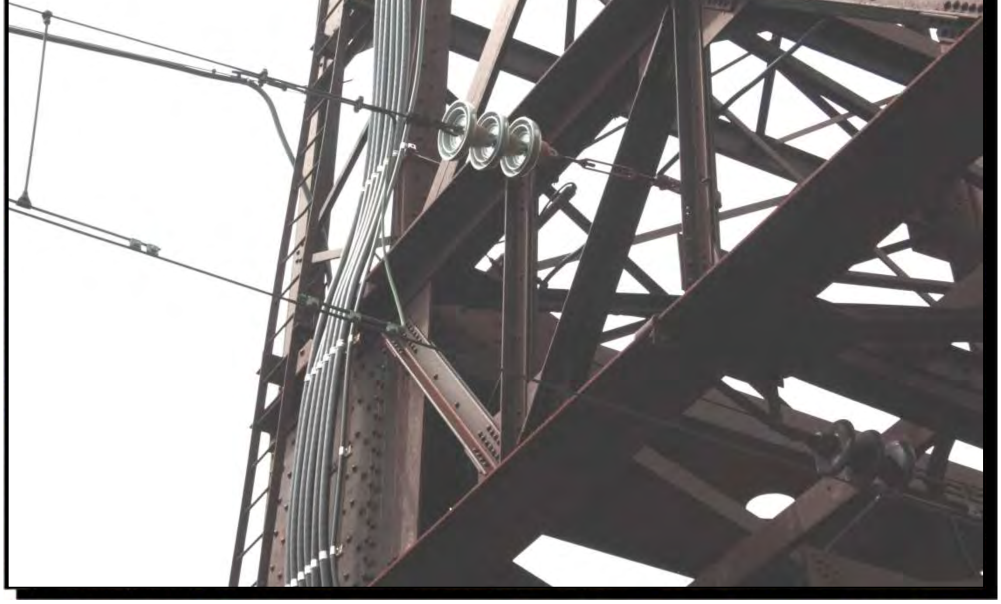
Written and Photographic Documentation:

New York, New Haven & Hartford Railroad Catenary Systems, 2017 Supplement

Walk Bridge Replacement Project
Norwalk, Connecticut
State Project No. 301-176

CP-243 Universal Interlocking Project
Norwalk and Westport, Connecticut
State Project No. 301-181



Prepared for the

Connecticut Department of Transportation

by

Bruce Clouette, Ph.D.
Marguerite Carnell, M. Phil.

Archaeological and Historical Services, Inc.
Storrs, Connecticut

December 2017

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NEW YORK, NEW HAVEN & HARTFORD RAILROAD
CATENARY SYSTEMS, 2017 SUPPLEMENT
Norwalk and Westport, Connecticut

Location:	Along the Metro-North Commuter Railroad New Haven Line between the South Norwalk Metro-North Railroad Station, Norwalk, and the Saugatuck River Railroad Bridge, Westport
U.S.G.S. Quadrangles:	Norwalk South and Sherwood Point
Latitude/Longitude:	41° 5' 46.94 " N / 73° 25' 16.79" W (West End) 41° 7' 9.28" N / 73° 22' 9.84" W (East End)
Design Engineers:	Benjamin G. Lamme (Westinghouse Electric and Manufacturing Company); E. H. McHenry, William S. Murray, and Calvert Townley (N.Y., N.H. & H. Railroad Company)
Builder - Contractor:	Westinghouse Electric and Manufacturing Company; N.Y., N.H. & H. Railroad Company
Date of Construction:	1914
Significance:	The electrification of the N.Y., N.H. & H. was the first use of electricity to power a mainline railroad. The engineering features and electrical characteristics of this pioneering effort were repeated in subsequent electrification projects in the United States and elsewhere. The first segment between Woodlawn and Stamford was completed in 1907; this portion, Stamford to New Haven, dates from 1914.
Project Information:	This recordation is intended as a supplement to the documentation prepared by Robert C. Stewart, Historical Technologies, in September 2000. This supplement fulfills stipulations in Memoranda of Agreement among the Federal Transit Administration, the Connecticut Department of Transportation, the Connecticut State Historic Preservation Office, and other parties regarding the Walk Bridge Replacement Project, State Project No. 301-176, and the CP-243 Universal Interlocking Project, State Project No. 301-181. This supplement was completed in September 2017.

Bruce Clouette, Ph.D., Historian
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I. INTRODUCTION

The Connecticut Department of Transportation (CTDOT) is undertaking a series of improvements to the Metro-North Commuter Railroad New Haven Line (NHL) in Norwalk and Westport, Connecticut, including the replacement of the Norwalk River Railroad Bridge (Walk Bridge) and the construction of a universal interlocking for the tracks between the Norwalk River in Norwalk and the Saugatuck River in Westport. The bridge replacement is State Project No. 301-176 and the interlocking, known as CP-243, is State Project 301-181. Both projects have the potential to affect historic components of the overhead catenary system that are considered contributing structures to this portion of the NHL as a National Register-eligible linear historic district. The Memoranda of Agreement (MOAs) for the two projects, executed by the Federal Transit Administration (FTA), the Connecticut Department of Transportation (CTDOT), the Connecticut State Historic Preservation Office (CTSHPO), and other parties, contain the following stipulation:

> When track access is granted to view individual catenary structures and prior to demolition, CTDOT shall determine whether the documentation entitled "New Haven Railroad Catenary System," prepared by Historical Technologies in 2000, encompasses the catenary structures to be demolished as part of the Undertaking. If the structures that were photographed and described in that documentation are essentially identical to those proposed for demolition, CTDOT shall notify CTSHPO of this determination and no further documentation will be necessary. If the structures to be demolished are unique and not adequately represented in the 2000 documentation, CTDOT will prepare additional written and photographic documentation of the structures to the professional standards of CTSHPO. CTDOT shall submit the documentation to FTA and CTSHPO for review and revise the documentation according to any comments. CTDOT shall submit the revised documentation to CTSHPO for permanent archiving and public accessibility.

The previous documentation referred to in the stipulation, which was prepared by Robert C. Stewart of Historical Technologies (Stewart 2000), covered the entire electrified line between Greenwich and Milford, Connecticut. It classified the catenary structures into several categories and documented them with written descriptions and 40 photographs. This supplement is intended to fulfill Stipulation 2 in the Walk Bridge Replacement Project MOA and Stipulation 1 in the CP-243 Project MOA by providing additional written and photographic documentation of structure types that were not included in the earlier document or were not fully represented in its photographic coverage. The locations of the included structures are shown on Figure 1 (Appendix A).

The methodology that was used to prepare the supplementary documentation is described in the next section, followed by detailed descriptions of the catenary structures that are included. The bound version of this report includes prints of 26 captioned photographs as

Appendix B, along with an index to photographs and a photographic key (on seven separate sheets).

This documentation was prepared by Bruce Clouette, Ph.D., Senior Historian, and Marguerite Carnell, M.Phil., Historian, both of Archaeological and Historical Services, Inc. of Storrs, Connecticut. Copies of this report, as well as archival copies of the text and the archival photographs, will be submitted by the CTSHPO to become part of the Connecticut Historic Preservation Collection housed at the Dodd Research Center at the University of Connecticut in Storrs.

II. METHODOLOGY

The products that make up this documentation include the following:

- Narrative text on acid-free, archival paper
- Digital color images on CD-ROM, .tif format, 300 dpi, minimum 1,200 by 1,600 pixels
- Index of photograph numbers and captions
- Graphic photographic keys
- Archival 5" by 7" color prints, labeled in soft pencil and placed in archival paper sleeves

In addition to the archival version deposited at the Dodd Center at the University of Connecticut, bound copies of the text and photographs have been compiled for CTDOT and CTSHPO, and one copy of the bound version will be included as part of the archived materials.

Standards for written and photographic documentation have been issued by the CTSHPO (Saunders and Moore 2007), and the narrative text and photographs that make up this documentation meet or exceed all the specifications in the standards. The photographs were taken in May and June 2017 using an 8-megapixel Canon Digital Rebel XS™ camera. Digital color images were saved on DVD-ROM as uncompressed .tif files, 300 dpi, 24-bit RGB color, at a resolution of 2000 by 3000 pixels or greater. The archival 5"-by-7" color prints produced for this documentation meet National Park Service standards for permanency; they were printed using Epson Claria™ high-definition archival inks and Epson Premium Glossy Photo Paper™. The prints were labeled using soft pencil and numbered sequentially. Photographs were placed in 5" by 7" acid-free paper archival sleeves, which also were labeled with the photograph number. In the bound copies, the photographs appear as Appendix B.

The standards do not specify any special requirements for supplements to earlier documentations. The descriptions, history of electrification, and bibliography in Stewart (2000) are comprehensive and so are not repeated here in any great detail. The intent is not to replace the earlier documentation, but rather to provide a comparable level of information for those structures within this particular geographic area that are different from the standard types covered earlier.

The catenary structures herein are presented in west-to-east order beginning with Anchor Bridge 524, a short distance east of the South Norwalk station, and ending with Bridge 578, at the west approach of the Saugatuck River Railroad Bridge in Westport. The graphic keys accompanying the photographs were prepared at a scale of 1" = 120'. This scale was chosen so that the resources could be related to some nearby intersection or other landmark, rather than being presented in isolation; at the same time, the scale is adequate to show the vantage points from which the photographs were taken.

In addition to the photographs, this documentation includes narrative text that gives a brief history of the railroad line and its electrification, and identifies the historical and engineering significance of the structures. To prepare the narrative text, background research was conducted using published railroad histories (e.g., Karr 1995, Turner and Jacobus 1989), as well as the reports filed with the Connecticut Railroad Commission. Archival sources include the 1915 New York, New Haven & Hartford Railroad valuation maps and various materials on the railroad's electrification at the Dodd Center, University of Connecticut, Storrs. In addition to the sources cited in the original documentation, two articles from the technical literature of the day (Electric Railway Journal 1914 and Bean 1927) proved to be especially informative. The additional sources of information for this supplement are identified in the References section of this document (Section VI).

III. DESCRIPTION OF THE CATENARY STRUCTURES

The standard catenary support structure on the Stamford-to-New Haven portion of the NHL consists of two latticed box girders supporting a box-section cross-member that extends over the tracks (see Figure 2). The uprights, which taper from top to bottom, rest on four-sided concrete bases. Typically, one upright is surmounted by an original tapered latticed extension that carries two arms for feeder and signal lines, with the other one modified for modern utility transmission lines. Curved braces formed from two angles connect the uprights and cross-beam. The span of the standard catenary bridges is 61', and the height of the uprights, from the base to the cross-beam, is 27'-6". The fixtures that attach the catenary to the bridges are in the process of being replaced; most are modern, but at the time of the photography (May 2017), some older ceramic stacked-bell insulators and attachment hardware remained in place and appear in this supplement's photographs (e.g. Photographs 14, 18, and 22). This type of catenary support structure, termed "tapered-post bridges," is extensively documented in the earlier recordation (Stewart 2000: 45-71). For this reason, no additional photographs of the standard type are included in this supplement, though some do appear in photographs of included structures (e.g. Photograph 6, foreground).

Another standard feature of the NHL electrification is the use of 3" I-section hanging beams to support the catenary (Stewart 2000: 45-58). Two hanging beams between each set of catenary bridges effectively divide the 300' span between the bridges into 150' sub spans. The presence of this feature in the portion of the NHL that is the subject of this supplement is documented in Photographs 9 and 14.

Originally, the catenary bridges also supported the lighted semaphore signals that characterized the NHL (see Figure 3); none of the signals remains in place.

Many of the features of the standard structures are repeated in the structures that are included in this supplement: riveted lattice construction, curved portal braces (Photographs 17, 18, 24, and 25), and four-sided concrete bases (Photographs 12, 13, and 26). What distinguishes the included structures is that the standard methods were adapted for situations having additional needs or circumstances.

Bridge 524

Bridge 524 (Photographs 1-4) is an anchor bridge, a catenary bridge of heavier construction that provides more stability than the standard tapered-post bridge; it is also a sectionalizing bridge, the function of which is to allow the power to be cut-off to a certain portion of the railroad line. The uprights for Bridge 524 consist of two lattice-channel legs that splay out to a width of 8' at the base, where they rest on concrete footings. The legs are braced by horizontal struts at the midpoint and by diagonal cross-bracing. Tapered lattice girders extending the legs carry horizontal arms for signal and feeder lines. Across the tracks is a deep box-section cross-beam that supports not only the catenary but also the electrical apparatus that effected the sectionalization. The fragmentary records of the railroad's electrification at the Dodd Center (University of

Connecticut, Storrs) suggest that the apparatus currently in place dates from the 1940s (See Figures 4 and 10). Photographs of the bridge taken in 1931 show slightly different apparatus atop the cross-beam (Figure 6 and 7). The substation formerly associated with the bridge on the north side of the right-of-way was in the process of being dismantled at the time of the recordation (May 2017). Bridge 524 was one of 15 sectionalizing bridges between Woodmont, New York, and New Haven; it controlled the track power between Darien and Greens Farms in Westport, a distance of 9.5 miles (see Figure 4).

The earlier documentation only included photographs of two sectionalizing bridges from the 1907 electrification (Stewart 2000: 26 and 28). These straight-legged bridges differ in details from Bridge 524 and overall they are less heavily constructed. The Historic American Engineering Record (HAER) includes documentation of three of the earlier type of sectionalizing bridge as HAER No. CT-142C, "New York, New Haven & Hartford Railroad, Bridge-Type Circuit Breakers." Two other HAER entries include photographs of Bridge 524 taken in 1977 and 1980, "Northeast Railroad Corridor, Amtrak Route between New York/Connecticut & Connecticut/Rhode Island State Lines" (HAER No. CT-11) and "New York, New Haven & Hartford Railroad, Automatic Signalization System" (HAER No. CT-8); see Figures 11-14.

Bridge 526

Bridge 526 is located just east of the Washington-Main intersection in South Norwalk, where the Danbury branch leaves the main line (Photograph 5). It shares the tapered uprights, crossbeam, curved portal braces, and concrete bases found in the standard design, but it has a greater width (73') to accommodate the extra track. The tapered lattice extensions for the signal and feeder lines are inboard from the uprights. This bridge was not included in the earlier documentation.

River-Crossing High Towers

In order to maintain electrical and signal continuity when the movable bridges were opened, both the Norwalk River (Walk Bridge) and Saugatuck River (Saga Bridge) crossings required the signal and feeder lines to be carried over the water at a level that would not obstruct navigation. The solution employed in 1914 was to carry the lines using high towers on either side of the river. This supplement documents the Norwalk River towers in Photographs 6 and 7 and the Saugatuck River towers in Photographs 19 through 23. The towers are 198.5' high (measured from the top of the rail and excluding the modern utility-line fixtures that have been added to the original finials). The legs of each tower consist of heavy angles forming a pair of channels that are connected by horizontal struts and angle cross-bracing. The legs are spaced 12' apart at the base, with the distance decreasing as the legs rise. The two sets of legs are connected across the tracks by three box-section cross-members, one 27' above the tracks (where it serves as a support for the catenary), one at the top of the tower, just below the tapered lattice finials, and one midway between. In between the cross-members is paired-angle diagonal bracing. The legs of the towers rest on pyramidal concrete bases (Photograph 7 and 21). The two Norwalk River towers are numbered as Catenary Bridges 529 and 530 and the Saugatuck River towers are Bridges 577 and 580.

The earlier documentation included a general description of the high towers and a photograph of the Norwalk River east high tower (Stewart 2000: 46, 60).

Overhead Bridge Towers

Bridge Street and Triangle Street in East Norwalk are both carried across the railroad right-of-way on overhead bridges. While the catenary itself passes under the bridges, the signal and feeder lines are carried over the intersecting highway by four lattice towers, two on each side of the bridge (Photographs 8-12). The lattice towers taper from bottom to top. While fundamentally similar, the towers at Bridge Street and Triangle Street are not identical. The Bridge Street towers have two cross-arms for the signal and feeder lines and rest on concrete footing that are built into the stone abutments for the bridge. The Triangle Street towers have three cross-arms and rest on free-standing four-sided concrete bases. The Triangle Street towers are also rectangular in cross-section rather than square. No structures of this type were included in the earlier documentation.

Bridge 575

Bridge 575 (Photographs 15 and 16) is an anchor bridge located at the west end of the Westport station. The uprights consist of two lattice girders spaced 8' apart, connected at three points by heavy angle cross-bracing. The cross-beam is necessarily wider than the standard, and it is deeper as well. The upright lattice girders are continued upward above the cross-beam to support two arms on each face for signal and feeder lines; modern utility-line structures are affixed to each extension. No bridges of this type were included in the earlier documentation.

Bridge 576

Bridge 576 (Photographs 17 and 18) is located at the Westport station, just west of the high tower for the Saugatuck River crossing. It follows the standard design, except that the tapered uprights and extensions are wider (48" instead of 27"), and the cross-beam is a little deeper. Both faces of the extensions have two arms for the signal and feeder lines. The reason for the slightly heavier construction of this bridge is that this is the point at which the signal and feeder lines begin their ascent to the high towers (on the left in Photograph 18). This is one of the few bridges to have both of its original extensions intact, unaltered by the installation of fixtures for modern utility lines. No bridges of this type were included in the earlier documentation.

Bridge 578

Bridge 578 (Photographs 24-26) is a standard tapered-post bridge, with the exception that the uprights have no extensions for signal and feeder lines. Instead, the uprights terminate in small tapered lattice finials. The reason no extensions were needed is because the bridge lies just west of the Saugatuck River Railroad Bridge in Westport, and the signal and feeder lines at that point are carried over the river by the two high towers. Similar bridges lacking extensions are at the approaches to the Norwalk River Railroad

Bridge. The earlier documentation included bridges of this type as part of the catenary on the Norwalk River Railroad Bridge itself (Stewart 2000: 58-59).

IV. HISTORICAL BACKGROUND OF THE CATENARY STRUCTURES

At the end of the 19th century, the New York, New Haven & Hartford Railroad had consolidated most of the other railroads in southern New England into a single system, effectively creating a near-monopoly on the region's rail transportation. One consequence of consolidation was the funneling of ever more freight and passenger traffic onto the main line between New Haven and New York City. In the 1890s, the railroad undertook a massive rebuilding of the line that increased the number of tracks from two to four and elevated the tracks above the level of city streets, thereby eliminating most grade crossings. The railroad's president at that time, Charles P. Clark, realized that electrifying the line might increase its capacity even more because it would allow trains to accelerate faster; moreover, there would be no need to change to electric traction in order to run in the New York City tunnels. However, the railroad's early experiments with electricity (which included both third-rail and overhead wire) had not yet yielded a reliable technology to electrify the main line.

Beginning in 1904, the railroad partnered with the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pennsylvania, in order to develop the innovative infrastructure and rolling stock that would allow heavy, fast trains to run on electricity. Initially, the railroad considered the 600-volt and 1200-volt direct-current systems then in use for streetcar and interurban systems and for moving trains in tunnels. Direct current systems were workable for a limited geographical area, but transmission losses made it impractical over long distances. In contrast, high-voltage alternating current could be transmitted with minimal loss. In order to realize the theoretical advantages of alternating current, a number of practical challenges had to be met, including:

- Installation of large steam-turbine generators in a central power plant
- Design and installation of a robust, effective overhead wire system
- Development of appropriate circuit-breaker protection
- Development of single-phase AC traction motors and the locomotives powered by them
- Provision to switch over to direct-current operation in the New York City zone, which ended at Woodmont, New York

The principal engineers for the railroad were E. H. McHenry, Calvert Townley, and William S. Murray, while Benjamin G. Lamme took the lead on the Westinghouse side. By June of 1907, when revenue service began, the railroad had completed the overhead between Woodmont and Stamford, Connecticut, a distance of 21.4 miles; installed Westinghouse steam turbines and 11,000-volt 25-cycle generators in the Cos Cob power plant in Greenwich, Connecticut; obtained 41 gearless alternating-current locomotives (all built by Westinghouse); and installed a comprehensive signal system covering that part of the line. New facilities specifically for electrically powered equipment were established in Stamford, Connecticut, and Van Nest, New York.

The electrified line immediately met the railroad's expectations, and work began to extend electrification to other parts of the system using the same approach. In 1912, the line between New York City and White Plains was electrified, as was the New Rochelle-to-Harlem-River freight line. Additional generators were installed at Cos Cob, more than tripling its capacity. In 1914, the electrification was completed from Stamford to the Cedar Hill freight yards in New Haven, a distance of 42 miles. Additional electric locomotives were brought into service, as were multiple-unit self-propelled passenger cars for local and commuter service. In addition to Cedar Hill, the 1914 phase also electrified freight yards in Bridgeport and Norwalk. Over the next few years, additional lines were electrified with the same type of catenary, including branch lines to New Canaan and Danbury in Connecticut, and connections to the Hell Gate Bridge and Fresh Pond Junction in New York. By the 1920s, the New York, New Haven & Hartford had become the busiest electrified railroad in the world (Bean 1927: 980).

V. SIGNIFICANCE OF THE CATENARY STRUCTURES

Collectively and individually, all of the catenary structures in this supplement are significant for their associations with the New York, New Haven & Hartford Railroad's pioneering main-line electrification. The use of high-voltage alternating current allowed great economies in generation and transmission, compared with the 600v DC then in use for streetcar systems and interurban lines, and unlike DC, alternating current allowed for expansion of the system over a wide geographic area. The lessons learned in the New York, New Haven & Hartford's first phase, from New York to Stamford (1907), and in the completion phase from Stamford to New Haven (1914), informed subsequent electrification efforts both in the United State and abroad, most notably the electrification of the Pennsylvania Railroad's New York-to Washington route (1928-1935), which used the same single-phase11,000-volt 25Hz power drawn from overhead catenary. The electrification of the New York, New Haven & Hartford Railroad was named a National Historic Engineering Landmark by the American Society of Mechanical Engineers in 1982.

All of the structures in this supplement are from the second phase of electrification, but they should be regarded as no less significant because the 1914 work improved upon what had been done earlier. The tapered uprights, for example, were adopted because they had a lower material cost (as well as being more attractive). More fundamental was the use of autotransformers for the 1914 electrification, which almost entirely eliminated the electrical interference with nearby telephone and telegraph lines that had occurred with the original power-feed method (Electric Railway Journal 1914). Autotransformers also allowed a more efficient system because the transmission voltage was doubled. Following the success of the 1914 project, the earlier electrified portions of the line were refitted with autotransformers.

For the New York, New Haven & Hartford, the completion of mainline electrification provided capacity for shipping freight to and from one of the nation's most densely industrialized regions (thereby facilitating production during both world wars) and for accommodating an exceptionally heavy passenger load, both intercity (Boston to New York) and commuting within the greater New York region. In the 1920s, the railroad's daily averages in each direction amounted to 700 freight cars and 23,000 passengers. The latter figure more than doubled on special occasions, such as the annual Yale-Harvard football game (Westinghouse Electric 1924: 38-41). Over time, electrification was extended with the New Canaan and Danbury lines, thereby serving even more suburban communities in Fairfield County, and additional sources of power were added to supplement that produced by the railroad's Cos Cob plant. One measure of the success of the system as completed in 1914 is that it continued in operation, with only minor modifications, for 70 years. Even after the conversion to 60-cycle commercial power (1985), much of the infrastructure, including the iconic lattice-girder catenary supports, remained in place.

The specific catenary structures included in this supplementary documentation are notable not for any radical departure from standard practice but rather for illuminating the variations in standard practice that were adopted for particular circumstances. For example, anchor bridges such as Bridge 524 and Bridge 575 used standard riveted-lattice construction but had much larger proportions suitable to their function of providing periodic points of greater stability. In the case of Bridge 524, the structure had to be even more massively proportioned to carry the heavy load of circuit breakers and other electrical apparatus. Bridge 576 would be considered a standard tapered-pole bridge were it not for the greater width of its uprights, a design modification made necessary because, instead of proceeding horizontally to the next bridge, the signal and feeder lines had to ascend to the high tower at the river crossing. Another subtle variation is the positioning of the extensions for the signal and feeder lines inboard on the cross-member rather than atop the uprights. The earlier documentation noted this practice in the case of the closely-spaced catenary bridges on Jenkins Curve in Bridgeport (Stewart 2000: 74-78). Bridge 526 documents the use of this variant for an exceptionally wide catenary bridge, just as Bridge 578 documents the variant of the standard design used when no provision had to be made for signal and feeder lines.

The river-crossing high towers and the overhead-bridge towers perform the same function at two different scales: carrying the signal and feeder lines in a way that does not restrict intersecting modes of transportation. Perhaps because most highway grade-separations on this line have the roadway passing under the tracks, the use of towers to carry the signal and feeder lines at overhead bridges has not been noted in earlier recordations. Like the catenary bridges, the river-crossing towers and overhead-bridge towers share in the overall construction vocabulary of riveted lattice structures resting on concrete bases.

VI. REFERENCES

Bean, W. L.
1927 "Twenty Years Electrical Operation on the New York, New Haven and Hartford Railroad," *Proceedings of the Session of the American Railway Association, Division V—Mechanical, June 7-10, 1927*. New York, NY: American Railway Association. Pp. 948-1019.

Electric Railway Journal
1914 "Reduction of Inductive Interference from the Power Lines of the New Haven Railroad, *Electric Railway Journal* 43, No. 18 (May 2, 1914): 960-966.

Lynch, Peter E.
2008 "Some New Haven Signals," *Shoreliner* 31: 15-23.

Saunders, Cece, and Robert Moore
2007 *Documentation Standards for Connecticut's Cultural Resources*. Hartford, CT: Connecticut State Historic Preservation Office.

Stewart, Robert C.
2000 *The New Haven Railroad Catenary System*. State-Level Documentation, copy in the Connecticut Historic Preservation Collection, Dodd Research Center, University of Connecticut, Storrs.

Westinghouse Electric & Manufacturing Company
1924 *New York, New Haven & Hartford Railroad Electrification*. Special Publication 1698, June 1924. East Pittsburgh, PA.

APPENDIX A:

FIGURES

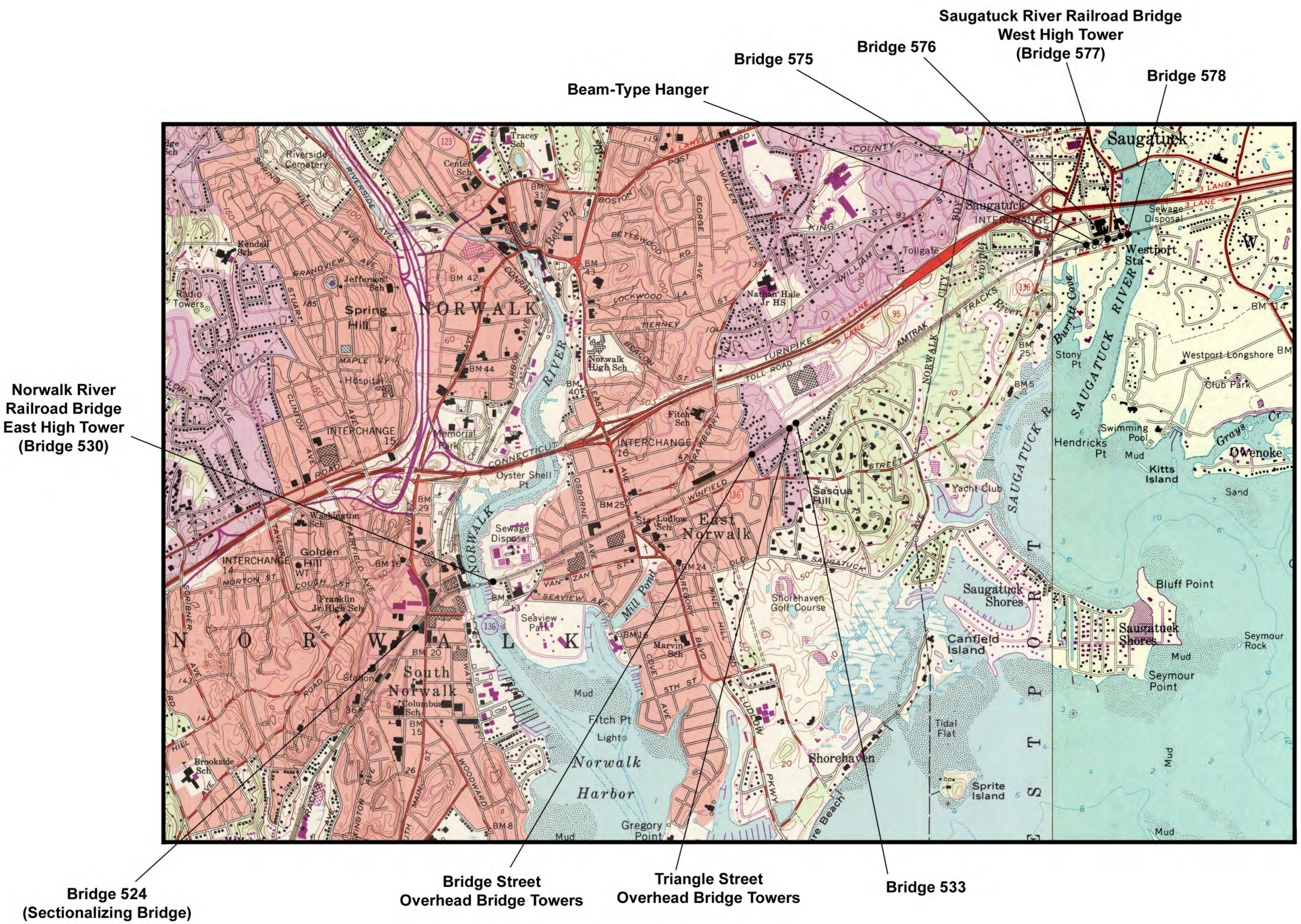

Figure 1:

Location of Structures

USGS Norwalk South and Sherwood Point Quadrangles

Scale 1:24000

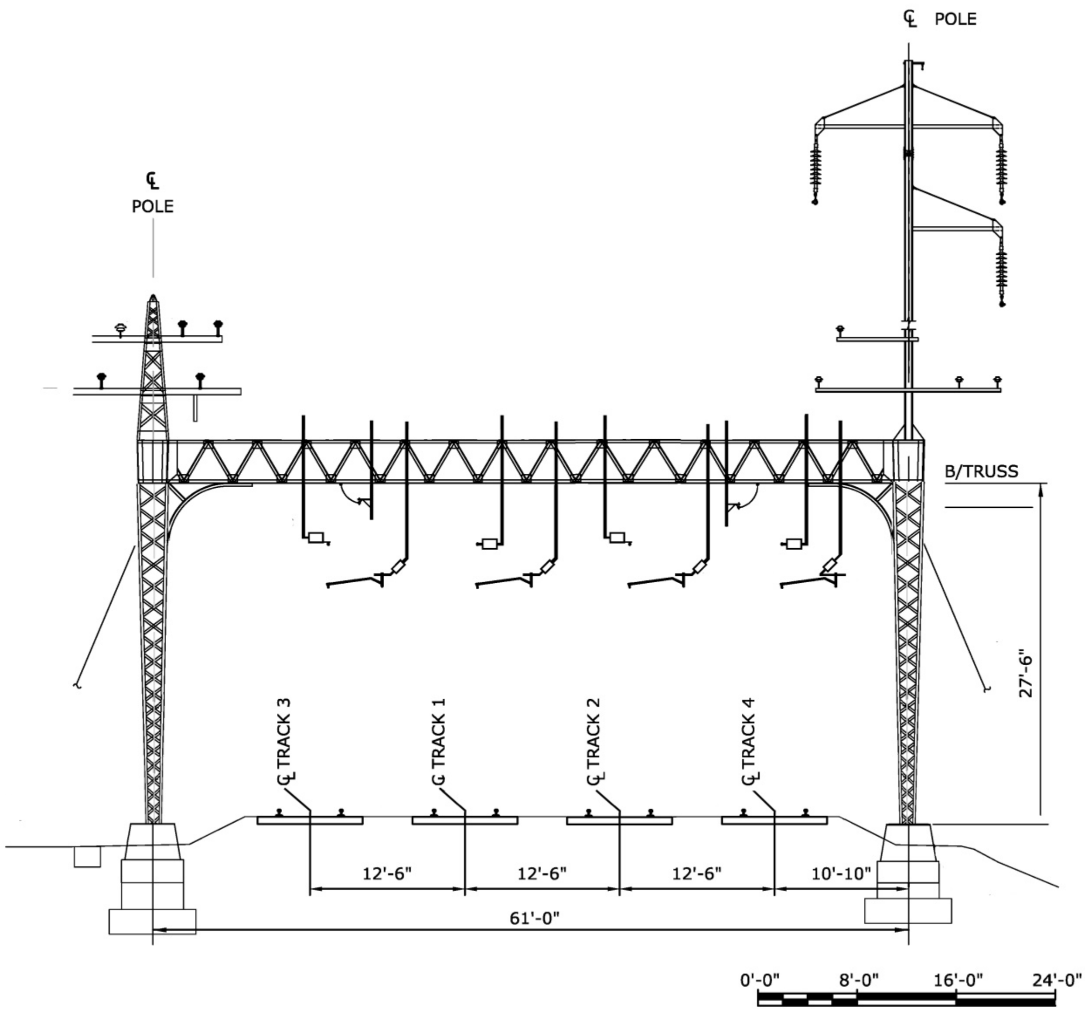

Figure 2: Dimensioned schematic of typical catenary bridge in the Norwalk-Westport area. Details of extension for feeder and signal lines (left) and added utility extension (right) vary; exposure of concrete bases for uprights varies.

Figure 3: Lighted semaphore signals at the approach to the Saugatuck River Railroad Bridge. Undated photograph by T. J. Donahue (Lynch 2008). Many of the catenary structures along this portion of the line would have been fitted with similar signals.

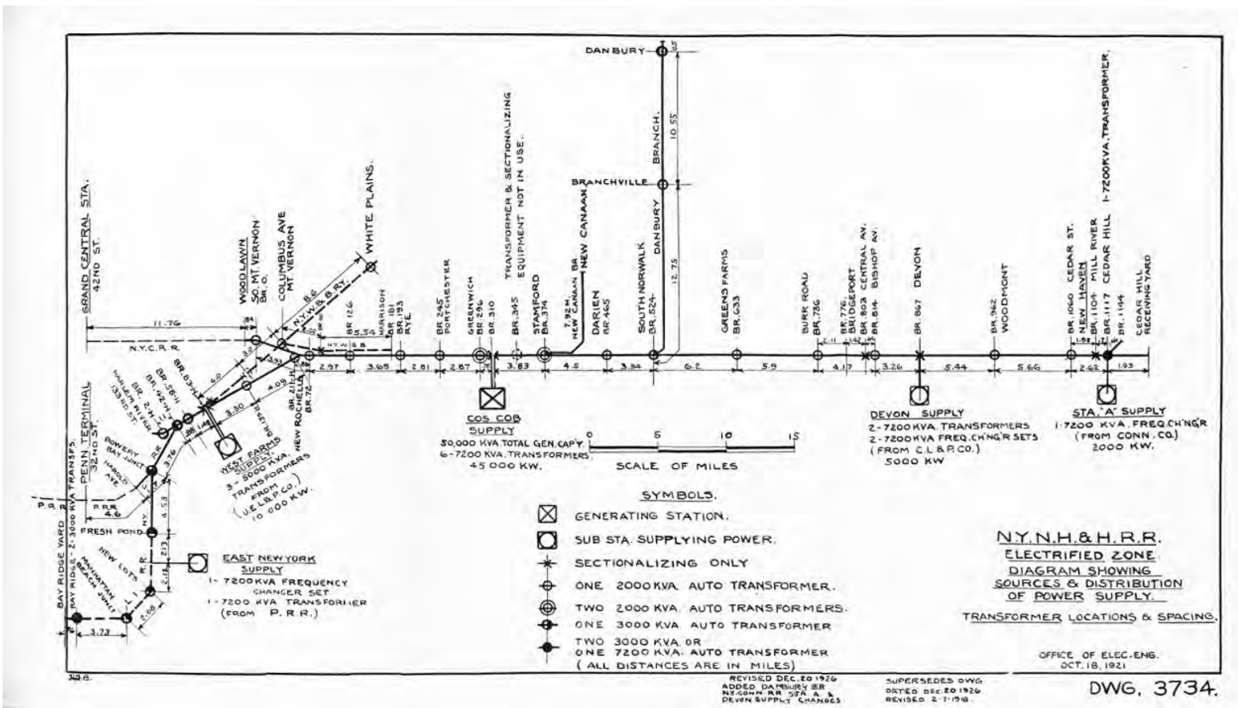

Figure 4: Sectionalizing of New Haven Railroad main line, from Bean (1927).

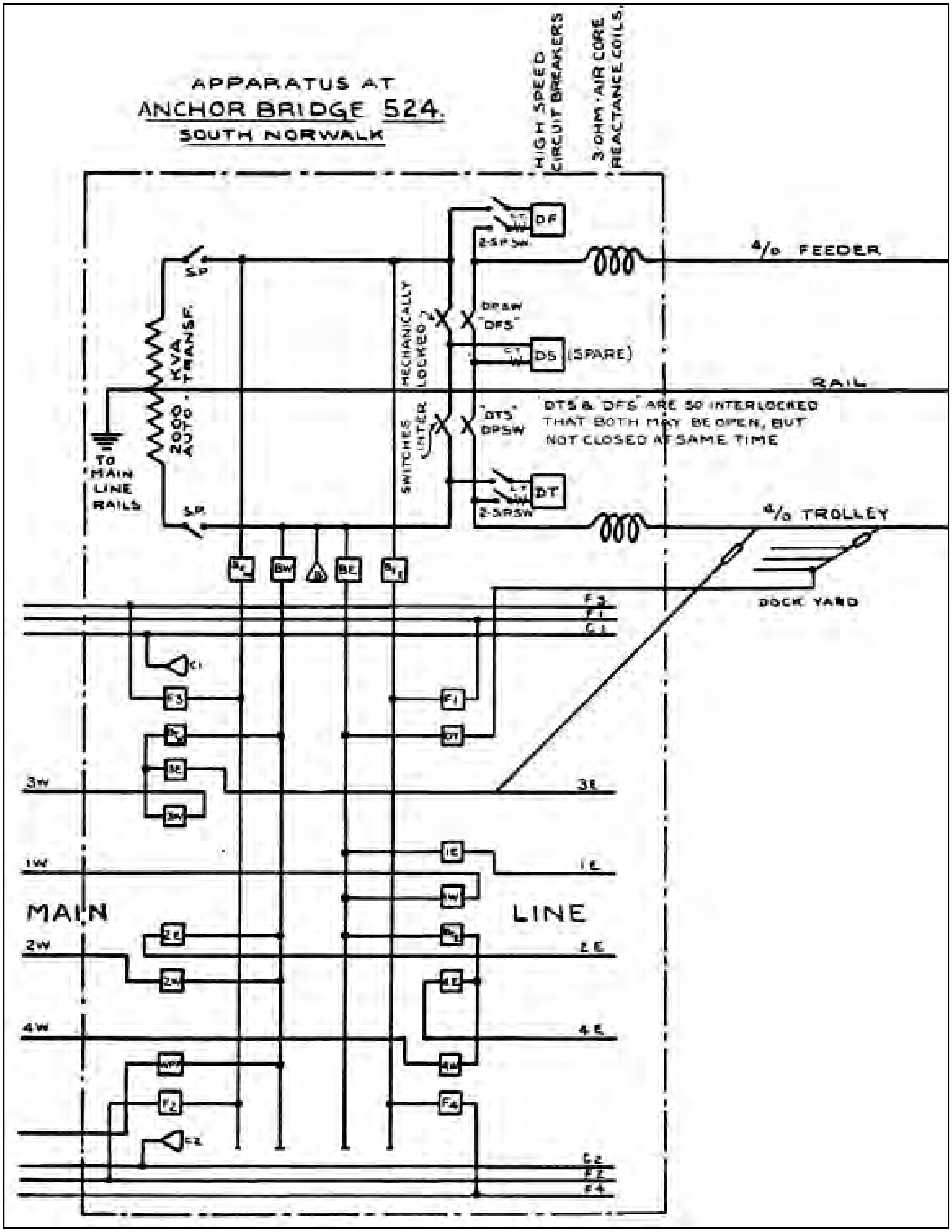

Figure 5: Diagram of electrical equipment, Anchor Bridge 524 (sectionalizing bridge), from Bean (1927).

Figure 6: Anchor Bridge 524 (sectionalizing bridge) looking east, Harry F. Brown photograph, 1931.

Figure 7: Anchor Bridge 524 (sectionalizing bridge) looking west, Harry F. Brown photograph, 1931.

Figure 8: Norwalk River Railroad Bridge west high tower (Bridge 529) looking east, Harry F. Brown photograph, 1931.

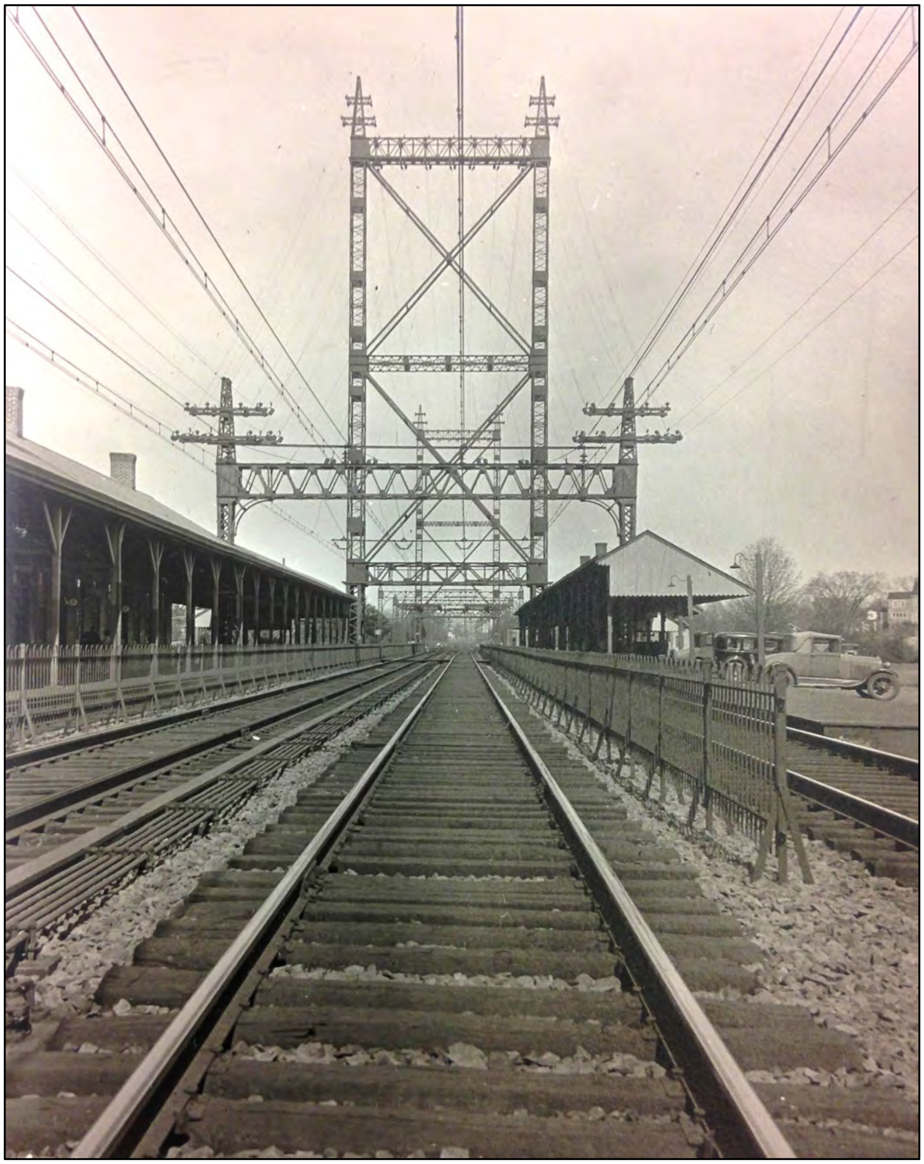

Figure 9: Saugatuck River Railroad Bridge west high tower (Bridge 577) looking east, Harry F. Brown photograph, 1931.

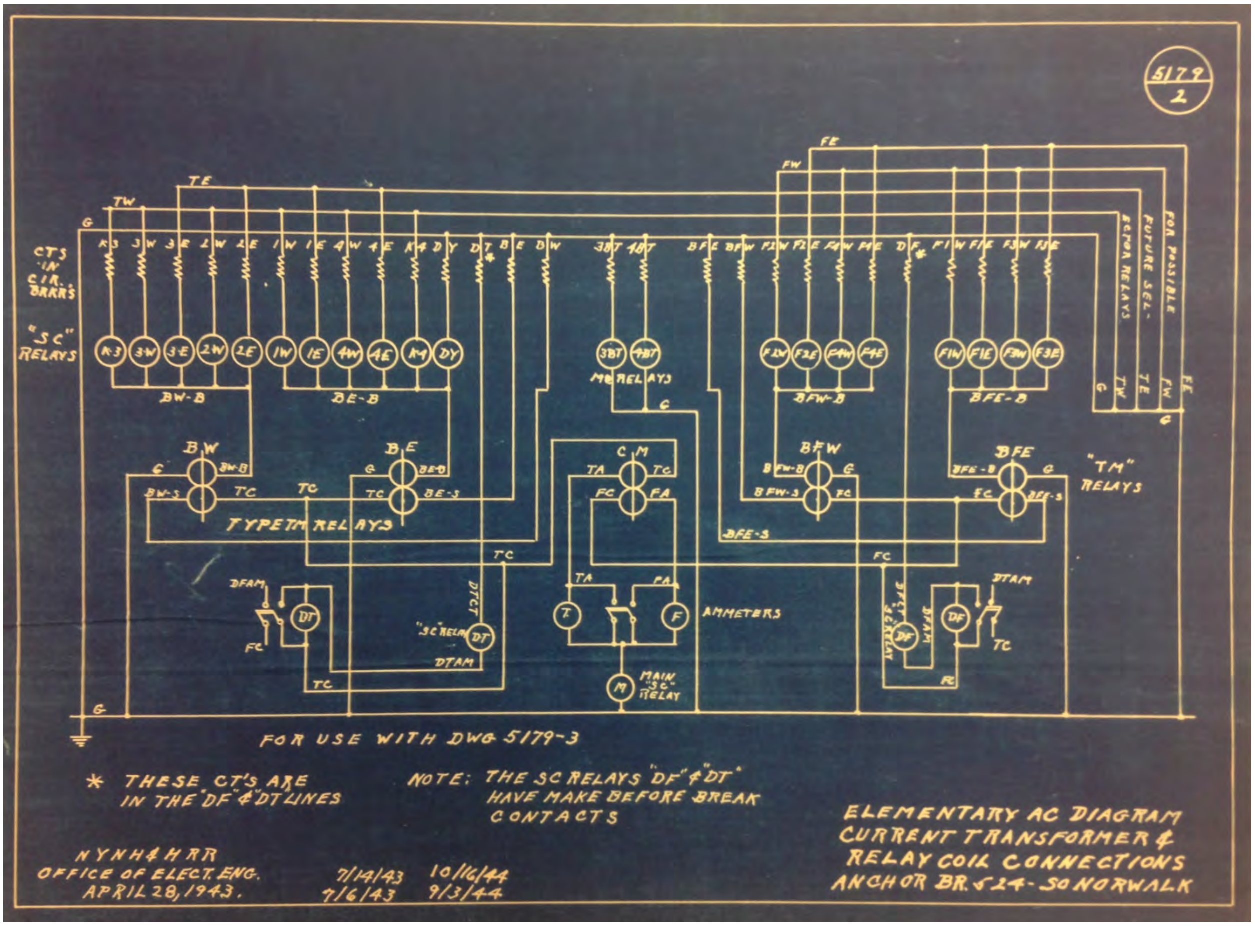

Figure 10: Diagram of electrical equipment, Anchor Bridge 524 (sectionalizing bridge), as re-configured in 1940. New Haven Electrification Collection, Dodd Research Center.

Figure 11: Anchor Bridge 524 (sectionalizing bridge) looking northwest, 1977, Historic American Engineering Record photograph by Jack E. Boucher, "Northeast Railroad Corridor, Amtrak Route between New York/Connecticut & Connecticut/Rhode Island State Lines" (HAER No. CT-11).

Figure 12: Anchor Bridge 524 (sectionalizing bridge) looking east, 1980, Historic American Engineering Record photograph by Thomas Brown, "New York, New Haven & Hartford Railroad, Automatic Signalization System (HAER No. CT-8).

Figure 13: Anchor Bridge 524 (sectionalizing bridge) looking west, 1980, Historic American Engineering Record photograph by Thomas Brown, "New York, New Haven & Hartford Railroad, Automatic Signalization System (HAER No. CT-8).

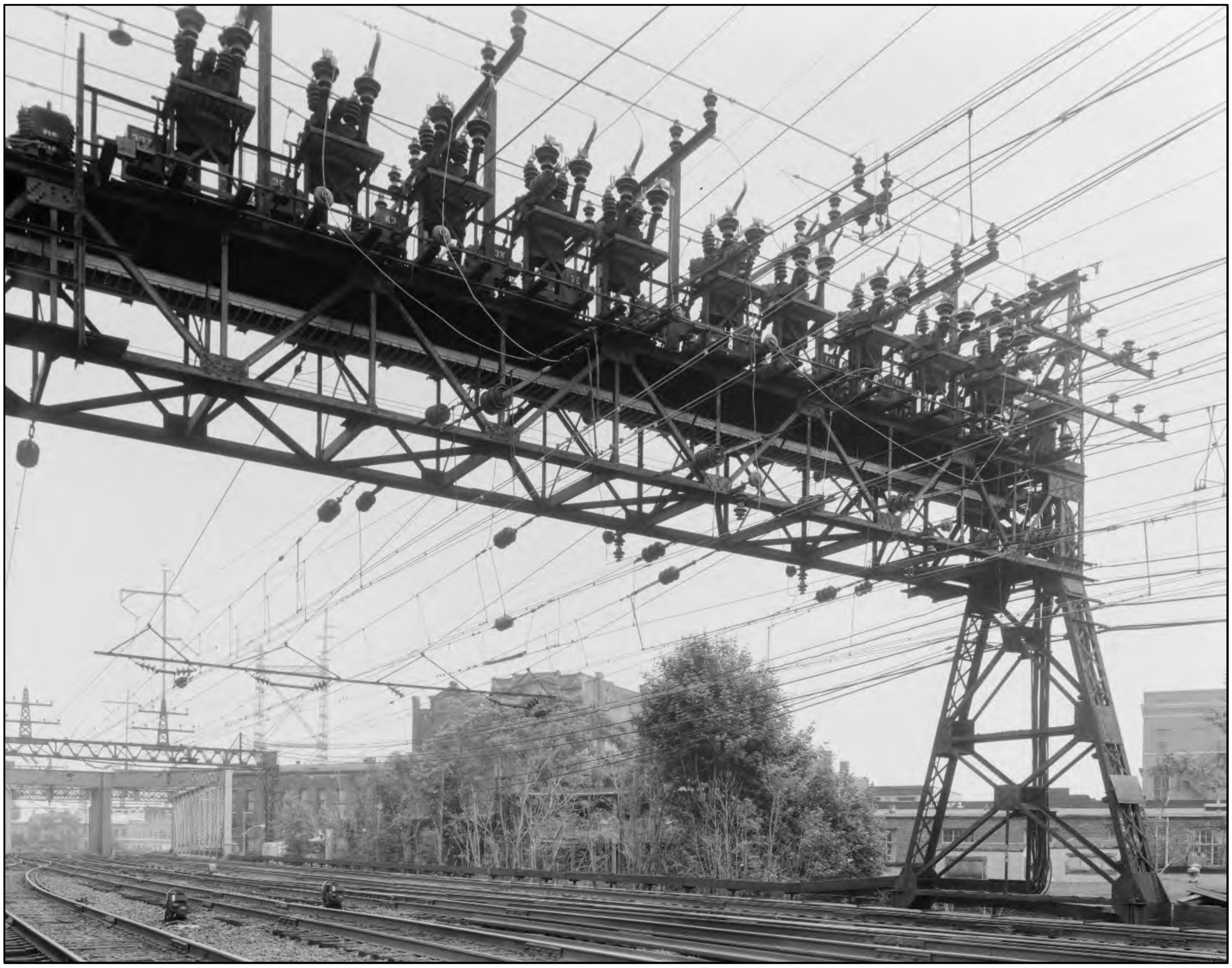

Figure 14: Anchor Bridge 524 (sectionalizing bridge) looking southeast, 1980, Historic American Engineering Record photograph by Thomas Brown, "New York, New Haven & Hartford Railroad, Automatic Signalization System (HAER No. CT-8).

APPENDIX B:

INDEX TO PHOTOGRAPHS AND GRAPHIC KEYS

New York, New Haven & Hartford Railroad
Catenary Systems, 2017 Supplement

Index to Photographs

All photographs: AHS, Inc., May 2017 (unless otherwise noted)

Captions:

Photograph 1. Anchor bridge (sectionalizing bridge), Bridge 524, overview, camera facing northeast.

Photograph 2. Anchor bridge (sectionalizing bridge), Bridge 524, overview, camera facing southwest.

Photograph 3. Anchor bridge (sectionalizing bridge), Bridge 524, detail of south support, camera facing south.

Photograph 4. Anchor bridge (sectionalizing bridge), Bridge 524, detail of electrical equipment mounted above tracks, camera facing southwest.

Photograph 5. Bridge 526, at the junction of the main line and Danbury line, camera facing southwest (June 2017).

Photograph 6. East high tower (Bridge 530), Norwalk River Railroad Bridge (Walk Bridge), camera facing west.

Photograph 7. East high tower (Bridge 530), Norwalk River Railroad Bridge (Walk Bridge), detail of north support and footing, camera facing northwest.

Photograph 8. Bridge Street (Norwalk) overhead bridge towers, north side, camera facing west.

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Vicinity of South Main and Washington streets, Norwalk, as shown on Google Earth™, 2016.

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Vicinity of South Main and Washington streets, Norwalk, as shown on Google Earth™, 2016.

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Vicinity of Norwalk River Railroad Bridge (Walk Bridge), as shown on Google Earth™, 2016.

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Vicinity of Bridge Street, Norwalk, as shown on Google Earth™, 2016.

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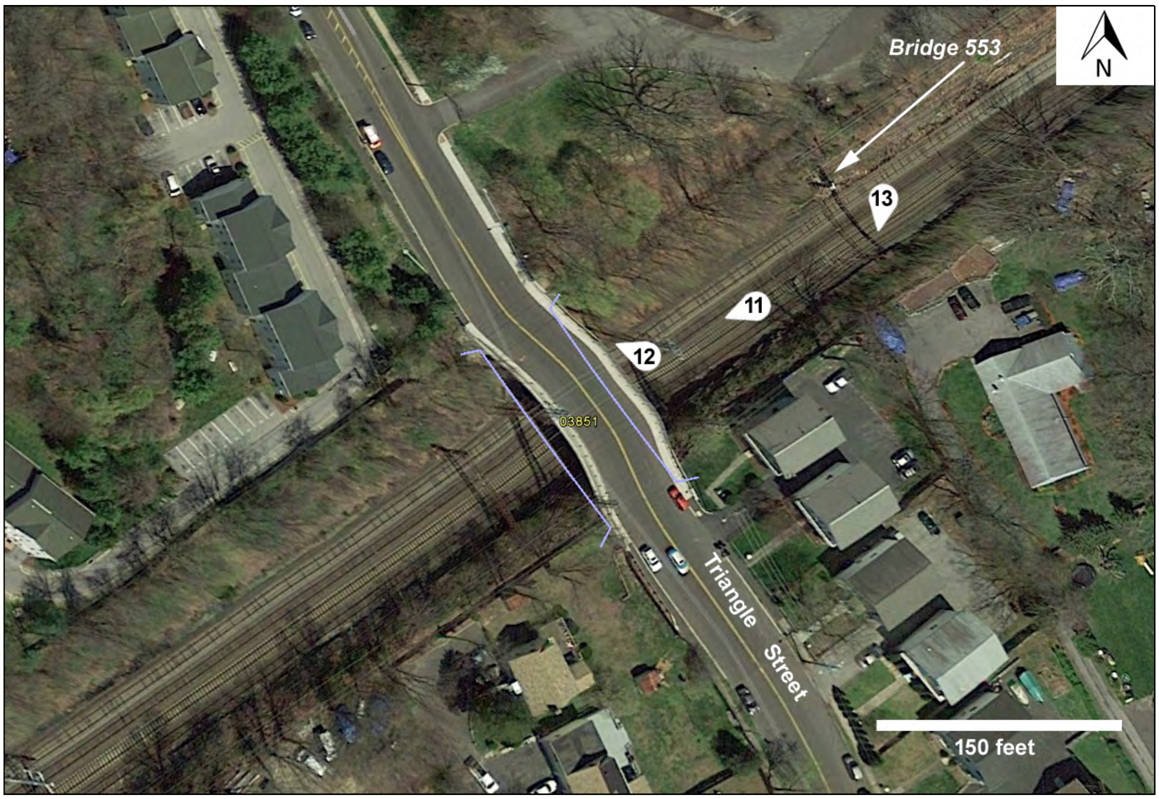
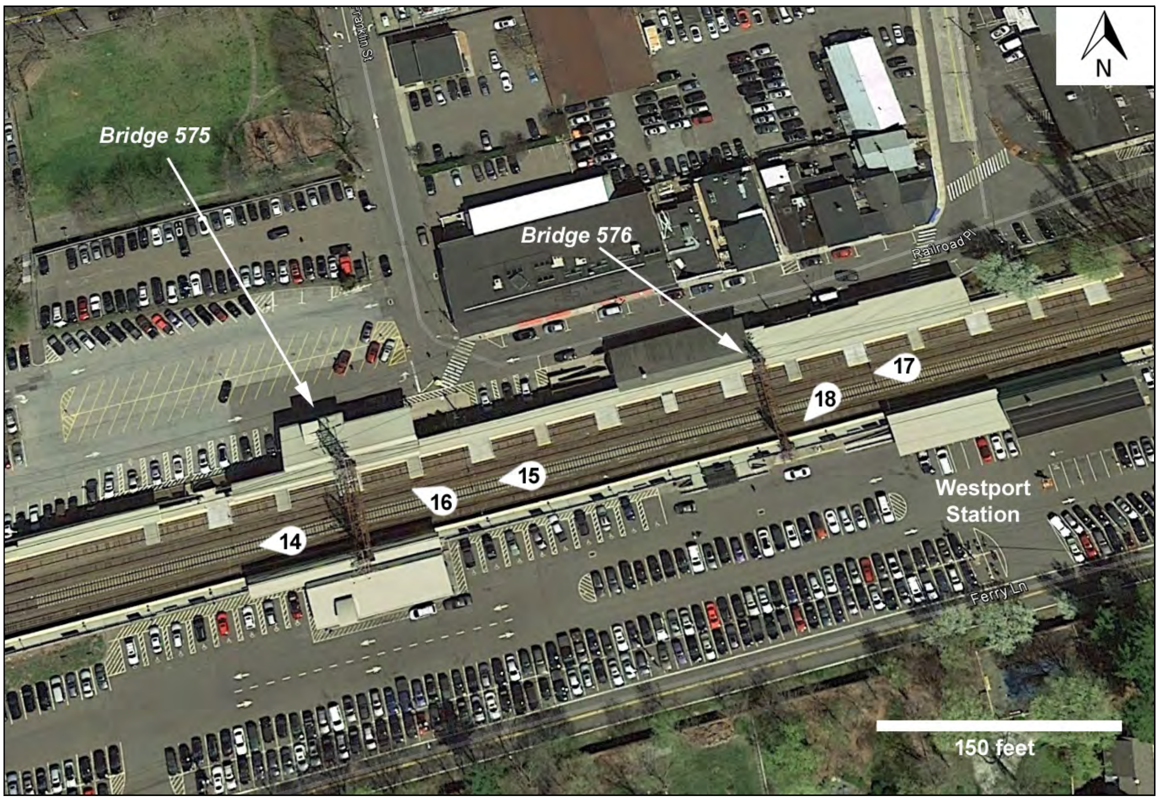


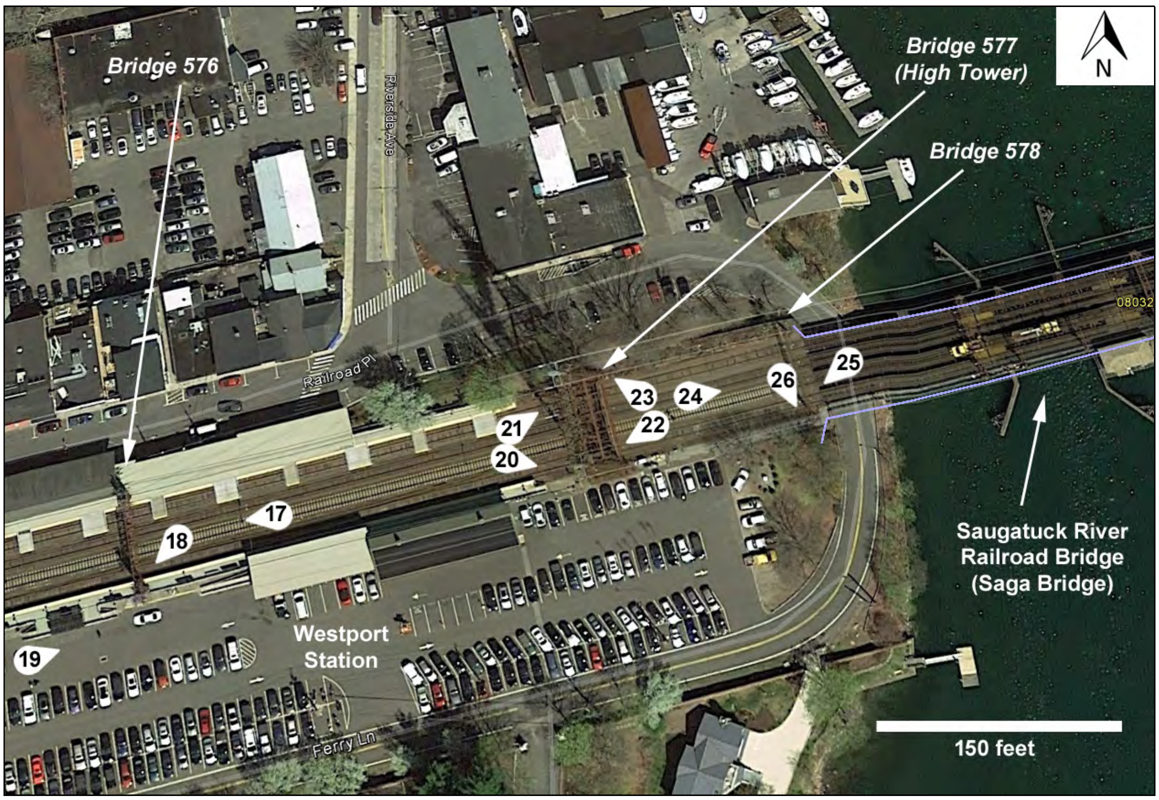
Vicinity of Triangle Street, Norwalk, as shown on Google Earth™, 2016.

Photograph Key 6 of 7



Vicinity of Westport Station, as shown on Google Earth™, 2016.

Photograph Key 7 of 7



Vicinity of Westport Station, as shown on Google Earth™, 2016.

APPENDIX C:

PHOTOGRAPHS

New York, New Haven & Hartford Railroad Catenary Systems:
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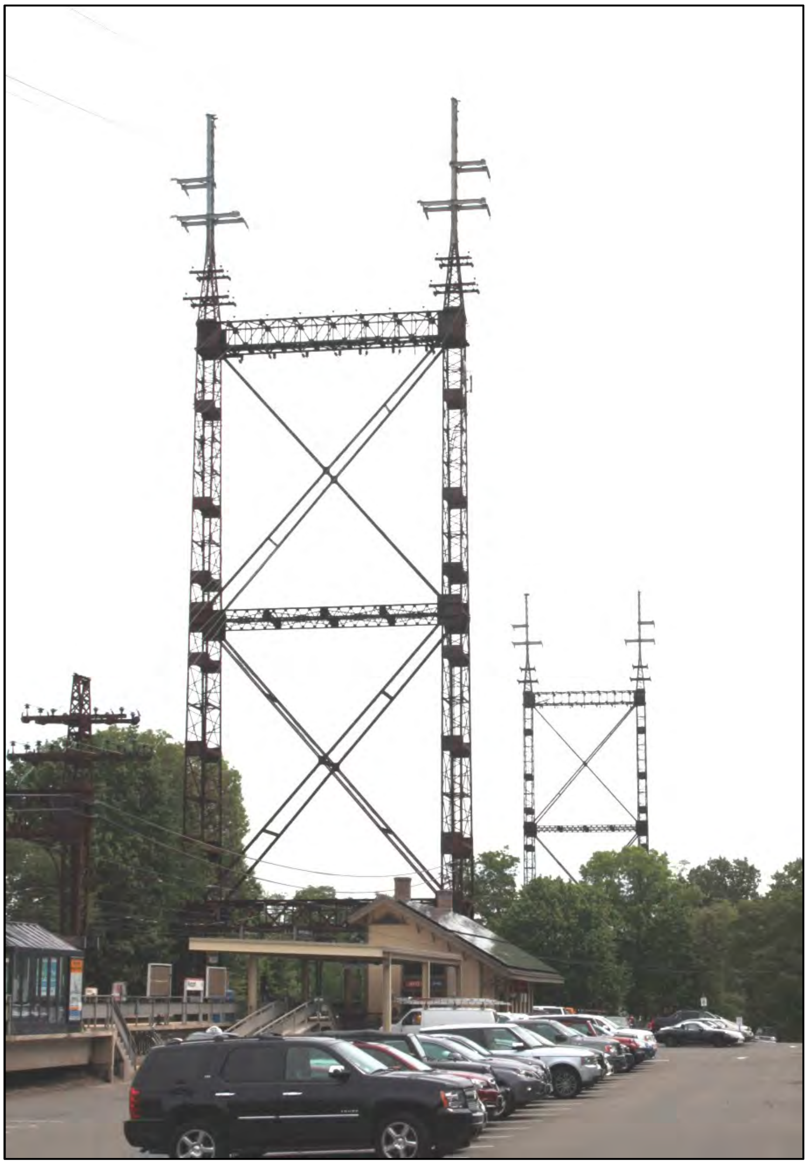
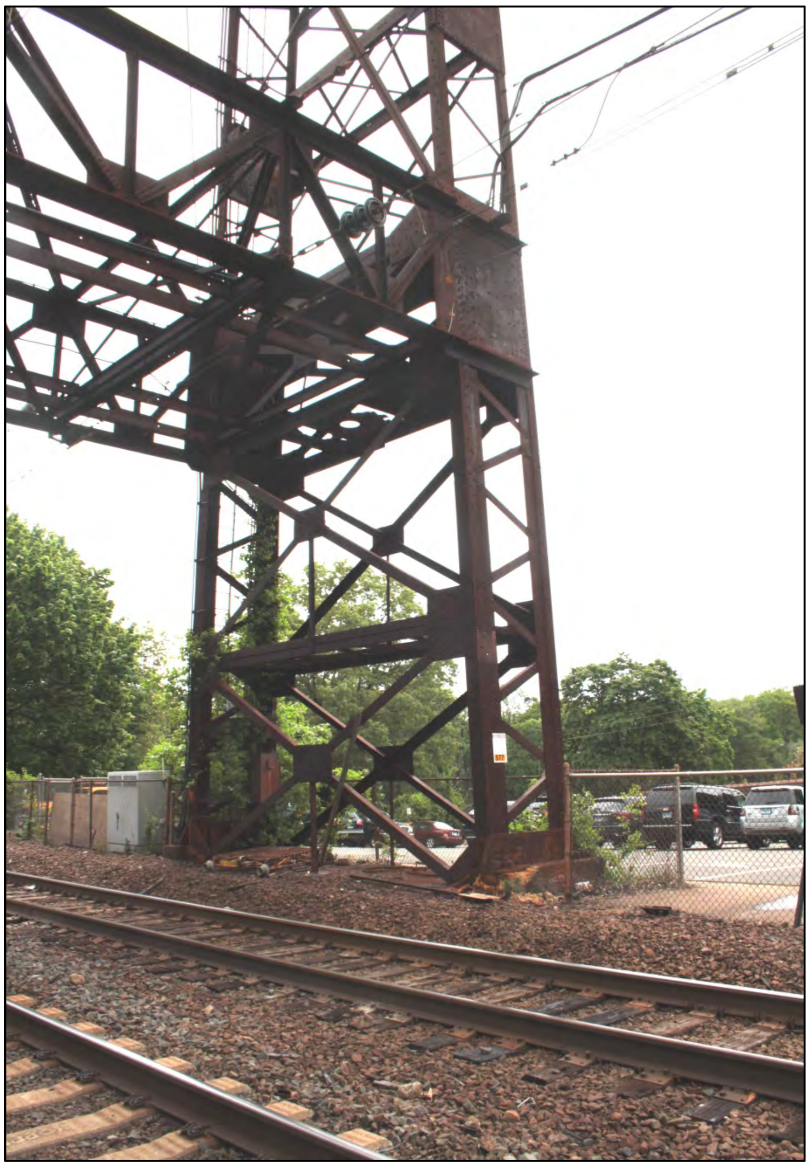
Photograph 18: **Bridge 576, Westport Station, detail of top of south support, camera facing southwest.**



Photograph 19: West high tower (Bridge 577), Saugatuck River Railroad Bridge (Saga Bridge, Westport), camera facing northeast.



Photograph 20: **West high tower (Bridge 577), Saugatuck River Railroad Bridge (Saga Bridge, Westport), detail of base of south support, camera facing east.**

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Photograph 26: **Typical concrete footing for catenary supports (Bridge 578, south support, Westport), camera facing south.**