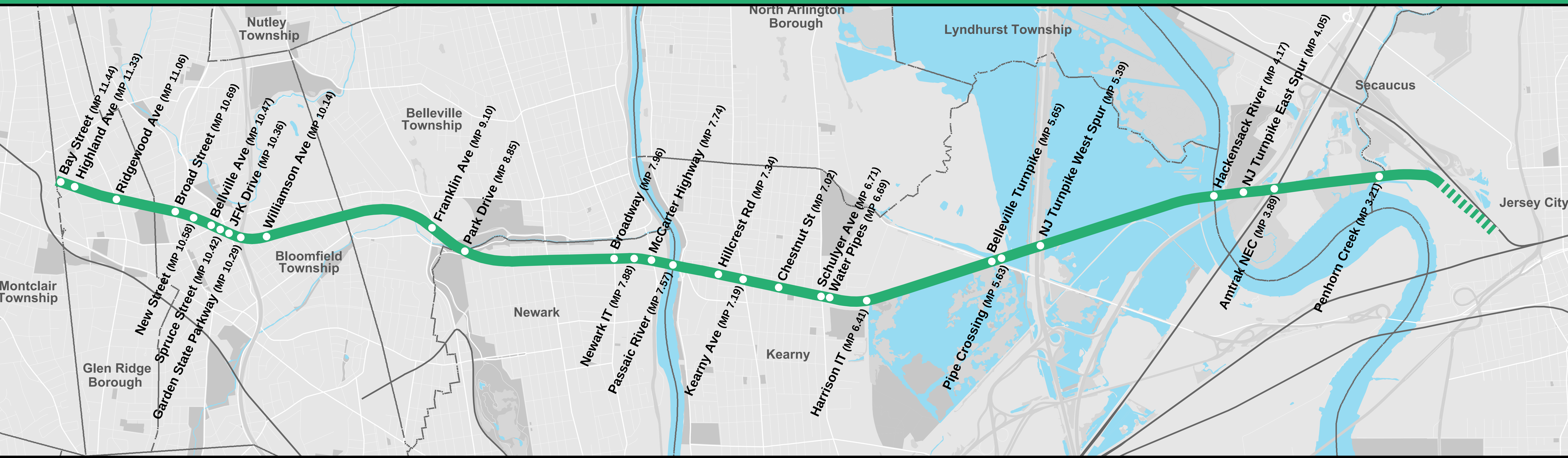
Essex Hudson Greenway
Structures Report



Vision for the Essex Hudson Greenway
Structures Report

ARUP

MNLA

Essex Hudson Greenway

Structures Report

REP/001

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Contents

Tables

Figures

Executive Summary

The Essex Hudson Greenway project aims to transform the Old Boonton rail line into a public greenspace and shared-use path. The proposed greenway extends for nine miles from Newark to Montclair, New Jersey. Along its length, the corridor traverses over or under 30 bridges, including two bridges over navigable waterways.

The purpose of this Structures Report is to provide an assessment of the existing bridge structures along the corridor. This report is intended to outline the possibilities for repurposing the railroad bridge structures for pedestrian use. This information will be used as input for the greenway's framework plan. The ideas presented in this report are preliminary, and the bridges should be further evaluated during future phases of study.

Methodology

Engineering Considerations

Criteria are established to identify what the existing bridges need to achieve in order to function as a pedestrian and cyclist greenway. The criteria are grouped in six categories that are qualitatively evaluated for each bridge:

- Existing Conditions: *what is the current state of the bridge and what upgrades may be required?*
- Structural Integrity: *what could affect the structural performance or load carrying capacity of the bridge?*
- Safety: *can the bridge provide adequate space and safe access to function as a greenway?*
- Constructability: *how will the work be completed and what are the potential impacts to the surroundings?*
- User Experience: *how will the bridge promote a positive and comfortable user experience?*
- Implementation: *what is the initial cost to repurpose the existing bridge as a greenway?*

Key Findings

Review of Previous Studies

The Preliminary Assessment Report by developed by Naik did not identify any fatal flaws with converting the abandoned railroad bridges into pedestrian bridges. Our assessment agrees with that conclusion but emphasizes the unique challenges posed by the bridge at the Hackensack River compared to the other bridges along the corridor.

Existing Bridge Inventory

There are 30 bridges along the length of the corridor, 14 of which are bridges where the greenway passes under a road, railway, or pipeline. The remaining 16 bridges carry the greenway on a structure over a feature or obstacle. Several of these bridges are more than 100 years old and are in varying states of repair.

Structural Assessment

The majority of the bridges along the corridor can be repurposed for pedestrian use through conventional rehabilitation and construction activities.

Where the greenway passes under an existing bridge, these bridges do not pose significant challenges for the construction for the greenway. There is sufficient space under these bridges for the greenway and all appear to be maintained by other transportation agencies or local municipalities.

Where the greenway is carried on an existing bridge over an obstacle, each of these bridges requires upgrades in order to be repurposed for pedestrian use. Typical work required includes replacement of the bridge deck and the addition of railings and fencing. Based on a comparison of assumed loads, these bridges likely have sufficient load carrying capacity to function as a greenway, but further evaluation is needed when existing bridge plans are made available.

The bridges crossing the Passaic and Hackensack Rivers require special attention. These bridges are both former movable bridges that cross navigable waterways. The Passaic River bridge appears suitable for rehabilitation, but a detailed inspection is required to verify the condition of the structure. The Hackensack River bridge exhibits extensive deterioration in the approach spans, which appear to become partially submerged during flood events. In addition, the bridge must provide 50ft navigation clearance over the shipping channel. Given these constraints, options for both rehabilitation of the existing bridge or replacement with a new bridge are reasonable alternatives to carry forward for further study.

1.0 Introduction

1 Introduction

1.1 Project Background

The Essex Hudson Greenway Project aims to transform the disused Boonton rail line into a public greenspace and shared-use path. The nine-mile long corridor extends between Montclair, NJ and Jersey City, NJ. When complete, the greenway will provide new options for recreation and non-motorized transportation to local residents.

The greenway corridor traverses over or under 30 bridges along its length, including two bridges over navigable waterways. The rail line fell dormant more than 16 years ago, and the bridges are in varying states of repair. Each bridge requires review to identify what is needed to repurpose the structure from a rail bridge into a greenway. A map of the bridges along the corridor is provided in Figure 1.

Arup USA, Inc. (Arup) has been contracted by Mathews Nielsen Landscape Architects (MNLA) to assess the bridge structures for the length of the greenway corridor. Arup has prepared the following Structures Report as input to MNLA for the framework plan for the Essex Hudson Greenway Project.

1.2 Scope of Report

The purpose of this report is to provide an assessment of the bridge structures along the Essex Hudson Greenway corridor. To complete this assessment, this report establishes criteria against which each bridge is reviewed and compiles an inventory of the existing bridge structures along the corridor in order to understand the full scope of structures considered.

The assessment includes:

- A general assessment of all bridges along the length of the corridor
- A detailed assessment of six key bridges along the bridge corridor

The report provides general comments and recommendations for structural improvements, repairs, and bridge decking materials required to convert the rail bridges into bridges suitable for pedestrians and cyclists. MNLA identified six bridges for the detailed assessment, which includes conceptual design recommendations for the bridges.

1.3 Exclusions and Assumptions

This report is intended to outline the structural possibilities for the bridges along the Essex Hudson Greenway corridor by identifying potential solutions and highlighting key challenges. The solutions presented herein are preliminary in nature and do not represent final designs of affirmative solutions. The bridge structures should be further evaluated during future phases of study.

The recommendations presented in this report are based on information provided by MNLA, a two-day site visit by Arup, and other publicly available information. Future outreach should be conducted with local municipalities and stakeholders to obtain additional records for the structures and gain a full understanding of the maintenance routines of the responsible jurisdictions and functional needs of the crossings.

Existing bridge drawings, including original construction or subsequent rehabilitation, repair, retrofit, or record drawings were not provided for any bridge structure along the corridor. All dimensions included in this report are scaled from aerial photographs or copied from railroad inspection reports. Future phases of study must obtain copies of engineering drawings for the bridge structures to review dimensions, sizes, and material grades of structural elements.

Geotechnical and subsurface conditions are not addressed in this report.

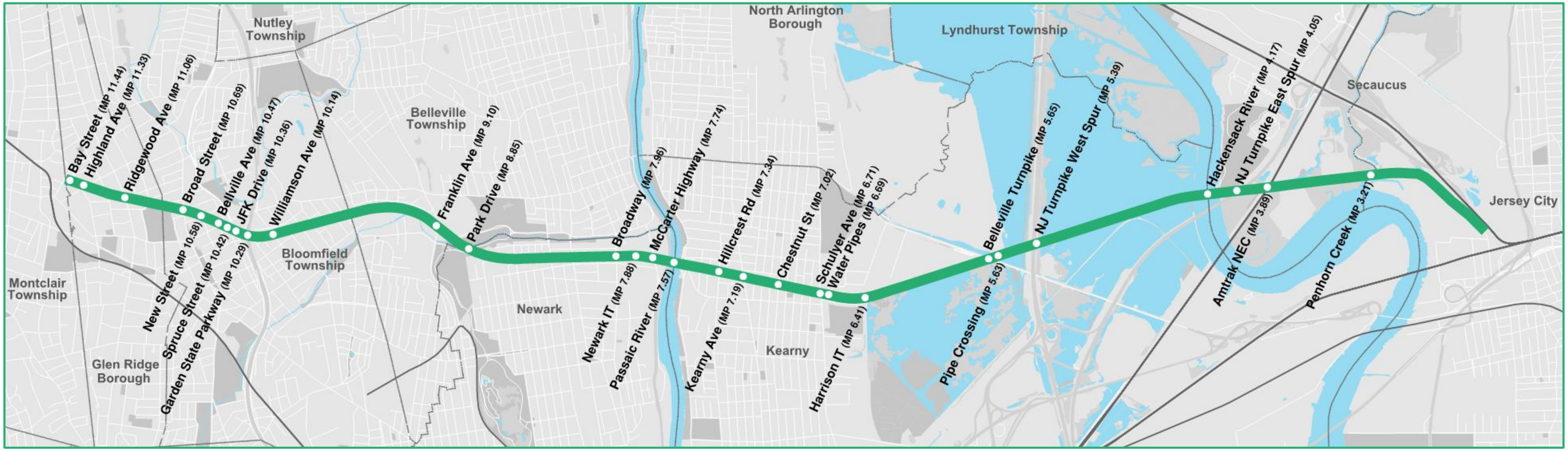


Figure 1 – Bridges along the Essex Hudson Greenway corridor

1.4 References

Available Documents:

The following sources of data were provided by MNLA:

[1] Preliminary Assessment of the Proposed Essex-Hudson Greenway, Naik Group, May 2020

[2] MNLA site visit photos (transmitted via email on July 23, 2020)

[3] Norfolk Southern Bridge Inspection Reports, November 2018

[4] Phase I Environmental Assessment / Preliminary Assessment Report, JM Sorge Environmental Consultants, May 2020

[5] ECG Essex-Hudson Greenway Connector Routing Plan, October 2017

Supplemental References:

The following additional documents are referenced in this report:

[6] AASHTO LRFD Guide Specification for Design of Pedestrian Bridges, 2nd Edition, 2009

[7] AASHTO Guide for the Development of Bicycle Facilities, 1999

[8] Americans with Disabilities Act (ADA) Accessibility Guidelines

[9] AREMA Manual for Railway Engineering, 2019

[10] NJDOT Design Manual for Bridges and Structures, 2016

[11] Portal Bridge Capacity Enhancement Project Final Environmental Impact Statement and Final 4(f) Evaluation, October 2008

[12] Hackensack Meadowlands Tide Gates Inspection Report, March 2006

[13] FEMA Flood Map Bergen County New Jersey, Panel 263 of 322

[14] New York City Panel on Climate Change Report, 2015

[15] Schuylkill Crossing Bridge Project, Bicycle Coalition, https://bicyclecoalition.org/an-update-on-the-schuylkill-crossing-bike-and-pedestrian-bridge-project/

[16] Development of Cost-Effective Timber Bridge Repair Techniques for Minnesota, November 2015

2.0 Engineering Considerations

2 Engineering Considerations

2.1 Introduction

This chapter defines what the bridges along the Essex Hudson Greenway corridor need to achieve in order to function as a pedestrian and cyclist greenway. These needs are defined as preliminary criteria, which are used to evaluate the bridges in their current state and to understand the scale of the modifications or upgrades required to convert the rail structures into pedestrian bridges.

Each criterion is intended to address a key question:

- Existing Conditions: *what is the current state of the bridge and what upgrades may be required?*
- Structural Integrity: *what could affect the structural performance or load carrying capacity of the bridge?*
- Safety: *can the bridge provide adequate space and safe access to function as a greenway?*
- Constructability: *how will the work be completed and what are the potential impacts to the surroundings?*
- User Experience: *how will the bridge promote a positive and comfortable user experience?*
- Implementation: *what is the initial cost to repurpose the existing bridge as a greenway?*

The criteria are intended to capture a wide range of engineering considerations to guide the development of bridge solutions. These include the fundamental structural needs for load carrying capacity, and also other functional or qualitative considerations such as safety, constructability, user experience, implementation costs, and operational needs (Figure 2). These factors are all interrelated and are considered both individually and collectively.

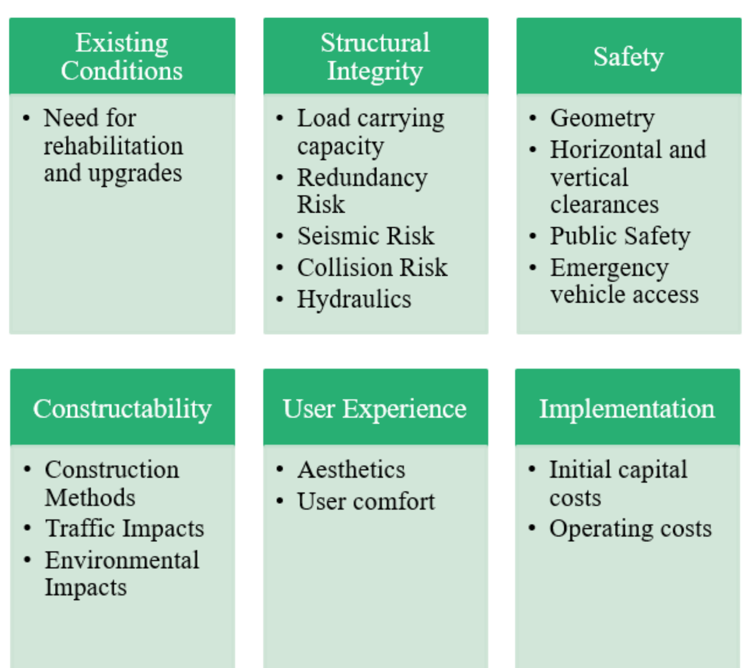


Figure 2 – Preliminary engineering considerations

2.2 Existing Conditions

The existing condition of the bridges along the corridor must be thoroughly understood in order to evaluate the current state of the bridges against the remaining criteria. The Boonton rail line that the corridor runs along was originally constructed more than 100 years ago, and several of the bridges along the corridor were built as part of the original construction of the rail line. The historic nature of these bridges requires consideration of both the deterioration of the structure over time as well as an understanding of the structural system, which often incorporates elements which are outdated versus modern construction. For example, connections on historic bridges frequently use rivets, instead of bolted or welded connections that would be used on modern bridges.

Key factors for consideration include:

- **Type of Bridge –** The existing type of bridge must be taken into consideration when evaluating the existing structures. The type and details of the bridge structural system will define the steps required for repurposing the structure. This includes the structural system and materials used to construct the bridge
- **Feature crossed –** The evaluation of the bridges must consider not only the structure itself, but the feature or obstacle crossed. Bridges that cross a roadway must consider function of the roadway below as well as potential impacts during construction. Bridges that cross a waterway must ensure that navigation of vessel traffic is not impacted, as well as evaluating foundations for scour due to the flow of water.
- **Deterioration** – It is important to identify the presence of deterioration that has occurred over the life of the bridge. Deterioration may have an impact on the remaining service life of the bridges and, depending on the extent of deterioration, may impact the structural load capacity of the bridges. The likelihood of continued deterioration should also be considered.
- **Design Standards –** When considering any bridge for rehabilitation, the structure must be reviewed for compliance with current Design Standards. For pedestrian bridges, the governing standard would be the *AASHTO LRFD Guide Specifications for Pedestrian Bridges* [6]. State and local design code requirements must also be considered. Generally, all bridges that are rehabilitated must be designed to the same standards as a new structure. Existing structures may require retrofits or upgrades in order to meet the current design standards. In some cases, it may not be possible for a historic structure to fully comply with a modern design standard. If the deficiency presents a critical risk when considered using modern engineering practice, then it may be a reason to replace the structure. Otherwise, some deviations from the design code may be permissible for historic structures, provided that the responsible agencies and jurisdictions approve of the deviation.

2.3 Structural Integrity

The structural integrity of the bridges is the ability of the structures to comply with performance requirements at all limit states. The existing structures, as well as any repairs, retrofits, or upgrades, should be evaluated at these limit states. The conventional limit states for design are:

- **Service Limit State** – Evaluation of the design against restrictions on stress, deformation, and crack widths to ensure the structure will achieve its desired design life.
- **Strength Limit State** – Evaluation of the structures for strength and stability requirements to resist statistically significant load combinations that the bridge may experience during its life span.

- **Fatigue and Fracture Limit State** – Restrictions on the stress range due to repetitive loading. This is typically not a concern for pedestrian structures, but existing bridges may require evaluation for fatigue prone details and fatigue cracking due to repetitive train loads over the life of the bridge.
- **Extreme Events Limit State** – Structural survival during a major earthquake, flood, when struck by a vehicle or vessel, and under scoured conditions.

These limit states cannot be fully evaluated at this preliminary state of study but must be considered in a general way, as they are the standard that the bridge designs must ultimately meet. To do so for this study, the structural integrity of the bridges is qualitatively assessed against the following factors:

- **Load Carrying Capacity** – The existing bridges must be able to support the design loads required by the Design Standards. For the greenway corridor, it should be recognized that the bridges are originally designed for train loads but will only be required to carry pedestrian loads as a greenway, or the occasional maintenance or emergency vehicle loads on the greenway.
- **Redundancy** – Redundancy is a significant factor in evaluating existing bridges. Non-redundant structures are typically defined as structures where the failure of one principle load carrying member would result in the probable collapse of the structure. Repurposing of non-redundant structures must take into consideration the sensitivity to being non-redundant, the consequences of no action, and feasibility of adding redundancy to the structure. Non-redundant structures also require more frequent hands-on inspections.
- **Seismic** – Seismic risk must be considered in the design and rehabilitation of bridge structures. While not typically thought of as a region with high-seismic risk, seismic events have occurred in New Jersey (Figure 3), and the Northeast US in general, which must be taken into consideration.

Location	Date	Intensity MM Scale	Magnitude Richter Scale
Newark	September 1, 1895	VI	5.0
Asbury Park	June 1, 1927	VII	5.0
Trenton	January 24,1933	V	4.0
Central NJ	August 22, 1922	V	4.0
Salem County	November 14, 1939	V	4.0
West Central NJ	March 23, 1957	VI	5.0
NJ – PA	December 27,1961	V	4.0
Southern NJ	December 10, 1968	V	4.0

Figure 3 – Historic earthquakes in New Jersey (from NJDOT Design Manual [10])

At a minimum, seismic considerations include ensuring there is adequate support lengths at the bearing locations and consideration of connection forces between the bridge span and support locations. In addition, the foundation supporting a bridge structure should not experience damage during an earthquake event. Additional analysis may be required for longer bridges, which are less stiff and may have a longer fundamental period of response that influences the structure response under seismic motions.

- **Vessel Collision** – Bridges should be evaluated for vulnerability for vessel collision. This is particularly important for bridges that cross navigable waterways. The risk of failure due to collision impact damage should be understood so that any necessary vulnerability reduction measures can be implemented.
- **Hydraulics and Scour** – Bridges that are in or over a waterway may be subjected to scour conditions. Scour is the erosion and removal of soil and sediment from around the bridge foundations due to the movement of water, which could undermine the foundations and cause a bridge failure. The vulnerability to hydraulic issues is a function of the foundation type, water velocity, and foundation soil material.
- **Durability** – It is important that bridges are durable and can be maintained to achieve the desired service life without undue effort. This factor considers what actions are necessary to provide or enhance the durability of the bridges, or how susceptible the bridge is to future durability issues. For example, the bridges may require a new paint system to protect the steel, or a new waterproof membrane to protect concrete structures.

2.4 Safety

The consideration of safety includes traditional aspects of safety for the bridge users, including providing fencing and railings at the edges of the bridge. In addition, safety includes consideration of the geometry of the bridge, such that adequate horizontal and vertical clearance are provided for roadways that cross under the bridge.

The following factors are considered:

- **Geometry** – The geometry of the bridge addresses the functional cross section of the greenway path on the structure. A 16 foot-wide path is anticipated for the greenway. Typically, the width of the pathway on the bridge should match the width of the pathway on land. It is recommended that two-foot wide clear areas are provided on each side, in order to provide a buffer between bicyclists and the railing. This additional width also provides additional space to maneuver emergency and maintenance vehicles.
- **Horizontal and Vertical Clearances** – Adequate horizontal and vertical clearance must be provided both under the bridge and across the bridge itself. When considering clearances for a roadway under the bridge, the accident history and accident potential should be examined. Geometrics that contain a clear potential for accident problems should be considered for improvement.

  The minimum required horizontal clearance, including clear zone or lateral offset, for a roadway crossing under a bridge is dependent on the volume of traffic. The minimum clear roadway width for new bridges is listed in Table 1. Existing bridges that do not provide these horizontal clearances may require acceptance of design exceptions.

Table 1 – Horizontal clearance for new bridges over roadways

Vehicles per Day	Minimum Clear Roadway Width
Under 400	22’ – 0”
400 to 1500	22’ – 0”
1500 to 2000	24’ – 0”
Over 2000	28’ – 0”

  The minimum required vertical clearance under a pedestrian or bikeway is listed in Table 2 and is dependent on the classification of the roadway. The vertical clearance for existing bridges should be evaluated and may require acceptance of design exceptions.

Table 2 – Vertical clearance over roadways

Roadway Classification	Vertical Clearance for Pedestrian and Bikeway Overcrossings
Interstates and Freeways	17' – 0"
Urban Arterials	17' – 0"
Local Roads and Streets	17' – 0"
Existing Bridges	Case by case

In instances where substandard vertical and horizontal clearances are not desired, the bridges may be replaced instead of rehabilitated in order to achieve the required clearance. Replacement bridges would require ramps or embankments at either end for the path to get up to the required height.

- **Slope / Grade** – The grade of bridges must comply with American for Disabilities Act (ADA) [8] requirements to ensure the structures remain accessible. The maximum permissible slope is 5% (1:20). This requirement is similar to the requirements for bicycle use, where grades greater than 5% are undesirable because the ascents are difficult for many users and the descents cause some bicyclists to exceed the speeds at which they are comfortable [7].

- **Public Safety** – Criteria for public safety include the need for safety railings along the bridge deck. For bicycle facilities, railings on both sides of the path on a structure should be a minimum of 42 inches high [7]. Railings should be provided where the paths cross over existing highways or rail lines. Railings should extend 20 feet beyond the end of the bridges onto the landings.

- **Emergency and Maintenance Vehicle Access** – It is assumed that the bridges must provide access for emergency vehicles. Since there will be limited access points for vehicles along the corridor, such as for the stretch of the pathway through the Meadowlands, it is important that the bridges do not become an obstacle for emergency access. In addition, bridges that are not accessible from below should be able to accommodate an under-bridge inspection truck (Figure 4) to facilitate future inspection and maintenance operations.

Figure 4 – Typical under-bridge inspection truck

2.5 Constructability

Constructability addresses how the bridge work will be performed in the field, to ensure there are reasonable methods available to complete the work without undue impact to traffic or the environment.

- **Construction Methods** – The methods of construction should be evaluated to determine if conventional means and methods can be used or if specialty construction work is required. Factors for this evaluation include the level of construction access, such as on land or over water, and whether the construction work activity itself requires specialty services.

- **Traffic Impacts** – Where bridges cross over or adjacent to active roadways, the potential impact to traffic must be considered, including the potential for temporary traffic control or detours.

- **Environmental Impacts –** The environmental impact of construction work must be considered. For example, will the work lead to unwanted noise or pollution to neighboring properties, involve hazardous or contaminated materials that must be remediated to prevent release into the environment, or disturbance to ecologically sensitive areas and wildlife.

- **Hazardous materials** – It is possible that hazardous or contaminated materials may be encountered on the existing bridges structures, and impact to these materials due to construction activities must be considered. Lead based paint systems may exist on existing structural steel elements. Anti-decay products such as creosol may be present on railroad ties, timber piles, or other timber structural elements. Asbestos containing materials (ACM) may be in tar on surfaces, rail plate insulator pads, structural paints, sealants/caulks, wire cabling, and waterproofing materials.

2.6 User Experience

Since the greenway corridor is ultimately intended for pedestrian use, the bridge solutions must provide for a positive user experience. Key considerations include:

- **Aesthetics –** The bridges should not have a significant visual impact on the surrounding environment. The structures should complement the existing characteristics of the surrounding area. Specific features can be enhanced through the use of architectural finishes, railings, and nighttime lighting. In addition, this factor considers maintaining prominent historical features for future users.
- **User Comfort** – User comfort encompasses a wide range of factors, including functional and subjective criteria. Functional considerations include providing a slip-resistant walking surface, adequate nighttime lighting, and pathway slopes that are not too steep. Subjective criteria may include vibrations, visual quality, and perceived safety.

2.7 Implementation

The implementation of the bridge solutions includes:

- **Initial Capital Costs** – the cost for the initial construction must be considered in order to ensure the bridge solutions are cost effective. The concept of time is also inherently considered within the initial capital costs; The deterioration of the bridges will continue with time, and therefore cost more to address increased levels of deterioration in the future.
- **Operation Costs** – In addition to upfront costs, operating costs over the life of the bridge must also be considered. These include the cost for performing routine maintenance, inspections, and costs of staff for operating movable bridges (if applicable).

3.0 General Assessment

3 General Assessment of Corridor Bridges

3.1 Overview

This chapter provides a general assessment of all the bridges along the Essex Hudson Greenway corridor. The existing bridges along the rail corridor are in varying states of repair. The majority of the bridges can be repurposed for pedestrian use through conventional construction methods, including the replacement of bridge deck and addition of railings and fencing where required. The bridges that cross navigable waterways require further inspection and review in order to determine the best solution, most notably the bridge crossing the Hackensack River.

The remainder of this chapter provides the general assessment of each bridge, including a comparison against the established criteria where applicable.

3.1.1 Review of Previous Studies

This general assessment takes into consideration the information presented in the Naik Preliminary Assessment Report [1]and builds on the information provided in that report.

Naik's Preliminary Assessment Report did not identify any fatal flaws with repurposing the abandoned rail bridges into pedestrian bridges. Our assessment agrees with this conclusion, although the challenges posed by the Hackensack River Bridge should not be understated. The challenges are not insurmountable, and in fact are relatively routine for bridge infrastructure projects. However, in comparison with the other bridges along the corridor, the Hackensack River Bridge poses unique challenges that will need to be addressed, including decisions on rehabilitation versus replacement considering life cycle costs, environmental impacts, and future operating needs.

3.1.2 Indicative Bridge Deck Replacement Options

All of the bridges that will carry the greenway on an existing structure will require a replacement bridge deck to provide a suitable trail walking surface. The selection of the replacement bridge deck is dependent on whether the existing bridge has an open timber deck or a ballasted deck.

Figure 5 - Ballasted bridge deck (left), open timber bridge deck (right)

For bridges with an existing timber deck, a precast concrete deck is assumed for all deck replacements in this report. The use of a full-depth precast concrete deck is a common system using accelerated construction techniques, which minimizes work in the field. Deck panels are cast off-site in a controlled environment and then shipped to site once they have gained adequate strength. This has the benefit of eliminating the need to pour concrete in the field, simplifying construction. In addition, for bridges where access is limited, the precast panels could be used as a platform to work from during construction (Figure 6).

For bridges with an existing ballast surface, it is assumed that existing ballast will be removed, a compacted stone aggregate base will be installed, and a conventional 6" concrete pavement is poured on top. The intent of removing the ballast is to gain access to the bridge deck below to install waterproofing, which will protect the structure and enhance the future durability of the structure.

The deck types adopted for this study assume that a closed drainage system is required to prevent rainfall runoff from discharging onto the roadways or into the waterways below the bridges. Either a trench drain or drainage inlets can be installed in the bridge deck, which will route rainfall runoff off the bridges to be stored or controlled elsewhere on the site. Providing a closed drainage system has the added benefit of protecting the bridge structure from water, which is often a catalyst for corrosion.

For bridges that currently use an open timber deck, the installation of a new drainage system will require new drainage pipes to be suspended from the existing girders below the new bridge deck. These drainage pipes should be located to be shielded from view while also being accessible for future maintenance. The pipes will carry drainage and rainwater off the structure at each end. For bridges that currently use a ballasted deck, the new drainage system may consist of drain pipes installed in the stone aggregate base under the new concrete paved trail surface.

Figure 6 – Precast concrete panels used on a rails-to-trails bridge, used to support equipment during construction

3.1.3 Indicative Structural Improvements

Potential structural improvements include rehabilitation or replacement of steel or concrete structural elements. These improvements may be necessary to maintain the structural integrity of the bridge or provide increased durability and protection from deterioration.

Potential improvements for steel elements include:

- Removal of corroded elements, to be replaced by new steel elements
- Removal of old paint coatings and application of a new paint system
- Replacement of structural bearings, which transfer loads from the girders into the piers or abutments

Potential improvements for concrete elements include:

- Removal of localized areas of damaged or spalled concrete, to be replaced with new a new concrete patch
- Application of a waterproofing membrane or sealer to protect the concrete from deterioration

Potential improvements for masonry elements include:

- Removal of vegetation growing in masonry elements, to prevent roots from opening gaps or damaging the masonry blocks
- Patching and repointing of masonry joints

3.1.4 Next Steps and Recommendations

The following summarizes key issues and recommendations:

- Near-term recommendations to progress preliminary engineering studies:
    - Obtain and review original bridge drawings to understand the original design concepts, dimensions, load assumptions, and the materials used for construction;
    - Obtain and review previous rehabilitation, repair, or retrofit construction drawings to understand how the bridges have been upkept or modified over time;
    - Conduct an in-depth inspection of the Hackensack River Bridge and Passaic River Bridge to thoroughly document the existing conditions of structural members, including an in-water inspection of the foundations to evaluate the risk of scour;
    - Coordinate with local municipalities and transportation agencies that will be responsible for maintaining the bridges in the future to understand operational needs and seek agreement on any deviations from established design standards, such as maintaining substandard vertical clearances for roadways crossing under bridges. It is critical to determine if the substandard features can remain – otherwise the bridges may require replacement.
- Future actions to be completed:
    - Based on the information obtained above (existing plans and inspection reports), complete load rating analysis of bridges along the corridor to verify the load carrying capacity of the bridges and further define the needs for rehabilitation and retrofit;
    - Coordinate with NJ Transit to understand the use of the Penhorn Creek Bridge during the Portal Bridge construction project. The options for the greenway may be altered by how the bridge is temporarily used to support the Portal Bridge construction project.
    - Begin coordination with the US Army Corps of Engineers (USACE), US Coast Guard (USCG), New Jersey Department of Environmental Protection (NJDEP), and any other agencies that will require permits for construction work;
    - Perform hazardous materials testing to identify asbestos containing materials (ACM), lead paint, and other contaminated materials that will need to be mitigated and/or removed from the bridges;
    - Complete environmental studies and assessments for project impacts, where required.

3.2 Structure Inventory

There are 30 bridges along the length of the Essex Hudson Greenway corridor. Bridges are identified by the bridge milepost number (MP #), which relates to its position along the original Boonton Line railroad. All bridges are listed in Table 3.

The bridges along the corridor can be categorized into two distinct groups: overpass and underpass bridges. There are 14 bridges where the trail passes under a road, railway, or pipeline that crosses the greenway corridor. For the purpose of this report, these bridges are referred to as underpass bridges. The remaining 16 bridges carry the greenway on a structure over a feature or obstacle. For the purpose of this report, these bridges are referred to as overpass bridges. The location of the overpass and underpass bridges along the corridor are identified in Figure 7 and Figure 8, respectively.

The overpass bridges are the primary focus of this assessment; these bridges are a physical structure that must support the greenway, and all require upgrades in order to be repurposed as pedestrian bridges. The underpass bridges cross over the greenway, and the primary concern is ensuring that there is sufficient space for the greenway under the bridge.

In order to assess the condition of the bridges along the corridor, the following documents were reviewed:

- Naik Preliminary Assessment Report [1]
- MNLA site visit photos [2]
- Norfolk Southern Bridge Inspection Reports [3]

In addition, Arup performed a site visit to the Essex Hudson Greenway corridor in July 2020 to observe the conditions of the existing railway bridges. This site visit is documented in Appendix A.

Table 3 – Greenway corridor bridges

Name	Bridge MP #	Trail Passes Over or Under	Feature Intersected	Length (ft)	Existing Walking Surface
Penhorn Creek	3.21	Over	Penhorn Creek	42	Ballast
Amtrak	3.89	Under	Amtrak	140	Ground
NJ Turnpike Eastern Spur	4.05	Under	NJ Turnpike Eastern Spur	-	Ground
Swing Bridge	4.17	Over	Hackensack River	740	Wood
NJ Turnpike Western Spur	5.39	Under	NJ Turnpike Western Spur	-	Ground
Pipelines	5.63	Over	Pipelines and Hackensack River	26	Wood
Belleville Turnpike	5.65	Under	Belleville Turnpike	112	Ground
Harrison IT	6.41	Over	Harrison IT	33	Ballast
Schuyler Water Pipes	6.69	Under	Water Pipes	53	Ground
Schuyler Ave	6.71	Under	Schuyler Ave	95	Ground
Chestnut St	7.02	Under	Chestnut St	175	Ground
Kearny Pipelines	7.18	Under	Pipelines	167	Ground
Kearny Ave	7.19	Under	Kearny Ave	192	Ground
Hillcrest Pipeline	7.34	Under	Pipelines	170	Ground
Passaic River	7.57	Over	Passaic Ave/Passaic River/NJ Rte 21	560	Wood
McCarter Highway	7.74	Over	McCarter Highway	66	Wood
Newark IT	7.88	Over	Newark IT	85	Wood
Broadway	7.96	Over	Broadway	125	Ballast/Wood
Second River	8.85	Over	Second River/Branch Brook Park Dr	175	Ballast
Franklin Ave	9.1	Over	Franklin Ave	86	Ballast
Williamson Ave	10.14	Under	Williamson Ave	85	Ground
Garden State Parkway	10.29	Over	Garden State Parkway	120	Ballast
JFK Drive	10.36	Over	JFK Drive North	110	Wood
Spruce St	10.42	Over	Spruce St	80	Wood
Belleville Ave	10.47	Over	Belleville Ave	100	Wood
New St	10.58	Over	New St	115	Wood
Broad St	10.69	Over	Broad St	60	Ballast
Ridgewood Ave	11.06	Under	Ridgewood Ave	112	Ground
Highland Ave	11.33	Under	Highland Ave	100	Ground
Bay Street	11.44	Under	Bay St	88	Ground

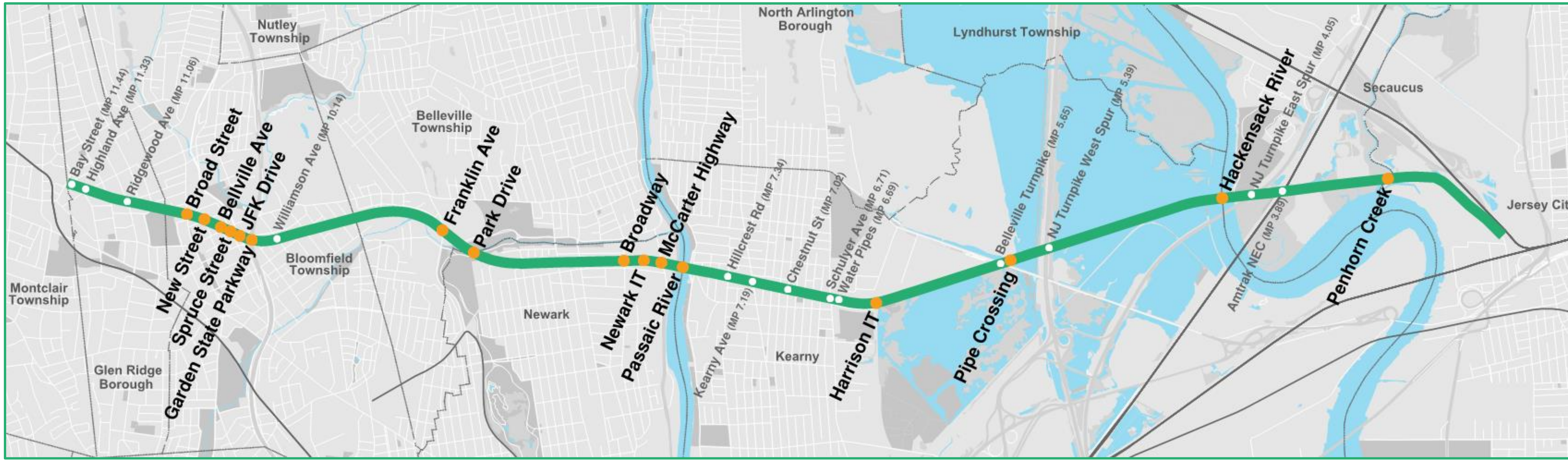


Figure 7 – Greenway bridges that cross over a feature (overpass)

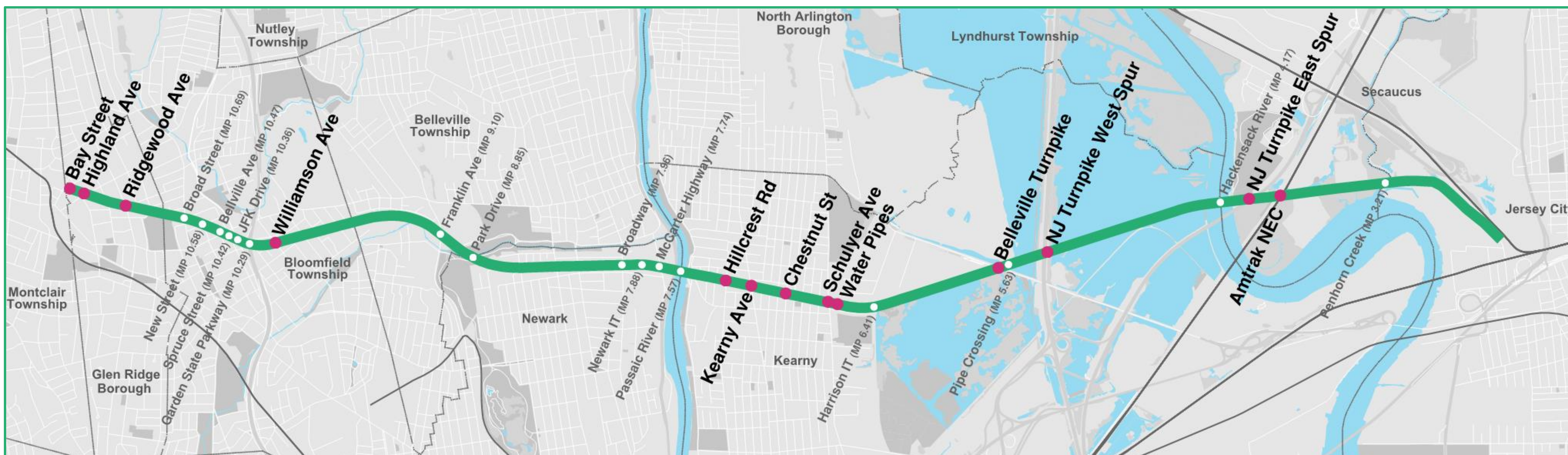


Figure 8 – Greenway bridges that cross under a road, railway, or pipeline (underpass)

3.2.1 Underpass Structures

Underpass bridges are those that carry a road, railway, or pipeline over the greenway corridor. Ten of these bridges are included in the National Bridge Inventory (NBI). To be included in the NBI, the bridges must carry vehicular traffic and be 20ft in length. Bridges on the NBI are rated by the agency responsible for maintenance of the bridge. Condition ratings include an evaluation of the bridge deck, superstructure, and substructure on a 0 to 9 scale. These ratings address the bridge's primary function to carry vehicular traffic and indicate that the bridges are currently maintained by other transportation agencies or local municipalities.

Table 4 – Underpass bridges on the National Bridge Inventory

Name	Bridge MP #	NBI Bridge Number	Maintenance Responsibility	Sufficient space under bridge?
NJ Turnpike Eastern Spur	4.05	E109830	State Toll Agency	Yes
NJ Turnpike Western Spur	5.39	W108910	State Toll Agency	Yes
Belleville Turnpike	5.65	0910154	State Highway Agency	Yes
Schuyler Ave	6.71	0964161	Other State Agency	Yes
Chestnut St	7.02	0964162	Township	Yes
Kearny Ave	7.19	0900014	Township	Yes
Williamson Ave	10.14	Unknown	Unknown	Yes
Ridgewood Ave	11.06	0769165	Other State Agency	Yes
Highland Ave	11.33	0769167	Other State Agency	Yes
Bay Street	11.44	0769168	Other State Agency	Yes

There are four underpass bridges that do not appear on the NBI. This includes the bridge that carries Amtrak's Northeast Corridor over the greenway and three pipelines. The Northeast Corridor bridge is maintained by Amtrak. It is planned to be replaced during the project to replace Amtrak's Portal Bridge [11], which is located about a quarter of a mile from this location. The Portal Bridge is a movable structure that is being replaced by a high-level fixed bridge to eliminate the movable span. As a result, the height of the bridge crossing the greenway corridor is expected to be raised by 10 to 15 feet to accommodate the approach to the new Portal Bridge.

The remaining three bridges are pipelines. The pipelines at MP 7.18 are supported off the structure of the MP 7.19 Kearny Avenue roadway bridge and are likely maintained by the jurisdiction responsible for the roadway bridge. The pipelines at MP 6.69 are supported on a truss structure parallel to the MP 6.71 Schuyler Avenue roadway bridge. The railroad inspection report identifies these as water pipes. The maintenance responsibility for these pipes is unknown but is likely either the state agency responsible for the roadway bridge or the water utility company. The pipelines at MP 7.34 cross the greenway at Hillcrest Avenue. These pipelines do not pose an obstacle for the greenway, but the function and responsible entity are unknown.

Table 5 – Non-NBI underpass bridges

Name	Bridge MP #	NBI Bridge Number	Maintenance Responsibility	Sufficient space under bridge?
Amtrak Northeast Corridor	3.89	N/A	Amtrak	Yes
Schuyler Water Pipes	6.69	N/A	Unknown	Yes
Kearny Pipelines	7.18	N/A	Unknown	Yes
Hillcrest Pipeline	7.34	N/A	Unknown	Yes

It is expected that all the underpass bridge structures are currently maintained by the transportation agency, utility, or railway responsible for its use. Therefore, for the greenway project, the primary concern for underpass bridges is ensuring there is sufficient space under the bridge for the greenway corridor. The existing Boonton Line consisted of two parallel tracks. The typical clearance envelope for a single track is 18 feet wide by 23 feet in height measured from the top of rail (Figure 9).

Along the length of the greenway, a two-foot thick cap will be placed over the historic fill that underlies the corridor. As a result, this cap will reduce the available clearance by two feet. Assuming that the underpass bridges originally provided clearance for trains as required by AREMA (Figure 9), the vertical clearance will be reduced to 21 feet, which is more than sufficient for the greenway. Thus, provided no new features were added since the abandonment of the rail line, there should be sufficient space to construct the greenway path under the bridges.

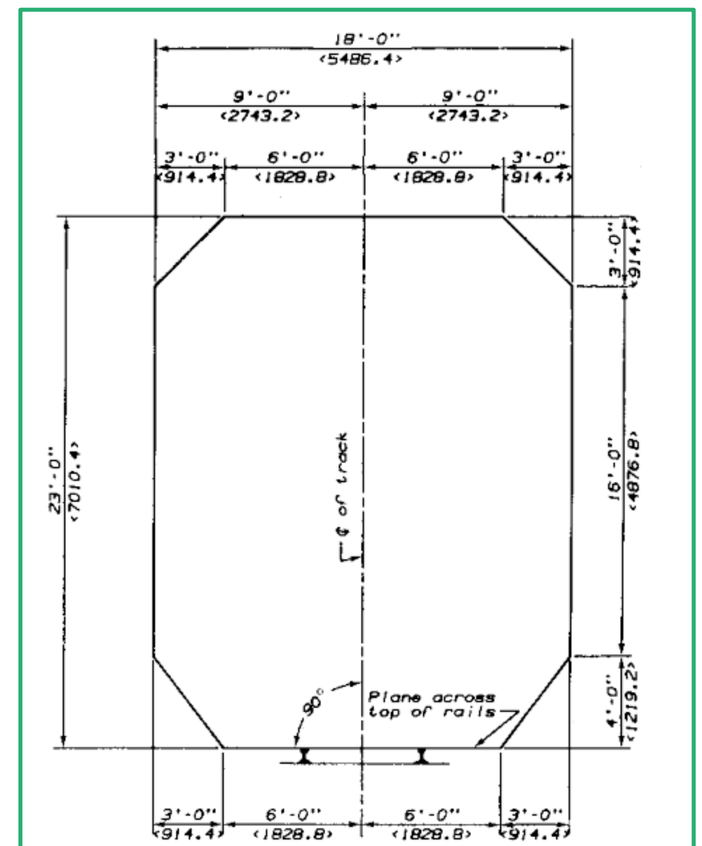


Figure 9 – Typical railway clearance envelope (AREMA [9])

The bridges may require cleaning for aesthetic reasons to remove stains and graffiti. Access control fencing may need to be provided along the greenway corridor as it crosses under these bridges, should it be required by the responsible jurisdiction to ensure no unauthorized access to the structure above. If bird roosting is found to be a concern on the underside of the bridges, bird deterrents could be installed.

The following section provides photos from the site visits and inspection reports for each underpass bridge. As shown, no new obstacles were identified under these bridges. Thus, these bridges are not expected to present significant challenges to the construction of the greenway.

MP 3.89 – Amtrak Northeast Corridor

- Sufficient clearance for greenway under the existing structures. Note these bridges will be replaced as a part of the Portal Bridge project, increasing the vertical clearance between the greenway and the Amtrak rail lines by 10 to 15 feet.
- Graffiti removal may be desired for aesthetic reasons.
- Access control fencing will likely be required to prevent unauthorized access into the Amtrak corridor.
- Access road on north side of the greenway corridor connects to Laurel Hill Road and Laurel Park. This access road will need to be maintained adjacent to the greenway for access by NJTransit and PSG&E for the overhead power lines.

Figure 10 – MP 3.89 Amtrak Northeast Corridor

MP 4.05 – NJ Turnpike Eastern Spur

- Sufficient clearance for greenway under the existing structure.
- Access road on north side of the greenway corridor connects to Laurel Hill Road and Laurel Park. This access road will need to be maintained adjacent to the greenway for access by NJTransit and PSG&E for the overhead power lines.

Figure 11 – MP 4.05 NJ Turnpike Eastern Spur

MP 5.39 – NJ Turnpike Western Spur

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 12 – MP 5.39 NJ Turnpike Western Spur

MP 5.65 – Belleville Turnpike

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 13 – MP 5.65 Belleville Turnpike

MP 6.69 – Schuyler Water Pipes

- Sufficient clearance for greenway under the existing structures.

Figure 14 – MP 6.69 Schuyler Water Pipes

MP 6.71 – Schuyler Ave

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 15 – MP 6.71 Schuyler Ave

MP 7.02 – Chestnut St

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 16 – MP 7.02 Chestnut St

MP 7.18 – Kearny Pipelines

- Sufficient clearance for greenway under the existing structures.
- Note that the pipelines are supported off the Kearny Avenue bridge

Figure 17 – MP 7.18 Kearny Pipelines

MP 7.19 – Kearny Ave

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 18 – MP 7.19 Kearny Ave

MP 7.34 – Hillcrest Pipeline

- Sufficient clearance for greenway under the existing structures.

Figure 19 – MP 7.34 Hillcrest Pipeline

MP 10.14 – Williamson Ave

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 20 – MP 10.14 Williamson Ave

MP 11.06 – Ridgewood Ave

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 21 – MP 11.06 Ridgewood Ave

MP 11.33 – Highland Ave

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 22 – MP 11.33 Highland Ave

MP 11.44 – Bay Street

- Sufficient clearance for greenway under the existing structures.
- Graffiti removal may be desired for aesthetic reasons.

Figure 23 – MP 11.44 Bay Street

3.2.2 Overpass Bridges

Overpass bridges are those that carry the greenway over a feature or obstacle. Each of these overpass bridges must structurally support the greenway path, including pedestrian and cyclist loads. The majority of these bridges are original structures built around the late 1890s or early 1900s when the Boonton Line was constructed. The bridges are in various states of repair.

The primary function of these bridges when converted to a greenway will be to carry the pedestrian loads as required by the Design Standards. Since existing drawings and design data are not available, an assessment of the load carrying capacity is made through a comparison of assumed railway loads against anticipated pedestrian loads. This comparison is summarized in the following section.

Each of the 16 overpass bridges is further reviewed in Sections 3.3 to 3.18. For each bridge, the existing condition is summarized based on prior site visits, and options are identified for deck replacements and structural improvements.

3.2.3 Load Carrying Capacity

The load carrying capacity of the bridges along the greenway corridor are evaluated based on a comparison of assumed loads while in operation as a railway bridge versus future loads as a pedestrian bridge.

The *AREMA Manual of Railway Engineering* [9] is the current designs standard for railway structures. This code specifies the design load as a train from the Cooper series. For modern bridges, the train load would be a Cooper E80 load (Figure 24). The Cooper series of train loads was originally developed more than 100 years ago. Given the age of the bridges along the greenway corridor, the design load at the time was likely less than the E80 train load. Lacking additional information, it is assumed that the bridges were designed for the Cooper E40 train load. This was the first Cooper series train load that was established in roughly the same time period as the construction of the Boonton line.

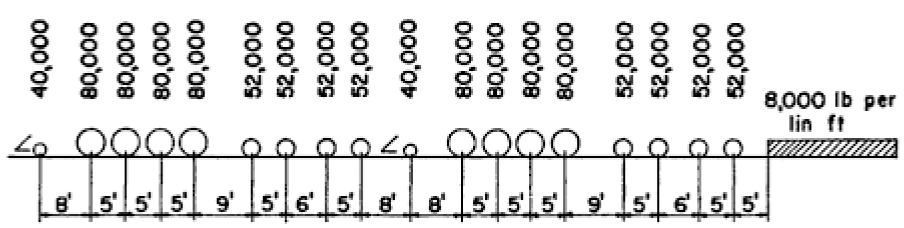


Figure 24 – Cooper E80 train load from AREMA

The modern design loads for pedestrian bridges are provided in *AASHTO LRFD Guide Specification for Pedestrian Bridges*. This design code requires that pedestrian bridges must support either a 90psf pedestrian load or a H10 maintenance vehicle (Figure 25). In some situations, consideration may be given to the maximum credible pedestrian load. There is a physical limit to how much load can be applied to a bridge from the static weight of pedestrians (Figure 26). However, given that the greenway is in an urban environment, where there are credible scenarios with high pedestrian traffic, such as during special events or running events, it is recommended that the designs comply with the 90psf design load specified by AASHTO.

Table 3.2-1—Design Vehicle

Clear Deck Width	Design Vehicle
7 to 10 ft	H5
Over 10 ft	H10

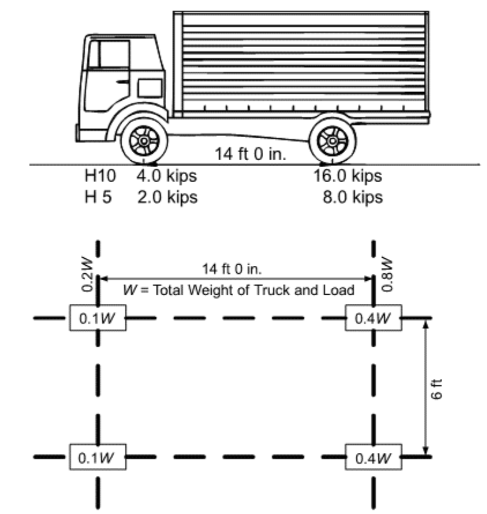


Figure 25 – H10 maintenance vehicle load from AASHTO

Figure 26 – Pedestrian live loads (left = 50psf, center = 100psf, right = 150psf)

A direct comparison of the train versus pedestrian loads indicates that the load effects from trains are several times larger than that of the pedestrian load. Conservatively assuming that trains were restricted to 10mph when crossing the bridges, the pedestrian load is still three times less than that of the train load. Therefore, provided the bridges are in a good state of repair, there should be sufficient load capacity to support the pedestrian loads.

3.3 Penhorn Creek (MP 3.21)

The bridge crossing Penhorn Creek is a three span structure that is 42 feet long. The bridge has a timber superstructure and substructure. There are two separate bridges that cross the creek at this location: one that services the access road on the north side of the railroad corridor and another that carries the railroad tracks. Due to the tight confines between the bridges, the substructure was not sufficiently visible during site visits. The vertical clearance between the bridge and the water looked to be about two feet at low tide. It appears that the bridge may become submerged during other tide conditions.

The Naik report indicated that the timber piles of the bridge are crushing. However, it is not clear if these piles were supporting the access road or the railroad trestle. Without more information, it is difficult to determine exactly what rehabilitation measures would need to be taken.

Additional review of this bridge is provided in the detailed assessments chapter of this report.

Bridge Geometry and Materials		
Bridge Length		42 ft
Bridge Width		30ft
# of Spans		3
# of Girders		Unknown
# of Piers		2
Materials	Deck	Ballast
	Superstructure	Timber
	Substructure	Timber

Photo descriptions:

1. Looking west
2. Looking east
3. Looking south
4. East timber pile foundation and south timber fascia

Table 6 – Review of MP 3.21 Penhorn Creek

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Timber trestle with timber piles
	Feature crossed	• Penhorn Creek, adjacent to tidal gate
	Deterioration	• Potentially damaged timber piles
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Low risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• Low risk – low stream velocity
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• N/A
	Railings and Fences	• Railing required at both edges
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• N/A
	Environmental Impact	• Potential impact for work in wetlands
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Structure is low level with minimal visual impact and flat grades

Next Steps

- Gain access to the underside of the bridge to inspect all timber piles and timber substructure
- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

Additional Notes:

- This crossing is expected to be used by NJ Transit for construction vehicles accessing the Portal Bridge replacement project on the Hackensack River. The analysis in this report does not include an assessment of the feasibility of this structure to accommodate construction vehicles and their loads. Additional study with specific construction vehicle loading criteria should be undertaken by the Portal Bridge project. The use of and potential upgrades to the bridge to support the Portal Bridge construction may impact how this bridge is incorporated into the greenway.

3.4 Hackensack River Swing Bridge (MP 4.17)

The bridge crossing the Hackensack River is a moveable bridge with six approach spans and center swing span. The approach spans are steel girders supported on a concrete substructure. The main spans consist of a swing truss that has been in the open position since the rail tracks were abandoned. The vertical clearance between the river and the underside of the swing span is seven feet.

The electrical equipment used to move the truss has been removed. The bridge exhibits extensive degradation and damage in the approach spans, which exhibit significant section loss from corrosion on the bottom flanges and the webs. Based on the vegetation present on the girders and FEMA flood plain maps, it is observed that the girders become submerged occasionally during high flood levels. The concrete piers exhibit spalling that can also be attributed to the variation in water level. The bearings are also significantly corroded and appear to be locked. The team was unable to determine the condition of the substructure or the truss of the main swing span due to lack of visibility and access during the site visits.

In order for this bridge to be converted to a greenway, the condition of the substructure and foundations below the waterline should be verified. Major rehabilitation measures or replacement will have to be considered for the approach and swing spans.

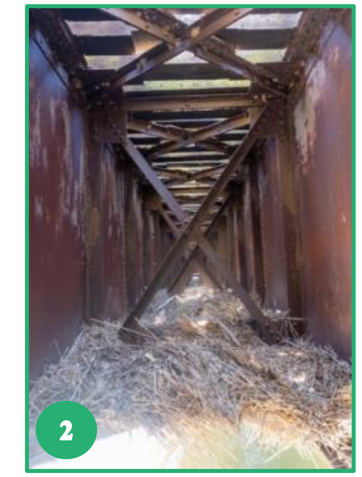
Additional review of this bridge is provided in the detailed assessments chapter of this report.

Bridge Geometry and Materials		Main Span	Approach Spans
Bridge Length		260 ft	480 ft
Bridge Width		24ft	24ft
# of Spans		2 (130-130)	6 (80-80-80) (80-80-80)
# of Girders		-	4
# of Piers		1	6
Materials	Deck	Wood	Wood
	Superstructure	Steel Truss	Steel Girders
	Substructure	Concrete	Concrete

Photo descriptions:

1. Looking west
2. Vegetation stuck in girders as evidence of flood plain levels
3. Section loss in secondary members of the superstructure
4. Section loss in the primary members of the superstructure
5. Spalling in the concrete piers
6. Bearings exhibiting extensive corrosion
7. Spalling in the concrete piers


1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3


4


5


6

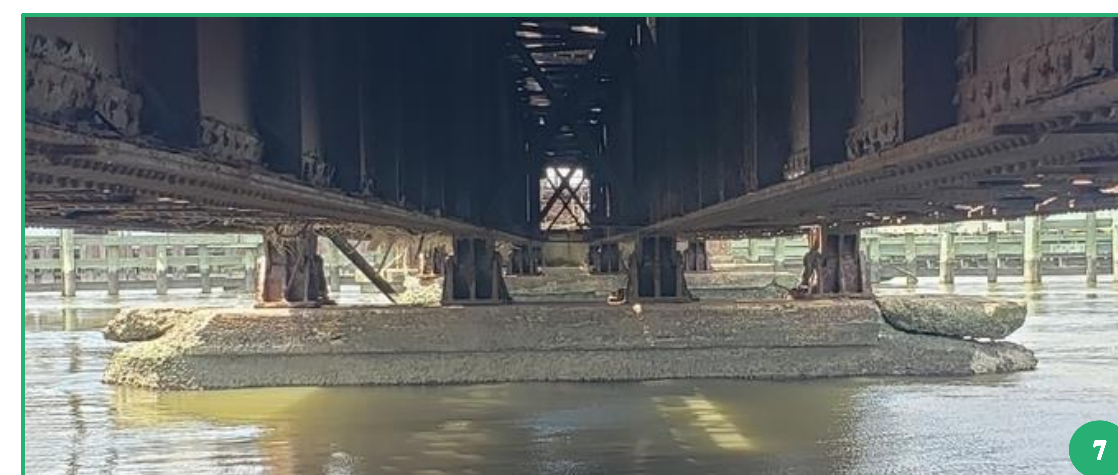
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Table 7 – Review of MP 4.17 Hackensack River Swing Bridge

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Riveted steel girder approach spans • Truss swing span • Mass concrete substructure pile caps • Unknown foundations
	Feature crossed	• Hackensack River
	Deterioration	• Areas of 100% section loss on approach girders • Corroded bearings • Concrete spalling at substructure pile caps • Inoperable movable span • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential risk – approach structures likely redundant. Swing truss potentially non-redundant.
	Seismic	• Potential risk – swing span requires review
	Collision	• Potential risk – bridge crosses navigable waterway
	Hydraulics	• Potential risk – requires further investigation
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• N/A
	Railings and Fences	• Railing required at both edges
	Emergency Vehicle Access	• Movable bridge stuck in open position: currently no access across the river
Constructability	Construction Methods	• Potential for in-water work
	Traffic Impact	• N/A
	Environmental Impact	• Potential impact for work in wetlands
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Significant structure with potential to be a key feature along the greenway

Next Steps

- The bridge across the Hackensack River presents a significant challenge to the construction of the greenway. The bridge must be thoroughly evaluated, and both rehabilitation and replacement scenarios should be considered in order to identify the most cost-effective solution.
- Obtain and evaluate existing bridge drawings and maintenance/repair history
- Detailed inspection of structure to identify locations and extent of deterioration across the structure, including an underwater inspection to review the condition of the substructure below the waterline and condition

3.5 Pipe Crossing (MP 5.63)

The bridge at MP 5.63 is a 26-foot-long, single span steel girder bridge that crosses a pipe line at a low clearance. Despite the low clearance, there is only minor corrosion on the girders, with moderate corrosion of secondary elements that may require replacement. The abutments appear to be in good condition. However, there is evidence of washout in the area surrounding the bridge. This may need to be addressed.

This bridge does not appear to have deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		26 ft
Bridge Width		27 ft
# of Spans		1 (26)
# of Girders		3
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel
	Substructure	Concrete

Photo descriptions:

1. Looking north
2. Looking south
3. The ground approximately 300 feet west of the bridge is washed out
4. Corrosion on the girders
5. Corrosion on the girders

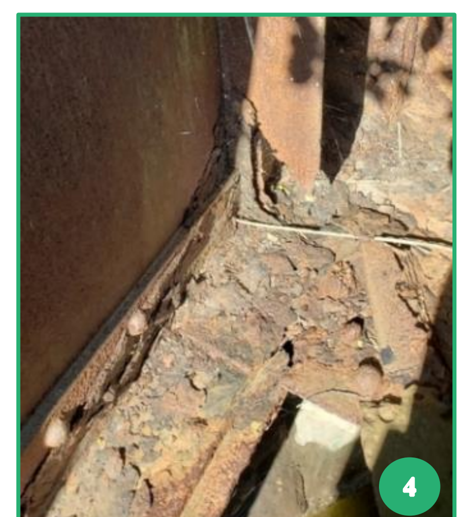


Table 8 – Review of MP 5.63 Pipe Crossing

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel through girders
	Feature crossed	• Wetlands and pipe lines
	Deterioration	• Minor to moderate corrosion of steel • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potentially non-redundant
	Seismic	• Low risk – single span structure
	Collision	• No risk – no vessel traffic
	Hydraulics	• Potential – evidence of nearby washouts
Safety	Geometry	• Adequate width and height for trail • Note through girder at centerline of bridge, essentially dividing the bridge into two halves.
	Horizontal and Vertical Clearances	• N/A
	Railings and Fences	• Railing required at both edges
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• N/A
	Environmental Impact	• Potential impact for work in wetlands
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Structure is low level with minimal visual impact and flat grades

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.6 Harrison IT (MP 6.41)

This structure is a single span, 33-foot-long concrete bridge crossing a stream. Since this bridge crosses private property (potentially another abandoned rail line), observations during site visits were unable to verify the condition of the underside of the superstructure and the substructure. It does appear that the superstructure and the abutments are in good condition where they were visible.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		33 ft
Bridge Width		34 ft
# of Spans		1 (33)
# of Girders		-
# of Piers		N/A
Materials	Deck	Ballast
	Superstructure	Concrete
	Substructure	Concrete

Photo descriptions:

1. Looking south
2. Looking northwest

Table 9 – Review of MP 6.41 Harrison IT

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Reinforced concrete
	Feature crossed	• Abandoned rail line (unconfirmed)
	Deterioration	• Minor concrete deterioration
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Low risk – single span structure
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• N/A
	Railings and Fences	• Railing required at both edges
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• N/A
	Environmental Impact	• Potential impact for work adjacent wetlands
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Value in preserving historic concrete features along the bridge parapet

Next Steps

- Gain access to the underside of the bridge to inspect superstructure and abutments
- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.7 Passaic Ave/Passaic River/McCarter Highway (MP 7.57)

The bridge at MP 7.57 crosses Passaic Avenue, Passaic River, and McCarter Highway. The structure consists of seven spans with a moveable section over the river. The moveable section has been locked in the closed position at least since the rail tracks were abandoned and thus it can be assumed that the current vertical clearance is sufficient for the navigation of vessel traffic in the river.

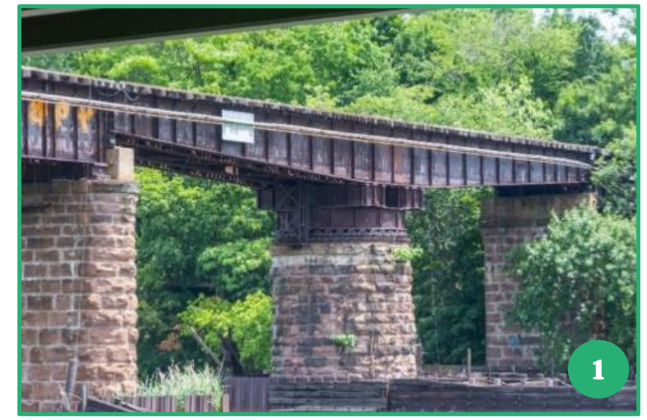
The superstructure appeared to be in relatively good condition with some minor corrosion. The bearings at the abutments are also exhibiting corrosion. The piers for the outermost spans appear to be in good condition and the abutment on the eastern side exhibits only minor cracking. The abutment on the western side exhibits more severe cracking which appears to be associated with a past widening or repairs to the original abutment. The substructure in the river was more difficult to assess based on accessibility and visibility. The components that were visible appeared to be in fair condition and to have been rehabilitated in the past. Where the masonry abutments needed rehabilitation in the past it was carried out using concrete. The river fender system, however, exhibits severe deterioration.

In order to convert this bridge to a greenway, the condition of the substructure in the water will have to be verified. It would be beneficial to have more information on the design and materials of the masonry piers, the moveable superstructure, and the foundations in the river.

Bridge Geometry and Materials		
Bridge Length		580 ft
Bridge Width		24 ft
# of Spans		7 (70-50-70-100-75-75-90)
# of Girders		4
# of Piers		6
Materials	Deck	Wood
	Superstructure	Steel
	Substructure	Masonry and Concrete

Photo descriptions:

1. Moveable span looking north
2. Looking west
3. East concrete abutment exhibiting some cracking
4. West masonry abutment has a major crack due to past expansion of the abutment
5. Corrosion of bearings at the eastern side of the bridge
6. Corrosion in girders and bearings
7. Deterioration of fender system
8. Evidence of past rehabilitation measures used on the bearings at one of the piers



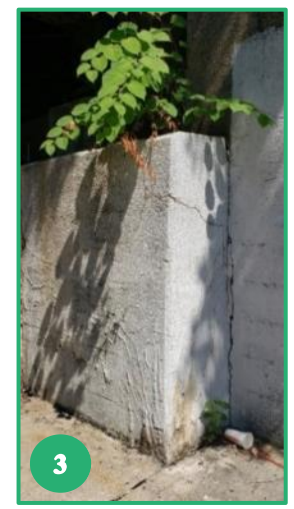


Table 10 – Review of MP 7.57 Passaic River Bridge

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders • Movable center span above navigation channel • Masonry piers in water, concrete adjacent to McCarther Highway
	Feature crossed	• Passaic River
	Deterioration	• Minimal corrosion evident on the steel girders • Some cracking evident at abutments, likely due to past widening of the abutment wing walls • Evidence of prior repairs on masonry piers in the river • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Potential risk – longer spans with masonry piers
	Collision	• Potential risk – navigable waterway with damaged fendering system
	Hydraulics	• Potential risk – unknown foundation and scour conditions below the waterline
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadways
	Railings and Fences	• Railing required at both edges • Fences required over roadways
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Complex construction methods, either from river or working solely from the bridge
	Traffic Impact	• Potential impact to roadways below. Will likely require shielding during construction
	Environmental Impact	• Potential impact in river and adjacent neighborhoods
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Significant structure with potential to be a key feature along the greenway

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, in particular the measures taken to close the movable span and previous repairs made to masonry piers
- Evaluate the vessel collision risk to determine the extent of repair required for the fender system
- Detailed inspection of structure to identify locations and extent of deterioration across the structure, including an underwater inspection to review the condition of the substructure below the waterline and condition
- Perform load rating calculations based on the drawings to verify load capacity

3.8 McCarter Highway (MP 7.74)

The bridge crossing McCarter Highway is a 66-foot-long, single span bridge with steel girders and masonry abutments. While the superstructure exhibits some corrosion, the overall condition of the bridge is good.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		66 ft
Bridge Width		24 ft
# of Spans		1 (66)
# of Girders		4
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel
	Substructure	Masonry

Photo descriptions:

1. Looking south
2. Minor corrosion on the underside of the girders
3. Looking east

Table 11 – Review of MP 7.74 McCarter Highway

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment
	Feature crossed	• Old McCarter highway
	Deterioration	• Minor steel deterioration • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Low risk – single span structure
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadways
	Railings and Fences	• Railing required at both edges • Potentially require fences over roadway, dependent on requirements of local jurisdiction
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Minimal
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat grades • Bridge is at an elevated height above the roadway, giving users a different perspective

Next Steps

- Review the encroachment into the embankment at the southwest abutment to determine if the cut into the slope poses any risk to the structure or to the slope stability of the embankment.
- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.9 Newark IT (MP 7.88)

The structure at MP 7.88 crosses a private lot. It is an 85-foot-long, single span bridge with steel girders and masonry abutments. The steel girders show some corrosion but generally appear to be in fair condition.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge depending on the condition of the substructure.

Bridge Geometry and Materials		
Bridge Length		85 ft
Bridge Width		24 ft
# of Spans		1 (85)
# of Girders		4
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel
	Substructure	Masonry

Photo descriptions:

1. Looking east
2. Looking north
3. Minor corrosion on the underside of the girders

Table 12 – Review of MP 7.88 Newark IT

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment
	Feature crossed	• Private property / pallet yard
	Deterioration	• Minor deterioration • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Low risk – single span structure
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• N/A – above private property
	Railings and Fences	• Railing required at both edges • Require fences over private property
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Minimal, but potential impact to private property
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Low impact and flat grades

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.10 Broadway (MP 7.96)

The bridge crossing Broadway is a 100-foot-long, three span bridge with steel girders and masonry abutments. The superstructure exhibits some minor corrosion and there is a crack in the western abutment. There is also a significant amount of vegetation growing on top of the deck.

While there are some minor issues in the superstructure and substructure, this bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		120 ft
Bridge Width		33 ft
# of Spans		3 (20-60-20)
# of Girders		2
# of Piers		N/A
Materials	Deck	Steel
	Superstructure	Steel Girders
	Substructure	Masonry

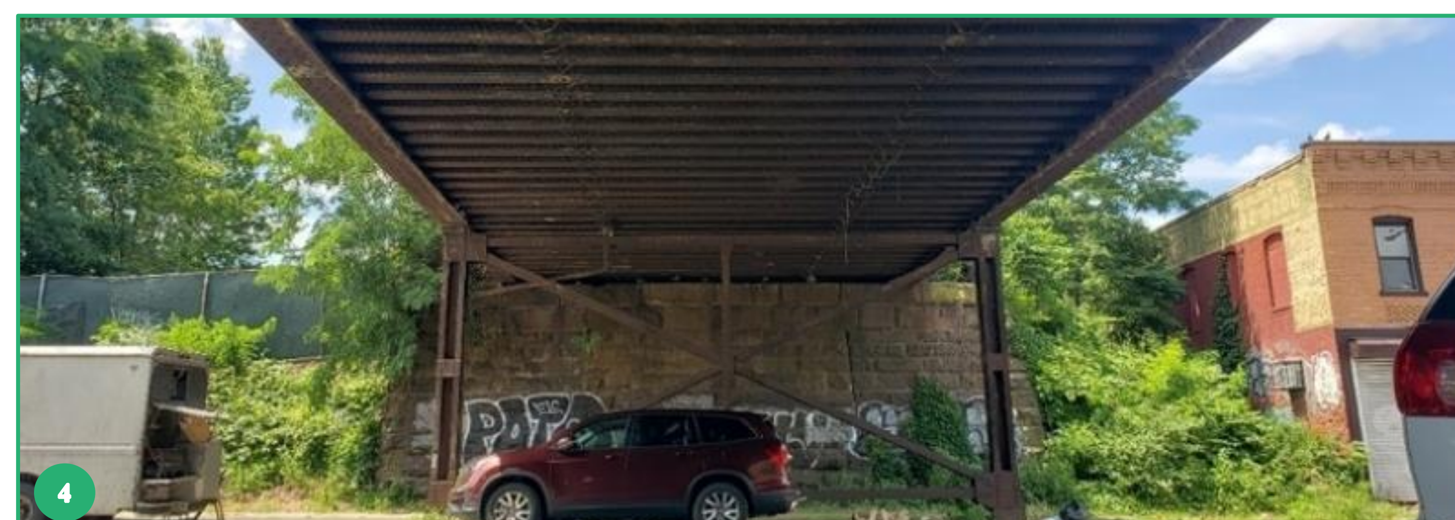


Photo descriptions:

1. Looking north
2. Crack in the western masonry abutment
3. Vegetation present on the deck
4. Looking east

Table 13 – Review of MP 7.96 Broadway

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment, with metal deck
	Feature crossed	• Broadway – local roadway
	Deterioration	• Minor deterioration
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Potential risk – substandard vertical and horizontal clearances
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat grades • Aesthetic impact from the roadway could be improved by repainting the structure

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity
- Consult with local transportation departments on nonstandard vertical and horizontal clearances

Additional Notes:

- If substandard vertical and horizontal clearances are not desired, the bridge could be replaced with a prefabricated truss pedestrian bridge in order to achieve the required height. Ramps and embankments would need to be constructed at each end. This option could potentially leave the existing abutments in place with the new bridge spanning above, but this would need to be studied to ensure they remain stable in the new configuration.

3.11 Second River / Branch Brook Park Drive (MP 8.85)

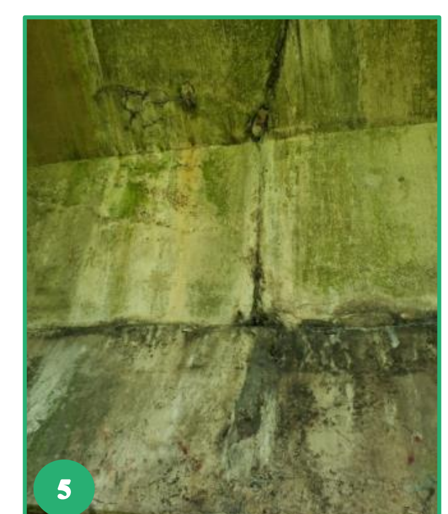
The structure at MP 8.85 is a 175-foot-long, three span concrete arch bridge that crosses Branch Brook Park Drive, Second River, and a path through the park. There is some localized spalling on one of the piers, as well as minor cracking and discoloration at the construction joint underneath the deck. Overall, however, the bridge is in good condition.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		255 ft
Bridge Width		35 ft
# of Spans		3 (80-95-80)
# of Girders		N/A
# of Piers		2
Materials	Deck	Ballast
	Superstructure	Concrete
	Substructure	Concrete

Photo Descriptions:

1. Looking northeast
2. Spalling and discoloration seen looking southwest
3. Spalling of concrete at construction joint under southern most span
4. Spalling at the base of one of the piers
5. Spalling and discoloration on the side of one of the piers
6. Spalling at the base of one of the piers



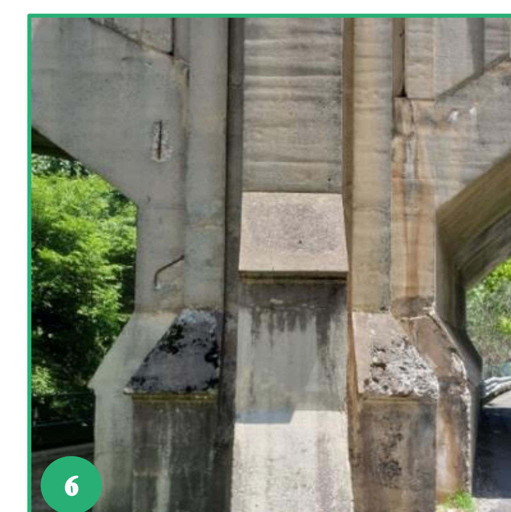


Table 14 – Review of MP 8.85 Second River / Branch Brook Park Drive

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Three span concrete arch bridge
	Feature crossed	• Second River and Park Drive
	Deterioration	• Minor spalling, leakage through soffit of arch joint
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure is redundant
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• Potential risk, dependent on foundations adjacent to the river and flood/scour event occurrence
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadways
	Railings and Fences	• Railing required at both edges • Fencing required over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Minor to none, dependent on level of concrete rehabilitation
	Environmental Impact	• Potential impact should work need to be performed in the span over the river
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Historic and notable arch structure from roadway below

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.12 Franklin Ave (MP 9.1)

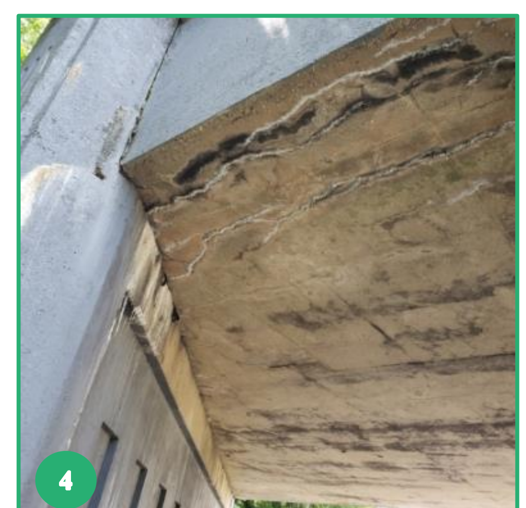
The bridge crossing Franklin Ave is an 86-foot-long, two span concrete structure. There is some damage to one of the abutments that may be evidence of an impact and the underside of the deck exhibits longitudinal cracking. However, overall the bridge is in fair condition.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		90 ft
Bridge Width		31 ft
# of Spans		2 (45-45)
# of Girders		N/A
# of Piers		1
Materials	Deck	Ballast
	Superstructure	Concrete
	Substructure	Concrete/Masonry

Photo descriptions:

1. Looking east
2. Cracking underneath the deck and discoloration at the top of the pier
3. Cracking underneath the deck
4. Cracking and discoloration underneath the deck
5. Spalling at the southern abutment and cracking in the superstructure



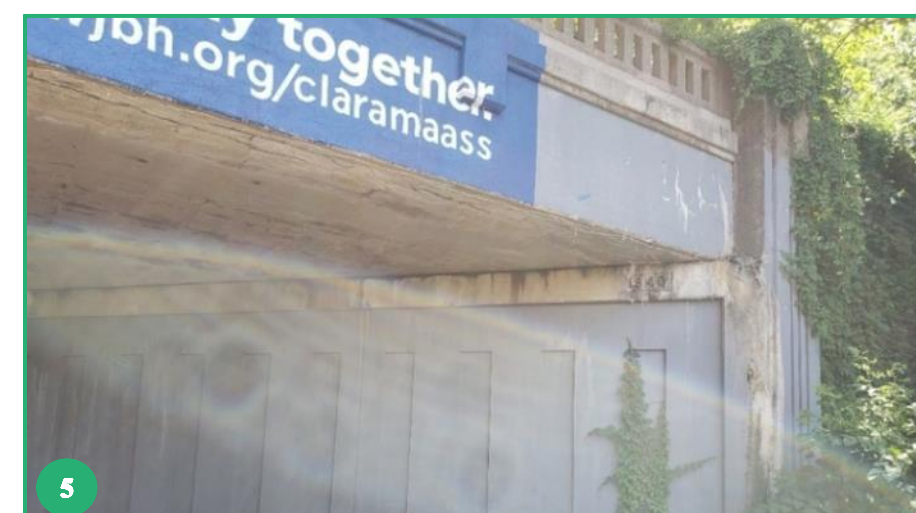


Table 15 – Review of MP 9.10 Franklin Ave

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Reinforced concrete
	Feature crossed	• Franklin Avenue
	Deterioration	• Minor concrete deterioration and spalling on the underside of the superstructure
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears redundant
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Potentially substandard horizontal clear zones
	Railings and Fences	• Railing required at both edges • Fencing provided over roadways
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• N/A
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Structure is low level with minimal visual impact and flat grades

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity
- Consult with local transportation departments on horizontal clearances, due to evidence of potential accident history. Consider adding traffic barriers at the approach roads to protect the bridge abutments

3.13 Garden State Parkway (MP 10.29)

The bridge crossing the Garden State Parkway is 120-foot-long, two span structure with two steel girders and a concrete substructure. The superstructure is in good condition despite some minor corrosion. The abutments have been repaired in the past and are also in good condition. There is some cracking above the wingwalls.

This bridge does not appear to have damage and deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		120 ft
Bridge Width		37 ft
# of Spans		2 (60-60)
# of Girders		2
# of Piers		1
Materials	Deck	Ballast
	Superstructure	Steel
	Substructure	Concrete

Photo descriptions:

1. Corrosion on the girders looking south
2. Cracking in the concrete above the abutment
3. Cracking in the concrete above the wingwall
4. Looking north

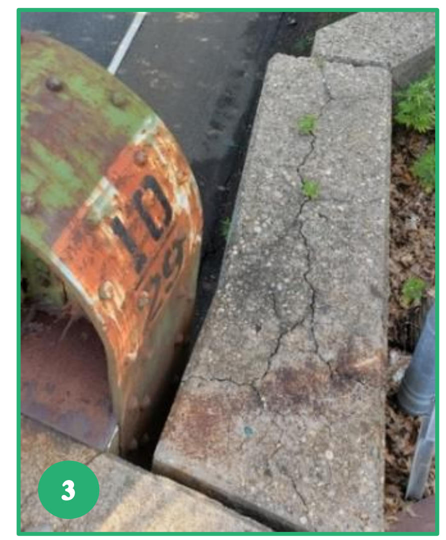


Table 16 – Review of MP 10.29 Garden State Parkway

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with concrete abutments
	Feature crossed	• Garden State Parkway
	Deterioration	• Minor deterioration in steel girders, cracking in abutment wingwalls
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadway
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic, particularly if work needs to be performed in the parkway right-of-way
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Low impact with flat grades

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.14 JFK Drive (MP 10.36)

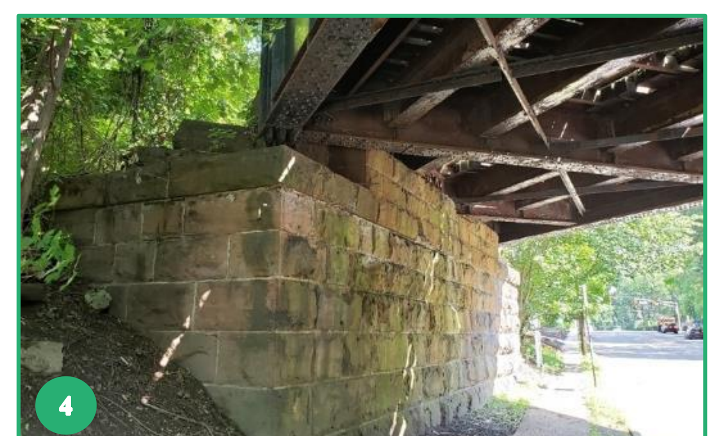
The bridge crossing JFK Drive is a 110-foot-long, one span structure with steel girders and masonry abutments. Despite some superficial rust, the bridge is in good condition. This bridge is a historic structure, originally spanning the Morris Canal, which traversed through New Jersey. Therefore, there is historic value in rehabilitating and retaining this bridge.

There is no obvious deterioration or damage that will significantly reduce the load carrying capacity of the bridge, and it can likely be rehabilitated using typical construction methods.

Bridge Geometry and Materials		
Bridge Length		110 ft
Bridge Width		33 ft
# of Spans		1 (110)
# of Girders		2
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel
	Substructure	Masonry

Photo descriptions:

1. Looking north
2. Crack running horizontally in masonry under bearing
3. Looking east
4. Western masonry abutment
5. Corrosion and graffiti on girder



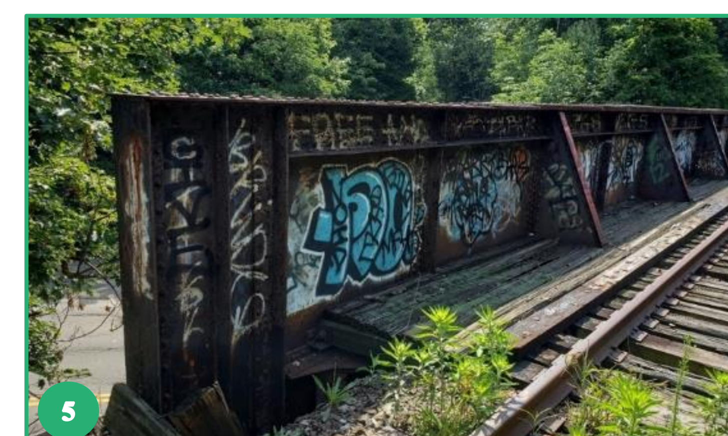


Table 17 – Review of MP 10.36 JFK Drive

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutments
	Feature crossed	• JFK Drive
	Deterioration	• Minor deterioration in steel girders, cracking in masonry abutment bearing stones • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadway
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat grades • Notable historic structure from roadway perspective

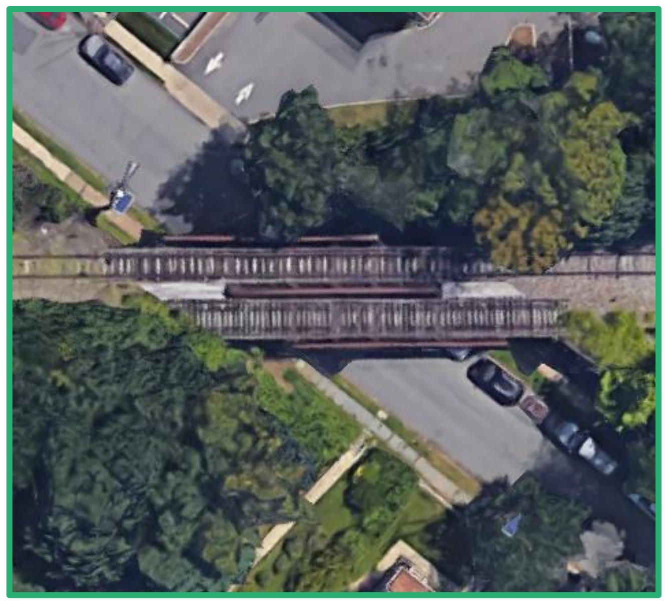
Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

3.15 Spruce Street (MP 10.42)

The bridge that crosses Spruce St is an 80-foot-long, three span structure with a steel superstructure, steel piers, and masonry abutments. The structure exhibits minor corrosion but is otherwise in good condition.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.



Bridge Geometry and Materials		
Bridge Length		80 ft
Bridge Width		28 ft
# of Spans		3 (20-60-20)
# of Girders		7
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel Girders
	Substructure	Masonry

Photo descriptions:

1. Looking north
2. Western abutment and pier
3. Western abutment and pier

Table 18 – Review of MP 10.46 Spruce Street

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment
	Feature crossed	• Spruce Street – local roadway
	Deterioration	• Minor deterioration • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail • Note through girder at centerline of bridge, essentially dividing the bridge into two halves.
	Horizontal and Vertical Clearances	• Potential risk – substandard vertical and horizontal clearances
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact • Potential impact to adjacent residential areas
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat grades • Aesthetic impact from the roadway could be improved by repainting the structure

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity
- Consult with local transportation departments on nonstandard vertical and horizontal clearances

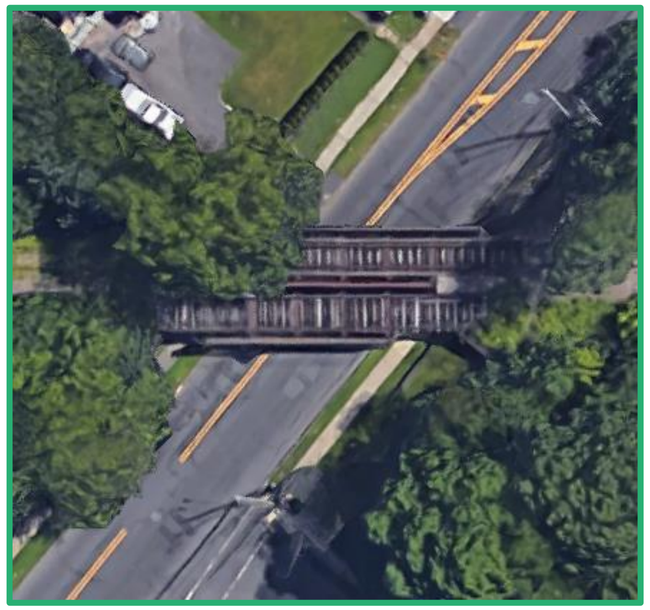
Additional Notes:

- If substandard vertical and horizontal clearances are not desired, the bridge could be replaced with a prefabricated truss pedestrian bridge in order to achieve the required height. Ramps and embankments would need to be constructed at each end. This option could potentially leave the existing abutments in place with the new bridge spanning above, but this would need to be studied to ensure they remain stable in the new configuration.

3.16 Belleville Ave (MP 10.47)

The bridge crossing Belleville Ave is an 80-foot-long, three span structure with steel girders, steel piers, and masonry abutments. The vertical clearance of the bridge is substandard at 11'-8". The bottom flanges and web stiffeners of one of the fascia girders and the flanges of one of the piers exhibit severe damage from impacts. The superstructure exhibits some corrosion.

While the structure is safe to be converted into a pedestrian bridge, it is recommended that the substandard vertical geometry be addressed through improved signage or raising the structure.



Bridge Geometry and Materials		
Bridge Length		100 ft
Bridge Width		25ft
# of Spans		3 (25-50-25)
# of Girders		7
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel Girders
	Substructure	Masonry

Photo descriptions:

1. Looking east
2. Damage to the fascia girder due to vehicular impact
3. Damage to the pier column due to vehicular impact
4. Looking north
5. Corrosion at a connection on the superstructure

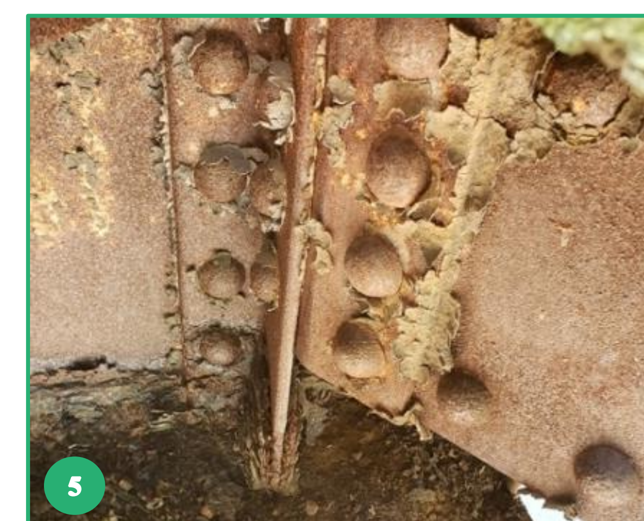


Table 19 – Review of MP 10.47 Belleville Ave

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment
	Feature crossed	• Belleville Ave – local roadway
	Deterioration	• Minor deterioration, significant vehicle impact damage • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail • Note through girder at centerline of bridge, essentially dividing the bridge into two halves.
	Horizontal and Vertical Clearances	• Potential risk – substandard vertical and horizontal clearances
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact • Potential impact to adjacent residential areas
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat Grades • Aesthetic impact from the roadway could be improved by repainting the structure

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity
- Consult with local transportation departments on nonstandard vertical and horizontal clearances

Additional Notes:

- If substandard vertical and horizontal clearances are not desired, the bridge could be replaced with a prefabricated truss pedestrian bridge in order to achieve the required height. Ramps and embankments would need to be constructed at each end. This option could potentially leave the existing abutments in place with the new bridge spanning above, but this would need to be studied to ensure they remain stable in the new configuration.

3.17 New Street (MP 10.58)

The bridge crossing New St is a 100-foot-long, three span structure with steel girders, steel piers, and masonry abutments. The vertical clearance of the bridge is substandard at 11’-6”. The bottom flange of the northern fascia girder is slightly damaged and may have been hit by a vehicle.

Despite its low clearance this bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		90 ft
Bridge Width		22 ft
# of Spans		3 (20-50-20)
# of Girders		4
# of Piers		N/A
Materials	Deck	Wood
	Superstructure	Steel Girders
	Substructure	Masonry

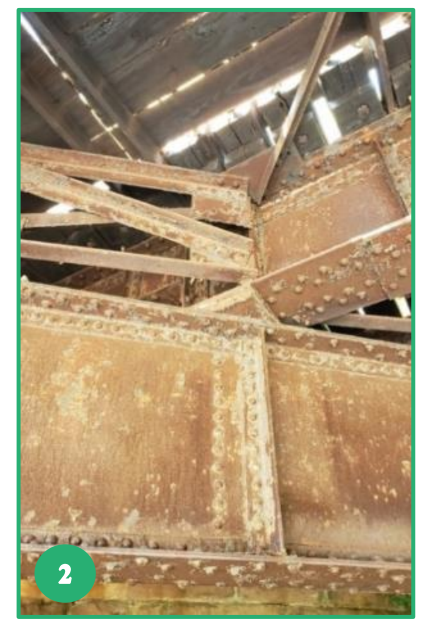


Photo descriptions:

1. Looking east
2. Corrosion in superstructure
3. Damage to bottom flange of fascia girder, potentially due to vehicle impact
4. Underside of bridge looking north

Table 20 – Review of MP 10.58 New Street

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with masonry abutment
	Feature crossed	• New Street – local roadway
	Deterioration	• Minor deterioration, minor vehicle impact damage • Deteriorated and rotten deck ties
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Potential – non-redundant through girders
	Seismic	• Potential risk
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Potential risk – substandard vertical and horizontal clearances
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact • Potential impact to adjacent residential areas
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Flat grades • Aesthetic impact from the roadway could be improved by repainting the structure

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity
- Consult with local transportation departments on nonstandard vertical and horizontal clearances

Additional Notes:

- If substandard vertical and horizontal clearances are not desired, the bridge could be replaced with a prefabricated truss pedestrian bridge in order to achieve the required height. Ramps and embankments would need to be constructed at each end. This option could potentially leave the existing abutments in place with the new bridge spanning above, but this would need to be studied to ensure they remain stable in the new configuration.

3.18 Broad Street (MP 10.69)

The bridge crossing Broad St is a 60-foot-long, single span structure with steel girders and concrete abutments. This bridge appears to be a relatively new structure, compared with others on the corridor, and is in good condition.

This bridge does not appear to have damage or deterioration that significantly reduces the load carrying capacity of the bridge.

Bridge Geometry and Materials		
Bridge Length		60 ft
Bridge Width		32 ft
# of Spans		1 (60)
# of Girders		4
# of Piers		N/A
Materials	Deck	Ballast
	Superstructure	Steel
	Substructure	Concrete

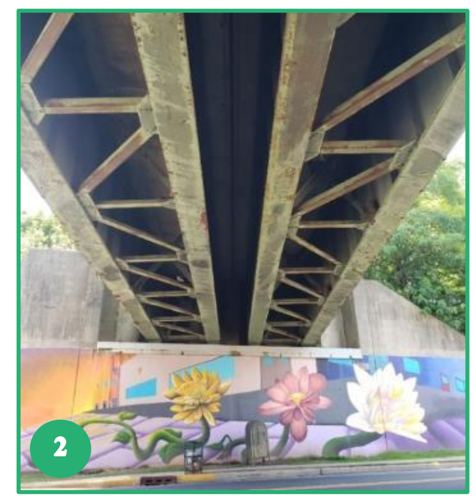


Photo descriptions:

1. General view of bridge, looking south
2. Underside of bridge looking east, in generally good condition
3. Western abutment
4. Looking north

Table 21 – Review of MP 10.69 Broad Street

Factor	Sub Factor	Key Observations
Existing Conditions	Type of bridge	• Steel girders with concrete abutment and ballasted concrete deck
	Feature crossed	• Broad Street – local roadway
	Deterioration	• Little deterioration evident
	Design Standards	• AASHTO LRFD Pedestrian Bridge Design Code
Structural Integrity	Load carrying capacity	• See comparison in Section 3.2.3
	Redundancy	• Low risk – structure appears to be redundant
	Seismic	• Low risk – modern structure
	Collision	• No risk – no vessel traffic
	Hydraulics	• No risk – not in a waterway
Safety	Geometry	• Adequate width and height for trail
	Horizontal and Vertical Clearances	• Adequate clearance over roadway
	Railings and Fences	• Railing required at both edges • Require fences over roadway
	Emergency Vehicle Access	• Adequate access available
Constructability	Construction Methods	• Assume conventional construction methods can be used with land-based equipment
	Traffic Impact	• Potential impact to traffic
	Environmental Impact	• Average potential for environmental impact
	Hazardous Materials	• Potential to encounter hazardous materials
User Experience	Aesthetics and User Comfort	• Low visual impact with flat grades

Next Steps

- Obtain and evaluate existing bridge drawings and maintenance/repair history, and perform load rating calculations based on the drawings to verify load capacity

4.0 Detailed Assessment

4 Detailed Assessment of Key Bridges

4.1 Overview

This chapter provides a detailed assessment of key bridges identified by the project team. This detailed assessment builds upon and should be read in conjunction with the general assessment. For each bridge considered in this chapter, significant constraints are highlighted.

4.2 Penhorn Creek (MP 3.21)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.3 for additional details provided in the general bridge assessment.

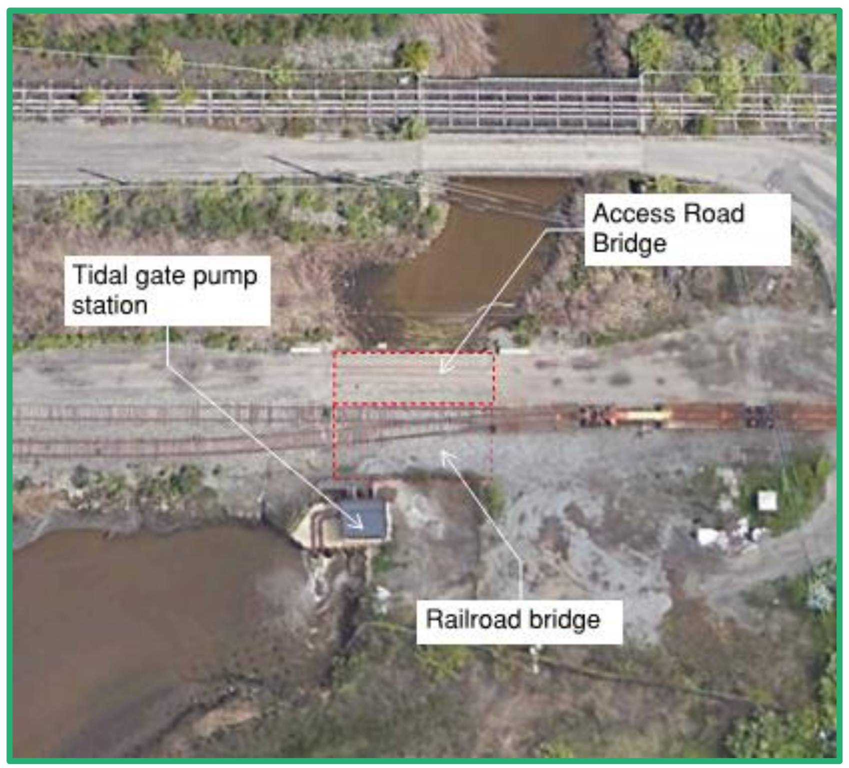


Figure 27 – Penhorn Creek Bridge Key Features

4.2.1 Key Features and Constraints

Adjacent bridges

The existing bridge at Penhorn Creek is identified in the Norfolk Southern Inspection Reports [3] as a timber trestle bridge with three spans and a total length of 42ft.

Based on aerial and site photos, there appear to be two bridges adjacent to each other at this location. The southern bridge carries the railroad tracks and the northern bridge carries an access road that runs parallel to the tracks. It appears that the two structures are independent, but access during site visits was limited so this was not properly confirmed. Thus, it is unclear if the two bridges share a substructure (piles and pile cap).

It is understood that the access road is used by NJ Transit and PSE&G to maintain the overhead electric lines. Access must continue to be maintained after the greenway is constructed.

Crushing timber piles

The NS inspection reports [3] state that the top of the piles are rotted and crushing on the north side. It is not evident if this is referring to the access road bridge or the railroad bridge. However, for the purpose of this study, it is assumed that timber piling needs to be replaced.

Tidal Gate Pump Station

There is a tidal gate located just to the south of this bridge. This tidal gate is identified as the St. Paul's Avenue Tide Gate and Pump Station [12]. It is believed to be maintained by the Hudson County Engineering Department. This pump separates the Hackensack River from the Penhorn Creek, potentially by a sheet pile wall and levee. Potential impacts to this tidal gate will need to be investigated and understood, particularly if any construction at this location could have a negative effect on the operation of this tidal gate system.

Portal Bridge Construction Access

The Penhorn Creek Bridge is expected to be used for construction access during the construction of the replacement Portal Bridge on Amtrak's Northeast Corridor. The analysis in this report does not include an assessment of the feasibility of this structure to accommodate construction vehicles and their loads. Rather, it focuses solely on converting the existing bridges from a rail bridge into a pedestrian bridge. The use of and potential upgrades to the bridge to support the Portal Bridge construction may impact how this bridge is incorporated into the greenway.

Tailing track for Croxton Intermodal Terminal

The Naik Preliminary Assessment Report indicates that this section of the track is still in use as a tailing track to the Croxton Intermodal Terminal. It is anticipated that the tailing tracks will not continue to be used and the tracks will be removed, posing no issue for use by the greenway. However, if this track must continue to be in use, then the location of the greenway will need to accommodate this by avoiding the existing railroad tracks. Adequate securing fencing and separation would need to be installed between the greenway and the active railroad.

The use of the bridge as a tailing track, along with the need for the access from by NJ Transit and PSE&G and the desire to use the bridge for Portal Bridge construction access amount to several concerns that will need to be resolved. There are several parties discussing the use of the same confined area of space. The use and function of these areas must be clearly defined and agreed, so that the greenway alignment and bridge selection can be finalized.

4.3 Hackensack River (MP 4.17)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.4 for additional details provided in the general bridge assessment.

4.3.1 Key Features and Constraints

Movable swing span

The Hackensack River Bridge comprises a center truss span that sits on a pivot pier in the middle of the Hackensack River, with three approach spans on either side. The truss span has been left in the open position for more than a decade. The Naik Preliminary Assessment Report indicates that all electronic controls equipment has been stripped from the operator's shed.

The center truss is a rim-bearing swing bridge, where all of the load of the truss is supported by rollers that run on a circular track on the pivot pier. It appears that the swing span is driven by a rack-and-pinion mechanical system at the pivot pier, but this cannot be verified based on the inspections alone.

The center swing span truss is approximately 260ft in length.

Figure 28 - Hackensack River pivot pier, with rim-bearing rollers partially visible

When the bridge is in the closed position, it is locked in place by wedges that extend into a block on the side span piers. It is evident that the wedges at the northeast corner of the truss have been replaced. Photos from the site visits show new steelwork attached to the truss with hex bolts rather than rivets as originally constructed. It is not known why this wedge was replaced or if it provides any indication of the expected condition of the remaining original wedges.

Figure 29 - Wedge at northeast corner of swing truss, with bolted repairs

In order to rehabilitate this movable span, all moving components would need to be inspected. New mechanical driving equipment and electric equipment would need to be installed. Lastly, electric and power would need to be supplied across the navigation channel to the center pier, via a submarine cable at the riverbed. It appears there may be existing supply cables along the southern edge of the approach girders, but it is assumed that they are inoperable.

Approach girders deterioration

On each side of the center swing, there are three approach spans, each approximately 80ft in length. There are four girder lines in the approach spans, which were presumably rail bearing girders that sat directly under the rail tracks above. The girders are arranged in pairs, with cross frames connecting two girders. The girders are assembled with rivets and are approximately eight feet deep. There is a bearing at the end of each girder span, indicating that each span is simply supported.

Site visits and previous inspection reports identified significant corrosion in the approach girders, including full section loss in the webs near each abutment. In addition, secondary cross frame members exhibit complete loss due to corrosion, as well as approximately the bottom 1ft of vertical stiffeners along the girders.

Figure 30 - Complete section loss of girder web and severe deterioration of bottom flange

The bridge bearings exhibit significant corrosion. Roller bearings at the abutment show severe corrosion and likely are not performing as designed. Pinned bearings also show signs of corrosion and may be seized due to packing of rust.

Figure 31 - Deterioration of bearings at abutment

Approach substructure deterioration

The approach substructure shows signs of significant deterioration at the waterline. The approach piers have large spalls, scoured surfaces, and seams running horizontally across the caps. It is evident that the caps are unreinforced, mass concrete elements. At some locations, significant portions of the piers have fallen away, nearly undermining the bearing locations.

Figure 32 - Cracking and degradation of concrete piers at the waterline

Figure 33 - Significant spall missing from pier, almost undermining a bridge bearing

Swing truss damage / deterioration

The swing truss appears to be in reasonable condition, with areas of corrosion that would be expected for a bridge of this age. Reviewing the gusset plate nodes identifies some locations with cracked or bent plates that would need to be evaluated and repaired.

Figure 34 - Truss gusset plate southeast side, with crack and bent gusset plate

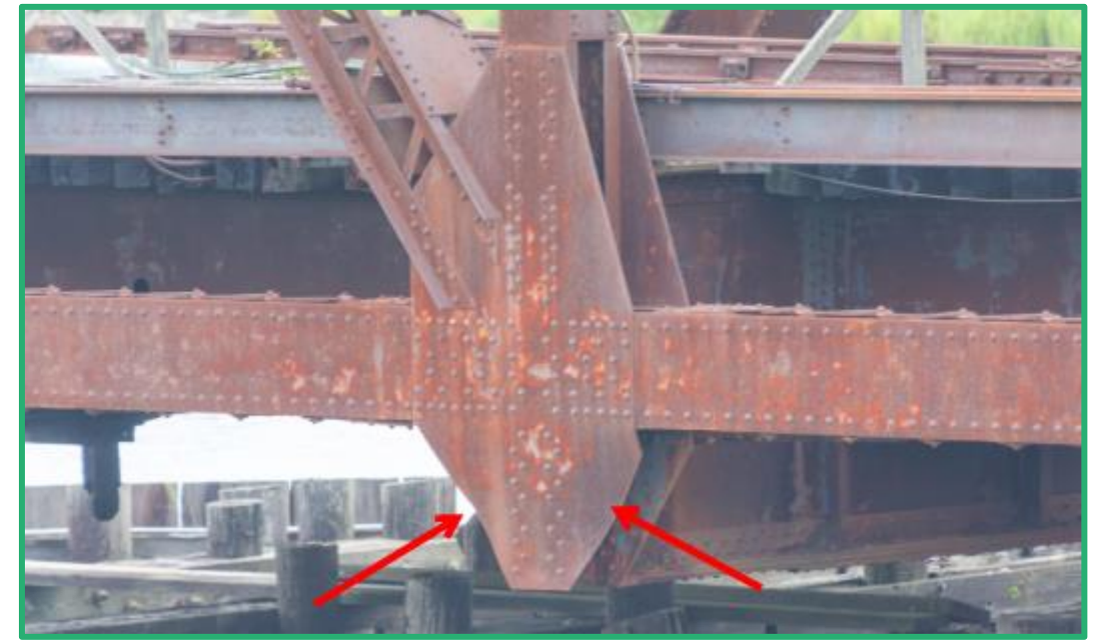


Figure 35 - Truss gusset plate southeast side, with warped or damaged gusset plate

Flood events and sea level rise

The significant deterioration of steel approach girders is caused by prior flood events submerging the bottom of the girder. This observation is supported by the amount of sea grass caught under the girders. The elevation of the FEMA 100-year flood plate is +8 (NAVD88). Based on the USCG navigation height clearances and approximate depth of approach girders, the elevation of the bottom of the girders is +7 (NAVD88). This indicates that the bottom of the girders sits within the flood plain and is subject to flooding more frequent than the 100-year storm, which is supported by field observations.

This location in the Hackensack River is brackish saltwater, which poses a major risk for steel corrosion that is wetted and dried in cycles, as is apparently the case with the approach girders.

The bottom of the approach girders is likely to see an increase in the frequency of flood events as a result of sea level rise. The New York City Panel on Climate Change estimates that by 2050 sea levels in New York City will rise by 11 to 21 inches (10^{th} to 90^{th} percentile). Further, the panel estimates that the frequency and intensity of flooding events will increase, between a doubling and an approximately 10 to 15-fold increase in frequency of the current 100-year flood by the 2080s [14].

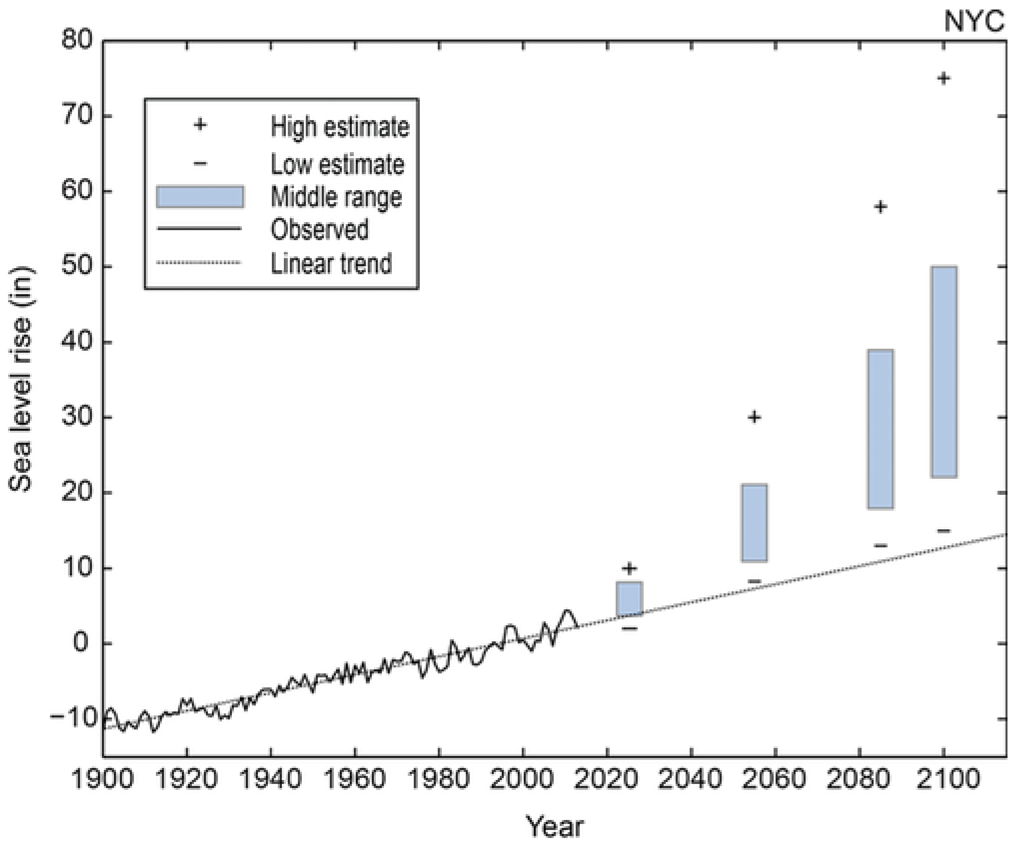


Figure 36 - Sea level rise observations and projections [14]

Therefore, even if the existing approach girders are repaired and brought back into a good state of repair, there is an increasing risk that the girders will more frequently be submerged by the tide in flood events, leading again to corrosion of the girders.

Navigation Requirements

The Hackensack River is a navigable waterway that must be accessible to marine traffic. The current bridge has not posed an obstruction to traffic since it was abandoned, as it was left in the open position providing unlimited vertical clearance.

The USCG Navigation Chart provides horizontal and vertical clearances for the navigation channel. As noted above, when the swing bridge is in the open position, it poses no restrictions to vertical clearance. When closed, the swing span has a 7 ft vertical clearance at mean high water (MHW). The side channels, on either side of the pivot pier, provide 99ft horizontal clearance.

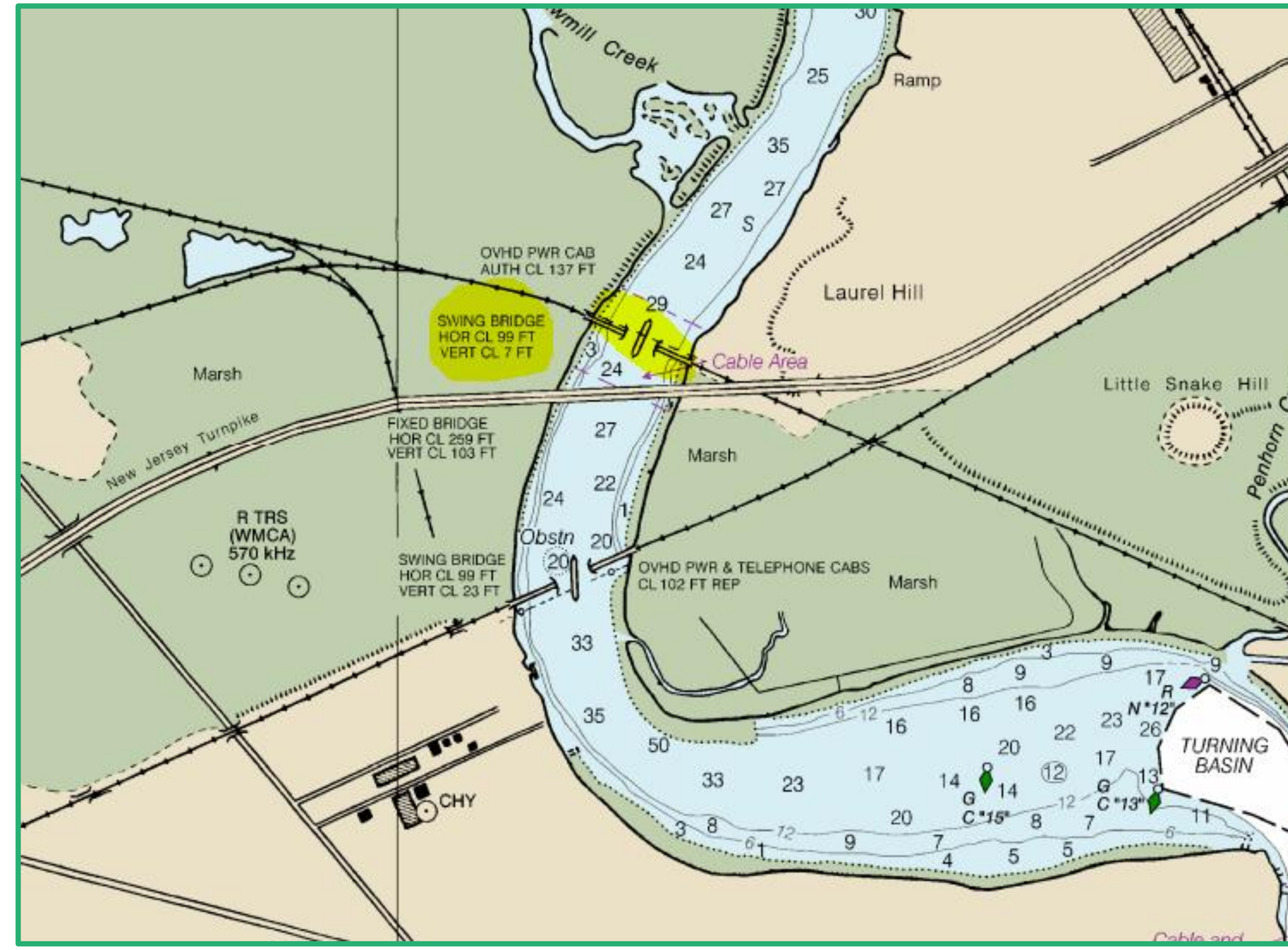


Figure 37 - USCG Navigation Chart, with Hackensack River Bridge highlighted

Table 22 summarizes the bridges upstream and downstream from the proposed greenway crossing at the Hackensack River. From the mouth of the Hackensack River, this bridge is currently the restriction on both horizontal and vertical clearance when closed. When the new Portal Bridge is constructed, it will be built with a 50ft vertical clearance at fixed height. This bridge will then become the restriction downstream for vertical clearance.

Table 22 - Hackensack River Bridges - Navigation Clearances

	Bridge Name	Location (nautical miles)	Bridge Type	Vertical Clearance (ft)		Horizontal Clearance (ft)
				Open	Closed	
North of Hackensack Bridge	NJ Turnpike	11.8	Fixed Auto	49		165
	Route 3WB	8.9	Fixed Auto	50		150
	Route 3 EB	8.8	Fixed Auto	50		148
	HX Draw	7.7	Bascule Rail	-	4	101
	Upper Hack	6.9	Lift Rail	110	8	127
***	Hackensack	5.4	Swing Rail	-	7	99
South of Hackensack Bridge	NJ Turnpike	5.3	Fixed Auto	103		259
	Old Portal Bridge	5.0	Swing Rail	-	23	99
	New Portal Bridge	5.0	Fixed Rail	50		300
	Lower Hack	3.4	Lift Rail	135	40	150
	Wittpenn	3.2	Lift Auto	135	25	158
	Hack Freight	3.2	Lift Rail	135	11	158
	PATH	3.0	Lift Rail	135	40	168
	Pulaski Skyway	2.4	Fixed Auto	135		300
	Lincoln Highway	1.9	Lift Auto	135	35	200

To understand the frequency of vessel traffic along the river, as well as the required clearance of the vessel traffic, the Portal Bridge FEIS provided the opening logs for the Portal Bridge from 2004 to 2006. Over this timeframe, 317 openings (or 48% of the total openings) required clearance of 35 – 40ft, with 657 openings total. It is understood that vessel traffic has decreased since then. However, this illustrates that should the existing movable bridge be brought back into operation, it may need to open 100+ times annually.

It is assumed that a movable bridge will require 24/7 monitoring by bridge operators to open and close the span, as required by vessel traffic. This requires an additional staffing cost. There will also be added maintenance costs for the mechanical and electric equipment.

Overhead Power Lines

There are overhead power lines that are nearly directly above the existing bridge. Based on the navigation chart clearances, these power lines provide 137ft of vertical clearance. These lines must be avoided during construction, which may lead to restrictions on crane boom height and lifting equipment used during construction.

Environmental Impacts

Any construction work at this bridge would require an environmental review, due to the proximity to the surrounding wetlands areas. This may include an assessment of impacts to aquatic and terrestrial ecology and wildlife. Such an assessment may result in restricted construction windows, such as those in place for the Portal Bridge Construction (see the Portal Bridge FEIS document for full details) [11].

Unknown Foundation Condition

At this time, the foundation arrangement is not known for the existing bridge. Such information would be available on existing construction drawings or potentially ascertainable from an underwater inspection. Given that a significant amount of dead load may be removed and/or added to the structure, the design and existing capacity of the foundation should be verified if they are reused for the greenway bridge.

4.4 Passaic River (MP 7.57)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.7 for additional details provided in the general bridge assessment.

4.4.1 Key Features and Constraints

Former swing bridge

The Passaic River bridge is a former swing bridge, which sits on a circular pivot pier offset to the east side of the river. The swing span comprises four plate girders supported on a rim-bearing. It is our understanding that the swing span has been closed for several years. However, the bridge opening procedure is still listed in 33 CFR 117.739, which governs the operation of movable bridges on the Passaic River.

Figure 38 - Pivot pier and swing span on Passaic River bridge

Figure 39 - Added bearing (black plates on concrete pedestal) that appears to lock swing span in closed position

Previous modifications and retrofits

The Passaic River bridge appears to have been modified over its life, most notably at its western end in order for NJ21 McCarter Highway to continue along the Passaic River. At the bridge, the highway alignment shifts into a stacked arrangement to pass under the bridge.

Masonry piers

The Passaic River bridge uses masonry piers in the river. These piers require a closer inspection to confirm the masonry is in good condition. Joints between blocks may need to be repointed with mortar.

During site visits, it was observed that the north portion of one pier has a portion of masonry blocks replaced with concrete. This includes a retrofit for the northern most bearing at this pier. It will be important to review previous repair and retrofit records to understand why this repair occurred and if it is a sign of other potential issues elsewhere in the structure.

Figure 40 - Repair to north half of masonry pier, replacing the masonry stones with concrete

Fender system

The NS Inspection Report, Nyack Preliminary Assessment, and subsequent site visits all identified the deteriorating fender system as an area of future concern to be addressed. A study of the ship impact risk can be undertaken to determine the need for the fender system and determine the level of robustness for the repaired or replaced system. Such a study can take place in subsequent design stages when more information is available.

Unknown Foundation Condition

At this time, the foundation arrangement is not known for the existing bridge. Information would be available on existing construction drawings or potentially ascertainable from an underwater inspection. The condition of the foundations should be verified, including the potential for any scour damage at the foundations.

4.5 McCarter Highway (MP 7.74)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.8 for additional details provided in the general bridge assessment.

4.5.1 Key Features and Constraints

Similarity to Passaic River Bridge structure

The superstructure on the McCarter Highway bridge is nearly identical to that of the approach spans on the Passaic River bridge. Site visits have not identified any significant areas of corrosion on the bridge structure itself that indicate a different solution is necessary. Therefore, for the purpose of this study, it is assumed that the same items of work identified for the Passaic River Bridge apply to this McCarter Highway bridge.

Encroachment into embankment slope

An adjacent property to the southwest of this bridge has cut into the slope of the embankment supporting the railway corridor. While this cut is likely not impacting the performance of the bridge itself, the condition should be evaluated by a geotechnical engineer to determine if there is any concern with slope stability of the embankment section.

Figure 41 - Cut into railroad embankment directly adjacent to McCarter Highway bridge wing wall

4.6 Second River / Branch Brook Park Drive (MP 8.85)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.11 for additional details provided in the general assessment.

4.6.1 Key Features and Constraints

Concrete Arch

The bridge over the Second River and Branch Brook Park Drive is unique along the greenway corridor, as it is the only concrete arch structure considered in this study. The arch structure is visually noteworthy, with unique architectural features that are worth preserving.

Figure 42 - MP 8.85 arch spanning over Branch Brook Park Drive

4.7 Garden State Parkway (MP 10.29)

This section builds on the information provided in the general assessment to identify an alternative bridge option. See Section 3.13 for additional details provided in the general bridge assessment.

4.7.1 Key Features and Constraints

Crossing over major highway

The Naik Preliminary Assessment Report suggests that an in-depth bridge inspection is completed for this bridge, because it “crosses over one of the most heavily trafficked highways in New Jersey and that the inspections are only done to highlight obvious safety concerns to the public”.

Fracture critical structure

The structure comprises two through girders at the exterior fascia of the bridge and several closely spaced stringers spanning between the girders. Based on these load paths, the bridge appears to be a non-redundant structure. Given that it is over the Garden State Parkway, it will likely require frequent hands-on inspection to verify there are no issues with these fracture critical elements. This additional activity must be taken into consideration when the jurisdiction responsible for maintenance schedules and budgets its future work.

Prior bearing seat repairs

This bridge appears to have undergone repairs to the bearing seats, between 2012 and 2013. During that time period a notable spall at the southeast bearing was present. This spall was repaired, and it appears like the concrete was sealed with a dark gray colored sealer.

Figure 43 - Southeast bearing in 2012 prior to repair

Figure 44 - Southeast bearing in 2013 after repair is complete

Appendices

Appendix A - Arup Site Visit Report

Appendix A

Arup Site Visit Report