3.1.6 High-Speed Light Rail (LRT1)

The intent of this scenario was to test a replacement bridge (see Subchapter 3.2) and a high-speed light rail service from Suffern to Port Chester, with transfer provisions to existing commuter rail. Light rail service can vary from "trolley car" type of operations, sharing roadway space with regular vehicles (and subject to the same traffic congestion), to fully grade-separated operation on elevated guideways or in tunnels. This scenario tested a fully grade-separated option to minimize travel times following a similar alignment to that described for the cross-corridor commuter rail under CRT1. Congestion pricing was also tested (see Subchapter 3.1.2). Figures 3-20 and 3-21 contain some sample cross sections and a schematic of the LRT1 alignment.

3.1.6.1 Alignment

Light rail design guidelines were based on acceptable practice for other LRT systems currently operating within the United States. High-speed LRT within the corridor would be configured as a two-track system utilizing overhead catenary electrification, although the fully grade-separated alignment could also support an automated system such as an AGT or monorail. Track centers would be spaced at 14 feet, with a dedicated right-of-way width between 36 feet (minimum) and 48 feet (desirable). LRT can operate on steeper grades (up to 7 percent for short distances) and tighter curvatures than CRT. As a result, LRT1 would have shorter and shallower viaducts and shallower depths of retained cuts/retained fills, as shown in Table 3-3.

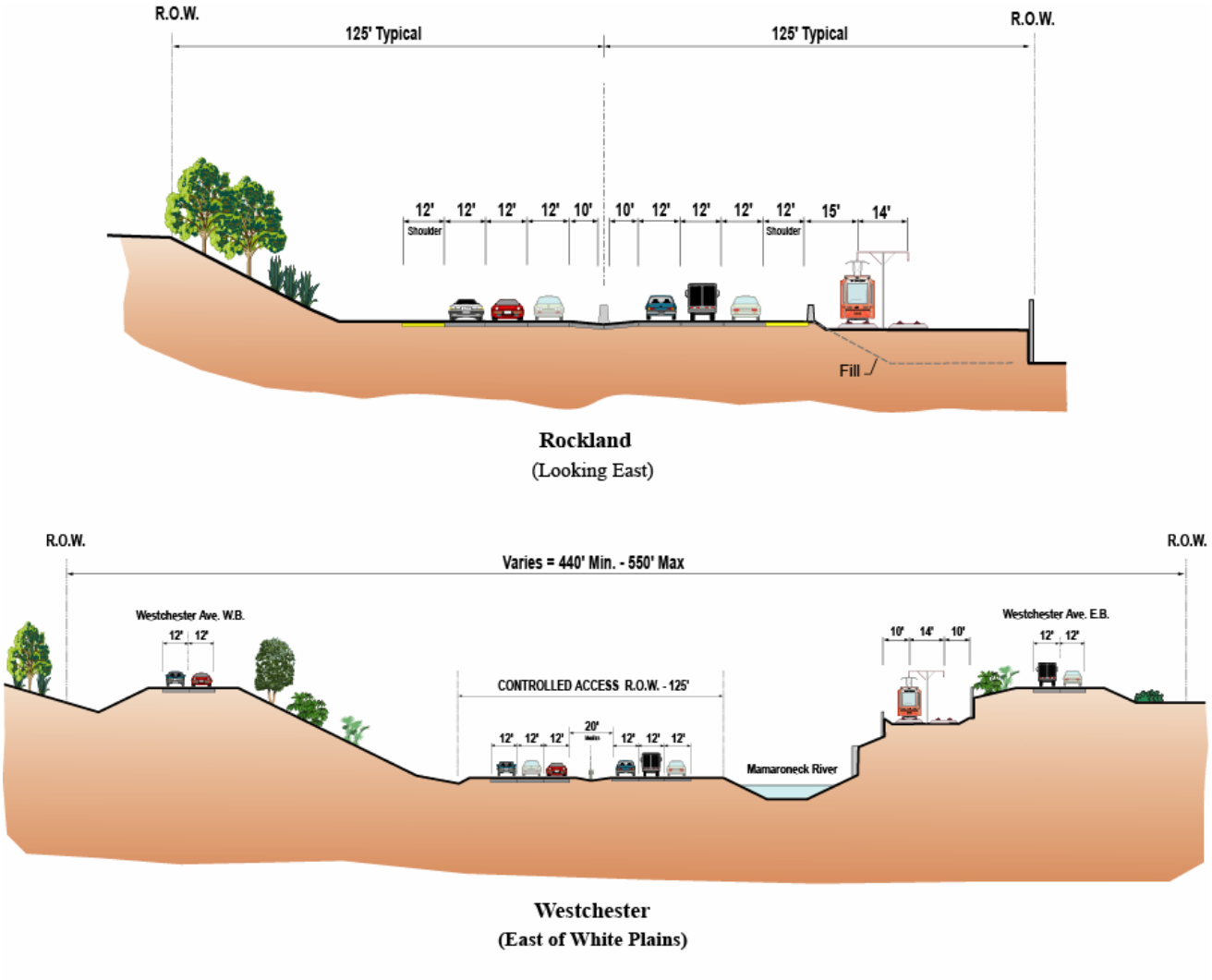
Table 3-3

Overall Construction Requirements for LRT1

Type of Structure	Rockland County Lineal Feet	Westchester County Lineal Feet
Viaduct	11,700	19,100
Retained Cuts/Retained Fills/At-Grade	60,800	37,250
Tunnel	0	11,600

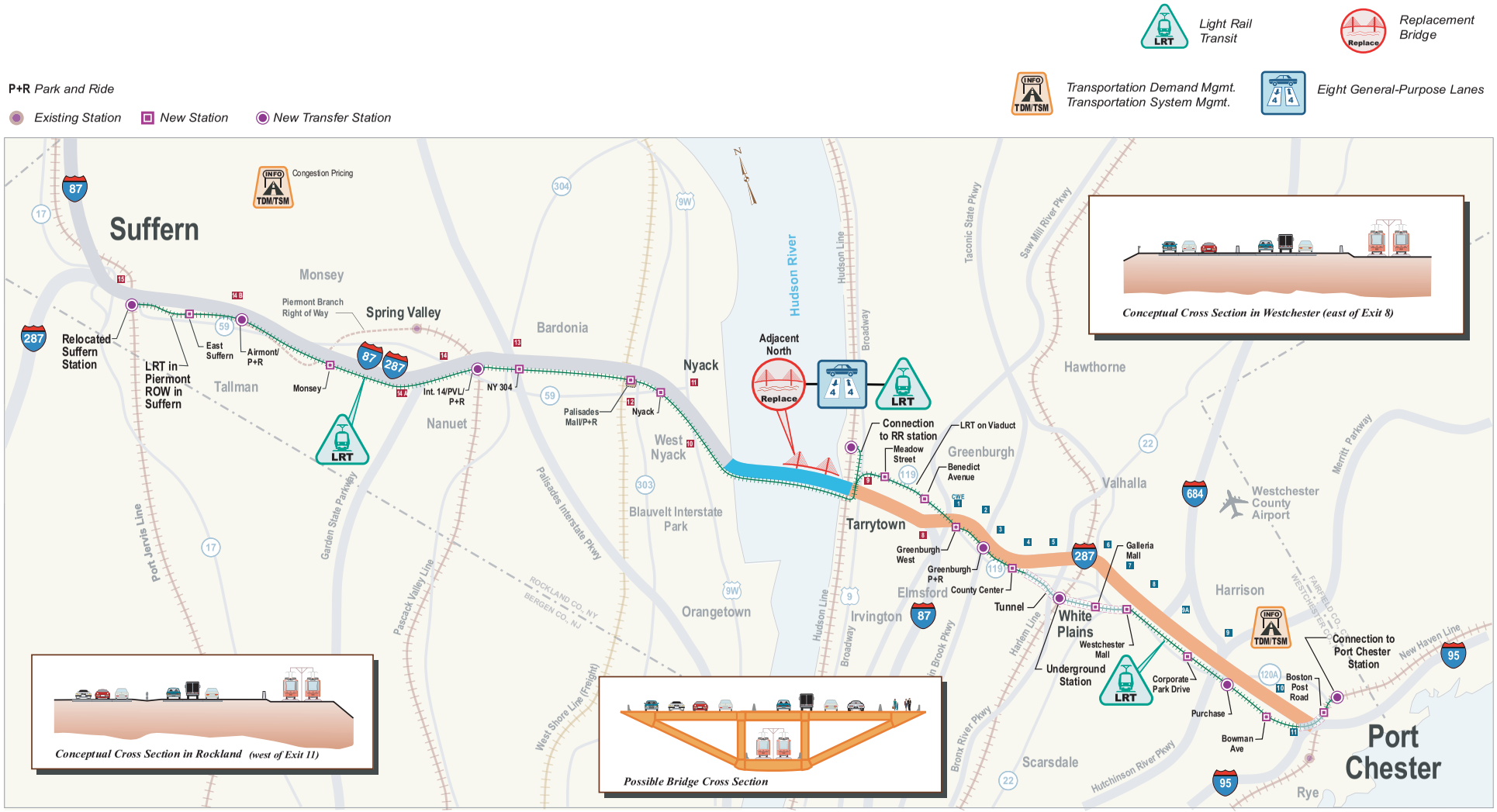
The alignment would, to a large extent, remain within the I-87/I-287 right-of-way. Exceptions include the at-grade use of the Piermont Line right-of-way from downtown Suffern to Airmont Road, use of the Route 119 right-of-way in Tarrytown between Broadway and the Saw Mill River Parkway (where the LRT would be on a viaduct), and an LRT White Plains tunnel, departing the I-287 Corridor near Hillside Avenue and rejoining the I-287 Corridor near White Plains Avenue (a shorter tunnel compared to CRT1).

The high-speed LRT would link all five north-south rail lines in the corridor via transfer facilities. Where connections would be made to other transit modes and to existing park-and-rides, intermodal centers would be constructed with provisions for bus circulation, kiss-and-ride, and parking facilities. The intermodal facilities would be similar in both size and location to the major stations/park-and-rides identified for CRT1. Six intermodal facilities and 15 smaller station areas (up to 2 acres with 200-foot station platforms) would be located on the line; a direct connection to the Tarrytown Station would also be provided. These facilities and stations are:



Existing Highway Configuration with Light Rail Alternative

Figure 3-20



Scenario LRT1 - Replacement Bridge with Full Corridor High Speed Light Rail Transit

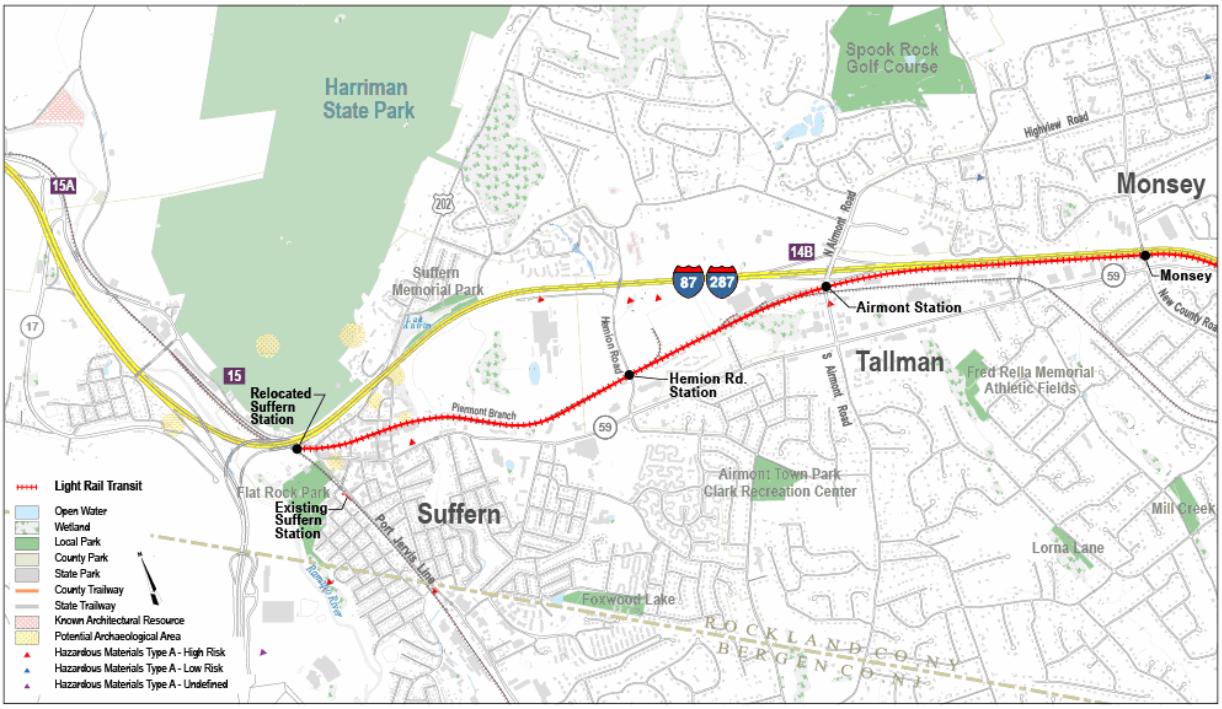
Figure 3-21

- **Rockland** – Intermodal facilities: Suffern, Interchange 14/PVL, and Palisades Mall. Stations: East Suffern, Airmont, Monsey, NY304, Nyack.

- **Westchester** – Intermodal facilities: Tarrytown, White Plains, and Port Chester. Stations: Meadow Street, Benedict Avenue, Greenburgh West, Greenburgh, County Center, Galleria Mall, Westchester Mall, Corporate Park Drive, Purchase, Bowman Avenue, and Boston Post Road.

Suffern Terminus/Port Jervis Line Transfers

LRT1 would use the existing Piermont Branch right-of-way (Figure 3-22) and its western terminus would be at a relocated Suffern Station. Conceptual development of the potential transfer station focused on a combined facility to service both LRT and commuter rail. To facilitate the connection to light rail, the existing Suffern Station would be relocated slightly to the north to be closer to the Piermont Branch, Route 59, and Route 202.



LRT Alignment Using the Piermont Right-of-Way

Figure 3-22

Adjacent walkways and a pedestrian overpass would facilitate access to the relocated platforms for the Port Jervis Line. In combination with the intermodal facility at this location, expanded parking would be provided on the west side of the realigned Suffern Station. The LRT terminus in Suffern would provide for the two-track alignment to follow the Piermont Branch curvature through the Route 59 at-grade crossing.

East of Suffern

East of the Route 59 at-grade crossing in Suffern, the two-track configuration would remain at grade within the Piermont Branch right-of-way, traversing a distance of approximately 2 miles before entering the I-87/I-287 right-of-way near Airmont Road. In addition to LRT stations to the west of Hemion Road, at Airmont Road, and at New County Road, a park-and-ride lot would be constructed just east of Airmont Road at the site of the existing Millennium Paper Recycling facility.

Spring Valley/Nanuet

After entering the I-87/I-287 right-of-way near Airmont Road, the alignment would remain on the south side of the existing highway, replicating the horizontal alignment proposed for CRT1. The vertical alignment, however, would result in shallower depths of retained cuts/retained fills and less significant viaducts than would be required for the CRT.

Within Spring Valley/Nanuet, light rail stations would be located at Route 45 (Chestnut Ridge Road) and Route 304. East of the Garden State Parkway, an intermodal center would provide for transfer capability to commuter rail service on the Pascack Valley Line near Interchange 14 (the Interchange 14/PVL station). Similar to considerations for a CRT facility at this location, the overall footprint would be 7 acres, requiring acquisition/displacement of the Home Depot retail facility. Vehicular access/egress for this facility would be from Route 59.

West Nyack (Including Palisades Mall)

East of the Route 304 station, the LRT1 alignment would descend toward the Hackensack River valley, primarily in a retained cut section, passing beneath the Palisades Interstate Parkway (Interchange 13). Near the existing park-and-ride at Palisades Mall, the LRT would pass beneath the CSX West Shore Line and remain at grade adjacent to the I-87/I-287 eastbound lanes. Vertical circulation elements would be required for passenger access from the proposed intermodal facility at Parking Lot J. Similar to CRT1, the intermodal facility at Palisades Mall is assumed to encompass a total footprint of 10 acres.

East of Palisades Mall, the LRT1 alignment would proceed in a retained cut, crossing beneath Interchange 12 and Route 303. The retained cut would continue eastward as the LRT alignment ascends toward Nyack on a 4 percent grade.

Nyack/South Nyack

East of Route 303, the alignment would remain along the south side of the I-87/I-287 right-of-way. A station would be constructed just east of Mountainview Avenue near Interchange 11. Continuing east, the alignment would descend toward the Hudson River at a grade of nearly 4 percent, with a shift of the horizontal alignment from the south side to the north side of the Thruway. The south-to-north alignment shift, achieved with the LRT crossing beneath I-87/I-287, would be necessary to facilitate aligning the LRT with the lower level of the replacement bridge (to be located north of the existing Tappan Zee Bridge).

Tarrytown

In combination with a replacement bridge, alignments at the Westchester shoreline were investigated that would transition the LRT1 alignment from the bridge to a viaduct traversing Route 119, while at the same time accommodating the LRT loop tracks to Tarrytown Station. Access ramps to Tarrytown Station would diverge from the main alignment to the south and cross beneath the through tracks under the toll

plaza. The spur tracks would align along the east side of the Hudson Line right-of-way and follow a descending grade on viaduct for the approach to Tarrytown Station.

East of Broadway, the LRT1 would transition from a retained cut to a viaduct aligned along Route 119. To the east of Meadow Street, an elevated LRT station would be constructed near the residential townhouse complex. An elevated LRT station would also be constructed at the existing office complex to the west of I-287/CWE Exit 1 near Benedict Avenue.

Greenburgh

As Route 119 approaches I-287/CWE at Exit 1, the viaduct would transition into a retained cut to pass beneath the existing interchange. After departing from Route 119, the alignment would proceed along the south side of the I-287/CWE right-of-way. East of the interchange, the LRT would be on viaduct crossing above the Saw Mill River Parkway, the Saw Mill River, Vreeland Avenue, and Central Avenue. An LRT station (Greenburgh West) is proposed to the east of North Central Avenue.

East of the viaduct, the LRT1 alignment would continue in a retained cut, crossing beneath the Sprain Brook Parkway and Knollwood Road. An LRT station and park-and-ride (Greenburgh) would be located at the existing commercial site south of I-287 (i.e., Bed, Bath and Beyond). Just east of Hillside Avenue, the LRT alignment would depart from the I-287 right-of-way to the south, with the profile descending to enter the west portal of White Plains tunnel.

White Plains

After entering the White Plains tunnel, the LRT1 would continue east, following the Route 119 alignment before curving toward the White Plains TransCenter. An underground LRT station would be located along Route 119, just east of Old Kensico Road at the County Center. The LRT would continue eastward, crossing beneath the Bronx River Parkway and the Harlem Line, with provision for platforms and a transfer facility, providing interface with the existing White Plains TransCenter. To the east, additional LRT stations are proposed at the locations of the Galleria Mall and the Westchester Mall. In the vicinity of White Plains Avenue, the White Plains Tunnel would surface in a retained cut, crossing beneath Westchester Avenue and continuing along the south side of I-287/CWE. The tunnel beneath White Plains would be similar to that shown for CRT1 (see Figure 3-14) but about half as long (i.e., approximately 2 miles). West of the Hutchinson River Parkway, an LRT station would be located at the Corporate Park Drive bridge over I-287/CWE.

Harrison

The LRT1 alignment would continue eastward in retained cut, crossing beneath the Hutchinson River Parkway. A station and park-and-ride facility would be located just west of Kenilworth Road (Purchase Station). Near Exit 10, the LRT alignment would cross above Westchester Avenue eastbound. An LRT station would be located at Bowman Avenue. East of Ridge Street the alignment enters a tunnel that curves north beneath Boston Post Road and the I-95 interchange and portals on the west side of the New Haven Line.

Rye/Port Chester

After crossing beneath Boston Post Road and I-95, the LRT1 alignment would proceed along the west side of the New Haven Line right-of way. A station would be located at Boston Post Road. Continuing north to the Port Chester Station, the LRT terminus would incorporate facilities for a transfer to commuter rail service on the New Haven Line. While a Rye Station terminus was considered for LRT1, the Port

Chester Station would offer greater potential to induce transit-oriented development and serve a larger transit-dependent population.

Rail Storage and Maintenance Facility

A new facility to service and store the light rail vehicles would be required. Based on the preliminary service plan assumptions and conceptual design, an approximate 10-acre footprint for the storage yard and a 6-acre footprint for the maintenance facility would be required. Siting a storage and maintenance facility for light rail has more flexibility than for commuter rail, since light rail operates on shorter headways and has greater schedule flexibility. For commuter rail, only options north of the Suffern North station would be considered in order to reduce deadhead miles. For LRT, yard locations could be anywhere along the line.

3.1.6.2 Operating Characteristics

Service Plan

High-speed LRT would provide a local service originating in Suffern and terminating in Port Chester, with transfer capabilities to commuter rail on the Port Jervis, Pascack Valley, Hudson, Harlem, and New Haven Lines.

During peak periods, there would be two types of rail service operating between Suffern and Port Chester. One would use the loop tracks to Tarrytown Station, while the other would operate straight through, providing faster travel times between Rockland County and White Plains. During off-peak hours, all trains would operate via Tarrytown. Each service would operate at 20- minute headways, providing for a total of 10-minute headways at each of the 22 stations on the line.

Bus Operating Plan

Similar to the bus operating plan for CRT1, all TZX, CRX, and I-Bus service would be eliminated and the OWL service would be truncated at the relocated Suffern Station.

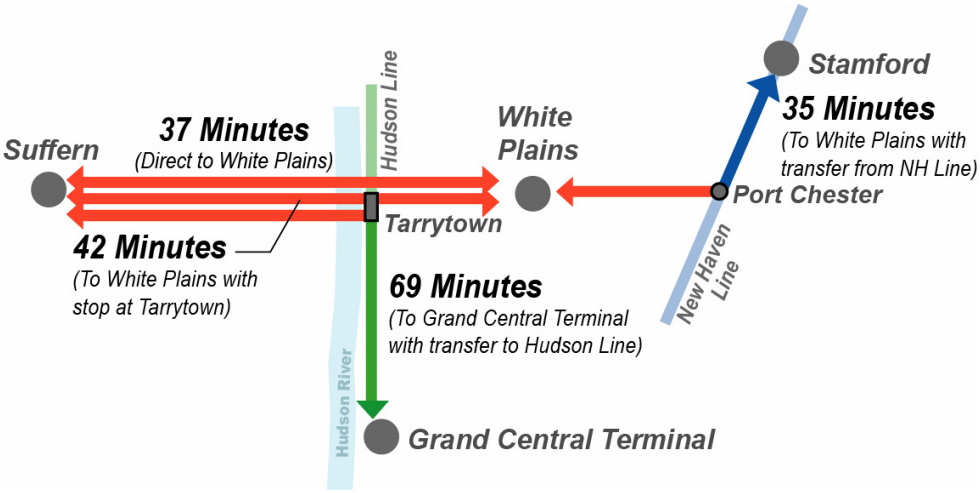
In Rockland County, most of the TOR and Clarkstown Mini Trans routes would be modified to serve as feeder routes to one (or more) of the new light rail stations, while continuing the intra-county service that is currently provided. To provide more attractive service, headways would be improved on many of the routes, especially during peak periods. In Westchester, office park shuttle buses would operate at increased frequencies to meet the light rail trains at the stations that best serve the parks.

Travel Times

The high-speed LRT would operate at a top speed of 65 mph (and an average speed of 34 mph). Figure 3-23 contains estimated travel times for selected origin-destination pairs.

Fares

A flat fare of $1.50 was assumed for LRT service. In addition, a rate for a combined LRT/commuter rail ticket was developed based on the 1996 rate of a combined TZX/Metro-North monthly pass.



High Speed LRT Travel Time for Selected Origin-Destination Pairs

Figure 3-23

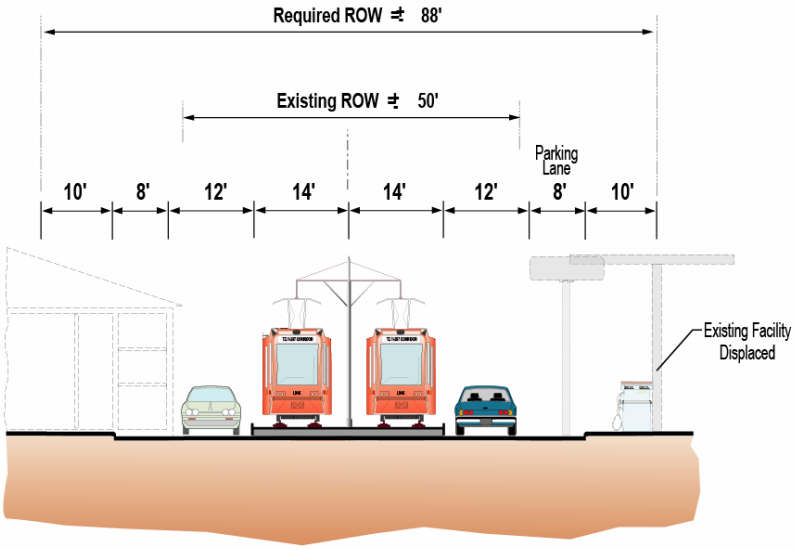
3.1.7 In-Street Light Rail (LRT2)

The intent of this new scenario (not one of the original 15) was to test a "trolley car," or "in-street," type of light rail operation, one that shares roadway space with regular vehicles (and would therefore be subject to the same traffic congestion). Figures 3-24 and 3-25 contain some sample cross sections and a schematic of this alignment.

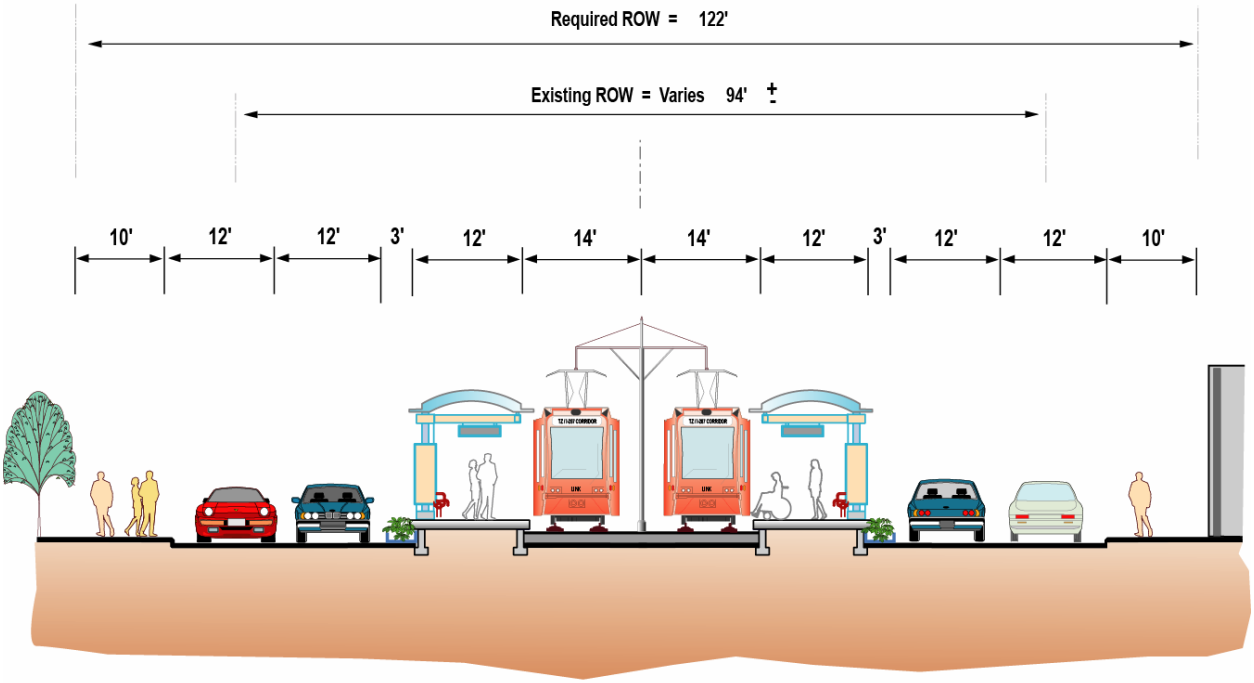
3.1.7.1 Alignment

The in-street LRT would be configured as a two-track system utilizing overhead catenary electrification. Adequate lateral clearance would be provided between the LRT vehicles and adjacent traffic for safety of operation (with or without positive separation such as raised medians and railings). LRT2 would follow the existing topography of the roadway. The horizontal alignment for LRT2 would be identical to LRT1 on certain segments (e.g., the Piermont Branch right-of-way between downtown Suffern and Airmont Road and Route 119 right-of-way in Tarrytown between Broadway and the Saw Mill River Parkway) but would extend into the communities utilizing local roads, such as Route 59 in Rockland County and local streets in downtown White Plains and Route 120A (Westchester Avenue) in Westchester County.

The in-street LRT would link all five north-south rail lines in the corridor via transfer facilities. LRT2 generally has more frequent and less sophisticated stations than high-speed LRT and these are more accurately described as "station stops;" however, where connections to other transit modes and to existing park-and-rides would occur, intermodal centers would be constructed with provisions for bus circulation, kiss-and-ride, and parking facilities. Six intermodal facilities and 23 station stops would be located on the line, many of them the same as identified in the high-speed LRT alignment, and a direct connection to the Tarrytown Station would be provided. These facilities and stations are as follows:



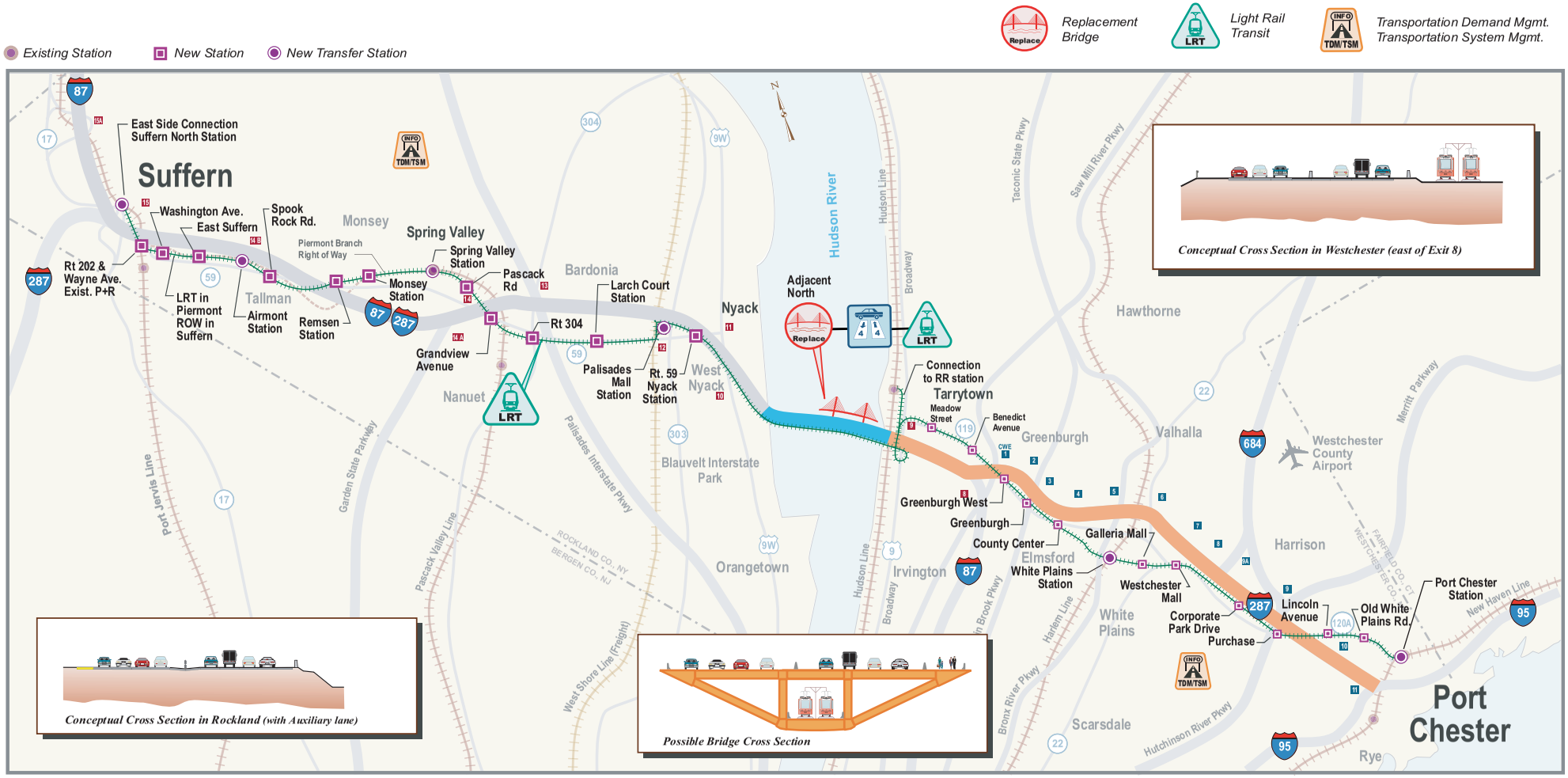
Rockland County - Route 59 - Spring Valley
(Looking East)



Westchester County - Route 119 Near Talleyrand Office Park
(Looking East)

Typical In-Street Light Rail Transit Cross-Sections

Figure 3-24



Scenario LRT2 - Full Corridor In-Street Light Rail Transit

Figure 3-25

- **Rockland** – Intermodal facilities: Suffern, Palisades Mall (Parking Lot J), and Spring Valley Station. Stations: Washington Avenue, East Suffern, Airmont, Spook Rock Road, Remsen Avenue, Monsey (Main St.), Pascack Road, Grandview Avenue, Nanuet Mall, NY304, Larch Court, Palisades Mall stores, and Nyack.

- **Westchester** – Intermodal facilities: Tarrytown, White Plains, and Port Chester. Stations: Meadow Street, Benedict Avenue, Greenburgh West, Greenburgh, County Center, Galleria Mall, Westchester Mall, Corporate Park Drive, Purchase, Lincoln Avenue, and Old White Plains Road.

Suffern/Spring Valley

The LRT2 alignment would connect to a relocated Suffern Station and follow the Piermont right-of-way to Airmont Road, as described in LRT1. At about 1 mile east of Airmont Road, the alignment would transition from the Piermont right-of-way onto Nyack Turnpike (Route 59) at Spook Rock Road in Monsey, continue for about 1.25 miles, and then reenter the Piermont right-of-way just east of Augusta Avenue. This segment of the Piermont right-of-way is located to the north of I-87/I-287 and runs through Spring Valley to the existing station on the Pascack Valley Line. In Spring Valley, the LRT2 alignment would share the existing (or expanded as necessary) Pascack Valley Line right-of-way for approximately 3,000 feet, after which it would transition back into the Route 59 right-of-way in the vicinity of Drayton Place and continue along Nyack Turnpike into West Nyack.

An alternative to locating LRT in the Pascack Valley Line right-of-way would be to use Route 59 through Spring Valley with a station located near Main Street. However, this mile-long section on Route 59 is narrow and several large buildings that would need to be acquired are located close to the roadway. In order to minimize property acquisition, use of Route 59 in this location was eliminated from further consideration.

At-grade rail crossings would be located along the Piermont right-of-way at Orange Avenue (Route 202), Chestnut Street, Washington Avenue, and Airmont Road. These crossings would require protection (lights, bells, and possibly crossing gates) to ensure safe operation for pedestrians, LRT vehicles, and vehicular traffic. At three other locations (Mahwah River, Hemion Road, and Spook Rock Road), existing grade-separated structures would be reconstructed as necessary to accommodate the proposed LRT alignment.

This segment of the In-Street LRT alignment would contain three intermodal centers – at the relocated Suffern Station, Airmont Road, and the Spring Valley Station. In addition, the following station stops would be provided:

- Washington Avenue (immediately east of the roadway).
- East Suffern (approximately 1,500 feet west of the Hemion Road underpass opposite the Good Samaritan Hospital on Route 59).
- Spook Rock Road (at Cherry Lane).
- Remsen Avenue (at Route 59).

Nanuet/West Nyack (Including Palisades Mall)

The LRT2 alignment would continue east along Route 59 through Nanuet (as Nyack Turnpike and West Nyack Road) for a distance of approximately 4 miles. In Nanuet the LRT would provide transit service through the heavily commercialized shopping area that includes the Nanuet Mall. East of Route 304

through West Nyack to Western Avenue, the land use is less commercialized and more residential. Throughout this segment the LRT would be built in the median with at-grade platform stops spaced approximately 1 mile, or less, apart. These stops would be located on Route 59 at the following crossroads:

- Pascack Road (west side of Route 59).
- Grandview Avenue (west side of Route 59).
- Nanuet Mall (west of Main Street/Middletown Road).
- NY304 (west of Smith Street).
- Larch Court (east side of Route 59).

After passing over Western Avenue and the tracks of the West Shore Line, the alignment would turn north on a viaduct across westbound Route 59 and follow the west side of the Palisades Mall ring road to Parking Lot J. This site would be become an intermodal center with expanded parking facilities and would provide transfer capabilities with the potential future commuter rail service on the West Shore Line. Improved access into the intermodal center would be provided with a direct connection from Route 59 and ramp improvements on I-87/I-287. From Parking Lot J, the LRT would move into the mall's north parking area on a viaduct and a station would be provided with direct access into the mall. The alignment would then turn northeast, span over the Interchange 12 ramps and Route 303, and transition to the south side of I-87/I-287.

Nyack

The alignment would be identical to that described for LRT1.

Tarrytown

The alignment would proceed from the bridge to loop tracks to Tarrytown Station and to Route 119 in an alignment similar to LRT1. The LRT2 alignment would continue at grade in the median of Route 119 through Tarrytown, with stops located near Meadow Street and Benedict Avenue. The alignment would continue on Route 119 under the I-287/CWE overpass east of Exit 8 into Greenburgh, where it would turn north and transition on aerial structure to the south side of the I-287/CWE right-of-way just east of Exit 1.

Greenburgh/Elmsford

The route for in-street LRT alignment in Greenburgh would follow the LRT1 alignment and include a Greenburgh West station stop and a Greenburgh Station (i.e., the Bed, Bath and Beyond site).

An alternative alignment to the I-287/CWE right-of-way would be to continue the LRT on Route 119 through Elmsford. However, the right-of-way on Main Street narrows to 60 feet and the roadway moves through a commercial district with one travel and parking lane in each direction. In order to minimize land use impacts, use of Route 119 through Elmsford was eliminated from consideration.

White Plains

East of the Hillside Avenue overpass near Exit 5, the alignment would transition south on aerial structure to the median of Route 119 (Tarrytown Road). The in-street alignment would remain at grade in the median as it enters the city of White Plains. A station stop would be located at Central Avenue. The LRT alignment would continue south on Route 119 and transition from the median over the Bronx River

Parkway and under the existing Harlem Line to the parking lot at the White Plains TransCenter and thence on to Hamilton Avenue.

Although there are a number of possible routes for the LRT alignment through downtown White Plains, the proposed alignment is on Hamilton Avenue to Broadway with a stop at the Galleria Mall. From Broadway the alignment would pass through Tibbets Park and continue east onto Westchester Avenue, with a stop at the Westchester Mall.

Port Chester/Rye

The alignment would continue east of White Plains and rejoin the I-287/CWE right-of-way near White Plains Avenue at Exit 8. The alignment would follow the south side of the I-287/CWE right-of-way generally located in retained cut, at grade, or retained fill to Route 120A (Westchester Avenue). Station stops would be located at Corporate Park Drive and Kenilworth Road (Purchase Station). The alignment would access Port Chester Station and connect to the New Haven Line via Route 120A and Broad Street. Station stops would be provided at Lincoln Avenue and at Old White Plains Road.

3.1.7.2 Operating Characteristics

Service Plan

The light rail operating plan for LRT2 would follow the same pattern as identified for LRT1. During peak periods, there would be two types of rail service operating between the Palisades Mall and White Plains. One would use the spur tracks to make a stop at Tarrytown Station, while the other would operate straight through, providing faster travel times between Rockland County and White Plains. During off-peak hours, all trains would operate via Tarrytown. Each service would operate at 20-minute headways, providing for 10-minute headways at each of the 29 stations on the line.

Bus Operating Plan

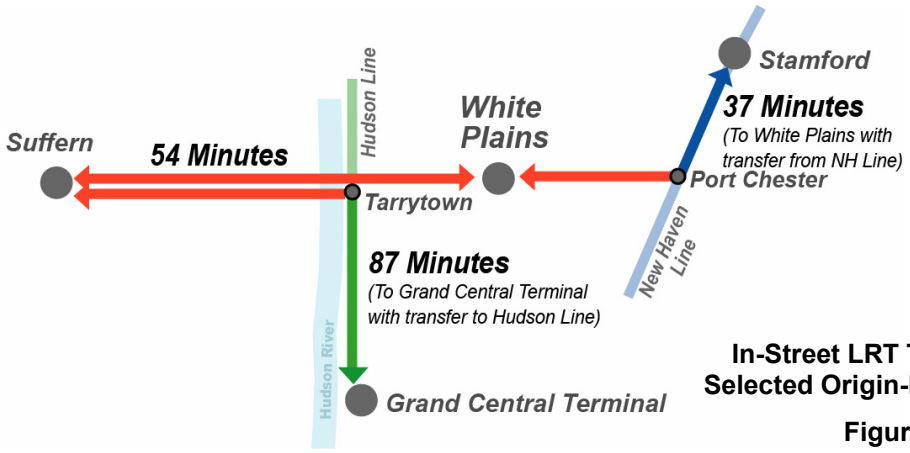
The changes to existing bus service in the corridor and the feeder bus system for the In-Street LRT would be similar to LRT1.

Travel Times

The in-street LRT would operate at a top speed of 55 mph (and an average speed of 24 mph). Figure 3-26 contains estimated travel times for selected origin-destination pairs.

Fares

A flat fare of $1.50 was assumed for LRT2 service. In addition, a rate for a combined LRT/commuter rail ticket was developed based on the 1996 rate of a combined TZX/Metro-North monthly pass.



In-Street LRT Travel Time for Selected Origin-Destination Pairs

Figure 3-26

3.1.8 Bus Rapid Transit – HOT Lanes (BRT1)

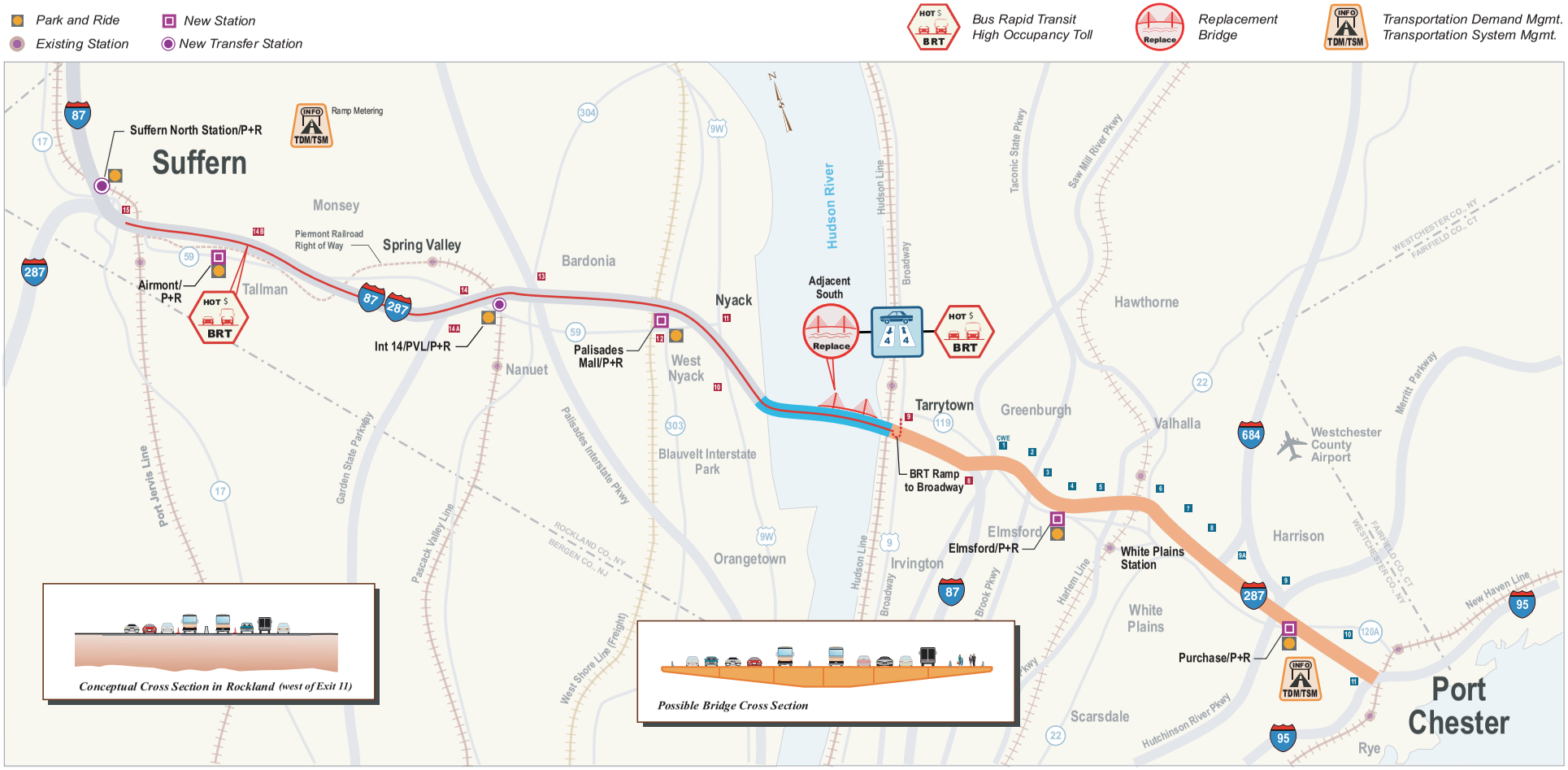
The intent of this scenario was to test a new single-level bridge (see Subchapter 3.2) and BRT service in buffer-separated HOT lanes along I-87/I-287 from Suffern to the east end of the Tappan Zee Bridge. Express buses would operate in regular lanes on I-87 and I-287/CWE in Westchester County. Ramp metering at the locations identified in Subchapter 3.1.2 was also tested as part of this scenario.

HOT lanes are a recent transportation management concept that combines HOV and congestion pricing strategies by allowing single occupancy vehicles (SOV) access into designated travel lanes by paying a toll utilizing E-ZPass technology. To attract toll-paying SOVs, free-flow conditions in the HOT lane are managed through variable toll pricing, especially during peak travel periods.

HOT lanes have the potential to provide significant travel time benefits to both motorists and transit users. BRT vehicles would be rubber-tire transit vehicles operating at relatively frequent intervals in the HOT lanes. ITS features on BRT systems would include convenient electronic fare collection and "real-time" bus information for waiting passengers. Buses would bypass queues on ramps to I-87/I-287 where ramp metering would be installed (see Subchapter 3.1.2). Figure 3-27 contains a schematic of the alignment for BRT1 and Figure 3-28 contains some sample cross sections.

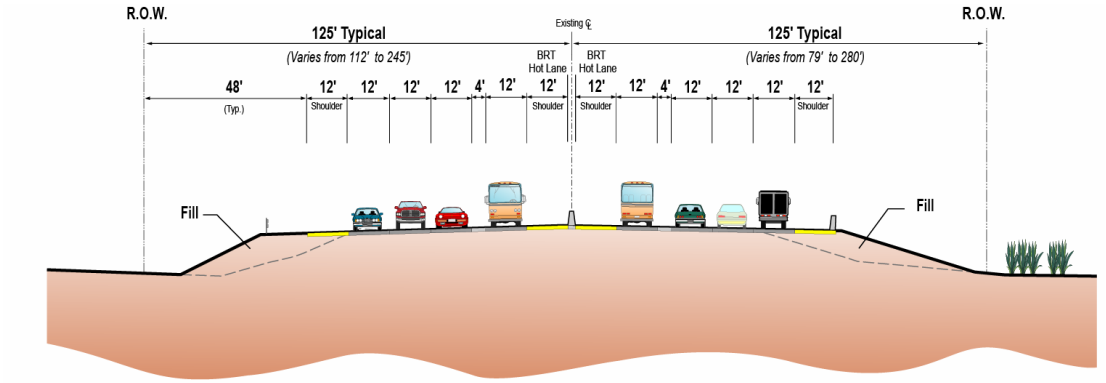
3.1.8.1 Alignment

A buffer-separated BRT/HOT lane would be developed as the inside left lane of I-87/I-287 in each direction between Suffern and Tarrytown. The transit facility would be incorporated into a reconstructed and widened I-87/I-287 roadway in Rockland County. The BRT/HOT lane would extend from the bridge to approximately 1 mile west of Interchange 14B. In Westchester, the BRT/HOT lane would merge with general traffic beyond the reconstructed toll plaza. A grade-separated ramp connection from the plaza up to Route 9 (Broadway) would be provided for buses traveling to the Tarrytown Station.

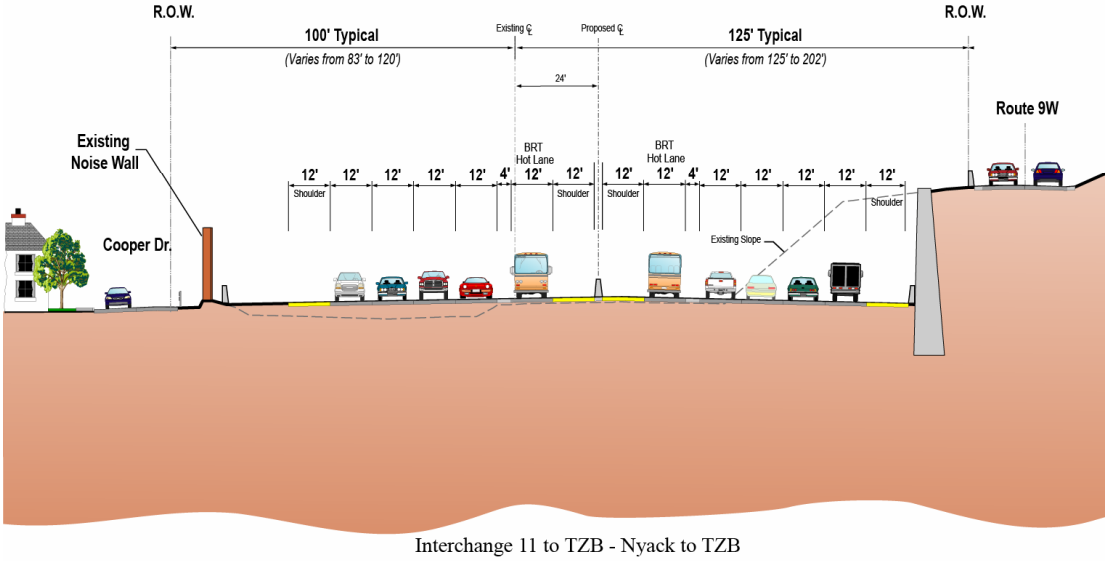


Scenario BRT1 - Replacement Bridge with Buffer-Separated Bus Rapid Transit HOT Lanes

Figure 3-27



Interchange 14B to Interchange 12 - Airmont Road to Palisades Mall
(Looking East)



Interchange 11 to TZB - Nyack to TZB
(Looking East)

Rockland - Typical BRT1 (HOT Lanes) Configurations

Figure 3-28

A new park-and-ride facility would be provided at Airmont Road (i.e., the site of the Millennium Recycling facility). Buses would also use the existing park-and-rides at Interchange 14 and the Palisades Mall (Parking Lot J).

General design features to be considered for the BRT/HOT lane include cross section, access/egress, toll collection, and signage:

- **Cross Section**: The BRT/HOT lane section would consist of a 12-foot-wide travel lane and a 12-foot inside shoulder separating the travel lane from the concrete median barrier. A 4-foot-wide painted pavement buffer strip would separate the BRT/HOT lane from the general-purpose lanes. I-87/I-287 in Rockland would be reconstructed as described for H3. The roadway would also be widened 32 feet to accommodate the BRT/HOT cross section.

- **Access/Egress**: Vehicles would enter and exit the BRT/HOT lane through slip ramps located between major interchanges. Slip ramps would be configured to include a deceleration lane, weaving area, and acceleration lane. Slip ramps need to be located between interchanges that have adequate distance to allow motorist to safely weave between the HOT lane and general-purpose lanes and highway entrance and exit ramps. Based on these requirements, slip ramps would be located between Interchanges 14B and 14, between Interchanges 13 and 12, and between Interchanges 11 and 10. There would also be a slip ramp on a replacement bridge to allow vehicles to exit at Interchange 9 after the toll plaza.

- **Electronic Toll Collection and Other Technology**: BRT/HOT lanes would require significant technology components, including automatic electronic toll collection (E-ZPass) and automatic vehicle classification and video enforcement systems.

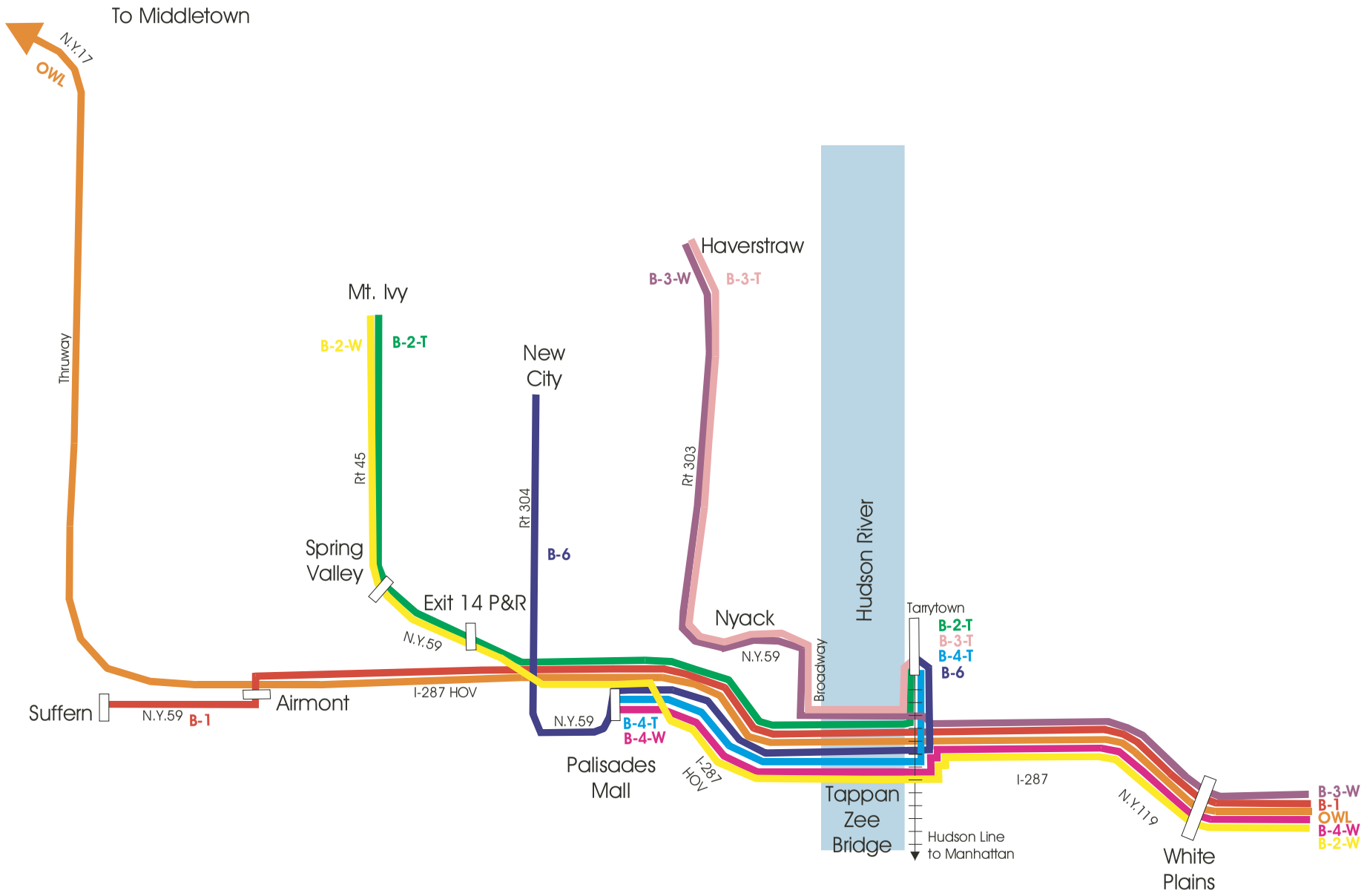
- **Signage**: Accurate and informative signage is essential for the safe and efficient operation of the BRT/HOT lanes. Information related to access and egress locations, occupancy requirements, operating hours, cost, and enforcement would be clearly shown to motorists utilizing ITS technology through variable message signs (VMS).

3.1.8.2 Operating Characteristics

Service Plan

Figure 3-29 contains a schematic of the service plan for BRT1. Buses would originate off line, serving residential areas in Orange and Rockland Counties before entering the HOT lane. The service plan for BRT1 would include replacing TZX and CRX routes with faster and more frequent service between major origins and destinations. During peak periods, there would be separate routes to Tarrytown and White Plains, generally at 20-minute headways, as follows:

- Suffern-Airmont - White Plains.
- Mt. Ivy-Spring Valley - Interchange 14 (Park & Ride) - Tarrytown.
- Mt. Ivy-Spring Valley - Interchange 14 (Park & Ride) - White Plains.
- Palisades Mall - Tarrytown.
- Palisades Mall - White Plains.
- New City - Route 304 - NY 59 - Palisades Mall - Tarrytown.
- Haverstraw - Route 303 - Nyack-Tarrytown.



BRT1 Proposed Peak Period Express Bus Service
Figure 3-29

- Haverstraw - Route 303 – Nyack - White Plains.

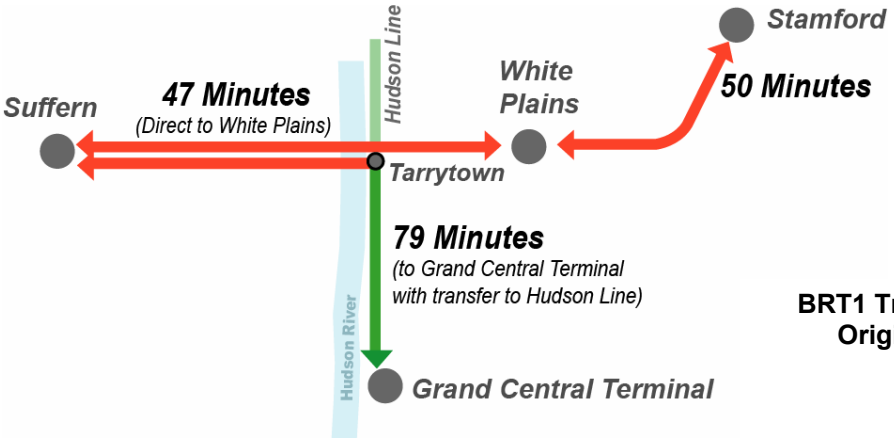
During off-peak hours, the routes would be combined, with buses that provide hourly service stopping at Tarrytown and then continuing to White Plains. The OWL and I-Bus service would be enhanced to provide 30-minute and 15-minute peak period service headways, respectively.

Feeder Routes

In Rockland County, most of the TOR and Clarkstown Mini Trans routes would be modified to serve as feeder routes to the major park-and-rides (Interchange 14 park-and-ride and Palisades Mall), while continuing the intra-county service that they currently provide. To provide more attractive service headways would be improved on many of the routes, especially during peak periods.

Travel Times

Buses would operate at speeds of 55 mph in the HOT lanes in Rockland County and be subject to roadway conditions in Westchester County. Figure 3-30 depicts estimated travel times for selected origin-destination pairs.



BRT1 Travel Time for Selected Origin-Destination Pairs

Figure 3-30

Fares

The same fares as described for LRT1 would be applied to BRT (i.e., a flat fare of $1.50 and a combined BRT/commuter rail ticket based on the 1996 rate of a combined TZX/Metro-North monthly pass).

3.1.9 Bus Rapid Transit – Exclusive Busway (BRT2)

The intent of this scenario was to test a new two-level bridge (see Subchapter 3.2) and a full-corridor exclusive busway. The busway would be mostly grade-separated, with some in-street segments in Westchester County. The scenario also includes roadway widening and reconstruction and a climbing lane in Rockland, as depicted in H3.

The BRT system would employ ITS features such as convenient electronic fare collection, "real-time" bus information for waiting passengers, and signal preemption. Signal preemption is used to facilitate transit vehicle movement at intersections on the in-street segments. The system assigns a priority to the signal, by intersection and by time of day, that would provide either an "early" green light or an "extended" green light to a transit vehicle; alternatively, drivers would trigger signal preemption from within their vehicles.

BRT vehicles would be rubber-tire passenger vehicles, operating at frequent intervals in a dedicated right-of-way from Suffern to the east end of I-287 (Exit 11) in Rye. Additional buses would use the facility en route to major origins and destinations, providing one-seat ride service to a large geographical area. Figure 3-31 contains a schematic of the alignment for BRT2 and Figure 3-32 contains some sample cross sections.

3.1.9.1 Alignments

BRT2 would be constructed as a two-directional roadway, or "busway," for exclusive use by buses in Rockland County in an alignment similar to LRT1 (and CRT1). A typical BRT cross section, configured for high-speed operation, would consist of two 12-foot travel lanes separated by a 12-foot-wide paved center median for passing a disabled vehicle. Concrete median barriers along the outside edges of the travel lanes would define the busway limits. The desirable total busway width would be 48 feet, (40 feet minimum). In certain locations where the typical 40-foot section would require significant right-of-way acquisitions, the median could be eliminated, reducing the total width to 28 feet. Since only professional drivers would drive the buses, elimination of the center median for relatively short sections would not be considered a significant safety issue.

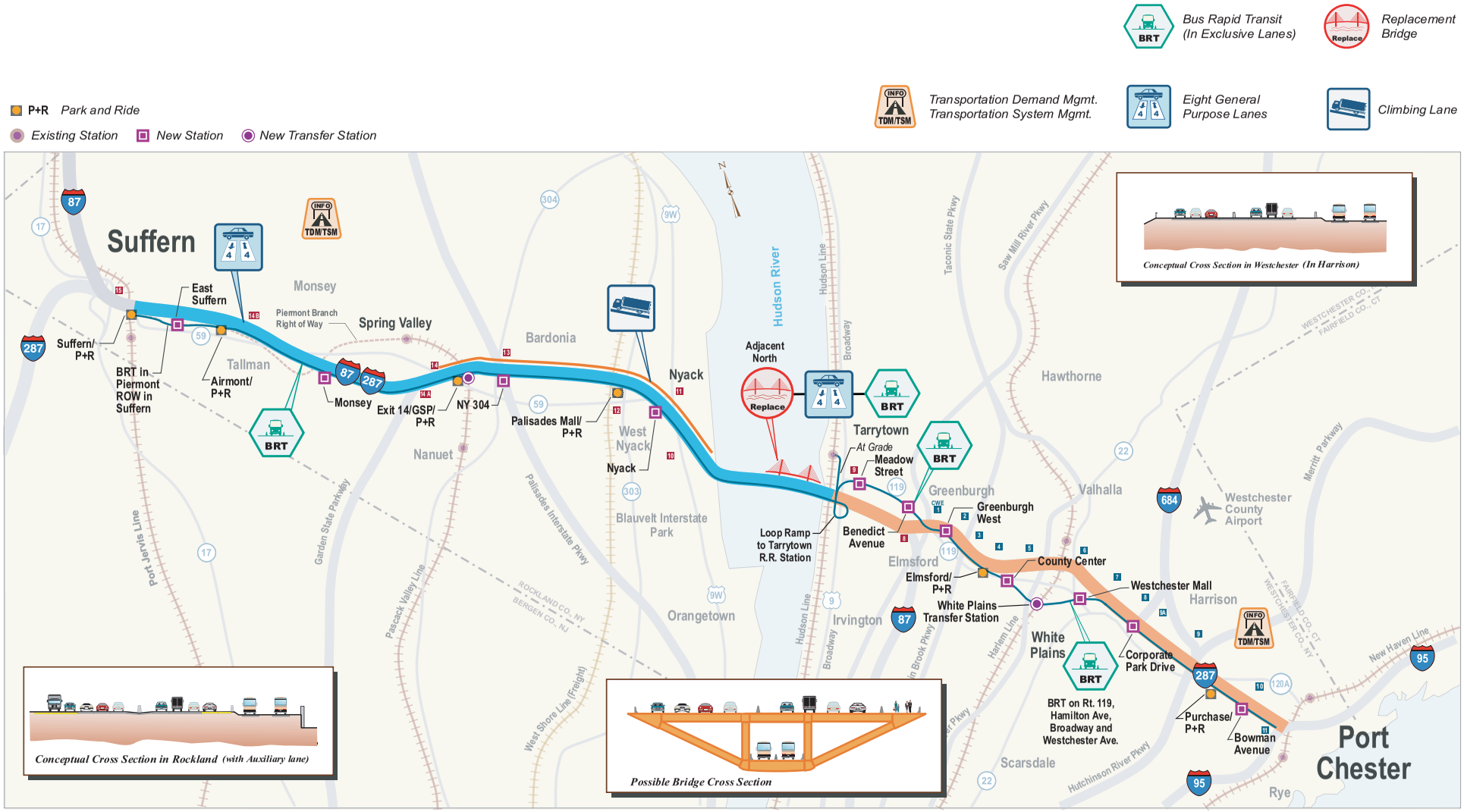
BRT2 within Westchester County would provide a combination of barrier-separated busway in the I-287/CWE right-of-way and exclusive bus lanes on sections of Route 119 in Tarrytown and along designated streets in White Plains (similar routes as described for the in-street light rail scenarios). The alignment would reenter the I-287 right-of-way near Exit 8, and the barrier-separated busway would follow the profile of the existing highway except at the existing exit ramps (Exits 9A, 9, and 10) where grade separation would be provided. To the east of Exit 10, the barrier-separated busway would transition into the I-287/CWE general-purpose lanes. Where the BRT alignment is on local roads, it would be subject to the congestion caused by cross traffic and turning movements.

The exclusive busway would link all five north-south rail lines in the corridor via transfer facilities. BRT stops would be designed to resemble light rail stops and/or commuter rail stations. Similar to LRT1, six major stations/park-and-rides and 14 additional stops would be located on the line (and a direct connection to the Tarrytown Station would also be provided):

- **Rockland** – Suffern, East Suffern, Airmont, Monsey, Interchange 14/PVL, NY304, Palisades Mall, Nyack.

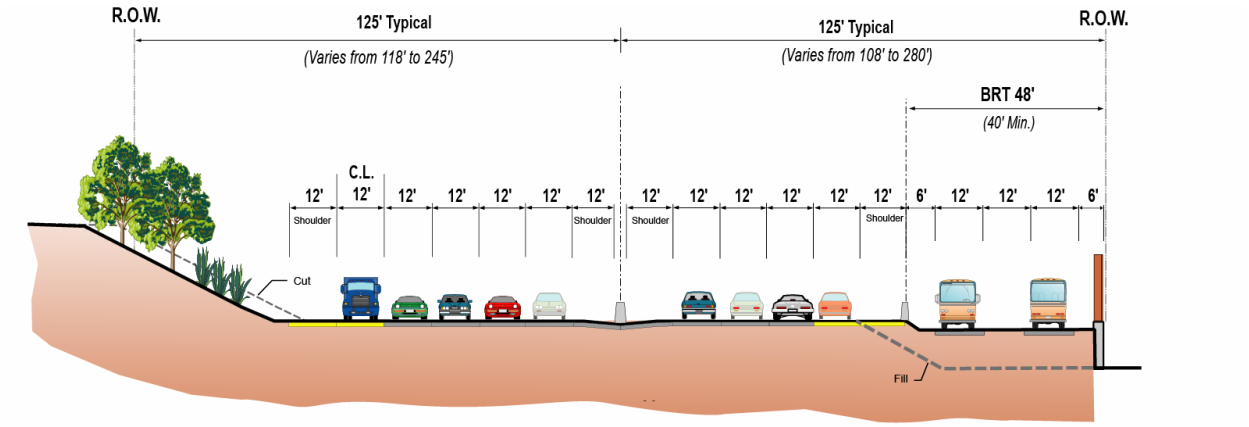
- **Westchester** – Meadow Street, Benedict Avenue, Greenburgh West, Greenburgh, County Center, White Plains, Galleria Mall, Westchester Mall, Corporate Park Drive, Purchase, Bowman Avenue, Port Chester (via local roads).

In addition, bus service would be provided to Greenwich and Stamford in Fairfield County, Connecticut.

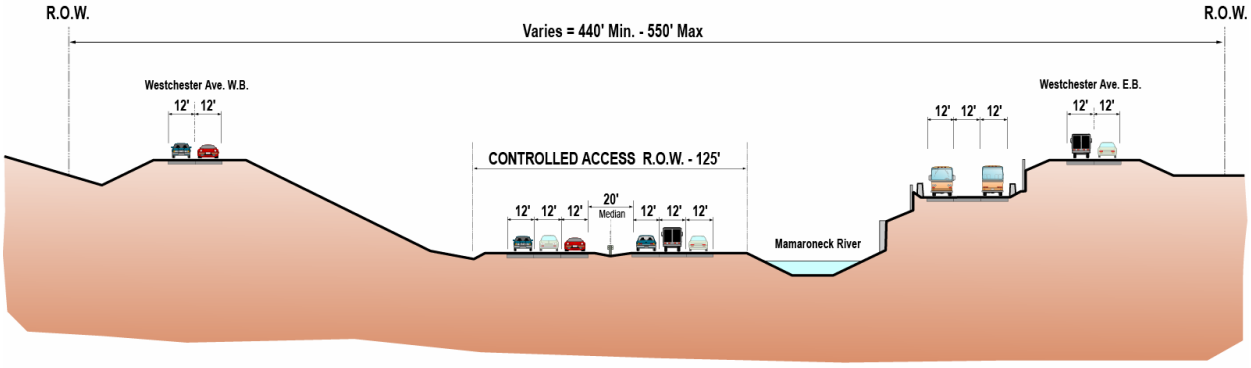


Scenario BRT2 - Replacement Bridge with Barrier-Separated Bus Rapid Transit

Figure 3-31



Rockland - Interchnage 14B to Interchange 12
Airmont Road to Palisades Mall
(Looking East)



Westchester - CWE Exit 8 to Exit 9
White Plains
(Looking East)

Typical BRT2 (Exclusive Busway) Cross-Sections

Figure 3-32

Rockland County

The western BRT terminus in downtown Suffern would be located at the existing park-and–ride facility west of the intersection of Route 202 (Orange Avenue) and Wayne Avenue. This facility, currently owned by New Jersey TRANSIT, would be expanded to accommodate the forecasted increase in bus service. From this location buses would cross Route 202 and enter directly into the Piermont right-of-way for approximately 2.3 miles to Airmont Road and Interchange 14B.

A new park-and-ride facility would be located east of Airmont Road along the south side of I-87/I-287, with direct access to Exit 14B and within one-quarter mile of Route 59 (requiring the acquisition of the Millennium Paper Recycling facility). East of the Airmont park-and-ride, the busway would continue along the south side of the I-87/I-287 right-of-way, essentially following a profile consistent with that of

the existing highway pavement to the river. Departure from the existing highway profile would be necessary at a number of locations to maintain grade separation between the proposed busway and the existing ramp configurations. Within Rockland County, grade separations would be required at the Garden State Parkway (Interchange 14A), Route 59 (Interchange 14), Palisades Interstate Parkway (Interchange 13), Palisades Mall/Route 303 (Interchange 12), and Route 9W (Interchange 10).

In addition to the Airmont location, BRT2 park-and-ride facilities are proposed at Interchange 14/PVL and the Palisades Mall (Parking Lot J). Passenger movement at the Palisades Mall park-and-ride would require vertical circulation elements from the busway to the level of the existing parking.

At South Nyack, in the vicinity of the Hudson River shoreline, the BRT2 profile would descend and connect to a lower level of the replacement Tappan Zee Bridge.

Westchester County

Similar to the loop tracks to the Tarrytown Station under the light rail scenarios, BRT2 includes a loop in the vicinity of the toll plaza that would provide bus access to the existing Tarrytown Station. The loop, initially curving to the south, would cross beneath the I-87/I-287 roadway and proceed northward along the east side of the Hudson Line right-of-way. The BRT loop and access ramp profile would descend in grade, ultimately reaching the existing rail station. The proposed loop/access ramp configuration would provide a direct connection to the station, without requiring the buses to operate in mixed traffic on Broadway and other local streets in Tarrytown.

Proceeding east from the vicinity of the loop and toll plaza, the BRT2 busway would cross Broadway at-grade and enter the Route 119 roadway as exclusive bus lanes. At Exit 1 on I-287/CWE, the exclusive bus lanes on Route 119 would transition into a barrier-separated busway along the south side of the I-287/CWE right-of-way. Proceeding along the south side of the highway, the BRT2 profile would essentially replicate the existing roadway profile, except for grade-separation provisions at existing exit ramps (Exit 1, 2, 3, and 4). Between Exits 3 and 4, a park-and-ride facility would be built where Bed, Bath & Beyond and Sims currently are located.

At Exit 5, the busway would depart the I-287/CWE right-of-way, and proceed at grade on Route 119 as exclusive bus lanes. Exclusive lanes would be provided on Hamilton Avenue and North Broadway and the busway would reenter the I-287/CWE right-of-way near Exit 8 and proceed as a barrier-separated facility. Bus stations within the White Plains area would be at the White Plains rail station, Galleria Mall, and the Westchester Mall.

After reentering the I-287 right-of-way near Exit 8, the barrier-separated busway would replicate the profile of the existing highway except at the existing exit ramps (Exits 9A, 9, and 10) where grade separation would be provided. A park-and-ride would be located to the east of the Hutchinson River Parkway, along the south side of Westchester Avenue at Kenilworth Road.

To the east of Exit 10, the barrier-separated busway would transition into the I-287/CWE general-purpose lanes.

3.1.9.2 Operating Characteristics

Service Plan

The service plan for BRT2 includes two types of bus service (Figure 3-33). Some routes would only operate along the busway. Other routes would begin off line, serving residential areas in Orange, Rockland, Westchester, and Fairfield Counties before entering the busway.

The busway would have stations at major park-and-ride lots, and intermediate stops at locations that correspond to the stations in LRT1. Some routes would skip some stops during peak periods in order to speed up travel times.

From Spring Valley and from Palisades Mall (the highest volume origins in Rockland), there would be separate bus routes to Tarrytown and White Plains. This would speed up travel to White Plains and achieve more efficient equipment utilization. During off-peak periods, including reverse-peak trips, all routes would make all stops.

The OWL, TZX , CRZ, and some Bee-Line routes would be replaced with the following routes:

- Busway – Suffern to Stamford (all stops including Tarrytown).
- Orange County-White Plains (making all stops in White Plains at Central Park Avenue, White Plains TransCenter, Galleria Mall, Broadway, and Westchester Mall).
- Suffern-White Plains Express (Airmont and all White Plains stops).
- Mt. Ivy-Spring Valley-Interchange 14/PVL-White Plains (all stops).
- Spring Valley-Interchange14/PVL-Tarrytown.
- Palisades Mall-Rye.
- New City-Route 304-NY 59-Palisades Mall-White Plains (all stops).
- Haverstraw-Route 303-White Plains (all stops).
- Palisades Mall-NY 59-Nyack-White Plains (all stops).
- Croton-Ossining-White Plains (all stops).
- Peekskill-White Plains (all stops).
- Eastview Skyline Drive.

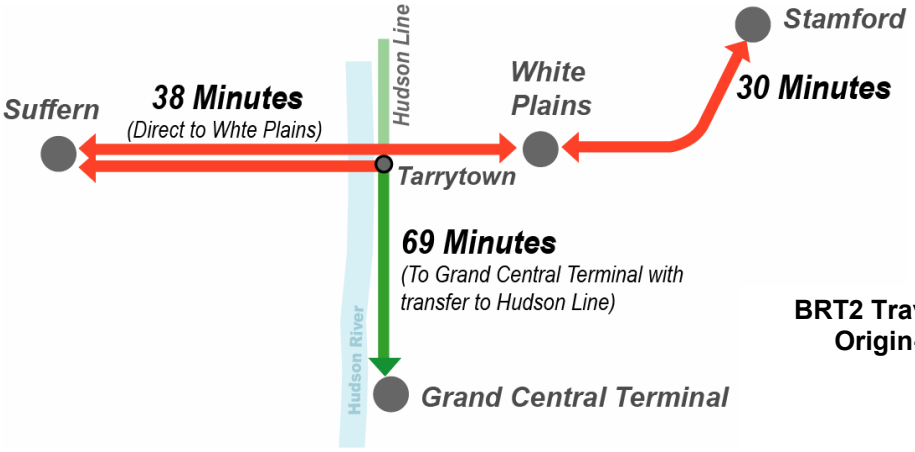
The busway would operate at 15-minute peak period headways. The frequency of service on the other routes would vary generally from 15- to 30-minute headways during peak periods. In addition, the I-Bus service between Stamford and White Plains would be enhanced to operate at 15-minute peak period headways.

Feeder Bus Routes

Local bus service would be reoriented to feed into the busway stops. The changes would be the same as those described for LRT1.

Travel Times

Buses would operate at speeds of up to 65 mph in the exclusive busway (average speed would be 31 mph). Figure 3-34 depicts estimated travel times for selected origin-destination pairs.



BRT2 Travel Time for Selected Origin-Destination Pairs

Figure 3-34

Fares

The same fares as described for BRT1 and LRT1 would be applied to BRT2 (i.e., a flat fare of $1.50 and a combined BRT/commuter rail ticket based on the 1996 rate of a combined TZX/Metro-North monthly pass).

3.1.10 Multi-Modal Scenarios

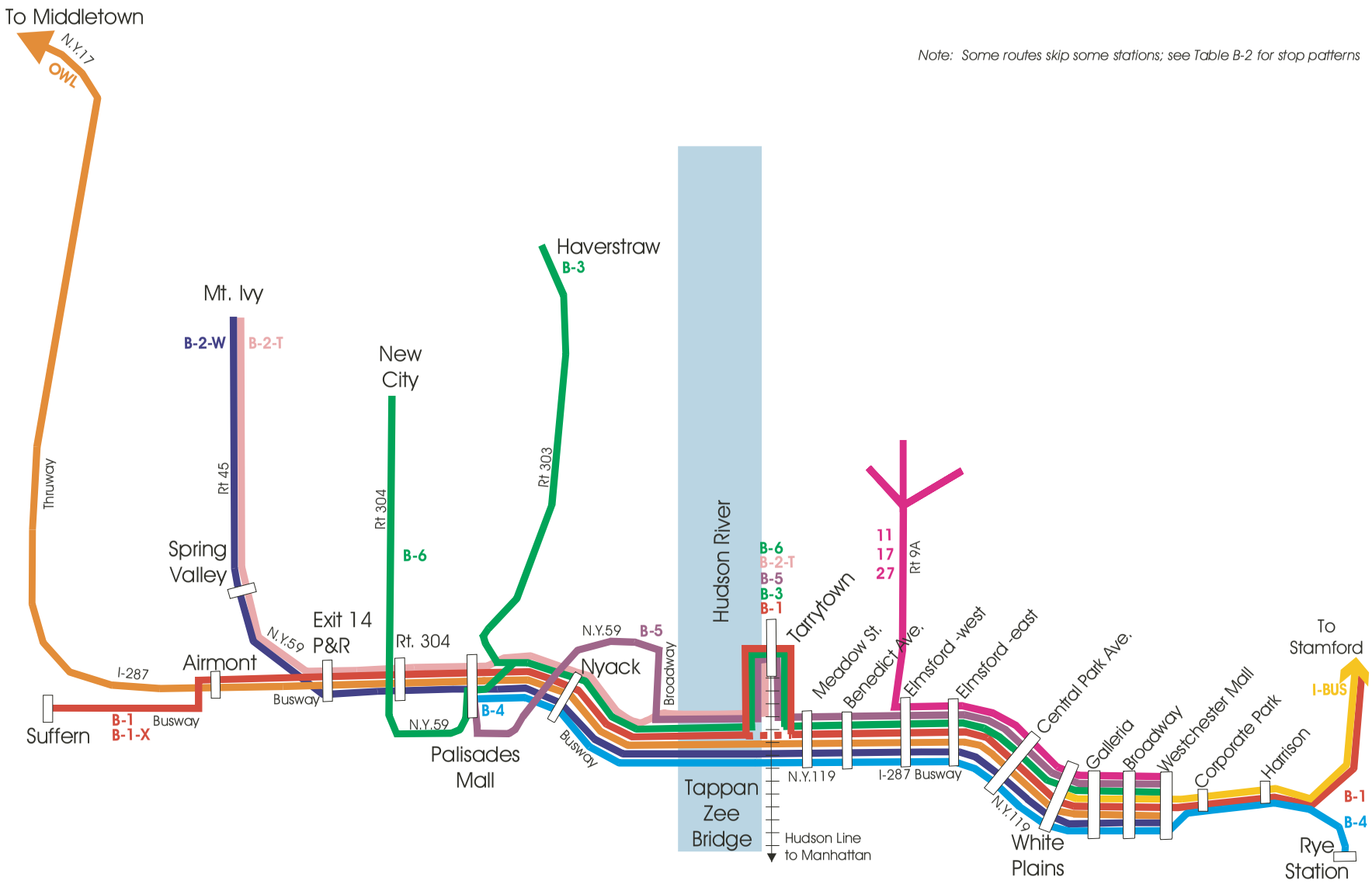
Six multi-modal scenarios were devised to test how the different modes (described above) in combination would perform with respect to the different travel markets in the corridor. The multi-modal scenarios also provided the opportunity to evaluate feasible alternative alignment choices against the goals and objectives established for the project. The alignments for most of the elements contained in these multi-modal scenarios were described in detail above and the description will not be repeated here. The discussion below elaborates on the aspects of the scenarios that are different from those that were previously described.

3.1.10.1 Scenario M1

Scenario M1 includes a cross-corridor commuter rail line (Suffern to Port Chester), located primarily to the north of the I-87/I-287 roadway but still within the right-of-way. A Tarrytown Transfer Station would be constructed for transfer to the Hudson Line in lieu of the direct connection that was described under CRT1. Scenario M1 also includes buffer-separated HOT lanes along I-287 from Suffern to the east end of the Tappan Zee Bridge (as in BRT1). Figure 3-35 contains a schematic of the alignment for Scenario M1.

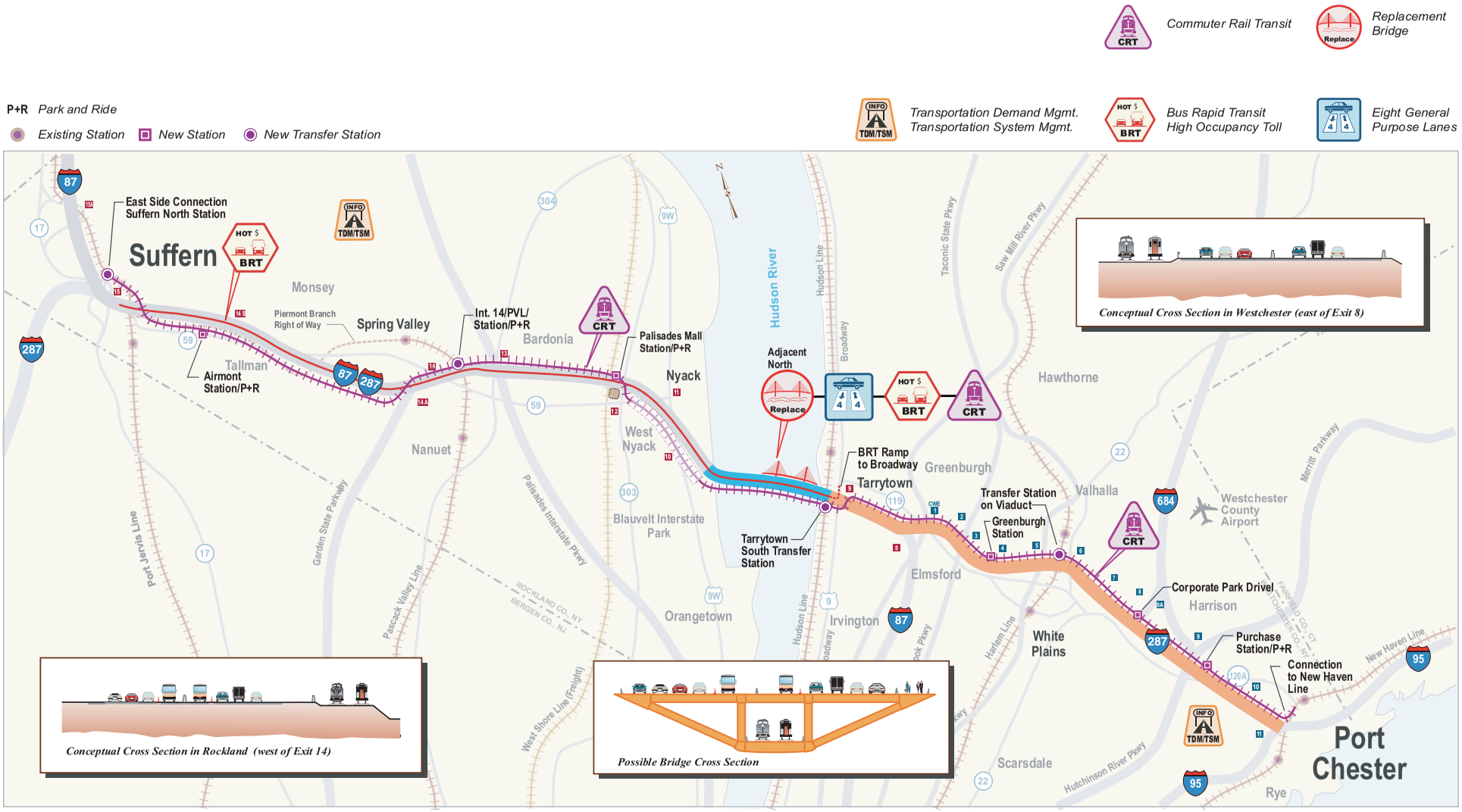
Northern CRT Alignment

Table 3-4 contains overall construction requirements for the northern CRT alignment.



BRT2 Proposed Peak Period Express Bus Service

Figure 3-33



Scenario M1 - Replacement Bridge with Full Corridor Commuter Rail and Buffer-Separated BRT

Figure 3-35

Table 3-4

Overall Construction Requirements for the Northern CRT Alignment

Type of Structure	Rockland County Lineal Feet	Westchester County Lineal Feet
Viaduct	24,200	14,200
Retained Cuts/Retained Fills/At-Grade	38,200	34,900
Tunnel	9,600	16,700

Rockland County

The connection to the Port Jervis Line and the alignment for M1 is identical to that of CRT1, with physical location of the commuter rail along the south side of the I-87/I-287 right-of-way, west of Spring Valley. As for CRT1, Scenario M1 would include an Airmont Road station/park-and-ride facility at the site of the existing Millennium Paper Recycling location.

East of the crossing beneath Hungry Hollow Road, the M1 alignment would enter a tunnel approximately 5,600 feet long that crosses beneath the I-87/I-287 roadway near Route 45, aligns to north of the roadway within the right-of-way, and crosses beneath Scotland Hill Road and the Garden State Parkway (Interchange 14A).

East of the Garden State Parkway, the M1 alignment would exit the tunnel and cross beneath Route 59 and the Interchange 14 ramps in a retained cut. After crossing beneath the Pascack Valley Line, the profile would proceed eastward on a viaduct of approximately 4,700 feet over Naurashank Brook, North Middletown Road, and Nauraushaun Brook. East of Interchange 14, a commuter rail station/intermodal center would be located on the north side of I-87/I-287, with transfer capability to the Pascack Valley Line (requiring acquisition of the Target retail store). East of the viaduct, the commuter rail would proceed in a retained cut and cross beneath Route 304 and the Palisades Interstate Parkway (Interchange 13).

East of the Palisades Parkway, the CRT would descend toward the Hackensack River valley on a 2 percent grade before transitioning to a viaduct section west of Strawtown Road.

From west of Strawtown Road, the proposed viaduct would extend approximately 6,000 feet and cross above the Hackensack River, the CSX West Shore Line, Palisades Center Drive, and the Interchange 12 ramps. With the commuter rail alignment on the north side of I-87/I-287, station platforms east of the CSX West Shore Line would dictate pedestrian cross-passages above the Thruway to provide access to the intermodal facility at Parking Lot J.

Near Route 303, the viaduct and bridge sections would transition into a retained cut before entering the portal for the tunnel section in Nyack. In the vicinity of Mountainview Avenue, the tunnel alignment would transition from the north side configuration to follow the CRT1 tunnel alignment toward the Hudson River.

Westchester County

Proceeding east from the replacement highway bridge structure with commuter rail in the lower level of the bridge, the M1 alignment at the Westchester shoreline would enter a tunnel of approximately 4,700 feet and align along the north side of the I-87/I-287 right-of-way. East of the tunnel portal near Meadow Street, the M1 profile would ascend on a 2 percent grade and transition onto a viaduct before crossing over Exit 8.

Beyond the east portal of the Tarrytown tunnel, a 7,000-foot viaduct would carry the commuter rail above Exit 8, the Saw Mill River Parkway (Exit 1), the Saw Mill River, and Central Avenue. East of the viaduct, a 3,500-foot tunnel would carry the M1 alignment beneath the Sprain Brook Parkway (Exit 3). The tunnel would daylight west of Knollwood Road (Exit 4), near the location of a proposed commuter rail station on the north side of I-287 (Greenburgh Station). East of Knollwood Road, the M1 profile would rise on another viaduct approximately 7,200 feet long over Manhattan Avenue and Hillside Avenue, continuing east toward White Plains.

Going east on the viaduct, the M1 alignment would cross above Kensico Road, the Bronx River Parkway, and the existing Harlem Line. To provide transfer capability to the Harlem Line, M1 would incorporate an elevated transfer facility, new Harlem Line platforms, and vertical circulation elements. The transfer facility would result in the introduction of an additional Harlem Line station located between the existing Metro-North stations at White Plains and North White Plains.

Proceeding east from the Harlem Line transfer station, the M1 viaduct would transition into an extended section of retained cut (approximately 21,800 feet) aligned along the north side right-of-way. Existing crossings would be carried above the retained cut on individual bridge structures. A station would be located at Corporate Park Drive.

At the eastern end of the 21,800-foot retained cut, a commuter rail station/park-and-ride facility would be located on the north side of I-287/Westchester Avenue between the Hutchinson River Parkway (Exit 9) and Kenilworth Road (Purchase Station). Near the proposed station, the retained cut would transition into a 3,500-foot tunnel, crossing beneath Kenilworth Road and Purchase Street. Beyond the east tunnel portal, the M1 alignment would cross above Westchester Avenue (Exit 10) on structure.

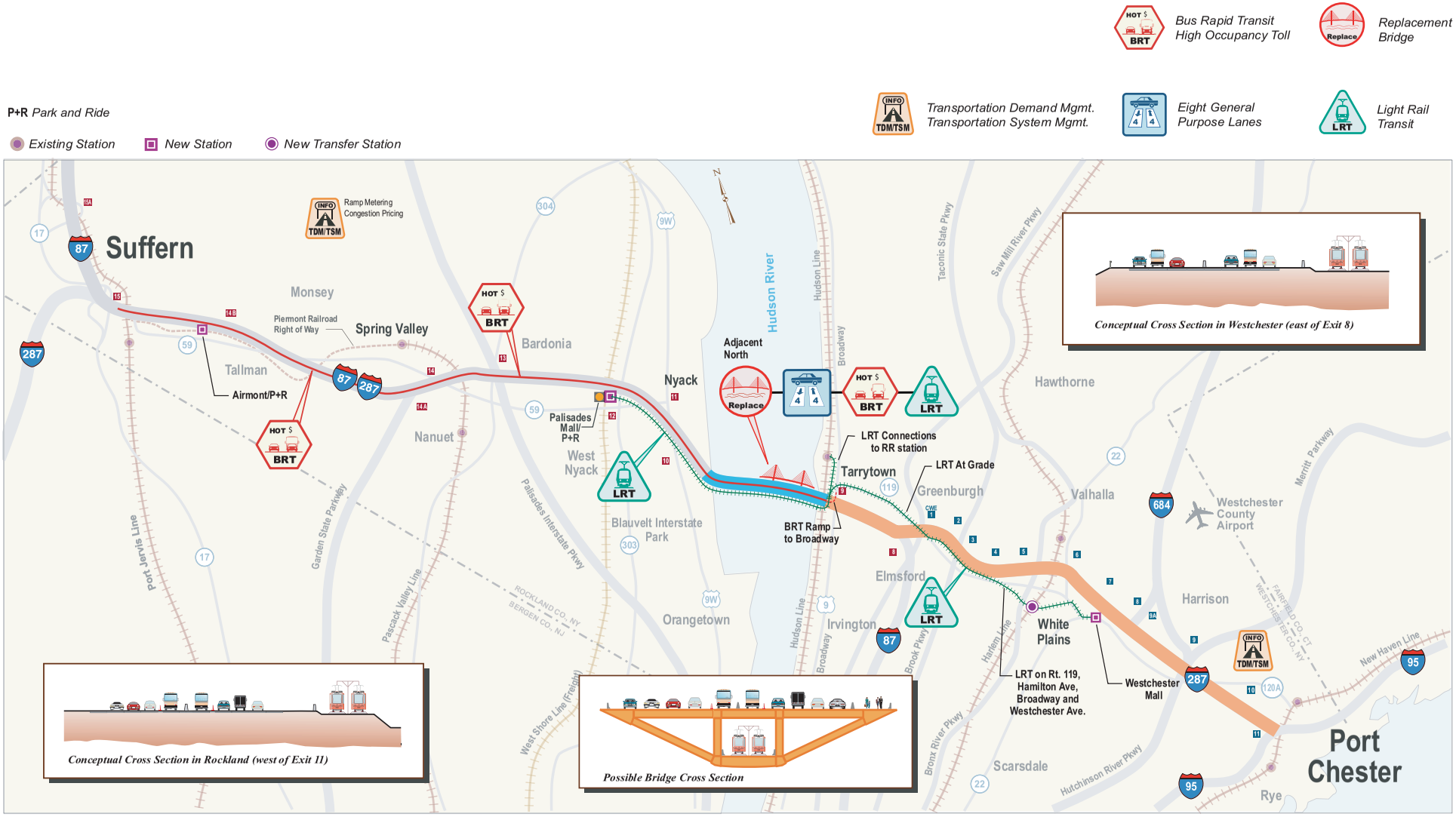
East of the Westchester Avenue crossing, the M1 profile would descend into a retained cut and cross beneath Bowman Avenue, proceeding into a tunnel section. The tunnel alignment would shift from the north side to the south side right-of-way and continue in tunnel beneath Ridge Street, High Street, Boston Post Road, and the I-95 Interchange. The tunnel would connect to the New Haven Line using the same alignment as in CRT1.

3.1.10.2 Scenario M2

The intent of this scenario was to test a truncated light rail service (between the Palisades Mall and White Plains) to serve local trips and BRT service via HOT lanes in Rockland County (i.e., BRT1) for the longer-haul work trip. The light rail service would be a “trolley” type service operating in-street on certain segments of the route. Congestion pricing and ramp metering were also tested (see Subchapter 3.1.2). Figure 3-36 contains a schematic of the alignment for Scenario M2.

3.1.10.3 Scenario M3

The intent of this scenario was to test an eight-lane highway, Manhattan-bound commuter rail, and BRT/HOT lanes in a bored tunnel across the Hudson River (see Subchapter 3.2). In addition, use of a



Scenario M2 - Replacement Bridge with Buffer-Separated BRT and Light Rail Transit

Figure 3-36

portion of the Piermont right-of-way in Suffern was tested as an alternative to remaining within the I-87/I-287 right-of-way for commuter rail. Ramp metering was also assumed at the locations identified in Subchapter 3.1.2. Figure 3-37 contains a schematic of the alignment for Scenario M3.

Piermont Right-of-Way

The M3 alignment would connect to the Port Jervis Line via the Ramapo Alignment described for CRT3. The M3 alignment would remain on viaduct to the existing Piermont Branch right-of-way. The viaduct would provide grade separation for the crossings of Route 59, Washington Avenue, and Chestnut Street.

East of the viaduct section in Suffern, the M3 alignment would descend to coincide with current track elevations of the existing Piermont Branch profile. At the approach to Airmont Road, the rail profile would transition onto a viaduct to provide grade separation from the existing roadway. After crossing Airmont Road, the alignment would proceed eastward along the south side of the I-87/I-287 right-of-way. The horizontal and vertical alignment to the river crossing described for CCRT1, and stations/park-and-rides described for CRT1, would apply to Scenario M3.

3.1.10.4 Scenario M4

The intent of this scenario was to test a highway and commuter rail (Manhattan-bound) tunnel with a rehabilitated bridge for LRT and a parkway with a pedestrian/bikeway promenade (see Subchapter 3.2). The light rail service would extend between Suffern and Port Chester and include in-street segments. Since the commuter rail line would provide direct access to Manhattan, the light rail line would not connect to the Tarrytown Station. Figure 3-38 contains a schematic of the Scenario M4 alignment.

3.1.10.5 Scenario M5

The intent of this scenario was to test a replacement bridge (see Subchapter 3.2) for Manhattan-bound commuter and cross-corridor in-street LRT, together with the highway improvements in Rockland County. Figure 3-39 contains a schematic of the Scenario M5 alignment.

3.1.10.6 Scenario M6

The intent of this scenario was to test a rehabilitated/widened bridge for a truncated light rail service between the Palisades Mall and White Plains, with a commuter rail tunnel for Manhattan-bound service. M6 includes ramp metering at the locations described in Subchapter 3.1.2. Figure 3-40 contains a schematic of the Scenario M6 alignment.

3.2 Level 2 Scenarios – River Crossing Elements

A variety of bridge and tunnel options was studied in the Level 2 scenarios, including:

- Preserving the existing bridge (H1).
- Conducting a major rehabilitation of the existing bridge with a seismic retrofit (H2, M4, M6).
- Constructing a replacement bridge (H3, BRT1, BRT2, LRT1, LRT2, CRT1, CRT3, M1, M2, M5).
- Constructing a supplemental tunnel for CRT only - highway and other transit modes (if any) would be on a replacement bridge (CRT2, M6).

- Constructing a tunnel for highway and transit modes (M3, M4).

3.2.1 Bridge Preservation

The No Build scenario would protect the bridge from unacceptable deterioration, extending its service life for another 50 years. Steel repairs on the west deck truss and towers, caisson hatches, dewatering and alarm improvements, and painting of the east deck truss and the causeway spans are in progress. Ongoing maintenance of the Tappan Zee Bridge over the next 20 years would include repairs to the steel superstructure, fender piles, substructure, and causeway spans, including those that are vulnerable to seismic activities and marine bore activity on the untreated timber piles supporting the substructure. A contract for steel and deck replacement for lanes 1, 2, 6, and 7 is to be let in December 2005.

It is anticipated that the deck concrete throughout the majority of the bridge will need to be replaced at some point during the next 20 years, with night-time working assumed over a 5- to 7–year period. This maintenance, while improving the structure, would not address seismic deficiencies, existing traffic capacity and operational deficiencies, or the potential for pedestrian and bicycle use. The current seven lanes, with the reversible seventh lane serving eastbound traffic in the morning and westbound traffic in the evening, would continue to operate on the bridge. Continuous maintenance would also be required on the movable barrier.

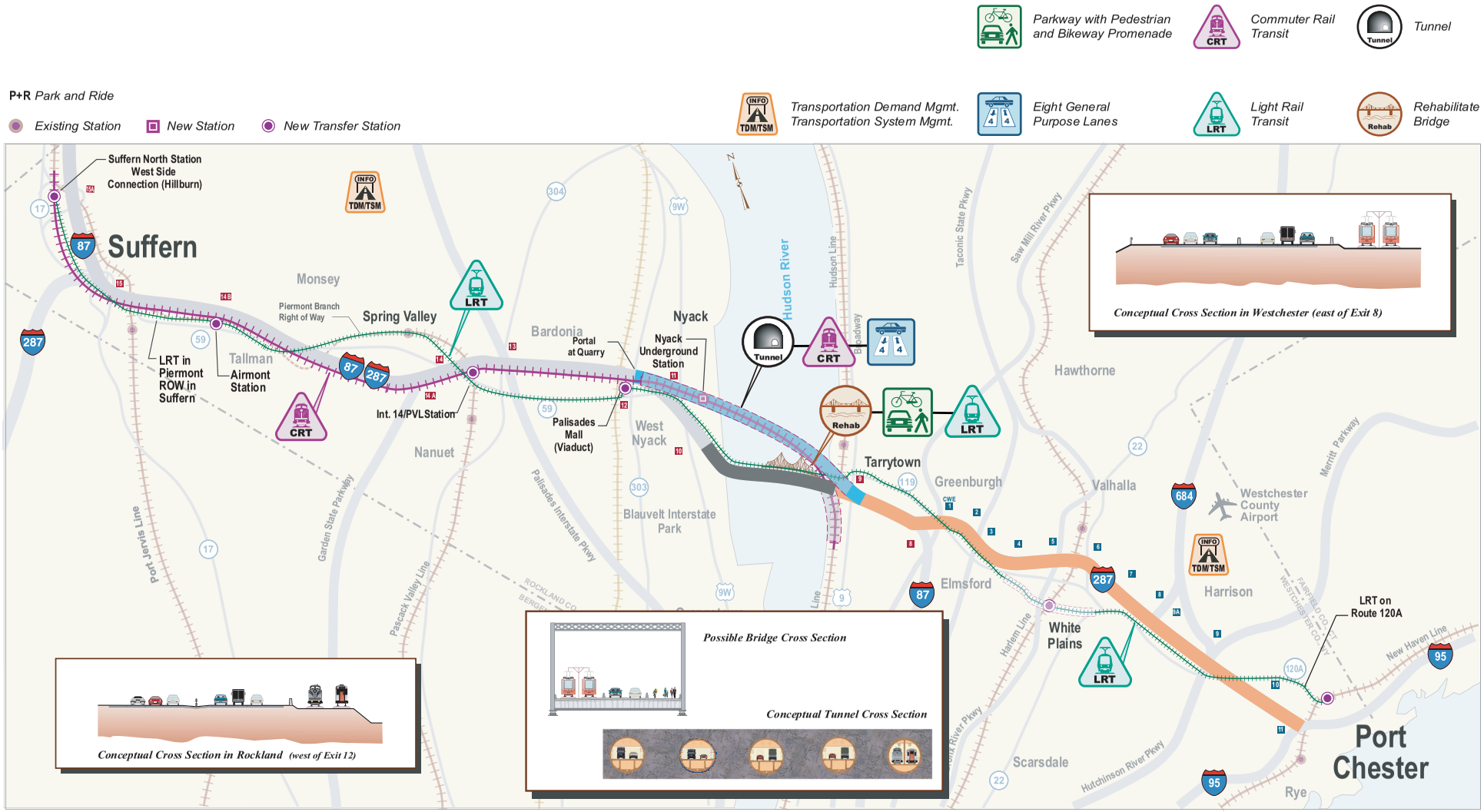
It has been demonstrated that the intensity of maintenance and repair activities will increase as the bridge ages. The impacts on traffic will generally reflect current experience at first. However, during the course of the bridge's extended service life, the frequency and severity of disruptions would be expected to increase as the frequency and extent of needed repairs required by the aging structure increase.

3.2.2 Bridge Rehabilitation

Rehabilitation of the Tappan Zee Bridge was studied under Scenarios H2, M4, and M6. The bridge would be retained and structurally rehabilitated to provide an additional 50 to 100 years of reliable service. The rehabilitation would include the retrofit measures necessary to bring the bridge into compliance with the current seismic criteria, as befits a lifeline structure (Figure 3-41).

Scenario M3 - Bored Tunnel for Highway, Commuter Rail and Buffer-Separated BRT

Figure 3-37

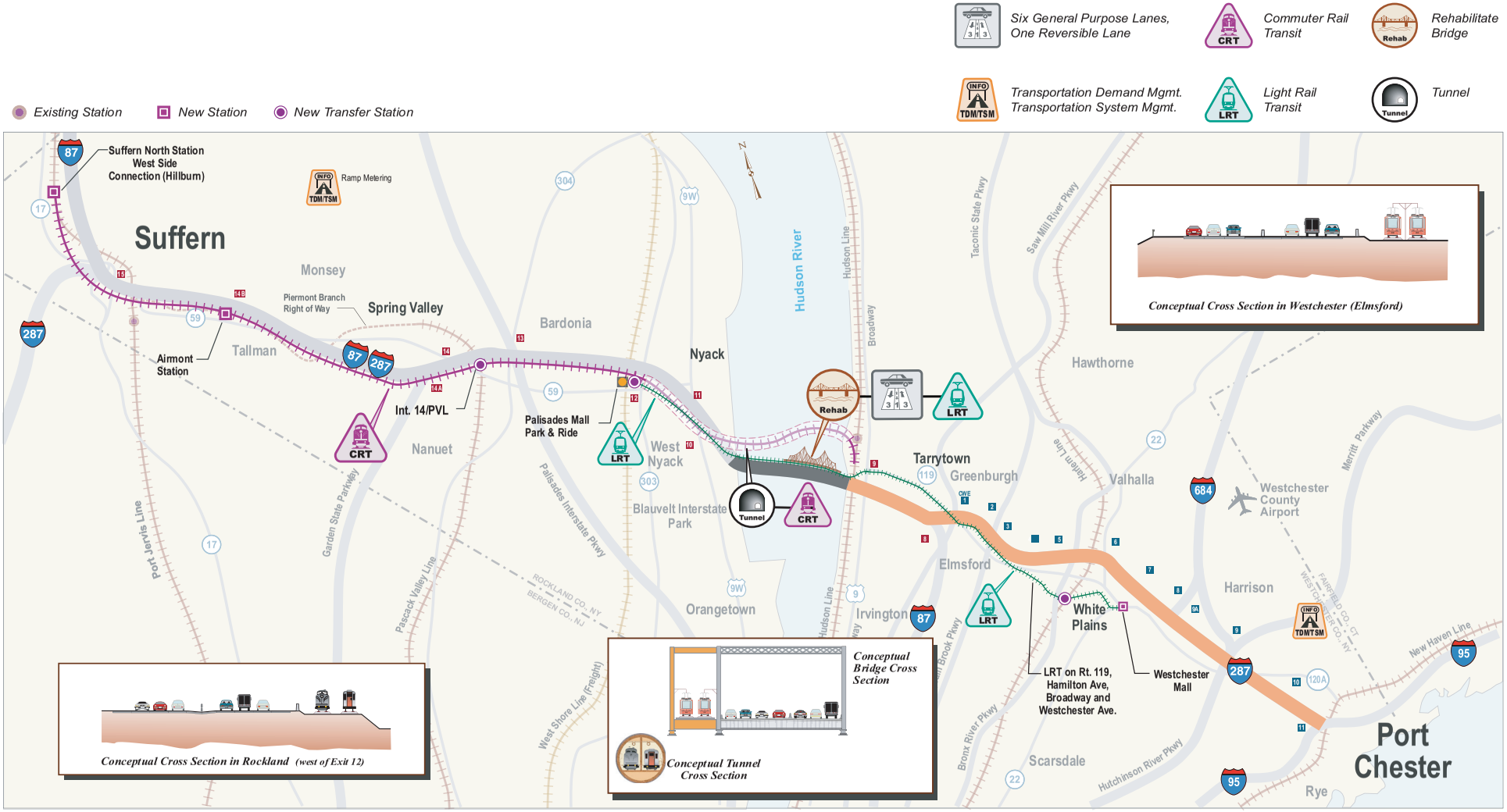


Scenario M4 - Rehabilitate Bridge for Parkway, Full In-Street LRT and Add Supplemental Tunnel for Highway and Commuter Rail

Figure 3-38

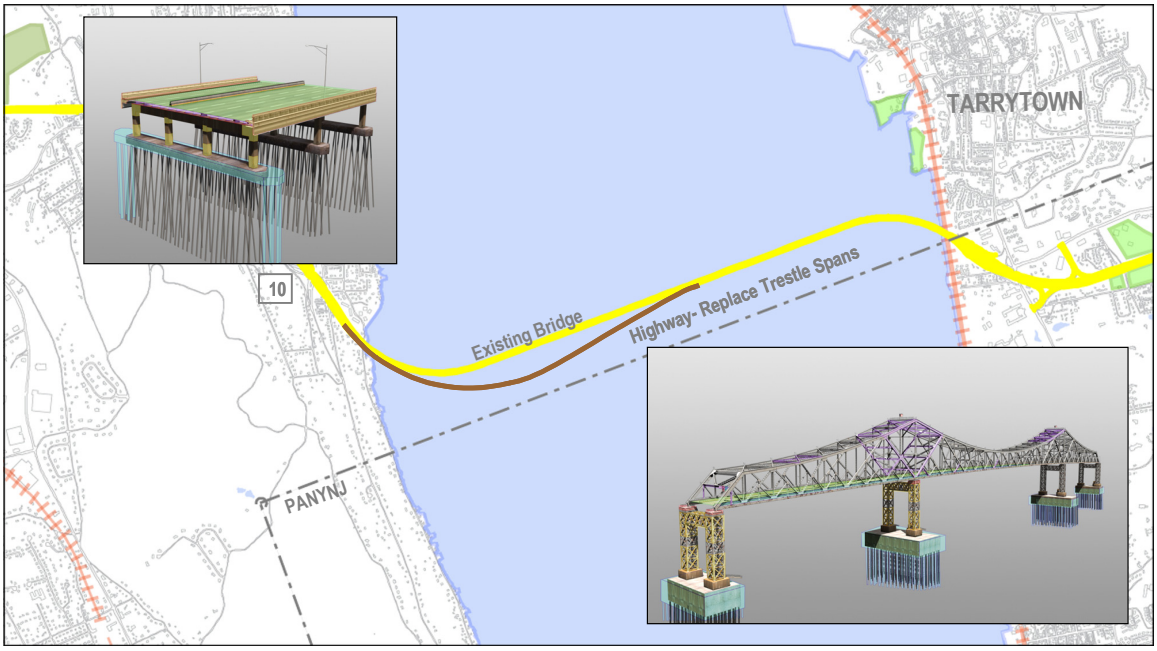
Scenario M5 - Replacement Bridge with Commuter Rail and Full Corridor LRT

Figure 3-39



Scenario M6 - Rehabilitate Bridge and Widen For LRT with Supplemental Tunnel for Commuter Rail

Figure 3-40



Bridge Rehabilitation

Figure 3-41

The seven-lane arrangement would not change, and the current practice of reversing the center lane to serve eastbound traffic in the morning and westbound traffic in the afternoon would continue. New shoulders would not be provided. However, a pedestrian walk would be added on one side, cantilevered from the strengthened structure. In addition, the "safety walks," drainage system, and parapet/fender systems on both edges of the existing roadway would be modified to provide for controlled drainage and to slightly widen the travel way, sufficiently so as to attain 12-foot lanes.

In addition to the work related to preservation that was described above, rehabilitation would include additional measures, such as:

- Strengthening numerous members to meet seismic demands.
- Attaining full composite action in the replacement deck.
- Strengthening of the west trestle pier cap beams.
- Strengthening of some elements to better resist wind.
- Providing auxiliary supports at critical main span pin locations.
- Improving overall structural redundancy.
- Providing additional vessel impact protection near the shipping channel.

The extent of work required along the west trestle, which extends approximately half way across the river, is such that it would be best served by full reconstruction. Given that all seven lanes of traffic are to be in service during peak periods, it would be necessary to widen the trestle temporarily to compensate for any lanes lost to the work zone. In contrast, it is not deemed practical to widen adjacent to the main spans, and any work requiring lane closures would have to be done strategically, during off peak periods, essentially at night.

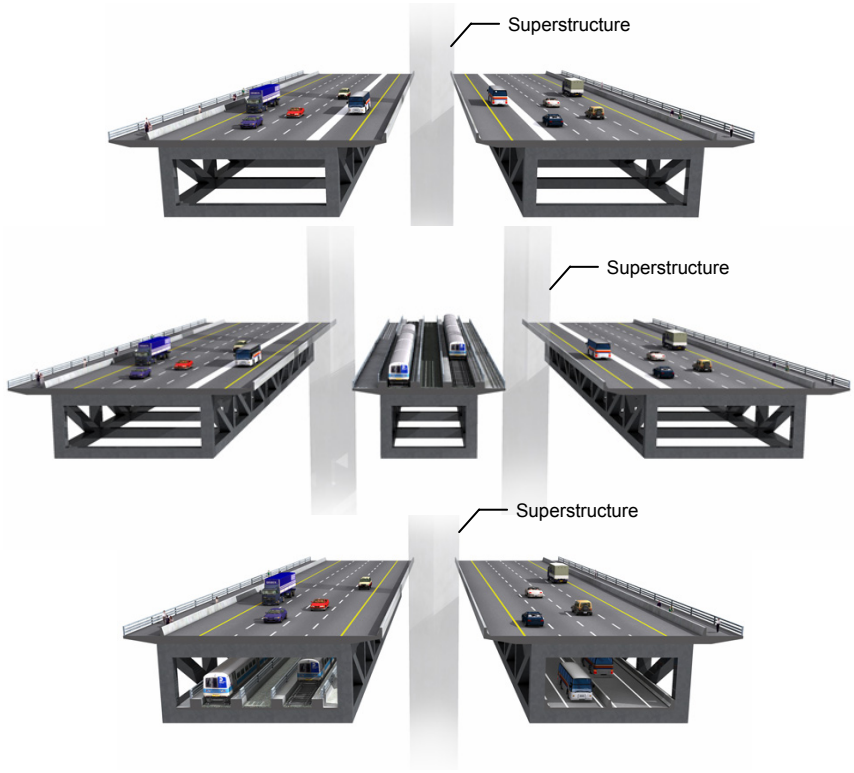
A different approach to west trestle reconstruction was considered under Scenario M6. Given that reconstructing the west trestle in its existing position calls not only for demolishing and rebuilding the

trestle itself, but also for constructing and demolishing a temporary bypass trestle at least four lanes wide, this scenario proposes to build the new trestle to the south of the existing trestle, which would continue to carry traffic. The existing trestle would be removed once the new one is placed in service.

Under Scenario M4, the existing Tappan Zee Bridge would be rehabilitated structurally as described above. However, on the rehabilitated bridge, the space occupied by the existing roadway would be given over to multiple uses: a two track LRT corridor, a parkway dedicated to local access consisting of one lane in each direction, and pedestrian amenities in the remaining space. The west trestle would be reconstructed in the same manner as described above.

3.2.3 Replacement Bridge

A replacement bridge was studied under many scenarios, the principal differences being (1) whether a north or south alignment (relative to the existing bridge) would be followed, (2) the type of transit mode to be carried by the bridge, and (3) whether the bridge would have one or two levels. Figure 3-42 depicts conceptual cross sections of a replacement bridge under several scenarios.



Several Scenarios of Bridge Replacement

Figure 3-42

3.2.3.1 Highway Bridge

As studied under H3, a new highway (only) bridge would be constructed adjacent to the existing Tappan Zee Bridge, which would be demolished upon completion of the new crossing. The new bridge would provide comparable functionality but at a higher level of safety, reliability, durability and operational effectiveness.

Each direction would comprise four 12-foot lanes and 12-foot left and right shoulders, as called for by current highway design standards, separated by a permanent rather than a moveable barrier. This cross section would also maintain the desired continuity with the proposed corridor improvements. In addition, the bridge would include a pedestrian walkway that would connect with pedestrian paths near the river shores. All transportation features would be on one level. The overall width of the bridge would be 170 feet.

The Corridor traverses established, well developed areas. It is particularly important to stay within or close to the available right-of-way. Consequently, the possible alignments for a replacement bridge fall into a narrow range. The alignment for the H3 scenario would run immediately north of the existing bridge. Some scenarios considered an alignment to the immediate south. The north side offers some additional right-of-way near the Rockland shoreline, which would be advantageous during construction.

The profile adopted for H3 emulates that of the existing bridge, skimming over the western portion of the river on a low trestle, and then rising at a grade of 3 percent to crest over the navigation channel. At a minimum, the new bridge would pass over the channel with as much vertical clearance (139 feet) as the existing bridge, and may provide additional clearance in anticipation of future navigational needs. The conceptual profiles assume a vertical clearance of 155 feet. Overall, the profile would be very similar to and slightly higher than that of the existing bridge, with the new abutments falling in the same general vicinity. A more gradual climbing profile would be possible. This potential is explored under the CRT scenarios, which require the flatter grades imposed by commuter rail limitations.

3.2.3.2 CRT Bridge Crossing

A bridge crossing with CRT was studied under Scenarios CRT1 and CRT3. A new two-level bridge would be constructed to carry an eight-lane highway and pedestrian walkway on the upper level and a two-track commuter rail system centered on the lower level. The new bridge would be built to the north (CRT1) or south (CRT3) of the existing Tappan Zee Bridge, which would be demolished. A single-level bridge concept with three separate decks (CRT in the center) was developed after the Level 2 process and is further described in Chapter 7.

The additional level and associated structural depth would add approximately 30 feet to the depth of the structure. CRT systems operate best at flat grades and inefficiently at grades steeper that 2 percent. Consequently a grade of about 1 percent, the flattest attainable, is proposed between the Rockland shore and the navigation channel, and a 2 percent grade or flatter is proposed between the channel and the Westchester shore. The result would be a bridge 30 feet deeper, rising 30 feet above the existing highway at the shorelines and navigation channel, and somewhat higher than that in the western half of the crossing. The added height would shift the Rockland abutment further inland, closer to Broadway.

In Rockland, due to grade limitations, the CRT would approach the bridge in a tunnel, which would align with the lower level at the center of the bridge as it approaches the west abutment. At the Westchester shore, the CRT tracks would enter a tunnel as it curves towards the south beneath the toll plaza. Emergency ventilation housing and shafts would be needed at each of the tunnels.

3.2.3.3 LRT Bridge Crossing

The LRT bridge crossing would be similar to the CRT1 crossing, but with LRT on the lower level. The additional level and associated structural depth would also add approximately 30 feet to the depth of the structure. While LRT systems are able to negotiate steeper grades than commuter rail, the LRT1 and 2 scenarios include a gradual 1.2 percent grade between the Rockland shore and the navigation channel and a 2 percent grade between the channel and the Westchester shore to facilitate the movement of LRT and truck traffic.

3.2.3.4 BRT1 Bridge Crossing

A new bridge would be constructed to carry a new roadway system comprising two BRT/HOT lanes in the center of eight general-purpose highway lanes. The total width would be 200 feet, which would include a pedestrian way in addition to the 10 lanes on a single level. The exclusive busway would require a dedicated ramp at the toll plaza to climb to meet Route 119 to the north. The new bridge would be built to the south of the existing bridge, which would be demolished. Because the existing highway already crowds the southern right-of-way limit at the Rockland shore, leaving little or no additional space for the southern alignment, the two bridges would occupy the same space in this area, requiring a more complicated construction staging plan as compared to the alignments to the north. The profile adopted for BRT1 is similar to that for H3.

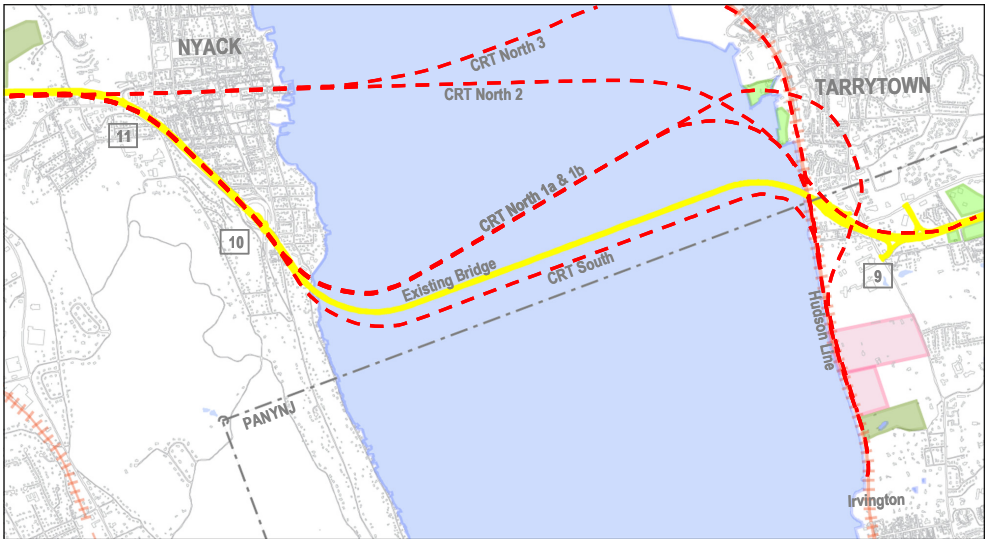
3.2.3.5 BRT2 Bridge Crossing

The BRT2 bridge crossing would be similar to the CRT1 crossing, but with BRT on the lower level. The lower level would accommodate an exclusive busway consisting of two 20-foot-wide roadways (sufficient to permit bypassing of a stopped bus) separated by a center barrier and protected by side parapet barriers. The exclusive busway, which would run along the south side of the Thruway (at essentially the same elevation), would shift to the lower level via a short tunnel that would cross to the center of the bridge beneath the eastbound roadway. At the Westchester shore, the upper level highway profile would meet the existing toll plaza elevation and pass beneath South Broadway. The exclusive busway would require a split tunnel, with one option to climb from the lower level to meet I-287 eastbound and another option to enter a dedicated ramp beneath the bridge that loops down to a new road east of the Hudson Line tracks and connects to Tarrytown Station.

Several other two-level bridge configurations with different mixes of transit modes were examined in Scenarios M1 (BRT on upper level, CRT on lower), M2 (BRT on upper level, LRT on lower), and M5 (LRT and CRT on lower level).

3.2.4 Supplemental CRT Tunnel

A CRT tunnel supplemental to a rehabilitated or replacement bridge was studied under Scenarios CRT2 and M6, respectively (Figure 3-43). As originally conceived in these scenarios, the tunnel would consist of a single circular bore that would carry two tracks in separate compartments divided by a wall. The purpose of the wall would be to provide a means of escape and an isolated refuge in case of smoke and fire. The horizontal clearance required on both sides of both tracks, together with the required services, determine the tunnel's overall diameter, conceptually estimated at 45 feet. However, subsequent analyses have indicated that a single-bore tunnel is not feasible with current technology and that twin-bore tunnels would be required (as explained in detail in Chapter 7).



Alignments for Supplemental CRT Tunnel

Figure 3-43

As a result of grade limitations for the CRT mode and local topographic conditions, the tunnel would begin well inland in Rockland, just east of Route 303. It would follow the I-87/I-287 right-of-way to the shore to minimize the need for underground easements. From there, the alignment would swing northward before heading south to meet the Hudson Line. The alignment would rise from beneath the river to meet the Hudson Line in the shadow of the Tappan Zee Bridge, approximately 100 feet below the bridge. The northward swing would add distance beneficial to the merge into the Hudson Line, which would need to be accomplished prior to reaching Irvington Station. Structures and shafts to house emergency ventilation provisions would be needed on both shores. The northern alignments allowed for a stop at the existing Tarrytown Station.

Other alignments further north under Nyack and to the south of the bridge are possible, and were considered under other scenarios.

Bored tunnel technology would be most suitable under the river, but mining (i.e., controlled drill-and-blast) would be considered at the shores, and cut-and-cover methods would become necessary where the depth of cover becomes too shallow for self-supporting systems. A construction shaft would be required at the interface between the soft riverbed soils and the rocky shore on each side of the river, possibly within the river.

3.2.5 New Highway and CRT Tunnel

A replacement tunnel was studied under Scenarios M3 and M4: M3 included eight highway lanes and provision for BRT lanes and CRT. M4 included eight highway lanes and provision for CRT.

3.2.5.1 Scenario M3

The largest bored tunnels currently being constructed worldwide are in the range of 40 to 45 feet in diameter. Consequently, the eight-lane highway crossing would require four bores, two in each direction, each carrying a pair of lanes and shoulders. The typical bore would include a roadway comprised of two 12-foot lanes, a 4-foot left shoulder, and a 12-foot right shoulder, with provision for 14 feet 6 inches of vertical clearance across the entire roadway and some additional space allowed for horizontal clearance and emergency egress provisions. This would result in an inside diameter conceptually estimated at 45 feet, or an outer diameter of about 48 feet. A comparable circular cross section would also accommodate BRT. The circular configuration would leave space above and below the roadway for ventilation and ancillary facilities (Figure 3-44). It was later determined that twin bores would be required for CRT, as explained in Chapter 7.

Potential Alignments and Cross Section for New Tunnel

Figure 3-44

The soil strength beneath the river must be accounted for in tunnel design. On the basis of a preliminary geotechnical assessment it has been approximated that a minimum spacing of a full tunnel diameter would be required between tunnels to ensure stability. With four highway bores and one BRT bore spaced out in this manner, the overall northern tunnel envelope would be more than 400 feet wide. When joined by the CRT bore under Nyack, the envelope becomes approximately 500 feet wide.

The depth of ground over a tunnel is also important. The minimum vertical embedment requirements are, as for horizontal spacing, a full tunnel diameter. Given the steep topographic conditions at both shores and the maximum allowable grades for a highway (4 percent), the highway and BRT bores would have to be extended through the shore bluffs to portals just west of Interchange 12 in Rockland (in the vicinity of the quarry to the northwest of the interchange) and east of Interchange 9 in Westchester (at the west end of the Talleyrand Swamp wetlands). In this scenario the Westchester portal is placed on the south side of I-287 (M4 would have a north side tunnel portal). The overall length of the tunnel crossing would exceed 6 miles.

Interchanges 9, 10, 11 and 12 would be bypassed and Interchanges 9 and 12 would have to be substantially reconfigured. The existing roadway between Interchanges 12 and 10 would be modified to reconnect them with the new mainline. The remaining distance to Interchange 8 is barely sufficient for traffic to safely align itself with its destination at this major fork, leaving no room for a toll plaza. Consequently the toll plaza would be relocated to the Rockland approach. Substantial ventilation structures would be needed to house ventilation plants at three or four points along the alignment, along with air intake and exhaust shafts, to maintain acceptable air quality within the tunnel and in the area of release and to deal with emergency fire and smoke conditions.

3.2.5.2 Scenario M4

The Thruway would be relocated into a new highway tunnel consisting of four spaced bores that extend past Interchanges 12 and 9, as described for Scenario M3, but along a different alignment. The M4 alignment would take a slightly shorter route well north of the existing bridge, passing more centrally under Nyack and under the river together with the CRT bore. The overall envelope width would exceed 400 feet. The highway would surface in Westchester with a portal in the Talleyrand Swamp on the north side of the existing highway. In other respects the highway tunnel would be the same as described for M3, including the reconfiguration of interchanges, the relocation of the toll plaza to Rockland, and the need for large ventilation structures, construction shafts at the soil/rock transition zones, and the potential for utilizing other tunneling methods at the shore areas. Twin bores would be required for CRT. The M4 alignment under Nyack would provide an opportunity to place an underground station in downtown Nyack, in the vicinity of Main Street and Broadway.

3.3 Level 2 Screening Criteria

Tables 3-5, 3-6, 3-7, and 3-8 summarize the evaluation criteria used in Level 2 screening. Unlike the Level 1 alternative elements, the scenarios developed for Level 2 encompass actions throughout the corridor. As a result, a single set of screening criteria was used for all of the corridor-wide scenarios, and distinctions were not made among the categories of transportation elements as was done for Level 1 screening. The Level 2 screening relied more on quantitative results, in particular, those related to travel demand forecasts.

Table 3-5

Level 2 Transportation Performance Screening Criteria

Screening Criteria	Measurement Methods	Related Goal(s)
Travel Time	Total network person-hours of travel[1]	1
Roadway Congestion	Total corridor highway lane-miles operating at LOS E and F during peak periods (weekday AM/PM, weekend)	1
	Number of interchange and adjacent connecting roadway intersections operating at LOS E or F during peak periods (Weekday AM and PM)	1
Alternative Mode(s) Not in Mixed Traffic	Inclusion of alternative mode(s) operating on roadway/guideway not subject to highway congestion	1,2,6
Mode Split	AM peak period/peak direction travel by transit and ridesharing at selected screenlines	1
	AM peak period/peak direction travel by transit for selected travel markets	1
Transit Ridership	Daily transit riders at key screenlines	1
	Daily transit riders on new and revised transit routes	1
Non-Vehicular Travel	Inclusion of pedestrian and bicycle facilities	1, 2
Support to Efficient Land Development Patterns	Design Year population and employment within ½ mile of transit stations (existing and proposed)	1
Reserve Capacity	Design Year reserve peak period/peak direction person-capacity (weekday and weekend) by all modes at selected screenlines	2
Rail Freight	Rating based on ability to accommodate rail freight	1, 2
Transportation System Integration	Ease of integration with existing transportation network	2,6
Traffic Safety	Judgment based on improvements in roadway geometrics and accident data	4

[1] This measurement method was later changed to a more meaningful measure of travel time. Four trips were selected and travel times for each trip estimated for each alternative.

Table 3-6

Level 2 Engineering Screening Criteria

Screening Criteria	Measurement Methods	Related Goal(s)
Structural and Seismic Integrity	Structural and seismic sufficiency based on degree to which river crossing is brought into compliance with current structural standards	3
Redundancy	The ability to increase reliability of the transportation system via duplication of critical components of the network	4
Emergency Response	Ease of response based on roadway geometry, design, and operations	4
Vulnerability	Assessment based on type and characteristics of structure(s)	4
Navigation	Level of conformance to navigational requirements of the US Coast Guard	5
Construction Impacts	Construction impact severity	5, 6
	Construction impact duration	5, 6

Table 3-7

Level 2 Cost Effectiveness Screening Criteria

Screening Criteria	Measurement Methods	Related Goal(s)
Capital Cost	Capital cost range	6
Operating and Maintenance Costs	Annual operating and maintenance costs by major transportation element	6
Cost-Effectiveness	Cost per vehicle mile, cost per passenger mile, or cost per passenger	6
Phasing Potential	Ability to phase short-term, intermediate, and long-term actions to address problems	6

Table 3-8

Level 2 Environmental Screening Criteria

Screening Criteria	Measurement Methods	Related Goal(s)
Land Use	Consistency with existing land uses	5
	Consistency with adopted land use plans and policies	5
	Potential to provide for "smart growth" opportunities	5
Socioeconomics	Potential for disproportionate impacts on minority and/or low income populations	5
Acquisitions, Displacements, and Relocations	Numbers and types of properties potentially acquired and displacements	5
Historic and Archaeological Resources	Potential for direct and indirect effects on resources listed on the National and State Register of Historic Places and mapped, published historic resources that are eligible for listing.	5
Parklands & Section 4(f)/6(f)	Potential direct effects on parks and 4(f)/6(f) resources	5
Air Quality	Design Year change in regional vehicle miles of travel (VMT)	5
Noise	Generalized assessment of change in noise levels	5
Ecosystems and Water Resources	Potential impacts to I-287 Corridor water quality	5
	Potential impacts to significant I-287 Corridor habitats including habitats of endangered and threatened species	5
	Potential impacts to Hudson River water quality	5
	Potential impacts to significant Hudson River habitats, including habitats of threatened and endangered species	5
Visual Resources and Aesthetics	Visual compatibility assessment	5
Energy	Design Year change in regional vehicle miles of travel (VMT)	5
Contaminated Soils and Groundwater	Total number of contaminated sites potentially directly affected	5
Major Utility Relocations	Impact to transmission lines and associated facilities	5

The Level 2 screening analysis yielded a considerable amount of information including data related to travel demand modeling of the scenarios and other transportation performance criteria:

- Engineering considerations related to structural integrity of the bridge.
- Roadway and track geometry.
- Highway widening and reconstruction considerations.
- Environmental factors.
- Cost.

A large number of possible combinations were tested in the scenarios in an attempt to isolate the interactions between the modes and to address the screening criteria.

Analyses and decision-making were focused in four areas:

- **No build condition**, which provides a baseline for comparison of other scenarios and takes account of all programmed improvements and developments within the study corridor. These would include all highway improvements that are currently shown in the TIP and all population and job growth that NYMTC believes would occur by the time this project is completed. For the Tappan Zee Bridge, it would consist of the replacement of the bridge deck and use of the existing toll plaza with express lanes implemented.

- **Highway elements**, which included consideration of adding general-purpose lanes or BRT/HOT lanes in Rockland County and on the bridge and westbound and eastbound climbing lanes where needed in Rockland County.

- **Transit elements,** which considered a range of full corridor, circumferential, and radial facilities. They included a variety of transit service options such as one-seat connections between Orange/Rockland and Westchester/Connecticut, and Manhattan, and transfer connections.

- **River crossing elements**, which included the scenarios of maintaining and rehabilitating the existing bridge, replacing it with a new bridge, or replacing it with a tunnel that would carry both the highway and commuter rail under the river. Construction of a supplemental tunnel exclusively for CRT with highway and other transit modes (if any) on a new or rehabilitated bridge was also considered.

The discussion in Chapters 4, 5, 6, and 7 highlights the trade-offs among the principal elements contained in the scenarios as evaluated against relevant criteria. Not all criteria had an impact on the decision-making process.


NYACK
HUDSON RIVER
TARRYTOWN
WHITE PLAINS
PORT CHESTER