An aerial photograph of a coastal city, showing a dense urban area with a grid-like street pattern. A dark blue horizontal band is overlaid across the middle of the image, containing white text. Below the band, the city continues down to a waterfront with a large body of water. A few ships are visible in the water, and a coastline with some vegetation is visible in the bottom left corner.

**VOLUME 2, SECTION 1:
OPPORTUNITIES AND CHALLENGES ASSESSMENT**

1.0 Opportunities and Challenges

The first step of the feasibility study is to understand what opportunities and challenges the siting of a trail would face in the project area. Several existing factors complicate the proposed siting a trail along the Hudson River shoreline in the area between the Spuyten Duyvil and Ludlow Metro-North stations. The project area is not readily accessible by the general public, due to the presence of the railroad right-of-way. Access to the project area would need to be created as part of any potential trail development. In addition, limited space is available between the railroad tracks and the shoreline to accommodate construction of a trail.

The following Opportunities and Challenges Assessment analyzes the project area against key several factors relevant to developing a trail in this area, including issues related to: safety, security and emergency access; trail user access; sea-level-rise, storm surge and resiliency; permitting and environmental review; design standards; and constructability and maintainability.

1.1 Safety, Security and Emergency Access

Safety, security and providing access for emergency services would be of the utmost concern for a trail sited in the proposed location along Metro-North's busy Hudson Line rail corridor. The development of a trail in this area must ensure the safety and security of Metro-North's customers, employees, and railroad operations. Moreover, the trail must strive to provide an enjoyable experience for trail users and make them feel safe and secure in their surroundings.

In order to promote safety and security at this location, the design of a trail would need to include a defined and consistent buffer that separates trail users from railroad areas and facilities. As discussed in more detail below in Section 1.5, "Design Standards," the design for a proposed trail in this location must incorporate a minimum separation distance of at least 15 feet from the trail to the edge of tie of the closest railroad track. This is the minimum setback distance Metro-North would require for a trail at this location. In addition, fixed railroad infrastructure present along the right-of-way would have to be kept separate from the trail areas. An eight-foot-high, non-scalable security fence would be required to separate the trail from active rail areas (See Photo A01).

Access to the project location is limited due to the railroad tracks separating the proposed trail site (along the Hudson River) from the land to the east. As a result, existing opportunities for potential access by emergency services would be limited. Currently, the only public access to the proposed trail area is via the Riverdale Station to the Riverdale Waterfront Promenade Park. Pedestrians cross one section of track (Track 6) to get to the pocket park located near the Riverdale Station. As discussed further in Section 1.2, "Trail User Access," the successful development of a trail in the project area would require new pedestrian bridges/overpasses created at set locations that could also serve to provide access for emergency services.

The new access points investigated for the project site (See Section 1.2, "Trail User Access") would need to be wide enough to allow, at a minimum, a small vehicle, such as an all-terrain vehicle, to gain access to the trail (See Photo A02). The safety and security of a trail in the proposed area depends on the trail developed with the access points contemplated in Section 1.2, as these access points would provide an efficient, secure and safe means to get to the trail.

If warranted by the magnitude of an emergency situation, the trail could be accessed from the waterside by marine vehicles. If the project were to advance, coordination would be necessary with Metro-North



Photo A01 Example of chain link security fence with mini-mesh



Photo A02 Example of emergency service all-terrain vehicle

and the New York City Police and Fire Departments to develop an access plan for emergency situations. It is recommended that a minimum of one emergency call box be placed at each access point along the proposed trail and at approximately 1,000 feet of trail between access points.

1.2 Trail User Access

The overarching guiding principle for identifying locations for trail access is to provide safe and secure access points for potential trail users that would not disrupt Metro-North's operations and maintenance needs. In addition, several key factors were considered to determine potential trail access points, including:

1. Existing infrastructure over the railroad tracks that could be reused or repurposed
2. Land uses present east of the rail corridor
3. Connectivity to existing or planned pedestrian or bicycle facilities east of the rail corridor
4. Topography that may assist in providing the vertical clearance required to cross the tracks
5. Space available west of the tracks to facilitate a landing for an access point

Based on the guidance above, seven trail access points were identified in the study area (See Figures 1.1 and 1.2). The proposed access points are at the following locations:



Photo A03: Potential Spuyten Duyvil Station connection



Photo A04: Example of potential view from "Sky Way" looking south

- **Spuyten Duyvil Station** - The access at Spuyten Duyvil Station is envisioned as an extension of the existing pedestrian bridge that currently connects to the center platform. The new bridge could extend as a "Sky Way" (See Photos A03 and A04) across the Metro-North tracks and continue west across the Amtrak tracks of the Westside Connection, landing in the space available adjacent to the river (See Photo A03). This potential access point would require property access negotiations and agreements with both Metro-North Railroad and Amtrak.
- **West 231st Street** - Access at West 231st Street (See Photo A05) could potentially be created by repurposing the remnants of the existing derelict bridge that descended to the river. A landing area would need to be created in the narrow swath of land that exists between the tracks and the river, or a structure over the water would need to be developed to accommodate trail access in this area. In addition, the existing overpass is privately owned (i.e., not owned by Metro-North Railroad) and negotiations would be required with the property owner to grant permission for its use as an access point.



Photo A05: Existing bridge near West 231st Street



Photo A06: Looking northeast at surviving abutments of former pedestrian bridge near Riverdale Park / West 246th Street

- **West 246th Street** - Proximate to West 246th Street and Palisades Avenue, a link between the Riverdale Park and a potential waterfront trail could be a great opportunity to enhance both recreational spaces. There are existing abutments of a former bridge crossing that could potentially be reused for an access point at this location. In addition, there is a small point formed on the bank of the river that could be used as a landing for an overpass (See Photo A06). This proposed access point would require negotiations with New York City to use a portion of Riverdale Park as an access point to the trail. In addition, Riverdale Park is designated "Forever Wild" and creating a trail access point in this location would need to be compliant with all relevant regulations or restrictions that govern use of the park.
- **West 254th Street** - There is an existing vehicular bridge that crosses the tracks and serves the Riverdale Yacht Club. A separate access ramp could be developed using the infrastructure of the existing bridge, to provide access to the trail. An investigation of property boundaries and access rights would likely be necessary to develop West 254th Street as an access point for a trail (See Photo A07).
- **Palisade Avenue/South of Hebrew Home (RiverSpring Health)** - The spit of land on the shoreline near this location could be used as a bridge landing making this an attractive location for an access point. However, a trail crossing at this location would be limited by the institutional and residential properties between the railroad right-of-way and Palisade Avenue. Property access negotiations would need to be pursued if this location were considered as a future potential access point (See Photo A08).
- **261st Street** - A potential access point at West 261st Street, through the College of Mount Vincent, would achieve the dual purpose of trail access and provide the College with a new recreational amenity. A bridge over the tracks exists at this location, as does a generous landing area west of the bridge (College Point). Negotiations and agreement with the College for access here would



Photo A07: West 254th Street Bridge

be necessary to take advantage of the opportunities at this location (See Photo A09).

- Ludlow Street - The northernmost access point for the trail could be created via Fernbrook Street to Ludlow Street in Yonkers. Ludlow Street spans over the railroad tracks, serving both vehicles and pedestrians. The trail in this area would use the existing street network to access Ludlow Street and points north of the proposed trail (See Photos A10 and A11).

Most of the proposed access points could be linked to an existing street, walkway or public space with minimal improvements. Proposed access points could take advantage of the raised elevation east of the tracks to enable the necessary vertical clearance required for a trail to cross the railroad tracks. In addition, access points are opportunities to create places of visual interest along a potential trail, as well as beacons that invite users to the new waterfront asset.



Photo A08: Potential Trail Access - Palisade Ave / South of Hebrew Home (Riverdale Spring Health)



Photo A09: College Point Bridge near West 261st Street



Photo A10: Ludlow Street Bridge over Metro-North tracks, looking east



Photo A11: Ludlow Street Bridge over Metro-North tracks, looking west



Figure 1.1: Potential Access Points

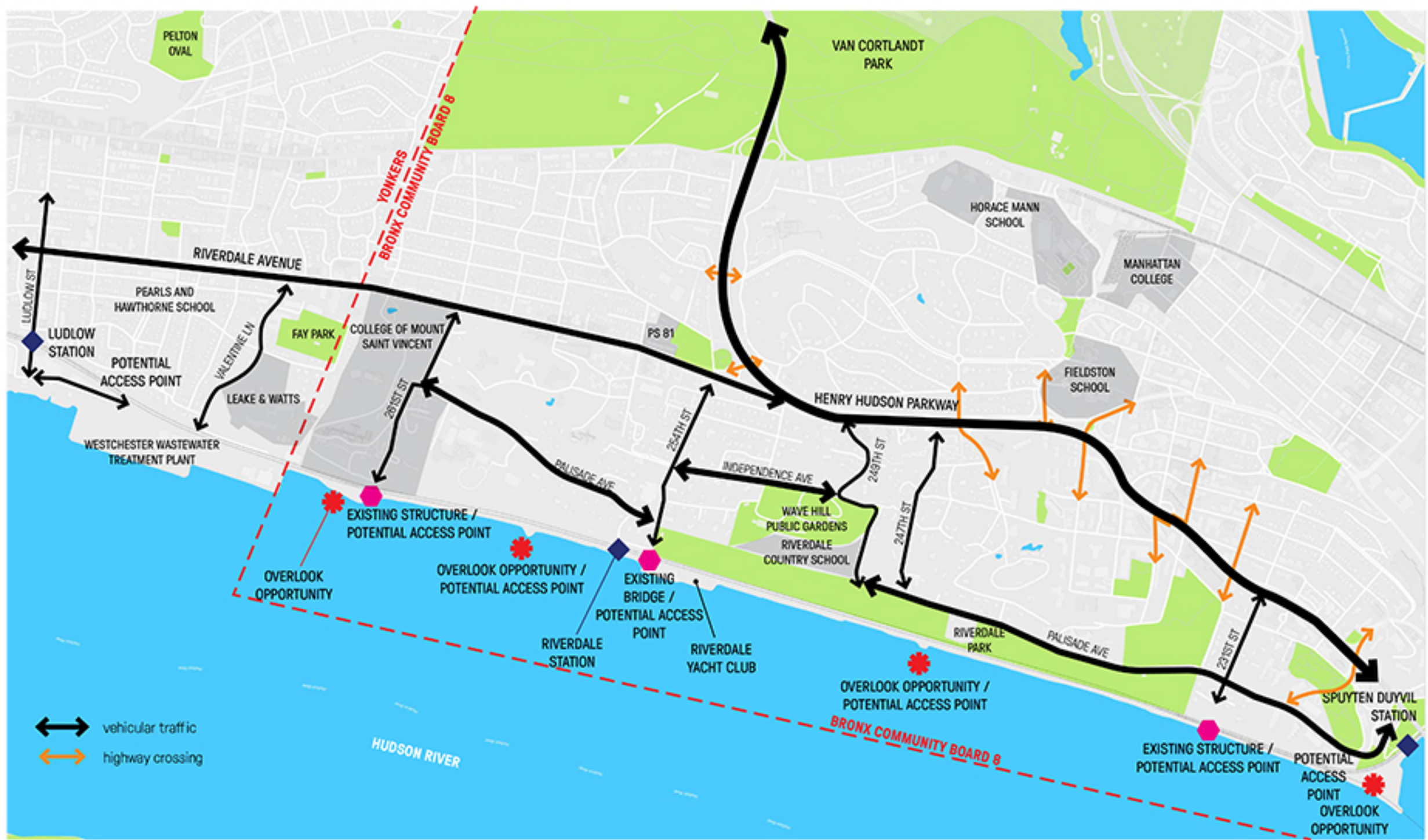


FIGURE 1.2: COMMUNITY CONTEXT DIAGRAM

1.3 Sea-Level-Rise, Storm Surge and Flooding

Following the impact from Superstorm Sandy in October 2012, Metro-North Railroad, New York City and New York State have embraced designing resiliency into all capital construction projects to prepare the City's infrastructure to withstand storm and tidal forces from future storm events.

The proposed project, located within the floodplain of the Hudson River, is particularly vulnerable to coastal flooding. Consequently, the area is sensitive to rising sea levels. There are various projections and guidance for sea-level-rise. The New York State Department of Environmental Conservation (NYSDEC) has recently provided ClimAID Sea-Level-Rise Projections for New York City from the 2020s through 2100. Based upon the current projections, the water level can be expected to rise 21-50 inches by 2100. (See Figure 1.3)

Combined with a major storm, similar to Superstorm Sandy, sea-level-rise would increase the potential impacts from coastal flooding substantially. Based upon the guidance from the NYSDEC, and historical data of the water levels observed during Superstorm Sandy, a reasonable design base flood elevation for the area has been recommended to be an elevation of 12 feet. (See Figure 1.4)

The design of the shoreline and walkway must balance providing protection from coastal flooding with producing additional flooding from rain events. Raising the walkway and shoreline provides additional protection from coastal flooding; however, since the stormwater runoff from the existing project area currently drains to the river, a raised shoreline would impede stormwater drainage.

Potential impacts on Metro-North infrastructure must also be considered in the design of the shoreline walkway. The resiliency design of the walkway must account for the possibility of flooding or storm surge events dislodging portions of the walkway and interfering with Metro-North infrastructure and operations. In addition, when determining the height of the walkway to address sea-level-rise, storm surge and flooding, the potential for visual impacts due to a walkway obstructing views for passengers riding along the iconic Hudson Line should also be considered.

Although NYSDEC has provided official guidance for sea-level-rise projections, there are currently no regulations or construction standards in place. The height of the walkway would be a design decision that balances project goals, input from stakeholders (including Metro-North Railroad) and guidance from permitting agencies. Raising the walkway elevation could lower the probability of flooding under unique and severe storm conditions in the future.

There are pros and cons to constructing an elevated walkway along the water in the project area to address issues related to sea-level-rise, storm surge and flooding. Elevated walkway sections can easily be raised by extending the piles that support them. However, raising the walkway elevation would require longer ADA-compliant transition areas between the portions of elevated walkway and any walkway sections that are at-grade. This would result in a higher percentage of the overall walkway length to be constructed with the more expensive elevated walkway sections, adding to cost of the project.



Figure 1.3: ClimAID Sea-Level-Rise Projections (NYC)

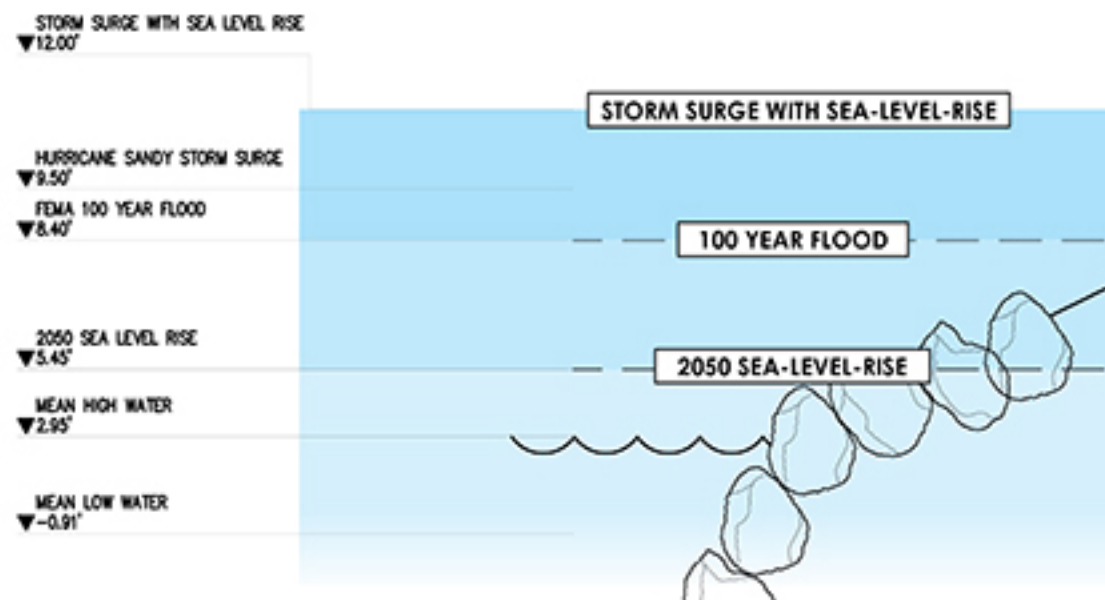


Figure 1.4: Expected sea-level-rise in the project area

Any attempts to raise the elevation of the at-grade walkway sections to address issues related to sea-level-rise, storm surge and flooding would prove to be more difficult. In order to raise the elevation of an at-grade walkway in areas along the water, the revetment slope would need to be expanded, which may not be feasible where the available space for the walkway is limited. The construction costs increase with the height of the walkway, as additional fill will be required. In addition, the stormwater from Metro-North facilities currently slopes gently towards the existing shoreline. Elevating the shoreline would prevent runoff from reaching the river, necessitating special stormwater considerations, such as tide valves or stormwater pump station(s), which would substantially increase the cost of the project.

Unless the walkway is proposed to be constructed entirely from elevated walkway sections, raising the shoreline would increase the cost of the project and may detract from the travel experience and views along Metro-North's Hudson Line. Section 2 of this report provides an assessment of the potential trail types (e.g., elevated, at-grade) that could be implemented in the project area, as well as their associated costs.

1.4 Permitting and Environmental Review

As noted in Volume 1, Existing Conditions and Preliminary Findings for the project, several types of environmentally sensitive resources (ESRs) are mapped as being present within the project area. However, upon closer examination (conducted utilizing literature reviews and field investigations), only a few of the resource types were determined to be present or likely present within the project area. For the purpose of this report, ESRs refer to land and water areas that are either mapped or regulated by government agencies due to their value as habitat for wildlife species. ESRs include: open waters, wetlands, essential fish habitat (EFH) and woodland areas that support rare ecological communities/species. As the multi-use trail is intended to serve as a waterfront walkway and as there is only a narrow area of land along the waterfront, impacts to these resource types would be unavoidable. As impacts to these resources are highly regulated, multiple permits under the jurisdiction of various city, state and federal agencies would be required.

The following regulatory programs and permits would apply to any trail alignment under consideration in the study area:

- United State Army Corps of Engineers (USACE) Section 10 Individual Permit
- New York State Department of Environmental Conservation (NYSDEC) Article 25: Tidal Wetlands Permit
- New York State Office of General Services (NYSOGS) – Lands Now and Formerly Under Water
- NYS Department of State (NYSDOS) – Coastal Consistency Review
- New York City Waterfront Revitalization Program Coastal Consistency Assessment

The extent of impacts, and thus compliance with the various regulatory programs, would vary based on the in-water fill necessary to accomplish any trail alignment in the project area (see Section 3, Evaluation of Trail Route Alternatives).

It is recognized that potential funding sources for the project would likely require the project to undergo environmental review potentially in accordance with National Environmental Policy Act (NEPA); State Environmental Quality Review (SEQR) and New York City Environmental Quality Review (CEQR) processes. The appropriate level of environmental review (i.e. Categorical Exclusion; Environmental Assessment; Environmental Impact Statement) cannot be definitively determined at this point. However, as the proposed trail would not be able to avoid impacts to ESRs, it is likely that either an Environmental Assessment or Environmental Impact Statement would be required.

As any project design would likely not avoid in water fill (see Section 3, Evaluation of Trail Route Alternatives), under the state and federal review processes, mitigation would be required for the filling of open waters to compensate for the resource impacts. Mitigation can be in the form of restoration, enhancement or construction depending on several factors. The mitigation review, approval, construction and monitoring processes are burdensome, time consuming and costly efforts requiring the proper allocation of resources and funding.

1.5 Design Standards

There are no national standards that specifically address the design of multi-use trails proximate to active rail lines. The following sources of trail design guidelines were reviewed and considered while developing design standards for the feasibility study:

- Metro-North Right-of-Way Trail Design Guidelines
- US DOT report FTA-MA-26-0052-04-1 (Rails with Trails – Lessons Learned)
- Guide for the Development of Bicycle Facilities, 4th Edition, AASHTO (2012)
- Cycling for Cities Bikeway Design Guide, NACTO (2011)
- Accommodating Bicycle and Pedestrian Travel: A Recommended Approach, FHWA
- America's Rails-with-Trails, Rails-to-Trails Conservancy (2013)

A study of existing conditions was commenced to review the following primary design standards for opportunities and challenges in the project area:

15' minimum clear maintenance zone between track and separation fence

Throughout the entire trail corridor, a minimum 15-foot-wide buffer zone should be preserved between the edge of the westernmost railroad tie and proposed trail. This buffer would maintain a distance between rail operations and trail users and allow for maintenance vehicles to access the railroad to perform necessary work (See Figure 1.5). In addition to maintaining the 15-foot buffer zone, the actual design of the trail would have to account for the existing and future presence of railroad infrastructure in the project area, including but limited to: cable troughs, conduit trays and equipment platforms.

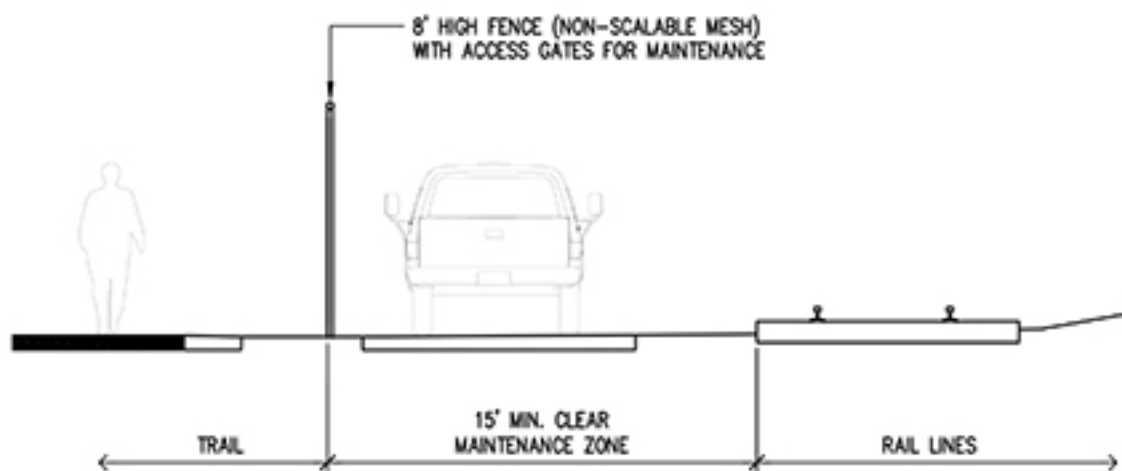


Figure 1.5: Minimum Clear Zone and Separation Fence

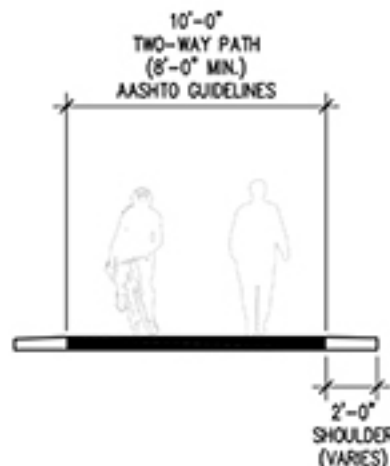


Figure 1.6: Minimum Trail Width

Right-of-way separated from trail with a fence with a minimum height of eight feet

A security fence with a minimum height of eight feet is needed to maintain sufficient separation between the right-of-way and area of the trail (See Figure 1.5 and Photo A01 in Section 1.1). Fences would need to be non-scalable but could include decorative features at periodic points along the trail to create visual interest and draw the trail users' attention away from the rails (See Photos A12-A14 for examples). These decorative fence 'moments' would be limited to access points and overlook areas. The separation fence would have strategically placed gates to allow authorized railroad and emergency personnel to access to both sides of the fence.

10' two-way trail is the preferred width

A ten-foot wide trail is considered preferable to support two-way bicycle and pedestrian traffic, due to the potential for a significant volume of users at this location (See Figure 1.6). However, an eight-foot wide trail would be acceptable in some constricted locations. The trail should be constructed with a permanent smooth, but slip-resistant finish. Primary surface materials preferred would be concrete or asphalt due to durability and minimal maintenance requirements. Limited feature locations such as overlooks and trail access points could be paved with materials such as unit pavers made from natural stone, concrete or asphalt.

Trail access points

As discussed in Section 1.2 Trail User Access, there are several potential access points for the trail. These entry points can provide a unique opportunity to design spaces and structures that would be attractive and appealing to the user while providing safe and effective conveyance to the trail. Creating these gateways/gathering spaces in the landscape could provide identifying markers for the potential access points along the trail.



Photo A12: Decorative fence example



Photo A13: Decorative fence example



Photo A14: Decorative fence example

1.6 Constructability and Maintainability

There are unique challenges faced by constructing a proposed trail in the project area, due to the limited space available between the busy commuter rail corridor and the Hudson River waterfront. Additional challenges are presented by the site location, including safety and security restrictions and resiliency concerns, which reduce the options available for the construction means and materials to develop a trail in the project area. In addition, many of the concerns regarding the construction of the trail would also have an impact on the maintenance of the proposed trail. It is important to note that the preliminary assessment of constructability and maintainability prepared for this feasibility study was conducted without the benefit of a detailed engineering study.

Construction Methods

Construction of the trail would be limited by the access to the site, and the materials and methods for constructing the trail should take these restraints into consideration, as well as resiliency concerns.



Photo A15: Example of construction of elevated walkway from barge



Photo A16: Example of rip-rap installation from a barge



Photo A17: Example of placement of large rip-rap



Photo A18: Example of concrete installation by barge

The recommended method for delivering equipment and materials to the site is from the Hudson River by barge (See Photos A15 through A18). All construction materials for the trail should be selected based upon resiliency of the trail and potential impact on Metro-North's operations and by the ease of transportation and installation from the waterfront side. In particular, the use of asphalt for the trail is discouraged due to the challenges of delivering it to the project site.

Prefabricated components, such as precast concrete, should be utilized wherever possible to minimize on-site labor. Due to the proximity to the railroad tracks, an allowance for railroad protective services should be considered when estimating the time and expense for the project. Minimizing on-site fabrication would also limit the need for railroad protective services (e.g., flagmen) and expedite construction.

Materials

Recommended materials for the construction of the trail and shoreline protection should include materials typically used for waterfront sites, such as concrete and stone. Quality marine-grade concrete requires minimal maintenance and is recommended for the walkway sections at the project site. The regular maintenance for concrete includes patching spalled concrete and sealing of large cracks.

Revetment stone is a natural product with a functionally unlimited lifespan. Provided the stones are properly sized, the rip-rap should require no maintenance for storm events up to the design storm. In order to maximize the structural stability of the rip-rap, stones should be carefully placed and chinked with smaller stones to lock the individual rock together, forming a single cohesive structure. (See Photos A16 & A17)

Maintenance

Access to the site for maintenance would be limited, similar to the access for construction. In order to prevent high maintenance costs, the design for the walkway should utilize construction materials and details which allow regular long-term maintenance to be performed using the completed trail for access.

Staging and Material Storage

Most material storage and construction staging would occur offsite, as there are few accessible areas suitable for this purpose. On-site storage and staging would be limited to the footprint of the proposed walkway.