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DOCUMENTARY ANALYSIS REPORT

FOR AREAS OF ARCHAEOLOGICAL SENSITIVITY

C10 HUDSON RIVER TUNNELS

CITY OF HOBOKEN, HUDSON COUNTY, NEW JERSEY
AND
MANHATTAN BOROUGH, NEW YORK COUNTY, NEW YORK

April 15, 2010

Revision 0

For:

NJ TRANSIT

Submitted by:

THE PARTNERSHIP

(A joint venture of PB Americas, Inc.,
STV Incorporated, and AECOM USA, Inc.)

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Revision	Date	Description:
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EXECUTIVE SUMMARY

This report presents the results of additional documentary analysis that was undertaken to refine areas of archaeological sensitivity for the C10 Hudson River Tunnels portion of the Access to the Region's Core (ARC) Trans-Hudson Express Tunnel Project (THE Project). The goal of the documentary analysis was to refine the assessment of areas of archaeological sensitivity for the C10 contract area. The footprint of ground disturbance, the principal focus for archaeological resources, is associated with the proposed ground stabilizations and underpinning of the Willow Avenue Viaduct in the City of Hoboken, New Jersey as well as tunnel excavation through soil beneath the Hudson River shoreline just west of the proposed Twelfth Avenue Fan Plant/Construction Access Shaft Site.

The assessment of archaeological resources sensitivity is determined on the basis of the potential for archaeological sites to exist in a given area, and the likelihood for the survival of intact cultural resources. The potential presence of prehistoric resources is based upon topographic setting, proximity to water, soil quality, and other environmental characteristics and predictive models based upon prehistoric land use patterns. The potential presence of historic resources is typically determined on the basis of historic cartographic documentary evidence. Sensitivity is an evaluation of the probability that intact archaeological resources exist in a given area and is determined by assessing the extent to which disturbance associated with earthmoving activities may have affected the information value of undocumented archaeological resources in high potential areas. Sensitivity is ranked as high, medium, or low. Archaeological monitoring or field testing is recommended in areas assessed to possess a high sensitivity for archaeological resources.

Additional documentary research reveals a high to moderate sensitivity, defined as the likelihood of the survival of intact archaeological resources, for the Hoboken Sea Wall within the eastern portion of the Hoboken ground stabilization area that is located in the New Jersey portion of the C10 Hudson River Tunnels contract area. The archaeological monitoring of any additional soil borings in the vicinity of the Sea Wall is recommended, as requested by the NJSHPO in a meeting dated September 17, 2009 (**See Appendix A**). The proposed method of ground stabilization or ground treatment will be selected by the Design-Build contractor.

However, during construction no archaeological monitoring is recommended if construction will involve only boring or trench excavation at shallow depths (i.e. five feet or less below the surface). If deep trench excavation is planned by the contractor archaeological monitoring during construction is recommended and a monitoring plan will be developed and submitted to the NJSHPO for review.

The area for the underpinning of the Willow Avenue Viaduct has a low sensitivity for archaeological resources. A trolley line is indicated in this area by 1873. The tracks for this line, however, were likely removed and the area substantially impacted during the construction of the viaduct and therefore, no archaeological field testing or monitoring is recommended at this location.

Construction of the C10 Hudson River Tunnels has the potential to impact pilings of the Hudson River Bulkhead and abandoned piers west of the proposed Twelfth Avenue Fan Plant/Construction Access Shaft Site in Manhattan. The pilings of the nineteenth century bulkhead and piers may have been spliced to lengths of up to 100 feet and may be encountered during tunnel excavation. However, due to the excavation of the tunnels using Tunnel Boring Machines archaeological monitoring is not a feasible alternative for the Hudson River Bulkhead or abandoned pier pilings. Previous archaeological studies of piers, wharves and bulkheads or

other fill-retaining devices have found that joinery techniques can vary and reveal details of craftsmanship that may be considered potentially significant aspects of these resources (Louis Berger Group 1989; Historical Perspectives 2004). The bottoms of pilings of the bulkhead or piers are considered unlikely to possess joinery features and are therefore, not considered potentially significant archaeological resources. Due to the excavation methodology and nature of the possible archaeological resources, no archaeological monitoring or additional archaeological investigation is recommended within the Manhattan portion of the C10 contract area.

It should be noted, however, that archaeological monitoring for pier pilings will be conducted at the Twelfth Avenue Fan Plant/Construction Access Shaft Site within the C12 Manhattan Tunnels contract area as further described in the Documentary Analysis Report for the Manhattan Tunnels (THE Partnership, 2009c).

In addition, the abandoned pilings of the former West Side Highway are likely present to the west of the Twelfth Avenue Fan Plant/Construction Access Shaft Site (C12 Manhattan Tunnels contract area). As also indicated in the Documentary Analysis Report for the C12 contract area, pilings from the former West Side Highway are not considered a potentially significant archaeological resource.

The sensitivity and potential impacts to resources are summarized in **Table E-1**.

Table E-1. Sensitivity for Archaeological Resources within the C10 Hudson River Tunnels Construction Contract

Potential Archaeological Resource	Sensitivity	Potential Impacts from Construction	Recommendations
Sea Wall (Hoboken, New Jersey)	High to Moderate sensitivity at depths of 10 to 15 feet below surface	Ground Stabilization	Archaeological monitoring of additional soil borings recommended; archaeological monitoring during construction only recommended if contractor proposes deep open cut trenching five feet or more in the ground stabilization area
Hudson River Bulkhead and Pier Pilings (Manhattan, New York)	High to Moderate sensitivity at depths of up to 125 feet	Tunnel Excavation	No archaeological field testing or monitoring; not feasible due to excavation method and unlikely to yield important information

Source: THE Partnership, 2010

1 INTRODUCTION

The specific construction contract section that is the subject of this Documentary Analysis Report is known as C10 Hudson River Tunnels. The C10 Hudson River Tunnels contract involves construction of two, approximately 7,480-foot-long bored tunnels beneath the Hudson River. The bored tunnels begin in Hoboken at the Hoboken Fan Plant/Construction Access Shaft, and would be approximately 100 feet below the surface. The tunnels would continue within or near bedrock at depths of approximately 100 to 150 feet below the surface of the Hudson River. The tunnels will enter Manhattan approximately 110 to 120 feet below surface level and connect to the Twelfth Avenue Fan Plant/Construction Access Shaft Site proposed between West 28th/West 29th Streets and Twelfth Avenue in Manhattan.

This report presents the results of additional documentary analysis for the evaluation of archaeologically sensitive areas for the C10 Hudson River Tunnels. Richard Grubb & Associates (RGA) conducted this work for the Trans-Hudson Express Partnership (THE Partnership), a joint venture of PB Americas, Inc./STV Incorporated./AECOM USA, Inc., for the Access to the Region's Core (ARC) Project. The goal of this additional research is to refine the assessment of areas of archaeological sensitivity within the C10 contract area. The footprint of ground disturbance, the principal focus for archaeological resources, is associated with the proposed ground stabilization and through underpinning of the Willow Avenue Viaduct in Hoboken, New Jersey as well as tunnel excavation though soil beneath the Hudson River shoreline to the west of the Twelfth Avenue Fan Plant/Construction Access Shaft Site in Manhattan. This work has been conducted in accordance with Exhibits I, J, and N of the Programmatic Agreement (PA) between the Federal Transit Administration (FTA), the Advisory Council on Historic Preservation, the New Jersey Transit Corporation (NJ Transit), the New Jersey State Historic Preservation Officer (NJSHPO), and the New York State Historic Preservation Officer (NYSHPO), executed on October 14, 2008.

This Documentary Analysis Report was conducted in accordance with the methods and standards for archaeology established in the implementation of the National Historic Preservation Act of 1966 (as amended), the Archaeological and Historic Preservation Act of 1974 (36 CFR 800 and 36 CFR 66, respectively), and the Secretary of the Interiors Guidelines for Archaeology and Historic Preservation (36 CFR 61.3 (b) and Chapter 6, Section C.1.a).

In accordance with the PA, NJ TRANSIT is to ensure that archaeological research, testing, analysis, and plans conducted pursuant to the PA will be conducted by or under the supervision of individuals who meet or exceed the Secretary of the Interior's Professional Qualifications and in fulfillment of certain other professional standards. All RGA principal investigators working on the project exceed these qualifications, and the report prepared by RGA for this additional documentary analysis adheres to the NJSHPO's *Guidelines for Phase I Archaeological Investigations: Identifications of Archaeological Resources*, the NJSHPO's *Guidelines for Preparing Cultural Resources Management Archaeological Reports Submitted to the Historic Preservation Office,* the New York Archaeological Council's *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State*, the New York City Landmarks Preservation Commission *Guidelines for Archaeological Work in New York City,* and the Department of Interior's *Standards and Guidelines for Archaeological and Historic Preservation.*

1.1 Project Description

The ARC Trans-Hudson Express Tunnel Project (THE Project) is located within portions of Kearny, Secaucus, Jersey City, North Bergen, Union City, and Hoboken in New Jersey, the Hudson River, and the Borough of Manhattan in New York (see **Figures 1.1 to 1.3**). THE Project consists of additional commuter rail tracks and connections on the Northeast Corridor, new tunnels under the Palisades in New Jersey, the Hudson River and Manhattan, and connections providing additional capacity under West 34th Street from Eighth Avenue to Sixth Avenue at the New York Penn Station Expansion (NYPSE). The purpose of ARC is to increase Trans-Hudson commuter rail capacity in order to: accommodate projected ridership growth from rail lines west of the Hudson River; enhance passenger convenience via a one seat ride on five NJ Transit lines; and improve system safety and reliability between Frank R. Lautenberg Station in New Jersey and midtown Manhattan. THE Project anticipates initial revenue service commencing in 2017, with the full operational plan implemented by 2030.

1.2 Description of the Area of Potential Effects

The Area of Potential Effects (APE) for the ARC Project has been defined as extending 200 feet from the existing or proposed tracks in New Jersey and the Hudson River, and 400 feet from the proposed tracks in Manhattan (see **Figure 1.4**; A.D. Marble & Company 2008: 37). The portion of the ARC Project included within C10 extends from the Hoboken Fan Plant/Construction Access Shaft Site and includes the Hudson River Tunnels extending east below the Hudson River, connecting with the C12 Manhattan Tunnels contract area at the Twelfth Avenue Fan Plant/Construction Access Shaft Site in Manhattan (see **Figure 1.5**).

The footprint of ground disturbance is the principal focus for archaeological resources within the APE. In Hoboken, proposed ground disturbance is confined to impacts associated with the ground stabilization and the underpinning of the Willow Avenue Viaduct (see **Figures 1.6 and 1.7**). The precise depth and limits and methods for ground stabilization are to be determined by the Design-Build contractor. The underpinning of Willow Avenue will involve ground disturbance within an approximately 160 foot by 60 foot area for utility relocations and the installation of load transfer beams and mini-piles depths of utility relocations. The tunnels will enter Manhattan just west of the proposed Twelfth Avenue Fan Plant/Construction Access Shaft Site above bedrock at depths of 110 to 150 feet below the surface, within the vicinity of pilings for nineteenth century piers and the Hudson River Bulkhead (see **Figure 1.8**).

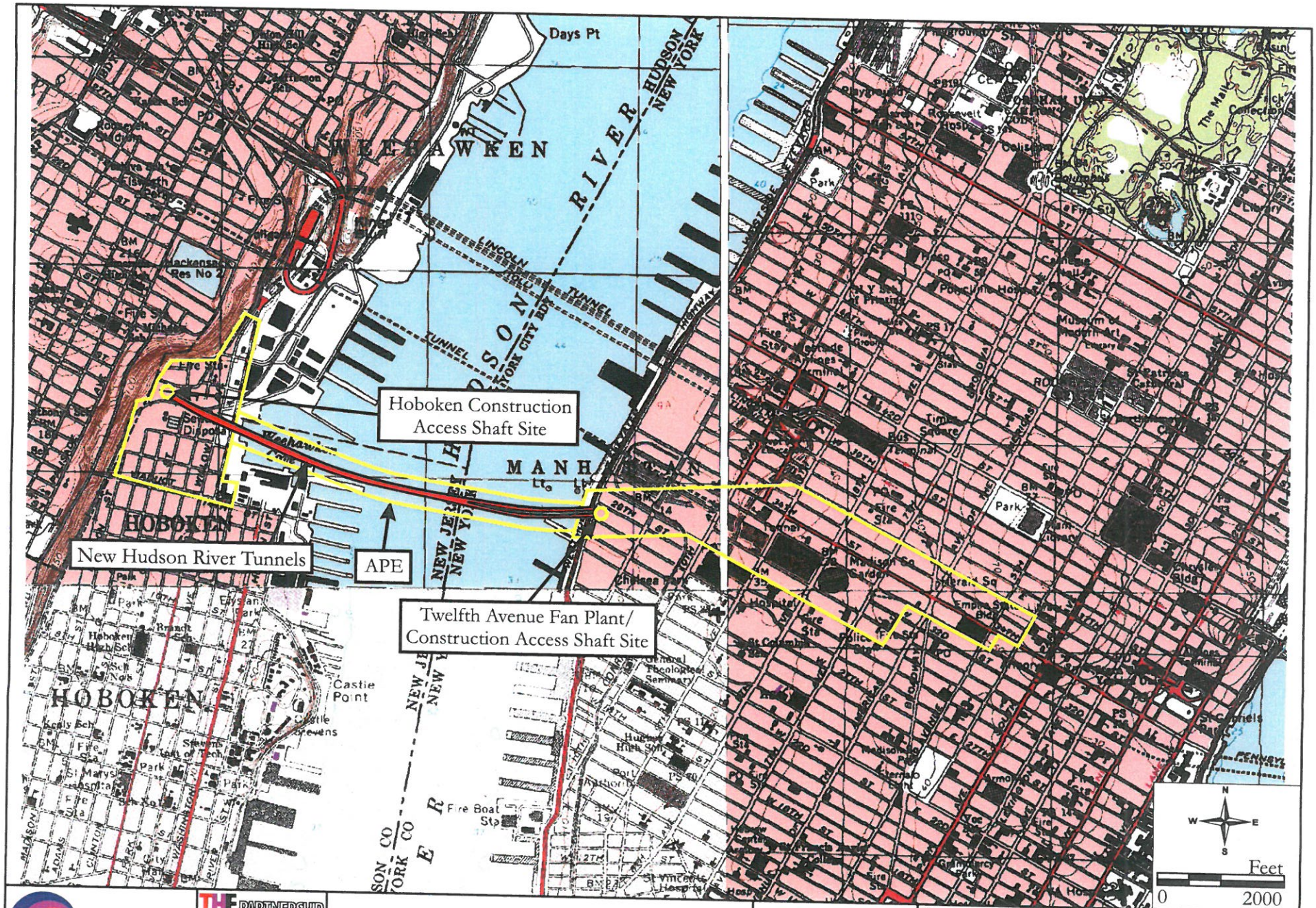
1.3 Summary of Previous Work

In accordance with the PA, this Documentary Analysis Report will serve as an addendum to the Phase IA Archaeological Survey Report (January 2008) prepared by A.D. Marble & Company for Transit Link Consultants (TLC) in association with the ARC Environmental Impact Statement (EIS).

The area between the Hudson River and the Hoboken ground stabilization and Willow Avenue Viaduct area consists largely of made land dating to the second half of the nineteenth century. The Phase IA conducted for the ARC project concluded that the APE within Hoboken possesses low potential for significant prehistoric archaeological resources (A.D. Marble 2008: 83). Previous cultural resource surveys conducted have

likewise assessed former low-lying, tidal marsh portions of Hoboken to possess a low potential for prehistoric archaeological resources (Marshall 1981; Raber Associates 1986; Richard Grubb & Associates 1996, 2000, 2002a, 2002b, 2003, 2005a, 2006). The vicinity of the Hoboken ground stabilization and Willow Avenue Viaduct area consisted of tidal marshland until the 1860s, and prehistoric site locations are predicted on the adjoining uplands rather than the low marshlands (Raber Associates 1986; A.D. Marble 2008: 80). The Phase IA survey conducted for the ARC Project did not consider the Hoboken ground stabilization or underpinning of the Willow Avenue Viaduct specifically, though assessed the nearby Hoboken Fan Plant/Construction Access Shaft Site and access route to possess a high potential for industrial and transportation-related resources (A.D. Marble 2008). The Phase IA survey indicated that direct impacts to archaeological resources, such as the Hudson River Bulkhead, within the Manhattan shoreline were not anticipated (A.D. Marble 2008: 95).

A geophysical survey undertaken for the ARC Project in the Hudson River found no evidence for shipwrecks in the APE, though the seismic penetration of the seafloor was limited to less than a few meters due to organic gas bubbles in the sediment (Alpine Ocean Seismic Survey 2007: 2). Side scans revealed that fields of pilings appeared to remain in place where former piers were demolished (2007: 24). A subsequent survey for metallic objects by Alpine Ocean Seismic Survey found nine anomalies, mostly at or near the sediment surface and not approaching the depths at which the tunnels will traverse through this area (THE Partnership 2009a: E-1).



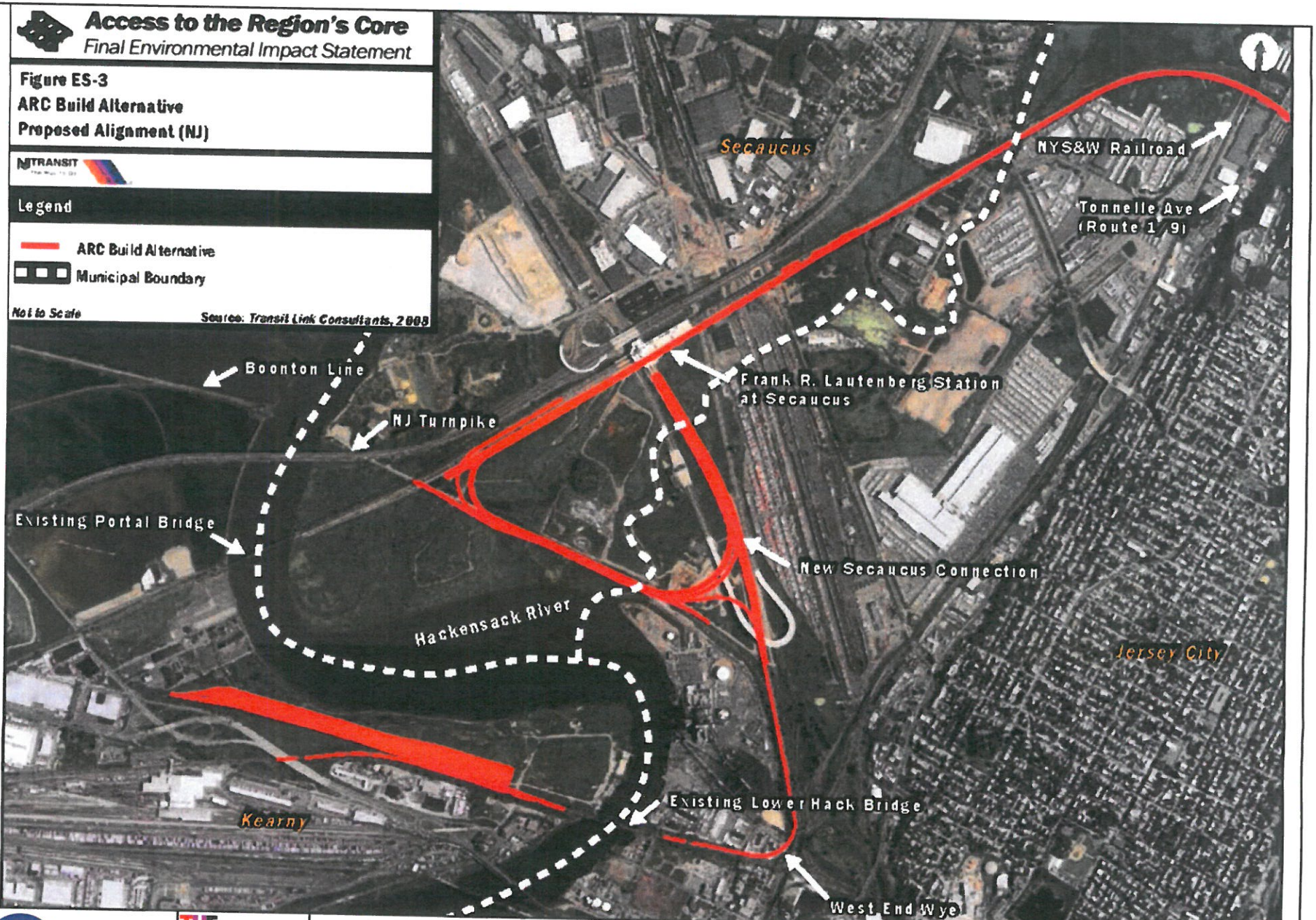
ACCESS TO THE REGION'S CORE
Trans-Hudson Express (THE) Tunnel

THE PARTNERSHIP

C10 Hudson River Tunnels

TRANS-HUDSON EXPRESS PROJECT

Figure 1.1: U.S.G.S. Map: APE in Hudson River and New York (from U.S.G.S. 7.5′ Quadrangles: Weehawken, NJ-NY 1995; Central Park, NY-NJ 1995; Brooklyn, NY 1995; Jersey City, NJ-NY 1967 [photorevised 1981]).



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C10 Hudson River Tunnels

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Figure 1.2: Build Alternative Alignment (New Jersey) (Source: New Jersey Transit 2008).

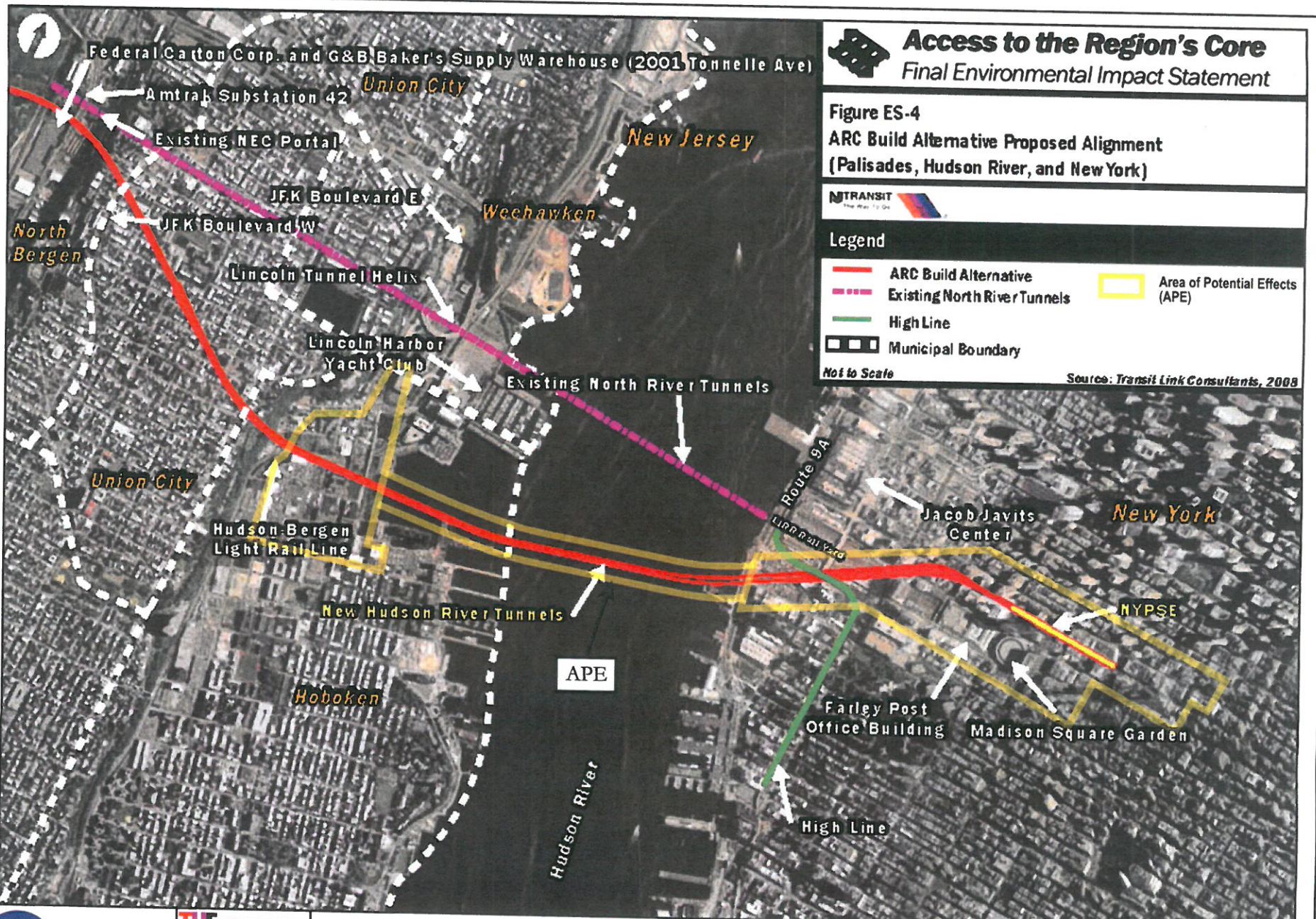

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Figure 1.3: Build Alternative Alignment (Palisades, Hudson River and New York) (Source: New Jersey Transit 2008).

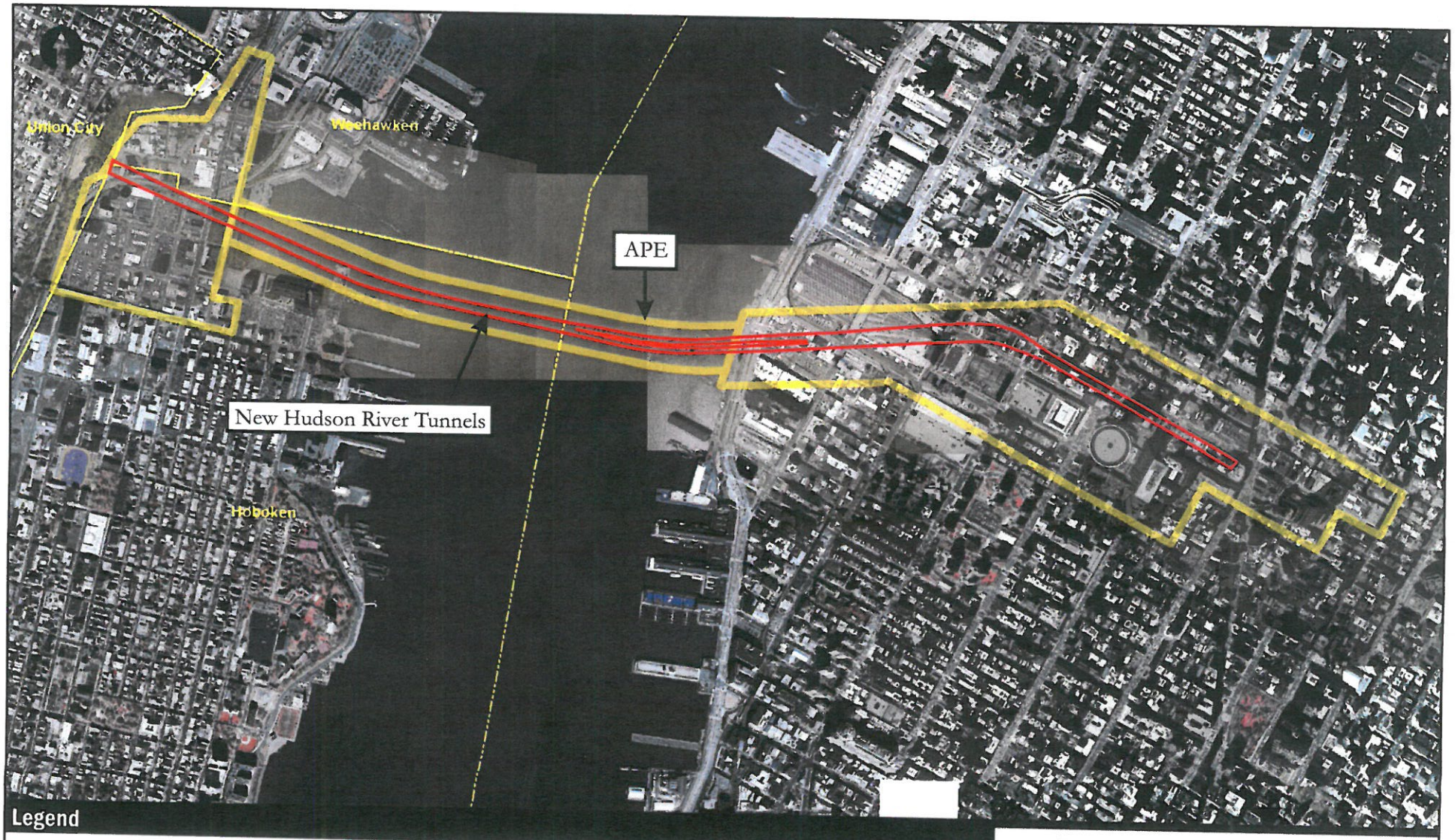
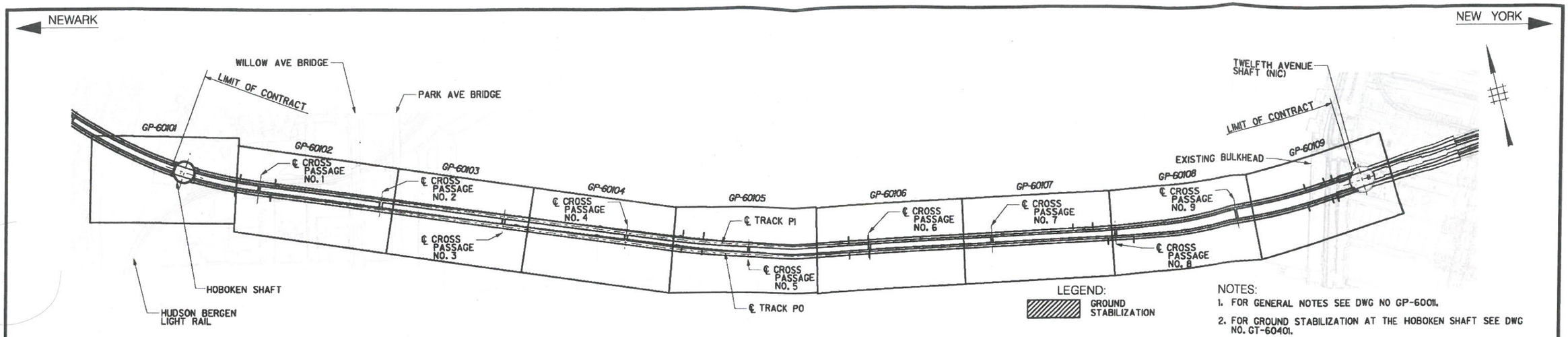
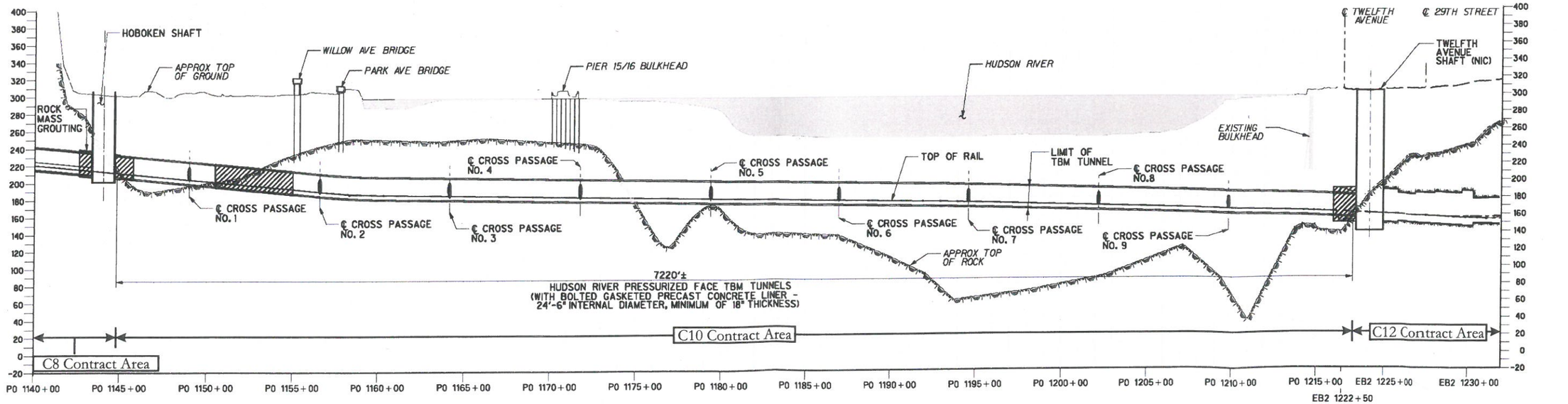


Figure 1.4: Area of Potential Effects: New Jersey, Hudson River and NY (Source: A.D. Marble 2008).



KEY PLAN



COMPOSITE TUNNEL PROFILE
(ALONG ℄ TRACK P0)

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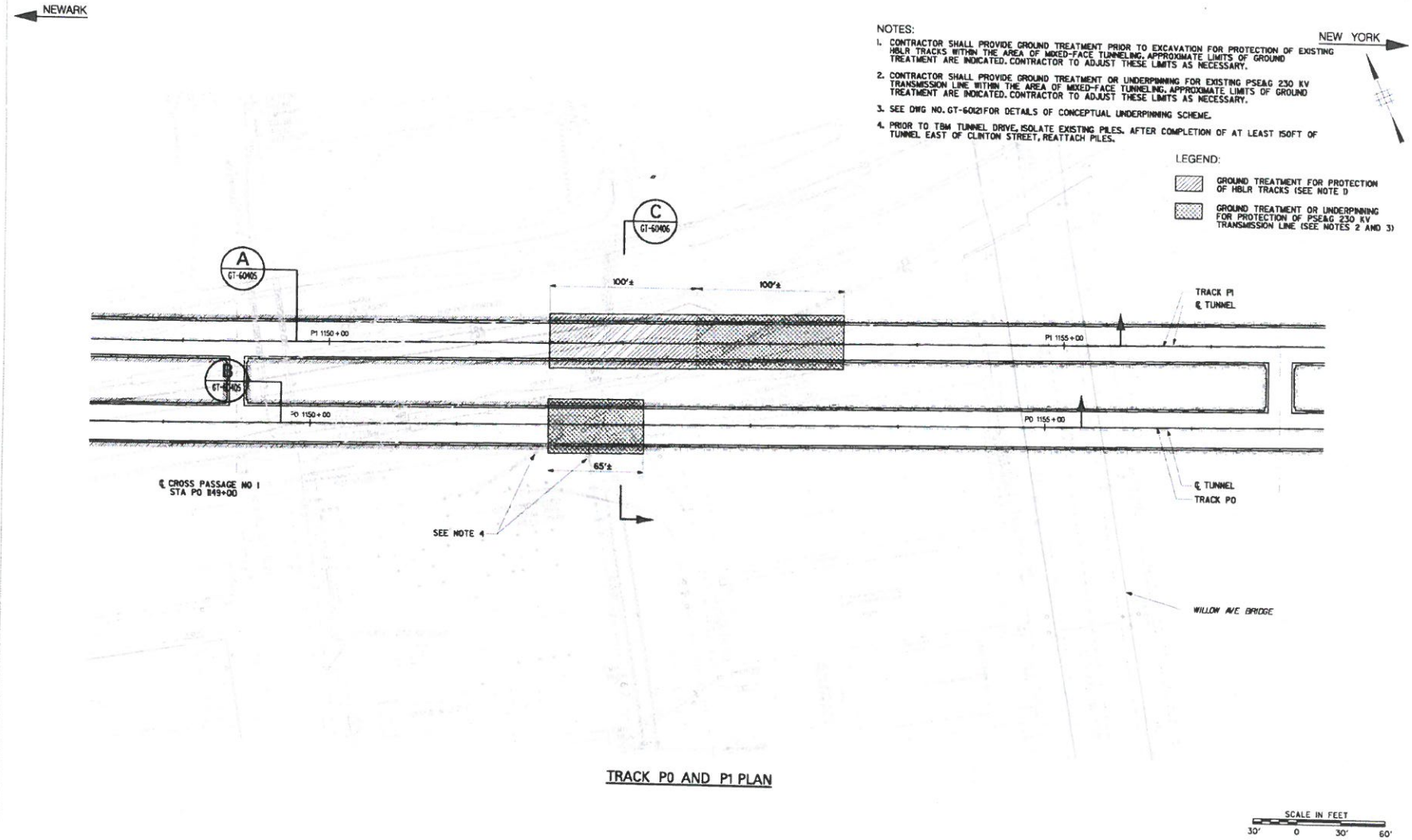
C10 Hudson River Tunnels

TRANS-HUDSON EXPRESS PROJECT

Figure 1.5: Construction Plan - Hudson River Tunnels, General Plan and Profile, Depicting Limits of the C8, C10, and C12 Contract Areas.



TRACK P0 AND P1 PLAN

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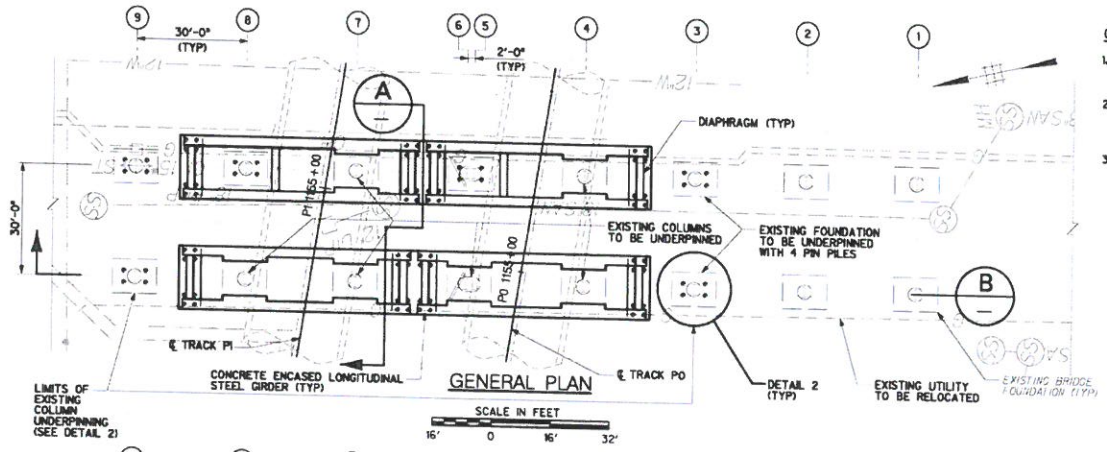
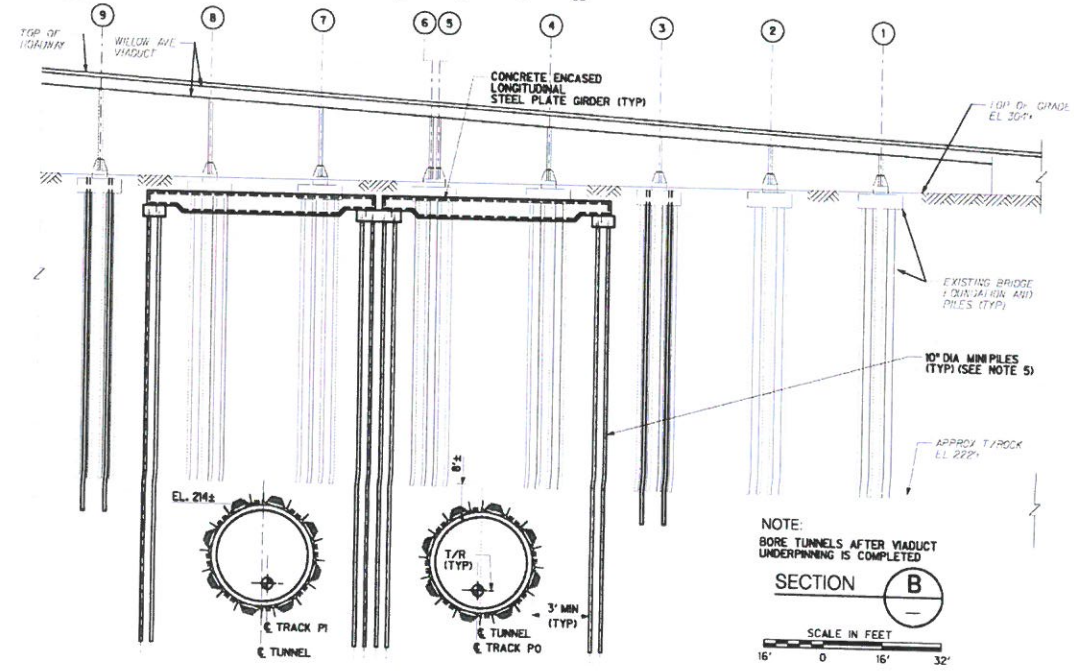
TRANS-HUDSON EXPRESS PROJECT

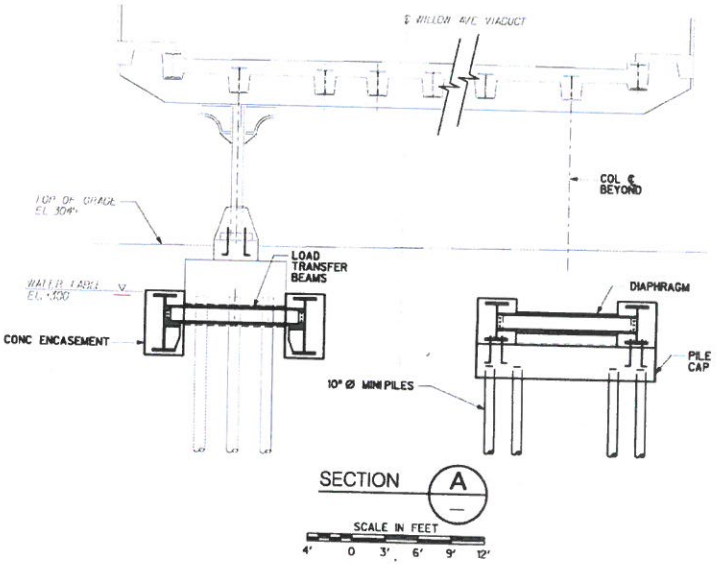
Figure 1.6: Construction Plan - Hudson River Tunnels, Ground Stabilization Plan.





GENERAL NOTES:

1. FOR GENERAL NOTES, GENERAL AND STRUCTURAL ABBREVIATIONS, LEGEND AND SYMBOLS SEE DWG NOS GP-60011, GP-60012 AND ST-60002.
2. UNDERPINNING METHOD SHOWN IS SUGGESTED AND SHALL BE MODIFIED BY THE CONTRACTOR AS REQUIRED TO ASSURE APPROPRIATE LOAD TRANSFER IN ORDER NOT TO IMPACT THE VIADUCT STRUCTURE AND ITS SERVICE.
3. CONTRACTOR SHALL PROVIDE TEST PITS TO VERIFY LOCATION OF EXISTING UTILITIES AS REQUIRED.
4. ANY TEMPORARY SUPPORT OF STRUCTURE DURING UNDERPINNING OPERATIONS TO BE DETERMINED BY CONTRACTOR.
5. CONTRACTOR SHALL EVALUATE PILE LENGTHS AND THEIR FINAL LOCATIONS IN ORDER TO PREVENT TRANSFER OF VIADUCT LOADS ON NEW TUNNELS.
6. UNDERPINNING STRUCTURE MUST BE BELOW GRADE.



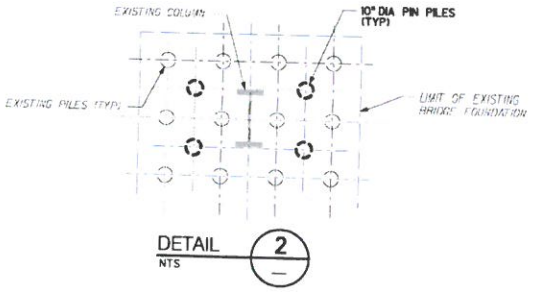


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Figure 1.7: Suggested Underpinning General Plan, Elevation, and Section.

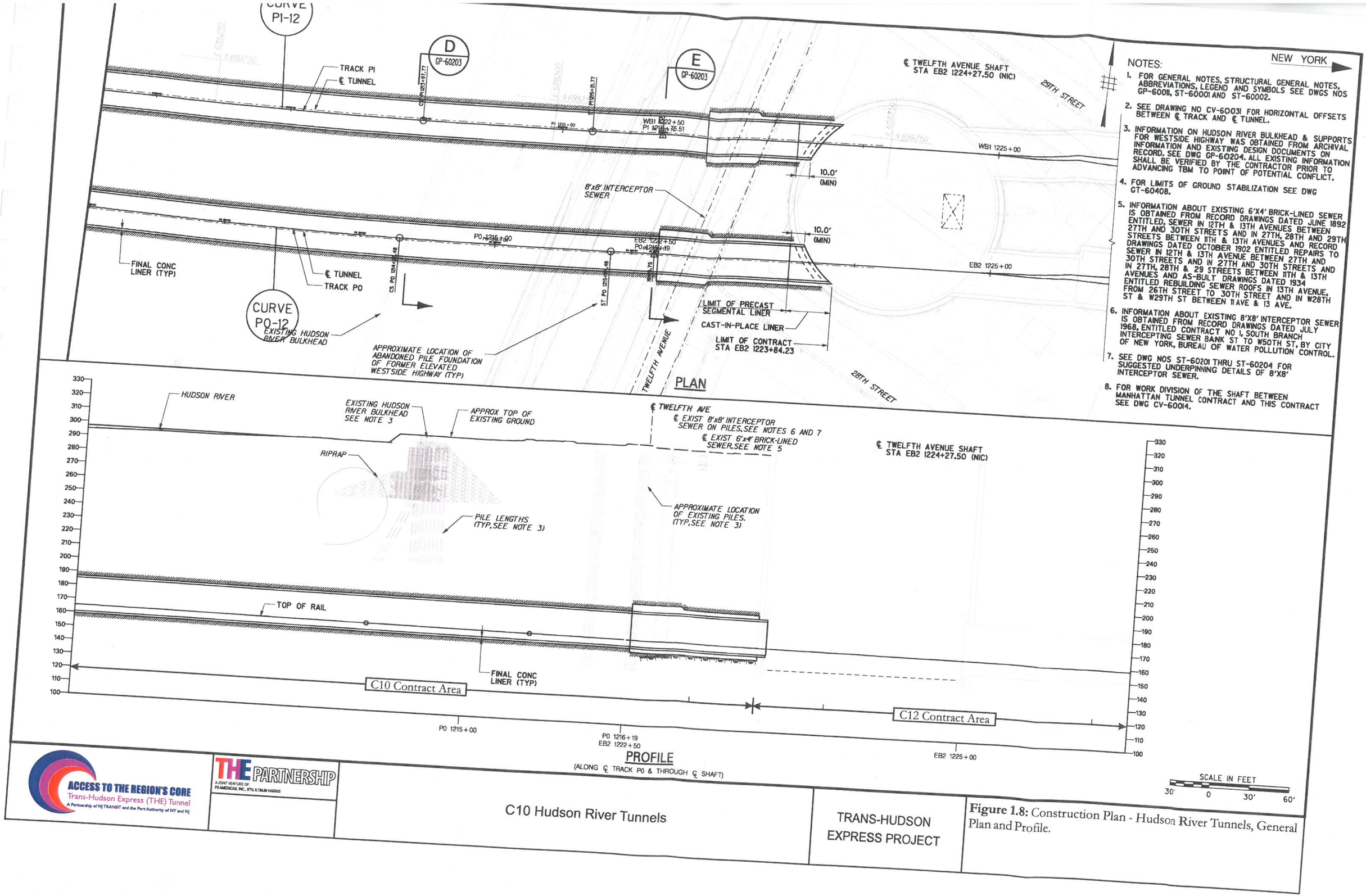

Figure 1.8: Construction Plan - Hudson River Tunnels, General Plan and Profile.

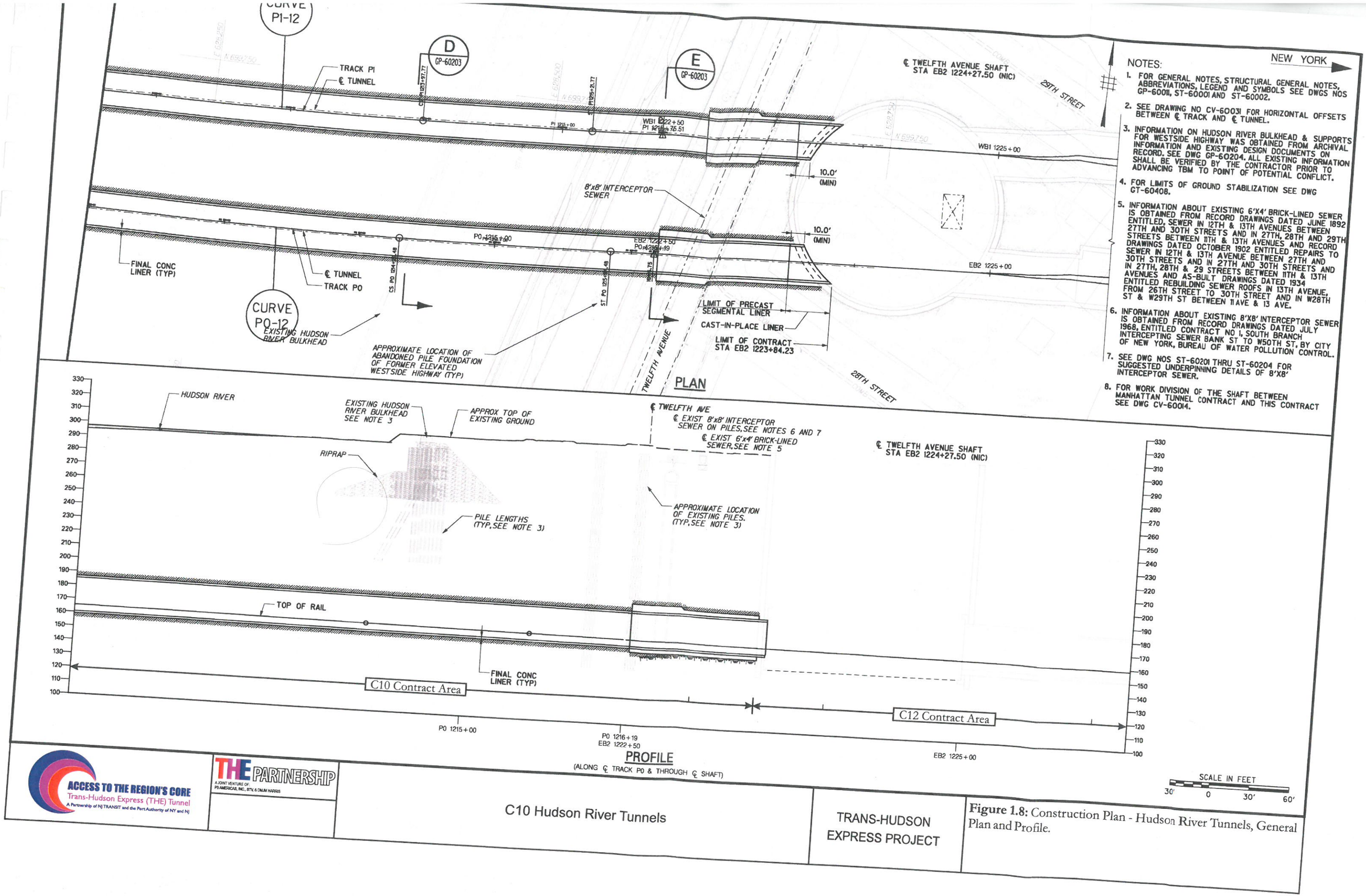

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Figure 1.8: Construction Plan - Hudson River Tunnels, General Plan and Profile.

2 OVERVIEW OF HISTORIC DOCUMENTS

Summaries of the historical development of the APE for the ARC Project have previously been completed (see, for example, A.D. Marble 2008). Using a series of historic maps (see **Figures 2.1 through 2.27**) and documentary sources, this section will focus on the historical development around the ground stabilization and Willow Avenue Viaduct area in Hoboken, New Jersey as well as the development of the Manhattan, New York waterfront west of the Twelfth Avenue Fan Plant.

2.1 Historical Development – Hoboken Area

In general, the APE for the Hudson River Tunnels within Hoboken, New Jersey passes through and beneath land made during the third quarter of the nineteenth century. Prior to that time, the area consisted predominantly of tidal salt marsh. A detailed history of the Hoboken, New Jersey area can be found in the Documentary Analysis Report for C8, the Palisades Tunnels (THE Partnership 2009b).

Dutch settler Michael Pauw acquired lands along the west bank of the Hudson River in 1630; these included all of present-day Hoboken (Hoboken Board of Trade 1907: 10; Winfield 1874: 315). In 1635, the land passed to the Dutch West India Company, after which a period of conflict with the Indians left possession of the area in constant dispute (Hoboken Board of Trade 1907: 10). An indenture between the Indians and Petrus Stuyvesant of New Amsterdam secured Stuyvesant's title to the lands in 1658 (Winfield 1895). Stuyvesant conveyed this tract to his brother-in-law, Nicholas Varlett, on February 5, 1663 (Hammond 1947). When Varlett died intestate in 1675 (Winfield 1895), the title passed to his daughter Susanna de Freest, and then to her daughter Susanna Hickman, wife of Robert Hickman. The Hickmans sold the tract in 1711 to New York City merchant Samuel Bayard, who improved the land and built a summer residence on the promontory now occupied by the Stevens Institute.

In 1718, a road was laid out between "Crom-kill" and "Wehocken ferry;" this road is thought to be the antecedent to the Bergen Turnpike (also known as the Hackensack Plank Road) located west of the ground stabilization area within Hoboken (Winfield 1874: 358). Cornelius Haring started regular ferry service from the terminus of the Bergen road at the southern tip of Hoboken to New York City in 1774 (Shaw 1884).

The State of New Jersey confiscated Bayard's estate from his Loyalist grandson, William Bayard, in 1780. In March of 1784, the tract was sold to Colonel John Stevens, Jr. for £18,360. At the time, the estate comprised 564 acres (Winfield 1872: 40). With an eye towards development, Stevens and others in the area began actively improving the western shore of the Hudson River. The Bergen Turnpike Company was incorporated on November 30, 1802 to construct an improved road from Hackensack to Hoboken (Winfield 1874: 363). The new Bergen Turnpike (also known as the Hoboken Plank Road) appropriated the alignment of the old Bergen road, and construction was completed by 1804 (Winfield 1874: 363).

Stevens sold off 327 acres of undeveloped meadow and salt marsh, including the portion of the APE in Hoboken, to Samuel Swartwout on April 15, 1814 (Winfield 1872: 40; 1874: 320). Swartwout constructed a series of sea walls and open ditches to drain the meadows and to reclaim part of the land. These sea walls or dikes were traditionally built by digging a trench four feet wide and two "spits" (estimated as measuring 18 inches each) deep to remove the sod and grass roots, and to provide a

firm foundation for the wall. Next, a ditch measuring 12 feet wide and three spits deep was dug on the water side of the trench to supply the necessary earth. The earth excavated from the ditch was cut and fit into the dike, in a fashion similar to laying a stone wall. When well-packed and kept moist, the dike formed a strong and durable wall (if left to dry out, it would crumble) (Wacker and Clemens 1995: 125). By 1819, Swartwout was able to pasture some 100 head of cattle and raise a host of crops in the reclaimed marsh (Winfield 1874: 320). The most prominent of the sea walls (which extends through the area for ground stabilization) ran through the marshes at the head of Weehawken Cove, eventually forming a continuation of Steven's well-known River Walk, built along the western banks of the Hudson River (Richard Grubb & Associates, Inc. 2005b). The alignment of this sea wall is visible passing through the central or western portion of the ground stabilization area in Hoboken, New Jersey through 1865 (see **Figures 2.1 through 2.3 and 2.5**). These images show slightly varying alignments of the sea wall; this may reflect mapping irregularities, or an actual shifting alignment due to repairs or erosion. All of the alignments extend through the APE for ground stabilization (see **Figure 2.18**).

Swartwout mortgaged his lands to John G. Coster on December 6, 1827. The mortgage was foreclosed on July 15, 1840, and the property conveyed to John G. Coster by deed dated October 24, 1840 (Winfield 1872: 40). Coster died on August 8, 1844, and his estate was surveyed off into building lots in 1860 (see **Figure 2.4**). Most of the ground stabilization area falls within the Coster subdivision; however, the eastern portion of the area extends beyond the Coster subdivision into land formerly belonging to the Hoboken Land & Improvement Company.

Although street alignments for what are now known as Seventeenth Street, Clinton Street, and Willow Street were depicted extending through the ground stabilization area by 1860 (see **Figure 2.4**), they were not constructed until after 1865 (see **Figure 2.5**). This 1865 survey does not show any of these alignments extant, and indicates the planned alignment for what was to become Park Avenue, labeled as a "road being opened." Development around the ground stabilization area increased in the second half of the nineteenth century. By 1873, the New York and Fort Lee Railroad line had been built extending through the northwestern corner of the ground stabilization area (see **Figure 2.6**). Willow Avenue, built 100 feet wide between 1865 and 1873, had trolley tracks running along it within the vicinity of the proposed underpinning of the Willow Avenue Viaduct by 1873. An 1880 map of the region indicates that, except for the railroad tracks and a portion of Willow Avenue, the ground stabilization area remained largely marshland. The rail line, formerly the New York and Fort Lee Railroad, was, by 1880, part of the Weehawken Branch of the New York, Lake Erie and Western Railroad (NYLE&WRR) (see **Figure 2.7**).

The New Jersey Junction Railroad (NJJRR) was incorporated on February 25, 1886 by the New York Central Railroad (NYCRR) (Transportation Corporation Files 1886). Soon after incorporation, the NJJRR acquired property along Seventeenth Street for its right-of-way, including lots that may fall within portions of the ground stabilization area (see **Figure 2.8**). By 1891, the NJJRR line had been constructed immediately north of the circa 1873 NYLE&WRR lines and the ground stabilization area is situated within the area of the tracks (see **Figure 2.9**). From the late nineteenth century to the present cartographic evidence indicates no structures within the ground stabilization areas (see **Figures 2.10 to 2.17**; see **Plates 2.1 and 2.2**).

2.2 Historical Development - Manhattan Area

At the eastern limits of the impacts of C10, the proposed tunnels cross Manhattan's pier headlines, and terminate at the western edge of the Twelfth Avenue Fan Plant shaft (see **Figure 1.7;** see **Plate 2.3**). A more detailed discussion of the development of piers and wharves in this area is provided within the Documentary Analysis Report for the C12 Manhattan Tunnels contract area (THE Partnership 2009c). In general there is no record of piers, wharves, or bulkheads documented in the vicinity of the C10 contract area until after 1870. This is due in part to the relative ease of docking on the well-protected East River and the depth to bedrock along this portion of the Hudson River, which precluded the use of cobb- or crib wharves (Hoag 1906: 64; Raber Associates 2000). It was not until the mid-nineteenth-century introduction of the steam driven pile driver that pile-driven wharves, piers, and bulkheads were possible in the river's deep mud in this location (Greene 1917; Historical Perspectives 2004: III G-4 and III G-5). Prior to the availability of gas- and oil-powered winches at the turn of the twentieth century, steam pile drivers would have been the most efficient means of driving piles necessary for pier and bulkhead construction. Unlike gas- and oil-powered winches, steam-powered drivers required a licensed steam engineer to operate (Flagg 1997).

In 1870, the New York City government was reorganized, and the Department of Docks was established. One of the mandates of the new department was to establish a system for the development of the Hudson River shore line. This development was implemented as properties were acquired from their previous owners, either through negotiation, condemnation, or seizure (Hoag 1906: 59). The system included:

- Establishing a bulkhead (in this case, the Twelfth/Thirteenth Avenue bulkhead) as a limitation for solid filling, and the exterior boundary of a marginal wharf or street;
- Establishing a pierhead line to limit the out-shore position of any structure;
- A system of piers with adequate slips between, extending from the bulkhead to the pierhead line under which the tide may ebb and flow, and along which vessels could securely and safely berth at any stage of the tide (Hoag 1906: 52-53).

The Hudson River redevelopment program was significant as the first and largest of its kind in the United States (Raber Associates 2000: 2).

Piles used for the post-1870 redevelopment of the Hudson River waterfront were required to be sound and straight, made of white pine, yellow pine, Norway pine, or cypress, with points of at least six inches. For both pier and bulkhead construction, piles were driven into the river bed, usually until they refused to penetrate more than one inch per blow under the last 10 blows of a 3,000 pound hammer falling 10 feet. Piles in deep mud were driven to depths of up to 80 feet; if greater depths were required for safety (or if bedrock or other resisting bottom could be reached), piles were spliced to approximately 100 feet (Hoag 1906: 102-103). Even where piles did not reach bedrock, they were stable in deep mud, and capable of holding considerable weight (see, for example, *Engineering News* 1905; Vernon-Harcourt 1885: 427-428). There is no specific mention of the use of iron or steel tips (called shoes) on the point ends of the pilings in New York City after 1870 (Greene 1917; Hoag 1906). Early twentieth century engineering texts, however, indicate that the use of iron or steel shoes on wooden pilings was "once deemed essential" (American Society of Civil Engineers 1909: 488). A 1922 reference describes their continued, occasional use; this same source also indicates that an iron band is frequently utilized around the top

of the piling during driving, to prevent fraying (Wade 1922: 623). It is possible that pilings within the project area may have iron or steel shoes, and may retain iron banding.

Structures associated with the West Twenty-Eighth Street pier first appear along the shore line near the eastern limits of the Hudson River tunnels between 1870 and 1879 (see **Figure 2.19**). The West Twenty-Eighth Street pier was demolished circa 1890 in advance of the completion of the Twelfth/Thirteenth Avenue bulkhead (see **Figures 2.20 and 2.22**). There are several examples of old pilings associated with piers and bulkheads being encountered during later construction. During the construction of the first railway tunnels running beneath the Hudson River (begun in 1874 and completed in 1907), bulkheads were encountered on both the New Jersey and New York sides of the river. These Hudson River tunnels were constructed entirely by boring through the sand and silt of the riverbed, above bedrock, and with a minimum of 15 feet of riverbed between the crown of the tunnel arch and the bottom of the Hudson River (Burr 1885: 12). These tunnels were located approximately 1.75 miles south of the ARC Project, and connected Fifteenth Street in Jersey City with Morton Street in Manhattan (Burr 1885: 11). A wood and stone crib bulkhead was encountered on the Jersey City side of the excavations, in some places projecting halfway through the tunnel. Complications caused by encountering this bulkhead resulted in an accident that killed 20 workers (Burr 1885: 23). Pilings associated with the post-1870 Twelfth/Thirteenth Avenue bulkhead were also encountered during the construction of the Hudson River tunnels, and the sharpened ends of the pilings were cut away (Burr 1885: 66). **Figure 2.21** details both the late nineteenth century tunnel alignment through the bulkhead and the arrangement of the pilings encountered. Pilings were also left in place either above or below grade following demolition of pier or bulkhead superstructures. For example, **Figure 2.22** shows pier pilings left in place within the C10 Hudson Tunnel alignment following the removal of the West Twenty-Eighth Street Pier superstructure. These pilings were likely simply buried by historic fill during the creation of fast land in the area, and if present, may be encountered during tunnel boring. In cases where the distance from mean high water to bedrock is less than approximately 100 feet, it is likely that the pilings were driven directly to bedrock.

Between 1871 and 1936, the City of New York constructed over five miles of bulkhead along the Hudson River (Raber Associates 2002: 2); the portion within the Hudson River Tunnels footprint was completed between 1890 and 1897 (see **Figures 2.19, 2.20, 2.22, and 2.23**). This newly constructed bulkhead consisted of masonry walls on a variety of foundation systems, with ashlar granite block forming the visible face (Raber Associates 2000: 2). The bulkhead within the APE has been identified as Type III-B (see **Figure 2.24**). Type III bulkhead construction consists of pile-supported granite bulkhead with timber relieving platforms, built on soft or deep mud bottoms 40 to 170 feet below mean high water. The relieving platforms were encased in fill or cut off from open water. Type III-B is specifically defined as "granite wall on narrow concrete block, with inclined bracing piles taking lateral thrusts to below base block, and timber binding frame around piles" (Raber Associates 2000: 7). This type of bulkhead was constructed on piles which did not extend to bedrock. During construction, mud was dredged to a depth of approximately 30 feet in an area about 85 feet wide, and a layer of cobble stones or gravel deposited to prevent the mud from flowing back into the trench while the piles were driven. Cobbles and riprap were then deposited up to about 18 feet below mean low water, and a binding frame sunk to the top of the cobbles using weights. This binding frame was used to prevent the front row

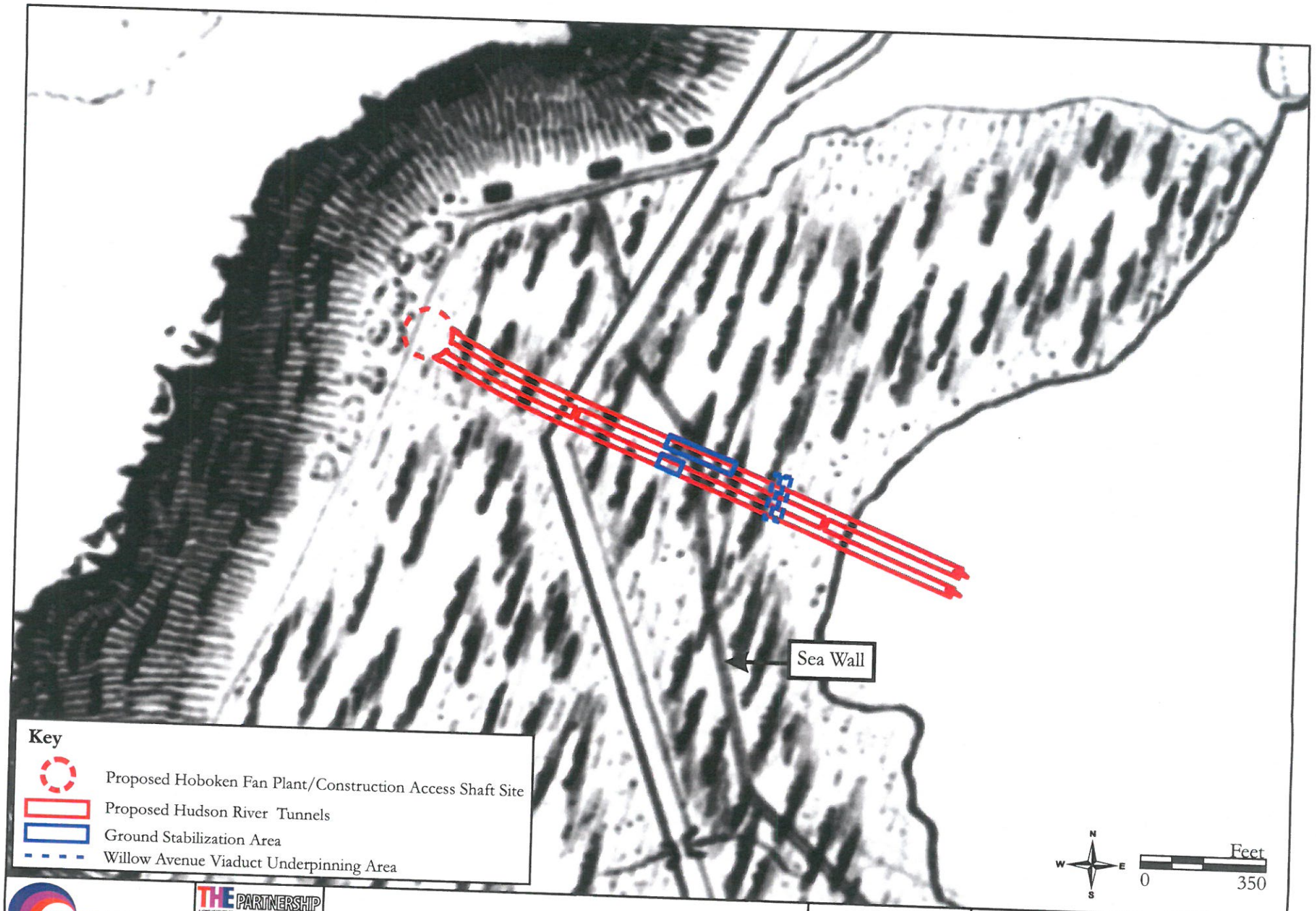
of piles from being displaced by the concrete blocks that were used to form the bulkhead facing. A concrete "mattress" was then placed across the tops of the piles, and the bulkhead superstructure built on top of it (Greene 1917: 88-90). The main piles extend up to approximately 100 feet below this concrete mattress, which corresponds roughly with the top of the riprap on the river side and the bottom of the granite bulkhead facing.

Extending westward from the new bulkhead was a series of New York City piers leased out to various companies. The tunnel alignment extends through the footprint of two of these piers which were present as early as 1883 (see **Figure 2.20**). In 1890, these piers were identified as Piers 27 and 28 (see **Figure 2.22**); by 1897, they had been renumbered (see **Figure 2.23**). Pier 57 was leased by the Columbian Line and the Panama Railroad Steamship Company (sailing for Colon, Panama; Hoag 1906: 86); the Bristol City Line (sailing for Swansea, Wales; Hoag 1906: 84) and the Arrow Line leased Pier 56.

Between 1899 and 1931, several additional, small piers with railroad sidings were constructed along the Twelfth/Thirteenth Avenue bulkhead, including one within the Hudson River tunnel alignment that serviced the Erie Railroad Freight Yard bounded by Twelfth and Eleventh Avenues, and West Twenty-Eighth and West Twenty-Ninth Streets (see **Figure 2.25**; Nationwide Environmental Title Research 1931; Sanborn-Perris Map Company 1899). The siding was probably completed following the 1901 purchase of the property by the Erie Land and Improvement Company, the real estate arm of the Erie Railroad (THE Partnership 2009c: 2-4). Tenants of Piers 56 and 57 from this time through at least 1967 were the Panama Railroad Company Steamship Line and the Lehigh Valley Railroad Company (George W. Bromley & Co. 1967). The small railroad pier within the APE was extended to the pierhead line sometime between 1954 and 1966, and demolished between 1966 and 1980 (Nationwide Environmental Title Research 1954, 1966, 1980). Although piers generally began to be abandoned and demolished rather than repaired and/or expanded between 1931 and 1954 (THE Partnership 2009b: 2-5), it was not until the late twentieth century that Piers 56 and 57 within the tunnel alignment were abandoned. Sometime between 1966 and 1980, Pier 57 had been demolished, with only remnant piles visible within the Hudson River; Pier 56 at this time appeared to be abandoned and deteriorating. Sometime between 1987 and 2004, the superstructure of Pier 56 had been removed, within only pilings remaining visible (Nationwide Environmental Title Research 1966, 1980, 1987, 2004).

By 1934, the portion of the elevated West Side Highway (also known as the Miller Highway) that intersects the tunnel alignment was completed (see **Figure 2.25**). The full length of the West Side Highway between the Battery and West Seventy-Second Street, generally following the alignment of Twelfth/Thirteenth Avenue, was completed by 1936. In December 1973, the West Side Highway was closed, following a partial collapse of the structure; between 1974 and 1987, the superstructure of the West Side Highway was demolished (YU & Associates 2007: 7). The upper portions of the remaining subsurface pilings and pier supports of the West Side Highway were scheduled for removal in the vicinity of the APE in the late-twentieth century; deeply buried portions of these piers and supports remain, and may remain within the C10 Hudson River Tunnel alignment (see **Figure 1.7;** Vollmer Associates 1997). These are not considered to be potentially significant resources.

Piers within the C10 Hudson River Tunnel alignment include: the West Twenty-Eighth Street pier (constructed between 1870 and 1879; demolished circa 1890); Pier 57 (constructed between 1879 and 1883; demolished between 1966 and 1980); Pier 56 (constructed between 1879 and 1883; demolished between 1987 and 2004); and a small railroad pier (constructed between 1891 and 1931, extended between 1954 and 1966; demolished between 1966 and 1980). According to the standards of the post-1870 New York City redevelopment program, the decking of these piers would have been approximately five feet above the mean high water mark (or approximately +300 feet on **Figure 2.27**). When these piers were demolished, their pilings appear to have been left in place. These pilings, as well as those associated with the circa 1883 to 1897 Twelfth/Thirteenth Avenue bulkhead, may be impacted by tunnel drilling above bedrock, as proposed for the Hudson River Tunnels approaching Manhattan. In cases where the depth from mean high water to bedrock is less than approximately 100 feet, it is likely that the pilings were driven directly to bedrock (see **Figure 2.27**).



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C10 Hudson River Tunnels

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Figure 2.1: 1837 United States Coast Survey, Map of the Part of the State of New Jersey Between Hackensack and Bergen.

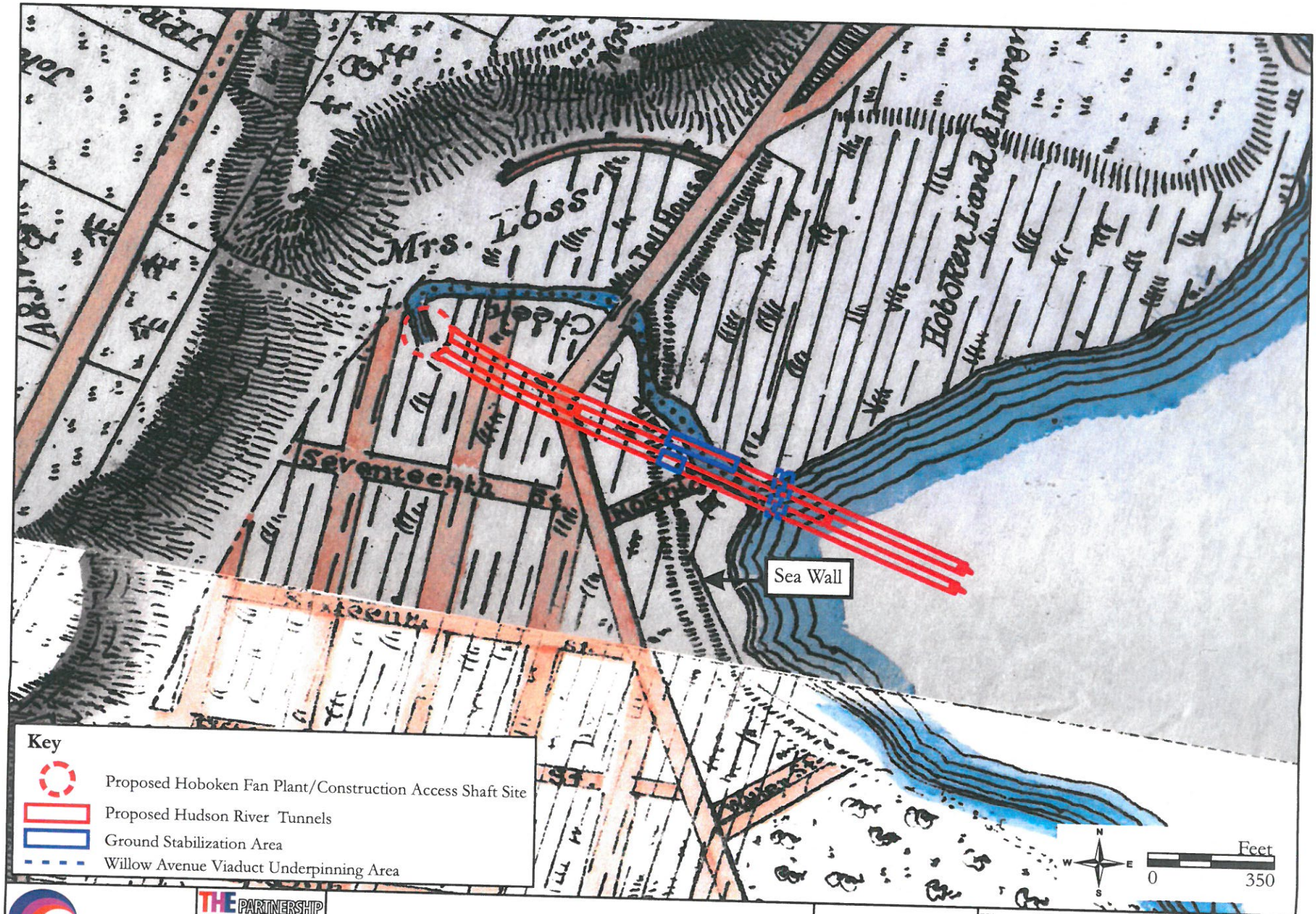

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Figure 2.2: 1841 L.F. Douglass, Topographical Map, Jersey City, Hoboken and the Adjacent County.

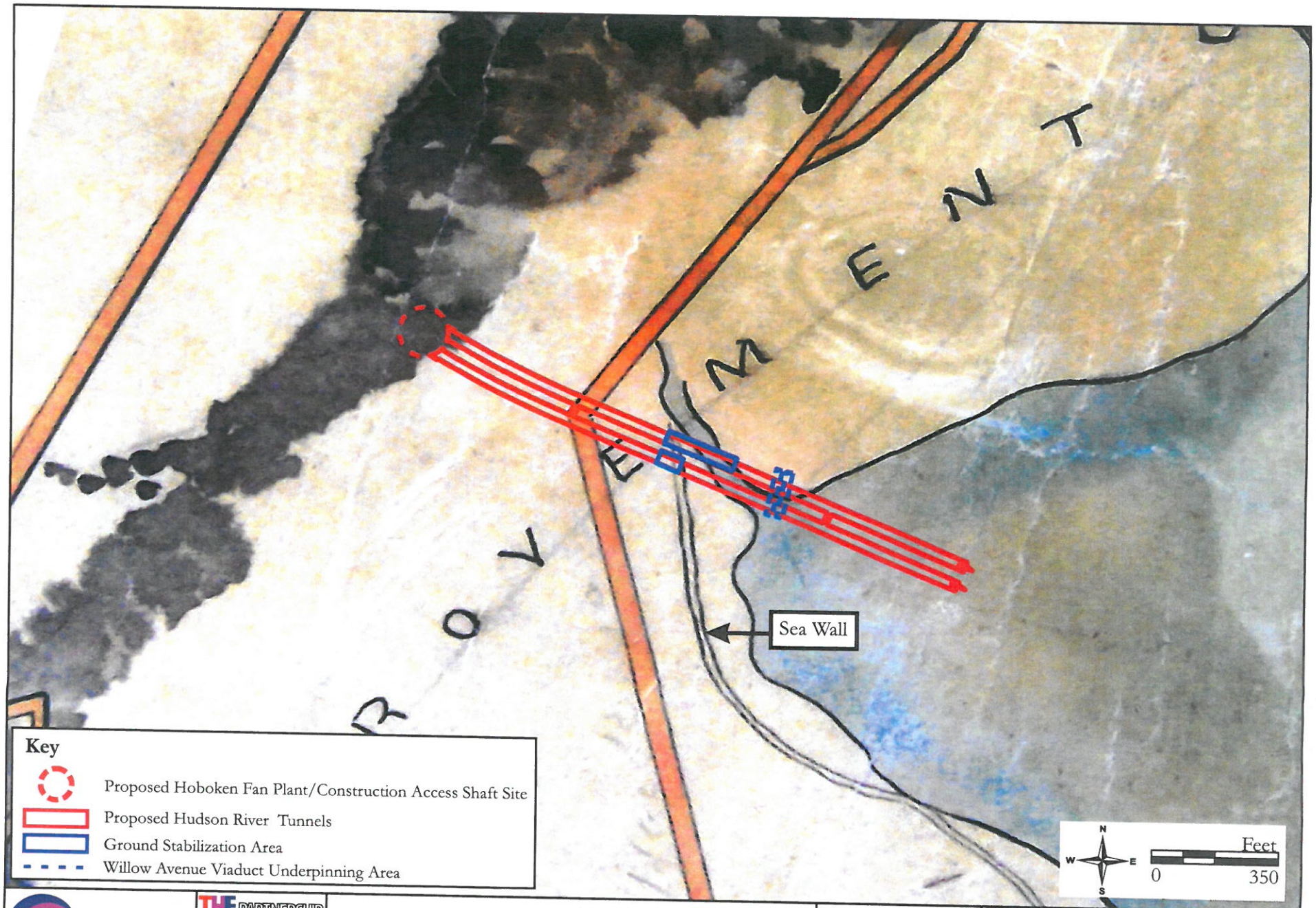

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Figure 2.3: 1848 A. Clerk, Map of Hudson County, State of New Jersey.

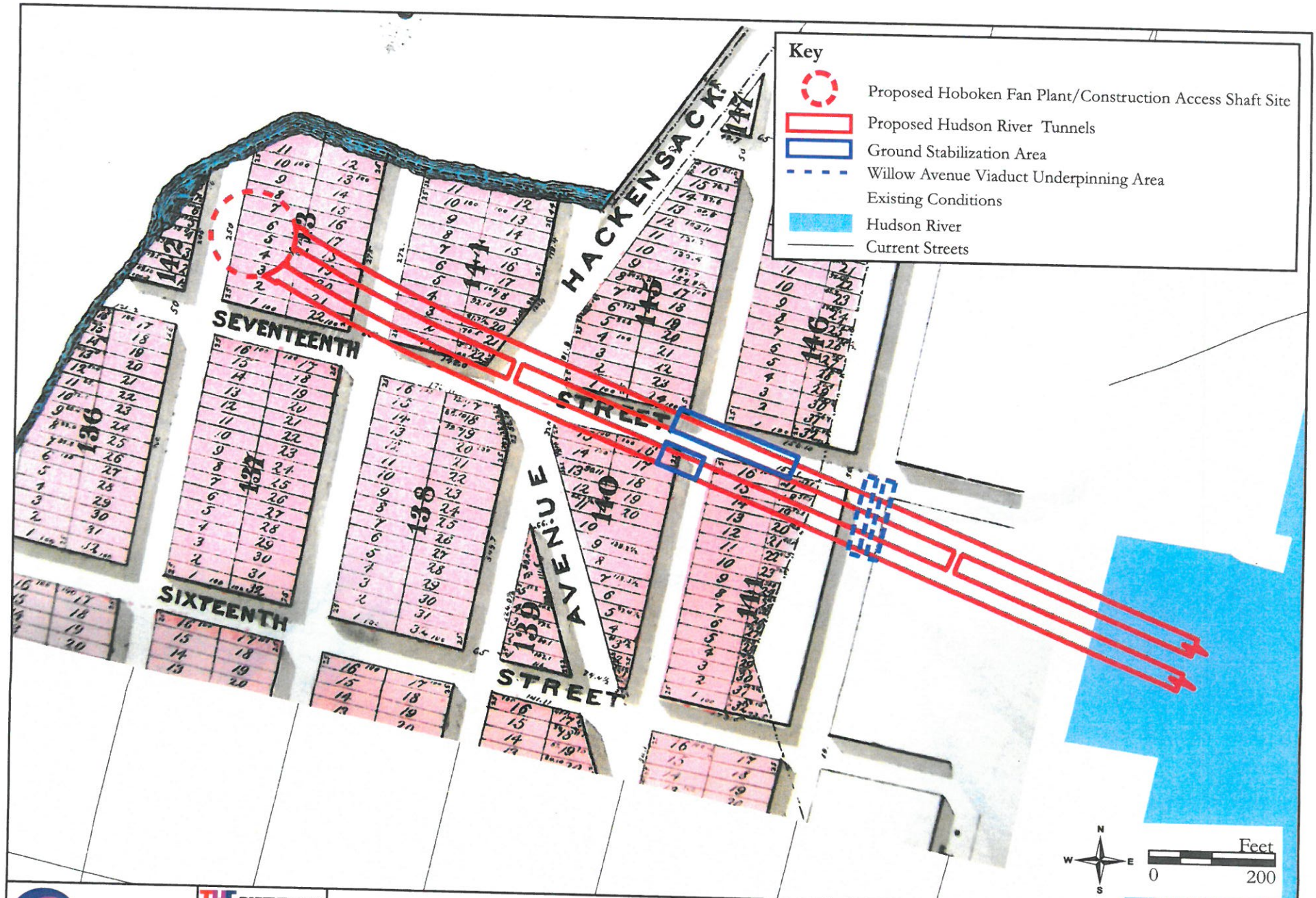

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Figure 2.4: 1860 Daniel Ewen and Austin D. Ewen, Map of the Properties Situate at Hoboken, Hudson County, New Jersey.

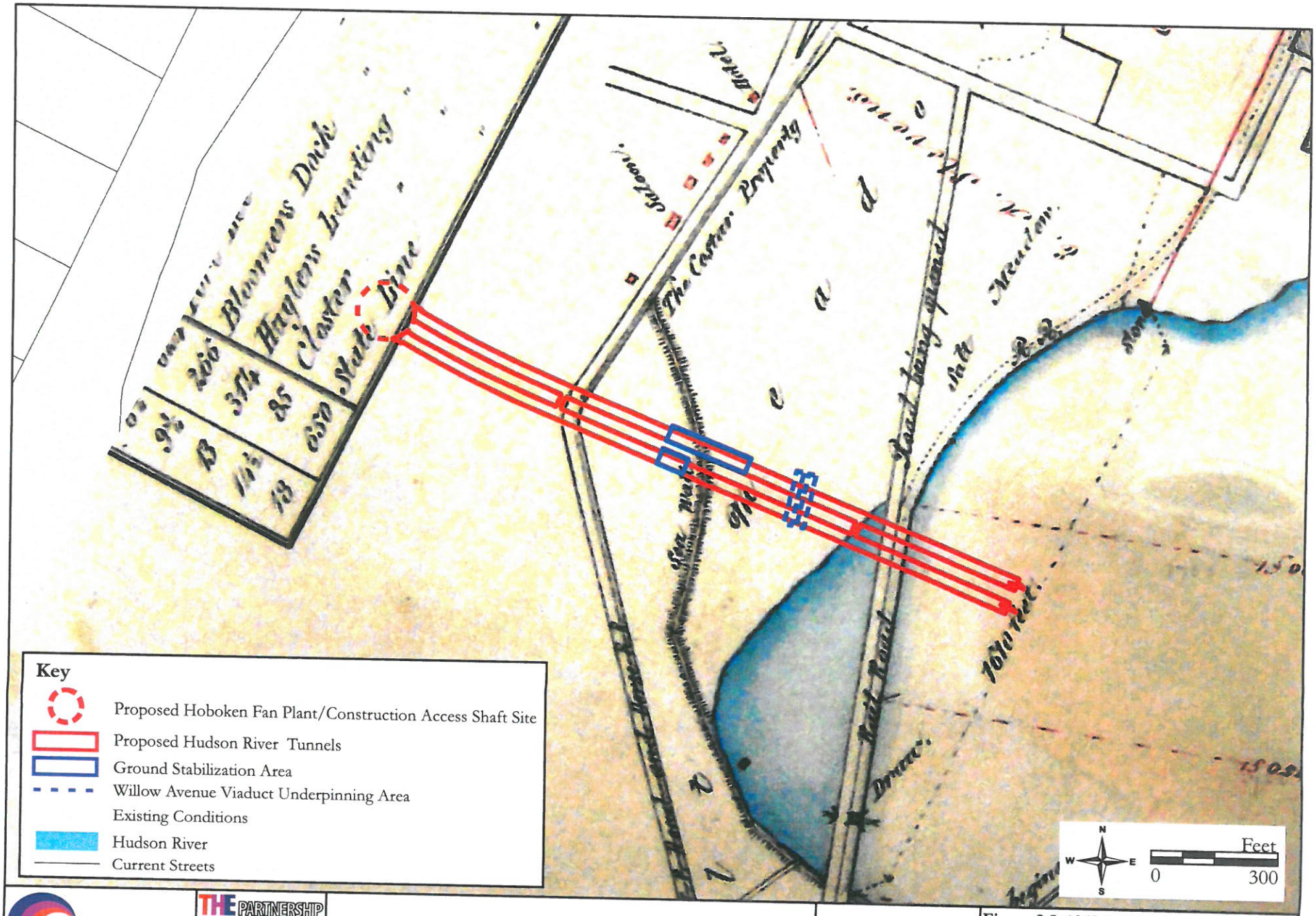

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Figure 2.5: 1865 F.J. Mallory and W.M. Miller, Section No. 5A, Map Showing the Survey of Lands Lying Under the Waters of the Hudson River.

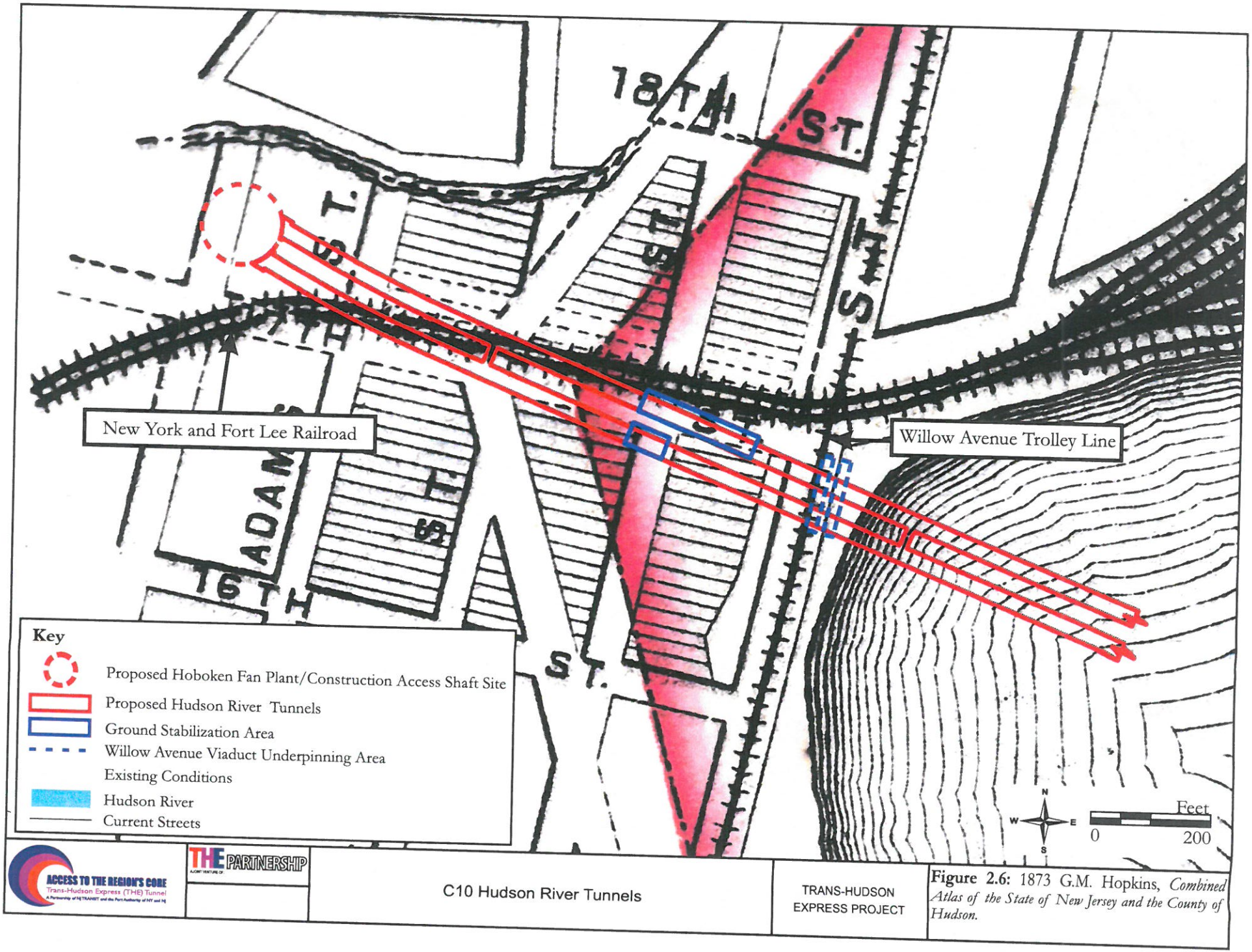

Figure 2.6: 1873 G.M. Hopkins, *Combined Atlas of the State of New Jersey and the County of Hudson.*

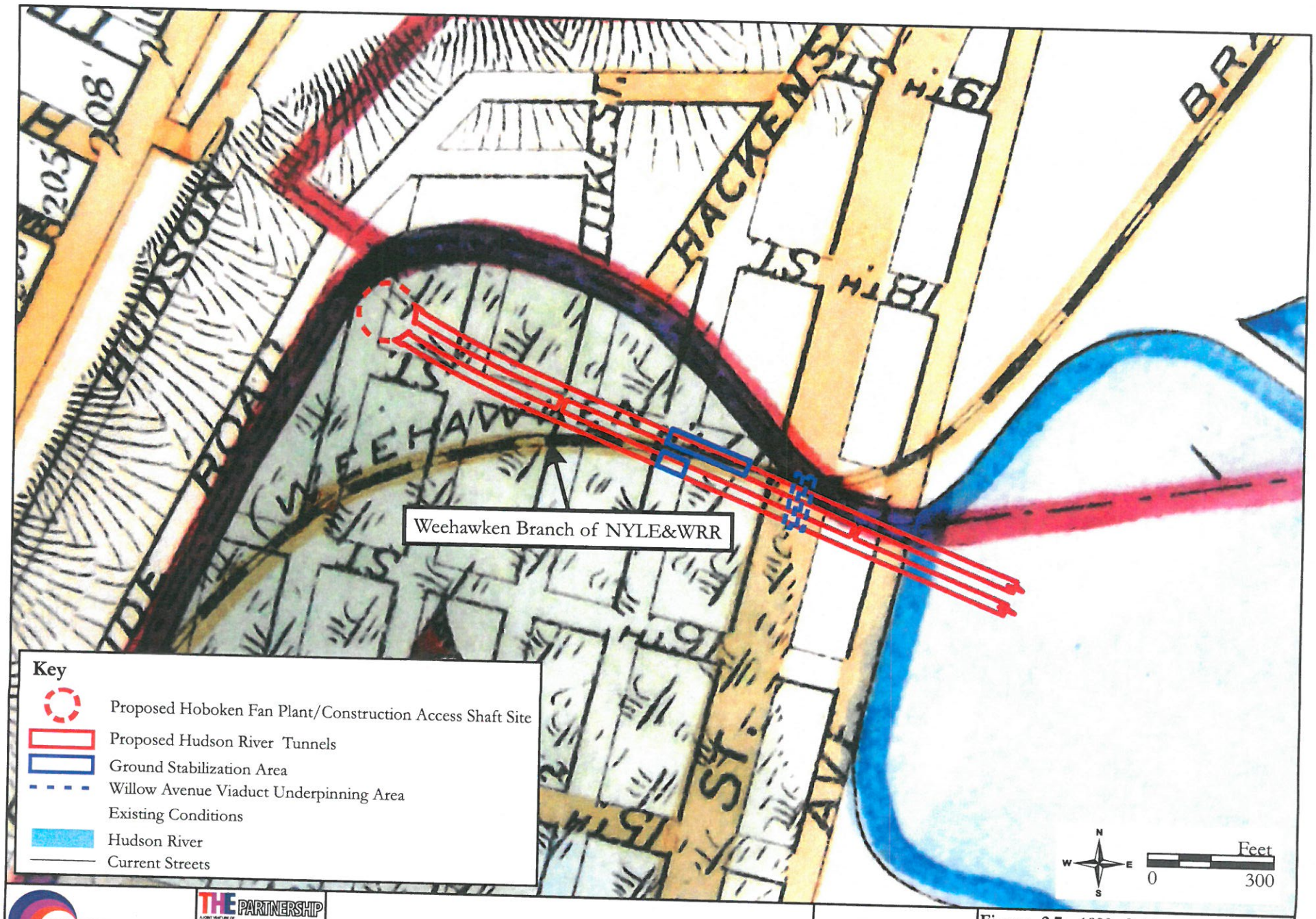

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Figure 2.7: 1880 Spielmann and Brush, Sanitary and Topographical Map of Hudson County, New Jersey.

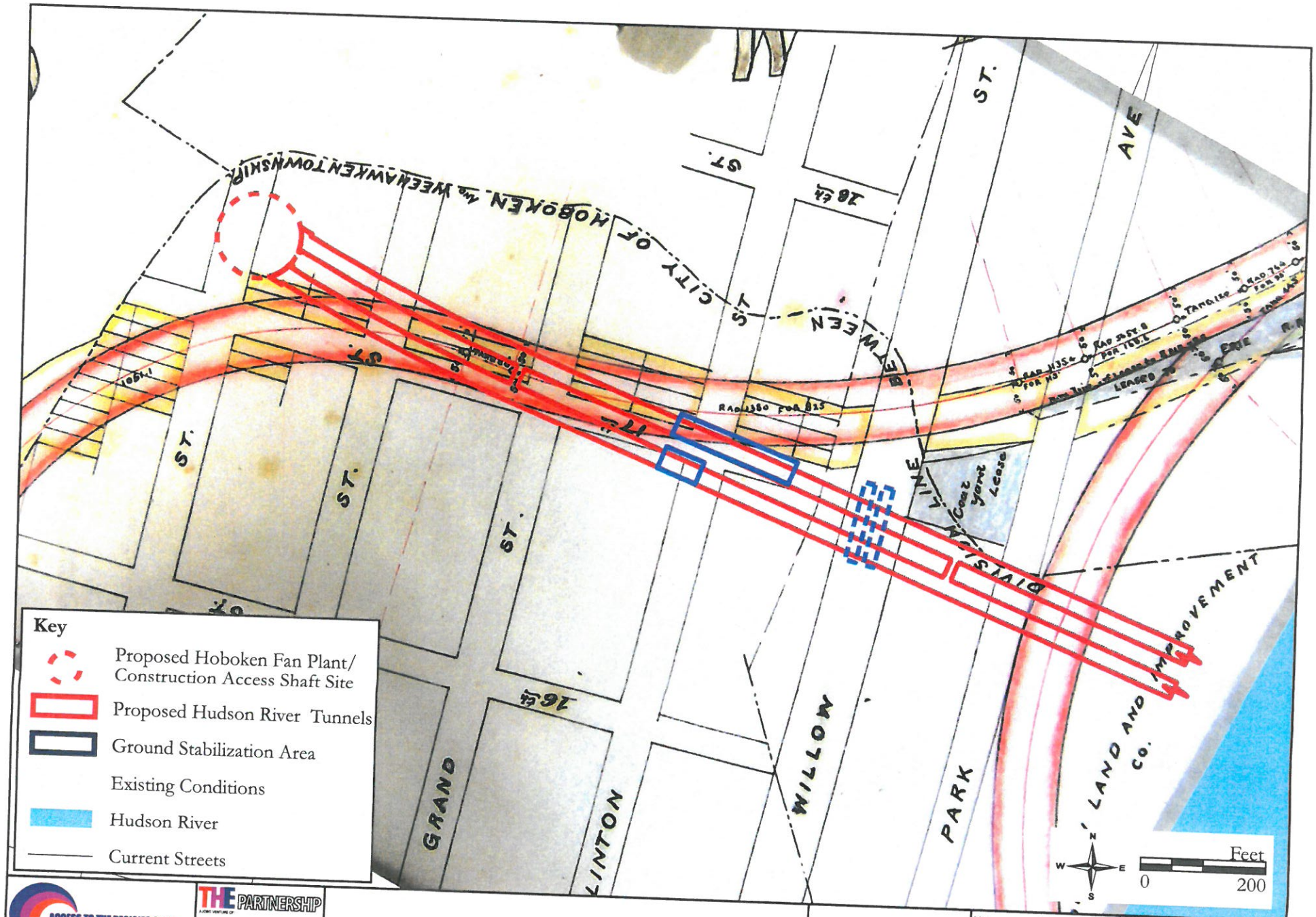

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Figure 2.8: 1886 New Jersey Junction Railroad, Survey and Map of the Route of the Railroad of New Jersey Junction Railroad Company.

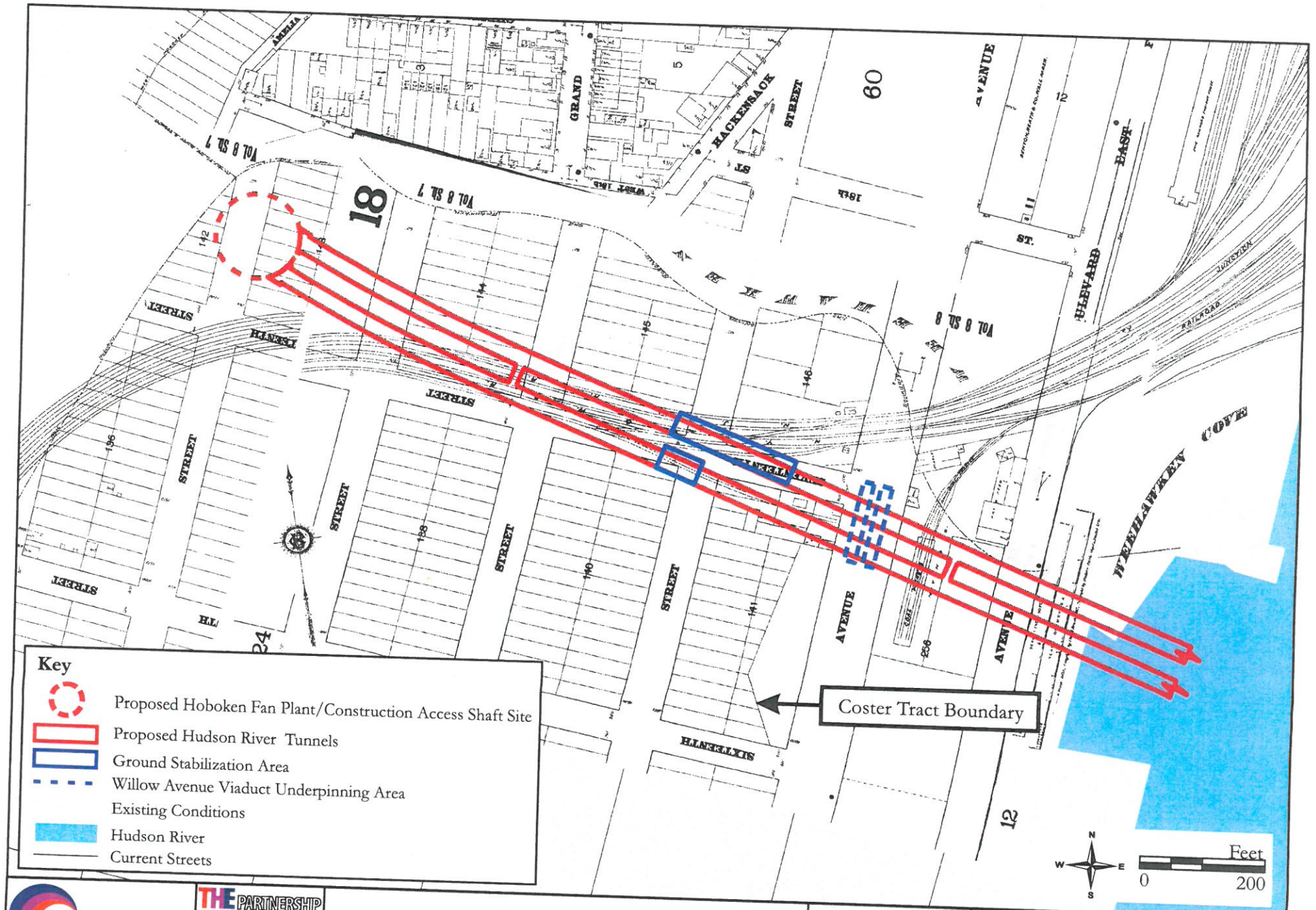

Figure 2.9: 1891 Sanborn Perris Map Company, Insurance Maps of Hudson County, New Jersey.

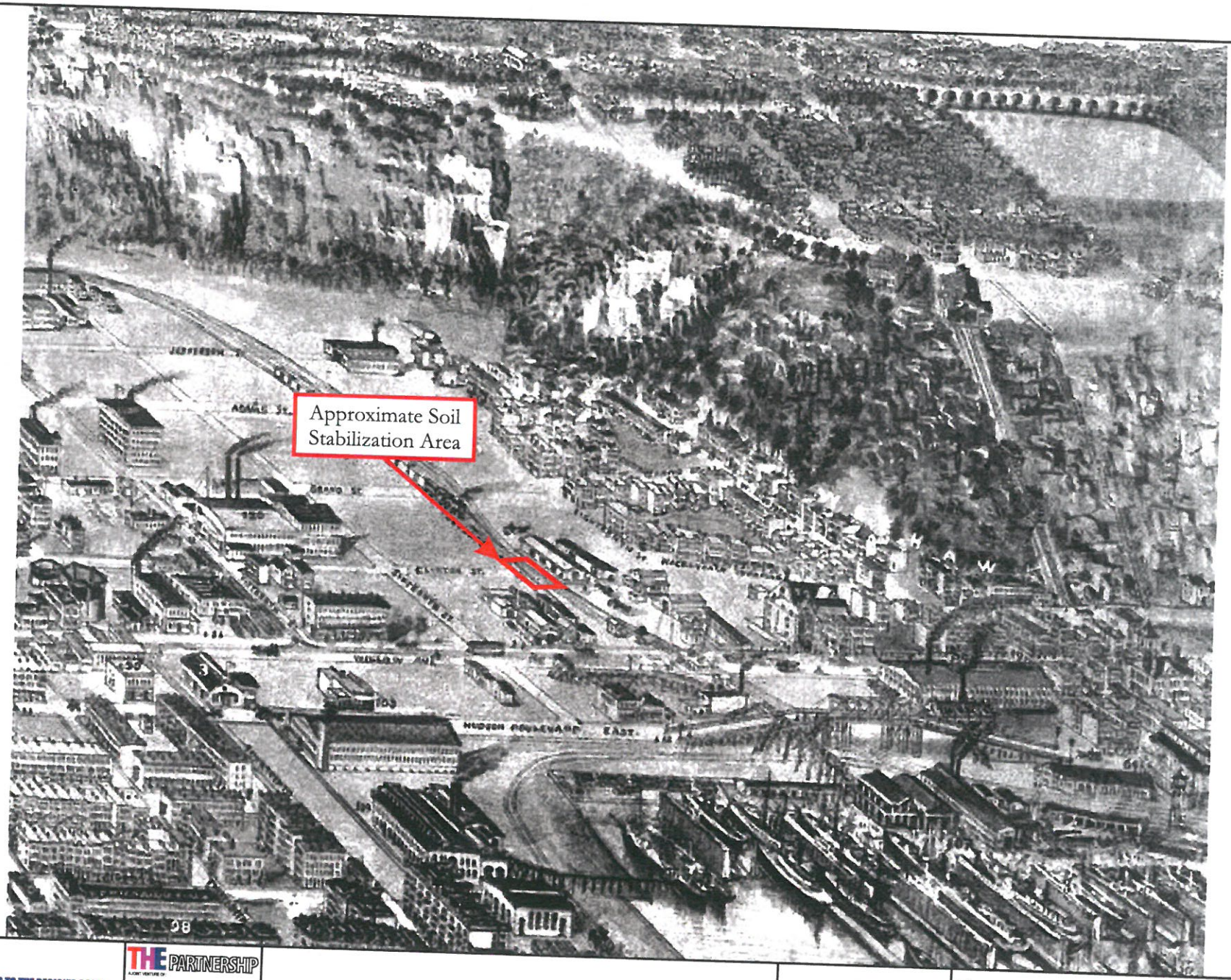

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Figure 2.10: 1904 Hughes and Bailey, City of Hoboken, New Jersey.

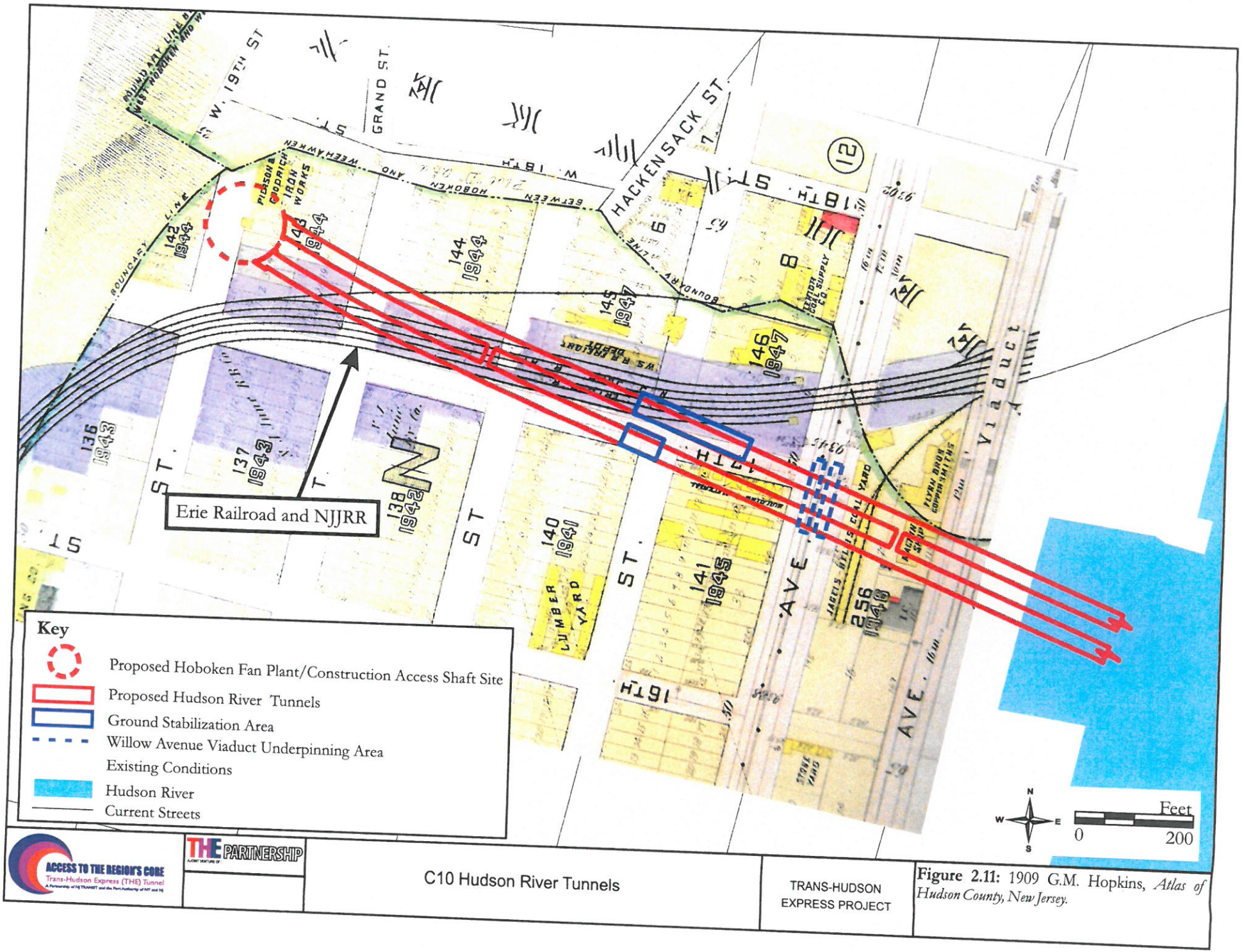

Figure 2.11: 1909 G.M. Hopkins, *Atlas of Hudson County, New Jersey.*

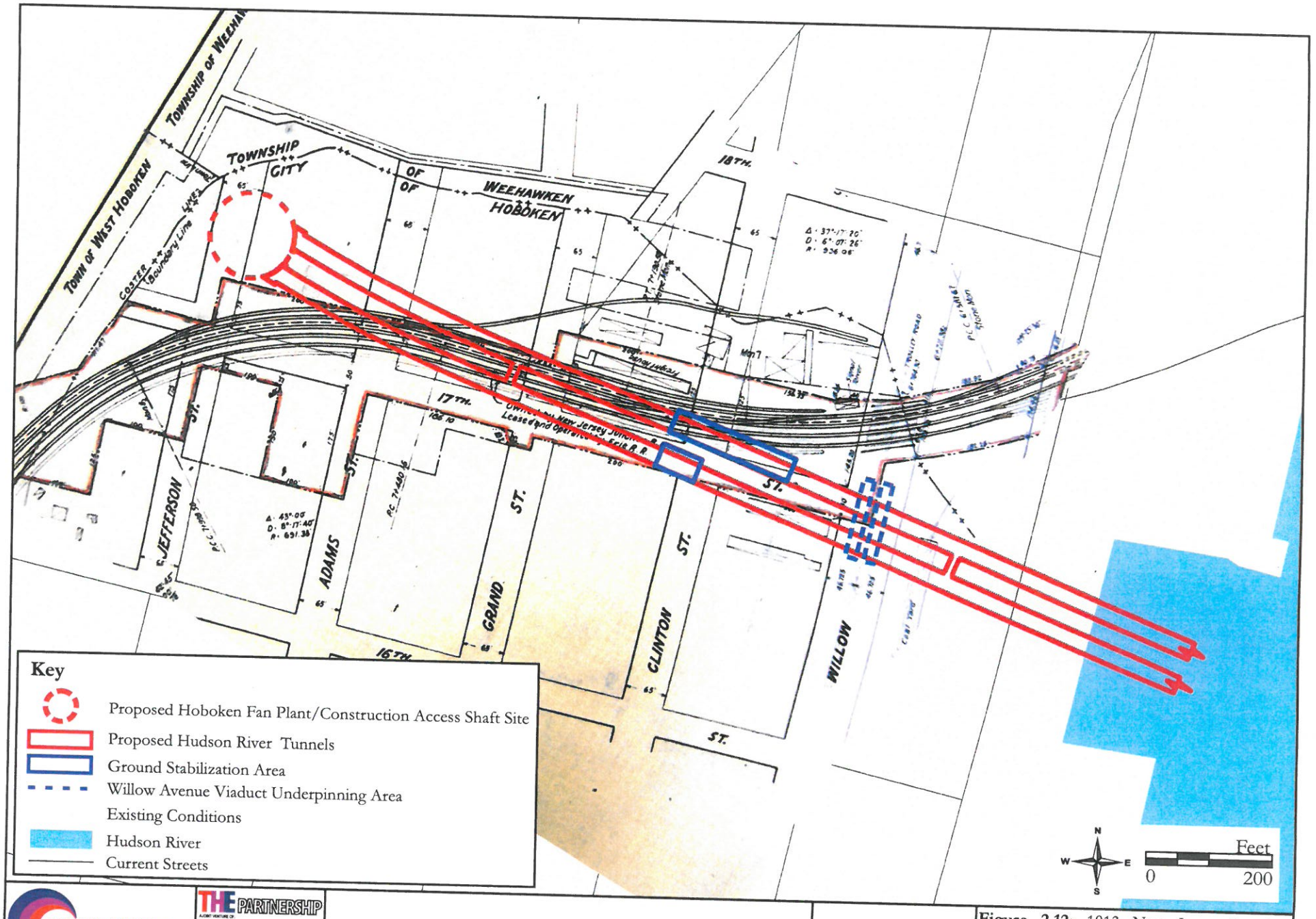

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Figure 2.12: 1913 New Jersey Junction Railroad, Map and Survey of the Line of the New Jersey Junction Railroad.

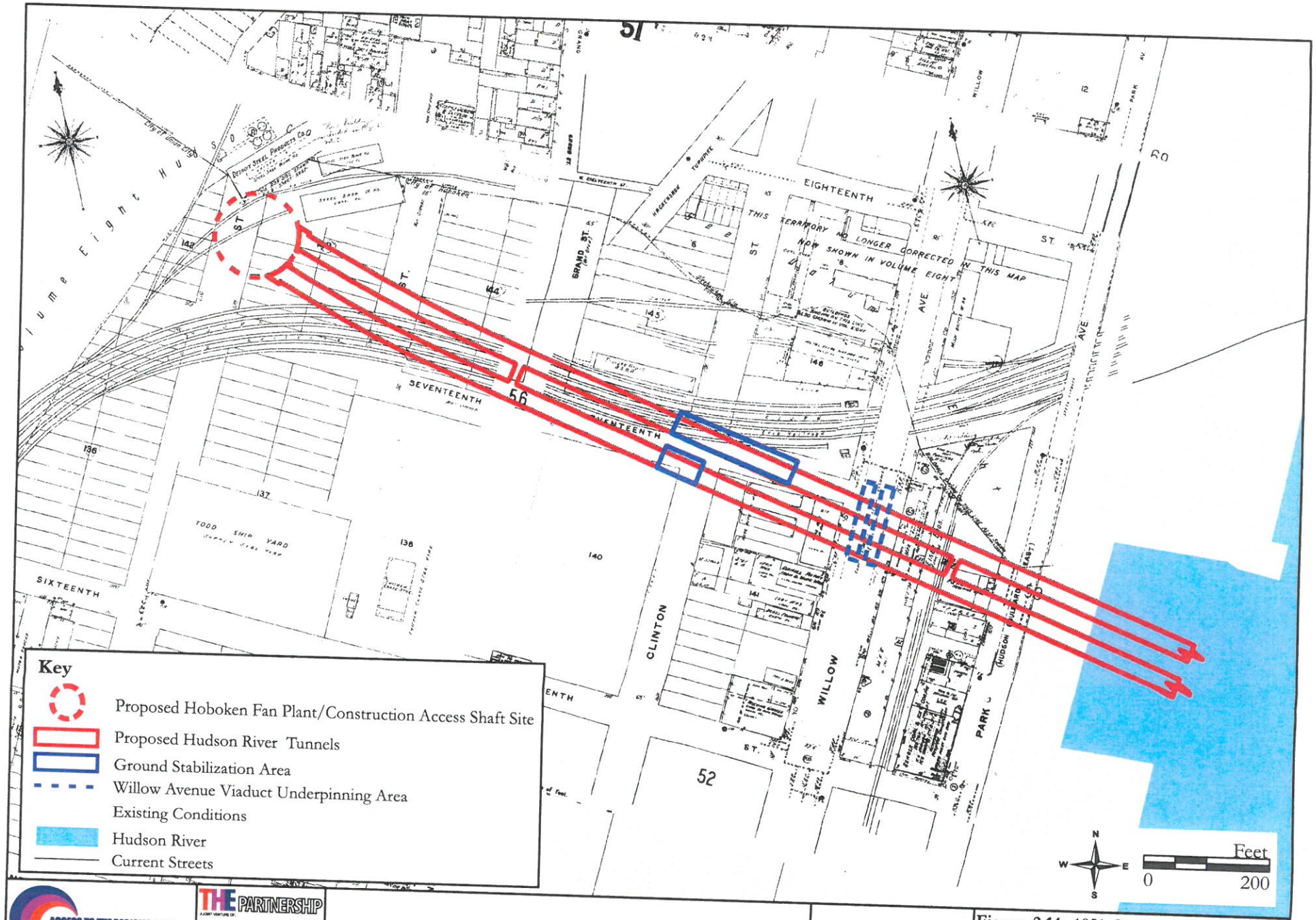

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Figure 2.14: 1951 Sanborn Map Company, Insurance Maps of Hudson County, New Jersey.

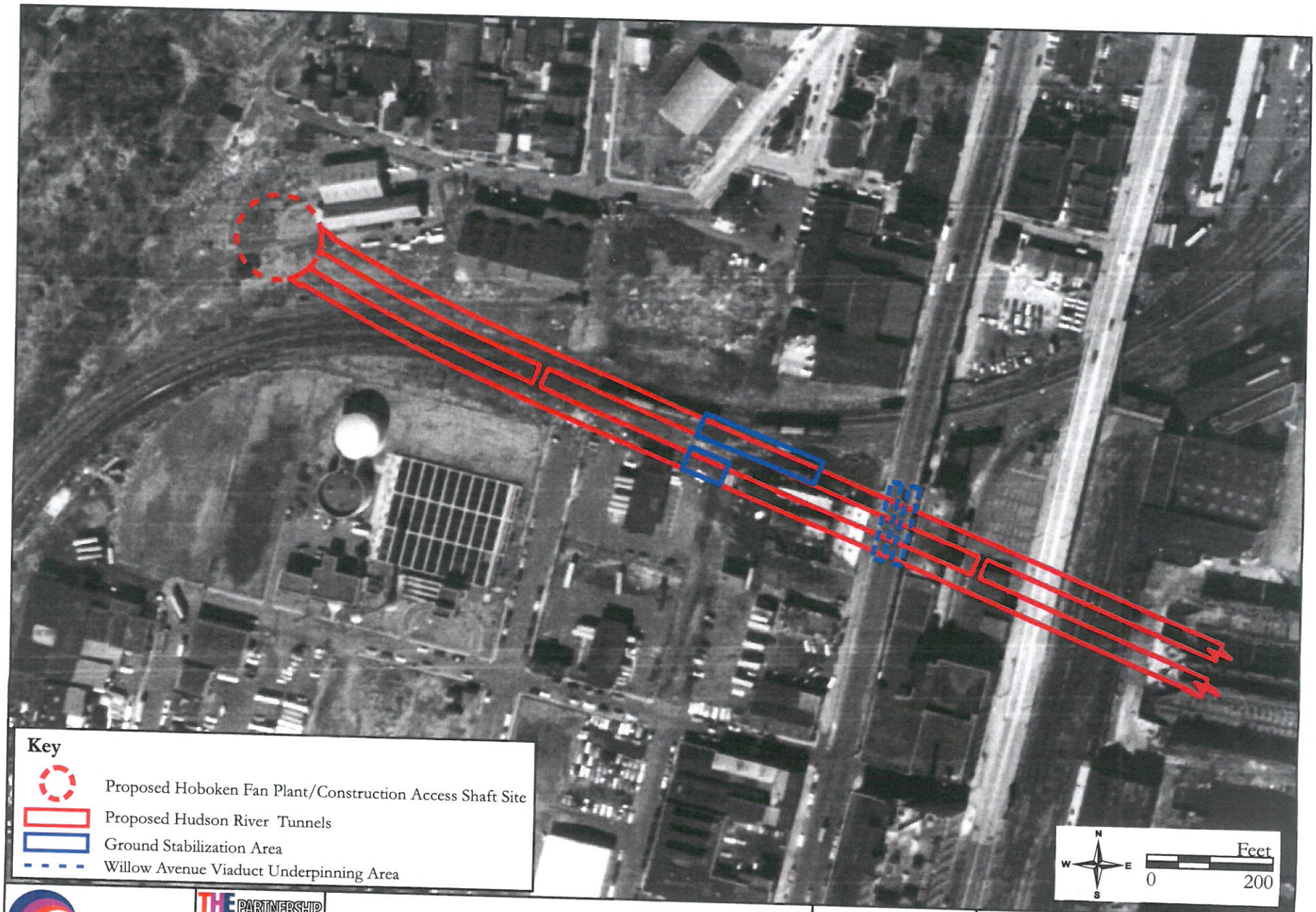

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Figure 2.15: 1966 Nationwide Environmental Title Research, Historic Aerial Photographs.

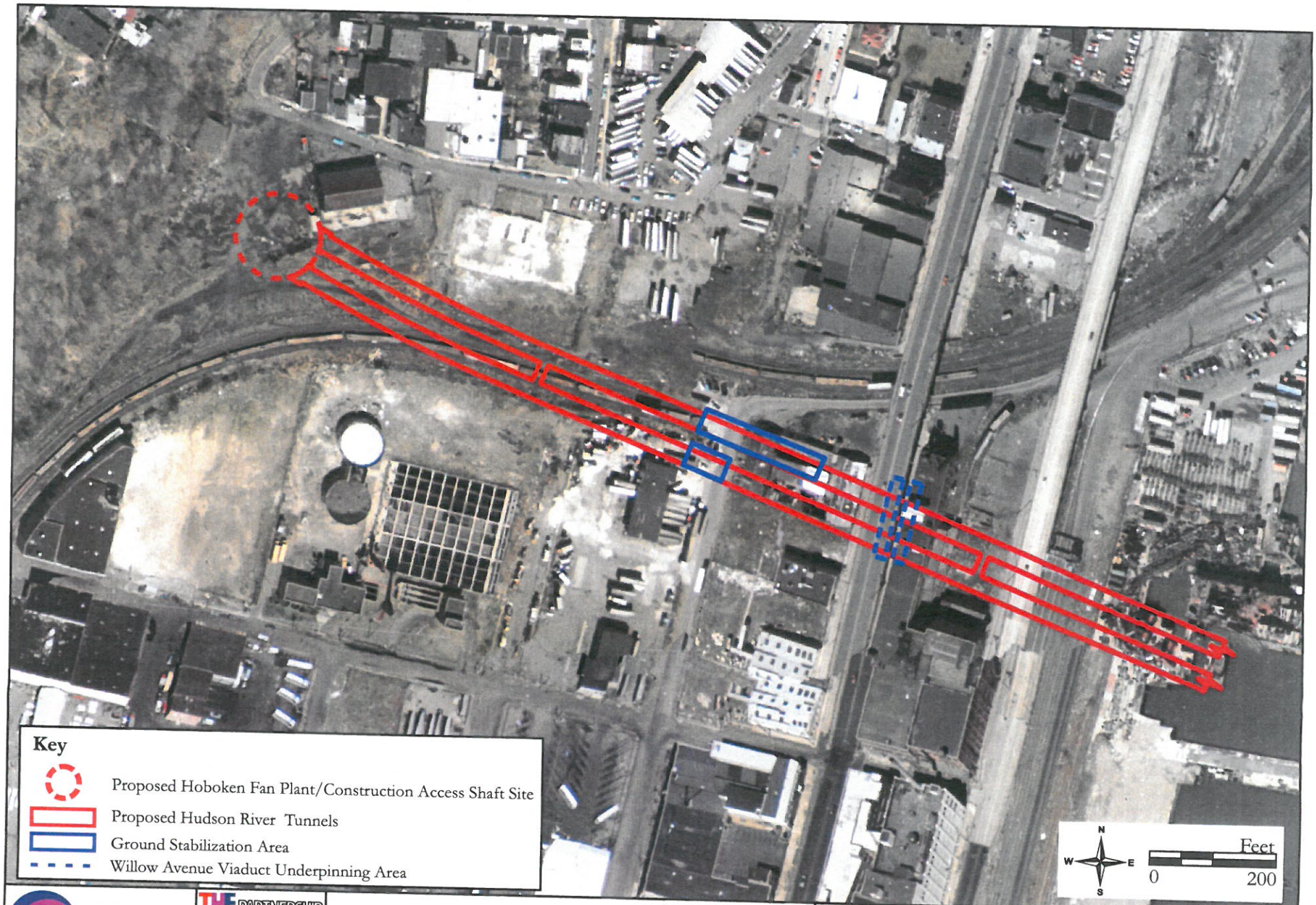

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Figure 2.16: 1979 Nationwide Environmental Title Research, Historic Aerial Photographs.

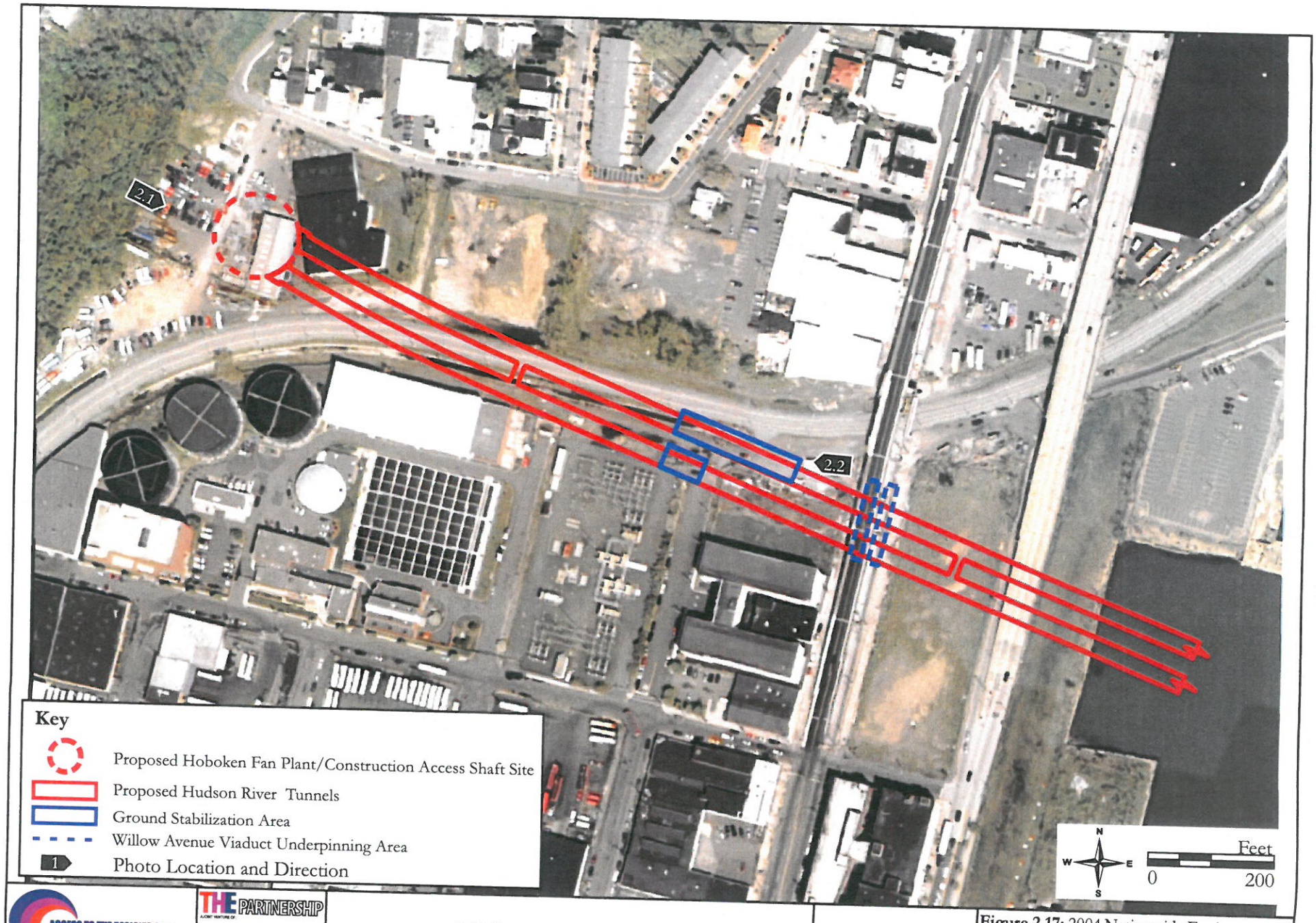

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Figure 2.17: 2004 Nationwide Environmental Title Research, Historic Aerial Photographs with Photo Locations and Directions (Hoboken).

NEWARK

NEW YORK

NOTES:

1. CONTRACTOR SHALL PROVIDE GROUND TREATMENT PRIOR TO EXCAVATION FOR PROTECTION OF EXISTING HBLR TRACKS WITHIN THE AREA OF MIXED-FACE TUNNELING. APPROXIMATE LIMITS OF GROUND TREATMENT ARE INDICATED. CONTRACTOR TO ADJUST THESE LIMITS AS NECESSARY.
2. CONTRACTOR SHALL PROVIDE GROUND TREATMENT OR UNDERPINNING FOR EXISTING PSE&G 230 KV TRANSMISSION LINE WITHIN THE AREA OF MIXED-FACE TUNNELING. APPROXIMATE LIMITS OF GROUND TREATMENT ARE INDICATED. CONTRACTOR TO ADJUST THESE LIMITS AS NECESSARY.
3. SEE DWG NO. GT-60121 FOR DETAILS OF CONCEPTUAL UNDERPINNING SCHEME.
4. PRIOR TO TBM TUNNEL DRIVE, ISOLATE EXISTING PILES. AFTER COMPLETION OF AT LEAST 150FT OF TUNNEL EAST OF CLINTON STREET, REATTACH PILES.

LEGEND:

- GROUND TREATMENT FOR PROTECTION OF HBLR TRACKS (SEE NOTE 1)
- GROUND TREATMENT OR UNDERPINNING FOR PROTECTION OF PSE&G 230 KV TRANSMISSION LINE (SEE NOTES 2 AND 3)

Soil Stabilization Area

C GT-60406

A GT-60405

B GT-60405

100'±

100'±

P1 1150+00

P0 1150+00

65'±

℄ CROSS PASSAGE NO 1
STA P0 1149+00

Soil Stabilization Area

SEE NOTE 4

TRACK P1
℄ TUNNEL

P1 1155+00

P0 1155+00

℄ TUNNEL
TRACK P0

WILLOW AVE BRIDGE

Key

Zone of high sensitivity for the Sea Wall (built between 1814 and 1819; present through 1865)

TRACK P0 AND P1 PLAN

SCALE IN FEET
30' 0 30' 60'

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C10 Hudson River Tunnels

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Figure 2.18: Hudson River Tunnels, Willow Avenue Mixed-Face Ground Stabilization Plan showing estimated impacts to potential resources.

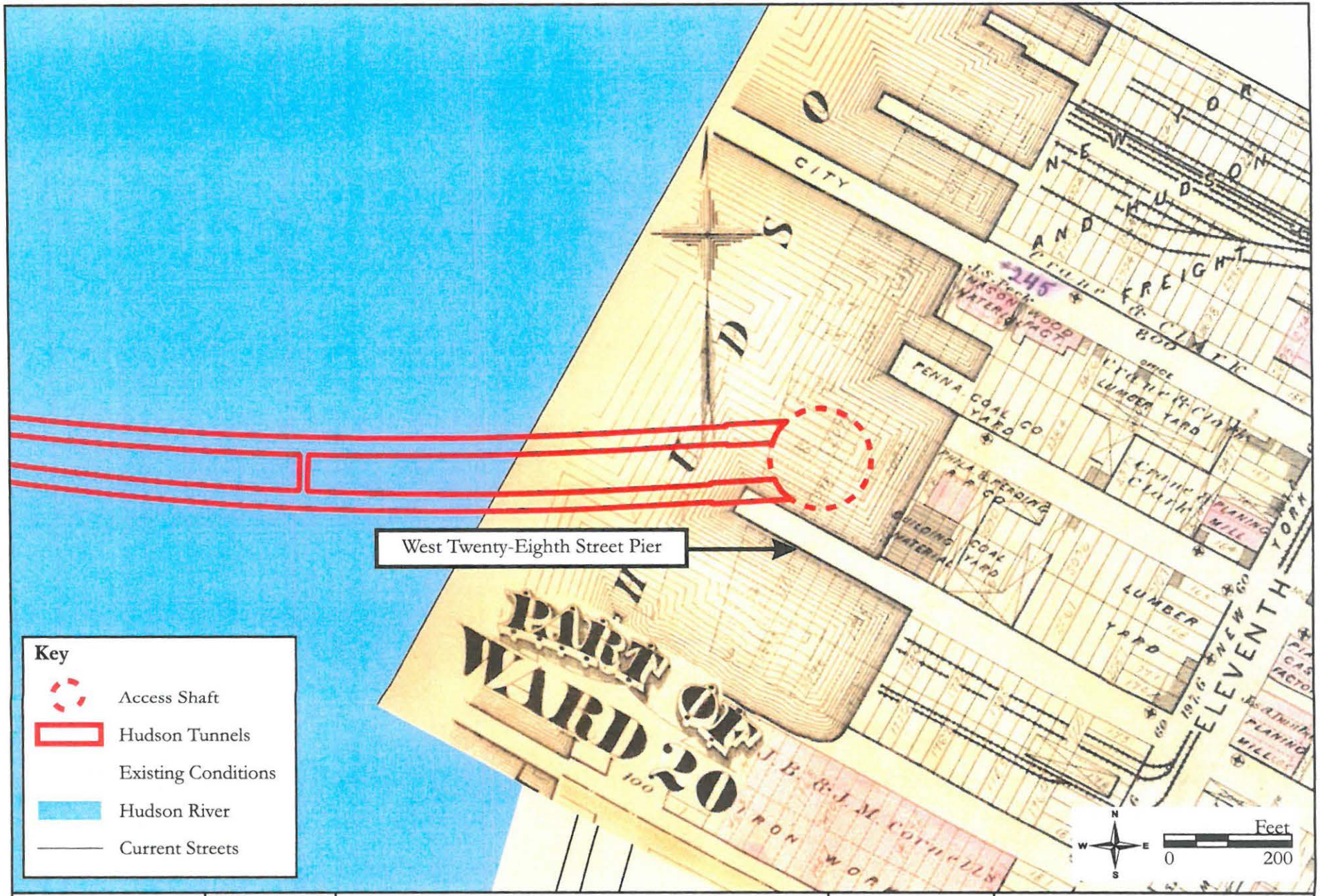

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Figure 2.19: 1879 George W. Bromley, *Atlas of the City of New York.*

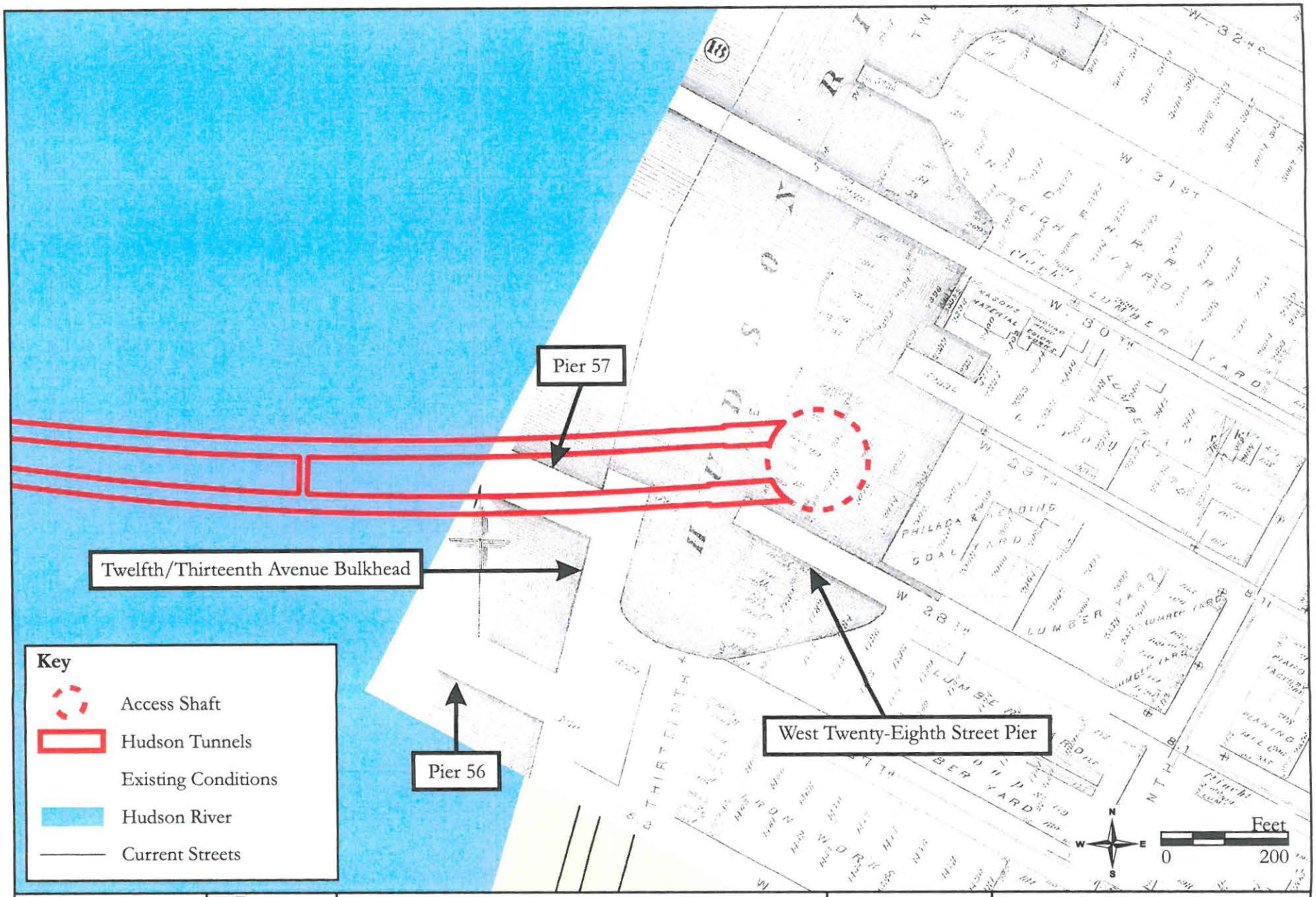

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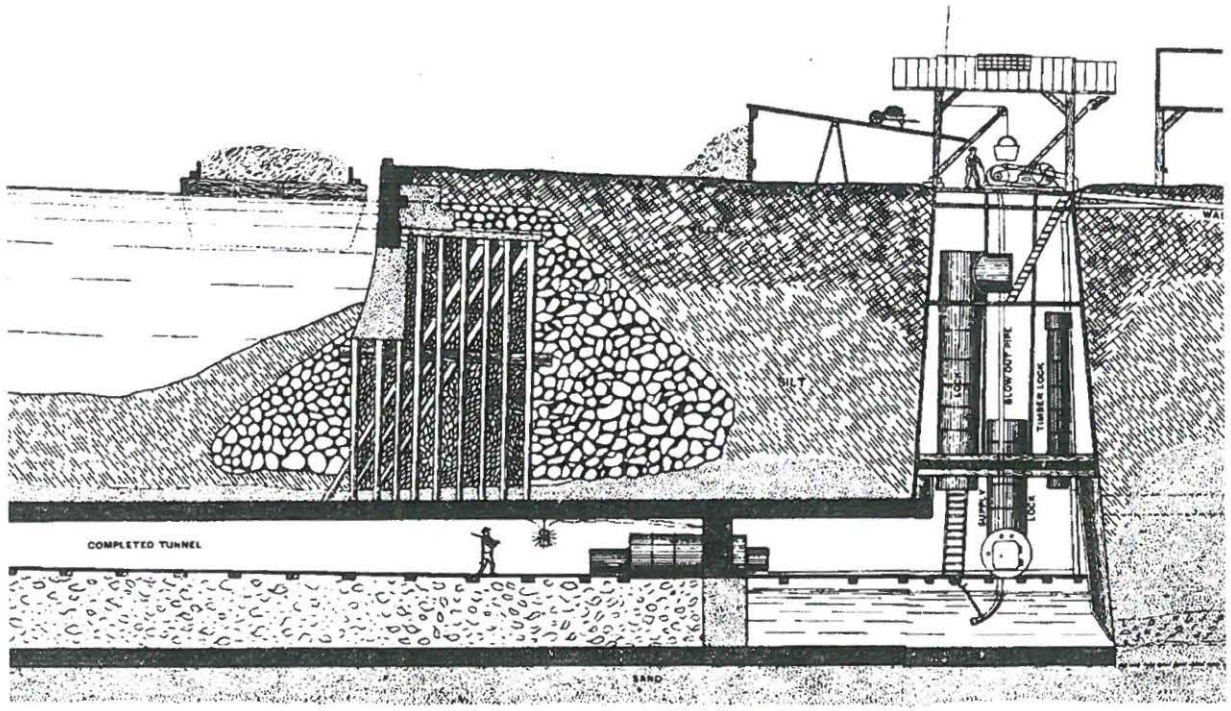
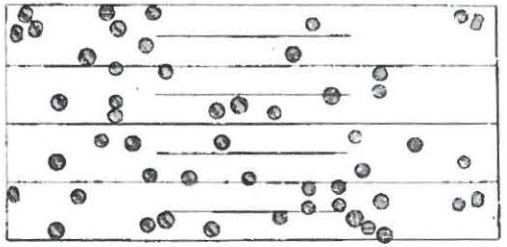
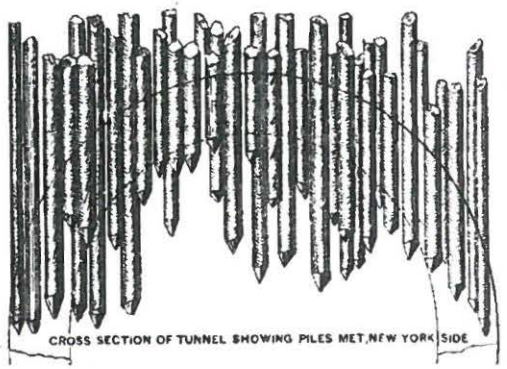
Figure 2.20: 1883 E. Robinson & R.H. Pidgeon, *Robinson's Atlas of the City of New York.*



LONGITUDINAL SECTION THROUGH TUNNEL - NEW YORK SIDE. July 1885



PLAN VIEW



CROSS SECTION OF TUNNEL SHOWING PILES MET, NEW YORK SIDE

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Figure 2.21: Hudson River Tunnels, longitudinal section in Manhattan and arrangement of bulkhead pilings.(Source: Burr 1885).

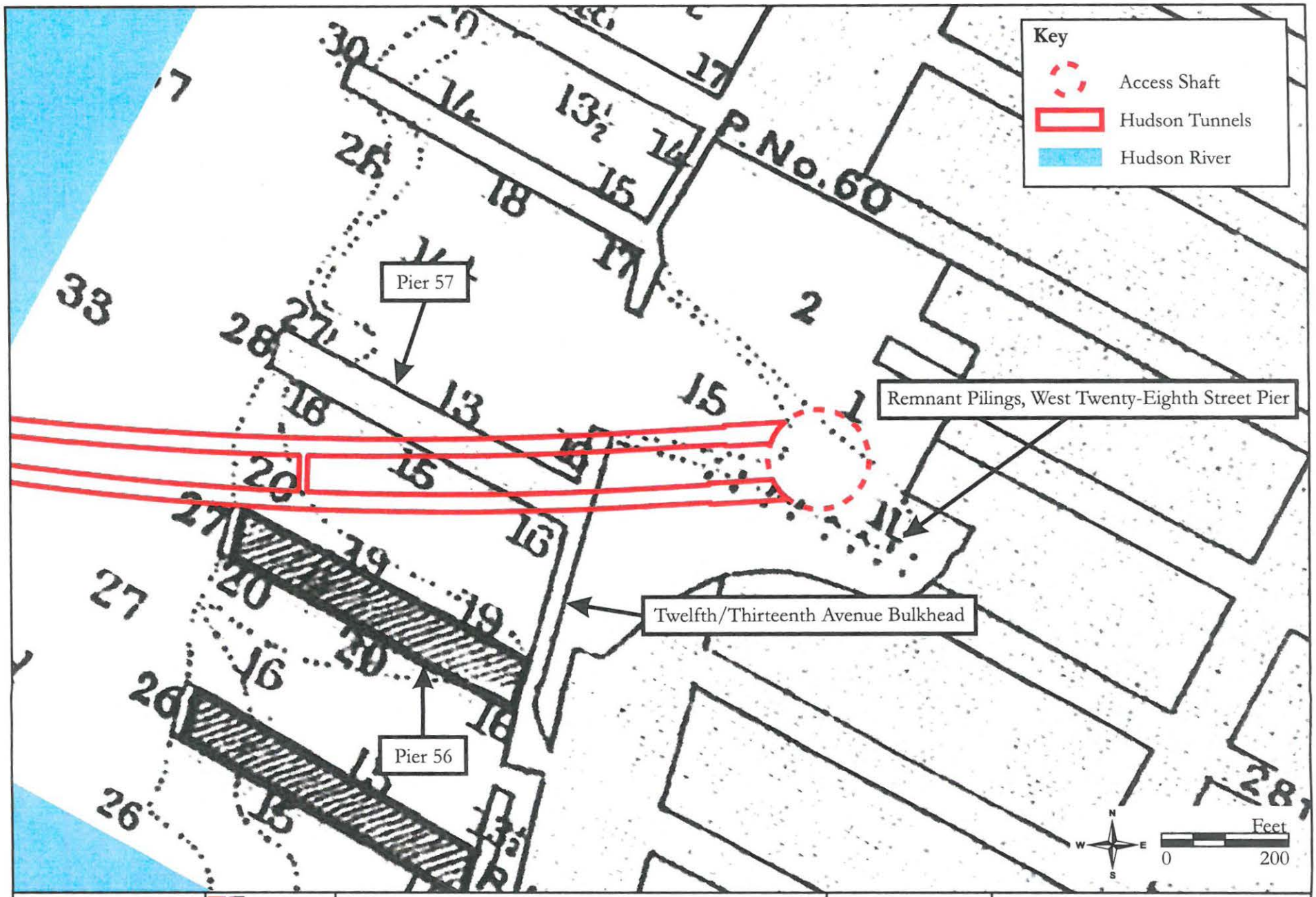

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Figure 2.22: 1890 United States Coast and Geodetic Survey.

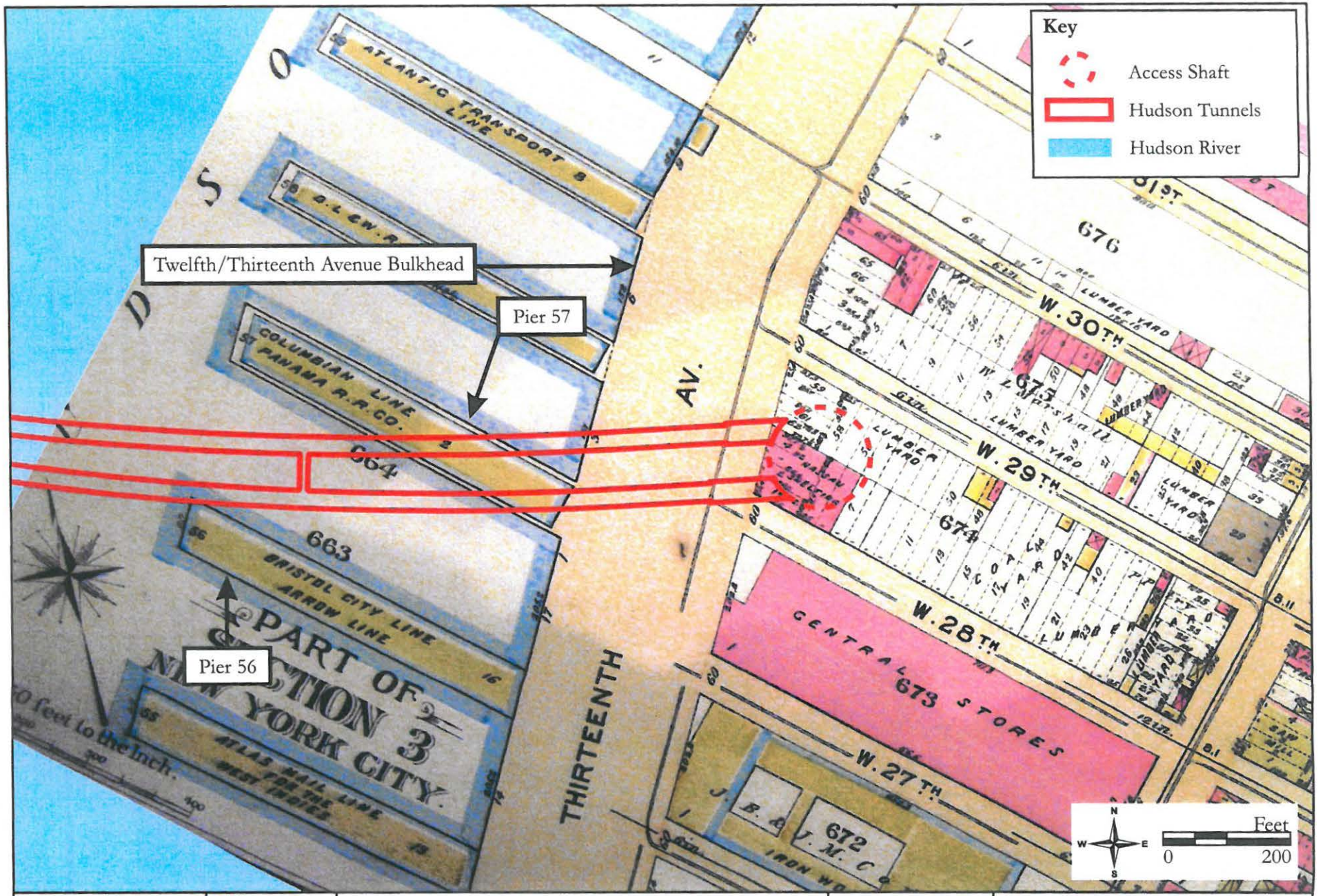

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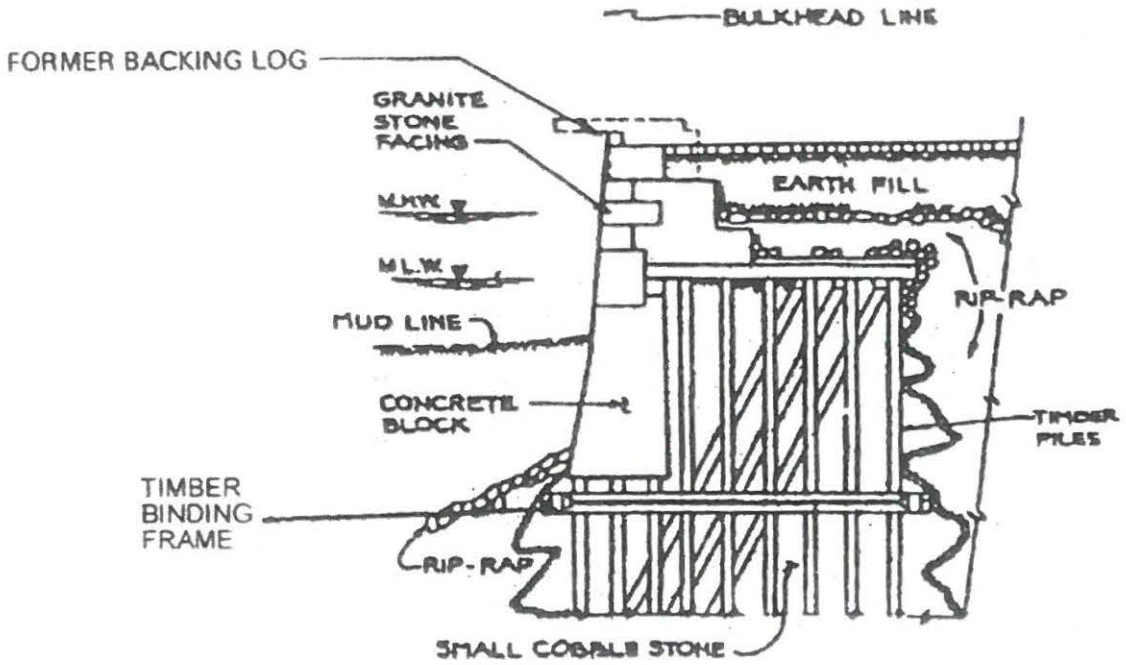
Figure 2.23: 1897 G. Bromley and W. Bromley, *Atlas of the City of New York.*



TYPE III-B

Granite wall on narrow concrete block, with inclined bracing piles taking lateral thrusts to below base block, and timber binding frame around piles. Built 1876-1898 in many areas between Warren and 38th Streets.

Figure 2.24: Detail, Type III-B Bulkhead Construction, from Type III: Pile-Supported Granite Bulkhead with Timber Relieving Platforms (Source: Raber Associates 2000).

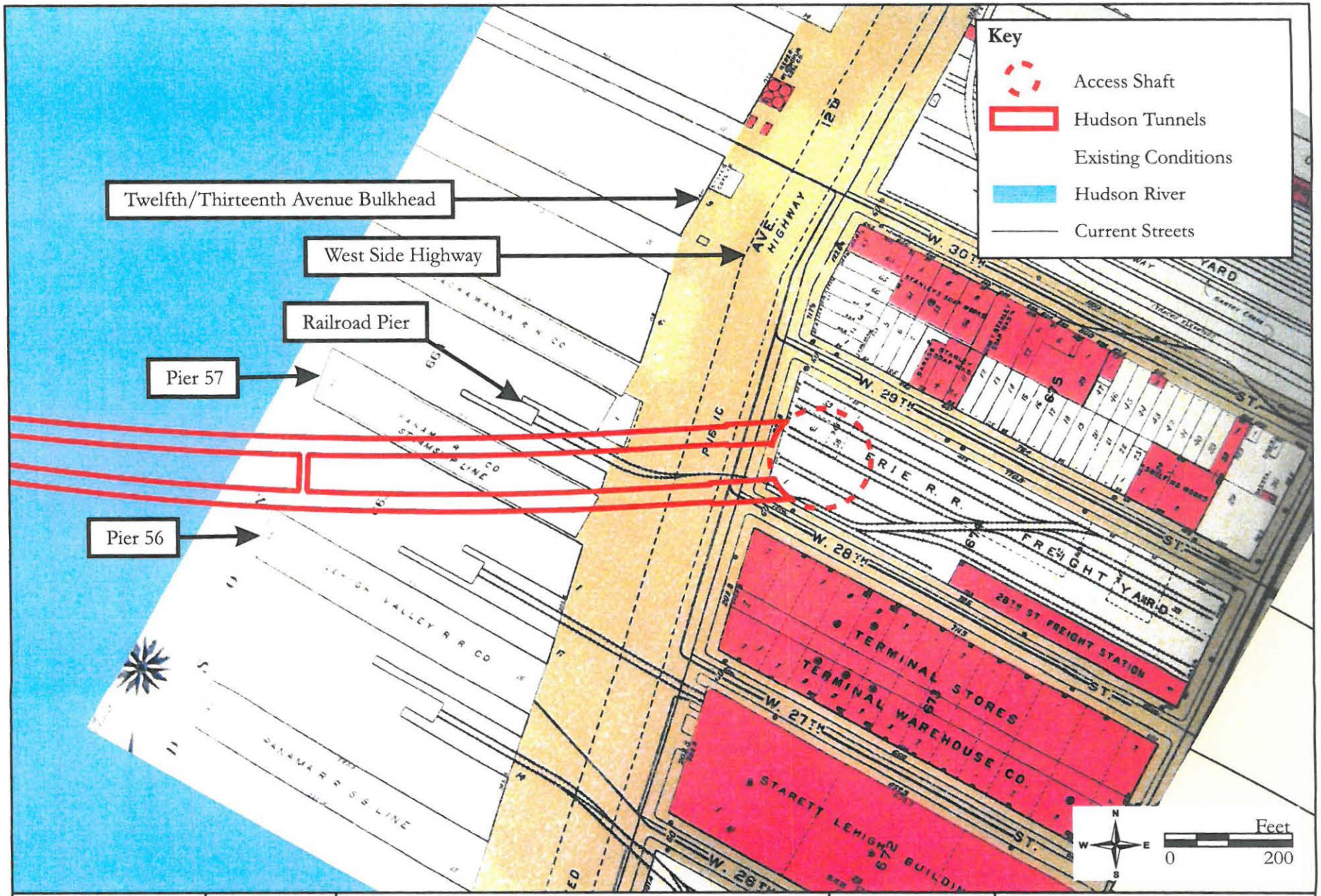


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Figure 2.25: 1934 George W. Bromley & Co., *Manhattan Land Book of the City of New York.*

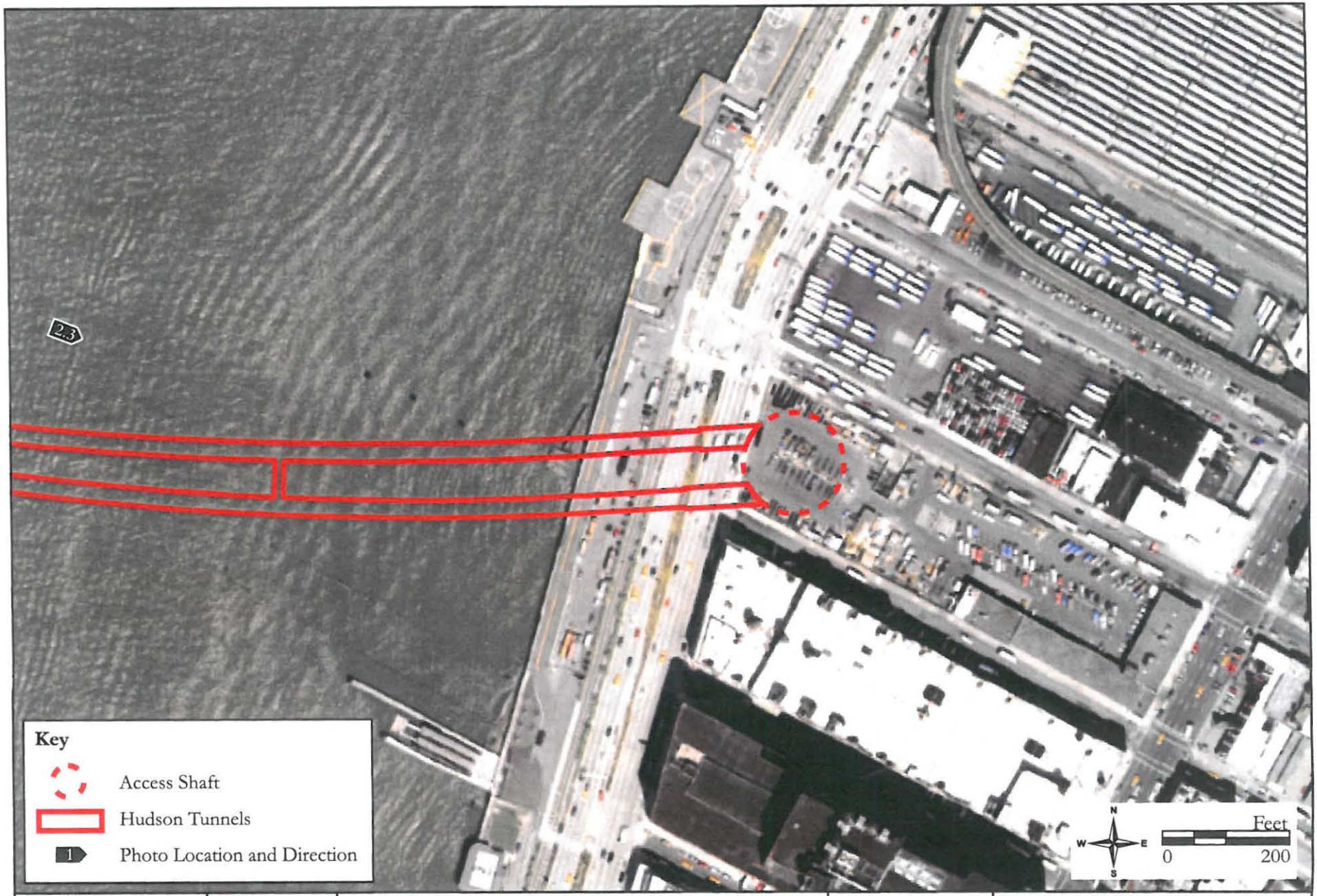

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Figure 2.26: 2004 Nationwide Environmental Title Research, Historic Aerial Photographs with Photo Locations and Directions (Manhattan).

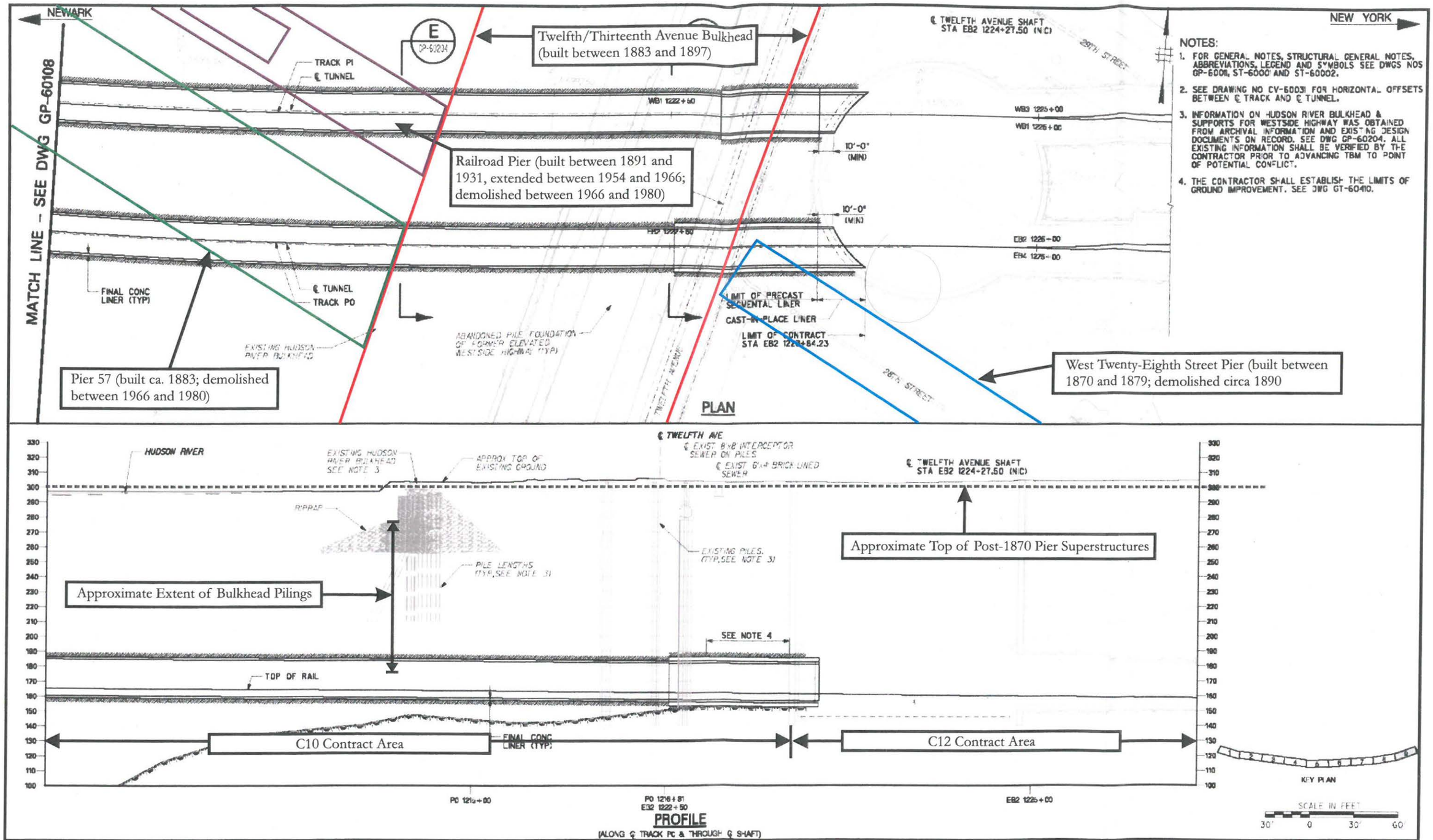

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Figure 2.27: Construction Plan Hudson River Tunnels, General Plan and Profile, Sheet 9 showing estimated impacts to potential resources.

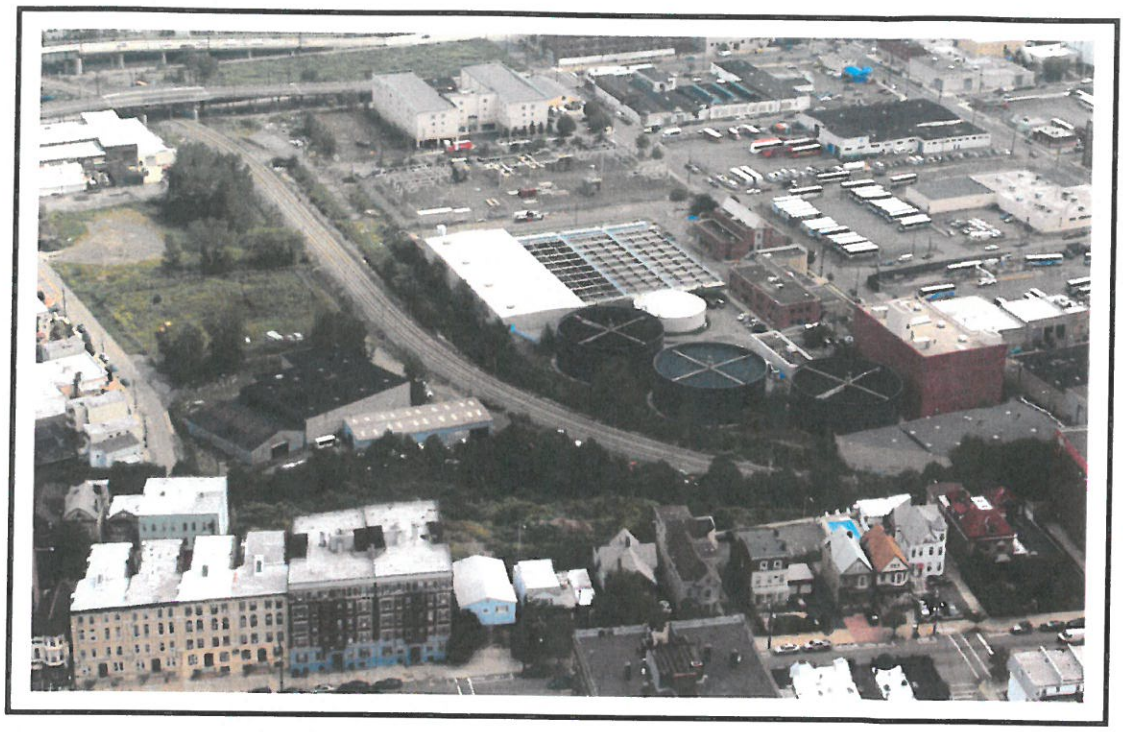

Plate 2.1:

Oblique aerial view of the soil stabilization area.
Photo view: Southeast
Photographer: THE Partnership
Date: May 18, 2007

Plate 2.2:

Overview of the soil stabilization area.
Photo view: Northwest
Photographer: THE Partnership
Date: December 7, 2006

Plate 2.3:

Oblique aerial view of eastern terminus of the C10 contract area showing the Twelfth Avenue bulkhead and examples of extant remnant pilings.
Photo view: Southeast
Photographer: THE Partnership
Date: May 18, 2007

3 GEOLOGICAL, GEOMORPHOLOCAL, AND GEOTECHNICAL DATA

A considerable amount of information regarding the geology and geomorphology of the vicinity of the areas for ground stabilization and the underpinning of Willow Avenue in Hoboken has been gathered. This information is distributed among several technical sources (A.D. Marble 2008; New Jersey Transit 2008; THE Partnership 2007, 2008a; 2008b; Transit Link Consultants 2006).

An overview of the regional geology and soils for the project is available in both the Phase IA report (A.D. Marble 2008: 8-12) and the Final Environmental Impact Statement (New Jersey Transit 2008: Section 4.11); also included in the Phase IA report is a geomorphological study of the ARC project area by Geoarcheology Research Associates (A.D. Marble 2008: Appendix E). In general, the New Jersey portion of the ARC Project spans various metamorphic and sedimentary bedrock formations, which are overlain by surficial deposits of glacial, aeolian, alluvial, and marsh/estuarine origin. These surficial sediments range in thickness from less than a few feet, in areas of rock outcrops at the Palisades and Laurel Hill, to greater than 150 feet at a glacially eroded bedrock trough in the vicinity of North Bergen (New Jersey Transit 2008: 4.11-1 to 4.11-3). Information specific to the area around the Hoboken Fan Plant/Construction Access Shaft site is summarized here.

Based on geotechnical information a general picture of the stratigraphy along the Hudson River Tunnels alignment has been compiled (THE Partnership 2008a). Depth to bedrock ranges from about 50 feet in Hoboken to its deepest at greater than 150 feet below the mudline of the Hudson River. Decomposed bedrock, consisting of very dense gravelly silty sands, extends from five feet to up to 50 feet above the bedrock. Decomposed bedrock is overlain by glacial till consisting of gravelly sand with pebbles, cobbles, and boulders. The till is overlain by varied silt and clay, and then by silty sand or sandy silt lacoustrine deposits ranging from two to eight feet in depth. Black organic soils, consisting of dark gray organic clay/silt, are situated within 10 to 40 feet from the river bottom. In the Hoboken area, a Lower Peat deposit of organic soils is present beneath Estuarine Deposits of gray silty clay to sandy silt. An Upper Peat layer of organic soils is present in some areas. Overlying all other strata, up to 25 feet of fill is present consisting of fine gravel, coarse to fine sand, with cinder, cobbles, brick, concrete, organic material, and wood (THE Partnership 2008a: 7-1 to 7-2).

A general stratigraphic sequence was compiled by Geoarcheology Research Associates for the ARC Project (in A.D. Marble 2008: Appendix E). A detailed stratigraphy was not possible because of gaps in the sampling sequence. Estuarine and near-shore locations in New Jersey were represented by core NJ-2. The subsurface consisted of historic fill extending to depths of approximately 25 feet below the surface, which constituted the maximum depth of boring at that location (in A.D. Marble 2008: Appendix E).

- *Unit 1*, the lowermost silty to massive clays. This unit includes sets of massive to lenticular silt and clay complexes, as well as peat horizons; the base of the sequence encountered firmer micaceous silt, possibly grading into bedrock. Partially intact bivalves were dispersed within the Unit 1 samples. The thickness of this unit varies, from approximately 15 feet (3 m), on the New Jersey side of the Hudson River, to over 50 feet in thickness (extending at least to 110 feet below datum), at the intersection of West Twenty-Eighth Street and Twelfth Avenue in Manhattan.

- *Unit 2,* tentatively identified as sets of well-sorted medium to coarse, quartz dominant sands interspersed with stiffer clay-silt matrices, and possibly intact peat horizons. The thickness of Unit 2 was less than 10 feet (3 m). The distribution of this unit was confined to the interior Manhattan cores.
- *Unit 3,* consisting of historic fills, dominated by asphalt, slag, ash, cinder, and angular stony rubble. The thickness of Unit 3 deposits ranged from 8 to 12 feet (approximately 3 m) below grade on interior cores, and in excess of 20 feet (6 m) closer to shore.

During investigations for the Jersey Avenue Viaduct, approximately two miles south of the Hoboken ground stabilization and Willow Avenue Viaduct area in a similar setting, a detailed stratigraphic sequence for the Lower Hudson River has been established (Geismer 2006, cited in A.D. Marble 2008, Appendix E: 7). A boring at this location indicated the presence of 14 feet of historic fill, organic silts and fine sands radiometrically dated Upper Middle and Late Holocene deposits extending to 60 feet, radiometrically dated Early Holocene peats from 60 to 62 feet, under which lay glacial till and bedrock.

The location for the ground stabilization and underpinning of Willow Avenue in Hoboken is situated within an area that was reclaimed by filling tidal marsh with a variety of materials; examples of this fill material from other areas of filled marshland include shotrock from tunnel construction, construction debris, clean granular fill, cinders, ash, and garbage (New Jersey Transit 2008: 4.11-3). **Figure 3.1** shows the locations of soil borings and bedrock corings conducted in advance of the ARC project (THE Partnership 2007a, 2007b, 2008a, 2008b; Transit Link Consultants 2006). A sample of borings taken in this vicinity of Hoboken showing the variability of the subsurface stratigraphy are summarized in **Table 3.1**. See the Documentary Analysis Reports for construction contract C08 Palisades Tunnels and C12 Manhattan Tunnels for additional data on borings in Hoboken and the Manhattan shoreline area (THE Partnership 2009b, 2009c).

Soil borings taken near the Hoboken ground stabilization and Willow Avenue Viaduct area indicate that soils consist of historic fill deposits that transition to the silty and massive clay deposits with shells or peat (Transit Link Consultants 2006). These soils are consistent with *Unit 1* soils identified by Geoarcheology Research Associates (in A.D. Marble 2008: Appendix E). Fill, approximately 10 to 15 feet deep near the ground stabilization area, typically overlies organic peat indicative of the marshlands once present within this portion of Hoboken. At the boring closest to the area for the underpinning of Willow Avenue, EPE-NJ-025, approximately 12 feet of fill was encountered.

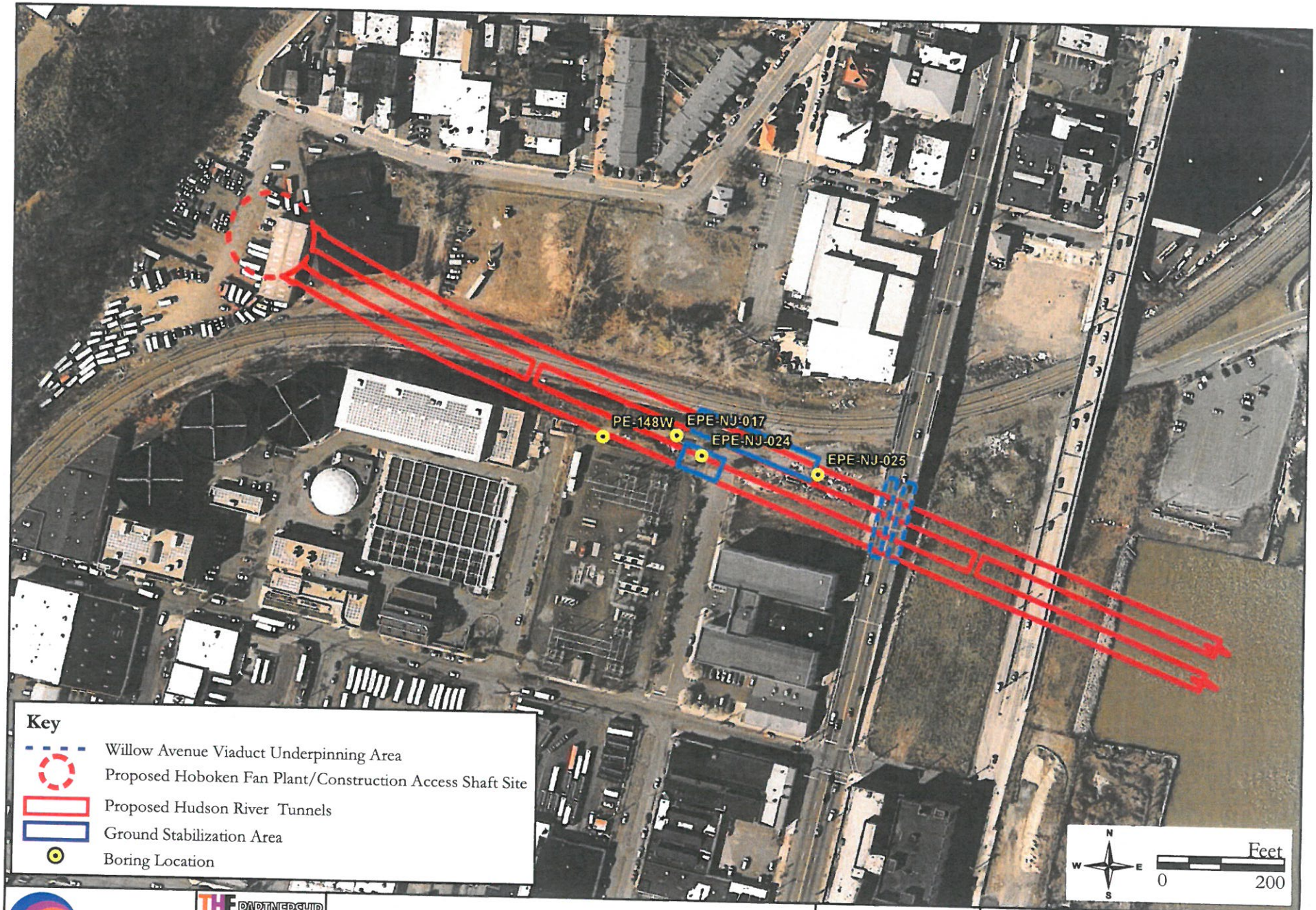

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Figure 3.1: Soil Boring Locations.

Table 3.1. Summary of Soil Boring Data in the Vicinity of the Hoboken Ground Stabilization and Willow Avenue Viaduct Area

Boring ID (Source)	Location (Approximate) (See Figure 3-1)	Description (elevations are approximate, in feet)
PE-148W (THE Partnership 2007b)	Approximately 60 feet southwest of ground stabilization area. Access road between HBLRT embankment and utility facility.	**Surface Elevation:** 0.0 feet **0.0 to -13.0 feet:** Gravel fill **-13.0 to -25.0 feet:** Gray/olive silt and clay with roots **-25.0 to -92.0 feet:** Gray/olive silty clay with shell fragments **-95.0 to -102.0 feet:** Black/dark brown organic clay **-105.0 to -110.0 feet:** Till, sand with some gravel **-112 feet:** Top of rock
EPE-NJ-017 (THE Partnership 2008b)	Immediately south of the ground stabilization area. 17th Street (unimproved) near Clinton Street	**Surface Elevation:** 0.0 feet **-1.0 to -12.0 feet:** Gray gravel with some sand and silt **-15.0 to -27.0 feet:** Dark brown silty clay with root fiber **-27.0 to -33.0 feet:** gray silty clay with shell fragments **-33.0 to -89.0 feet:** gray silty clay **-91.0 to -93 feet:** dark brown peat **-95.0 to -101.3 feet:** red gravel with sand and a trace of clayey silt **-104+ feet:** Bedrock
EPE-NJ-0024 (THE Partnership 2008b)	Approximately 40 feet southeast of the ground stabilization area. Clinton Street	**Surface Elevation:** 0.0 feet **-1.0 to -10.0 feet:** Dark gray sand with brick, wood, and coal fragments **-10.0 to -12.0 feet:** Dark gray silty clay with occasional peat fragments **-13.0 to -17.0:** gray silty clay **-20 to -27.0 feet:** gray silty clay with peat **-30.0 to -87.0 feet:** gray silty clay with shells **-90.0 to -92 feet:** dark gray to black peat with shells **-100+ feet:** Bedrock
EPE-NJ-025 (THE Partnership 2008b)	Approximately 200 feet east of the ground stabilization area Approximately 100 feet west of Willow Avenue	**Surface Elevation:** 0.0 feet **-0.0 to -10.0 feet:** dark gray sand with gravel, silt, wood, coal, and brick fragments **-10.0 to -12.0 feet:** dark gray with wood, little gravel and sand **-15.0 to -17.0 feet:** Dark gray silty clay with peat **-20.0 to -73.0 feet:** Dark gray clay/marine silty clay **-75.0 to -82.0 feet:** Brown silty clay with sand **-85.0 to -95.7 feet:** Gray to red brown, silt and clay with some sand **-85.0 to -92 feet:** Tan pink-green sand with some silt and gravel **-108.5+ feet:** Bedrock

Source: THE Partnership, 2009

4 SYNTHESIS AND SUMMARY OF INTERPRETATIONS

The goal of this report is to refine the assessment of areas of archaeological sensitivity associated with the proposed ground stabilization and Willow Avenue Viaduct area in Hoboken, New Jersey, and the Manhattan shoreline west of the Twelfth Avenue Fan Plant/Construction Access Shaft Site. The assessment of archaeological resources sensitivity is determined on the basis of the potential for archaeological sites to exist in a given area, and the likelihood for the survival of intact cultural resources. Archaeological monitoring or field testing is recommended in areas assessed to possess a high sensitivity for archaeological resources.

Additional documentary research reveals a moderate to high sensitivity for the Hoboken Sea Wall within the eastern portion of the Hoboken ground stabilization area. This resource would be expected below the fill at depths of at least 10 to 15 feet below the surface (see **Figure 2.18**). The archaeological monitoring of any additional soil borings in the vicinity of the Sea Wall is recommended, as requested by the NJSHPO in a meeting dated September 17, 2009 (**Appendix A**). The proposed method of ground stabilization or ground treatment will be selected by the Design-Build contractor. Possible methods include boring and the installation of grouting, or open trenching and underpinning through the installation of pilings and load transfer beams. No archaeological monitoring is recommended if construction will involve only boring, driving piles, and trench excavation at shallow depths (i.e. five feet or less below the surface). If deep trench excavation is planned by the contractor this could potentially impact the Sea Wall and archaeological monitoring during construction is recommended. In that event an archaeological monitoring plan will be developed and submitted to the NJSHPO.

The area for the underpinning of the Willow Avenue Viaduct has a low sensitivity for archaeological resources. This area consisted of tidal salt marsh until the initial construction of Willow Avenue in 1873. The only potential resource indicated on historic cartographic evidence is a trolley line within this roadway. The tracks for this line, however, are likely to have been removed and the area substantially impacted during the construction of the viaduct and no archaeological field testing or monitoring is recommended at this location.

The C10 Hudson River Tunnels have potential to impact pilings of the Hudson River Bulkhead and abandoned piers within Manhattan west of the Twelfth Avenue Fan Plant/Construction Access Shaft Site. The pilings of the nineteenth century bulkhead and piers may have been spliced to lengths of up to 100 feet and may be encountered during tunnel excavation at depths of approximately 175 feet (see **Figure 2.27**). It should be noted that if the pilings were not spliced they may remain above the area of the tunnels and not be encountered during tunnel excavation.

Due to the excavation of the tunnels using tunnel boring machines archaeological monitoring is not a feasible alternative for the Hudson River Bulkhead or abandoned pier pilings. Previous archaeological studies of piers, wharves and bulkheads or other fill-retaining devices have found that joinery techniques can vary and reveal details of craftsmanship that may be considered potentially significant aspects of these resources (Louis Berger Group 1989; Historical Perspectives 2004). The bottoms of pilings of the bulkhead or piers are considered unlikely to possess joinery features and are therefore not considered potentially significant archaeological resources. Due to the excavation methodology, and nature of the possible archaeological resources, no

archaeological monitoring or additional archaeological investigation is recommended. It should be noted, however, that archaeological monitoring for pier pilings will be conducted at the Twelfth Avenue Fan Plant/Construction Access Shaft Site within the C12 Manhattan Tunnels contract area as further described in the Documentary Analysis Report for the Manhattan Tunnels (THE Partnership, 2009c).

The abandoned pilings of the former West Side Highway are likely present to the west of the Twelfth Avenue Fan Plant/Construction Access Shaft Site. As also indicated in the Documentary Analysis Report for the C12 Manhattan Tunnels contract area, pilings from the former West Side Highway are not considered a potentially significant archaeological resource.

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6 ANNOTATED BIBLIOGRAPHY

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Title:	Access to the Region's Core, Documentary Analysis Report, C10 Hudson River Tunnels, City of Hoboken, Hudson County, New Jersey and Manhattan Borough, New York County, New York
Date:	August 2009
RGA Database Title:	ARC C10
State:	New Jersey and New York
County:	Hudson County, NJ and New York County, NY
Municipality:	City of Hoboken, NJ and Manhattan Borough, NY
U.S.G.S. Quad:	Jersey City, NJ/NY and Weehawken, NJ/NY
Drainage Basin:	Hudson River, Atlantic Ocean
Regulation:	Section 106
Project Type:	Transportation
Project Sponsor:	Federal Transit Administration and New Jersey Transit Corporation
Client:	THE Partnership
Level of Survey:	Supplemental Phase IA archaeological survey
Cultural Resources:	Areas of historic archaeological sensitivity

APPENDIX A

New Jersey State Historic Preservation Office (NJSHPO) Meeting Notes

ACCESS TO THE REGION'S CORE
Trans-Hudson Express (THE) Tunnel
A Partnership of NJ TRANSIT and the Port Authority of NY and NJ

MEETING MINUTES

TO:	Distribution	
FROM:	Nick Caiazza	
MEETING SUBJECT:	NJSHPO Monthly Coordination Meeting	
MEETING DATE, TIME:	September 17, 2009, 2:30 PM	
MEETING LOCATION:	NJ TRANSIT Headquarters, Newark, New Jersey	
ATTENDEES:	NJSHPO:	Daniel Saunders Charles Scott Patti Christman
	NJ TRANSIT:	Dara Callender
	THE Project PMT:	Nick Caiazza
	THE Partnership:	Mary Ann Mason Peter Dewes Johan Schor Derrick Hallahan
	Richard Grubb:	Philip Hayden
DATE:	October 7, 2009	

I. C10 HUDSON RIVER TUNNELS / SEA WALL

Mr. Saunders explained that based on consultation with Kate Marcopul of the New Jersey State Historic Preservation Office (NJSHPO), pre-construction field testing and/or construction monitoring for remains of the former Hoboken Sea Wall will not be necessary and instead, Mr. Saunders recommended monitoring of soil borings in the area proposed for ground stabilization.

II. PROGRAM-WIDE PLANS (CULTURAL RESOURCE MANAGEMENT PLAN / CONSTRUCTION ENVIRONMENTAL PROTECTION PLAN)

Mr. Scott indicated that he had reviewed these two "program-wide" plans and that he would be sending a letter stating that the NJSHPO concurs with the intent of the plans and NJ TRANSIT's commitment to protecting cultural resources during construction and design of the Access to the Region's Core (ARC) project.

III. C09 PALISADES INTERNAL CONCRETE (WESTERN PORTAL) DRAFT CONSULTING PARTY LETTER

Mr. Scott provided initial comments on the Draft correspondence to be sent to consulting parties in support of the Section 106 Programmatic Agreement requirement for consulting and interested parties' participation in the design of the Palisades Tunnels' portal. Mr. Scott recommended that one or two more sentences be added to the correspondence to explain the specific actions and level of commitment that would be required of the consulting or interested party; for example, attendance at a meeting(s) or review of plans, etc. Mr. Caiazza agreed and suggested that the Draft correspondence be revised as per Mr. Scott's recommendation and re-submitted to NJSHPO for final review and concurrence prior to sending to the list of consulting and interested parties.

IV. PROJECT STRUCTURE DESIGN APPROACH

This agenda item was added to address the previous SHPO comment (letter dated July 2, 2009) that the project design should be compatible with the Pennsylvania Railroad Historic District.

Using a project area graphic developed for the meeting (copy attached to these meeting notes), Mr. Dewes provided an overview of the existing bridge types and embankment located along the Northeast Corridor (NEC) alignment in the project area, as well as the types and locations of bridges that are proposed as part of the ARC project. He explained that in areas where the Pennsylvania Railroad placed fill/embankments, the ARC project would build some fill embankment but primarily concrete box girders due to modern day constraints related to environmental impacts (i.e. wetlands) and construction cost. The concrete box girder design was chosen as a result of an alternatives analysis conducted during Preliminary Engineering that considered steel vs. concrete. Concrete is preferred due to its lower initial construction cost, as well as lower life-cycle cost (i.e. easier maintenance vs. steel.

Mr. Dewes also explained that steel through girder structures were historically built for crossings over roads, streams and railroads/railroad yards along this section of the Northeast Corridor. Correspondingly, steel girder structures (mostly through girders) would also be built in these locations as part of the ARC project. This includes the proposed bridges over the NJ Turnpike and the NJ TRANSIT Main Line, Seaview Drive, Croxton Yard, County Road, and the NYS&W and Conrail railroad bridges. One location that differs from this approach is at Secaucus Road, where the existing NEC rail line crossing is a steel bridge. The proposed ARC crossing here is the last (western) span of a concrete viaduct consisting of several equal length (65 foot) spans. It was suggested that a steel span could be substituted for that proposed over Secaucus Road to attempt to be more consistent with the over-all bridge design approach. (Note: Subsequent to the meeting, the ARC project team members assessed the added cost of substituting steel for the span over Secaucus Road. It is estimated that the construction cost of the bridge would increase by an estimated $600,000 to $700,000. There would be additional maintenance costs as well. Given these added costs, and the fact that the substituted steel span would be part of an otherwise concrete viaduct, it is the opinion of the ARC project team that it is more appropriate to keep the original concrete span over Secaucus Road.) Mr. Dewes also explained that a discussion of the architectural details of the selected structures (i.e. colors, finishes) would be undertaken at a later date, since such details have not yet been advanced as part of Final Design. Mr. Scott noted that there is limited flexibility for architectural finishes of concrete bridge structures and retained earth walls and questioned the type of finishes/treatments that would be used.

Mr. Saunders also stated that it is understandable that the finishes for structures that are not located in public view would be made simple. Mr. Saunders stated that there needs to be an agreed upon color of the bridge structures. He also recommended that consideration should be given to the support structures (i.e. square columns vs. circular); former liners; abutments, etc.

Mr. Saunders asked if Mr. Scott or Ms. Christman had any concerns regarding the types and locations of bridges proposed along the NEC as part of the ARC project. Mr. Scott stated that he appreciated that the types of structures were selected based on consideration of the existing structure types along the NEC, as well as engineering design/construction issues. Mr. Scott asked if bridge design and systems design (i.e. catenary) would be integrated so as to maintain a sense of consistency between the types of structures.

Mr. Saunders, Mr. Scott and Ms. Christman were in agreement with the basic structure/retaining wall types that are being advanced by the ARC project team along the NEC. The ARC project team will begin to develop concepts for architectural treatments and finishes of bridge structures and retaining walls (including integration of systems design) for discussion at subsequent meetings with the SHPO.

Mr. Dewes explained that Richard Grubb and Associates would provide consultation with regard to the architectural details of the structures; in particular historic elements/details utilized by the Pennsylvania Railroad that could be incorporated into the ARC project designs.

Mr. Hallahan noted that a subsequent discussion would be required for the types of ARC project structures proposed along the Main Line and Morris and Essex Line (Delaware Lackawanna and Western Historic District).

V. OTHER ISSUES/NEXT STEPS

The next coordination meeting is scheduled for October 16, 2009.

VI. ACTION ITEMS FROM 9-17-09 MEETING

NJ TRANSIT to submit revised correspondence to NJSHPO for the Palisades Tunnels' Portal design review process.

NJ TRANSIT to submit an Archaeological Documentary Analysis Report for the C10 Hudson River Tunnels contract to NJSHPO for review and comment.

Distribution:
Attendees
Project Manager
Deputy Project Manager
Responsible Discipline Managers
Others
PDCC