHOTO: REVIEWED BY: DATE:

Figure 1

Survey Short Form

Conventions were adopted for consistency of punctuation and spelling in order to maintain the usefulness of the database as a means of sorting, tallying, and reviewing the bridge inventory for specific information about individual bridges and groups of bridges and bridge types. For this reason, standards were prepared for each bridge field. All data is capitalized except for the narrative information contained in the Setting, Current National Register Status, National Register Recommendation, and Summary fields.

The informational categories (database fields) on the Delaware Historic Bridge Inventory survey form (Figure 1) are described as follows:

Bridge Number: Each bridge under state jurisdiction has an identification number. The numbers are three digit (e.g. 076, 687) and in some instances three digit with a letter postfix (e.g. 067A).

Owner: Governmental entity, agency, or corporation that owns the bridge. This data was derived from the NBIS data.

CRS#: The Cultural Resources Survey number is a unique, sequential number obtained from the Delaware SHPO. It is used by the agency for mapping and file management. It works in conjunction with the SPO map.

County: The county in which the bridge is located.

Hundred: The hundred in which the bridge is located. Hundreds are traditional sub-county taxing districts in Delaware. The geographic boundaries of the hundreds are used by the Delaware SHPO to locate cultural resources.

Zone: The name of the geographic zone in which the bridge is located. The zones are obtained from the Delaware SHPO's state plan.

Location: A verbal description of the location of the bridge, usually referenced to the nearest town or village.

SPO Map: The map number designation for the Delaware SHPO's State Planning Office aerial maps on which all surveyed properties are mapped by their CRS number.

Road Number: The DelDOT road number on which the bridge is located.

Milepost: The bridge's roadway milepost location, when available from the bridge maintenance database.

USGS Quad: The name of the 7.5 minute US Geological Survey quadrangle map on which the bridge is located.

Facility Carried. The facility carried field lists the route number and/or name of the road or highway carried by the bridge. The data was downloaded from the bridge management data and modified for consistency of format and information. The following conventions have been adopted for state routes (e.g. SR 2/Kirkwood Highway); and US numbered routes (US 113/DuPont Highway).

Name/Feature Intersected. The name/feature intersected lists the name of route and the stream, railroad, or highway over which the bridge passes. The data was downloaded from the NBIS and modified for consistency and completeness of format and information. All abbreviations such as TRIB, CRK, RVR, etc. have been spelled out (i.e., TRIBUTARY, CREEK, RIVER). The name of the railroad that currently operates the line was used rather than the historic name. Thus, former B&O Railroad tracks are listed as CSX RAILROAD (B&O RR), with the historic name in brackets.

Type. A standardized entry based on a list of all bridge types found in the statewide survey (Figure 2).

Design. A standardized entry based on a list of bridge type designs found in the survey (Figure 2). Design assists with better identifying bridges with similar physical characteristics within broad types such as stringers and slabs. The design field is left blank when none of the standardized designs apply.

Material. A standardized entry based on the material of the primary members of the main span.

Spans. Total number of spans.

Length. The back wall to back wall overall length of the bridge. The length appears first in feet and is followed in brackets by the metric equivalent.

Width. The width of the bridge (out-to-out). The width appears first in feet and is followed in brackets by the metric equivalent.

Date of Construction. The date of original construction. Data was initially downloaded from the bridge management database and updated based on research and documentation. For undocumented bridges that were dated based on style, approximate dates were noted as "circa", e.g. 1950CA.

Alteration. The date of significant alterations, if known.

Figure 2: DELAWARE HISTORIC BRIDGES BY TYPE AND DESIGN

TYPE	DESIGN
Bascule	Scherzer Simple Trunnion
Box Culvert	
Deck Arch	Closed Spandrel Closed Spandrel/Tied Open Spandrel
Deck Girder	Continuous
Multi Girder	Cantilever Continuous Drop In Encased Partially Encased Simple
Pipe Culvert	
Pony Truss	Warren
Rigid Frame	Continuous Ribbed
Slab	Composite Continuous Simple
Swing Span	Bobtail Center Bearing
T Beam	Continuous Simple
Thru Arch	
Thru Girder	
Thru Truss	Pratt Town Lattice

Source. The field specifies the source upon which date of construction/alteration(s) are based. In some instances it also references the source of historical data. In addition to the self-explanatory entries, "STYLE" is the convention used when the date is based on the physical evidence of the structure itself. "CONTRACT FILE" refers to the date provided in the DelDOT contract files. That date was used when it was confirmed by physical evidence and research.

Designer/Builder. Identifies who designed and/or built the bridge. "DE HWY DEPT BRIDGE DIV" is the convention used to identify bridges designed by the state highway department bridge engineers. The second entry lists the contractor who actually constructed the bridge. For example, an entry of "PARSONS BRINCKERHOFF/JAMES JULIAN CO" refers to a bridge designed by consulting engineers Parsons Brinckerhoff and constructed by general contractor James Julian Co.

DOT Dist. Identifies the DelDOT district in which the bridge is located.

The following sections of the survey form were developed to record the qualitative data about the bridge that supports the National Register recommendation.

Setting. Surroundings and historic contexts are an important part of the National Register evaluation process. Sometimes a bridge is found to be eligible because it is located in an identified potential or listed historic district. For example, it might contribute to a historic context of industrial development or community planning. It could also be in an area that once had historic significance but has been so altered that the significance has been lost. The bridge might be newer than its historic setting and therefore not contribute to it. Or, the span could be isolated in a rural setting surrounded by woods or fields. This category was defined to explain and assess the environment and historical associations of the span as a means of better supporting the National Register recommendation.

Current National Register Status records whether the bridge has been previously evaluated for National Register eligibility. The 1946-1956 bridges had not been previously reviewed and "Not Evaluated" was entered. For the 80 previously eligible bridges, SHPO files were checked to determine which bridges might have been listed in the National Register, either individually or as contributing resources to listed historic districts. These bridges were noted as listed with date of listing, e.g. "Listed. 1973" or, in the case of contributing resources, the name of the historic district and contributing status, e.g. "Listed. 1976. Brandywine Park Historic District. Contributing."

The Delaware SHPO National Register files were also searched to determine which bridges were located in listed historic districts or previously identified eligible historic districts. SHPO files were reviewed, and historic district boundaries were marked on highway maps that were used to locate all surveyed bridges. Where district boundaries and bridges overlapped, information was gathered regarding the district's period(s) of significance and area(s) of significance. In those cases where a bridge clearly dated from the district's period of significance and area of significance, and had integrity, the bridge was recommended a contributing resource.

National Register Recommendation is the professional opinion of the survey compilers and reviewers of whether the structure appears to meet the evaluation criteria for inclusion in the National Register of Historic Places. It is a studied and carefully considered opinion based on all the information gathered statewide during the field work, research, and review phases of the survey. The recommendation reflects the perspective of historians and engineers.

Summary is a narrative that briefly describes the bridge and significant alterations and justifies and explains the National Register recommendation. It is the "heart" of the assessment and serves as a summation of the engineering and historical significance of the structure and its setting or context.

Photo lists the black & white film roll number and negative numbers for the accompanying photo documentation. Thus, an entry of "7:10-15" refers to roll no. 7, negatives 10-15.

Reviewed By records the principal historian who inspected the bridge and made the evaluation.

Date is the month and year that the bridge was field inspected.

Development of Criteria for Determining Significance.

Each bridge in the Delaware Historic Bridge Survey Update has been evaluated on its own merits against the National Register of Historic Places criteria as set forth in 36 CFR Part 60.4. In Phase I, criteria for determining the significance of the bridges were developed based on a full interpretation of the National Register criteria A, B, C, and D. The National Register criteria are defined broadly and there are numerous areas of significance associated with those criteria, such as transportation, community planning and development, engineering, and landscape architecture, that relate to bridge and transportation development. The criteria are also discriminating and can be used to distinguish the subtle yet often crucial distinctions of significance among large numbers of similar resources with a common history, separating those that are eligible from those that are not.

The criteria for determining significance takes into account the many ways a bridge might be considered significant including individual, contribute to district, historic context, property type, etc. The criteria were prepared to reflect a complete and balanced evaluation of the technological as well as the historical value and significance of the bridges.

The criteria for determining significance addresses not only historic significance but develops guidelines for assessing integrity. Integrity is a synonym of the state of completeness or preservation of a historic resource, most importantly it refers to the retention of original fabric and/or historic appearance. It does not refer to the state of repair or its structural and/or functional adequacy. Integrity is defined in the criteria for evaluation as an integral part of the assessment of the significance of the structure. The seven elements of integrity are "location, design, setting, materials, workmanship, feeling and association." A majority of these elements must be retained for a resource to be evaluated as eligible.

The criteria were developed in conjunction with the historic contexts. Information was continually synthesized and revised to reflect the latest findings and evaluations. The criteria were developed to recognize the subtle yet often important technological distinctions among common bridge types that characterized the Delaware pre-1957 bridge population. To that end registration requirements addressed identification and explanation of alterations or modifications that compromise integrity of original design; definitions of what bridge types were rare, uncommon, or common; definition of features that make a bridge type significant and which features are ubiquitous and therefore less significant; defining what distinguishes some roadway development project in historical and technological significance from others; and definitions of thresholds of integrity that individual structures, districts, corridors, and historical contexts must meet.

Development of Draft Historic Contexts

In order to establish the historical framework, or context(s), for the National Register eligibility evaluation of the 1946-1956 bridge population in Delaware, Lichtenstein researched and prepared twofold historic contexts: one on the history of highways and the Delaware State Highway Department from 1946 to 1956, and the second on the application of bridge technology within the state during the same period. These contexts were designed to supplement the contexts prepared for the previous survey and were crafted so as to stand as additional chapters or sections in the revised publication.

To gather the information that comprised the contexts, historians experienced with industrial and technological history consulted a wide variety of primary- and secondary-source materials including state and local histories, historic atlas maps, roadway maps, official state and county records, plans, historic photographs, railroad corporate records, and technical literature like engineering journals and bridge engineering books.

The context for the history of Delaware's highways from 1946 to 1956 was written as a narrative with the first part focusing on the impact of roads on the cultural landscape and pattern of economic and social development. The second part of the narrative delved into the impact of federal aid and the strong influence of the Delaware State Highway Department on the state's highway transportation history during the mid-20th century. Special emphasis was given to the state highway department's bridge division and its role planning and designing bridges for the state highway system, which by the 1940s included most of the state's highway mileage except for urban streets.

The context for the application of technology in Delaware was prepared to present historical background for the bridge types present in the state from 1946 to 1956 including steel multi girder bridges, wood multi girder bridges, and reinforced concrete bridge types such as arches, slabs, T beams, rigid frames, and box culverts. The historical significance of each bridge type was discussed with special emphasis given to when and by whom they were initially developed, and to identifying what was technologically innovative or significant about them.

The technology context emphasizes that all of the 1946 to 1956 bridge types identified in the survey were well established by the first decades of the 20th century. For this reason, the technology context emphasizes that certain bridge types from 1946 to 1956 needed to be compared with the population of similar bridges from earlier decades. In most cases, the previous survey identified historically and technologically significant examples of standard bridge types such as steel multi girder bridges, reinforced concrete slab bridges, and reinforced concrete box culverts. These previously identified examples are often representative of the common 20th-century bridge types used by the state highway department, counties, or municipalities.

It was requested that an expanded historic context on Delaware's railroad development be prepared. The context replaces the abbreviated railroad history from the previous survey, and it is designed to provide assistance assessing the historic significance of railroad right of ways and other railroad-related resources including overpass bridges by examining the role the railroads played in the state's economy and transportation network from 1827 to 1997.

At the end of Phase I, the draft contexts were complete, thus providing the contextual information and understanding necessary to proceed confidently with the field inspections and National Register evaluation of bridges in Phase 2. It was realized, however, that the rich texture of Delaware's bridge history would not become fully developed in the contexts until after further research, especially that associated field inspections could be completed. For this reason, the contexts were left in a draft stage, noting that examples and further elaboration would be added as the project progressed.

Completion of Phase I

In June 1996, draft historic contexts and criteria for determining significance were submitted for review, comment and revision by DelDOT in consultation with the Delaware SHPO and advisory committee members. Based on this consultation and concurrence, Lichtenstein personnel began Phase II field inspections, evaluations, final eligibility coordination, and final preparation of the new publication.

PHASE II

Field Inspections

Field inspections of the 80 eligible bridge from the prior survey, the 76 highway bridges from 1946 to 1956, and two railroad bridges on the Milton-Ellendale line were conducted from October 1996 to January 1997. Inspections were completed on a county-by-county basis by a historian and engineer team. Matching the architectural/technological historian and the engineer experienced with historic bridge types was designed to achieve well-reasoned and supportable eligibility assessments that address all aspects of significance.

Bridges to be surveyed were plotted on county highway maps. A survey form for each bridge to be inspected was generated from the software programs used for the project. Field notes were taken directly on the survey forms.

Each bridge and its setting and context were analyzed to determine its significance and state of preservation. Significant alterations were carefully documented to determine if they reduce or enhance the value of the span and its setting. The issue of historic integrity of original design was of particular importance when reinspecting the 80 previously eligible bridges. Attention was given to inspecting for interesting, unusual, or innovative construction details. Questions generated by the items observed during the field inspection were noted so that they could be followed up by further research.

If the bridge appeared to be within a potential historic district, a reconnaissance-level assessment of the district was made to determine possible areas of significance, the period of significance, and potential boundaries in order to be able to determine if the bridge is a contributing or noncontributing resource. A similar procedure was used for bridges existing in already listed or eligible districts.

Each bridge was thoroughly photographed in black-and-white in order to convey the condition and setting of the structure and to assist with the evaluation. At a minimum, the photographs included elevation, through, and detail views. At least one color slide was taken per bridge. The 3" x 5" black-and-white prints were numbered and labeled, and attached to their survey forms. Sketch maps were prepared referencing each photo view.

Location maps using USGS quad maps were prepared for the 1946-1956 inspected bridges. The maps were attached to the survey forms.

Historical Research

After the field inspections, additional historic research was completed as needed to support the final National Register eligibility recommendations. This research included extensive use of the DelDOT contract files, maintenance files, and plans, and a variety of local and state histories, newspapers, clipping files, and journal articles.

The research was also used to revise the draft historic contexts and to identify key illustrations and photos for the survey publication.

Synthesis of Information and Final National Register Recommendations

Highway Bridges, 1946-1956. When sufficient information to justify and support a National Register eligibility recommendation had been obtained from field inspections and further research, the data was used to complete all data fields of the survey forms. At this step similar resources were evaluated as a group. The best examples of the type statewide, regionally, and locally were identified and used for comparison throughout the evaluation process. Comparison was not limited to just the 1946-1956 bridge population but included comparison of similar groups of bridges from the previous survey. Thus, for instance, a 1953 steel multi girder bridge was not just compared with others from the 1950s, but with the eligible and not eligible multi girders from the prior survey with dates of construction beginning in the 1910s. Special emphasis was place on identifying innovative features, unusual details, or advances in engineering.

The bridges and supporting documentation were judged against the National Register criteria using the survey criteria for evaluation, and the transportation and technology contexts developed in Phase I and refined during field inspections and research to determine which of the population (1) appear to meet the criteria individually or as contributing to a historic district or historic context, (2) which do not appear to meet the criteria either individually or as a contributing resource to a potential historic district or context. No bridge was left as questionable.

A long form was prepared for each 1946-56 bridge that was field inspected, whether it was evaluated as eligible or not eligible. It consists of an expanded physical description, statement of historical and technological significance, boundary description, and a select bibliography. It was prepared by the historian who conducted the field inspection and research and then reviewed by the engineers and other historians. The long forms refer back to significant themes developed in the historic contexts. Judgements as to whether the bridge represented an early, long, rare, or common example of its type and design were determined by sorting the database on a variety of parameters.

The physical description identifies any significant construction details or other noteworthy features. It also contains a description of any alterations or modifications, and a judgement of whether these have compromised or enhanced the bridge's integrity of original design.

The historical and technological significance narrative identifies and expands upon any significant historical associations, setting, or technologically significant features of the bridge. It also specifically identifies the National Register criteria that the bridge meets. The long form also contains a judgement to the bridge's integrity of original design, materials, and workmanship. The boundary description for eligible bridges specifically identifies the eligible portion of the bridge or its environs, with specific reference to historic district boundaries when applicable.

Lichtenstein historians and engineers coordinated review of the forms to ensure a complete and balanced evaluation of historical and technological significance from the national, state, and local perspective. Once in-house review of the draft survey forms was completed by Lichtenstein, the draft forms were submitted to DelDOT for their review and comments. Lichtenstein then revised the forms to address review comments and did what research and fieldwork was required to resolve any questions. The revised, or final draft survey forms, were then returned to DelDOT for final review by the department in coordination with the Delaware SHPO.

<u>Railroad Bridges on the Milton-Ellendale Line</u>. During field inspections, it was determined that the two railroad bridges had been replaced in 1988. Survey forms

were completed for the bridges and a not eligible recommendation made based on the new dates of construction.

Previously Eligible Bridges from the 1988-1989 Survey. Each of the 80 previously evaluated eligible bridges was reinspected and researched as needed to determine if it maintained the integrity and significance to still meet the National Register criteria for evaluation. An opinion was prepared and compiled on a summary survey form and attached inspection narrative that justifies the recommendation. Evaluations began with the assumption that each of the 80 bridges had historical or technological significance based on the findings of the previous survey. It was not the purpose of the reevaluation to reassess the significance of the bridge or to conduct further in-depth research into its history. In some instances, it was important, however, to amplify or refine a point about significance, and when appropriate, that was done.

The focus of the evaluations was to determine if any alterations, such as recent rehabilitation projects or accidental loss of original materials, had significantly affected the historic integrity of original design. For a bridge to merit a not eligible recommendation, it had to have a significant loss of integrity as defined by the criteria for evaluation. Integrity is a synonym for the state of completeness or preservation, and the retention of original fabric or historic appearance. The integrity of each bridge was assessed based on its individual state of completeness and in comparison with other similar bridges in the survey population of eligible bridges. A higher degree of alteration was acceptable for rarer bridge types such as trusses and stone arches.

In some few instances, field inspections identified a discrepancy in a bridge's history and what had been reported by the previous survey. In these instances further research was done to clarify questions and rectify the discrepancy if possible. It was found that some bridges previously determined eligible had a history of alterations that had not been identified during the 1988-1989 survey. These alterations were entered on the survey forms and inspection narratives, and in some instances it was felt that a reverse recommendation of not eligible was justified based on the new information.

As with the survey forms for the bridges from 1946 to 1956, draft forms for the 80 previously eligible bridges were submitted to DelDOT for their review and comments by both DelDOT and SHPO. The survey forms were revised to address the comments, and some additional research and fieldwork was undertaken in order to resolve questions. The revised survey forms and supporting report were then returned to DelDOT for final review.

Preparation and Submission of Final Report

The final report was prepared that incorporated all requested revisions and a justified National Register-eligibility recommendation for each bridge included in the survey. The survey report consists of the methodology, criteria for evaluation, Delaware highways (1946-1956) context, bridge technology (1946-1956) historic context, Delaware railroads (1827-1997) context; and the completed survey forms for all bridges. The information was also compiled into a camera-ready, publication layout approved by DelDOT.

The final submission also included the Delaware Historic Bridge database on Access 2.0 software. A tabulated summary of survey findings by eligiblity status was prepared. Field forms and notes, slides in archivally stable sleeves, and an electronic copy of the text of the report were returned to DelDOT.

DELAWARE HISTORIC BRIDGE SURVEY UPDATE

Criteria for Determining Significance

Each bridge will be evaluated on its own merits against the National Register of Historic Places criteria for evaluation as enumerated in 36 CFR 60.4. The National Register criteria are broadly defined, and there are numerous areas of significance associated with those criteria, such as transportation, community planning and development, engineering, and landscape architecture, that relate to bridge and transportation development. The criteria are also discriminating and can be used to distinguish the subtle yet often crucial distinctions of significance among large numbers of similar resources with a common history, separating those that are eligible from those that are not.

The National Register of Historic Places criteria for evaluation are

> The quality of significance in American history, architecture, archeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:
>
> A. that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. that are associated with the lives of person significant in our past; or
>
> C. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. that have yielded or may be likely to yield information important in prehistory or history.

To assist with applying the criteria for evaluation, several considerations addressing specific types of resources are included in the criteria. Two of the "criteria considerations" are relevant:

> Ordinarily...structures that have been moved from their original locations...and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However,

such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

b. a building or structure removed from its original location but which is significant primarily for architectural value or which is the surviving structure most importantly associated with a historic person or event; or

g. a property achieving significance within the past 50 years if it is of exceptional importance.

Reasoning that time is needed to develop "historical perspective and evaluate significance," the National Register criteria for evaluation generally excludes properties that are not 50 years old. In so much as the time period addressed in the bridge survey is contextually based (common history and common technologies), rather than chronology, bridges that are less than 50 years of age will be included. Since the contexts cover the period through 1956, all bridges will be evaluated in the same manner for determining significance albeit in anticipation of some bridges becoming 50 years old.

Applying the Criteria for Evaluation

The following explain how the individual criterion will be applied in the evaluation of historic bridges in Delaware:

Criterion A addresses an event or pattern of events that made an important contribution to the historical and physical development of a locality, region, or the state. This could range from the development of a settlement as a regional trading or industrial center or the influence of the Delaware Railroad on the subsequent transportation network development in lower Delaware. Criterion A can include significant transportation routes like the Philadelphia, Wilmington & Baltimore Railroad that became the Pennsylvania RR through Northern Delaware and spurred industrial development and growth in Wilmington, the Du Pont Highway, which ended downstate dependence on railroad and water-borne transportation, or the improvements done in conjunction with the 1952 opening of the Delaware Memorial Bridge.

All bridges have a history. They were built by a railroad, a county, the state, or a private commission, and were thus related to larger historic contexts such as development of improved railroad rights-of-way or expanding the state highway system with the then-prevailing bridge technology. Criterion A differentiates between history that is common to like features, such as all railroads having an impact on the subsequent development of the areas through which they passed or

1950s dualized state highways facilitating the suburbanization of the northern part of the state, and distinguishable events that made a significant contribution to historical development. Thus, representative examples of common bridge types, such as steel and wood multi girder bridges, reinforced concrete slab and T beam bridges, and box culverts, with no distinctive or unusual historical background or setting will not be evaluated as meeting criterion A.

Criterion B addresses historic association with great persons from the past. This criterion is not commonly applied to bridges, as the works of noted engineers and builders are usually better represented under criterion C.

Criterion C addresses the distinctive characteristics of a type, period, or method of construction, the work of a master, or the significance of a historic district and is thus the most broadly applicable criterion. The criterion affords recognition of the evolution of bridge building technology as well as the setting of the structure, or of the importance of the engineer who designed it and fabricator/contractor who erected it. Bridges with unusual construction details or rare survivors of a type that was significant in the development of bridge technology, were the work of noted engineers, engineering firms, or bridge companies, or were particularly good examples of their type are eligible under criterion C.

Criterion C applies to common resource types, like steel multi girders or reinforced concrete T beam spans. Common resource types are analyzed to identify which examples of types and designs best represent the population and distinguish some examples as being noteworthy and historic. Priority is placed on recognizing (1) examples that mark technological/engineering advances, improvements, or variations and (2) the better or best examples of a resource type or construction detail when a sufficient population is identified. Parameters of distribution also include common topographical, economic, historic, and development factors as well as political boundaries. Better or best was often meant being the earliest, larger, more complicated, or least altered example of a type or a structure that exhibits several distinctive details or notable historical association(s). At times, some noteworthy feature like a particularly well-detailed, custom balustrade or original light standards and luminaires, will be required to merit an eligibility recommendation. This policy will apply to all bridge types and designs, both fixed and movable.

Under criterion C, bridges that are documented as to designer, builder, and/or fabricator will be evaluated as more significant than those that are undocumented. Such information establishes the historical, and frequently, technological significance of the span.

Because of the historically important role the Bridge Division of the Delaware Highway Department has played in the development of the state's roads and bridges since 1917, the historical and technological significance of standardized bridge designs will be a dominant consideration. The historic contexts establish when and under what historical circumstances standardized bridge designs and details were introduced, the frequency at which a standardized design was built, and the technological significance of the designs. The contexts coupled with the survey database provide a means of acknowledging on a statewide basis the oldest extant examples of a type, design or detail in an effort to set the engineering history in the state context. These examples are generally regarded as more significant than later examples. Identifying the early application of a particular technology is an objective of the survey, and tabulating the findings make it possible to determine which structures truly marked transitions from one technology or design to another.

Unique, rare, or infrequent survivors of a type or construction detail are also evaluated as having engineering significance under criterion C. Bridge types like a Pratt thru truss or reinforced concrete deck arch are often evaluated as significant because they are no longer common. Yet, they represent the development of bridge technology in this country. Likewise, unusual construction details, like the first use of hammerhead piers in the 1950s or the early use of continuous designs with rigid frame or T beam bridges are evaluated as significant because they reflect an era of experimentation in the development and popularization of different bridge technologies.

Criterion D is generally interpreted to refer to archaeological resources, and has limited application to this survey. It may be applied to structures and objects that contain important information that themselves are the principal sources of information. This could apply to an unusual and technologically significant bridge for which no plans or other documentation survives. The study of the bridge would have to yield important information for the structure to be evaluated as eligible under criterion D. An example of such a bridge might be a wood bridge from the colonial period that has remained buried or submerged for the past 200 years and would yield important information about colonial bridge construction techniques. The vast majority of identified extant bridges in Delaware date to within the last 100 years. They represent bridge types that are well documented in historical literature including engineering journals and textbooks, plans, and photos. No bridges have been evaluated as eligible by this survey under criterion D.

Historic Districts

Another component of assessing National Register eligibility is evaluating the setting and contexts to determine if they meet the criteria as a potential historic district. Entire routes or portions of routes can also be historic districts. There are three ways a resource located within a listed or potential historic district can be considered a contributing and thus National Register-eligible resource.

Firstly, the bridge was present in the district during the years that the district achieved its significance. The period of significance is determined by historical research and the physical development of a district. To be evaluated as a contributing resource within a historic district a structure must have been built within that period of significance, such as a 1950 reinforced concrete slab bridge built as part of a well preserved and architecturally significant post-World War II suburban community. Conversely, a late-1940s steel multi girder bridge built in a historic district that achieved its significance prior to World War I would be evaluated as noncontributing regardless of its state of preservation because it is outside the period of significance of the district.

Secondly, the bridge needs to support the historic themes or areas of significance for which the district is being recognized. It must add to the historic architectural qualities, historic associations, or archaeological values for which a district is significant. Thus, unless a structure is related to one of the themes or areas of significance for which the district is eligible, it is evaluated as noncontributing

Thirdly, some structures located in historic districts meet the National Register criteria on individual merit and are thus eligible independent of their setting and associations. Provisions for such individually significant structures located in historic districts are made in the programmatic procedures of the National Register. The conclusion of the evaluation will be specified on the individual survey forms.

Emphasis will be placed on looking at entire roads as potential historic districts to ascertain if they possess sufficient integrity and significance to meet criteria A and/or C. Did its development make a significant contribution to the broad patterns of our history, and thus meet criterion A, or was it part of the overall history of the ongoing development of roadways in the state? Did the road possess engineering significance or was it a typical solution to common traffic bridge engineering problem? Does it possess the integrity of original design, setting and feeling?

Integrity

One of the most important considerations in the evaluation of National Register status is integrity. A synonym for the state of completeness or preservation, integrity refers to the retention of original fabric and historic appearance. It does not refer to its state of repair or its structural or functional adequacy. Integrity is defined in the criteria for evaluation as an integral part of the assessment of the significance of a structure. The seven elements of integrity are "location, design, setting, materials, workmanship, feeling and association." A majority of these elements must be retained for a resource to be evaluated as eligible. In other words, a structure must appear much as it did when it achieved its significance in order to meet the National Register criteria. The issue of integrity is applied to structures that are individually evaluated as well as to those that are located in historic districts, contexts, and routes or corridors.

To arrive at an accurate assessment of integrity, alterations will be studied to determine if they (1) are historic or not (executed within the past 50 years), (2) changed the design or how a bridge functions, or (3) compromised the technological and/or historical significance of the structure. These issues figure greatly in the assessment of the historical and technological significance of each bridge.

Alterations that are considered as drastic enough to make a bridge not eligible include removal of original concrete balustrades/parapets from common bridge types, widening on both sides so that the original structure is undiscernible in elevation, removal of the major portions of the operating mechanisms on a movable bridge, and post-1956 rebuilding, even if it is in kind, of a timber bridge. A higher degree of alteration is acceptable as significance in other areas increased, especially for very old or very rare structures.

Some modifications common to a particular bridge type or design were not considered as alterations that detracted from the potential significance of a span because the changes (1) were necessary to address inherent weaknesses in the original design, (2) were necessary replacements to keep the bridge operational, (3) were such minor changes that they did not affect the overall appearance or design of the span, (4) were sensitive alterations that were done in a manner which did not detract from the original design, or (5) are reversible alterations that did not involve the removal of original fabric. These common modifications include replacement of decks or wearing surfaces on multi girder bridges and the replacement of sources of power, brakes, locks, and control panels on movable bridges. Other common alterations that do not diminish integrity include the addition of beam guide rails when they were attached in a manner so as not to irreversibly impact the historic fabric or repointing to masonry when done in a reasonably sensitive manner. Limited in-kind replacement does not adversely affect the technological and historical significance of a bridge, but reconstruction of the structure does, especially in cases such as timber multi girder bridges that have had wholesale superstructure replacements.

Movable spans that survive in complete condition have greater historical and technological significance than examples that have altered movable leaves, machinery, and/or operators houses. This became an important consideration with well-represented 20th-century movable bridge types such as the simple trunnion bascules. It was a less weighty issue with rare types such as Delaware's two Scherzer bridges. In-kind replacement of open gear sets is not regarded as an alteration that compromises integrity.

Certain allowances in integrity were made for bridges that are a unique or rare surviving example of their type and or/design. When a resource type or detail becomes so infrequent or rare that losing one or two examples will mean that it is no longer represented, then the integrity question is secondary to recognizing a disappearing historic artifact. Examples of these bridge types in Delaware include metal trusses, wood trusses, and stone arches.

The integrity necessary for a resource to contribute to a historic district is commonly interpreted differently from the integrity needed for individual eligibility. This is because a district as a whole can meet the criteria for significance and integrity even though some of the components are altered somewhat (criterion C). For example, a reinforced concrete slab bridge that has been widened on one side might not be individually eligible, but if it has retained much of its original appearance and is from the period and area(s) of significance of the district, the bridge might contribute to the historic character of the district and thus be evaluated as a contributing resource. On the other hand, a steel multi girder bridge that has been widened to both sides and has had original railings removed and replaced with safety shape barriers, no longer appears or functions as it did when the district achieved its significance and would be evaluated as noncontributing.

DELAWARE HISTORIC BRIDGES SURVEY UPDATE

Historic Contexts

Scope of the Historic Contexts

In order to evaluate the National Register eligibility of the 1946-56 highway bridge population in Delaware, two historic contexts were prepared. One addresses the history and development of Delaware's post-World War II state highway system, placing roads and bridges in their economic, political, and social contexts. The other covers the application of bridge technology within the state during the same period of time. The historic contexts developed for the Delaware Historic Bridge Survey Update build upon the historic research prepared for the 1988-89 Delaware Historic Bridges Survey that considered the state's pre-1946 bridges. Readers are referred to the earlier survey for further background information on Delaware's pre-1946 highway and bridge history.

A third historic context has been prepared tracing the growth and development of railroads in Delaware from the beginning in 1827 through 1997. It provides a framework for assessing the historic significance of railroads in the state. It was developed specifically to address questions about railroad bridges, including overpass and underpass bridges, but has broader application to a host of other rail-related resources including railroad rights of way.

A. Delaware's Roads and Bridges, 1946-56

Summary

The immediate post-World War II years were a period of transition for Delaware's roads and bridges. Founded in 1917, the Delaware State Highway Department had focused its early efforts on the completion and improvement of the state highway system. By the early 1930s, Delaware had what was considered one of the finest state highway systems in the nation with US 13 north of Dover, the state's first dualized, four-lane, median divided highway as its centerpiece. In 1935, the department's responsibilities were greatly expanded when all county roads and bridges were transferred to its jurisdiction, but World War II intervened before the secondary road system could be significantly improved. In the postwar years, the department's job of managing all of the state's highways and bridges was made all that much greater by the five years of deferred maintenance during the war. Additionally, Delaware's highway officials, like those of most every other state, had difficulty adjusting to the unexpectedly rapid increase in the number of automobiles and trucks. They found themselves in the unenviable position of redesigning and rebuilding highways and bridges in an effort to catch up with the automobile society while simultaneously struggling to maintain what was already built.

With the singular exception of the opening of the Delaware Memorial Bridge in 1952, there were few historically outstanding accomplishments in the field of highway and bridge engineering in the decade following World War II. The department primarily worked reconditioning existing roads and bridges by widening highways and improving traffic control to meet the increased demands of motor vehicles. Bridge design was centralized at the Delaware State Highway Department's bridge division, with a majority of the routine work completed in-house by department engineers. In general, the department's bridge division continued using the standard steel and reinforced concrete bridge technologies of the immediate prewar years to replace structures that no longer met traffic demands or were worn out, inadequate, and unsafe.

From the 1940s to the mid 1950s, the department's engineers found that their efforts to plan ahead for the expansion of the state highway system were frustrated by the lack of a statewide political consensus on the future of Delaware's roads. Powerful rural downstate interests blocked efforts that would have shifted highway funds from the maintenance and improvement of existing roads to the construction of a new system of expressways to serve Wilmington and the Northeast Corridor where traffic was heaviest. The political stalemate over Delaware's future highways was not broken until late 1956 when events at the national level overtook Delaware and the U.S. Congress passed the Federal-Aid

Highway Act creating an integrated system of limited-access interstate highways. The act, which marked a major redirection of federal highway policy, broke opposition in Delaware to the upstate expressways by providing 90 percent federal funding for such highways. The interstate highway program marked a new era of highway construction, including new post-1956 developments in the field of bridge technology.

The Automobile Age Comes of Age: The Economic and Social Context of Delaware's Roads and Bridges, 1946-1956.

The lack of a strong postwar highway planning policy was characteristic of the largely uncontrolled development of Delaware in the late 1940s and 1950s. The state had never experienced such sprawling growth, and the government initially lacked the means to plan for, or even keep up with, the expanding suburban landscape. The most dramatic changes were in New Castle County, where the middle class abandoned downtown Wilmington for the suburbs with their new residential subdivisions and shopping centers. Growth also accelerated downstate; farmers successfully adjusted to agri-business, building poultry houses and growing truck crops on ever larger individual farms. Meanwhile, the resort towns of Rehoboth and Bethany Beach experienced increased popularity. Whether upstate or downstate, driving postwar growth were numerous and interlinked social and economic forces, but perhaps the most influential force was the automobile (Hoffecker 1983: 137-147).

In the 1920s and 1930s, the motor vehicle had been a potent yet adolescent transportation technology promoting suburbanization, industrial development, agricultural diversification, and tourism. One of the factors limiting the impact of the automobile was that the price of a new car remained beyond the income of most working class Americans until mid-century. Although Henry Ford's mass production techniques had made automobiles widely available, fewer than 50 percent of all families owned a car as late as 1940. After 1945, postwar prosperity and pent-up consumer demand boosted automobile sales to record highs and accelerated prewar social and economic trends. Nationally, car registrations soared from 25 million in 1945 to 52 million in 1955. Truck registrations also boomed, growing from 10 million to 26 million trucks, and interstate trucking cut into the railroad's freight business. Trends in Delaware mirrored the nation. State vehicle registrations increased almost 250 percent from 72,000 in 1946 to 178,000 in 1959. Delawareans took to their cars as never before and the landscape rapidly was reshaped to accommodate the automobile (Jackson 1985: 162; Annual Reports 1946, 1959).

After 1946, the automobile placed every increasing demands on the state's roads and bridges. The Concord Pike (US 202) was reconstructed and the Kirkwood Highway (SR 2) and Dover Bypass (US 13) were built on new alignments for greater traffic capacity and grew into commercial strips while the surrounding farmland was carved into residential subdivisions. As a smaller size city, Wilmington's traffic jams were hardly comparable to those of Philadelphia or New York, but the routine five-to-fifteen minute delays and downtown parking shortages were considered inconvenient, and businesses chose to forsake the inner city for more convenient suburban locations. As downstate farmers increasingly trucked their goods to the metropolitan markets, heavier and larger trucks took their toll on roadway surfaces and bridges. Each summer automobile vacationers clogged US 13 and US 113 on the annual pilgrimage to the beach (Hoffecker 1977: 60-61).

Despite the sometimes annoying problems of automobile travel and its accompanying sprawl and congestion, the postwar decade was in general a time of optimism and the state's attitude toward growth and the benefits of the automobile were overwhelmingly positive. In 1949, the state highway department's chief highway engineer, M. Allan Wilson, noted that conditions in Delaware had changed much since the early 1910s when highways lacked funding and strong institutions. In contrast to earlier days, Delaware motorists strongly supported the well-equipped and staffed highway department, even if they often disagreed over which particular projects should be given priority. Although the department often found itself embroiled in political controversy and unable to undertake all of the work it desired, the department remained the largest and best funded of all the state's bureaucracies (Annual Report 1949).

Delaware and The Federal Aid Program, 1916-1956: Influence on Delaware's Postwar Road Programs

A key ingredient to the growth of the Delaware State Highway Department was its cooperative relationship with the federal highway administration. Much of the postwar-era road and bridge construction was funded with the assistance of federal aid administered by the Bureau of Public Roads (BPR)[1], the agency responsible for managing national highway policy. Since the 1910s, the BPR had worked in association with the American Association of State Highway Officials (AASHO) and the American Society for Testing Materials (ASTM) establishing national standards for highway design and construction. Most states, including Delaware, sent their state highway officials to national conferences where committees prepared and reviewed specifications to be used as minimum

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[1]The BPR was renamed the Federal Highway Administration (FHWA) in 1967.

standards for all roadways and bridges. Although federal aid usually amounted to less than one-fifth of the Delaware State Highway Department's annual budget, it had a proportionately greater impact because any project using the funds had to meet AASHO and ASTM guidelines, as well as the approval of BPR engineers. Under the growing influence of the federal aid system and ever growing federal appropriations, the nation's and Delaware's postwar roads and bridges reached an unprecedented level of standardization of design (AASHO, Standard Spec., 1947; Seely 1987: 118-135).

Historically, the demand for federal support for good roads had begun with requests by bicyclists for routes into the countryside. In 1893, Congress approved the formation of the Office of Road Inquiry (ORI) within the Department of Agriculture. The small bureau, originally created to gather information on the nation's roads for bicyclists, formed the nucleus of what eventually became the BPR. Early automobile enthusiasts and Progressive reformers added their voices to the good roads movement, the former desiring roads for long-distance touring and the latter demanding good roads and bridges to improve the quality of rural life through easier access to towns and markets. BPR engineers guided federal legislation, and in 1916 achieved the passage of the first federal aid act that required states to create professionally staffed highway departments in order to qualify for the federal dollars. Those states that did not yet have departments, including Delaware, immediately created departments in order to cash in on the federal windfall. In 1917, the Delaware General Assembly created the Delaware State Highway Department headed by a five-member commission (USDOT 1976: 36-89; Dolan 1956: 265).

In the 1920s and 1930s, the BPR worked in cooperation with state highway departments creating roads to serve motor vehicles. The federal funding formula required states to expend a large portion of the aid on new construction of primary US highways. Engineering experts, led by the BPR's Chief Thomas MacDonald, encouraged states to match federal funds through dedicated funding sources such as fuel taxes. In 1923, Delaware adopted a dedicated fuel tax, and with the infusion of funds, became the first state to complete its primary highway system to BPR standards. The rapid completion was made possible in part because of the state's relatively small size and the head start given by the privately built Du Pont Highway (US 13/US 113).

In the late 1920s, the Delaware State Highway Department used its federal aid to help pay for the conversion of the northern section of the Du Pont Highway (US 13 north of Dover) and the Philadelphia Pike (US 13 from north of Wilmington to the Pennsylvania state line) to four-lane highways. The Du Pont Highway was among the earliest median-divided highways in the nation and was looked at as a model by many other states. In the 1930s, the federal government turned road construction into the largest of the New Deal public works programs. Delaware's state government used work relief programs and funding to widen existing state and local roads and to build new bridges. The department undertook an expanded program to improve safety at dangerous at-grade railroad crossings, including the addition of new signals and the construction of a limited number of overpasses. In 1935, the state legislature transferred all county roads and bridges to the state highway department, thus relieving the financially strapped county governments and taking advantage of increased federal aid to secondary highways. Much of the additional federal aid was used to improve rural dirt roads with asphalt pavements and short-span wood multi girder bridges (Del. State Hwy. Dept. A Factual Report 1948, pp. 29-31).

By the 1930s, Delaware had what many considered one of the finest hard-surfaced primary highway systems in the United States. However, the federal aid system that had helped fund the roads and bridges was not without its shortcomings. Close political alliances to rural interests at the federal level had largely limited highway improvements to the countryside. In fact, until the Depression, no federal aid was allowed inside of urban areas defined as towns with populations greater than 2,000 people. As a consequence, US 13 (Du Pont Highway to the south and Philadelphia Pike to the north) stopped at the Wilmington city line leaving motorists to pick their way through congested city streets. After 1936, BPR engineers worked to shift attention to urban highways, but progress was slow. By the late 1930s, the need for improved urban highways was pressing, but the BPR's traditional rural backers resisted expanded federal aid to cities (Annual Reports 1919-1941; Seely 1987: 149-164, 196-201).

The urban-versus-rural highways issue that nagged at federal highway policy translated directly to Delaware state politics where rural downstate interests traditionally clashed with urban upstate interests. As state highway engineers began to promote plans to extend expressways in and around Wilmington in order to improve highway connections along the Northeast Corridor and to relieve New Castle County roads serving suburban communities, downstate interests balked at the proposals increasing the gas tax and debt to pay for those improvements. In 1939, the legislature passed the Single Fund Act over the opposition of the highway department. The act diverted highway-dedicated gas tax revenues to the general fund rather than it being dedicated to highways. The Single Fund Act limited the department's ability to plan construction projects because the department could no longer estimate schedules based on the steadily increasing gas tax revenues but on what state funds were made available within the state government's two year budget cycle. Every two years the department's funding and construction schedule was thrown into question. Highway financing for the desperately needed upstate urban and suburban roads became mired in state house politics where downstate politicians controlled appropriations (Factual Report 1948: 26-27; Dolan 1956: 129; Hoffecker 1977: 200-201).

Another problem for highway planning from 1947 to 1955 was that federal politicians failed to agree on the funding formula to provide for a system of long-distance, limited-access interstate highways. The need for interstate roads was particularly acute in the urban northeast, but it lacked support in other regions of the country. The engineering community was divided over the best means to pay for the roads. BPR's Chief MacDonald strongly opposed toll roads like the Pennsylvania Turnpike (opened in 1940) on the grounds that politicians would use such self-liquidating toll roads as a justification to cut back the BPR's traditional "free road" funding formula based on gasoline taxes and user fees such as registrations. After 1947, many eastern states including New Jersey, Massachusetts, Maine, and New Hampshire built toll roads despite the objections of the BPR. The popularity of the turnpike roads created problems for states like Delaware when automobiles were dumped from the turnpike exits on to old, unlimited-access, two- and four-lane US highways at the state line.

From 1948 to 1954, Congress passed federal-aid highway bills that provided states with ever increasing amounts of aid collected from the federal fuel tax. However, the federal aid was given within the bounds of the old funding formulas that largely limited expenditures outside of urban areas on the preexisting US highways and rural roads. While some states went ahead and passed laws providing for limited access expressways, most like Delaware continued to work within the existing federal guidelines. In 1954, Vice President Richard Nixon, speaking for President Eisenhower, outlined a massive $50 billion dollar highway program to relieve highway congestion. The speech, which marked the shift of the initiative for highway policy from Congress to the White House, was the icebreaker in the rural-versus-urban and toll roads stalemates because it brought the debate from the back rooms of Congress into the highly politicized light of presidential politics. Eisenhower's backing of a first-class interstate highway system primed the public with high hopes for new highways, almost entirely paid for by federal dollars. In 1956, Congress passed the interstate highway bill that was the culmination of more than a half-century long effort of highway engineers to guide both the general goals and details of national highway policy. The bill's 90 percent federal funding formula to all intents and purposes eliminated local political opposition to the upstate freeways in Delaware (Seely 1987: 208-218).

Years of Transition: The Delaware State Highway Department, 1946-56

As World War II concluded, Delaware's highway officials eagerly awaited a new era of road and bridge construction. At the top of the Delaware State Highway Department's agenda was planning expressways for Wilmington and pushing forward a bridge over the Delaware River to New Jersey. The department presented a long list of proposed projects specific to the state's bridges including improvements to structures on US 13, a new bridge over Red Clay Creek at Curtis Mill Road (Bridge NC-231), and an overhead bridge eliminating a dangerous crossing (Bridge NC-632) of the B&O Railroad at Elsmere, a suburb west of Wilmington. In addition to these plans, dozens of other bridges required immediate attention and were scheduled for repair or replacement due to deferred maintenance during the war (Annual Report 1945).

The hopes of the department were dashed even as postwar automobile travel set new records. Inflation soared out of control, raising the price of materials and labor high above anticipated levels. By 1946, the state's chief engineer Warren W. Mack reported gloomily that due to economic conditions and the failure of the legislature to appropriate funds, no immediate prospect of a comprehensive, large-scale highway and bridge program existed. The chief engineer's annual reports became a plea to the legislature for funds and repeal of the Single Fund Act, so that the department could have the unrestricted use of the state's gasoline tax, and thus, plan construction in advance of the state budget. In 1949, a huge increase in federal aid helped boost highway and bridge construction to all time levels, but did little to end the confusion caused by the lack of an overall plan for the state's highways.

Adding to the department's responsibilities were the miles of privately built suburban residential streets with varying pavements, different roadway widths, and sometimes complete lack of adequate drainage. The suburban street situation created serious problems, especially when new homeowners complained about potholes and flooded streets and basements. The Suburban Road Act of 1945 was meant to remedy the problem by providing homeowners the power to request the county courts to issue bonds and collect taxes to pay the cost of the state highway department's work to improve local streets, but the funding mechanism was awkward, time-consuming, and unpopular. Zoning regulations setting standards for streets in residential subdivisions were slow in coming. The regulations were only gradually strengthened by New Castle County's Regional Planning Commission in the late 1950s and early 1960s. The types of small culverts common in residential subdivisions were generally left to the design of local developers and contractors (Annual Report 1949).

The premiere engineering accomplishment of the postwar decade was the construction of the first bridge of the Delaware Memorial Bridge, completed in 1951 and opened to traffic in 1952 (Figure A-1). The 3,650'-long suspension bridge ranked the sixth largest in the world and was entirely financed and built by the State of Delaware. Designed by Howard, Needles, Tammen, and Bergendoff of New York City, the bridge linked Delaware with New Jersey and replaced the

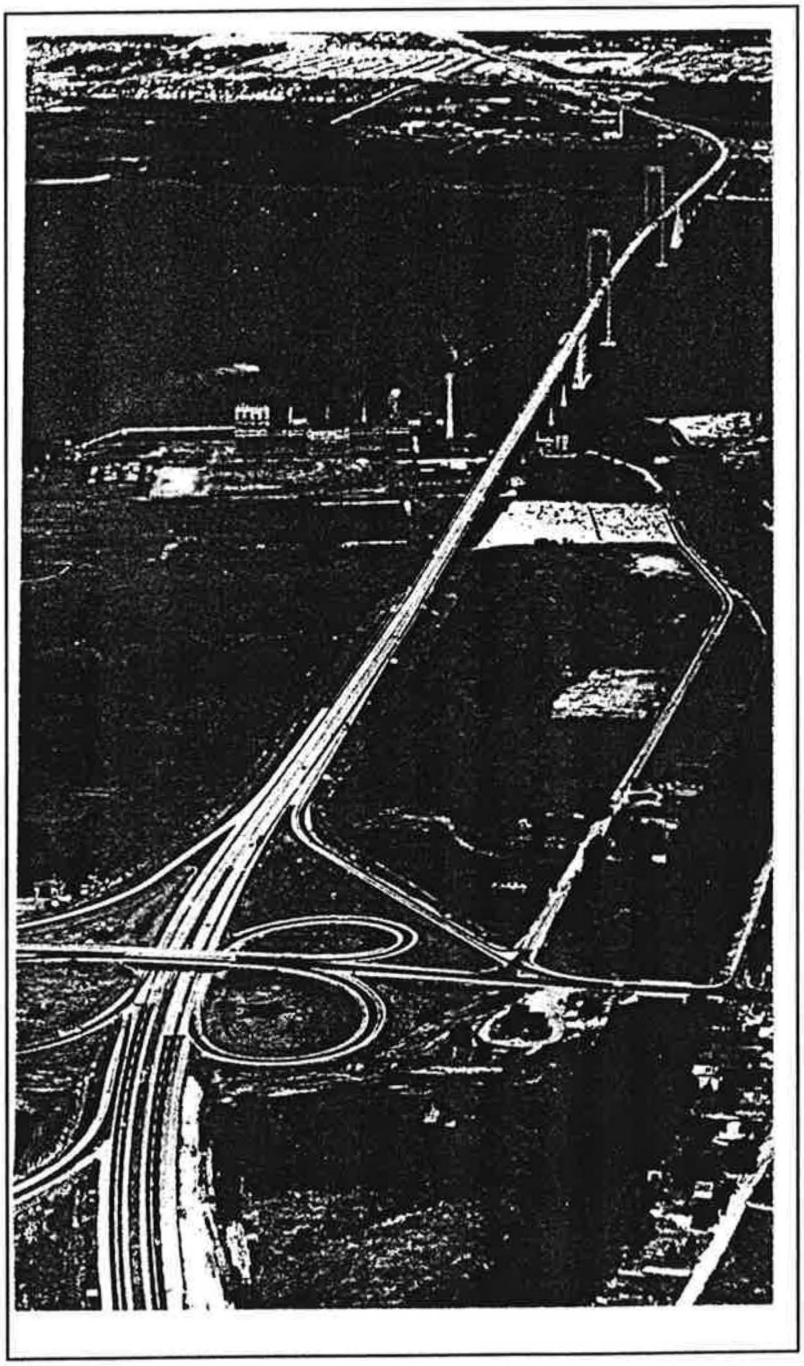


Figure A-1: Delaware Memorial Bridge (1952), looking toward Delaware from the New Jersey side. Notice in the foreground the newly completed interchange with the New Jersey Turnpike. Source: William J. Miller, Jr., Crossing the Delaware (Wilmington: Delapeake Pub.), 1983, p. 49.

old New Castle-Pennsville Ferry. The original bridge had two lanes of traffic in each direction. Funded by revenue bonds on the income from the tolls, the bridge was constructed under the direction of a separate division of the state highway department. In 1963, the bridge was turned over to the Delaware River and Bay Authority. The authority directed the construction of the second of the twin bridges that opened to traffic in 1968.

Planners had greatly underestimated the impact the Delaware Memorial Bridge would have on local and regional traffic volumes and patterns. Ironically, during construction many officials had worried that tolls would be insufficient to pay off the debt, but the result was exactly the opposite. By 1955, eight million vehicles annually crossed the bridge, nearly double the original estimates and close to the limit of its capacity. The bridge was a magnet for traffic on the Northeast Corridor, and neighboring states soon started incorporating the bridge as part of their own highway planning. In 1949, New Jersey announced that the New Jersey Turnpike would terminate at the bridge's eastern approach. The last segment of the turnpike opened in 1953 shifting on to the bridge thousands of daily travelers between New York City and points south of Wilmington. In 1952, Maryland added more cause for concern by opening the Chesapeake Bay Bridge between Annapolis and the Eastern Shore and announcing plans to build an expressway from Baltimore to Delaware. Pennsylvania revealed it, too, had plans to build an expressway from Philadelphia to northern Delaware, also undoubtedly bringing even more traffic to the bridge, especially during the annual summer exodus to the Jersey Shore.

As the unanticipated and record-breaking number of automobiles flooded from the Delaware Memorial Bridge onto Delaware's US 13 and US 40, traffic congestion was becoming an increasingly visible and pressing problem, especially in northern New Castle County. State highway officials worked at building the political consensus necessary to secure funding for expressways servicing the bridge and preventing Delaware from becoming the Northeast Corridor's number one traffic snarl. Although the department hired outside consultants who prepared two independent reports on the need for an upstate expressway, downstate legislators were unwilling to divert tax revenues to a major highway building initiative in the northern part of the state at the expense of local road and bridge projects. Further complicating the picture were the objections of northern New Castle County businessmen who argued that limited-access highways would draw away shoppers from their stores.

Another problem was that the Delaware Memorial Bridge was simply making too much money. At the rate toll revenues were being generated, the bonds used to finance the bridge would be paid off too soon, at which time the bridge would become toll free. Controversy existed over whether the excess funds could legally be invested in additional facilities, such as expressways or additional bridge capacity. Delaware lawmakers were not willing to assume the maintenance and operating costs of the bridge once the bonds were paid off and the bridge became free, so they began to look for ways to restructure the bridge's funding and operation. After several years of debate and negotiations in the late 1950s, Delaware's officials unveiled a workable comprehensive plan proposing the creation of a bridge authority to take over the bridge and a turnpike authority to build what would become the I-95 and I-295 expressways linking with the bridge (Miller 1983: 54-61; Del. State Hwy. Dept. Factual Report 1948; Knappen, Tippetts Abbett Eng. Co., Connecting Highways, 1950; Del. State Hwy. Dept., Annual Reports 1946-56; Haber, "Innovation in the Primary Road Program," 1953; Schmidt, Del. Highway Impact Study 1963, pp. 3-14).

With the major exception of the Delaware Memorial Bridge, the immediate postwar years were marked by few major highway or bridge initiatives. The atmosphere of uncertainty coincided with the first major changes of the leadership of the Delaware State Highway Department since its inception. During the 1940s, many of the engineers that had worked on Delaware's roads and bridges from the time Coleman du Pont had recruited them as young men in the 1910s to build the Du Pont Highway reached retirement age. In 1946, Chief Highway Engineer Warren W. Mack retired after 30 years with the department. The following year State Bridge Engineer Arthur Livingston, another department veteran, retired from his post. In 1949, Francis V. du Pont, son of Coleman du Pont, stepped down after 27 years as probably the most effective and politically influential state highway commissioner in Delaware history. In contrast to the steady prewar leadership du Pont provided, the postwar leadership was fluid with seven different chief highway engineers and four state bridge engineers between 1946 and 1955. The department also reported difficulty staffing its departments and recruiting young engineers, especially for field work and construction supervision. The constant leadership changes further hampered the development of a consistent postwar state highway policy (Dolan 1956: 265-66).

The Delaware State Highway Department's more than 800 employees continued the ever-present work of maintaining and repairing the state's highway system throughout the sometimes tumultuous and troubling reorganizations of top level management. Postwar inflation and lack of materials, especially steel, delayed the award of construction contracts, but by mid-1948, the number of projects resumed a near normal prewar level and grew steadily each year thereafter, with minor delays caused by materials shortages during the 1950-53 Korean conflict. Given the political situation, the department established as its priority bringing the highways up to standards before beginning a large number of new projects. Most of the projects were for the reconditioning and upgrading of existing highways including new signals and redesigned intersections for better traffic control.

An area of concern was the substandard width of the majority of the state's primary and secondary roads. Delaware was noteworthy for its large percentage of concrete-surfaced roadways, yet most of these roads had been paved in the days of lighter automobiles and trucks. Not only were heavier vehicles now taking their toll on the concrete surfaces, but the narrow 16' and 18' roadway widths were a safety hazard. Paving and widening occurred throughout the state with some notable projects including the dualization of US 13 in the vicinity of Laurel and Seaford. A large dualized highway project was the Kirkwood Highway (SR 2), begun in 1939-41 and resumed in 1949 (Figure A-2). The four-lane, approximately 12-mile long road between Newark and Wilmington had been planned in the mid-1930s at the insistence of an influential highway commission member from Newark. The highway was built on a mostly new alignment and replaced the Capital Trail, a winding two-lane road. The Kirkwood Highway was a significant factor promoting the 1950s suburban development west of Wilmington.

In 1951, the legislature passed a $22.5 million bond issue to match the increasing amounts of federal aid. The department began the 1951 fiscal year with the largest construction budget in its history and spread the money throughout the state on programs ranging from the asphalt surfacing of secondary county roads in Sussex and Kent counties to improvements to US 13 and US 40 in the vicinity of the Delaware Memorial Bridge. In 1953, the department began work on the Walnut Street Extension with a new bascule bridge over the Christina River and a new underpass of the Pennsylvania Railroad's Northeast Corridor in Wilmington. The extension was designed as an improved route connecting the city with the Delaware Memorial Bridge. In mid-1955, the department undertook a new $10 million initiative to hard-surface the state's remaining rural dirt roads, located mostly in Sussex County (Annual Reports 1951-56).

The Delaware State Highway Department's Bridge Division

The bridge division was created within the state highway department in the early 1920s. The division was responsible for the design and inspection of the state's highway bridges and employed a relatively small staff. In 1948, the division had a total of six engineers and draftsmen. Arthur G. Livingston, the first state bridge engineer, joined the department in 1918 and served until 1948. Succeeding Livingston were James M. Gordon (1948-49), Victor A. Jost (1949-50), and Joe S. Robinson (1950-58). As of 1946, the division had charge of slightly less than 300 bridges (20' clear span), some built and designed by the division over the previous 30 years and many more inherited from the counties and municipalities (A Factual Report 1948: 58).

The bridge division's design philosophy differed little from other state highway departments throughout the nation; bridges were built to federal and state design

Figure A-2: The first section of the dualized Kirkwood Highway (SR 2) between Limestone Road and Cranston Heights was begun in 1939-1941. The highway was completed between Wilmington and Newark from 1949 to 1952. Notice the rural setting. Since the late 1950s, the highway has been widened repeatedly and the setting is now completely dominated by a late-20th-century commercial strip. Source: Delaware State Highway Department, Annual Reports, 1939-40.

standards with roadway width and load-carrying capacity determined by the class of road. From its inception, the bridge division used economy of material and design as the most important factors influencing the choice of materials and bridge technology. The division's engineers adjusted their designs based on the price and availability of materials and labor, and on local factors such as hydrological and foundation conditions. Staff attended national engineering conferences and kept abreast of new technological developments through professional journals and BPR bulletins.

Delaware's small size and few large rivers offered limited opportunities to build large or exceptionally challenging bridges. However, unlike larger states that repeatedly built nearly identical standard-design bridges on hundreds of miles of state highway, Delaware's bridge division did have the luxury of approaching each bridge as an individual design problem. Engineers took the opportunity to apply aesthetic treatments, such as architectonic railings and stone facing, to small bridges that might not have received such individualistic treatments in larger states. Moderne-style detailing was used beginning in the 1930s and remained popular through the 1950s.

During the postwar decade, Delaware's bridge division introduced no major new bridge technologies or materials. Prewar technologies, especially the steel multi girder and the reinforced concrete slab and box culvert, remained popular but were adapted to higher standards to meet present and future traffic needs. There was a general trend toward the use of heavier loading design of bridges on all classes of highways. Full width bridge roadways with shoulders were advocated for greater traffic capacity and safety (Annual Reports; USDOT 1976: pp. 433-435).

The bridge division reported anywhere from 10 to 20 bridge projects per year once construction schedules resumed a normal level in 1948. While most projects were routine replacements of short-span structures, a few were featured in the state highway department's Annual Report as the division's most significant accomplishments of the year. In addition to bridges designed as part of larger projects such as the Du Pont and Kirkwood highways, structures singled out as deserving attention included the Curtis Mill Road Bridge NC-231 (1948-49), an innovative reinforced concrete rigid frame bridge; Elsmere Viaduct Bridge NC-632 (1948-49), a continuous steel multi girder bridge that eliminated a dangerous railroad crossing; SR 141 over Brandywine River Bridge NC-587 (1951-52), designed to improve access to the DuPont Company's experimental station; and the Walnut Street Bridge NC-687 (1954-57), a large double-leaf bascule bridge over the Christina River in Wilmington. Some of the bridges were notable as the largest projects of the year or for prominent locations, and others featured innovative design or construction techniques.

In the early 1950s, the bridge division suffered manpower shortages caused by the quickening pace of construction schedules, the difficulty recruiting engineering staff, and the transfer of staff from the bridge division to the Delaware River Crossing Division (a special division created in 1945 to supervise construction of the Delaware Memorial Bridge). The bridge division met the problem by contracting with consulting engineers. In the past, the department had usually only turned to consultants for specific technical problems for which it did not have expertise, such as the design of movable bridges. In the early 1950s, consultants designed many bridges for which the department had in-house expertise, but not the manpower to complete the work in a timely fashion. While most of these bridges, such as a series of steel multi girder bridges on the US 13 bypass of Seaford and Laurel (Figure A-3), were standard technology, in several cases the bridges designed by consultants included innovative features such as Parson-Brinckerhoff's design of the hammerhead piers of the SR 141 Bridge NC-630 (Tyler McConnel Bridge), one of the first documented uses of hammerhead piers in the nation (Figure A-4).

In the late 1940s, the bridge division expanded its inspection program as a result of a bridge failure in Sussex County that caused the death of three motorists. On February 10, 1948, the approach spans of the SR 14 over Indian River Inlet Bridge collapsed as a result of unusually high tides, easterly winds, and ice flows that caused excessive scour underneath several of the piers. An independent report concluded that the accident might have been prevented with more in-depth inspection even though bridge engineers had visited the bridge earlier in the day of the disaster. They failed to detect the problem. The bridge collapse prompted the division to step up regular inspections and, in particular, to update its standards to prevent and detect scour (Annual Report 1948).

While the bridge division slated many old bridges for replacement, the 1950s were notable for the department's first significant historic preservation effort. By 1950, fewer than six of the approximately 26 covered bridges that had once stood within New Castle County remained. Many were posted for restricted weights. In the historically conscious communities of north Wilmington, the bridges were increasingly seen as reminders of the region's disappearing rural past. In 1954, a truck, exceeding the three-ton loading, severely damaged Smith's Bridge, the last remaining covered wood truss over the Brandywine River (Figure A-5). Public support rallied to save the Burr arch truss, and the department's chief engineer approved reinforcement of the structure while maintaining its historic appearance. The local community considered the preservation of Smith's Bridge an outstanding effort on the part of the highway department; unfortunately, in 1961, arsonists burned the bridge and the covered span was not rebuilt (McNinch 1995: 22-25).

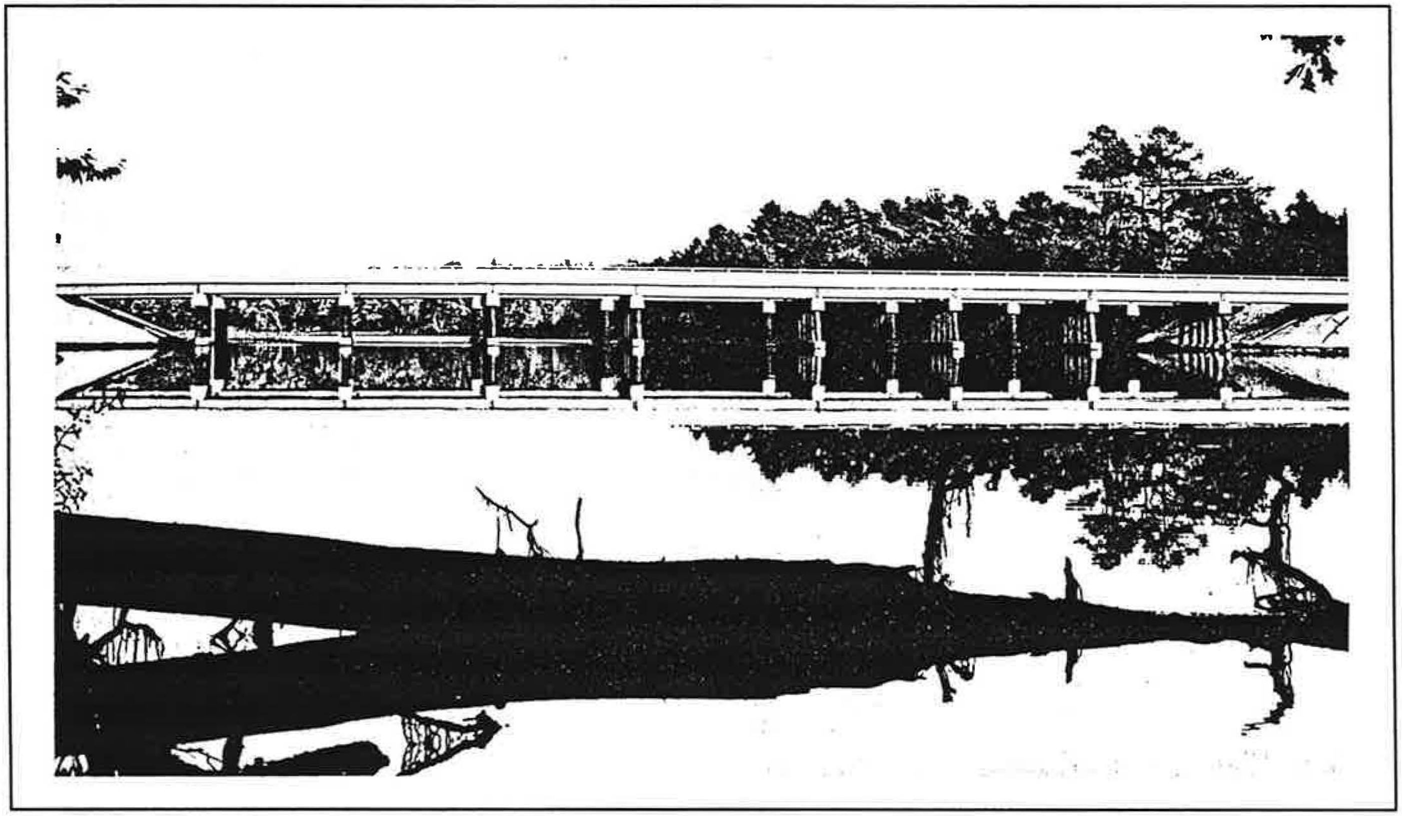


Figure A-3: The steel multi-girder bridges built for the US 13 crossing of the Nanticoke River near Seaford are examples of one of the most common bridge types of the 1920s through the 1950s. Source: Delaware State Highway Department, Annual Reports, 1953-54.

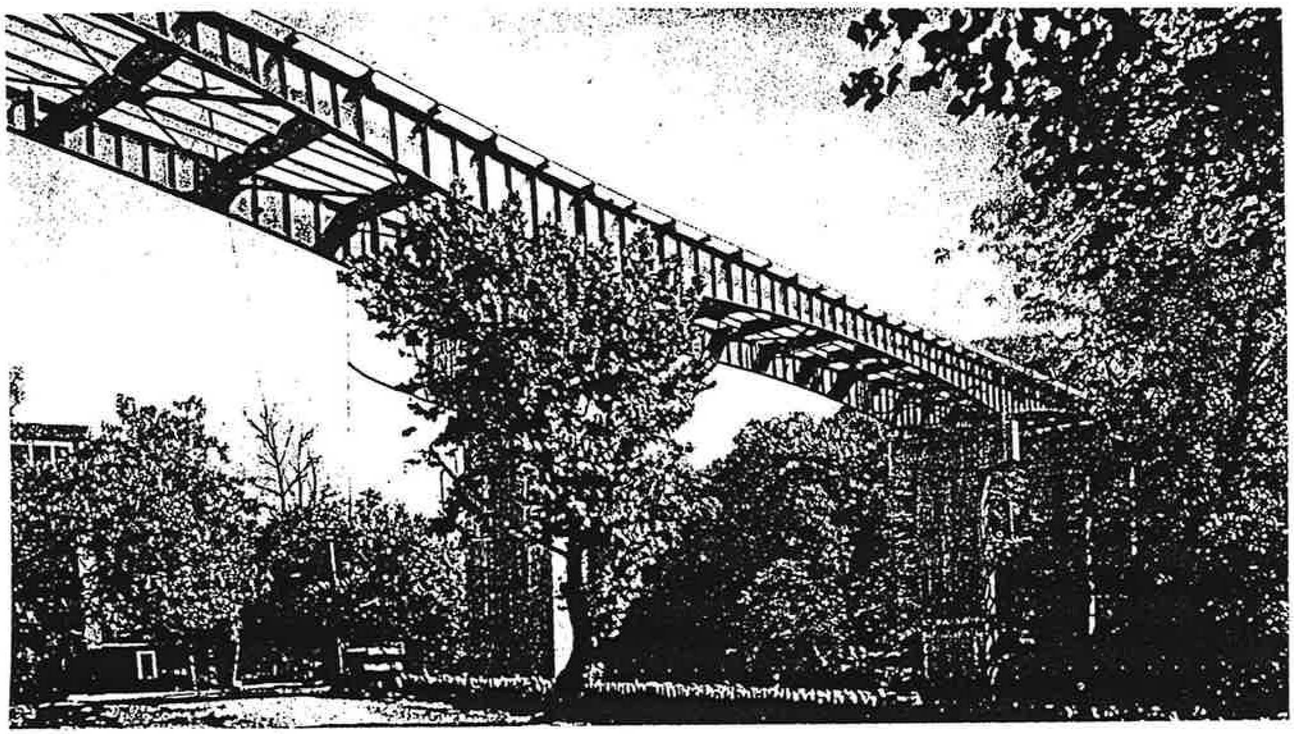


Figure A-4: The SR 141 (Tyler McConnel Bridge) was built with financial support from the DuPont Company, which desired improved access to its experimental station. The bridge was among the largest structures built by the department in the postwar decade. It featured a continuous deck girder main span and innovative hammer head piers. Source: Delaware State Highway Department, Annual Reports, 1951-52, p. 33.

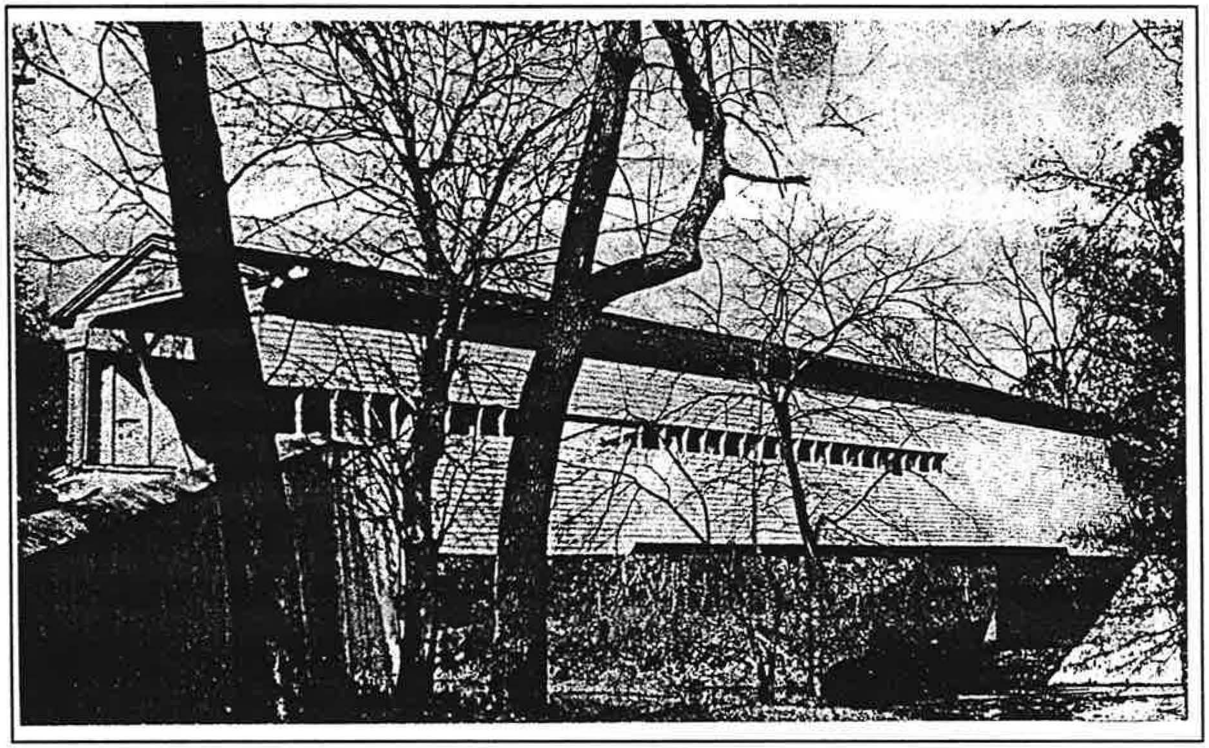


Figure A-5: Smith's Bridge before restoration in 1956. The bridge was one of the state highway department's first projects with an emphasis on preservation of a historic bridge. Considered a great success, the restored bridge was burned by arsonists in 1961. Source: Marge McNinch, Bridges (Wilmington: Cedar Tree Press, 1995), p. 23. Original Source, Hagley Museum and Library.

Conclusion

The historic context of Delaware's roads and bridges from 1946 to 1956 places the bridges at a time when Delaware, and much of the nation, was coming to terms with the new automobile age. Leading the effort to build new roads and bridges was the Delaware State Highway Department staffed by professionally trained engineers. By 1946, the Delaware State Highway Department had grown to maturity; it was no longer a fledgling agency, but a powerful force in the Delaware political and economic scene with strong ties to the federal highway administration. Most new bridge designs originated in the department's bridge division where the state's bridge engineers chose from well-established, standardized bridge technologies of rolled steel beam and reinforced concrete materials. The engineers brought with them a scientific approach to bridge building that stressed theoretical and practical knowledge of structural behavior, strength of materials, and economy of design. When they viewed their plans for Delaware's roads and bridges, they adopted an essentially national outlook, but molded it to fit local conditions.

B. Delaware's Bridge Technology Context, 1946-56

Delaware's postwar bridges reflect national trends that were marked more by increased strength of materials than development of innovative designs. The state's extant bridges illustrate the mid-20th century dominance of steel beams and reinforced concrete and their nearly universal application to any combination of crossing requirements. By the late 1910s, the rolled steel I beam and reinforced concrete, introduced in this country in the late-19th century, had emerged as the two most common bridge building technologies based upon their economy, ease of erection, capacity, and maintenance requirements. Delaware's engineers, like those everywhere, utilized these well-established, standardized technologies until the start of the interstate highway system in the late 1950s. Steel and reinforced concrete beam and slab bridges so dominated the national scene that bridges from Florida to Maine or Ohio were virtually indistinguishable from one another.

Because the properties of the material of which a bridge is built directly affect its design, bridge technology is best understood from that perspective. Three materials account for all of the 1946 to 1956 bridges in Delaware; steel, reinforced concrete and wood. The same engineering principals apply to specific bridge types and designs regardless of its construction material. Thus, the only differences between a multi girder bridge built in steel or wood are those inherent to the material itself.

Sixty-six (66) bridges built between 1946 and 1956 were evaluated. The following is a summary of surveyed bridges classified by material and type:

I. Steel Bridges
- Multi Girder -18
- Deck Girder - 1

II. Wood Bridges
- Multi Girder - 4

III. Reinforced Concrete Bridges
- Arch - 1
- Slab - 17
- T Beam - 3
- Box Culvert - 15
- Pipe Culvert - 1
- Rigid Frame - 4

IV. Movable Bridges
- Bascule - 1
- Swing Span - 1

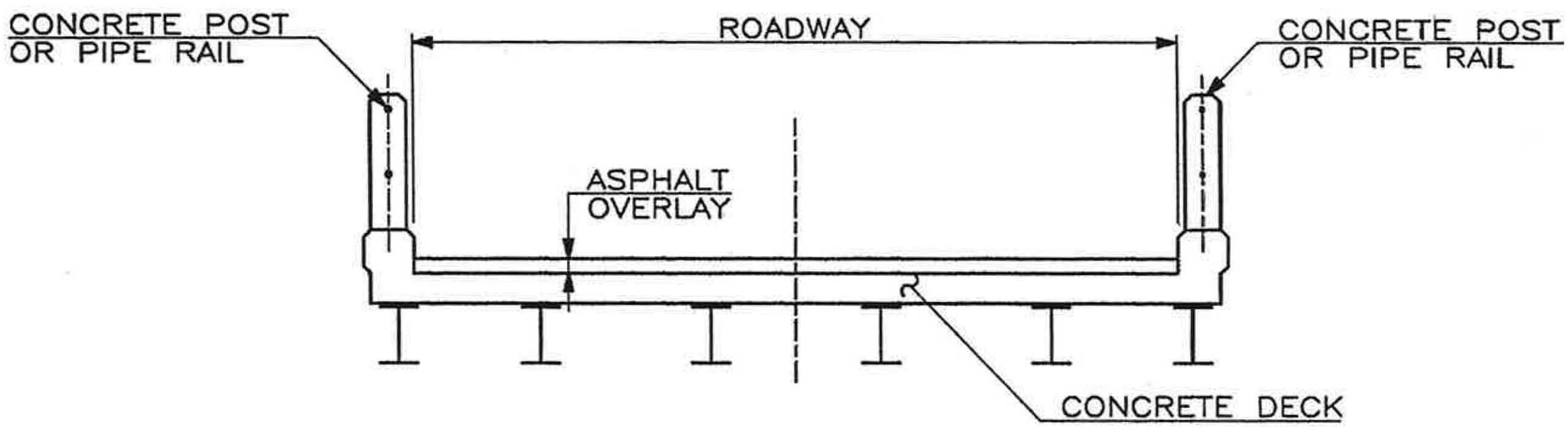
I. Steel Bridges

A. Multi Girder Bridges

Steel was initially utilized for truss bridges, but with technological advances in rolling mills and metallurgy, multi girder bridges composed of rolled steel beams came to the fore after World War I, and by the mid 1920s, were ubiquitous (Figure B-1). The advantages of the technology were particularly attractive to the state highway departments and county bridge engineers for spans up to 60' in length. They could be easily and economically erected with available beam sections and were cheaper than low (pony) truss bridges. With primarily accessible flat surfaces, multi girder bridges were easy to clean and paint, and a concrete deck over the beams added protection from exposure. Concrete or steel diaphragms were used to stiffen the bridge. Another advantage that was particularly important in the era of rapidly increasing traffic volume and weight demands was the ability to readily widen the bridge or salvage the beams.

The introduction of steel I beams for multi girder bridges was related to improvements in open-hearth steel manufacturing that resulted in larger quantities at lower prices. A major technological breakthrough that affected bridge building occurred in 1908 when the Bethlehem Steel Company began producing wide-flange steel beams on the Grey Mill. The mill rolled beams at greater speed and depths and at an approximately 10 percent savings in material with no reduction in strength. Although the company first met difficulties producing and marketing the new 26-, 28-, and 30-inch deep beams, by the early 1910s Bethlehem had overcome the problems. In his 1916 edition of Bridge Engineering, J. A. L. Waddell touted the superiority of the improved steel I beams, calling them "a great boon to bridge designers and builders" (p. 47) because of their simplicity, compactness and lower price. A wide top and bottom flange allowed for increasing the beam's capacity without increasing its section depth, an important issue for vertical clearance. The rolled steel beams could be used plain or encased in concrete, as was often the case with state highway bridges. Complete encasement of the beams added dead load to the superstructure but had long term benefits in protection of the beams and eliminated the need for painting.

In Delaware, steel multi girder bridges were the most frequently built type of bridges with span lengths of over 20'-long from the 1920s through at least the mid 1950s. They continue to be built today. Early examples and those that first incorporated later refinements of design and aesthetic treatments, such as stone facing and Moderne-style detailing, best represent the technological and historical significance of the bridge type. Among the 16 significant pre-1946 examples identified by the first survey are the ca. 1915 Still Road over Choptank River Bridge (K-211A), one of the oldest identified extant steel multi girder bridges in the



MULTI GIRDER BRIDGE
N.T.S.

FIGURE B–1

state; the 1922 Faulkland Road over Hyde Run Bridge (NC-182), an example of an encased steel multi girder bridge designed by the New Castle County Engineer; and the 1928 North Market Street over Brandywine Creek Bridge (NC-575), a 213'-long bridge employing cantilevered beams.

The survey update evaluated 18 steel multi girder bridges built from 1946 to 1956. As much as any class of bridges, the steel multi girder bridges are representative of the continued use of a well-established, economical, functional and standardized bridge technology that was basically unchanged from the 1920s through the postwar period. Some minor variations in design were noted, such as the increasing application of continuous beams, but no significant engineering advances, improvements or variations were noted. The use of aesthetic and architectural treatments to the steel multi girder bridge type was limited. Railings were most often stock W-beam guide rails, pipe railings, or concrete parapets such as those found on many earlier steel and reinforced concrete bridges.

Of the extant 1946-56 steel multi girder bridges, a significant example based on its size and history as a major state highway department project was judged to be the 1948-1949 SR 2 (Elsmere Viaduct) over CSX Railroad Bridge (NC-632), composed of one, five-span continuous unit and two, four-span continuous units. The bridge, however, has been widened, and the deck and railings have been replaced. The 1951-52 SR 141 over Brandywine Creek deck girder bridge (NC-587) and the 1954-57 Walnut Street over Christina River bascule bridge (NC-687), both judged technologically significant for their main spans, also include multiple steel multi girder approach spans that well illustrate the post-World War II application of multi girder technology.

B. Deck and Thru Girder Bridges

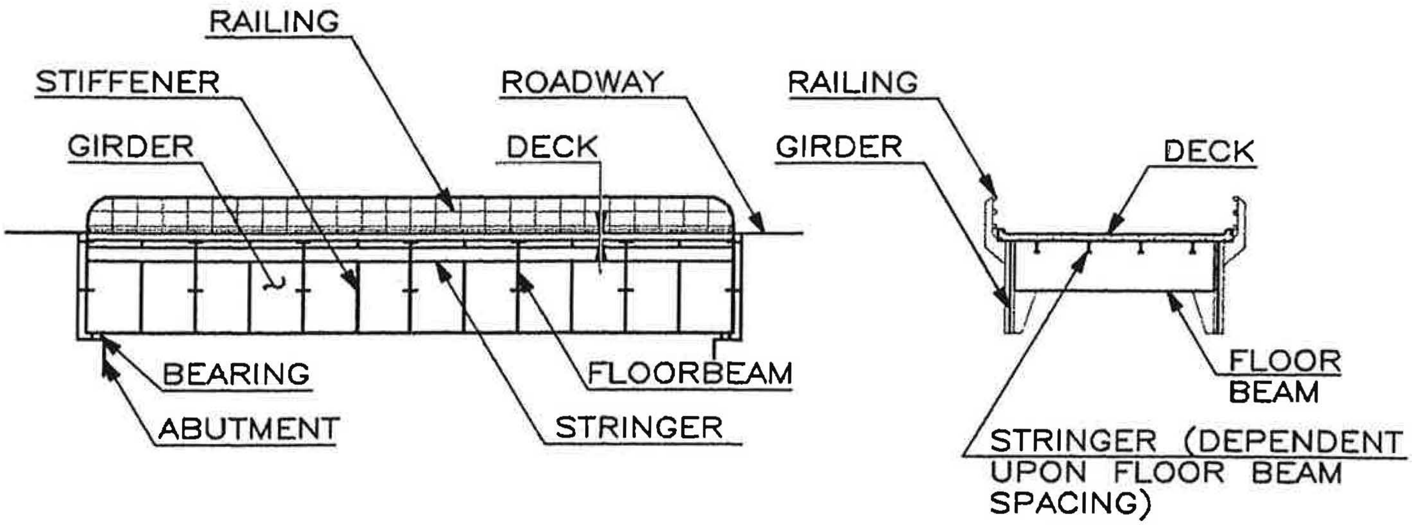
Metal girder bridges, consisting of a system of at least two girders with transverse floorbeams, were introduced by the railroads as early as 1847. In most instances the railroads used built-up girders, composed of rivet-connected plates for the web and angles for the flanges to make a beam of sufficient depth to span greater distances than possible with the available rolled beams. Depth of beam is related to span length, and girders were generally used for spans greater than 60' in length. By 1900, built-up girders were made of steel rather than wrought iron. Girder bridges proved to be efficient and economical for railroad-carrying spans. Another reason for the popularity of the bridge type was its ease of installation. Since the girders were almost completely assembled in fabricating shops, conveniently located on rail lines, the bridges could easily be loaded onto flatbed cars. Once at the erection site, cranes quickly hoisted them into position, often on earlier abutments, with minimal traffic interruption. The ability to transport girders was often the factor limiting their length. In general, most 19th-century girder bridges are associated with railroads. Later 20th-century girder highway bridges are not technologically noteworthy except as particularly well-detailed examples of the work of a state highway department or county engineer.

The Delaware State Highway Department used steel girder bridges starting in the late 1910s, employing both the deck girder and thru girder varieties, the difference between the two designs being the placement of the floorbeams level with the top or bottom flanges of the main girders (Figure B-2). Girder bridges were frequently encased for the same reasons as multi girder bridges, to protect the steel and reduce maintenance. Both the 1931 Old Capitol Trail over Red Clay Creek Bridge (NC-155) in Newport and the 1939 SR 82 over Red Clay Creek Bridge (NC-119) near Mt. Cuba are steel thru girder bridges designed by the department's bridge division. Like many of the bridge division's mid-20th-century bridges, the two thru girder bridges are most noteworthy for the individual attention given to aesthetic details such as concrete pylons, light standards, luminaires, and railings. While girder and floorbeam highway bridges proved popular prior to World War II, they were used with less frequency after the war, in part because of the increased availability of deep-section rolled beams at less cost.

Long span (100'+) continuous steel girder bridges had limited application after 1945 because of the economy of material achieved in comparison to simply supported spans of similar length. Continuous spans allowed for longer spans for the given depth of beam, and the built-up girders frequently were haunched achieving their greatest depth over the piers of the main span where the stresses are greatest. The 1951-52 SR 141 (Tyler McConnel) over Brandywine Creek bridge (NC-587) consists of a three-span, continuous, haunched built-up deck girder main span of 87'-156'-87' and nine, 53'-long steel multi girder approach spans (Figure B-3). The bridge was designed by Parsons, Brinckerhoff, Hall & MacDonald, with the principal designer being Alfred Hedefine, a noteworthy mid-20th-century bridge engineer whose greatest accomplishment was the Newport (RI) Suspension Bridge. With the SR 141 bridge, Hedefine used a large continuous deck girder design and a new type of pier, the hammer head pier, which was introduced in the early 1950s because of the economy of materials, lessening the weight on the foundation and the cost of construction. The SR 141 bridge is one of Delaware's technologically significant bridge projects in the decade after World War II.

II. Wood Bridges

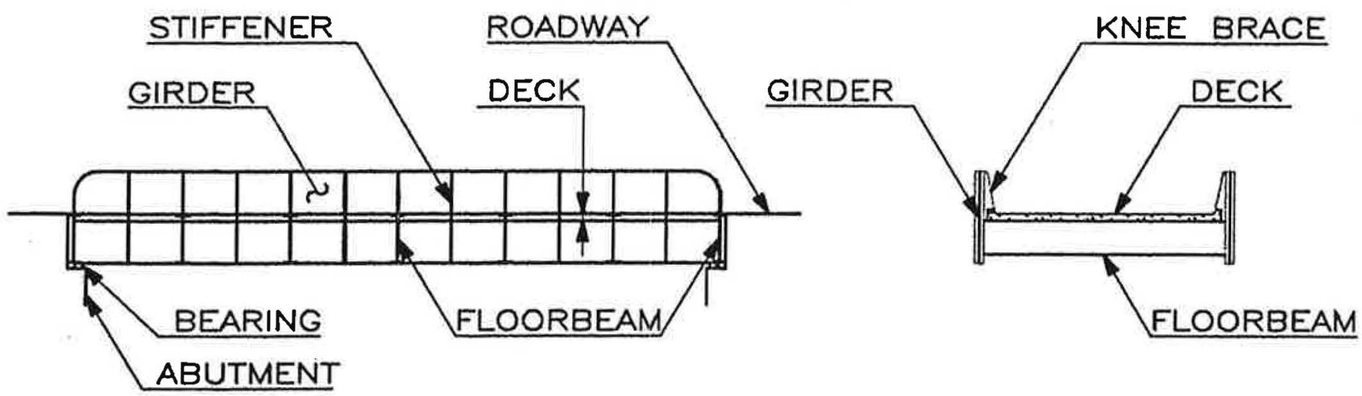
The wood multi girder bridge represents the oldest bridge technology, dating to time immemorial when felled trees were laid across streams. Whether the material is wood or metal, the principle behind the multi girder bridge is the same: it relies on the bending strength of the material to resist the loads. Wood span lengths are



LONGITUDUAL SECTION

SECTION

DECK GIRDER



LONGITUDUAL SECTION

SECTION

THROUGH GIRDER

GIRDER ARRANGMENTS

N.T.S.

FIGURE B-2

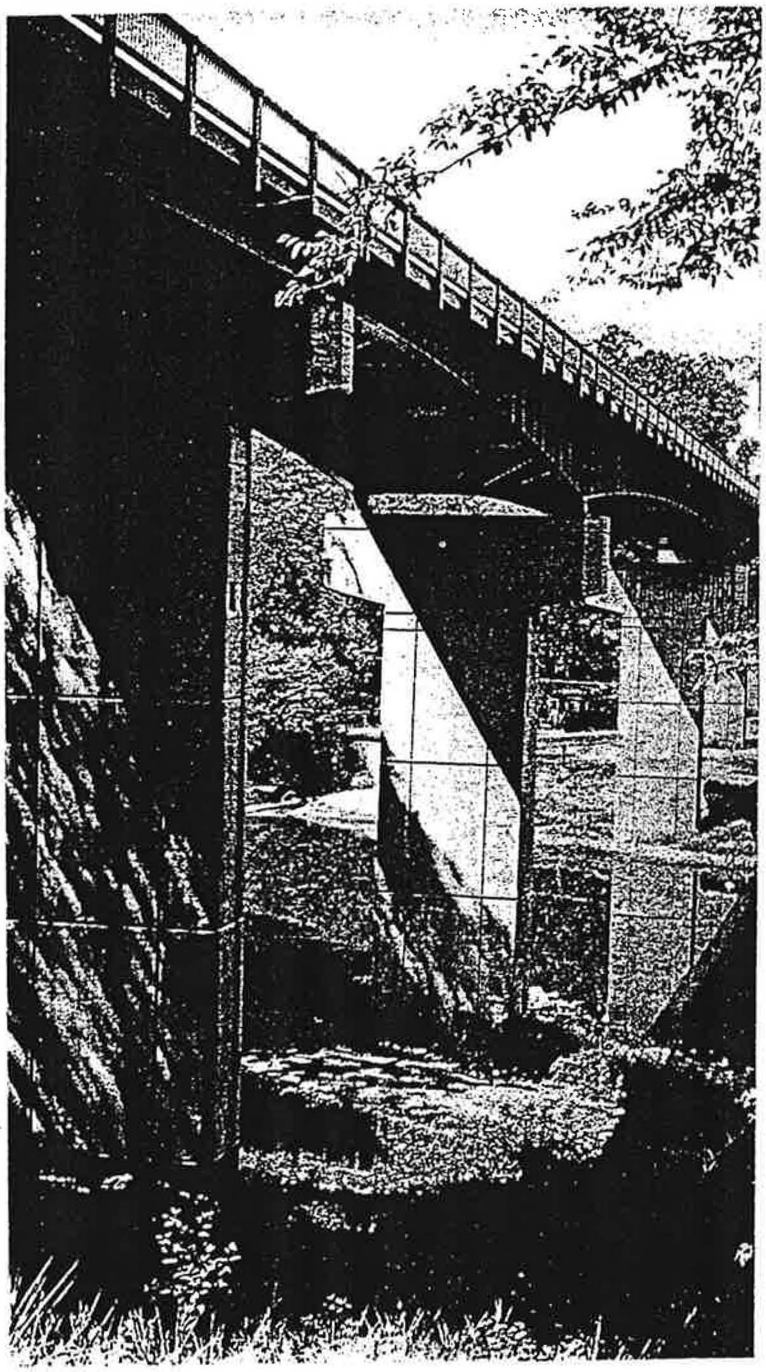


Figure B-3: The SR 141/Tyler-McConnel Bridge (NC-587) over Brandywine Creek, 1951-52. The continuous steel deck girder bridge featured the innovative use of hammer head piers. Source: Delaware State Highway Department, Annual Report, 1951-52, p. 46.

generally controlled by live-load deflection (vertical movement of member under load) making the modulus of elasticity of a particular wood specie as important a factor in selection as the ultimate fiber strength. Wood beams up to 16" depth have a present day span length of about 16'-long, and historically most wood multi girder bridges rarely exceeded 25' spans. Short span wood multi girder bridges were common in Delaware from the 18th century, and the technology continues to be used.

The wood multi girder bridge is usually carried on a wood bent substructure composed of round wood piles driven into the ground and a wood cap beam upon which the girders rest. This technology takes advantage of the fact that timber is an excellent material in compression. The bents often have diagonal bracing to add rigidity and prevent movement and thus failure of the individual piles. Most wood multi girder bridges are finished with wood plank decks and railings.

The Delaware State Highway Department recognized the structural simplicity and economy of wood multi girder bridges. In the early 1920s, the department inventoried over 130 wood bridges in New Castle County alone. Standard plans were prepared for the wood multi girder bridges and they proved especially economical and easy to erect by state maintenance forces during the 1930s Depression. In 1937, the department built 52 wood multi girder bridges on the secondary road system. The department continued to build wood multi girder bridges on secondary roads in the late 1940s and early 1950s, but when funds were available preferred to replace timber bridges with longer-lasting concrete culverts or short span concrete slab bridges.

Most wood multi girder bridges built by the state highway department in the first half of the 20th century were treated with creosote, a second distillation of coal tar, that extends the life of wood bridges. The creosote process was developed in 1838 by an Englishman but did not become common in the United States until about 1900. The typical creosote treatment involves removing moisture from the wood and then impregnating the precut member with creosote by pneumatic pressure. An expensive process that was initially adopted by railroads for railroad ties, the treatment meant that wood species not naturally resistant to rot could be used for structural applications.

The life expectancy of most treated wood multi girder bridges varies from 25 to 35 years, and individually deteriorated members are usually replaced in kind. The Delaware experience is not unlike other regions of the country, where most, if not all, the current pre-1956 wood multi girder bridges continue a long-lived technology. Surviving examples are composed of a very high degree of replacement material, often with modern pressure-treated members replacing the original creosoted members. In many cases, all of the original bridge fabric has been replaced except for the piles. Review of maintenance records indicates all four of Delaware's extant wood multi girder bridges from 1946 to 1956 have a high degree of replacement material.

III. Reinforced Concrete Bridges

Well represented among the 1946 to 1956 Delaware bridges are those built using reinforced concrete. The material was introduced into this country for bridge construction in 1886, but it was not in common use until the first years of the 20th century. After that, its advantages as a strong, versatile, and low-maintenance material were recognized by bridge builders and the material was quickly and universally adopted for several bridge types both as cast-in-place and precast units. The earliest reinforced concrete bridges built in this country were arches dating to around 1890. The material was also used for bridge substructures. The technology did not begin to seriously challenge metal truss bridges in Delaware until after 1905, with the earliest identified extant in-state example being the 1906 Van Buren Street over Brandywine Creek bridge (NC-698), slated for rehabilitation in 1997.

By 1912, reinforced bridge technology was in widespread use all across the country with advancement in the understanding of reinforcing bar placement to accommodate tension and shear forces resulting in the use of reinforced concrete most frequently for slab, T beam, and arch bridges. The appropriateness of one bridge type over another was predicated on several factors, such as length of span, roadway profile, and economical use of reinforcing steel. By 1920, the major period of experimentation in reinforced concrete had ended with all of the bridge types reaching an unprecedented level of standardization. Through the 1950s, there were few basic changes in the reinforced concrete bridge technology, with most variations and improvements geared toward simplification of design and economy in selection and use of materials.

A. Arch Bridges

Reinforced concrete arch bridges are well represented in Delaware's pre-1957 bridge population with 13 historically significant examples dating from 1906 to 1956. The arch bridges range from plain utilitarian structures, such as the 1910 Road 413 over Scott Run closed spandrel arch bridge (NC-383), to large monumental structures, such as the 1920-21 Washington Street Bridge over Brandywine Creek open spandrel arch bridge (NC-576). After 1929, reinforced concrete arch bridges were built less frequently as plain utilitarian structures because of their comparatively high cost of construction and material in comparison to steel and other reinforced concrete bridge types. They did, however, continue to be built in small numbers in urban or park settings where an aesthetically pleasing bridge was desired. Among the later reinforced concrete arch bridges in the state are three Colonial Revival-style arch bridges in Dover that were designed to complement the nearby state capitol complex. The three bridges are the 1934 Loockerman Street Bridge over St. Jones River (K-23A), the 1937 US 13 Business over Silver Lake Bridge (K-3C), and the 1956 Court Street over St. Jones River Bridge (K-67A) (Figure B-4). The latter bridge is the only identified reinforced concrete arch bridge dating from 1946 to 1956. It is significant not only for its architectonic treatment but for its design that included the addition of ties between the abutments to assist in reducing the thrust of the arch against the pile foundations of the abutments -- a detail used on reinforced concrete arch bridges since the 1910s.

B. Slab Bridges

Slab bridges date to at least 1911 in Delaware, and the technology has changed little to the present day (Figure B-5). The simply supported, cast-in-place slab bridge was used primarily for clear spans of up to 20' prior to World War I, but afterwards span lengths were increased by state and county engineers for spans up to about 35', beyond which length other bridge types became more economical. The slab bridge concentrates reinforcing steel, in the form of twisted or deformed rods, in the lower portion where tensile forces due to bending are greatest, and in the ends where shear is maximum. As with all other bridge types, the amount of steel and depth of the slab is predicated on its length and live-load capacity.

The slab bridge type was featured prominently in pre-World War I engineering journals and texts, federal Office of Public Roads (OPR) technical pamphlets, and concrete manufacturer advertising. It appeared everywhere across the country at about the same time and there were few variations. In Delaware, pre-World War I slab bridges, such as those built on the Du Pont Highway, were built less than 20' wide, and many have been subsequently replaced or widened. A noteworthy early example is the ca. 1915 SR 100 over Brandywine Creek Tributary bridge (NC-76), which was widened and finished with stone parapets in 1932.

From 1920 through the 1950s there were few noteworthy changes in the slab bridge technology in Delaware. Some variations included the application of continuous designs achieving longer spans with an economy of material. An example of a continuous slab bridge is the 1941-42 High Street over Conrail bridge (S-258) in Seaford. The slab is haunched achieving its greatest depth over the piers where the stresses are greatest. Other important examples of continuous slab design are the mushroom column-supported approach spans of the 1938 US 13 Business over Conrail (NC-686) and 1942 South Heald Street over Conrail bridges (NC-684).

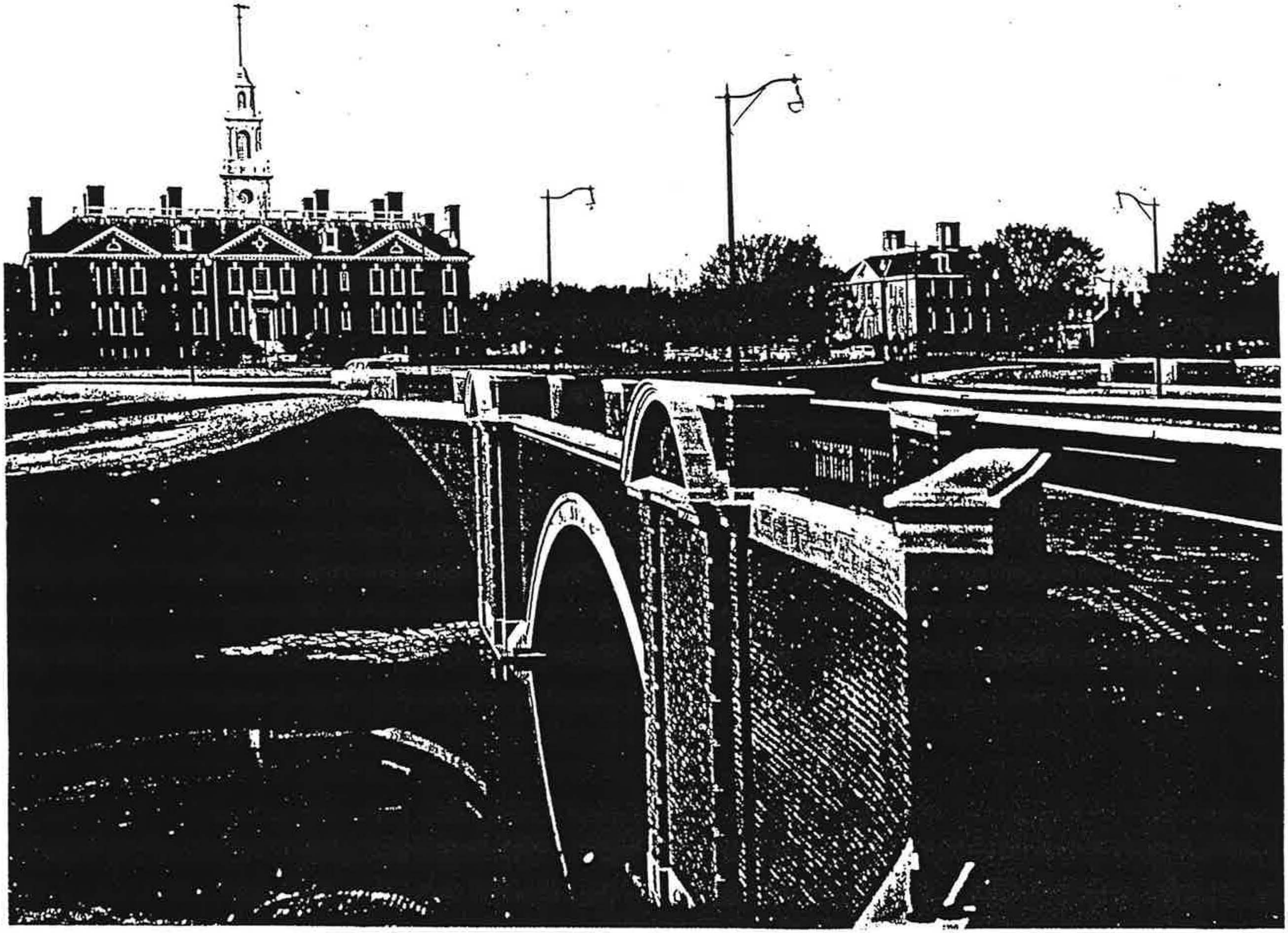
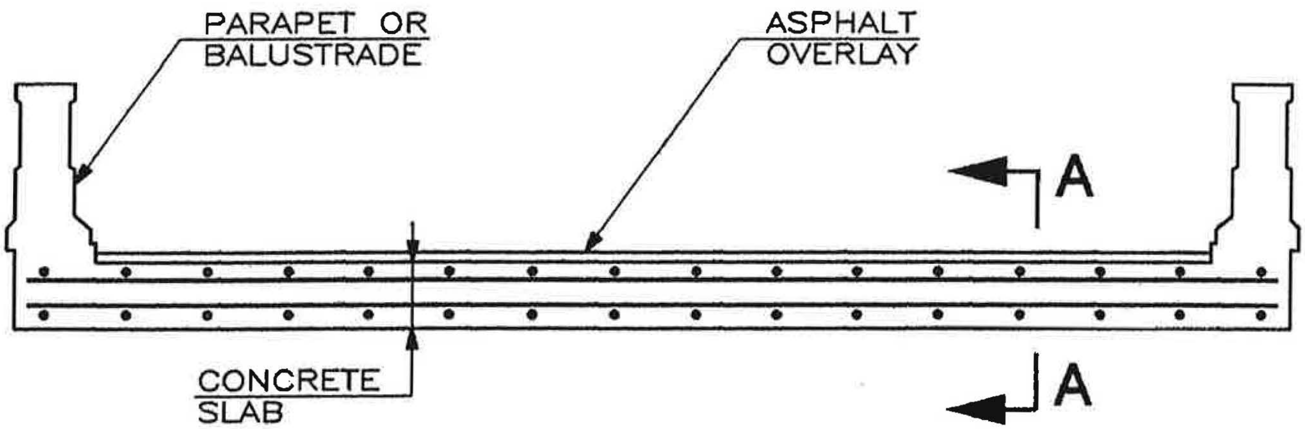
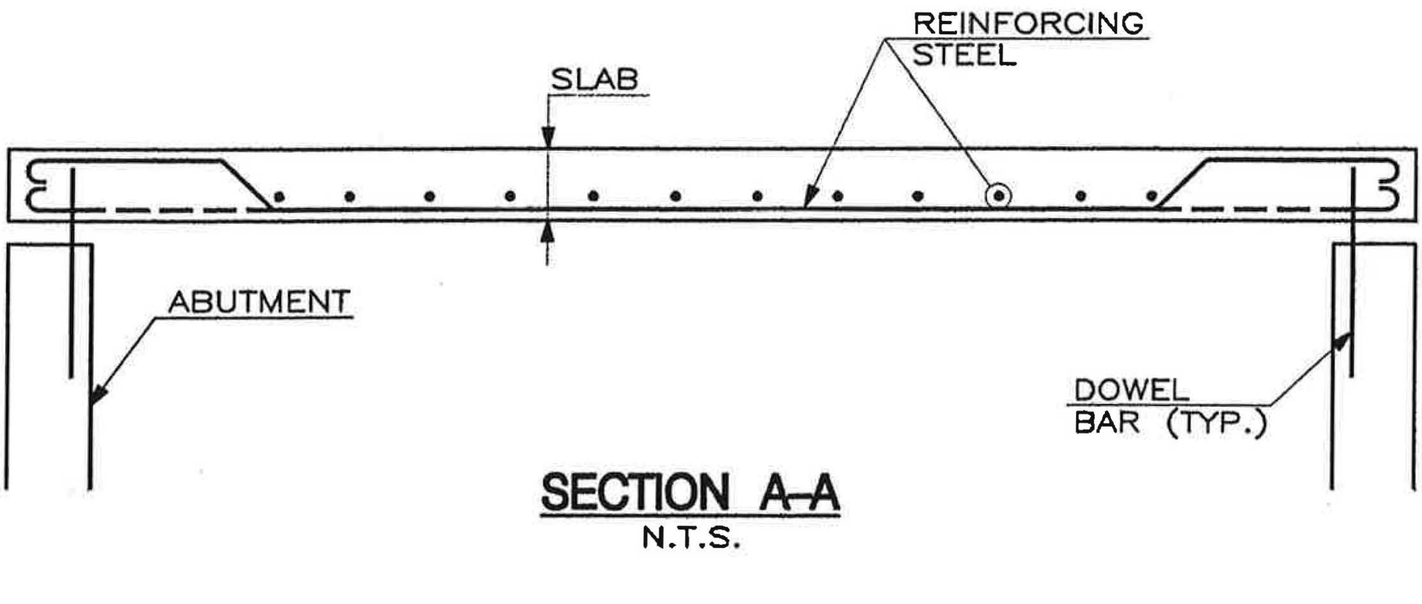


Figure B-4: Court Street over St. Jones River (K-67A), 1956. The Colonial Revival-style architectural treatment was in keeping with the state capital complex. Source: DelDOT, Bridge Inspection File, Neg. No. K-954-2.



SLAB BRIDGE
N.T.S.



SECTION A-A
N.T.S.

FIGURE B-5

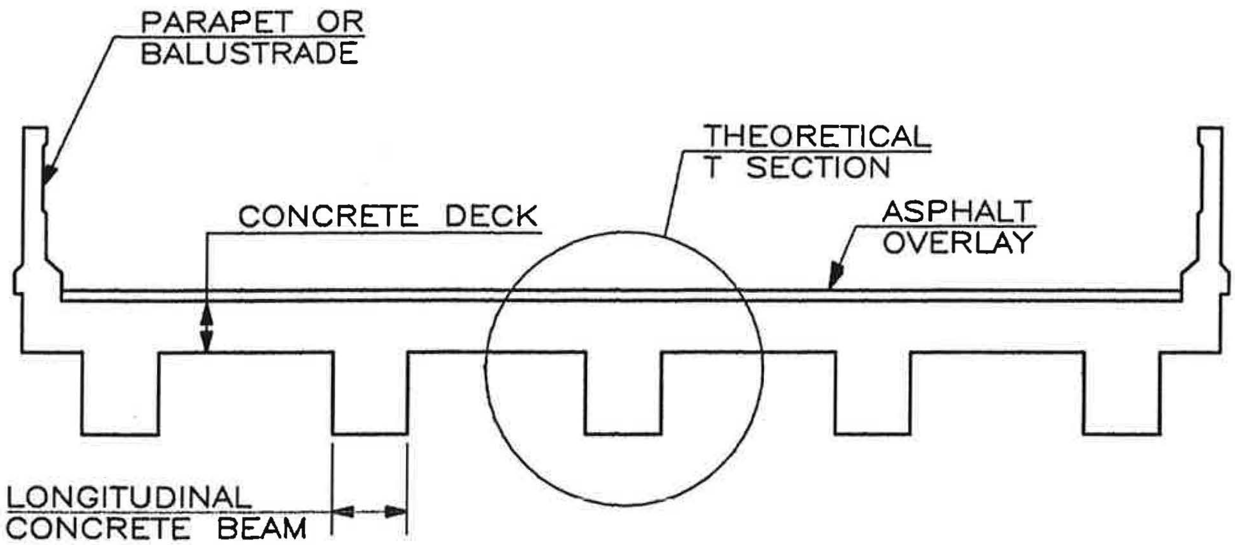
Nationally, the only significant change in slab construction in the postwar years was the increased desirability of using precast concrete over cast-in-place concrete for short-span bridges. Precasting slab units made possible the manufacture of large numbers of like structural elements under controlled conditions in factory-like casting yards. After fabrication, the pieces could be shipped to construction sites and speedily erected. The economy of precast designs was found in the repetition of large numbers of alike units, and in a small state such as Delaware there were only marginal cost advantages because of the state's relatively small number of bridges. No precast reinforced concrete bridges were identified by field work and there is no documentation in the department's Annual Reports of any having been built.

Seventeen (17) slab bridges dating from 1946 to 1956 were evaluated. Fifteen (15) bridges were single span structures ranging from 12' to 26' long, and the other two bridges were two-span structures with a maximum single span length of 23'. All of the bridges were undistinguished, standard designs of the state highway department bridge division. In comparison with the pre-1946 population of slab bridges, the 1946-56 population had no significant differentiating characteristics, variations, or engineering improvements. Typical railings, such as paneled parapets, vertically scored parapets, and metal guide railings, were all of standard designs also found on previously identified pre-1946 bridges.

C. T Beams

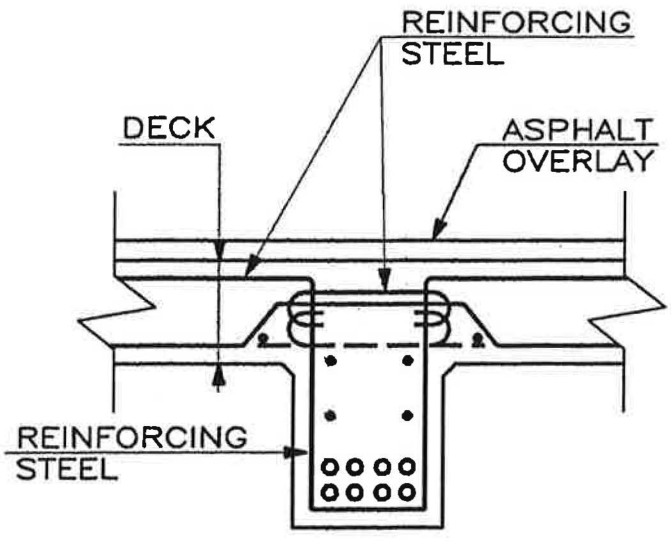
T beam bridges are primarily simple-span, cast-in-place, reinforced concrete beams with integral monolithic flanking deck sections used for spans of up to 50' in length (Figure B-6). The primary reinforcing steel is placed longitudinally at the bottom of the beam stem, and the deck or flange reinforcing is placed perpendicular (transversely) to the stem. T beams are almost always supported on reinforced concrete substructures, and they were favored for span lengths of over 20' because of their low long-term maintenance and thus overall economy of material. From its inception in 1917, the State Highway Department made use of T beams; they were used with less frequency after World War II, often because steel multi girders could be built at the same or less cost. An example of a T beam bridge identified by the prior bridge survey is the 1934 Adams Dam Road over Wilson Run bridge (NC-69). The technology of the T beam bridge did not change from the 1910s through the 1960s. A more efficient use of material than the slab design, the T beam design proportions the deck thickness and longitudinal beam size and spacing to achieve a lighter, stronger, and more economical section.

Three (3) T beam bridges from 1946 to 1956 were identified. Of these, the three-span, 200'-long, continuous, T beam bridge carrying US 13 over the St. Jones River (K-24A) in Dover (Figure B-7) is by far the most visually impressive and



T BEAM BRIDGE

N.T.S.



T BEAM SECTION

N.T.S.

FIGURE B–6

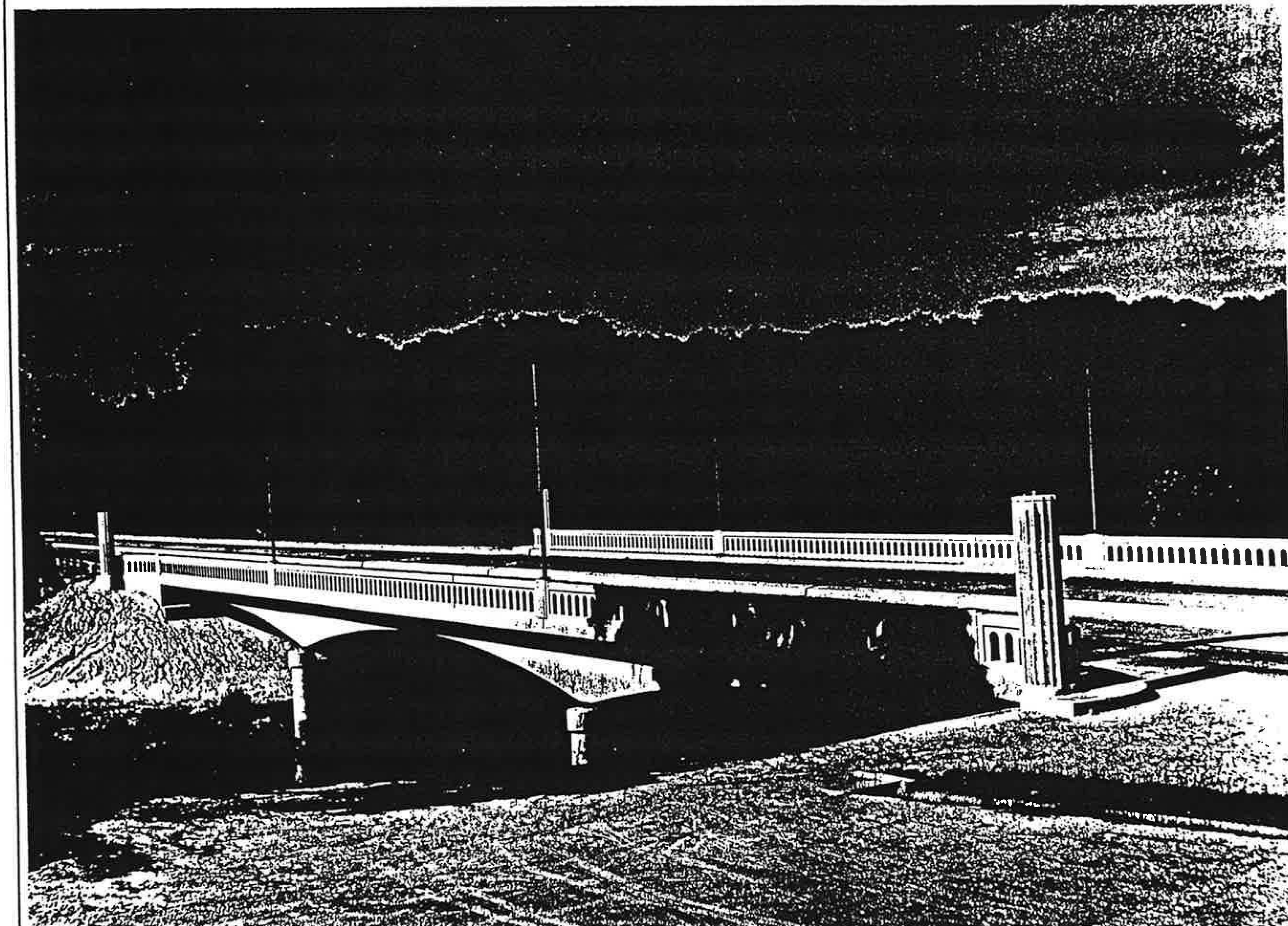


Figure B-7: US 13 (Dover Bypass) over St. Jones River, Dover (K-24A), 1951.

technologically significant. The bridge reflects post-1940 advances in the application of the T beam bridge technology to longer span continuous structures, and like other previously mentioned continuous designs, has haunched beams achieving the characteristic greatest depth at the piers. The Delaware State Highway Department Bridge Division designed the bridge as part of the Dover bypass project, completed in early 1952.

D. Box Culverts

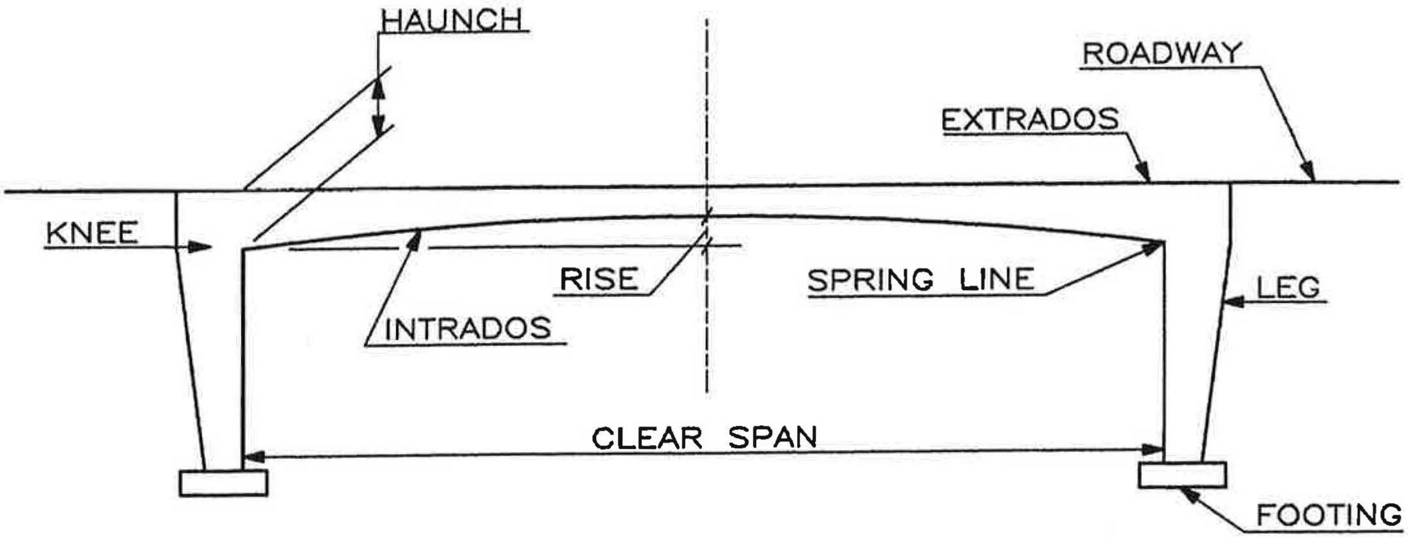
Reinforced concrete box culverts were first used on American highways in the first decade of the 20th century and have a history nearly identical to the development of slab bridges. A box culvert derives its name from its similarity to a box with open ends and is distinguished from a slab bridge by a slab integral with the side walls and floor (invert slab). Box culverts are especially adapted to minor or seasonal streams and locations where head-room is limited. They require little expensive form work or foundation work and may be placed in trenches. The cover (top) slab may either directly support the roadway or be placed under fill, and is proportioned to carry both live load and the entire weight of the fill, if any. Box culverts may be single or multiple cell (one or more openings) with the single-cell span length rarely exceeding twice the height. Since the 1910s, box culverts have been found to be economical and practical under the majority of conditions for spans in the range of 8' to 15'. The technology has changed little since the early 20th century; the only noteworthy change is the increasing substitution of precast box sections for cast-in-place sections during the last 30 years.

In Delaware, it is the early, unaltered box culverts and those historically associated with larger water control projects, such as the reconstruction of mill pond spillways and dams, that best represent the box culvert's technological significance. Two early examples are the ca. 1910 Willow Street over Records Pond box culvert (S-329) in Laurel and the 1912 Hearn's Millpond Spillway box culvert (S-200H-1). Standard examples of 1920s to 1950s state highway department box culverts are the 1928 Road 460 over Barlow Branch Tributary culvert (NC-430), the 1933 Road 42 over Massey Pond Spillway culvert (K-42A), and the 1938 SR 24 over Burton Mill Pond Spillway culvert (S-709).

Fifteen (15) box culverts dating from 1946 to 1956 were identified. Span lengths ranged from 8' to about 13' long. The postwar box culverts, all designed by the state highway department's bridge division, were found to have no unusual features and do not merit historical or technological distinction.

E. Rigid Frames

The rigid frame bridge consists of a deck slab that is cast as an integral unit with the abutments (Figure B-8). The slab is often a flat plane on the upper surface and



RIGID FRAME

N.T.S.

FIGURE B-8

slightly arched on the lower, giving the bridge a pleasing appearance, but primarily serving to resist the complex bending pattern near both faces of the slab and abutments. Rigid frame technology came to national attention in the mid 1920s when the Westchester County Parks Commission (NY) chose the bridge type for the Bronx River and Cross County scenic parkways. The engineer credited with the development and promulgation of the design was Arthur G. Hayden (Condit 1968: 259-260).

The Delaware State Highway Department first introduced rigid frame technology in 1931 with the US 13 Northbound over Blackbird Creek bridge (NC-488N). The intrinsic form of the rigid frame with its typical shallow arch appearance lent itself well to settings where an aesthetic bridge was desired. Delaware State Bridge Engineer Arthur G. Livingston favored the design from the mid-1930s to the early 1940s, and it continued to be built to a limited extent from 1946 to 1956 with at least four identified extant examples.

The 1948-49 Curtis Mill Road over White Clay Creek bridge (NC-231) in Newark is noteworthy as one of the nation's earliest examples of a variation in rigid frame design -- a continuous, three-span, ribbed, rigid frame bridge. The state highway department's bridge division under the direction of Livingston prepared the design of the Curtis Mill Road bridge from 1938 to 1941 but construction was delayed until 1948 by World War II. By the late 1930s, rigid frame bridges were common, but in general were used only for single-span applications of 35'- to 85'-long. Multiple span applications, such as the innovative Curtis Mill Road bridge, required difficult and sophisticated stress analysis because of the indeterminate nature of rigid frame structures, and were not often attempted. Livingston sought out the assistance of engineers from the federal Bureau of Public Roads and the Portland Cement Association, who commented on the stress analysis and the placement of the reinforcing steel. The Curtis Mill Road bridge demonstrates engineers' growing mid-20th-century confidence in the design calculations necessary to build continuous, indeterminate structures of both steel and reinforced concrete.

IV. Movable Bridges

Movable bridges over navigable waterways are an important bridge type in Delaware with its numerous streams feeding the Delaware River and Bay. The oldest extant movable bridges on state highways date from the 1920s and 1930s, and represent the two dominant movable bridge technologies of the 20th century, the bascule bridge and swing span bridge, the modern forms of which were both developed in the 1890s. The 1988-1989 survey identified eight movable bridges, six bascule and two swing span. One of the swing span bridges (NC-393) was replaced in 1992. Two additional movable bridges were included in the update survey: SR 36 over Cedar Creek swing span bridge (S-164, 1949) and the Walnut

Street over Christina River bascule bridge (NC-687, 1954-57). The SR 36 swing span bridge was replaced in 1997, shortly after it was surveyed.

After 1945 movable bridge technology was not subject to significant technical advances, but like other technologies, it benefited from the application of higher strength materials. Most postwar movable bridges featured electrical motors and controls including automated signals. Because of the high costs associated with manning and maintaining the movable bridges, as well as the delays caused to traffic by bridge openings, high-level fixed-span bridges became an increasingly preferred option to movable spans.

The Walnut Street double-leaf bascule bridge in Wilmington (NC-687) (Figure B-9) consists of an operable 276' long, double-leaf bascule main span flanked by steel multi girder approach spans. The bridge was built from 1954 to 1957 by the Delaware State Highway Department with the design work performed by Parsons Brinckerhoff of New York City. The bridge was built as part of a project to relieve traffic congestion in Wilmington by providing an alternative route south of the city to US 13 and the Delaware Memorial Bridge. The Walnut Street bridge was one of the largest projects undertaken by the state highway department bridge division in the decade after World War II, and is the largest extant pre-1957 bascule bridge in Delaware. In 1954, Delaware's chief highway engineer commented that the department would have preferred a fixed high-level bridge for the new Walnut Street crossing but that the high price of land-acquisition and construction costs of a longer high-level bridge had prevented that option (Annual Report 1954: 16-17).

V. Pipe Culverts

A very common type of drainage structure on highways and railroads throughout Delaware and the nation is the pipe culvert. Pipes have been used since time immemorial to direct the flow of small streams and run-off. Early builders used materials such as wood and terra-cotta, while builders of the 19th-century made increasing use of cast iron. Most pipe culverts have too short a span length to be classified as bridges, but occassional larger diameter or multiple pipe culverts are included in state bridge inventories, such as Delaware's. In general, pipe culverts are so ubiquitous that they are not considered significant unless they have the distinction of association with an important construction project, such as a historically important highway or railroad.

During the 20th century, the majority of pipe culverts have been made of either reinforced concrete or steel. Both are characterized by the prefabrication of the pipes at factories and shipping the pipes to the construction site. Usually, the pipes are manufactured in standard lengths and diameters unless a custom order is made by the contractor.

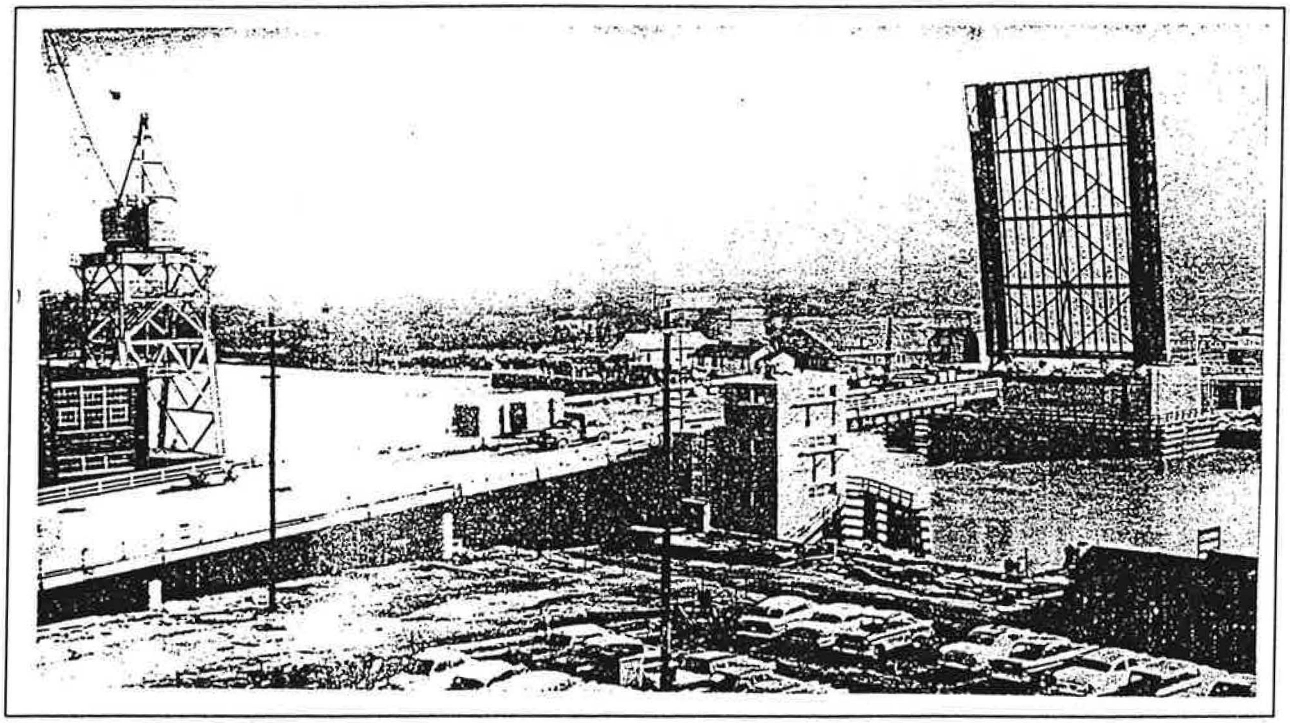


Figure B-9: Walnut Street over Christina River, Wilmington (NC-687), 1954-57. The construction photo was taken during a test of the operating mechanism of the south leaf, which is in the open position. The view is from the roof of the Pennsylvania RR office building. Source: Delaware State Highway Department, Annual Report, 1956-57, p. 60.

Reinforced concrete pipe culverts in precast units ranging from 15"- to 6'-diameter have been available to builders since the first decade of the 20th century. The history of reinforced concrete pipe manufacture parallels the development of reinforced concrete as a building material, and it was a mature technology by the 1910s. The amount of reinforcement in the pipe depends on its size and the load or embankment to be carried by the pipe.

Corrugated steel pipe culverts were first introduced in the United States about 1905 with diameters ranging up to about 4'. In the mid-1920s, Armco Drainage & Metal Products, Inc. of Middletown, Ohio, began producing a multi-plate corrugated steel culvert in diameters up to about 15'. The larger culverts proved very economical and were popular from the 1930s onward. Concrete and stone headwalls were used to achieve aesthetic designs.

VI. Prestressed Concrete

Nationally, the development of prestressed concrete provided the groundwork for a significantly expanded range of concrete structures in the post-1956 era of urban expressways and interstate highways. Prestressed concrete had European origins and was successfully promoted by engineer Eugene Freyssinet in the 1920s, but was not transferred to the United States until the early 1950s. Pennsylvania was a leader in prestressed concrete technology, and the nation's first large prestressed concrete bridge, the Walnut Lane Bridge (non-extant) was built at Philadelphia in 1950-1951. Prestressing induces a controlled stress in the concrete member, usually by imbedding high strength steel cables in the lower or tension half of the beam. The precompressive stress helps to cancel the imposed tensile stress, and thus overcomes one of the weaknesses of common reinforced concrete.

According to the Delaware State Highway Department's annual reports, prestressed concrete was not introduced in Delaware until 1954 when the state's bridge division reported the completion of its first prestressed concrete box beam bridge at Market Street over the Murderkill River (K-389A) in Frederica (Figure B-10). The bridge was prefabricated by the Concrete Products Company of America of Pottstown, PA, a national leader in the development of precast, prestressed concrete bridges in the early 1950s. This bridge marked the introduction of an important new technology to Delaware, however, it suffered from the problems of many first generation box beam bridges in that the imbedded wire strands did not have enough concrete cover and eventually became exposed and corroded resulting in loss of prestress. The bridge was replaced in 1996. The Market Street bridge is the only pre-1957 prestressed concrete highway bridge reported to have been built by the Delaware State Highway Department.

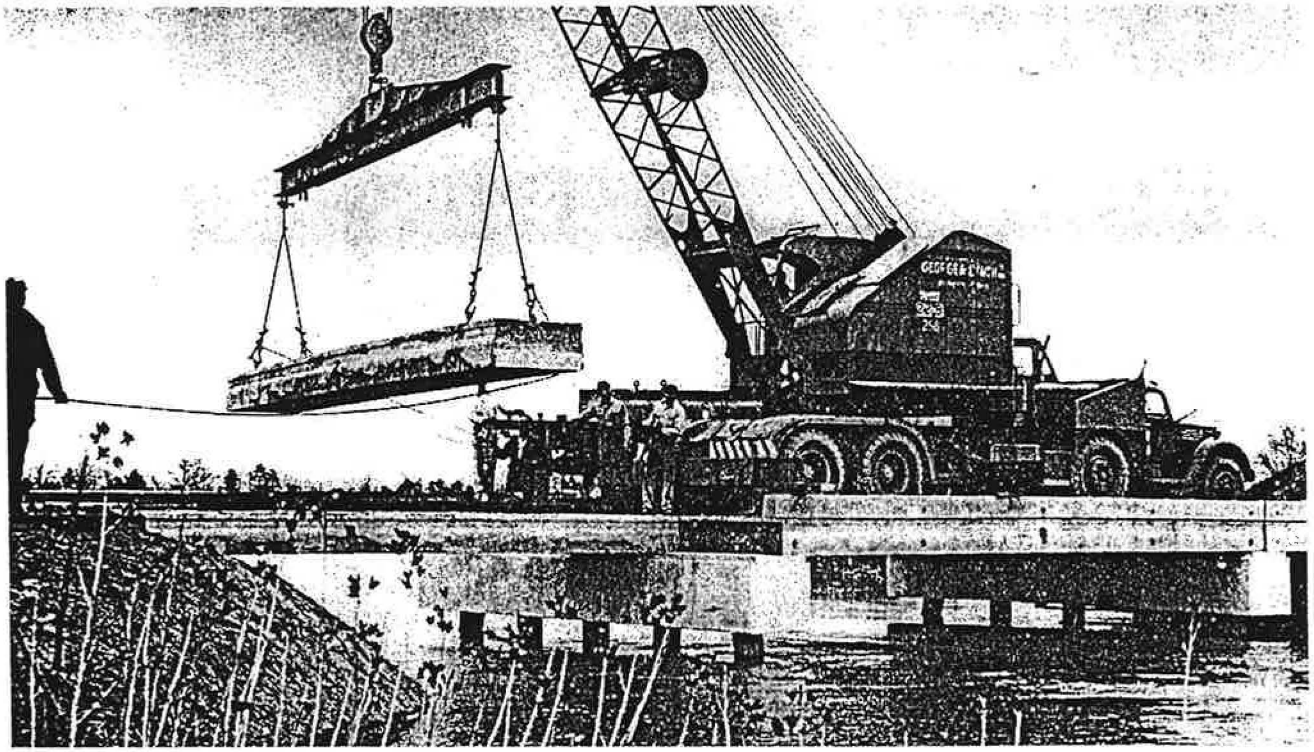


Figure B-10: The Market Street over Murderkill River bridge (K-389A) in Frederica was the state's first prestressed concrete bridge. The precast box beams were fabricated by the Concrete Products Company of America at its shops in Pottstown, PA. Here one of the precast beams is lowered into place. The bridge was replaced in 1996. Source: Delaware State Highway Department, Annual Reports, 1954-55, p. 39.

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C. Railroad Development in Delaware, 1827-1996

Introduction

The historic context traces the growth and development of railroads in Delaware from the beginning in 1827 through 1996. Its provides a framework for assessing the historic significance of railroad right of ways and other railroad-related resources in Delaware, including overpass and underpass bridges, by examining the role the railroads played in developing the state's economy and transportation network. The impact of the railroad industry is large, economically, socially, and politically. Railroads helped Wilmington develop as a manufacturing and trading center. They transformed the economy of lower Delaware, creating new towns and shifting the center of gravity in established ones in the process. Their imprint remains large on the built environment in the form of buildings, like depots, towers, office buildings, and shops, and in structures like bridges, rights-of-way and signal towers.

The development of the railroad industry in Delaware mirrors that of the nation as a whole: railroads developed beginning in the late 1820s as a rapid, all-weather transportation alternative; they expanded their geographic range throughout the 19th and early 20th centuries, fostering community development at transshipment points and transforming the local economy by providing greater access to market; but years of overbuilding left railroads vulnerable to outside forms of competition, particularly motor vehicles operating on improved highways, which in the early to mid-20th century undercut the dominance of railroads as the major long-distance transportation system. Delaware railroads, like railroads throughout the country, restructured in the face of competition, emerging as a part of new, consolidated systems that continue to play a prominent role in the state's economy.

Through World War II one carrier dominanted the Delaware railroad industry: the Philadelphia, Wilmington, and Baltimore (PW&B) and its corporate successor, the Pennsylvania Railroad. The carrier converted the state's transportation system from water dependent to rail based, and fundamentally altered the state's physical environment. It stimulated the development of industrial corridors and agricultural warehouses and processing sites along the railroad's right-of-way. The PW&B's rail line tied Wilmington and New Castle County into a megalopolis running from Washington, D.C. to New York City, the nation's busiest rail corridor. Electrified in the early 20th century, the line continues to serve rail passengers today as part of Amtrak's Northeast Corridor. The PW&B's downstate extension, the Delaware Railroad, was the transportation spine for the state prior to the development of Delaware's highway system. In its wake came towns, feeder rail lines, and roads that transformed the economy and environment of the area. The Delaware Railroad continues as part of Conrail's Delmarva section. The PW&B/Pennsylvania/Amtrak line through New Castle County and the Delaware

Railroad, as well as the Delaware, Maryland, and Virginia line to Selbyville, are significant on a statewide level. The Pennsylvania Railroad/Amtrak portion of the line is also nationally significant in association with the electrification project of the 1920s and 1930s.

Other railroads have played a part in the Diamond State's development, including the B&O, the Reading, and a number of smaller carriers feeding traffic to the Pennsylvania and Delaware Railroads. None had the formative, long-term impact on the state of the PW&B-Pennsylvania consortium, and all should be considered local in importance. This includes the B&O, one of the "Big Three" mid-Atlantic carriers (along with the Pennsylvania and New York Central), whose operations in Delaware were restricted to passenger operations and one minor freight line.

Early Railroad Development in Delaware

Railroading in Delaware began as part of an attempt to link the major cities of the eastern seaboard, including Wilmington, through a reliable, year-round transportation network. Delaware's first railroad line actually began as a turnpike. In 1811, the New Castle and Frenchtown Turnpike (NC&F) opened an improved, 16-½ mile long road across the First State's northern neck between Frenchtown on the Elk River in Maryland and New Castle on the Delaware (Figure C-1). The roadway linked together steamboat operations on the Chesapeake and Delaware bays, forming part of a transportation route between Baltimore and Philadelphia. The graded turnpike converted to a railroad in 1830, in order to more effectively compete with the Chesapeake and Delaware Canal, a water-based link opened in 1829 between the two bays. Key capital for the reorganized NC&F Railroad came from Philadelphia and Baltimore financiers interested in improved transportation between their cities (Holmes II, 152-54, 165-180; Burgess and Kennedy, 388-389).

The NC&F was an instant success; the steam-powered railroad leg cut the travel time between Baltimore and Philadelphia in half, but the need to transfer freight from boat to railroad car and the difficulty of navigating on the Chesapeake and Delaware bays in winter proved to be the line's undoing. In 1832, Wilmington interests chartered the Wilmington and Susquehanna Railroad, the Delaware portion of a rail line slated to run between Baltimore and Philadelphia (see next section). By 1843, the integrated Philadelphia, Wilmington & Baltimore Railroad, successor to the Wilmington and Susquehanna, had assumed control of the NC&F, relegating it to branch line service (Holmes III, 239-240, 249-264). The westernmost nine miles were abandoned in 1857. The remainder of the old right-of-way was used as part of the link between Wilmington and the downstate Delaware Railroad. Six original miles are still in use today as part of Conrail's New Castle Secondary line (Hayman, 21, DTC).

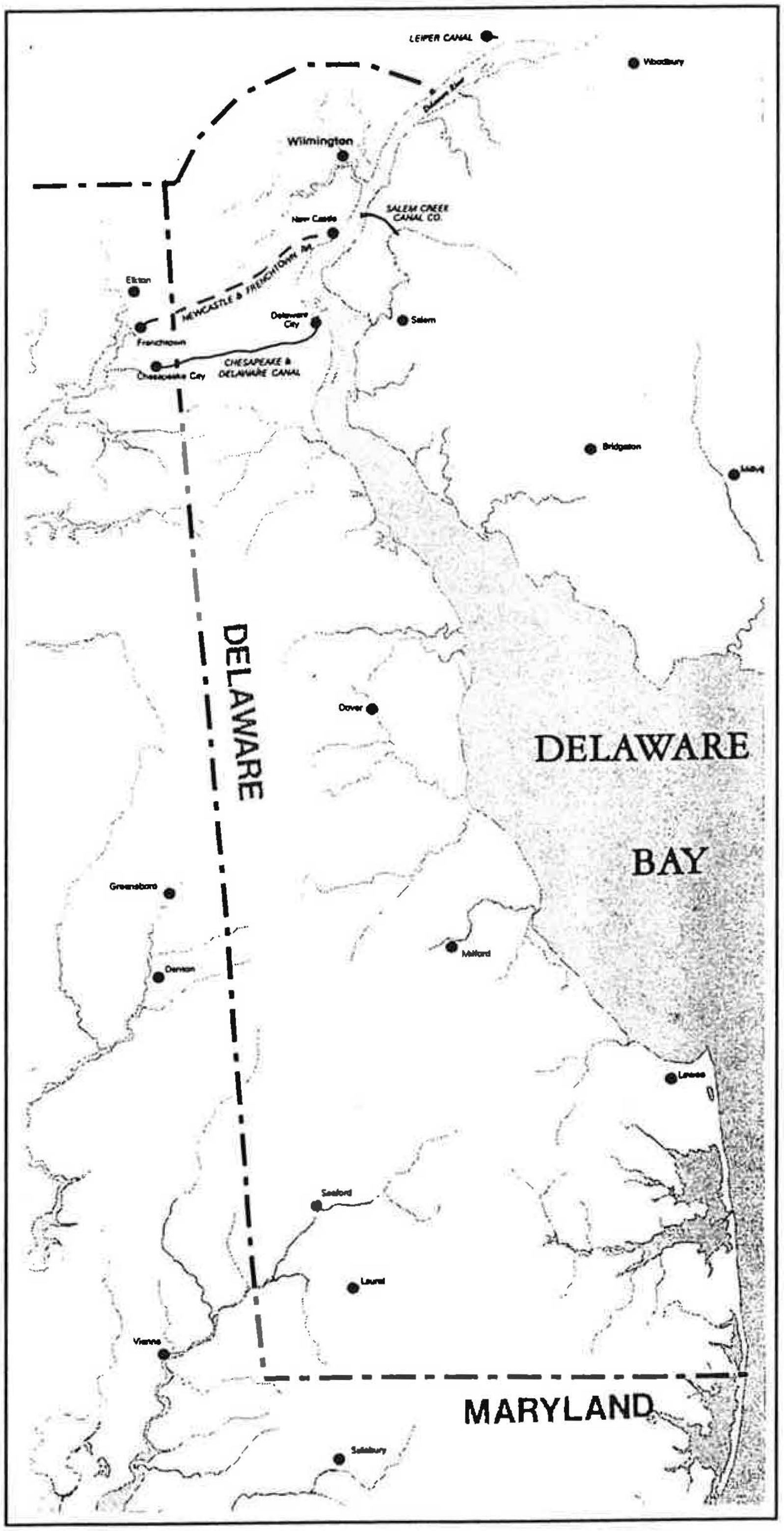

Figure C-1: Delaware's Canals and Railroads, 1830. The Chesapeake & Delaware Canal from Chesapeake City to Delaware City and the New Castle & Frenchtown Railroad crossed the state's northern neck. Source: Christopher T. Baer, ed., Canals and Railroads of the Mid-Atlantic States, 1800-1860 (Wilmington: Regional Economic History Research Center, Hagley Museum and Library), 1981.

A Near Monopoly: The Philadelphia, Wilmington & Baltimore Railroad

Construction of the all-rail route between Baltimore and Philadelphia began in 1837. Chartered as four separate companies, the lines merged in 1840 to form the Philadelphia, Wilmington & Baltimore Railroad (PW&B) (Burgess and Kennedy, 389-91; Holmes II, 152-158). The PW&B would dominate Delaware railroading for the next 45 years by offering two essential services: a fast, dependable all-weather route between Washington and New York, and reliable transportation linking all parts of Delaware with markets in the Northeast and the world (Figure C-2).

The all-rail route between Baltimore and Philadelphia and through northern Delaware was opened in 1838, but engineering mistakes and poor economic decisions threatened the line's existence. By the late 1840s, the PW&B verged on bankruptcy. New management, however, engineered a dramatic turnaround, relaying the line with heavier T rail, contracting for better locomotives and cars, building new stations, and improving the quality of service. By the end of the decade, the PW&B was a well-run, crucial rail link between Washington and the north (Wilson, 305).

Economically, the PW&B had a profound economic impact on Wilmington and northern New Castle County. The railroad opened new national markets to Wilmington's growing manufactories, a real boon to a city often caught in the shadow of Philadelphia, its larger neighbor to the north. Wilmington became a key supplier to the burgeoning railroad industry, spurring the growth and development of such firms as Diamond State Iron, Lobdell Car Wheel Company, and railroad car manufacturers, Jackson and Sharp and Harlan and Hollinsworth. Convenient transportation and proximity to other businesses made the narrow strip of land between the PW&B tracks and the navigable Christina River through Wilmington prime industrial territory (Seely, 2-5; Hoffecker, 48-50). The PW&B relocated their own repair shops there after 1865, replacing an earlier complex on Walnut between Water and Front streets (Figure C-3). The shops continually expanded throughout the late-19th and early 20th centuries, employing greater numbers of people as they did. Thus, the railroad made both direct and indirect contributions to the development of Wilmington's economy.

Expansion Downstate: The PW&B and the Delaware Railroad

The success of the NC&F and the PW&B provoked some interest in constructing a railroad linking Wilmington with Delaware's downstate, agricultural counties. The state granted charters in 1836 and again in 1849, but financial backing could not be found. During the mid-19th century, water remained the primary means of downstate transportation. Maintained roads generally led to waterside docks.

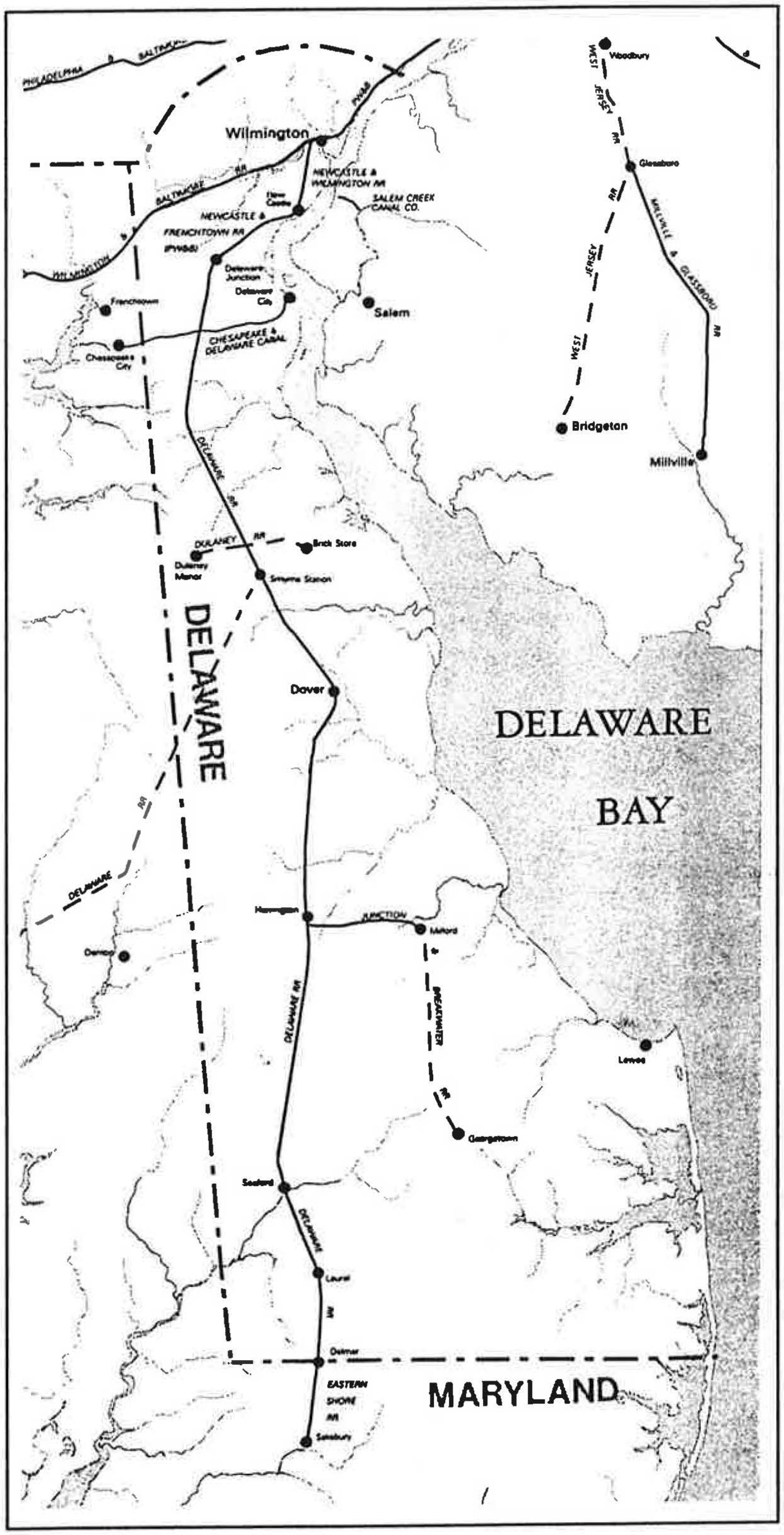

Figure C-2: Delaware's Canals and Railroads, 1860. By 1860, the Philadelphia, Wilmington & Baltimore and the Delaware Railroad were established as the state's two leading railroads. Source: Christopher T. Baer, ed., Canals and Railroads of the Mid-Atlantic States, 1800-1860 (Wilmington: Regional Economic History Research Center, Hagley Museum and Library), 1981.

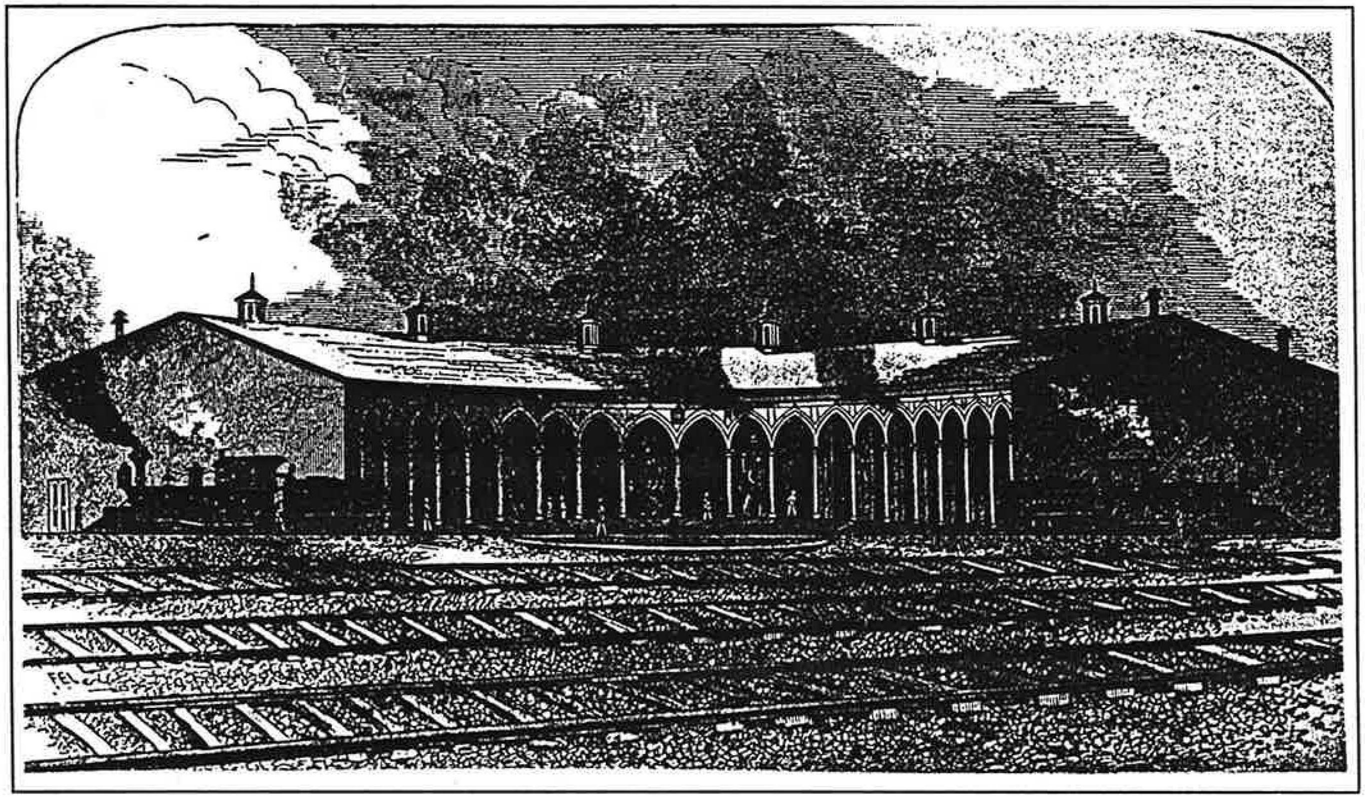

Figure C-3: The Philadelphia, Wilmington & Baltimore Railroad expanded its repair shops in Wilmington after 1865. The roundhouse is shown here as it appeared in the late-1870s. The repair shops, greatly expanded and modified, continue to be used by Amtrak. Source: Andrew S. Brown, Guidebook and Industrial Journal of the Philadelphia, Wilmington & Baltimore Railroad (West Chester, PA), 1877, p. 70.

Farmers in southern Delaware on the whole favored the development of the Chesapeake and Delaware Canal as a transportation outlet over the nascent railroad industry, which seemed to benefit only New Castle County.

In 1852, with another railroad charter company floundering, the state stepped in, subscribing 5,000 shares of stock of the proposed Delaware Railroad. The following year, the PW&B and the DuPont family, who were attracted by the fertile farmland of lower Delaware, stepped in to guarantee the Delaware Railroad's bonds. The PW&B formally leased the road in 1855 and, from 1857 on, operated the line as its Delaware Division.

With PW&B backing, construction proceeded quickly. The Delaware Railroad chose a route through the western side of the state, bypassing established towns in favor of easier engineering and potential business from Maryland's eastern shore. The new line proceeded south from Wilmington via a junction with the old NC&F between Bear and Glasgow. (The PW&B had built a railroad connecting New Castle and Wilmington in 1852.) Dover was reached in January 1856, and Seaford, the original finishing point, by the end of the year. In 1859, the line was extended to Delaware's southern boundary and a connection with Maryland's Eastern Shore Railroad in the new town of Delmar.

The railroad transformed lower Delaware, improving transportation, providing greater access to market for agricultural and other products, and tying northern and southern Delaware together through a common technology. Trade moved inland, away from tidewater areas, with new towns growing up at the railheads, including Cheswold, Felton, Viola, Wyoming, Harrington, Greenwood, and Delmar (Figure C-4). Equally dramatic was the change to southern Delaware's economy. The lumber stands of southwest Delaware were exploited for hardwoods. Farmers began experimenting with perishable products that could now move more rapidly to market via the railroad. Peaches quickly became downstate Delaware's largest cash crop. In Kent County, income from peaches jumped from $10,000 to $500,000 in just two decades. The peaches, melons, and early spring vegetables were destined for northern markets, which could enjoy fresh produce in season thanks to the railroad's more rapid transportation.

With its main line to the south completed, the PW&B/Delaware Railroad turned its attention to building or gaining control of the rail lines branching from its stem. The Junction and Breakwater, running from Harrington to Lewes, was completed in 1869 and then extended to Rehoboth by 1878. A branch from Georgetown to the state line at Selbyville was completed in 1874. In 1883, the line was renamed the Delaware, Maryland & Virginia Railroad. The rail connections helped spur the development of fish oil processing near Cape Henlopen. The DM&V was an important second freight line in southern Delaware for the Delaware Railroad; it also brought vacationers to Rehoboth Beach (Figure C-5).

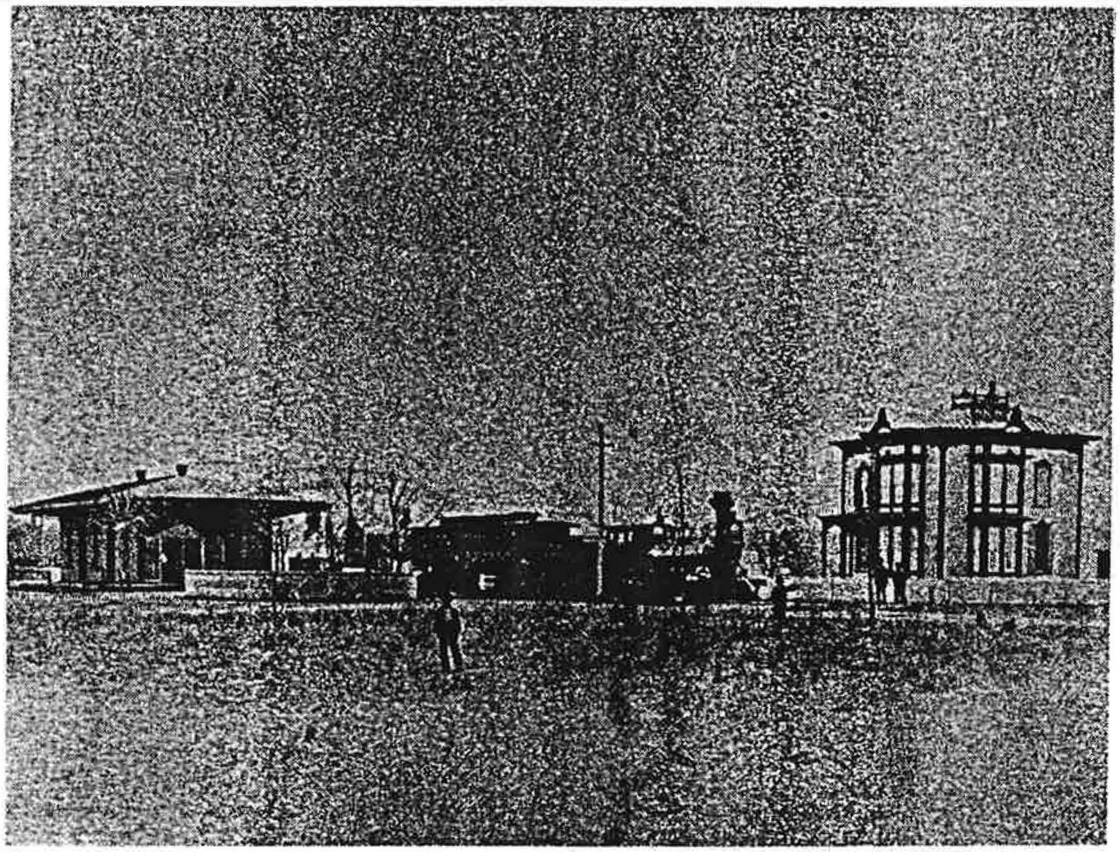

Figure C-4: Felton, ca. 1870. The Delaware Railroad was a major factor in the transformation of downstate Delaware. Clayton, Felton, Viola, Wyoming, Harrington, Greenwood and Delmar grew into small villages and towns centered around the railroad depots created by the Delaware Railroad. The photographer conveyed a sense of optimism and progress in this scene of a depot, locomotive and residence in Felton, where a brief time before had been a farmer's field. The railroad opened new markets for Delaware produce including peaches, melons, and vegetables. Source: Delaware State Archives, Dover, as appeared in John C. Haymon, Rails Along the Chesapeake: A History of Railroading on the Delmarva Peninsula, 1827-1978. Marvadel Press, Salisbury, MD, 1979.

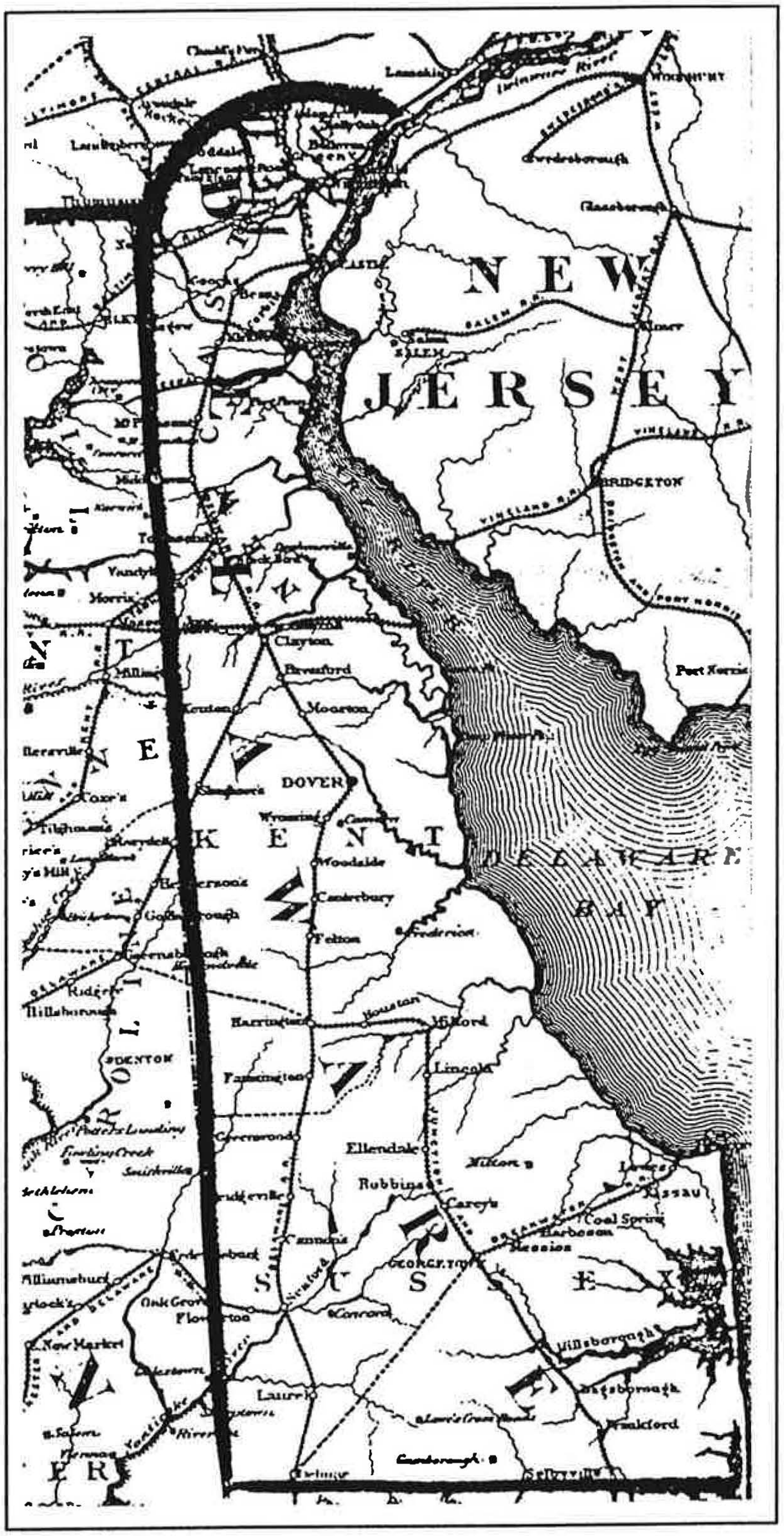

Figure C-5: Map of Delaware railroads, 1877. By the late 1870s, the Delaware railroad map was nearing completion with branch lines from the Delaware RR serving downstate and several small lines running north from the PW&B to points in southeastern Pennsylvania. Source: John C. Haymon, Rails Along the Chesapeake: A History of Railroading on the Delmarva Peninsula, 1827-1978. Marvadel Press, Salisbury, MD, 1979.

Other branches fed the Delaware Railroad freight business and passengers from Maryland's fertile Eastern Shore. Lines ran from Symrna to Oxford, Maryland (1871); Townsend to Massey's Crossing and Centreville, Maryland (1867); and Seaford to Cambridge, Maryland (1867). The last, which carried agricultural products, timber, and seafood, was reputedly the most valuable freight route on the Delmarva peninsula. Oversight of the branch lines gave the railroad control over most of the freight emanating from the peninsula. Because of the relatively flat topography, the branch lines offered the railroads few significant engineering challenges and few major stream crossings requiring other than the standard bridge technology (Figure C-6). The railroad branch lines, like those everywhere, had an impact on local economies, linking formerly isolated communities more closely with other towns and urban areas served by the integrated rail system.

Controlling the Delaware Corridor

Nationally, the railroad situation was equally dynamic. The railroad industry boomed following the Civil War, with rail lines reaching all corners of the country. Railroads evolved into the nation's first "big business," assuming control of vast holdings of capital, real estate, equipment, and employees. The railroad industry grew from 30,000 miles of track in 1869 to more than 200,000 miles by 1900. As it did, the railroads moved to standardize operations, gradually eliminating the multiplicity of gauges that had plagued the industry during the Civil War in favor of the standard gauge of four feet eight-and-one-half inches. At the same time, the railroads upgraded their physical plant, replacing iron rails with heavier steel ones, wood and iron bridges with stronger steel and stone spans, wooden cars with steel, and early locomotives with larger, more powerful varieties. Roadbeds were realigned, graded, and reprofiled for the heavier and faster equipment. The railroad industry pioneered such business techniques as decentralized management, cost accounting, electronic telecommunications, and engineering standardization in order to manage their complex, far-flung enterprises. The railroad industry became the dominant form of transportation and the model of modern business enterprises (Chandler, 82-121).

In this supercharged atmosphere, the populous Washington to New York corridor took on new importance, with the centrally located PW&B the lynchpin in the heavily traveled transportation route (Seely, 7-8). The rival rail lines that moved trains over the PW&B, the Baltimore & Ohio and the Pennsylvania, each sought control over the system. In February 1881, the B&O announced that it had purchased the PW&B. The declaration, however, proved premature; the Pennsylvania Railroad countered with a higher offer, wrestling control from its competitor and securing a direct connection between Washington, D.C. and New York harbor. The PW&B and the Delaware Railroad were now part of the Pennsylvania Railroad's vast system stretching from New York westward to Chicago (Burgess and Kennedy, 404-406).

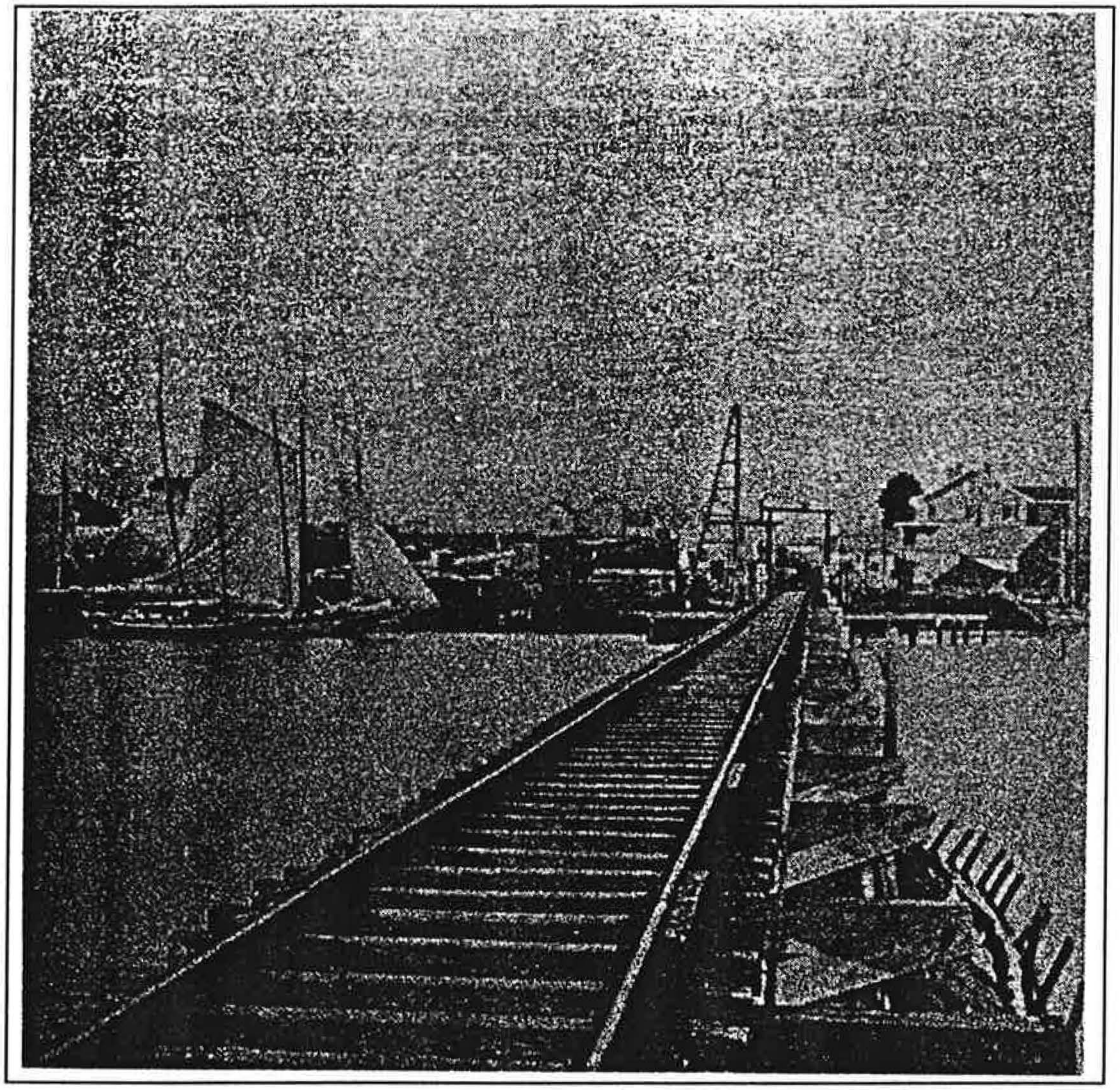

Figure C-6: The Delaware Railroad crossed the Nanticoke River at Seaford on a swing span bridge with timber stringer approach spans. The tower of the swing span is just visible at the far north end of the bridge in this photo, taken ca. 1870. The present swing span bridge replaced the bridge shown here in 1890. The Delaware Railroad had few major stream crossings requiring significant bridge engineering. The railroad contributed to the decline of river transportation. Source: Delaware State Archives, Dover, as appeared in John C. Haymon, Rails Along the Chesapeake: A History of Railroading on the Delmarva Peninsula, 1827-1978. Marvadel Press, Salisbury, MD, 1979.

Rather than concede the Washington-to-New York traffic to the Pennsylvania, the B&O, at great expense, built a parallel, double-tracked line to Philadelphia between 1883 and 1890, which linked up with the Jersey City line of the Reading Railroad. The route required the construction of many bridges, including truss bridges over the Brandywine at Wilmington and the Susquehanna near Havre de Grace, Maryland (Figure C-7). The B&O also assumed control of the Wilmington and Western Railroad, a line founded in 1871 to service Delaware's Red Clay Creek valley (Scharf, 432; Stover, 165-66; Burgess and Kennedy, 406-07). The B&O's Philadelphia Division, however, generated little on-line freight business, although passenger traffic initially was fairly healthy. The B&O's decision to expend capital on a new line rather than concede traffic to the Pennsylvania is an example of overbuilding that plagued the railroad industry in the 1880s and 1890s. This multiplicity of railroad lines would, in the long run, have a calamitous effect on the railroad industry.

Completing Delaware's Railroad Map

A number of other railroads were founded in Delaware during the period of expansion, including the Wilmington and Northern, the Pennsylvania and Delaware, the Baltimore and Delaware Bay, and the Maryland, Delaware, and Virginia. None were as significant on a national or statewide basis as the combined PW&B/Pennsylvania consortium. They were smaller players in Delaware's economy, serving primarily local needs and generally feeding traffic to the Pennsylvania and the B&O. In place by the beginning of the 20th century, they completed the Delaware railroad map that remained in place until the restructuring of the post-World War II years.

The Wilmington and Northern, running from Birdsboro, Pennsylvania, south through Wilmington to the Delaware River, began in 1866 as the merger of two smaller lines. In 1874, the line was extended north to Reading (Scharf, 379, 462). It was absorbed into the railroad of the same name ca. 1899. The Wilmington and Northern was formed to bring anthracite coal to Wilmington's manufactories for fuel and to the docks for export. Its performance, while adequate, never matched expectations. The Wilmington and Northern also switched out the towns and industries of the Brandywine Valley, connecting with the Pennsylvania Railroad at Octoraro, Pennsylvania (WPA, 79; Seely, 4-5) (Figure C-8).

The Pennsylvania and Delaware, a branch of the Pennsylvania Railroad, originally ran from Pomeroy, Pennsylvania to Delaware City, Delaware, where its backers planned a large coal wharf. Founded in 1869, it was a relatively unimportant branch of the Pennsylvania Railroad by 1873 (Hayman, 61-63). It was placed under PW&B control following Pennsylvania Railroad purchase of that line. The portion east of Davis Tower in Newark was renamed the Newark and Delaware

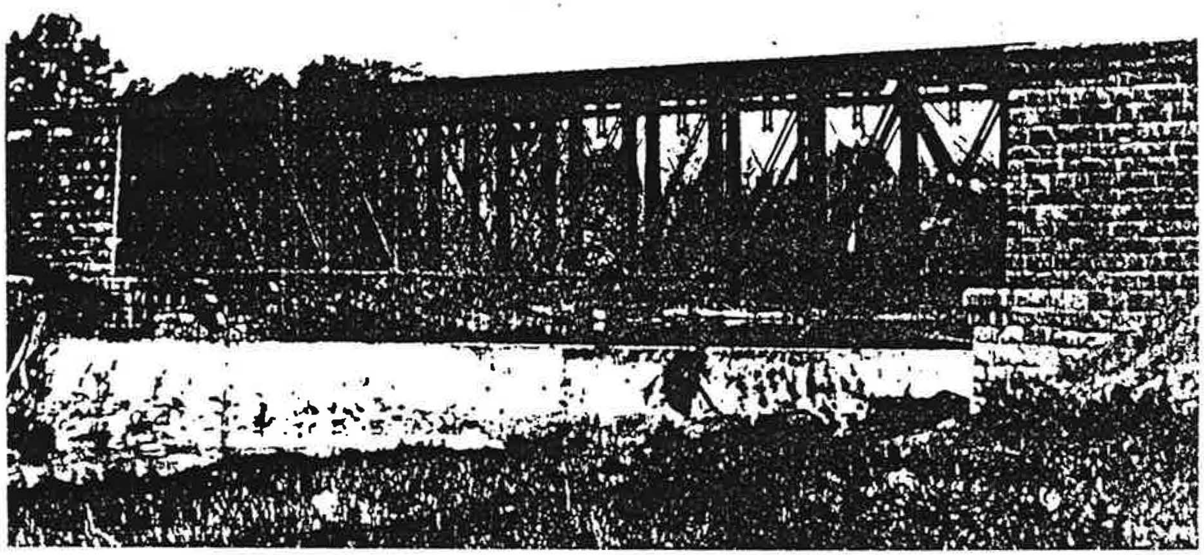

Figure C-7: The B&O Railroad iron truss bridge over Red Clay Creek near Kiamensi, ca. 1895. The B&O built its own line between Philadelphia and Baltimore from 1883 to 1890. In Delaware, the line ran across northern New Castle County parallel to the PW&B, which had been acquired by the Pennsylvania RR in 1881. The B&O's right-of-way was less desirable and required the construction of numerous expensive bridges, cuts and fills. An example of the overbuilding of railroads in the late-19th century, the B&O's Philadelphia Division was never a great financial success. Source: Hagley Museum and Library, Photo No. 84.257.7.

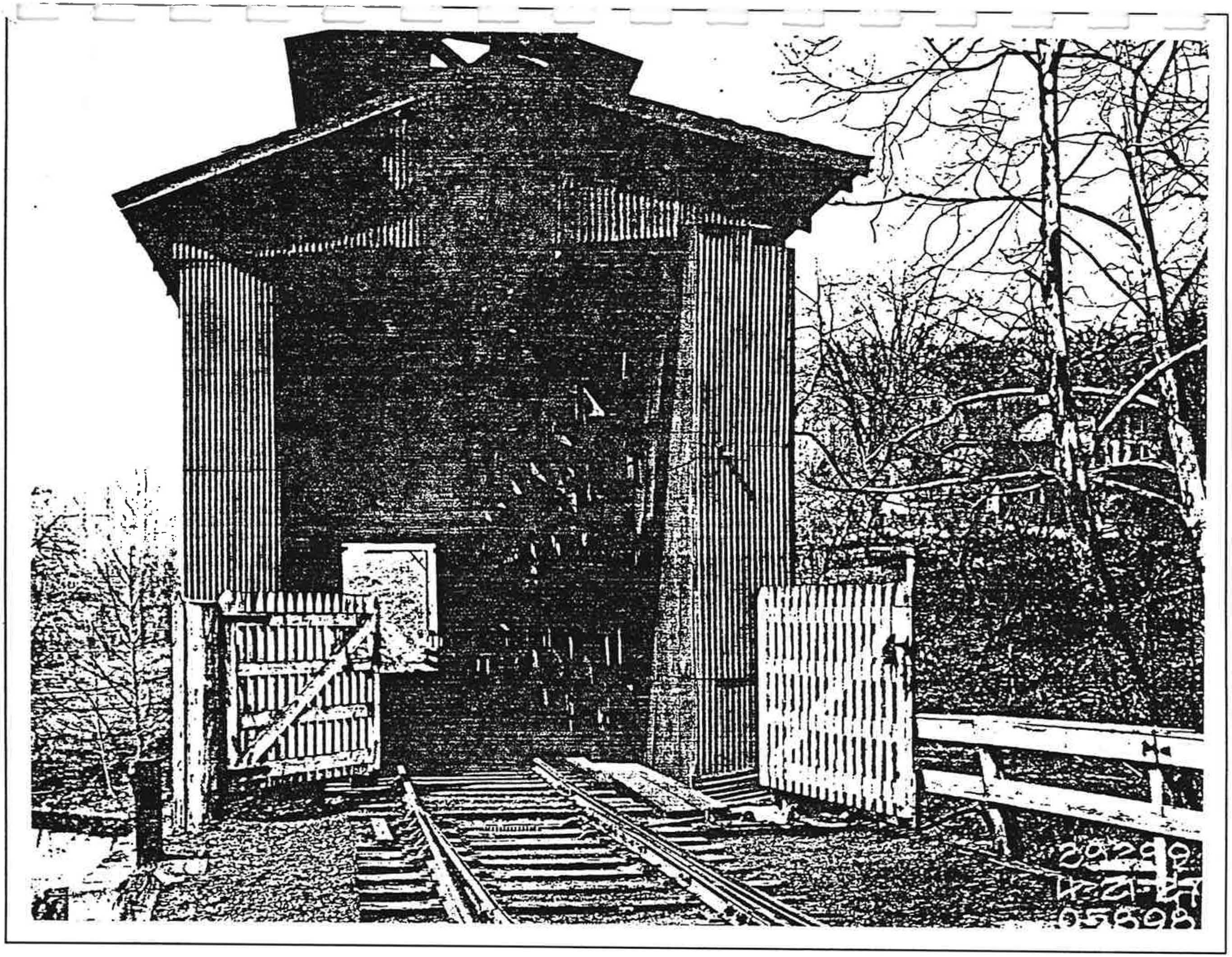

Figure C-8: A branch of the Wilmington and Northern served the paper mills at Rockland, crossing the Brandywine Creek by way of a covered bridge, built ca. 1866. The covered bridge was eventually replaced by the extant steel girder bridge. Source: Edward M. Kutsch, private collection.

City, and the section between Davis Tower and the Pennsylvania border was designated the Pomeroy and Newark.

Delmarva's expanding peach and produce harvests of the late-19th century spawned a rail line that briefly competed with the Delaware Railroad for the freight business. In 1879, railroad financier Jay Gould and the Southern Railroad of New Jersey purchased an existing rail line running from Pierson's Cove/Bombay Hook, Delaware, to Chestertown, Maryland. For one season, it operated a car ferry service between Bombay Hook and Bayside, New Jersey. But with the Jersey Southern's bankruptcy the following year the line came under the control of the Central of New Jersey, who used it primarily to ferry passengers to a resort at Woodland Beach and excursion boats bound for Cape May. In 1902, being a very minor line, it was merged into the Delaware Railroad (Hayman, 55-60).

The Maryland, Delaware and Virginia, running from Love Point on the Chesapeake Bay to Lewes on the Delaware, was chartered and built between 1894 and 1898 as the Queen Anne's Railroad. In Delaware, the line ran through Greenwood, Ellendale, and Milton to Lewes. The line came under Pennsylvania Railroad control in 1905. Sold at foreclosure in 1923, the MD&V operated as the nominally independent Maryland and Delaware Coast, although its right-of-way continued to be owned by the Pennsylvania. The line has some local significance during the period of 1898-1931 for its role in bringing vacationers from Washington and Baltimore to Rehoboth Beach, helping to make the town a popular resort (Hayman, 118-125).

With the founding of these lines, the railroad map of Delaware was essentially complete. Routes would be realigned and certain tracks abandoned due to business exigencies. More would be built in and around Wilmington as cut-offs to relieve congestion and to service a new yard at Edgemoor, but the map would change little substantively until late in the 20th century.

Railroad Consolidation and Expansion, 1881-1945

Following its purchase of the PW&B, the Pennsylvania Railroad moved to consolidate and expand its Delaware holdings. Beginning in 1884, the important line between Washington and New York, including the Newark to Wilmington corridor, was double tracked (PRR Annual Reports). The Pennsylvania also moved the Delaware Railroad's headquarters and shops to Clayton, a relatively new town founded with the coming of the railroad. Clayton would become lower Delaware's largest railroad center (Hayman, 28, 61-63). The Pennsylvania Railroad's extensive holdings made it the largest landowner and taxpayer in the state and a key player in statewide politics (Munroe, 160-165).

The Delaware Railroad held particular value for the Pennsylvania Railroad at this point. The Pennsylvania saw the road as a potentially direct and relatively short conduit between southern agriculture and northern markets. In 1894, the Pennsylvania purchased and completed the New York, Philadelphia, and Norfolk (NYP&N), which connected the Delaware Railroad at Delmar with Cape Charles, Virginia, across the Chesapeake Bay from the thriving port of Norfolk. By instituting a car ferry service, the Pennsylvania created an alternative route to New York for southern produce, especially early vegetables, berries, peaches, and other fruits, as well as for tobacco, cotton, and Chesapeake Bay oysters. The NYP&N's purchase had a residual effect on agriculture in Kent and Sussex counties. As the line and its Delaware Railroad connection became more important to the Pennsylvania, it opened new markets for all products along the line, including Delaware peaches, melons, and strawberries. The expanded truck farming in lower Delaware, in turn, spurred a growth in the cannery industry throughout the state. The Delmarva freight lines were among the most profitable on the Pennsylvania Railroad system in the early 1900s (Hayman, 71, 82-84; Davis, 104-106).

To better control its expanded Delmarva operation, in 1901 the Pennsylvania reorganized its Delaware holdings into a new company, the Philadelphia, Baltimore & Washington, a wholly owned subsidiary of the Pennsylvania Railroad (Schotter, 279). The name change reflected, in part, Wilmington's declining position after 1890 as a manufacturing center. Changing markets and less dynamic business leadership altered Wilmington's economic base away from intensive industry. Wilmington remained, however, an important railroad town and northern Delaware a vital part of the northeast transportation corridor (Seely, 9-11) (Figure C-9).

With its corporate house in order, the Pennsylvania Railroad embarked beginning in 1902 on a substantial and wholesale rebuilding program designed to bring its Delaware holdings up to the company's engineering standards. New Castle County saw the bulk of the improvements, from relaying and regrading of track to the adoption of the Pennsylvania's trademark stone construction for bridges and stations on its main line. Wilmington, between 1901 and 1907, saw the construction of a historically significant, four-mile long stone arch and steel-girder viaduct to eliminate grade crossings by carrying the tracks above street level through town (Figure C-10, C-11). Other construction included a new station, office building, powerhouse complex, and freight depots; a swing span bridge over the Brandywine River; a new freight yard; and expansion and construction of new shops at the old PW&B facilities in Wilmington (Seely, 9-14). In order to speed operations and increase traffic capacity, the track system from Newark to Wilmington was expanded from two to four (PRR Annual Reports).

The B&O followed suit, opening in 1910 a graceful, technologically significant, seven-arch stone viaduct over the Brandywine River in Wilmington on a slightly

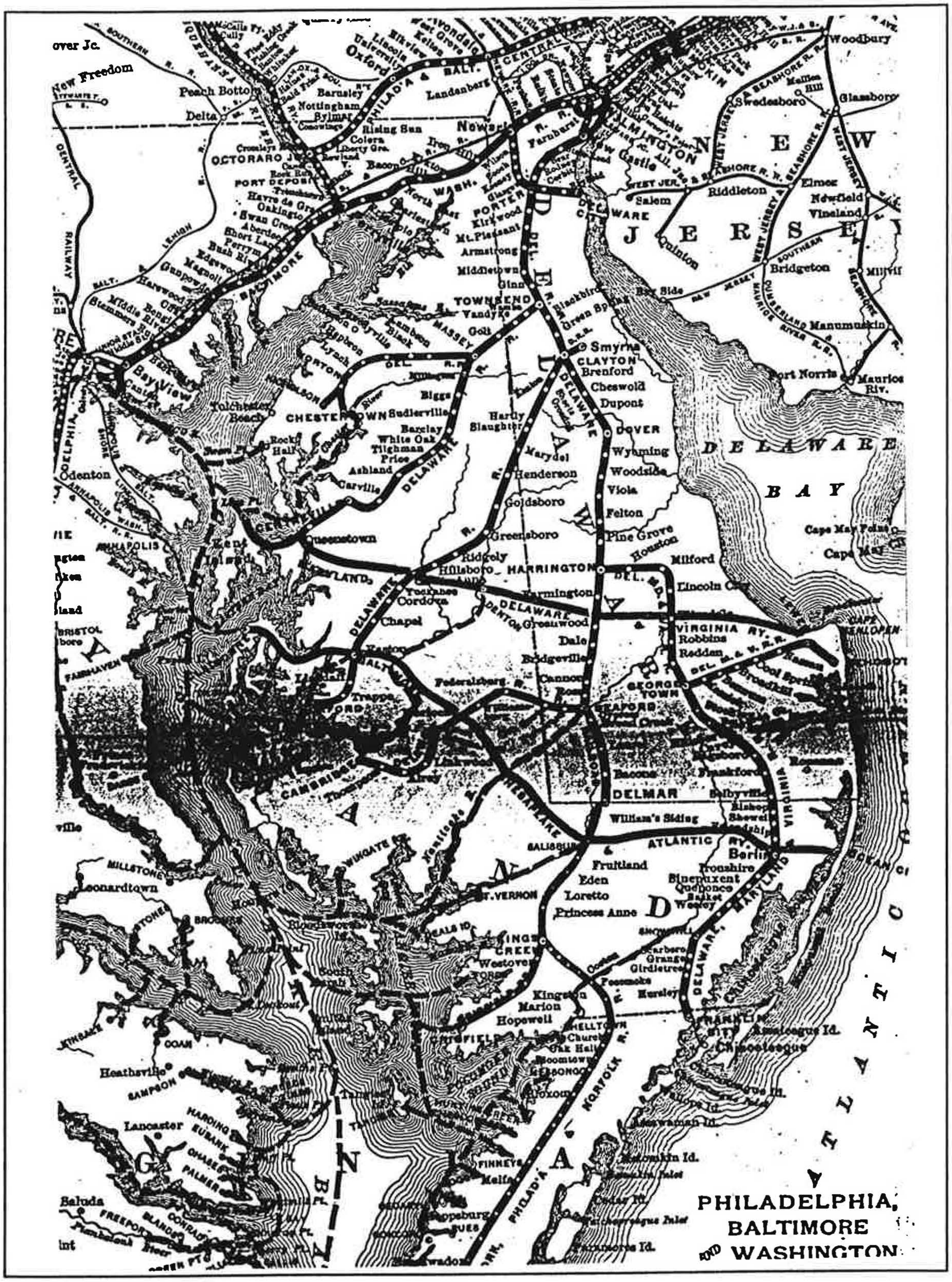

Figure C-9: Philadelphia, Baltimore & Washington Railroad System, 1907. Source: PW&B Annual Reports, 1907.

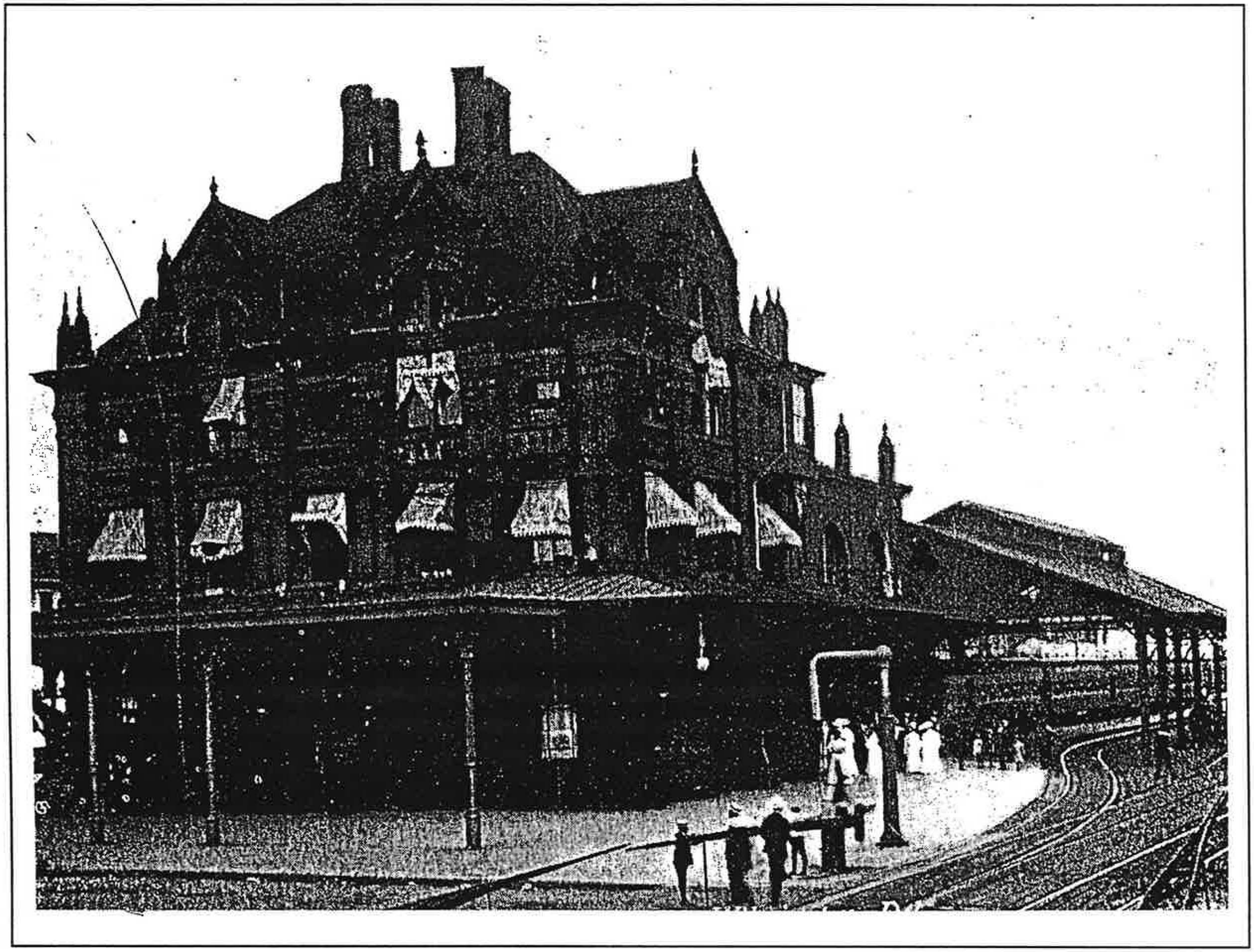

Figure C-10: The old PW&B Railroad Station, shown here, was replaced from 1901 to 1907 as part of a wholesale rebuilding program. At-grade crossings of Wilmington's streets were considered a safety hazard and inefficient to railroad operations. Source: Hagley Museum and Library, Photo 71.502.1. Copied from Postcard.

Figure C-11: The new PB&W Railroad station in Wilmington was built from 1901 to 1907. It featured a station platform and steel girder and stone arch viaduct grade-separated from the city streets. Source: Hagley Museum and Library, Photo 71.502.1. Copied from Postcard.

different alignment. Its original 1885 deck truss bridge remained in place and was rebuilt in 1920 as the Augustine Cutoff highway bridge. The superstructure was replaced in 1980. In 1918 the B&O also rebuilt and expanded the Wilsmere Yard outside of Wilmington to more easily accommodate the switching of freight trains bound for New York (Harwood, 107, 128).

Electrification of the Northeast Corridor

The most significant improvement to rail operations in the region began in 1910 when the Pennsylvania Railroad constructed electrified tunnels under the Hudson and East Rivers, providing for the first time with direct access to New York City (Previously, trains transferred to car ferries at Jersey City and were floated across New York harbor). Pleased with the results, the Pennsylvania boldly decided to electrify its entire line between Washington and New York, the nation's busiest transportation corridor, believing that the unprecedented proposition, expensive in the short run, would provide long-term economies of scale (Bezilla, 109; Burgess and Kennedy, 394-395; Stilgoe, 32-36).

The electrification project started in New Jersey and along several Philadelphia commuter branches in 1915, with plans to extend electrification by stages southward to Washington, D.C. The mammoth undertaking required erecting over 325 route miles and 1,300 track miles of catenary; relaying all four tracks with heavier, high-speed rail; rebuilding bridges for heavier, faster loads; reconstructing signal bridges, and, at grade-crossing underpasses, erecting fences to keep the public from throwing debris on the track and catenary. Railroad and highway bridges crossing the line had to be raised as needed to provide sufficient space for wires (Bezilla, 112-118). The Philadelphia to Wilmington portion was begun in 1926 and completed by 1928. The Pennsylvania completed the line south of Wilmington in the depths of the Great Depression with $45 million secured from the New Deal's Public Works Administration; the loan was called the most productive ever made by the PWA. Through electrical passenger service was inaugurated in February 1935, with electrified freight service beginning three months later (Burgess and Kennedy, 612-616).

The large-scale electrification of main line service was a stupendous engineering feat. It changed the complexion of railroading in northern Delaware and dramatically altered the physical environment in ways that remain today. High-speed trains expanded passenger travel in the corridor, which generated more passenger miles than any other main line of comparable length. The improvements would keep the railroad corridor viable long after passenger service had declined in other areas of the country. Electrification severely undercut passenger service on the rival B&O, who had trouble competing effectively with the direct, high-speed service. This, too, would have long-range implications for railroading in Delaware. Finally, electrification tied Wilmington ever more firmly into a megalopolis stretching from Washington, D.C. to New York. Wilmington became the Pennsylvania's main repair shop for electric locomotives, a role that continues today with Amtrak, assuring the shops' continued existence and securing Wilmington's future as a railroad town.

Restructuring in the Railroad Industry, 1917-1946

The Pennsylvania's decision to electrify was driven, in part, by growing problems in the railroad industry. Railroads have always been a business of comparatively modest profits, with high fixed costs tied up in essential holdings like rights-of-way, track, bridges, locomotives and cars, stations, warehouses and other fixed structures. The large holdings, in turn, subject the railroads to an equally large property tax load, a burden that was increased, often beyond what could be justified by traffic, during the overbuilding of the 1880s and 1890s. Competition, like the parallel B&O and Pennsylvania lines through northern Delaware, assured that the rates railroads charged shippers would remain comparatively low. Moreover, arcane, government-regulated, freight-pricing structures established maximum and minimum acceptable rate levels, rather than letting the carriers set them based on competition, commodity, and distance. The railroad industry remained profitable as other costs and competition from outside forms of transportation remained static, but its position was precarious (Douglas, 379-395).

And competition was increasing from trucks and automobiles, as states began developing highway systems. Coleman du Pont's innovative Du Pont Highway began in 1911 and was heavily subscribed by Kent and Sussex counties farmers that were only too glad to have an alternative to the Pennsylvania's near monopoly on downstate transportation. Road building activity increased following the passage of the Federal Highway Act of 1916. America's entry into World War I exacerbated the railroad's woes as more and more shippers, exasperated with railroad car shortages and freight bottlenecks, turned to the nascent trucking industry for short- and medium-distance hauls over the nation's improving road and highway system (Burgess and Kennedy, 561-563).

The situation improved for the railroads during the 1920s. Railroad companies, led by the Pennsylvania, reorganized ruthlessly, consolidating shop operations (a process helped by electric locomotives, which require less maintenance than steam engines), reducing employment, and rolling back war-time union gains. But competition from private automobiles, trucks, barges, and pipelines continually increase. Trucking offered the advantage of door-to-door service, eliminating the long delays associated with shifting railroad cars in freight yards and cargo between cars and destinations. Delaware's improved roadways undercut railroad passenger usage, as people in the prosperous postwar years turned to the increasingly affordable automobile for their transportation needs (Rae, 171-83; Douglas, 394).

The Great Depression worsened the situation, with freight and passenger traffic slipping to an all-time low. With the notable exception of the Pennsylvania's electrification project south of Wilmington, the railroads deferred maintenance on track and other physical structures to spread already thin revenues. The Pennsylvania continued to turn profits and pay dividends, but shipments along its Delaware freight routes slipped. From this point forward, downstate Delaware freight would play a declining role in the Pennsylvania Railroad empire. But the situation was worse on the rival B&O, which tottered on the edge of bankruptcy.

With America's declaration of war in December 1941, the lean years of the Depression became a distant memory. Troop train movements, decreased ship activity along America's coasts, and restrictions on automobile travel thrust the transportation burden back onto the railroads. Freight and passenger volumes skyrocketed, particularly in the industrial east. In Delaware, the Pennsylvania and B&O lines in the northern part of the state bore the brunt, as Wilmington industries switched to war footing and goods and war material moved to the ports of Wilmington, Philadelphia and New York. The railroads' wartime performance was lauded nationwide, but the glory would be short-lived.

Railroads in the Postwar Years

Physically, the railroad industry was in sorry shape by war's end. Increased traffic loads and a lack of replacement parts had punished track and equipment already suffering from the deferred maintenance of the Depression years. Outside competition was accelerating, with trucking industry taking a growing percentage of the short and medium distance, high volume business that the railroad industry counted on to subsidize higher weight but less profitable goods like coal. Railroad attempts to establish their own trucking subsidiaries were found to violate anti-trust laws (Douglas, 394). The improved road system also spurred the growth of automobile suburbs, shifting passengers and businesses away from railroad corridors. The dramatic growth of the airline industry decimated long-distance railroad passenger traffic and made slow, but steady inroads into the freight business.

The declining business, plus years of overbuilding and high-fixed costs, heavy debt loads, and declining business, left railroads with little or no money to upgrade routes and equipment. A painful restructuring began. Postwar passenger routes were the first victims. The Pennsylvania eliminated downstate passenger service on the branch lines by 1949, and on the Delaware Railroad by 1965 (Hayman, 137-142). Its dense, electrified corridor through northern Delaware remained competitive with the airlines even as equipment continued to deteriorate. The financially shaky B&O Railroad was less fortunate. Unable to compete with the Pennsylvania, it ended passenger service in the corridor in 1958.

The Pennsylvania's Delaware freight business fell off steadily. The Delmarva peninsula had relatively few heavy industries, and the perishable agricultural commodities that formed the backbone of the downstate business were most vulnerable to truck competition. Additionally, much of the intensive, weather sensitive crops shifted from Delaware to the longer growing seasons of the southern and western United States. Delaware's growing broiler chicken industry shipped primarily via truck, not railroads. All Delaware railroads--Pennsylvania, B&O, Wilmington Northern/Reading--eliminated unprofitable short-haul sidings and branches. Then, in 1956, the Pennsylvania downgraded the Delmarva line as a through route, removing one of the two tracks (Hayman, 142-43).

The railroad industry introduced a number of innovations that curtailed the decline and won some traffic back. Diesel locomotives on the B&O and the Pennsylvania Delmarva lines increased efficiency, allowing an engine to operate 28-30 days per month, rather than the 15-18 day limit of a steam locomotive. Equally important, joint ventures with the trucking industry revolutionized the industry. The introduction of piggyback trains (truck trailers on railroad flat cars), containers on flat cars, and unit trains (trains shipped and routed as a unit, eliminating switching) won back for the industry some of the medium distance and long-haul freight business. Ironically, the introduction of the tri-level automobile car secured for the railroads the movement of automobiles from manufacturing plant and import point to its final destination (Douglas, 382-395). In the late 1940s, the proximity of the B&O and Pennsylvania rail lines was an important factor in the location of a General Motors assembly plant near Newport and a Chrysler plant at Newark.

The innovations slowed, but did not halt the losses. Declining freight revenues and massive debt forced the B&O, the nation's first common carrier, into a merger in the early 1960s with the Chesapeake and Ohio and Western Maryland railways, a union that eventually became known as the Chessie System. In 1968, the rival New York Central and Pennsylvania railroads completed a merger, forming the Penn Central Corporation. Delaware shippers worried how, if at all, their comparatively small business would fit into the giant corporation. But the unwieldy Penn Central collapsed in on itself within two years.

The Penn Central bankruptcy and the ailing condition of the industry in general convinced Congress that a legislative solution was needed. In 1970, Congress created the National Railroad Passenger Corporation, better known as Amtrak, to run the nation's passenger train service, including the Northeast Corridor through Delaware. Wilmington remained the heavy repair facility for locomotives used in the corridor (Seely, 18). The Penn Central's freight side was reorganized, along with that of several other northeastern bankrupt railroads (including part of the Reading/Wilmington & Northern tracks in Delaware), into a quasi-public company, the Consolidated Rail Corporation or Conrail. Conrail closed a number of railroad yards, including the one at Delmar.

The formation of Conrail and the creation of CSX Corporation through a merger of the Chessie and the Seaboard systems in 1980 produced a spate of abandonments of smaller feeder lines throughout Delaware and the Eastern Shore. Some were picked up by smaller carriers, some by the state railroad administration, and some by the state of Maryland. Partial deregulation of the railroad industry in 1980 with the passage of the Staggers Act finally gave the railroads the right to set rates competitively and to own other forms of transportation, like barge and truck lines. This has led to a boom in the intermodal business, particularly on routes of greater than 400 miles. It has also led to an improved climate for the railroad business (Martin, 390; USRA, 49-59).

Today, the railroad industry continues to be an important player in Delaware's economy and transportation picture (Figures C-12, C-13). Traffic through New Castle County, both passenger and freight, is quite heavy, although most begins and ends elsewhere. Amtrak passenger service, thanks to electrification, continues to serve Wilmington and the Northeast Corridor. Both Conrail and CSX Transportation carry freight along their historic routes in northern Delaware. Ironically, the former B&O line, historically the less significant of the two, now carries more annual freight tonnage than all of Conrail's Delaware lines and the short line railroads combined (DTC). The electrified, former Pennsylvania line cannot accommodate the intermodal container and trailers on flatcars trains, and it is predominantly used for Amtrak passenger line service. Trains from competitors, like Conrail and Norfolk Southern, as well as trains from the Canadian Pacific Railway, are routed over the CSXT line. Most of the freight on this line originates from outside of the Diamond State.

Conrail operates the former Delaware Railroad spine line as its Delmarva Secondary Track. Branches in New Castle County connect the line to the Port of Wilmington (the New Castle Secondary track) and the chemical plants in Delaware City (the Reybold Industrial Track). The branch east from the spine line at Harrington, historically known as the Delaware, Maryland & Virginia, is now Conrail's Indian River Secondary Track as far as Frankford. The small amount beyond that in Delaware is run by the Maryland & Delaware (M&D), an independent railroad, for the Snow Hill Shippers association. The M&D also operates most of the smaller lines feeding traffic to Conrail, including the former Townsend Branch between Townsend and Chesterton and Centreville, Maryland, the former Cambridge branch between Seaford and Cambridge, Maryland, and the old Breakwater and Junction Railroad between Georgetown and Lewes, as well as its branch between Ellendale and Milton. The line through the Red Clay Valley between Wilmington and Hockessin is once again known as the Wilmington and Western; privately owned, it operates primarily as a tourist railroad business. The remnants of the former Wilmington and Northern/Reading Railroad line are now known as the Delaware Valley Railroad. A bridge route to shippers in Pennsylvania, the line generates no business in Delaware (DTC).

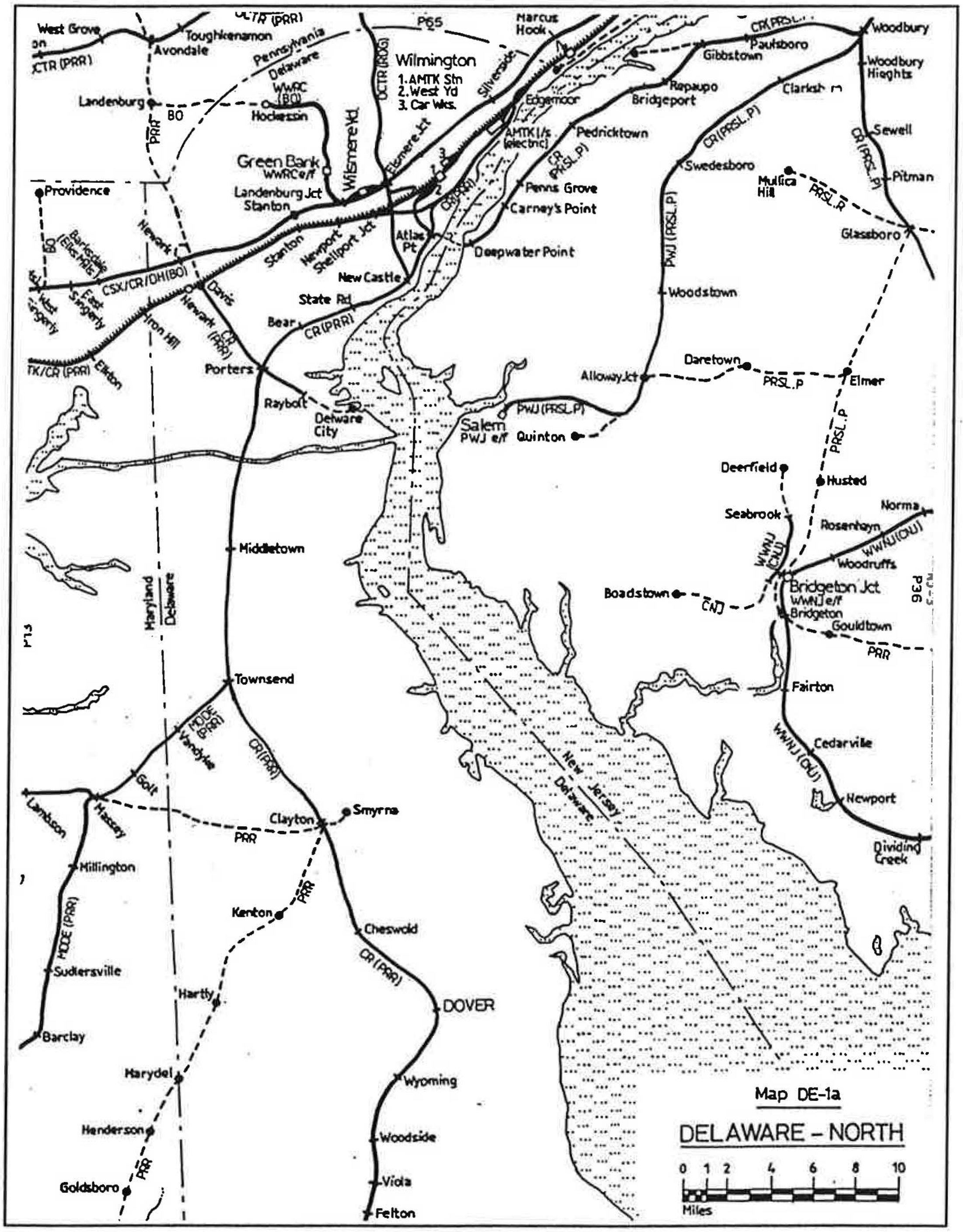

Figure C-12: Delaware-North, railroads as of 1995. Solid lines are in-service rail lines, hatched line is active electrified line, i.e. Northeast Corridor; dashed lines are abandoned rail lines. Key: AMTK = Amtrak; (BO) = historic B&O Railroad lines; CR = Conrail; CSX = CSX Transportation; MDDE = Maryland Delaware RR; OCTR = Octarora Railroad, now Delaware Valley RR; (PRR) = historic Pennsylvania RR lines; (RDG) = historic Reading lines; WWRC = Wilmington & Western RR. Source: Mike Walker, Railroad Atlas of North America: Northeast USA (Faversham, UK: Steam Powered Publishing), 1995.

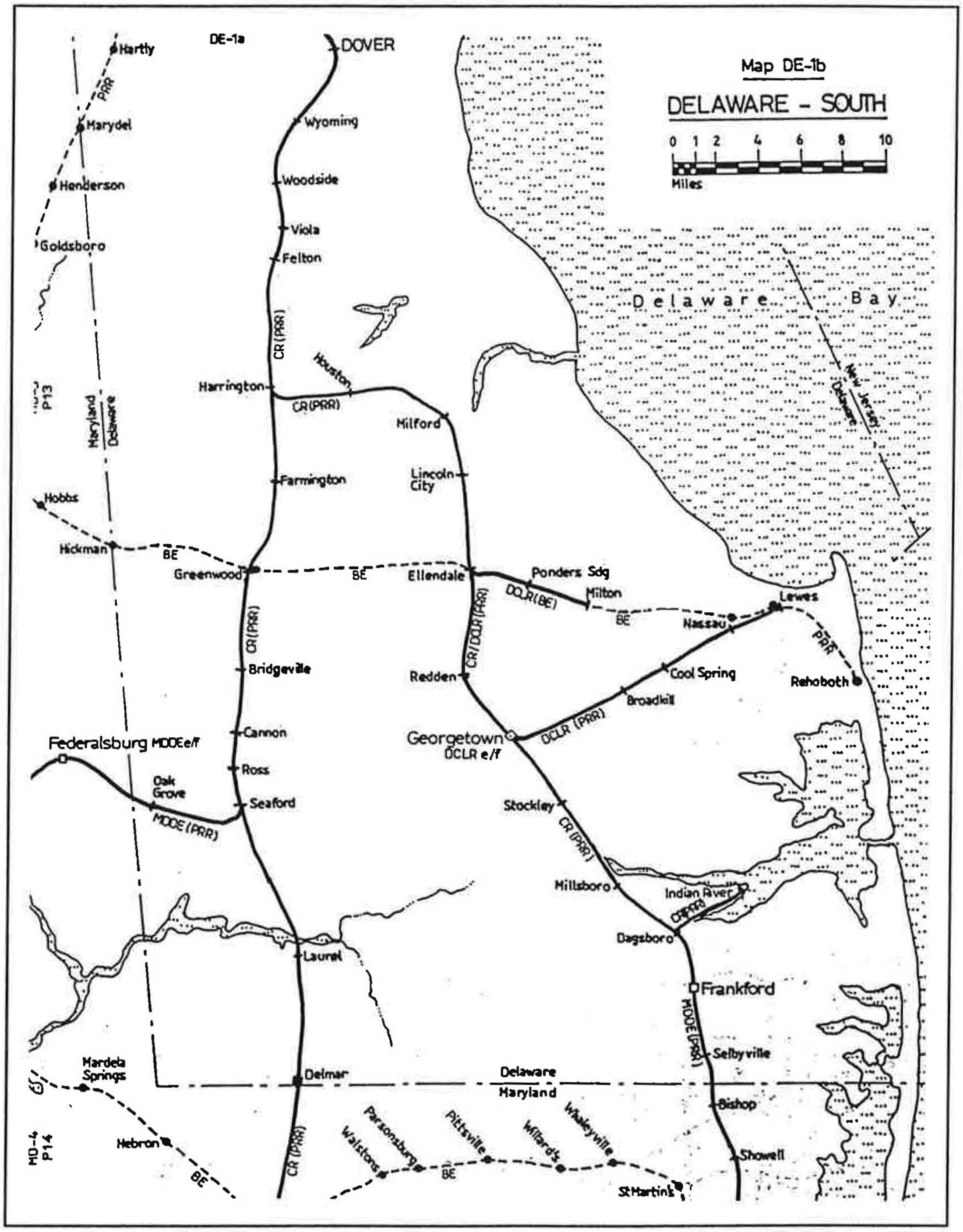

Figure C-13: Delaware-South, railroads as of 1995. Solid lines are in-service rail lines, dashed lines are abandoned rail lines. Key: BE = Baltimore Eastern; CR = Conrail; DCLR = Delaware Coast Line RR; MDDE = Maryland Delaware RR; (PRR) = historic Pennsylvania RR lines. Source: Mike Walker, Railroad Atlas of North America: Northeast USA (Faversham, UK: Steam Powered Publishing), 1995.

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DELAWARE HISTORIC BRIDGE SURVEY UPDATE

Summary of Recommendations

Following is a summary of the National Register recommendations for each of the surveyed bridges. The summary with attached tables is presented as a reference tool. The heart of the survey is the individual bridge survey forms, which serve to elaborate the historic significance and integrity of each bridge on its own merits as applied against the National Register criteria for evaluation.

Bridges with Dates of Construction from 1946 to 1956

The survey update began with a population of 76 bridges with dates of construction from 1946 to 1956. The dates of construction were taken from the NBIS database. The population was inclusive of all highway bridges and culverts owned or inspected by DelDOT. The population is exclusive of railroad bridges and highway bridges, such as the Delaware Memorial Bridge and its approaches, that are owned and maintained by the toll and bridge authorities.

During the field inspection and research phases of the project, dates of construction were verified. When possible, researchers reviewed contract files to determine the actual dates of construction. NBIS dates sometimes refer to the dates of construction for substructure elements, such as concrete abutments that were reused with a replacement superstructure, or to the dates of plans that were prepared years in advance of actual construction.

As a result of further research, it was determined that six (6) of the 76 bridges had actual dates of construction that were post-1956, and thus later than the survey parameters and contexts (Table 1). Survey forms were completed for the post-1956 bridges and are part of the survey record.

Four (4) of the 76 bridges had pre-1946 dates of construction (Table 2). The four bridges are early 20th-century reinforced concrete structures that were widened between 1946 and 1956. In each case, survey forms were completed explaining the history of alterations. It was recommended that alterations had compromised historic integrity of original design and an evaluation of not eligible was justified.

That left a total of 66 bridges with verified dates of construction from 1946 to 1956 (Table 3). The vast majority of these bridges (50 of 66) are either steel multi girder bridges, reinforced concrete slab bridges, or reinforced concrete box culverts (Table 4). They are common bridge types and have little to distinguish them from the population of similar bridges in use by the state highway department and counties from the late 1910s through the mid 1950s. The 1988-1989 survey has identified a large number of the earliest, innovative, architectonic, and precedent setting examples of each of these bridge types. The survey update identified few significant features, such as innovative construction details, engineering improvements, or changes in architectural style, to distinguish the postwar examples of the standard bridge types from their predecessors.

Of the total of 66 bridges, six (6) bridges were evaluated National-Register eligible. The six bridges represent six different bridge types, each with historically or technologically significant contexts or associations that distinguish them from among the bridges of similar age and type. The remaining 60 of 66 bridges were evaluated not eligible (Table 5).

Reinspection and Evaluation of 80 Previously Eligible Bridges

A revised National-Register eligibility recommendation was prepared for each of the 80 bridges evaluated eligible by the previous historic bridge survey. The recommendations are that 62 of the 80 bridges remain eligible. Tables 6 lists each of the bridges with the updated National Register recommendation (NRR) and updated status of either rehabilitated, replaced, recommended for reverse eligibility, or blank (no change). Tables 7 and 8 present the same information broken down for each bridge grouped by bridge material and type.

Ten (10) bridges that were previously eligible have been demolished and replaced since 1988-1989 (Table 9). Survey forms were completed for the bridges in order to memorialize the history of demolition and replacement. A note was made on the survey form in cases where older bridge elements, such as concrete abutments, piers or railings, were reused.

Eight (8) bridges were recommended for reverse eligibility based on field inspections and research that revealed significant loss of integrity from previously unidentified alterations and/or additional documentation of the bridge's history that markedly changed the interpretation of the bridge's historical or technological significance (Table 10). The bridges were carefully reviewed against the revised criteria for evaluation, and based on the new information a reverse recommendation of not eligible was justified.

Railroad Bridges on the Milton-Ellendale Branch Railroad

Two (2) bridges on the Milton-Ellendale Branch Railroad were included in the scope of the project. Field inspections and research indicates that both wood multi girder bridges were built in 1988. The replacement bridges were based on the design of the previous structures and some timber piles were reused. The bridges are modern replacement structures and are not eligible for the National Register.

Table 1

Surveyed Bridges with Post-1956 Dates of Construction

Bridge Number	Date of Construction	Comment
NC 74C	1959	NBIS Date of 1953 based on plans. Not built until 1959 based on contract files.
NC 135	1996	New p/s box beam bridge replaced steel multi girder from 1949.
K 17A	1995	New p/s box beam bridge replaced slab bridge from 1952.
K 84A	1996	New p/s slab bridge replaced timber multi girder bridge from 1955.
K 389A	1996	New p/s box beam bridge replaced p/s box beam bridge from 1954.
S 661	1996	New pipe culvert replaced box culvert from 1952.

Table 2

Surveyed Bridges with Pre-1946 Dates of Construction

Bridge Number	Date of Construction	Comment
NC 53	1926	Slab bridge has two bridge numbers. NC-52 refers to the older 1926 portion of the bridge. NC-53 refers to slab extension from 1947. Both are evaluated not eligible.
NC 172	ca. 1929	Box culvert from ca. 1929 was widened in 1947.
K 6E	1919	Slab bridge has two bridge numbers. K-6B for the southbound US 13 and K-6E for the northbound. The southbound side was built in 1919 and widened in 1956 for the northbound dualization.
S 227	1914	Slab bridge was built in 1914 and widened in 1948.

COUNTY	BRIDGE#	FACILITY CARRIED	FEATURE INTERSECTED	YEAR BUILT	CRS#
NEW CASTLE	048	WILSON ROAD	SHELLPOT CREEK	1955	N-13575
NEW CASTLE	049	WILSON ROAD	SHELLPOT CREEK TRIBUTARY	1955	N-13576
NEW CASTLE	050	VEALE ROAD	STONEY CREEK	1955	NC-13577
NEW CASTLE	051A	HARVEY ROAD	CSX RAILROAD	1954	N-13578
NEW CASTLE	143	SR 141 (CENTER ROAD)	LITTLE MILL CREEK	1955	N-13579
NEW CASTLE	170	SR 41 (LANCASTER PIKE)	MILL CREEK	1954	N-13580
NEW CASTLE	193	NEWPORT ROAD	RED CLAY CREEK	1954	N-13520
NEW CASTLE	211A	SR 2 (KIRKWOOD HIGHWAY)	PIKE CREEK	1948	N-13582
NEW CASTLE	229B	SR 2 (KIRKWOOD HIGHWAY)	WHITE CLAY CREEK	1954-1955	N-13583
NEW CASTLE	231	CURTIS MILL ROAD (PAPER MILL ROAD)	WHITE CLAY CREEK	1948-49	N-13584
NEW CASTLE	234	SR 2 (KIRKWOOD HIGHWAY)	MILL CREEK	1949	N-13585
NEW CASTLE	307	SR 9 (RIVER ROAD)	PIPE LINES	1955	N-13586
NEW CASTLE	368	FRAZER ROAD (ROAD 391)	GUTHRIE RUN	1948	N-13587
NEW CASTLE	386	SR 9 (BIDDLES CREEK ROAD)	ST. GEORGES CREEK	1952	N-13588
NEW CASTLE	513	SR 9	AUGUSTINE CREEK	1952	N-13602
NEW CASTLE	562	BELLEVUE ROAD	DELAWARE RIVER TRIBUTARY	1956	N-13589
NEW CASTLE	567A	HAY ROAD	SHELLPOT CREEK	1951	N-13590
NEW CASTLE	587	SR 141 (TYLER MCCONNELL BRIDGE)	BRANDYWINE CREEK/ROAD 260	1951-52	N-13591
NEW CASTLE	607	NORTH STAR ROAD	PIKE CREEK	1955	N-13592
NEW CASTLE	611	SR 41 (LANCASTER PIKE)	MILL CREEK TRIBUTARY	1953	N-13593
NEW CASTLE	622	SR 72 (POSSUM PARK ROAD)	MUDDY RUN	1953	N-13594
NEW CASTLE	630	JEFFERSON AVENUE	CHESTNUT RUN	1953	N-13595
NEW CASTLE	631	SR 2 (KIRKWOOD HIGHWAY)	LITTLE MILL CREEK TRIBUTARY	1949	N-13596
NEW CASTLE	632	SR 2 (ELSMERE VIADUCT)	CSX RAILROAD/DELAWARE VALLEY	1948-1949	N-13597
NEW CASTLE	639	SR 2 (KIRKWOOD HIGHWAY)	MILL CREEK TRIBUTARY	1949	N-13598
NEW CASTLE	651	NEWPORT AVENUE	CSX RAILROAD	1951	N-13599
NEW CASTLE	680	SR 141 (BASIN ROAD)	US 13/US 40 (DUPONT HIGHWAY)	1954-1955	N-13600
NEW CASTLE	687	WALNUT STREET	CHRISTINA RIVER	1954-57	N-13601
KENT	003A	US 13	ISAACS BRANCH	1952	K-6833
KENT	005B	US 13 (NORTHBOUND)	BROWNS BRANCH	1956	K-6834
KENT	005D	US 13 (NORTHBOUND)	MURDERKILL RIVER	1954	K-5649
KENT	005E	US 13	HUDSON BRANCH	1954	K-6835
KENT	006A	US 13	WHITE MARSH BRANCH TRIBUTARY	1956	K-6847
KENT	006D	US 13 (NORTHBOUND)	BROWNS BRANCH TRIBUTARY	1956	K-6836
KENT	012B	SR 9 (DENNY STREET)	LEIPSIC RIVER	1952	K-6841
KENT	024A	US 13	ST. JONES RIVER	1951	K-6842
KENT	024B	US 13	PUNCHEON RUN	1951	K-6843
KENT	024C	US 13	TIDBURY CREEK	1952	K-6838
KENT	067A	COURT STREET	ST. JONES RIVER	1956-57	K-6844
KENT	084B	ROAD 84 (BIG WOODS ROAD)	SPRAUNCES NECK BRANCH	1955	K-6845
KENT	086A	ROAD 86 (TEXAS LANE/SAVANNAH ROA	MUDDY BRANCH	1955	K-6846
KENT	284C	ROAD 284 (LITTLE MASTENS CORNER RO	MURDERKILL RIVER TRIBUTARY	1949	K-6839
KENT	285A	ROAD 285 (HILLS MARKET ROAD)	BLACK SWAMP CREEK	1949	K-6840

COUNTY	BRIDGE#	FACILITY CARRIED	FEATURE INTERSECTED	YEAR BUILT	CRS#
SUSSEX	105	GOVERNORS AVENUE	CART BRANCH	1955	S-9087
SUSSEX	146A	US 13	BRIDGEVILLE BRANCH (GRAVELLY R	1951	S-9088
SUSSEX	147A	US 13	TURKEY BRANCH	1951	S-9089
SUSSEX	214	ROAD 536	TURTLE BRANCH	1956	S-9094
SUSSEX	226	ROAD 561	FREIDEL PRONG	1948	S-9090
SUSSEX	242	HIGH STREET	NANTICOKE RIVER TRIBUTARY	1955	S-9095
SUSSEX	253N	US 13 NORTHBOUND/SR 20 WESTBOUND	NORTH FORK OF NANTICOKE RIVER	1952	S-9096
SUSSEX	253S	US 13 SOUTHBOUND/SR 20 EASTBOUND	NORTH FORK OF NANTICOKE RIVER	1952	S-9096
SUSSEX	254N	US 13 NORTHBOUND/SR 20 WESTBOUND	NANTICOKE RIVER	1951	S-9097
SUSSEX	254S	US 13 SOUTHBOUND/SR 20 EASTBOUND	NANTICOKE RIVER	1951	S-9097
SUSSEX	255	US 13	CLEAR BROOK	1952	S-9092
SUSSEX	256	ROAD 535B (RIVERVIEW DRIVE)	WILLIAMS POND (NANTICOKE RIVER	1954	S-9098
SUSSEX	305	ROAD 492	HOLLY BRANCH	1949	S-9099
SUSSEX	306	ROAD 493	COLLINS & CULVER DITCH	1951	S-9100
SUSSEX	347	ROAD 449	TRAP POND SPILLWAY	1952CA	S-4007
SUSSEX	350	ROAD 72	RACOON BRANCH (RACOON POND	1947	S-9102
SUSSEX	365N	US 13 NORTHBOUND	RECORDS POND	1951	S-9101
SUSSEX	365S	US 13 SOUTHBOUND	RECORDS POND	1951	S-9101
SUSSEX	410	US 113 (DUPONT HIGHWAY)	VINES CREEK	1948	S-9103
SUSSEX	418	US 113 (DUPONT HIGHWAY)	PEPPER CREEK	1947	S-9104
SUSSEX	511	SR 24	COWHOUSE BRANCH	1950	S-9105
SUSSEX	911	SR 36	JOHNSON BRANCH	1947	S-4034
SUSSEX	164	SR 36	CEDAR CREEK	1949	S-9093

Table 4

Summary of Recommendations by Bridge Type
Bridges Built from 1946 to 1956

Bridge Type	Total No. Evaluated	No. Evaluated NR Eligible
Steel Multi Girder	18	0
Reinforced Concrete Slab	17	1
Pipe Culvert	1	0
Box Culvert	15	0
Rigid Frame	4	1
Steel Deck Girder	1	1
T Beam	3	1
Reinforced Concrete Arch	1	1
Wood Multi Girder	4	0
Bascule	1	1
Swing Span	1	0
Totals	**66**	**6**

Notes: The survey database began with 76 bridges. During the course of field work and research six (6) bridges were eliminated due to post-1956 dates of construction and four (4) bridges were determined to have pre-1946 dates of construction. Survey forms were completed for the bridges, but they are not reflected in the totals.

COUNTY	BRIDGE#	YEAR BUILT	NRR	MAIN STRUCTURE	MAIN SPAN MATERIAL	CRS#
NEW CASTLE	687	1954-57	Eligible	BASCULE	STEEL	N-13601
SUSSEX	255	1952	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	S-9092
NEW CASTLE	170	1954	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	N-13580
SUSSEX	147A	1951	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	S-9089
SUSSEX	214	1956	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	S-9094
KENT	024C	1952	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6838
KENT	024B	1951	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6843
KENT	005E	1954	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6835
KENT	006D	1956	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6836
KENT	005B	1956	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6834
KENT	003A	1952	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	K-6833
NEW CASTLE	386	1952	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	N-13588
NEW CASTLE	513	1952	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	N-13602
NEW CASTLE	611	1953	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	N-13593
NEW CASTLE	050	1955	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	NC-13577
NEW CASTLE	562	1956	Not Eligible	BOX CULVERT	REINFORCED CONCRETE	N-13589
KENT	067A	1956-57	Eligible	DECK ARCH	REINFORCED CONCRETE	K-6844
NEW CASTLE	587	1951-52	Eligible	DECK GIRDER	STEEL	N-13591
NEW CASTLE	680	1954-1955	Not Eligible	MULTI GIRDER	STEEL	N-13600
NEW CASTLE	229B	1954-1955	Not Eligible	MULTI GIRDER	STEEL	N-13583
NEW CASTLE	651	1951	Not Eligible	MULTI GIRDER	STEEL	N-13599
NEW CASTLE	632	1948-1949	Not Eligible	MULTI GIRDER	STEEL	N-13597
KENT	012B	1952	Not Eligible	MULTI GIRDER	STEEL	K-6841
KENT	086A	1955	Not Eligible	MULTI GIRDER	STEEL	K-6846
NEW CASTLE	234	1949	Not Eligible	MULTI GIRDER	STEEL	N-13585
SUSSEX	347	1952CA	Not Eligible	MULTI GIRDER	STEEL	S-4007
NEW CASTLE	051A	1954	Not Eligible	MULTI GIRDER	STEEL	N-13578
SUSSEX	365S	1951	Not Eligible	MULTI GIRDER	STEEL	S-9101
SUSSEX	242	1955	Not Eligible	MULTI GIRDER	STEEL	S-9095
SUSSEX	253N	1952	Not Eligible	MULTI GIRDER	STEEL	S-9096
SUSSEX	365N	1951	Not Eligible	MULTI GIRDER	STEEL	S-9101
SUSSEX	253S	1952	Not Eligible	MULTI GIRDER	STEEL	S-9096
SUSSEX	254N	1951	Not Eligible	MULTI GIRDER	STEEL	S-9097
SUSSEX	254S	1951	Not Eligible	MULTI GIRDER	STEEL	S-9097
SUSSEX	256	1954	Not Eligible	MULTI GIRDER	STEEL	S-9098
NEW CASTLE	211A	1948	Not Eligible	MULTI GIRDER	STEEL	N-13582
SUSSEX	350	1947	Not Eligible	MULTI GIRDER	WOOD	S-9102
KENT	084B	1955	Not Eligible	MULTI GIRDER	WOOD	K-6845
SUSSEX	305	1949	Not Eligible	MULTI GIRDER	WOOD	S-9099
SUSSEX	306	1951	Not Eligible	MULTI GIRDER	WOOD	S-9100
SUSSEX	410	1948	Not Eligible	PIPE CULVERT	CONCRETE	S-9103
NEW CASTLE	048	1955	Not Eligible	RIGID FRAME	REINFORCED CONCRETE	N-13575
NEW CASTLE	231	1948-49	Eligible	RIGID FRAME	REINFORCED CONCRETE	N-13584

COUNTY	BRIDGE#	YEAR BUILT	NRR	MAIN STRUCTURE	MAIN SPAN MATERIAL	CRS#
NEW CASTLE	622	1953	Not Eligible	RIGID FRAME	REINFORCED CONCRETE	N-13594
NEW CASTLE	193	1954	Not Eligible	RIGID FRAME	REINFORCED CONCRETE	N-13520
NEW CASTLE	307	1955	Not Eligible	SLAB	REINFORCED CONCRETE	N-13586
NEW CASTLE	368	1948	Not Eligible	SLAB	REINFORCED CONCRETE	N-13587
NEW CASTLE	143	1955	Not Eligible	SLAB	REINFORCED CONCRETE	N-13579
NEW CASTLE	049	1955	Not Eligible	SLAB	REINFORCED CONCRETE	N-13576
KENT	284C	1949	Not Eligible	SLAB	REINFORCED CONCRETE	K-6839
SUSSEX	911	1947	Not Eligible	SLAB	REINFORCED CONCRETE	S-4034
SUSSEX	511	1950	Not Eligible	SLAB	REINFORCED CONCRETE	S-9105
SUSSEX	418	1947	Not Eligible	SLAB	REINFORCED CONCRETE	S-9104
SUSSEX	226	1948	Not Eligible	SLAB	REINFORCED CONCRETE	S-9090
SUSSEX	146A	1951	Not Eligible	SLAB	REINFORCED CONCRETE	S-9088
KENT	285A	1949	Not Eligible	SLAB	REINFORCED CONCRETE	K-6840
KENT	006A	1956	Not Eligible	SLAB	REINFORCED CONCRETE	K-6847
NEW CASTLE	639	1949	Not Eligible	SLAB	REINFORCED CONCRETE	N-13598
NEW CASTLE	631	1949	Not Eligible	SLAB	REINFORCED CONCRETE	N-13596
NEW CASTLE	630	1953	Eligible	SLAB	REINFORCED CONCRETE	N-13595
NEW CASTLE	607	1955	Not Eligible	SLAB	REINFORCED CONCRETE	N-13592
SUSSEX	105	1955	Not Eligible	SLAB	REINFORCED CONCRETE	S-9087
SUSSEX	164	1949	Not Eligible	SWING SPAN	STEEL	S-9093
KENT	024A	1951	Eligible	T BEAM	REINFORCED CONCRETE	K-6842
NEW CASTLE	567A	1951	Not Eligible	T BEAM	REINFORCED CONCRETE	N-13590
KENT	005D	1954	Not Eligible	T BEAM	REINFORCED CONCRETE	K-5649

COUNTY	BRIDGE#	NRR	STATUS
KENT	003C	Eligible	
KENT	008F	Eligible	SCHEDULED FOR REPLACEMENT
KENT	009A	Not Eligible	REPLACED 1995
KENT	021A	Eligible	REHABBED 1996
KENT	023A	Eligible	
KENT	039C	Eligible	
KENT	042A	Eligible	
KENT	123A	Not Eligible	REPLACED 1997
KENT	137A	Not Eligible	REHABBED 1993/REVERSE ELIGIBILITY (INTEGRITY)
KENT	211A	Eligible	SCHEDULED FOR REPLACEMENT
KENT	501	Eligible	
KENT	505	Not Eligible	REPLACED 1995
NEW CASTLE	001	Eligible	
NEW CASTLE	002	Eligible	REHABBED 1993
NEW CASTLE	020	Not Eligible	REPLACED 1993
NEW CASTLE	066	Eligible	
NEW CASTLE	068	Eligible	
NEW CASTLE	069	Eligible	SCHEDULED FOR REPLACEMENT
NEW CASTLE	076	Eligible	
NEW CASTLE	088	Eligible	
NEW CASTLE	112	Eligible	REHABBED 1990
NEW CASTLE	118	Listed. 3/20/1973.	
NEW CASTLE	119	Eligible	
NEW CASTLE	120	Eligible	
NEW CASTLE	137	Listed. 4/11/1973.	
NEW CASTLE	153	Eligible	
NEW CASTLE	155	Eligible	
NEW CASTLE	159	Not Eligible	REVERSE ELIGIBILITY (INTEGRITY)
NEW CASTLE	160	Eligible	
NEW CASTLE	177	Eligible	REHABBED 1996
NEW CASTLE	179A	Eligible	REHABBED 1995
NEW CASTLE	182	Eligible	
NEW CASTLE	216	Eligible	REHABBED 1995
NEW CASTLE	246	Eligible	
NEW CASTLE	257	Eligible	REHABBED 1996
NEW CASTLE	300	Eligible	
NEW CASTLE	330	Not Eligible	REVERSE ELIGIBILITY (NOT A STONE ARCH)
NEW CASTLE	336	Listed. Cooch's Bridge H. D. Contributing.	
NEW CASTLE	337	Listed. Cooch's Bridge H. D. Contributing.	
NEW CASTLE	383	Eligible	
NEW CASTLE	393	Not Eligible	REPLACED 1995
NEW CASTLE	407	Eligible	
NEW CASTLE	424	Eligible	TRUSS RELOCATED 1997

COUNTY	BRIDGE#	NRR	STATUS
NEW CASTLE	430	Eligible	
NEW CASTLE	456	Not Eligible	REPLACED 1997
NEW CASTLE	476	Eligible	
NEW CASTLE	488N	Eligible	
NEW CASTLE	504	Eligible	
NEW CASTLE	543	Eligible	
NEW CASTLE	575	Eligible	
NEW CASTLE	576	Listed. 1976. Brandywine Park H.D. Contributing.	
NEW CASTLE	577	Eligible	REHABBED 1994
NEW CASTLE	617	Eligible	
NEW CASTLE	684	Eligible	REHABBED 1994
NEW CASTLE	686	Eligible	REHABBED 1994
NEW CASTLE	688	Eligible	
NEW CASTLE	698	Listed. 1976. Brandywine Park H.D. Contributing	SCHEDULED FOR REHAB
SUSSEX	151	Eligible	REHABBED 1992
SUSSEX	152	Listed. Laurel HD. 7/27/1988. Contributing.	REHABBED 1992
SUSSEX	161	Listed. Laurel HD. 7/27/1988. Contributing.	REHABBED 1994
SUSSEX	200H-1	Eligible	
SUSSEX	202	Eligible	
SUSSEX	237	Eligible	
SUSSEX	239	Eligible	
SUSSEX	257E	Eligible	
SUSSEX	258	Eligible	
SUSSEX	329	Eligible	
SUSSEX	404S	Not Eligible	REVERSE ELIGIBILITY (INTEGRITY)
SUSSEX	445	Eligible	SCHEDULED FOR REPLACEMENT
SUSSEX	494	Not Eligible	REVERSE ELIGIBILITY (LOCATED IN MD)
SUSSEX	504S	Not Eligible	REVERSE ELIGIBILITY (INTEGRITY)
SUSSEX	508S	Not Eligible	REVERSE ELIGIBILITY (INTEGRITY)
SUSSEX	673	Eligible	
SUSSEX	680	Not Eligible	REVERSE ELIGIBILITY (INTEGRITY)
SUSSEX	707	Eligible	REHABBED 1995
SUSSEX	708	Not Eligible	REPLACED 1993
SUSSEX	709	Eligible	
SUSSEX	713	Not Eligible	REPLACED 1993
SUSSEX	808	Not Eligible	REPLACED 1992
SUSSEX	809	Not Eligible	REPLACED 1993

COUNTY	BRIDGE#	MAIN SPAN MATERIAL	MAIN STRUCTURE T	NRR
SUSSEX	200H-1	REINFORCED CONCRETE	BOX CULVERT	Eligible
KENT	042A	REINFORCED CONCRETE	BOX CULVERT	Eligible
SUSSEX	709	REINFORCED CONCRETE	BOX CULVERT	Eligible
NEW CASTLE	430	REINFORCED CONCRETE	BOX CULVERT	Eligible
SUSSEX	329	REINFORCED CONCRETE	BOX CULVERT	Eligible
SUSSEX	237	REINFORCED CONCRETE	DECK ARCH	Eligible
KENT	003C	REINFORCED CONCRETE	DECK ARCH	Eligible
KENT	023A	REINFORCED CONCRETE	DECK ARCH	Eligible
NEW CASTLE	383	REINFORCED CONCRETE	DECK ARCH	Eligible
NEW CASTLE	337	REINFORCED CONCRETE	DECK ARCH	Listed. Cooch's Bridge H. D. Contributing.
NEW CASTLE	336	REINFORCED CONCRETE	DECK ARCH	Listed. Cooch's Bridge H. D. Contributing.
SUSSEX	202	REINFORCED CONCRETE	DECK ARCH	Eligible
NEW CASTLE	576	REINFORCED CONCRETE	DECK ARCH	Listed. 1976. Brandywine Park H.D. Contributing.
NEW CASTLE	160	REINFORCED CONCRETE	DECK ARCH	Eligible
NEW CASTLE	120	REINFORCED CONCRETE	DECK ARCH	Eligible
NEW CASTLE	069	REINFORCED CONCRETE	DECK GIRDER/T BEA	Eligible
NEW CASTLE	488N	REINFORCED CONCRETE	RIGID FRAME	Eligible
NEW CASTLE	300	REINFORCED CONCRETE	RIGID FRAME	Eligible
SUSSEX	508S	REINFORCED CONCRETE	SLAB	Not Eligible
NEW CASTLE	684	REINFORCED CONCRETE	SLAB	Eligible
NEW CASTLE	504	REINFORCED CONCRETE	SLAB	Eligible
NEW CASTLE	476	REINFORCED CONCRETE	SLAB	Eligible
SUSSEX	258	REINFORCED CONCRETE	SLAB	Eligible
NEW CASTLE	076	REINFORCED CONCRETE	SLAB	Eligible
SUSSEX	673	REINFORCED CONCRETE	SLAB	Eligible
SUSSEX	504S	REINFORCED CONCRETE	SLAB	Not Eligible
NEW CASTLE	686	REINFORCED CONCRETE	SLAB	Eligible
NEW CASTLE	153	REINFORCED CONCRETE	SLAB	Eligible
NEW CASTLE	246	REINFORCED CONCRETE	THRU ARCH	Eligible
NEW CASTLE	577	STEEL	BASCULE	Eligible
NEW CASTLE	159	STEEL	BASCULE	Not Eligible
NEW CASTLE	688	STEEL	BASCULE	Eligible
KENT	021A	STEEL	BASCULE	Eligible
SUSSEX	152	STEEL	BASCULE	Listed. Laurel HD. 7/27/1988. Contributing.
SUSSEX	151	STEEL	BASCULE	Eligible
NEW CASTLE	698	STEEL	DECK ARCH	Listed. 1976. Brandywine Park H.D. Contributing
KENT	211A	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	257	STEEL	MULTI GIRDER	Eligible
SUSSEX	239	STEEL	MULTI GIRDER	Eligible
SUSSEX	257E	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	575	STEEL	MULTI GIRDER	Eligible
KENT	501	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	182	STEEL	MULTI GIRDER	Eligible

* Table 7 is exclusive of bridges replaced since the 1988-1989 Survey. See Tables 8 and 9.

COUNTY	BRIDGE#	MAIN SPAN MATERIAL	MAIN STRUCTURE T	NRR
NEW CASTLE	088	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	543	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	068	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	407	STEEL	MULTI GIRDER	Eligible
NEW CASTLE	002	STEEL	MULTI GIRDER	Eligible
KENT	008F	STEEL	MULTI GIRDER	Eligible
SUSSEX	404S	STEEL	MULTI GIRDER	Not Eligible
NEW CASTLE	330	STEEL	PIPE CULVERT	Not Eligible
NEW CASTLE	112	STEEL	PONY TRUSS	Eligible
NEW CASTLE	216	STEEL	PONY TRUSS	Eligible
SUSSEX	161	STEEL	SWING SPAN	Listed. Laurel HD. 7/27/1988. Contributing.
NEW CASTLE	155	STEEL	THRU GIRDER	Eligible
NEW CASTLE	119	STEEL	THRU GIRDER	Eligible
NEW CASTLE	001	STEEL	THRU TRUSS	Eligible
KENT	039C	STONE	DECK ARCH	Eligible
NEW CASTLE	177	STONE	DECK ARCH	Eligible
NEW CASTLE	617	STONE	DECK ARCH	Eligible
SUSSEX	494	WOOD	MULTI GIRDER	Not Eligible
KENT	137A	WOOD	MULTI GIRDER	Not Eligible
SUSSEX	680	WOOD	MULTI GIRDER	Not Eligible
NEW CASTLE	137	WOOD	THRU TRUSS	Listed. 4/11/1973.
NEW CASTLE	118	WOOD	THRU TRUSS	Listed. 3/20/1973.
SUSSEX	707	WOOD/CONCRETE	SLAB	Eligible
SUSSEX	445	WOOD/CONCRETE	SLAB	Eligible
NEW CASTLE	179A	WROUGHT IRON	PONY TRUSS	Eligible
NEW CASTLE	066	WROUGHT IRON	PONY TRUSS	Eligible
NEW CASTLE	424	WROUGHT IRON	PONY TRUSS	Eligible

Table 8

Summary of Reinspection Evaluations for Previously Eligible Bridges from Prior Survey

Bridge Type	#Eligible in Previous Survey	# Replaced	#Rehabilitated	#Recommended for Reverse Eligibility	#Evaluated Eligible or NR-Listed by Current Survey
R.C. Deck Arch	11	0	0	0	11
R.C. Slab	12	1	2	2	8
Composite Wood and Concrete Slab	3	1	1	0	2
R.C. Box Culvert	5	0	0	0	5
R.C. Thru Arch	1	0	0	0	1
R.C. T beam	1	0	0	0	1
R.C. Rigid Frame	2	0	1	0	2
Wood Multi Girder	7	4	1	3	0
Wood Truss (Covered Bridges)	2	0	0	0	2
Steel Multi Girder	16	3	2	1	13
Metal Trusses	6	0	3	0	6
Metal Thru Girder	2	0	0	0	2
Stone Arch	4	0	1	1	3
Bascule	6	0	4	1	5
Swing Span	2	1	1	0	1
TOTALS	80	10	16	8	62