6 Level 2 Screening Results – Transit Scenarios

This chapter describes the procedures used to develop the transit elements of the alternatives to be carried forward into the DEIS. As the analyses progressed, a two-step decision-making process emerged. The process began with an evaluation of the transit elements of the 16 scenarios in terms of transportation performance, alignment issues, and environmental considerations (Subchapter 6.1).

After these initial evaluations, it became apparent that seven refined versions of the 16 scenarios (called "modal options") offered the most potential transportation benefits in the corridor (Subchapter 6.2). Four of these modal options were essentially unchanged from comparable scenarios, while three were substantially new combinations of modes. These modal options were then assessed using the transportation performance criteria as well as cost-effectiveness. One result of these refinements is that headways, travel times and forecast volumes were changed from the original scenarios.

Finally, the potential for rail freight operations in the corridor was analyzed (Subchapter 6.3).

6.1 Preliminary Evaluation of Transit Scenarios

The scenarios allowed for the study of both transit modal choices and transit alignment choices. Transit elements were considered in many of the 15 scenarios (BRT1, BRT2, LRT1, CRT1, CRT2, CRT3) and in six multi-modal scenarios (M1 through M6). An additional scenario (LRT2) was created to facilitate the study of in-street LRT. There was much overlap among both the CRT scenarios and the multi-modal scenarios, so that only one representative of each is described in this analysis. Transit elements were evaluated using three categories of criteria:

- Transportation performance.
- Routing and alignment factors (including the environmental impacts of those choices).
- Cost and cost-effectiveness measured in terms of costs per passenger and costs per passenger-mile.

6.1.1 Transportation Performance

The existing and future travel market in the corridor has two general components:

- The circumferential market consisting of a myriad of origins and destinations running from northern New Jersey and the mid-Hudson Valley, across Rockland and Westchester Counties and on to Connecticut.
- Manhattan-bound trips originating west of the river in Rockland and Orange Counties.

The extent to which each scenario would serve these two changing market components is best understood through a discussion of the following:

- Daily ridership on new transit services for both cross-corridor and Manhattan-bound markets, as well as the overall transit market share.

- Corridor mobility in terms of roadway congestion, travel time for selected origin/destination pairs, exclusive rights-of-way, and reserve capacity to accommodate growth beyond the study years.

- Transportation system integration, or how the new service integrates with the existing transportation system, including Metro-North's five existing radial lines and NJTransit lines in Rockland.

- Potential to support efficient transit-oriented land development (or "smart growth") and to minimize sprawl.

- Ability to meet changing needs, including changing travel destinations, dependability requirements and energy conservation.

In terms of these criteria, results for the cross-corridor markets were varied, with some components better served by the more locally oriented LRT or BRT modes, while longer-distance trips (such as Rockland to Stamford) were better served by CRT. The Manhattan-bound markets, taking advantage of the extensive existing infrastructure, were clearly best served by CRT.

6.1.1.1 Transit Ridership and Market Share

The BPM was used to simulate each scenario and to forecast total daily transit ridership in the major transit markets found in the corridor (this includes ridership on both the new services studied here and on existing transit routes in the corridor). As described in Subchapter 4.1, the BPM was run in this stage for a base year of 1996, for a 2025 No-Build scenario, as well as 2025 Build scenarios. The BPM ridership results are shown in Table 6-1. In the 2025 No Build scenario, transit in the corridor would carry about 104,000 passengers daily, a 76 percent increase over 1996 ridership. In the scenarios with the greatest potential to raise corridor-wide transit use (in this case, CRT1), 120,000 passengers would use transit in 2025 – representing an increase of 16,000 new daily transit trips, or 16 percent, compared to the No Build scenario. Other scenarios generate anywhere from 500 to 11,000 new trips.

Table 6-2 shows daily ridership specifically using the **new transit modes** in the Level 2 scenarios. The flow diagrams in Figures 6-1 through 6-6 illustrate this daily ridership for different segments of the new service – cross-corridor (trans-Hudson), intra-Rockland, Connecticut-Westchester (including intra-Westchester), and Orange/Rockland-New York City.

BRT2 would attract the most trips in the cross-corridor market due to the flexibility of service and the greatest number of trip pairs that can be served without transfers. As shown in Figures 6-1 through 6-6, BRT2 also incorporates more of the existing transit services in the corridor.

LRT1, LRT2, and BRT2 outperform CRT1 in Westchester County with respect to the intra-county markets, since these modes are better suited to serve local trips, providing better access to population centers and offering more frequent service. In Rockland County, LRT1 attracts the fewest intra-Rockland trips because of its alignment away from population centers and its lack of a one-seat ride to Manhattan.

Table 6-1

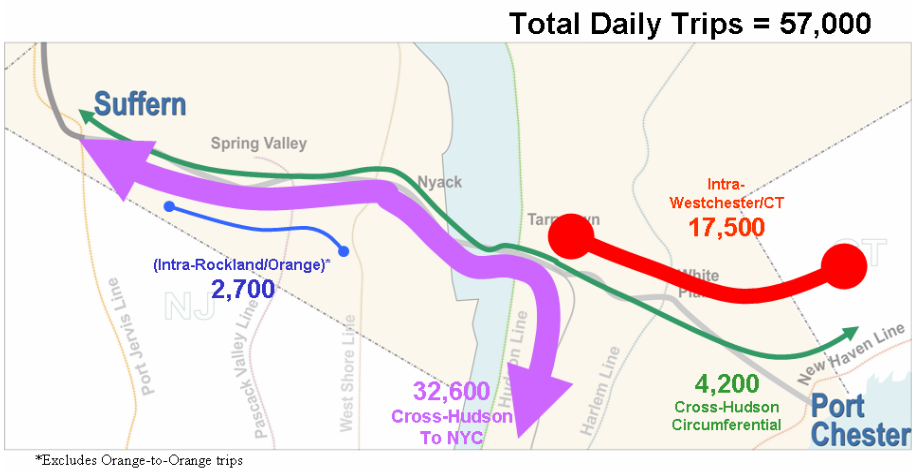
Total Daily Transit Ridership for Major Markets Found in Corridor by Scenario

Market	1996 Existing	Scenario (Year 2025)						
		2025 No Build	Full-Corridor CRT (CRT1)	High-Speed Light Rail (LRT1)	In-Street Light Rail (LRT2)	HOT Lanes (BRT1)	Exclusive Busway (BRT2)	Manhattan-bound CRT and LRT2 (M5)
Total Selected Transit Markets	59,100	104,200	120,500	106,300	107,800	104,700	111,900	115,500
New York City-Bound Transit Markets	24,400	46,300	56,700	44,000	45,700	46,300	43,000	52,000
Cross-Corridor Transit Markets	34,700	57,900	63,800	62,300	62,100	58,400	68,900	63,500
Notes: As a result of the variable trip table used in BPM, in the scenarios without direct Manhattan-bound rail (LRT and BRT), the new cross-corridor service would decrease the relative attractiveness of Manhattan.								

Table 6-2

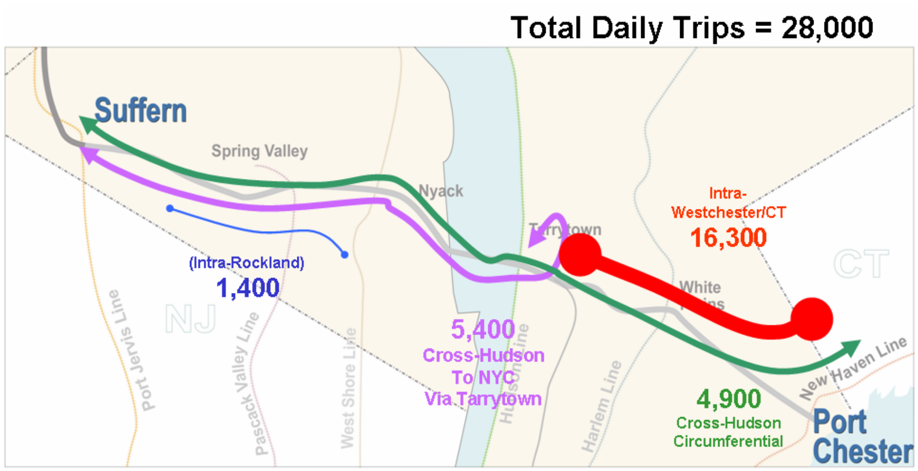
Daily Ridership on New Transit Service by Scenario

Market	Scenario (Year 2025)					
	Full-Corridor Commuter Rail (CRT1)	High-Speed Light Rail (LRT1)	In-Street Light Rail (LRT2)	HOT Lanes (BRT1)	Exclusive Busway (BRT2)	Manhattan-Bound CRT and LRT2 (M5)
Total Riders	57,000	28,000	29,700	6,100	49,000	55,400
% Diverted/New	71/29	91/9	88/12	92/8	84/16	80/20%
Cross-Corridor	24,400	22,600	24,600	3,300	42,000	27,400
New York City-Bound	32,600	5,400	5,100	2,800	7,000	28,000
Note: Diverted riders are those who would otherwise use other transit services (such as buses or the Port Jervis, Pascack Valley, or Hudson Lines) in the No Build condition.						



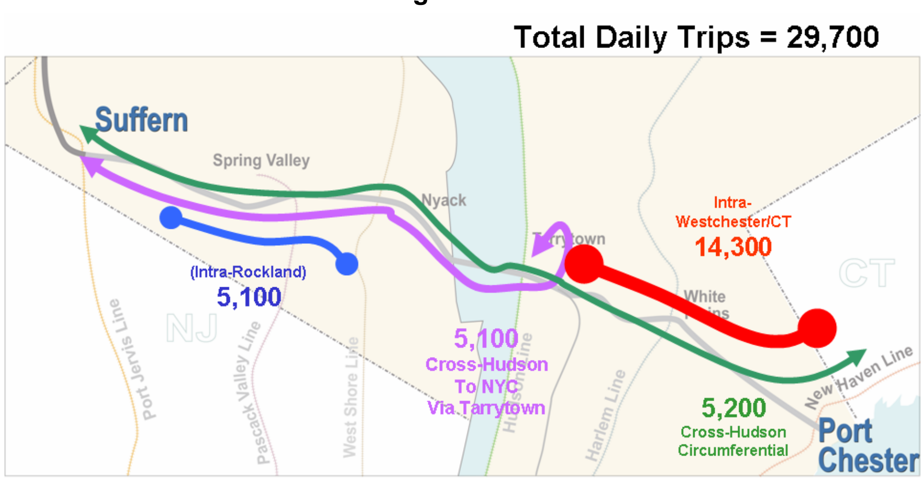
Daily Ridership on New Commuter Rail Transit Service (CRT1)

Figure 6-1



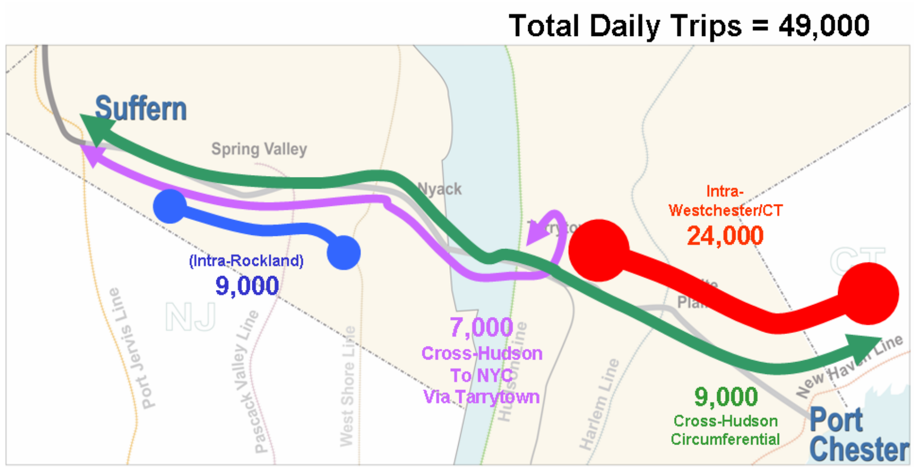
Daily Ridership on New High Speed Light Rail Transit Service (LRT1)

Figure 6-2



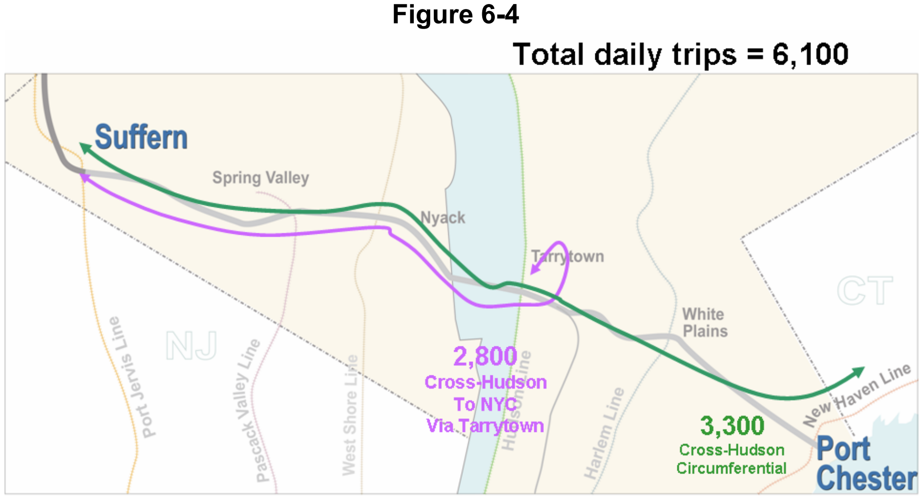
Daily Ridership on New In-Street Light Rail Transit Service (LRT2)

Figure 6-3



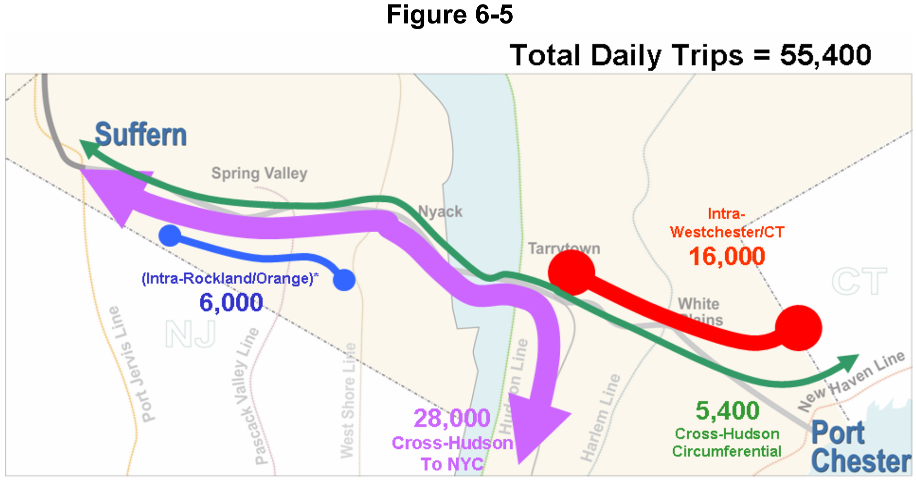
Daily Ridership on New Exclusive Busway Transit Service (BRT1)

Figure 6-4



Daily Ridership on New Exclusive Busway Transit Service (BRT2)

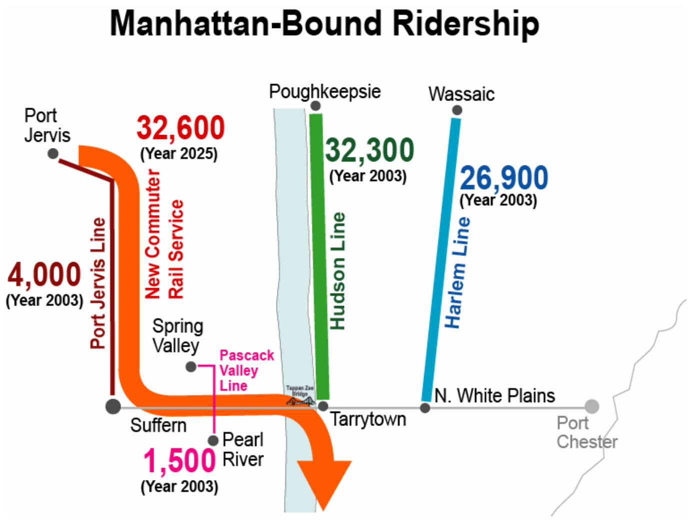
Figure 6-5



*Excludes Orange-to-Orange trips

Daily Ridership on Manhattan-Bound CRT and LRT2 Transit Service (M5)

Figure 6-6



Daily Ridership Forecasts
New Manhattan-Bound CRT Service vs. Current Ridership

Figure 6-7

CRT1 has more ridership for long-haul work trips, particularly to New York City, and attracts more new transit riders as compared to the other modes. Manhattan-bound commuter rail would attract about 32,600 daily riders, which is comparable to today's ridership on the Harlem Line (north of North White Plains) and the Hudson Line (north of Tarrytown), as shown in Figure 6-7. CRT1 also performs best in serving the Connecticut-to-Westchester market, as that is largely composed of long-haul trips.

M5 shows ridership numbers similar to CRT1, but with slightly higher cross-corridor ridership, due mainly to the presence of two transit lines running across Rockland County. This extensive service tends to slightly suppress the number of trips to New York City, because some Rockland and Orange residents would choose to work in areas served by the extra cross-corridor service instead of in New York City.

The relatively slow travel times and transfer requirements of the LRT and BRT modes factor into the low Manhattan-bound ridership. BRT1, as defined, would be ineffective in attracting a large number of daily riders. This is due to the longer travel times that would result from buses operating in mixed traffic in Westchester County and the lack of a good connection to Tarrytown Station for Manhattan-bound commuters. Moreover, as configured, BRT1 offers no new intra-Rockland or intra-Westchester service.

Each of the scenarios would divert a large number of riders from the transit services that currently exist in the corridor. About half of the riders diverted from transit onto the new Manhattan-bound service would be from Metro-North services (both east- and west-of-Hudson) and half from buses.

Table 6-3 presents the percentage of people who would take transit in selected representative markets. This table illustrates patterns among scenarios similar to those revealed in the ridership tables: CRT1 attracts the most riders in Manhattan-bound markets, while BRT2 shows the greatest potential for mode shifts in cross-corridor markets.

Metro-North's current east-of-Hudson market share for peak period trips to Manhattan from Orange and Rockland Counties is currently about 10 to 15 percent (on the Port Jervis, Pascack Valley, and Hudson Lines) compared to 78 percent for east-of-Hudson counties (on the Hudson, Harlem, and New Haven

Lines). With the opening of the Secaucus Transfer, the market share for Orange and Rockland County rail riders has increased. It is expected to reach 50 percent by 2025 (No Build).

Table 6-3

Percentage of Overall Transit (Bus and Rail) Market Share by Scenario

Market	1996 Existing %	Percentage by Scenario (Year 2025)						
		No Build	Full-Corridor CRT (CRT1)	High-Speed Light Rail (LRT1)	In-Street Light Rail (LRT2)	HOT Lanes (BRT1)	Exclusive Busway (BRT2)	Manhattan-bound CRT and LRT2 (M5)
Orange/Rockland to White Plains	3	3	5	5	5	4	6	5
CT to White Plains	20	21	25	22	22	21	27	23
Orange/Rockland to Manhattan CBD (south of 60th Street)	64	71	78	74	73	71	72	78

CRT1 would significantly increase the transit market share due to the line's ability to handle future growth and its convenience for most travelers in the east-of-Hudson market. The 78 percent transit market share with new Manhattan-bound service for Orange/Rockland commuters represents a significant increase compared to No Build conditions (71 percent). The portion of the market specifically on rail would, of course, also rise, from 50 percent in the No Build to 62 percent in CRT1.

In the cross-corridor and intra-county markets, the transit market share would be comparatively low under all of the scenarios, due to the dispersed nature of the trips (and the readily available parking). In a market with multiple origins and multiple destinations, it is difficult for transit to achieve high market penetration. For example, in the Orange/Rockland-to-White Plains market only 3 percent would take transit in the No Build. However, although comparatively low, all of the build scenarios do show improved market share, rising up to 6 percent in BRT2.

Among the cross-corridor markets, the Connecticut-to-White Plains market currently shows the highest transit shares, due mainly to the established transit-oriented development along the New Haven Line. The largest increases in transit share would be found in BRT2 and CRT1, both of which provide one-seat rides between Stamford and White Plains. Both LRT alternatives would require a transfer at Port Chester between the New Haven Line and the new LRT, and BRT1 does not serve this market at all; therefore, these scenarios show only minor increases in market share.

6.1.1.2 Corridor Mobility

The west-of-Hudson transit service in the existing and future No Build condition (which includes numerous planned and budgeted improvements) has limited ability to meet current and future needs for west-of-Hudson customers. Severe limitations such as capacity constraints at Hoboken terminal, low track speeds, and numerous grade crossings hamper the ability of the Port Jervis and Pascack Valley Lines to accommodate future growth, improve current levels of service, and improve reliability. The Trans-Hudson Express (THE Tunnel) project, currently in the EIS phase, would increase capacity to Manhattan with the construction of a new rail tunnel and station below 34th Street between 7th and 8th Avenues, but the speed and grade crossing limitations through New Jersey and New York (for the Pascack Valley Line) and the inability to expand Woodbine Yard, would not be alleviated.

Aspects of corridor mobility discussed here include consideration of roadway congestion, travel time, alternative modes not in mixed traffic, and reserve capacity.

Roadway Congestion

The transit scenarios would attract new transit customers and lead to reductions in regional vehicle-miles traveled (VMT), though as more fully described below, the congestion benefits within the corridor itself would be limited. Again, based on from BPM runs, CRT1 would have the greatest impact on VMT, removing about 12,000 trips per day from the region's roadways and reducing regional VMT by as much as 375,000 miles compared to No Build conditions (0.1 percent reduction of regional VMT[1]).

Within the corridor, using BPM results as inputs to Synchro (a traffic analysis package), it was determined that CRT1 would alleviate traffic within the village of Tarrytown. The main traffic benefit would be the elimination of the need for west of Hudson commuters to cross the Hudson River into Tarrytown by car or bus and then travel from the bridge to the Tarrytown Station. In addition, the new station locations would be more accessible to the regional highway system. Traffic would also be reduced in the vicinity of existing stations such as Nanuet and Spring Valley, as customers would divert to the new stations at the Palisades Center Mall or Interchange 14/Pascack Valley Line.

Based on BPM runs and Highway Capacity Software, significant congestion reduction on the Thruway itself would not occur under any of the transit alternatives. These results are attributable to the variable trip table contained in the BPM and the capacity-constrained highway network. For each scenario, the BPM creates a new "trip table" by which it estimates the number of trips from every origin to every destination, depending mainly on the time and cost between each possible pair. In a congested regional environment, any local improvements in highway flows would lower the time and costs for trips in the corridor, thus drawing new trips into the area from more congested areas. This effectively spreads out that improvement across the wider region but dilutes the local benefit. Thus, while transit would attract customers who would otherwise drive and free up a certain amount of local highway capacity in the short-term, this capacity would subsequently tend to get refilled. As shown in Table 6-4, transit improvements would not lead to significant improvements in LOS on the mainline (note that some improvements are shown in Rockland, but these are mostly attributable to the benefits of a new eight-lane bridge with full shoulders).

The transit alternatives, however, particularly those not subject to roadway congestion, would improve mobility in the corridor by providing a fast and dependable alternative to driving previously unavailable for many travelers in the corridor. Transit would significantly increase throughput capacity in the corridor, accommodate future growth, support the economic success of the area, and reduce travel times for users of the new system.

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[1] Reductions in VMT would also lead to improvements in regional air quality. While such reductions would be greatest for CRT, they would be expected to improve under all transit options. Similarly energy savings under CRT and LRT would result from diversions of automobiles and buses to rail transit.

Table 6-4
Estimated Main Line Vehicle Volumes/LOS – Year 2025

Expressway Segment	Eastbound AM Peak Hour			Westbound PM Peak Hour		
	No Build (H1)[1]	Transit without Highway Widening[3]	Transit with Highway Widening[4]	No Build (H1)[1]	Transit without Highway Widening[3]	Transit with Highway Widening[4]
Int 15 (Rte 17) – Int 14A (GSP)	4800 D	5200 D	5800 C	7200 F	7200 F	8000 E
Int 14A (GSP) – Int 14 (Rte 59)	5000 D	5200 D	6000 C	6700 F	6900 F	8500 E
Int 14 (Rte 59) – Int 13 (PIP)	4400 F[2]	4600 C	5800 C	6300 E	6700 F	9000 D
Int 13 (PIP) – Int 12 (Rte. 303)	5000 F[2]	5300 D	6300 D	7300 F	7800 F	9700 E
Int 12 (Rte 303) – Int 11 (Rte 9W, Nyack)	5400 F[2]	5700 E	6600 D	7100 F	7600 F	9000 D
Int 11(Rte 9W, Nyack) – Int 10 (Rte 9W, S. Nyack)	7200 F[2]	7600 D	8200 F[2]	7100 D	7800 E	8800 D
Int 10 (Rte 9W) – TZB	8800 F	9100 F	9500 F	8100 F	9000 F	9500 F
TZB – Int 8	7800 E	8200 F	8500 F	6300 F[2]	6900 F[2]	7600 F[2]
Exit 2 (Rte 9A) – Exit 3 (Sprain Brook)	5200 E	5500 E	5600 E	5800 F	5900 F	5900 F
Exit 4 (Rte. 100A) – Exit 5 (Rte. 100)	6800 D	7000 D	6900 D	6300 F	6400 F	6500 F
Exit 7 (CWP) – Exit 8W (Rt. 127)	6800 F	7000 F	7000 F	6000 F	5600 E	5700 E
Exit 9 (HRP) – Exit 10 (Rt. 120)	4500 D	4500 D	4500 D	4200 D	4400 D	4300 D

1. 2025 No Build was estimated based on 1996 counts, the year to which BPM is calibrated. Recent 2004 counts indicate that in the AM peak congestion may be underestimated and in the PM peak overestimated in the western portion of the Rockland corridor.
2. LOS F is caused by queues from bridge, not volume on segment itself.
3. Results are based on model run for CRT1, which contained transit without highway widening but with a new bridge.
4. Results are based on model runs for CRT3 and BRT2, which included the H3 highway improvements.

Note: Due to the variable trip table in the BPM, transportation improvements draw more people into the corridor. This tends to dampen the speed and level-of-service improvements in the highway network (though increases the number of people that would accrue benefits).

Travel Time

Table 6-5 contains travel times for selected origin and destination pairs for each modal choice for all transit users. Each of the transit scenarios would provide significant travel time savings over No Build transit travel time for the Suffern-White Plains trip, saving between 50 and 75 minutes on the trip.

LRT1 and BRT2 would have comparable travel times across the corridor. LRT2 would be considerably slower than the other transit modes due to the additional station stops, slower speeds operating along roadways with at grade crossings, and its more circuitous route. In addition, LRT2 would be subject to roadway conditions and would be less reliable.

Travel time between Stamford and White Plains (via the existing I-Bus) is projected to increase by 20 minutes from 1996 to the 2025 No Build as a result of increased congestion from future growth, which will lead to increased congestion on area highways. Under both CRT1 and BRT2, travel times would return to today's levels; compared to future No Build conditions, these modes would therefore save 20 minutes on the trip in 2025. Furthermore, due to their exclusive rights-of-way, CRT1 and BRT2 would be more reliable than the existing I-Bus.

Currently there is no direct rail service to Grand Central Terminal in east Midtown Manhattan (where the majority of Midtown Manhattan jobs are found) for west-of-Hudson commuters. Rail service on the Port Jervis and Pascack Valley Lines is a two-seat ride (via a transfer at Secaucus) to Penn Station on Manhattan's west side. Walk time between the two terminals adds approximately 20 minutes; the subway would take about 15 minutes, on average.

Manhattan-bound CRT would significantly improve travel time to Manhattan (by 32 minutes) for those in the central Rockland area (e.g., the Spring Valley-Manhattan trip). Currently, travel time to Manhattan on the single-track Pascack Valley Line is long because of the transfer at Secaucus and rail infrastructure constraints, which restrict speeds and limit the schedule to local service. While the difference in travel times for the Suffern-to-Manhattan trip would not be as significant (the new service would be 4 minutes faster to Grand Central Terminal than the existing line/No Build condition to Penn Station), the new service would provide a one-seat ride to Grand Central Terminal.

Alternative Modes Not in Mixed Traffic

CRT1, LRT1, and the Rockland portions of BRT1 and BRT2 would provide alternative modes of travel not in mixed traffic. In-street LRT and BRT1 in Westchester would be subject to mixed traffic and delays related to roadway conditions.

Reserve Capacity

Commuter rail, as compared to light rail and bus rapid transit, would offer the most reserve capacity to capture growth in travel beyond the horizon year for this study (2025). Commuter rail can operate at 2-minute headways (or 30 trains per hour) and carry up to 1,000 people per train per direction. The carrying capacity of commuter rail in the corridor, therefore, is 30,000 people per hour per direction, as compared to the 7,000 directional peak hour capacity of the current Tappan Zee Bridge. By comparison, seating capacity on light rail is 560 for a four-car system (with standees) and 50 for a bus (without standees). Thus, the amount of reserve capacity offered by these modes is considerably less, at 16,800 people per hour for light rail (assuming 2-minute headways) and 9,000 people per hour for buses (assuming 20-second headways).

Table 6-5

Travel Time by Transit Mode for Selected Trips by Scenario

Trip	Travel Time in Minutes							
	2004 (Transit)	Scenario (Year 2025)						
		No Build (Transit)	Full-Corridor Commuter Rail (CRT1)	High-Speed Light Rail (LRT1)	In-Street Light Rail (LRT2)	HOT Lanes (BRT1)	Exclusive Busway (BRT2)	Manhattan-Bound CRT and LRT2 (M5)
Suffern to White Plains	70[1]	104	30	37	54	47	38	54
Stamford to White Plains	31[2]	50	29	35[b]	37[b]	50[c]	30[c]	37[b]
Spring Valley to Manhattan	78 (to PSNY)[4,5]	78 (to PSNY)[4,5]	46 (to GCT)	58 (to GCT)[a]	72 (to GCT)[a]	62 (to GCT)	58 (to GCT)	46 (to GCT)
Suffern to Manhattan	55 (to PSNY)[3,5]	55 (to PSNY)[3,5]	51 (to GCT)	69 (to GCT)[a]	87 (to GCT)[a]	79 (to GCT)[a]	69 (to GCT)[a]	51 (to GCT)

Note:
This table represents a sample of the travel times for selected O-D pairs used in the BPM to estimate travel demand forecasts.

Assumptions:
Run times are based on service plans developed for CRT, LRT, and BRT. HOT lanes would be priced to maintain speeds up to 55 mph. Connection to the existing Tarrytown station is not included in the Suffern-to-White Plains travel times. A 5-minute transfer and wait time was added to all trips that require a transfer.

a. Transfer to the Hudson Line at Tarrytown.
b. Transfer to the New Haven Line at Port Chester.
c. Buses in mixed traffic between Port Chester and Stamford.

Sources:
1. Suffern to White Plains – Rockland County bus schedule effective February 23, 2004.
2. Stamford to White Plains – I-Bus effective January 4, 2004.
3. Port Jervis, Suffern to Penn Station – Main/Bergen County Line schedule effective December14, 2003.
4. Nanuet to Penn Station – Pascack Valley Line schedule effective February 15, 2004.
5. Tarrytown to Grand Central Terminal – Hudson Line schedule effective April 27, 2003.

6.1.1.3 Transportation System Integration

With regard to the ability of the new service to integrate with the existing transportation system, CRT1 would:

- Be fully compatible with existing Metro-North/NJTransit service.
- Connect all five north-south rail lines.
- Permit one-seat rides for several travel markets in the corridor (i.e., Rockland/Orange-Manhattan, Connecticut-White Plains, cross-corridor).
- Connect the west-of-Hudson service with the Hudson Line, which would improve customer utilization of the railroad, accommodate new trip patterns, and create opportunities for more flexible operations.

  The Hudson Line has become a key regional transit link connecting five counties (Dutchess, Putnam, Westchester, Bronx, and Manhattan) and providing direct service for Orange and Rockland residents to Grand Central Terminal for those who drive or take the bus to the Tarrytown station (as well as to Beacon via car or ferry, and Ossining by ferry. By comparison to the capacity, speed, and service constraints on the Port Jervis Line and Pascack Valley Line, Metro-North's Hudson Line has four tracks; a modern infrastructure (signals, power, track, etc.); and high-speed, frequent peak and off-peak/weekend service to Grand Central. It is within Metro-North's ability to expand, improve, and handle future increase in demand on the Hudson Line.
- Offer multiple transit choices to Manhattan depending on destination (i.e., lower Manhattan via Hoboken/PATH/ferry or commuter rail and subway; Midtown West via Secaucus; Midtown East via proposed TZB/trans-Hudson service).
- Provide both access to employment centers and shopping areas east of the Hudson and opportunities to travel to Westchester destinations.
- Allow Metro-North to have full control over the commuter rail system, eliminating the need to coordinate with multiple operators, and improving the flexibility of service.
- Avoid the problems of congestion and limited capacity on Main/Bergen Lines and at the Hoboken Terminal.
- Support rail access to Stewart Airport in the event that a direct connection is provided to the airport property from the Port Jervis Line (a project that has independent utility and is currently being studied separately from this project).

BRT1 and BRT2 would provide some of the above advantages, and would:

- Serve 10 to 13 existing bus lines, the only transit mode currently available for cross-corridor service.
- Provide a one-seat ride for the Connecticut-Westchester market.

- Connect the most origin-destination pairs with a one-seat ride.

LRT1 and LRT2 would also connect all five north-south rail lines but would require transfers for nearly all trips (most notably for trips ending or beginning west of Suffern, east of Port Chester, or New York City), and introduce a new system not currently in operation in the corridor. Whereas CRT1, BRT1, and BRT2 would take advantage of established infrastructure, system administration, and operations capabilities, the light rail scenarios would require all new infrastructure and management organization. Like BRT, it would better serve local markets. The busway and light rail alignments would not preclude the future construction of commuter rail.

6.1.1.4 Support to Efficient Land Development

Land development issues will be explored in the DEIS as they relate to potential transit routes and station locations. Many communities that have successfully introduced rail options have also implemented supporting land use and policy development. Rail transit is seldom successful in the absence of strategic policies and development initiatives to reinforce transit-supportive density and development patterns. Such policies may include infill development projects, higher land use densities in proximity to transit services, and encouragement of mixed-use, transit-oriented developments. It is beyond the purview of NYSTA or Metro-North to implement any such changes in land use, so close coordination with local planning agencies will be necessary to take full advantage of rail transit's land use benefits

Fixed-rail systems have the greatest potential to support such "smart growth". Transit stations can become focal points for economic and social activities. Light rail and commuter rail can channel new population and employment growth to higher density station areas, thereby preserving open space and creating more livable communities. Depending on the amount of local support for light rail and/or commuter rail, and on the transit-oriented development initiatives undertaken by municipalities, demand for light rail and commuter rail could increase significantly over the forecasts shown in this report. (However, it should be emphasized that the ridership for all scenarios was based on a single 2025 land use forecast without transit oriented development).

Because it has the largest passenger capacity, commuter rail has the potential for the highest-intensity development at stations, although it calls for fewer stations than light rail. Because commuter rail would reach directly into Orange County, it has the best potential to curb suburban sprawl in the high residential growth areas of Rockland and Orange Counties. Manhattan-bound commuter rail would bring west-of-Hudson customers to east Midtown Manhattan (Grand Central Terminal), where there is a rich job market (as described in Subchapter 4.3). Similarly, with one-seat connections to the Hudson and New Haven Lines, CRT would create the most connectivity between employment centers such as east Midtown Manhattan, Suffern, White Plains, Greenwich, and Stamford. This connectivity would serve to strengthen those commercial centers.

Light rail has also been shown to have been a major spur to higher-density development, notably with the Hudson-Bergen Light Rail in New Jersey.

Outside studies have been inconclusive on bus rapid transit's impacts on land use and economic development along its corridors. Bus rapid transit has the potential to distinguish itself from the poor image of regular bus service; however, its desirability is not as strong as that of light rail or commuter rail.. While BRT has the potential to distinguish itself from the poor image of regular bus service, it is less likely to spur private investment than LRT or CRT. The permanent infrastructure of LRT or CRT would become a part of the urban structure and encourage development. Because BRT is less capital-intensive, it would be more of a risk for development in the event the market did not support the new service.

6.1.2 Routing and Alignment Factors

In Rockland and Westchester Counties, new transit services would primarily be routed either along the I-287 right-of-way or along parallel local roadways. Depending on the mode, these potential routes have different implications on transportation performance, constructability, property takings, and other environmental impacts. Because commuter rail transit already exists in the region, a number of specific connections to the existing system were also examined. It should be noted that the discussion in this subchapter refers to transit modes themselves, not to individual scenarios unless specifically indicated.

6.1.2.1 Transit Across Rockland County

All three modes (CRT, LRT, and BRT) could potentially be routed along the I-287 right-of-way, but the impacts of doing so differ:

- The CRT option would not follow the topography of the I-287 roadway. Due to grades, development of a CRT system would require construction of tunnels and viaducts. The added heavy construction activity and the visual intrusion of new viaducts would be impacts unique to CRT in the I-287 right-of-way. Both LRT and BRT would follow the roadway topography.

- If BRT (barrier-separated) or LRT modes were coupled with CRT along the I-287 ROW in Rockland, the combined development would require significant right-of-way acquisition, the extent of which will be evaluated in the DEIS.

LRT and BRT modes can potentially be routed along local roadways such as Route 59; however, doing so would entail either taking of travel or parking lanes, or acquisition of property. Of the two options on local roadways, BRT is expected to have less impact than LRT, both in terms of traffic interference and visual intrusions. LRT would require overhead catenary. The in-street LRT segments would require major reconstruction of local streets and relocation of the utilities in the streetbed. Construction would also be taking place closer to the communities.

At proposed station locations for CRT, impacts may include displacements, acquisitions, and increases in traffic and traffic-related noise. Impacts of stations/stops for LRT (less than 1 acre for a stop, 2 acres for a station, 5-7 acres with park and ride, or 7-10 for a transfer station) and BRT (3-5 acres with park and ride) are generally expected to have fewer environmental impacts than CRT stations (7-10 acres) due to their generally smaller scale. However, the particular site characteristics at each station would be major factors. This will be evaluated in greater detail in the DEIS.

6.1.2.2 Transit Across Westchester County

Where CRT, LRT, and BRT run parallel to the I-287 right-of-way in Westchester, the environmental implications are similar to those in Rockland County (CRT requires tunnels and/or structures while LRT and BRT do not). However, Westchester's greater development density would result in an increased need for acquisitions.

LRT and BRT modes could potentially be routed along local roadways such as Route 119. However, as is the case for Rockland County, doing so would entail either taking of travel or parking lanes, or acquisition of property. Also, as is the case for Rockland, BRT on local roadways, with exclusive lanes that are not physically separated from the traffic lanes, is expected to have less impact than LRT on local roadways.

In White Plains, either the CRT or LRT mode could be routed through a tunnel. Construction of the tunnel for either mode would minimize street disruption during construction and operating phases within the city, albeit at significant expense.

LRT and BRT could be routed via local streets through White Plains. The relative impacts of the two modes would be the same as for the case where routing is along local arterials such as Route 119. However, the degree of disruption to city traffic and the need for acquisitions to accommodate either of these new modes is expected to be greater in White Plains than elsewhere in the project corridor.

The implications for new stations in Westchester are comparable to those for Rockland, as the envelopes for above-ground stations would be similar. However, a number of Westchester stations will likely be built underground.

6.1.2.3 Transit Connections and Integration with Existing CRT

A series of more location-specific alignment choices was built into the transit scenarios (primarily for CRT) to answer the following questions:

- If CRT is selected, should the alignment be north or south of the I-87/I-287 roadway?
- What alignment should be chosen for the Port Jervis Line connection for CRT?
- Should any of the transit alignments use the Piermont right-of-way?
- What is the best way to connect CRT to the Pascack Valley Line?
- Should the CRT connection to the Hudson Line be direct or via transfer?

North vs. South CRT Alignment

The Level 2 screening process resulted in a recommendation that the north alignment for CRT be eliminated from further consideration. The north alignment, while less costly, would not integrate well with the Metro-North system in Westchester County for the reasons discussed below.

In Westchester County, the south alignment includes a tunnel beneath White Plains to minimize impacts in the densely developed city while providing transfer to the Harlem Line at the existing White Plains TransCenter (see Figure 3-9). While the north alignment (see Figure 3-35) would be less expensive by $550 million than the south alignment (primarily because there would be no White Plains tunnel), there would be operational impacts to Metro-North Harlem Line service and greater land use impacts to Section 4(f) and ecological resources, specifically the Bronx River Parkway and the Bronx River.

The north alignment would require a new station between the North White Plains and White Plains Stations on the Harlem Line. Harlem Line customers would be affected due to this additional station. Under No Build conditions, the Harlem Line would be operating near capacity. An additional station in this location could not be accommodated without adversely affecting the mix of local and express service in the peak direction, reverse commute service, and/or train service reliability. Additionally, the north alignment would not allow for a station at the White Plains TransCenter or at the Westchester Mall; hence accessibility to shopping and office parks is better under the tunnel alignment. Based on BPM sensitivity runs, the north alignment would attract almost 5,000 fewer daily riders than the south alignment stop at the existing White Plains TransCenter.

Port Jervis Line CRT Connection

The Level 2 screening process resulted in the recommendation that the Hillburn and Ramapo connections to the Port Jervis Line be eliminated from further consideration, and that the East Side connection from the Port Jervis Line be advanced into the DEIS (see Figure 3-12).

While the west side connections (Hillburn and Ramapo) would allow for a Suffern North station more accessible from Interchange 15a, they would require additional trackage and, in the case of the Hillburn alignment, a 9,000-foot viaduct, which would add significantly to the cost. Approximate costs for these options are:

- **East Side** – $160 million.
- **Hillburn** – $480 million.
- **Ramapo** – $360 million.

The East Side option would require acquisition of commercial properties north and south of 4th Street (the Hillburn industrial park containing about three tenants), whereas the Hillburn option would require taking property in, and have proximity impacts to, a community that qualifies for environmental justice consideration. The Ramapo option would involve construction in a floodplain and potential impacts to ecological resources. The East Side option allows for a Suffern North transfer station to the Port Jervis Line, which could serve moves between northern New Jersey and the corridor. The west side options require Port Jervis line passengers to transfer at Harriman for cross-corridor service on the new line (a transfer would be possible if a multi-level station were built in Suffern, but that would add even more expense and would have significant visual impacts in the community).

Piermont Right-of-Way

Use of the Piermont right-of-way in Suffern for CRT was found to be unacceptable, as described below. Use of the Piermont right-of-way for LRT or BRT was found to be acceptable; both of these modes have fewer impacts and provide better service by being nearer to the community than an alignment along the I-287 right-of-way.

While use of the Piermont right-of-way for CRT would save approximately $100 million compared to the I-87/I-287 (south/north) alignment and would offer the potential for locating a new station in downtown Suffern (enhancing smart growth opportunities), community impacts (visual and noise) would be expected due to the elevated structure required to avoid an at-grade crossing with Route 59 – the structure would extend about a mile in close proximity to the commercial properties in downtown Suffern.

Use of the Piermont right-of-way for CRT would avoid the property acquisition requirements of the south I-87/I-287 alignment at Wayne Avenue (affecting commercial/residential properties and raising environmental justice issues in the community); however, long-term noise, vibration, visual/aesthetic, safety, and quality of life concerns would potentially result from the introduction of heavy rail into this community setting.

Pascack Valley Line CRT Connection

The Level 2 screening process resulted in the recommendation that the direct connection to the Pascack Valley Line be eliminated from further consideration due to environmental and cost considerations.

A direct CRT connection to the Pascack Valley Line would likely require double-tracking to Spring Valley to avoid impacts to NJTransit service. It would require modification of existing grade crossings and electrification to Woodbine Maintenance Yard.

While there would be no land use impacts associated with the direct connection itself, storage expansion at Woodbine Yard to accommodate direct service would require significant property taking in a residential community with environmental justice considerations, and also commercial and institutional property takings (i.e., a synagogue, yeshiva, or Veterans of Foreign War facility, depending on which side of the yard is expanded).

Due to the proximity of the Spring Valley Station to the proposed Interchange 14/Pascack Valley Line transfer facility, the direct CRT connection would offer little benefit over the transfer facility in terms of ridership and travel time savings. Customers from south of Spring Valley would be inconvenienced. Further, customers would likely drive directly to the new transfer station even if a direct connection were provided.

The capital cost for the direct connection (including the cost of double-tracking/electrifying and expanding Woodbine Yard) is estimated at $150 million compared to the $40 million cost of a transfer facility, with minimal ridership benefit.

Direct Connection to the Hudson Line

Both a direct connection and a transfer from the Rockland CRT to the Hudson Line were studied. Based on several factors, including significant differences in cost-effectiveness as described below, the transfer from the Rockland CRT to the Hudson Line was eliminated from further consideration in favor of a direct connection.

A direct connection would allow a one-seat ride for Rockland and Orange County residents to New York City; these customers currently need to take the Port Jervis or Pascack Valley Lines to Secaucus and then transfer to Penn Station. In addition to the more convenient ride, the direct connection would provide substantial time savings, particularly for those with destinations on Manhattan's East Side. For example, direct connection passengers from Spring Valley to Manhattan would save 32 minutes over the No Build condition.

Because of the topography at the Westchester shoreline, the transfer station for the connection would be 75 feet above and 1,000 feet east of the Hudson Line, and would require a series of walkways and up to four high-speed elevators to facilitate transfers. In addition, a new station along the Hudson Line would be required 3,500 feet from the existing Tarrytown Station which, because of such proximity, would introduce operational problems for Hudson Line service.

Although, with a Tarrytown transfer, those same passengers traveling from Spring Valley to Manhattan would save 22 minutes over the No Build, they would still have a two-seat ride. For other origins, such as Suffern, the direct connection would provide a 4-minute savings over the existing Port Jervis Line, but for the same trip the Tarrytown transfer option would actually be 6 minutes slower.

With direct connection travel time savings over No Build such as the 32 minutes in the Spring-Valley-Manhattan example above, and with no need to transfer, the direct connection (as modeled in CRT1 using the BPM) would attract 32,600 daily weekday Manhattan-bound riders. The Tarrytown transfer station (based on the M1 model run with some adjustments) would attract only 7,000 such riders. However, due to the variable trip table (described in Subchapter 6.1.1.2), cross-corridor ridership would actually be higher, as the reduced accessibility to Manhattan would increase the relative attractiveness of cross-corridor trips. With the transfer station, there would be 27,000 daily cross-corridor passengers vs. 24,400 for the direct connection.

Major capital cost components for the direct connection include a mile-long shoulder tunnel connecting the main alignment to the Hudson Line, a new underground Tappan Zee Station just north of the toll plaza, new track, signals, and track relocation and interlocking considerations. This would total $785 million. Capital costs for the transfer station are estimated at $200 million; with lower rolling stock requirements (due to lower ridership), net savings vs. the direct connection would be about $855 million.

However, based on ridership and time savings benefits, along with annualized capital costs and operating costs, the net cost per passenger with the direct connection would be about $17.60, about $10.00 less than the comparable figure of $28.50 for the transfer station. Because the direct connection serves more longer-distance trips, if the length of passenger trips is also considered direct connection net costs would be about $0.52 per passenger mile, nearly one third the $1.50 per passenger mile for the transfer station. Given the physical and operational constraints and the mixed travel time savings discussed in the foregoing text and these significant differences in cost-effectiveness, the Tarrytown transfer station was eliminated from further consideration.

6.1.3 Cost-Effectiveness

The cost-effectiveness of each scenario was assessed comparing costs and benefits per passenger. These net costs reflect the subsidy required after benefits to the user (time savings) and operator (fare revenues) are taken into account.

Incremental capital and operating costs for each of the scenarios and for the components of those scenarios were calculated and then annualized using the formula:

Annual costs = (the annual payment necessary to amortize a 50 year loan at 4% interest for the capital costs) + (the annual operating and maintenance costs[2])

Benefits included estimates of fare revenues and the dollar value of travel time savings. Fare revenues were based on estimates of ridership. For Manhattan-bound commuter rail service from Rockland County, revenues were calculated using one-fortieth of the monthly fare to Manhattan for all boarding passengers at each station, multiplied by a factor of 1.2 to represent the actual yield from fares for the west-of-Hudson service. For cross-corridor commuter rail, fares to Palisades Mall, White Plains, and Stamford were used from each station based on the number of people disembarking at each of those stations. This was factored by 1.38, as fewer cross-corridor passengers are expected to use monthly tickets.

Travel time savings were calculated for existing transit riders who are provided a faster route, based on the travel time difference between the new route and the previous path, whether it was bus or rail. To calculate a benefit value, time saved was multiplied by $8.50/hour[3], the current value of time for FTA New Starts. For new transit riders, the calculation of benefits was more complex. In many cases, travelers shift from auto to transit even without travel time savings, due to the convenience of transit, or the savings

[2] Annual operating and maintenance costs were developed for each scenario, for all transit modes, for new services. They include all labor, supplies and fuel costs for operation and maintenance of the vehicles, based on estimated usage of the vehicles and staffing requirements.

[3] Section 5309 (Section 3(j)) FTA New Starts Criteria.

of not having to pay for parking. To capture those benefits in the cost effectiveness, the average savings enjoyed by existing transit riders making the same trip were used as a proxy.

Net costs were then determined by dividing the annual costs by the total number of annual riders (calculated by factoring the daily peak ridership). Because different scenarios serve trips of different average lengths, a per-mile net cost was also determined.

Table 6-6 contains the results of these calculations. Key findings include:

- Fares exceed operating and maintenance costs for BRT2 and CRT1. This is in part due to the extensive existing infrastructure for bus and commuter rail in the corridor.

- Bus rapid transit has the lowest net cost per rider, with BRT1 at $7 per passenger and BRT2 at $5 per passenger. However, BRT1 has by far the lowest benefits of all scenarios due to its low ridership, and was therefore eliminated from consideration.

- Full-corridor rail alternatives have the highest net cost per rider, CRT 1 at $18 per passenger and M5 at $21 per passenger. Note, however, that on a per-mile basis, CRT1 net costs are more competitive with the other scenarios ($0.52 per passenger mile, as compared to $0.35 for BRT2).

- Both high-speed LRT and in-street LRT would be ineffective. Full-corridor LRT would be less effective than commuter rail in serving both cross-corridor passengers and Manhattan-bound passengers, requiring transfers at Suffern, Exit 14, Tarrytown, White Plains, and Port Chester to connect with Manhattan-bound service. High-speed LRT, with its alignment along the highway, would not be as effective as in-street LRT in serving communities in both Rockland and Westchester Counties. The combination of high construction costs for a grade-separated right-of-way and low ridership results in the highest net costs per passenger ($29) and per passenger-mile ($1.34) (Table 6-6), making it the least cost-effective alternative.

- Even though in-street LRT (LRT2) attracted slightly more riders than high-speed LRT (LRT1) and would be less expensive to build, its slower run times lead to lower travel time benefits, so LRT2 also has very high net costs of $20 per passenger and $1.16 per mile.

- Selected individual segments of each type of LRT service performed well, however; a hybrid LRT concept was therefore developed that included elements of both high-speed LRT and in-street LRT service to better assess the maximum potential of LRT.

6.1.4 Conclusions from First Level of Transit Screening

Early in the evaluation process of the transit components of the Level 2 scenarios, the following overall conclusions were reached:

Table 6-6

Cost per Passenger and per Passenger Mile by Scenario

Transit Cost Effectiveness – Net Cost per Rider and Net Cost per Passenger Mile						
Costs	Full-Corridor Commuter Rail (CRT1)	High-Speed Light Rail (LRT1)	In-street Light Rail (LRT2)	Exclusive Busway (BRT2)	HOT Lanes (BRT1)	Manhattan Bound CRT and LRT (M5)
Capital Costs						
Rockland	$ 2,112	$ 1,430	$ 1,070	$ 823	$ 115	$ 3,181
Crossing	$ 2,173	$ 910	$ 910	$ 797	$ 58	$ 3,083
Westchester	$ 2,782	$ 2,270	$ 1,590	$ 480	NA	$ 953
Equipment	$ 367	$ 143	$ 183	NA	$ 22	$ 411
Total Capital Costs	$ 7,434	$ 4,753	$ 3,753	$ 2,100	$ 195	$ 7,628
Annualized Capital Costs	$ 346	$ 221	$ 175	$ 98	$ 9	$ 355
O&M Costs	$ 52	$ 35	$ 39	$ 30	$ 17	$ 83
Annual Total Costs	$ 398	$ 256	$ 214	$ 128	$ 26	$ 438
Fare Revenue	$ 69	$ 12	$ 14	$ 32	$ 2	$ 63
Travel Time Savings Benefit Existing Riders	$ 25	$ 20	$ 15	$ 24	$ 14	$ 24
Transit Benefits New Riders	$ 8	$ 1	$ 1	$ 4	$ 0	$ 7
Annual Net Costs	$ 297	$ 223	$ 184	$ 68	$ 10	$ 345
Annual Ridership	17	8	9	14	1	16
Net Costs/Rider	$ 18	$ 29	$ 20	$ 5	$ 7	$ 21
Passenger Miles	575	169	159	196	87	530
Net Cost/Passenger Mile	$ 0.52	$ 1.32	$ 1.16	$ 0.35	$ 0.11	$ 0.65

Notes:
All figures are in millions except the cost/rider and cost/passenger mile.
HOT Lane costs are 10% of the cost of the HOT lane construction, based on the estimated roadway capacity used by transit.
Bridge crossing costs are the incremental costs of adding transit infrastructure to a newly constructed highway bridge.
O&M and equipment costs include costs associated with bus service changes (both feeder bus and cross-corridor, depending on the mode) and change in Metro-North equipment and O&M costs as compared to No Build conditions.
Annual riders were assumed to be 291 times average weekday riders, based on Metro-North experience.
Revenues are based on existing fares and yields per passenger on Metro-North.
Travel time savings compared new services to No Build for existing riders.
Transit benefits for new riders are calculated using the average travel time savings for existing riders.

- To meet project objectives, a high capacity, reliable transit element that operates independent of general purpose highway traffic is needed. Because of the constraints on both sides of the river, the bulk of future growth in travel will need to be accommodated by means other than single-occupant autos. To be effective and attractive, transit must operate in the corridor independent of general purpose traffic.

- While the Manhattan-bound transit market is at present dominant, the cross-corridor transit market is significant and has significant growth potential, especially if future land development planning reinforces the need for major transit investment in the corridor. In combination, these two transit markets are quite large and can justify a major investment across the river as well as in the balance of the corridor.

- The Manhattan-bound transit market is served most effectively by a commuter rail connection that provides a one-seat ride from west of the river to Midtown Manhattan and the East Side.

- While the ideal transit solution would be a single mode to address both markets, the nature of the densities and pattern of travel led to the conclusion that a second mode of transit to serve the cross-corridor market should be kept under consideration. This led to the development of three new "modal options" to be studied further – Manhattan-bound CRT combined with CRT through Westchester, with BRT in Westchester, or with LRT in Westchester.

- Neither high-speed LRT nor in-street LRT were cost-effective by themselves in serving the corridor. However, on certain segments each performed well, so a new hybrid LRT option (high-speed in some areas, in-street in others) was developed to maximize LRT effectiveness.

- BRT1 as initially modeled attracted very few riders due to the lack of exclusive right-of-way in Westchester. It was eliminated from consideration, though its combination with HOT lanes was incorporated into a modified BRT option.

A number of preliminary conclusions were also developed with respect to connections and alignments:

- **A CRT alignment** through downtown White Plains is preferable to an alignment along I-287, as integration with the existing Metro-North Harlem Line would be better with that alignment.

- **The Port Jervis connection** would be best accomplished with the East Side option; the Hillburn and Ramapo options would be significantly more expensive and would have more significant environmental justice and ecological impacts.

- **A direct CRT connection to the Pascack Valley Line** would require $150 million in problematic track and yard improvements, compared to the $40 million cost of a transfer facility with minimal ridership benefit. Thus, a direct connection to the Pascack Valley Line was eliminated from further consideration.

- **Use of the Piermont right-of-way for CRT** was eliminated from further consideration due to long-term noise, vibration, visual/aesthetic, safety, and quality of life concerns in Suffern, though it remains a possibility for LRT and BRT.

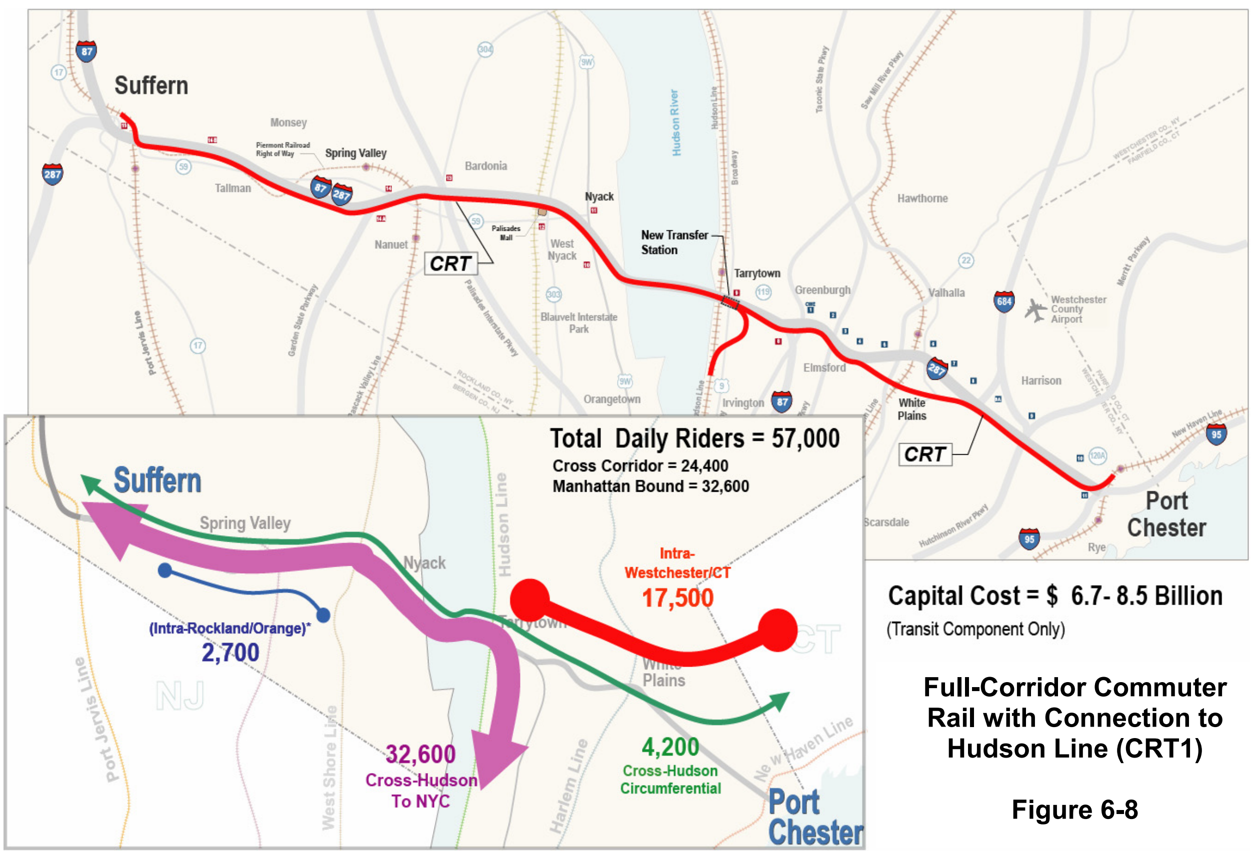
- **Transfer from the cross-corridor CRT line to the Hudson Line with a new station in Tarrytown** was eliminated when the transportation model showed a sharp drop in riders with the difficult transfer as compared to a one-seat ride from Orange/Rockland to Manhattan, as well as negative impacts on Hudson Line operations.

6.2 Transit Modal Options

After consideration of the initial set of transit improvements contained in the original scenarios, it became apparent that seven refined versions of the original 15 scenarios offered the most potential transportation benefits in the corridor. Thus, the AA process with respect to analyzing transit modes evolved into an analysis of seven potential transit modal options.

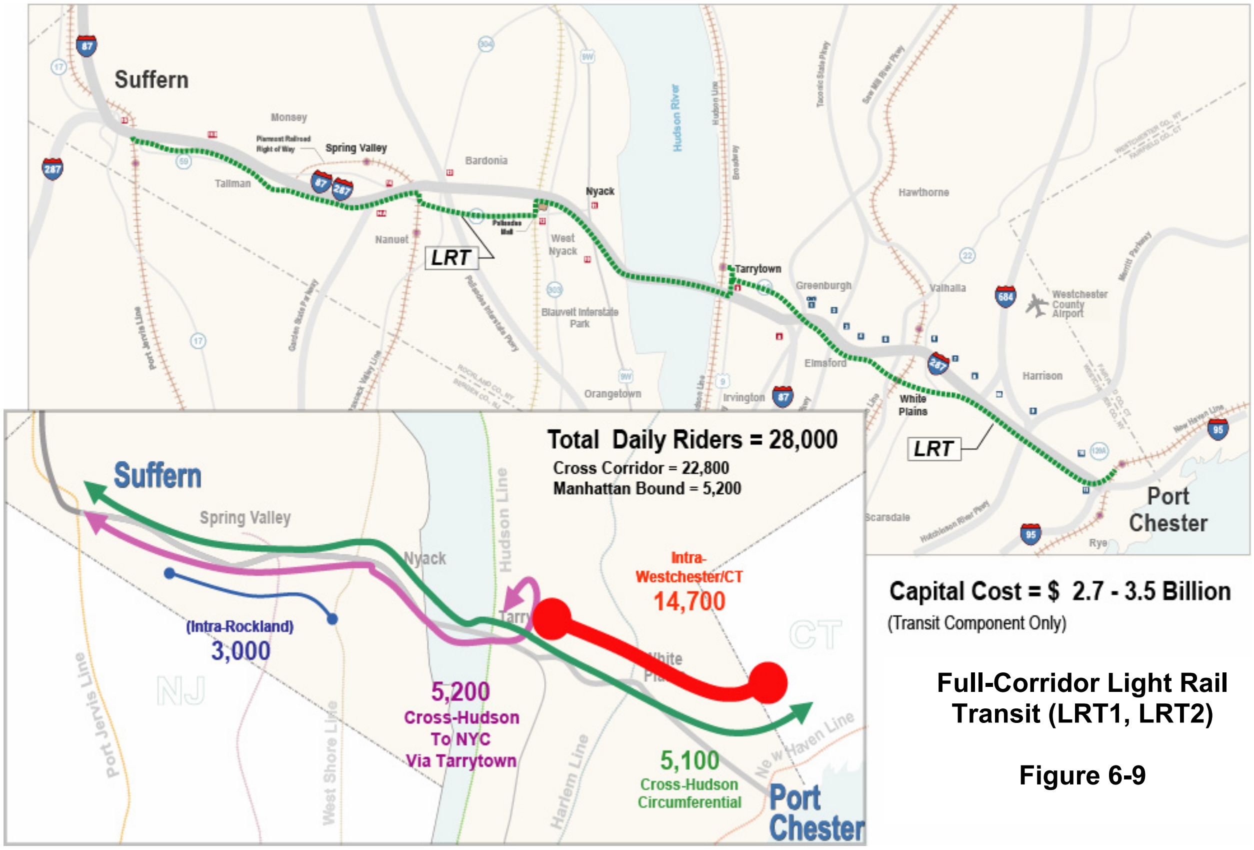
6.2.1 Description of Transit Modal Options

The Level 2 screening process was performed for the seven transit modal options using the evaluation criteria described above. Four of these modal options were essentially unchanged from the comparable scenarios analyzed in Subchapter 6.1, while three were substantially new combinations of modes. Figures 6-8 through 6-14 contain illustrations of this set of modal options, described below:



Full-Corridor Commuter Rail with Connection to Hudson Line (CRT1)

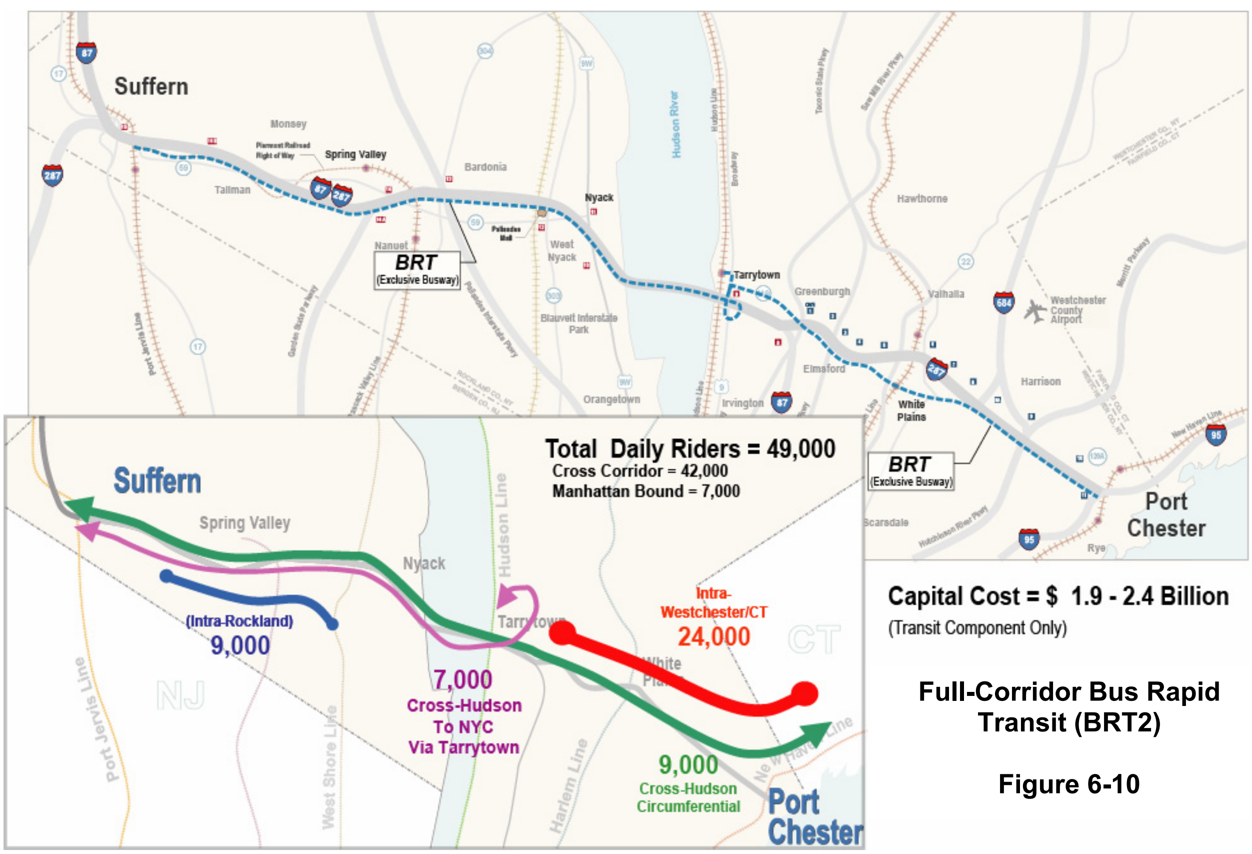
Figure 6-8



Capital Cost = $ 2.7 - 3.5 Billion
(Transit Component Only)

Full-Corridor Light Rail Transit (LRT1, LRT2)

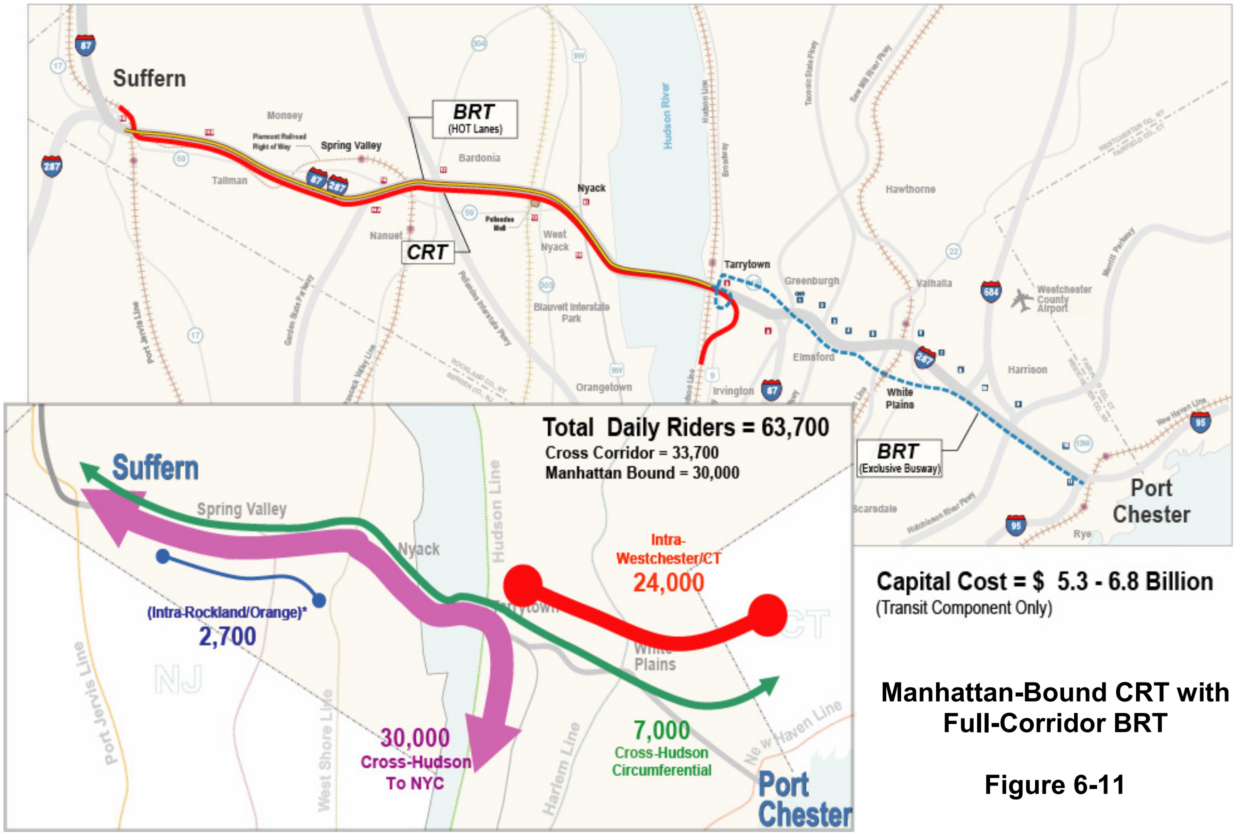
Figure 6-9



Capital Cost = $ 1.9 - 2.4 Billion
(Transit Component Only)

Full-Corridor Bus Rapid Transit (BRT2)

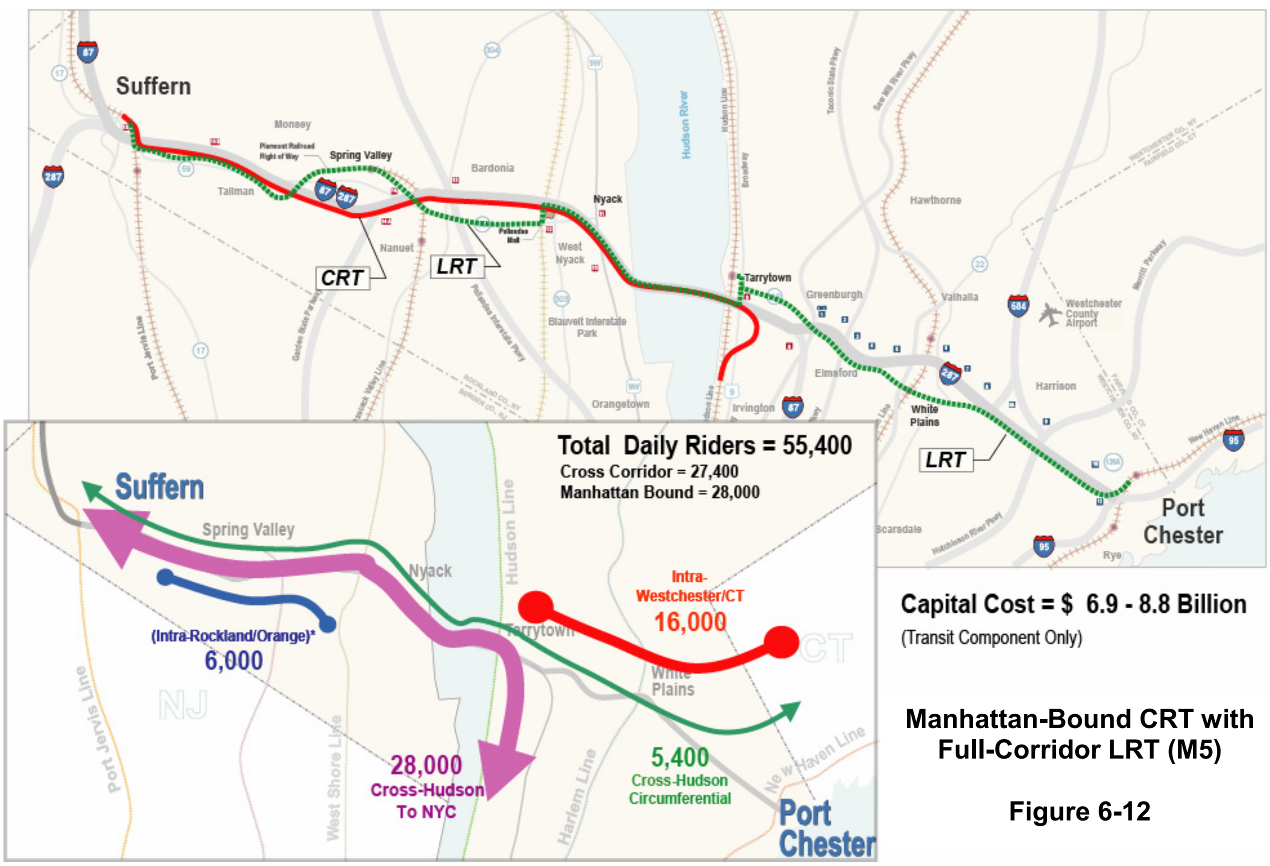
Figure 6-10



Capital Cost = $ 5.3 - 6.8 Billion
(Transit Component Only)

Manhattan-Bound CRT with Full-Corridor BRT

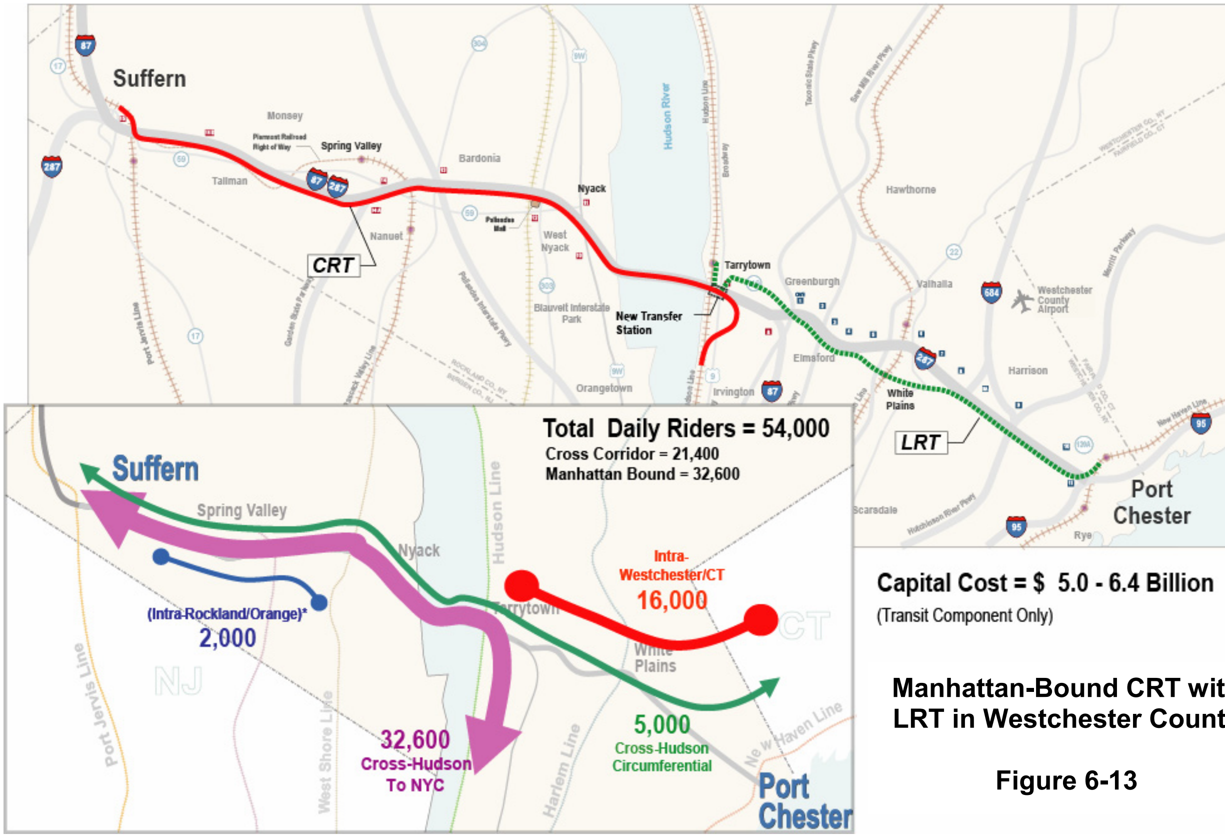
Figure 6-11



Capital Cost = $ 6.9 - 8.8 Billion
(Transit Component Only)

Manhattan-Bound CRT with Full-Corridor LRT (M5)

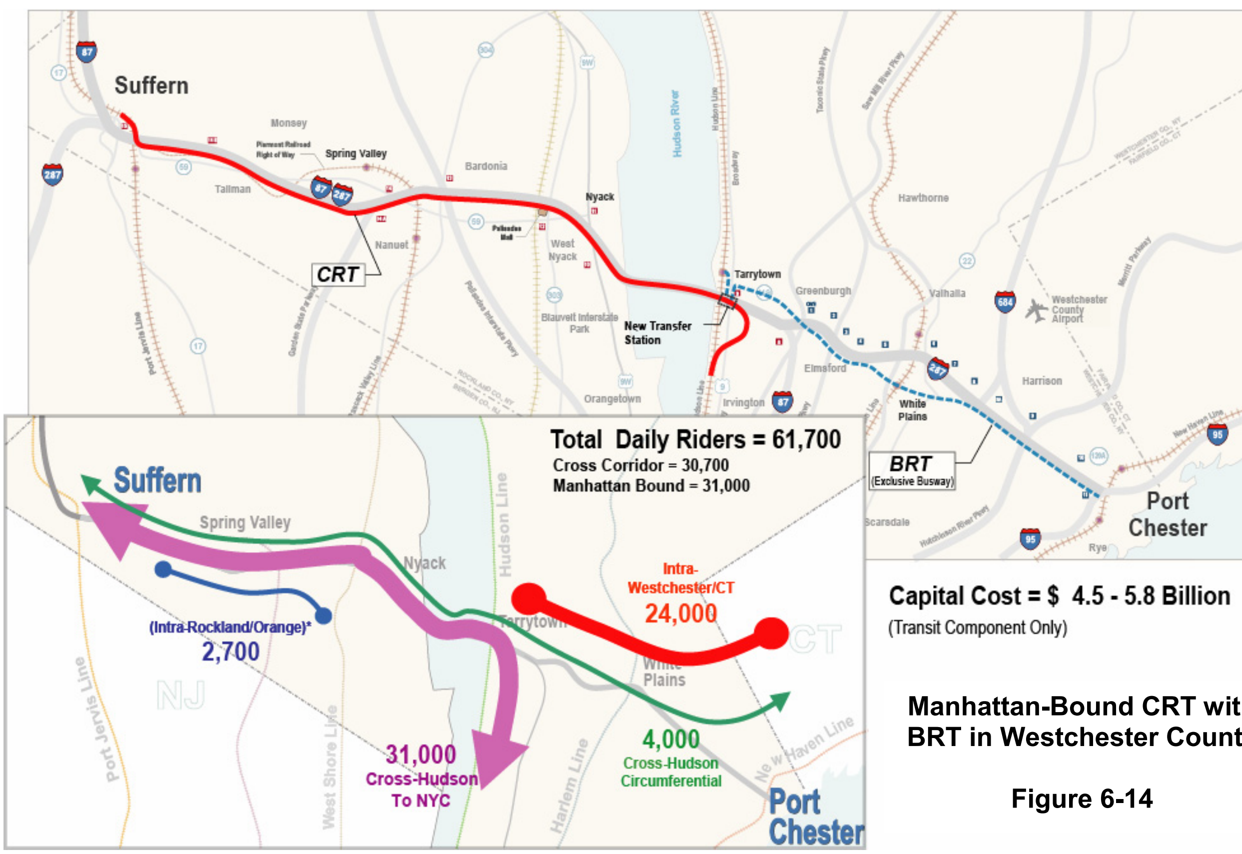
Figure 6-12



Capital Cost = $ 5.0 - 6.4 Billion
(Transit Component Only)

Manhattan-Bound CRT with LRT in Westchester County

Figure 6-13



Capital Cost = $ 4.5 - 5.8 Billion
(Transit Component Only)

Manhattan-Bound CRT with BRT in Westchester County

Figure 6-14

1. **Full-Corridor Commuter Rail with Connection to Hudson Line (CRT1)** – CRT from Suffern to Port Chester, including Manhattan-bound CRT through a direct one-seat ride via the Hudson Line.

2. **Full-Corridor Light Rail Transit (LRT1, LRT2)** – LRT from Suffern to Port Chester with a transfer at Tarrytown. The service would follow a hybrid in-street/high-speed LRT alignment (e.g., in-street on sections of Route 59 in Rockland and Route 119 in Tarrytown and high-speed on selected arterials in White Plains and in dedicated transitways along I-287 in other areas).

3. **Full-Corridor Bus Rapid Transit (BRT2)** – BRT from Suffern to Port Chester with transfer at Tarrytown. Buses would use a barrier-separated exclusive bus facility in Rockland County and portions of Westchester County (alongside I-87/I-287), and exclusive bus lanes on Route 119 in Tarrytown and on selected arterials in White Plains. Special lanes/ramps would connect to existing and new park-and-ride facilities. This modal option was modified to include HOT lanes in Rockland County instead of an exclusive busway, as the proposed highway concept already included HOT lanes.

4. **Manhattan-Bound CRT with Full-Corridor BRT** – Commuter rail from Suffern to a connection with the Hudson Line south of Tarrytown; BRT from Suffern to Port Chester with HOT lanes in Rockland; exclusive bus lanes and exclusive busway in Westchester, as in BRT2.

5. **Manhattan-Bound CRT with Full-Corridor LRT (M5)** – CRT from Suffern to a connection with the Hudson Line south of Tarrytown and LRT from Suffern to Port Chester; an in-street LRT alignment in Rockland County and hybrid LRT alignment in Westchester County.

6. **Manhattan-Bound CRT with LRT in Westchester County** – CRT from Suffern to Tarrytown, connecting to the Hudson Line, and LRT from the existing Hudson Line Tarrytown Station to Port Chester using the hybrid alignment. The CRT service would be designed to allow for future commuter rail service across the I-287 corridor in Westchester.

7. **Manhattan-Bound CRT with BRT in Westchester County** – CRT from Suffern to Tarrytown connecting to the Hudson Line, and BRT from existing Hudson Line Tarrytown Station to Port Chester. The CRT service would be designed to allow for future commuter rail service across the I-287 corridor in Westchester.

6.2.2 Evaluation of Transit Modal Options

The different transit modes in each modal option have both advantages and disadvantages when considering future transit ridership in the relevant markets, costs, and impacts to the local community and region. The effects of these modal concepts and alignment changes were estimated by inferring from the results of the travel demand forecasts and other data generated from the scenarios. Tables 6-7 through 6-9 contain results of these analyses, which are also reflected in Figures 6-8 through 6-14.

Table 6-7

Daily Ridership on New Service by Modal Option

Market	Modal Option (Year 2025)						
	Full-Corridor:			Manhattan-Bound CRT with:			
	1	2	3	4	5	6	7
	CRT with Connection to Hudson Line	LRT with Tarrytown Transfer*	BRT with Tarrytown Transfer	Full-Corridor BRT	Full-Corridor LRT	BRT in Westchester	LRT in Westchester
Total Riders	57,000	28,000	49,000	63,700	55,400	61,700	54,000
% Diverted/New	71/29	91/9	84/16	74/26	80/20	73/27	76/24
Cross-Corridor	24,400	22,800	42,000	33,700	27,400	30,700	21,400
Manhattan-bound	32,600	5,200	7,000	30,000	28,000	31,000	32,600

Note: Diverted riders are those who would otherwise use transit (such as buses or the Port Jervis, Pascack Valley, or Hudson Lines) in the No Build condition.

Table 6-8

Travel Time by Transit Mode for Selected O-D Pairs by Modal Option

Trip	Travel Time in Minutes								
	2004 (Transit)	2025 No Build (Transit)	Modal Option (Year 2025)						
			Full Corridor:			Manhattan-Bound CRT with:			
			1	2	3	4	5	6	7
			CRT with Connection to Hudson Line	LRT with Tarrytown Transfer	BRT with Tarrytown Transfer	Full-Corridor BRT	Full-Corridor LRT	BRT in Westchester	LRT in Westchester
Suffern to White Plains	70[1]	104	30	49	38	34	54	41	41
Stamford to White Plains	31[1]	50	29	35[b]	30[c]	30[c]	37[b]	30[c]	35[b]
Spring Valley to Manhattan	78 (to PSNY)[4,5]	78(to PSNY)[4,5]	46(to GCT)	58(to GCT) [a]	58(to GCT) [a]	46(to GCT)	46(to GCT)	46 (to GCT)	46(to GCT)
Suffern to Manhattan	55 (to PSNY)[3,5]	55 (to PSNY)[3,5]	51(to GCT)	72 (to GCT)[a]	69 (to GCT) [a]	51(to GCT)	51(to GCT)	51 (to GCT)	51 (to GCT)

Assumptions:
Run times are based on service plans developed for CRT, LRT, and BRT. HOT lanes would be priced to maintain speed up to 55 mph. A connection to the existing Tarrytown station is not included in the Suffern to White Plains travel times. A 5-minute transfer and wait time was added to all trips that require a transfer.

a. Transfer to the Hudson Line at Tarrytown.
b. Transfer to the New Haven Line at Port Chester.
c. Buses in mixed traffic between Port Chester and Stamford.

Sources:

1. Suffern to White Plains – Rockland County bus schedule effective February 23, 2004.
2. Stamford to White Plains – I-Bus effective January 4, 2004.
3. Port Jervis, Suffern to Penn Station – Main/Bergen County Line schedule effective December 14, 2003.
4. Nanuet to Penn Station – Pascack Valley Line schedule effective February 15, 2004.
5. Tarrytown to GCT – Hudson Line schedule effective April 27, 2003.

Table 6-9
Net Cost per Rider and Net Cost per Passenger Mile by Modal Option

Cost	Modal Option (Year 2025)						
	Full Corridor			Manhattan Commuter Rail with			
	1	2	3	4	5	6	7
	CRT with Connection to Hudson Line	LRT with Tarrytown Transfer	BRT with Tarrytown Transfer	Full-Corridor BRT	Full-Corridor LRT	BRT in Westchester	LRT in Westchester
Capital Costs							
Rockland	$ 2,112	$ 1,035	$ 823	$ 2,227	$ 3,181	$ 2,112	$ 2,112
Crossing	$ 2,173	$ 910	$ 797	$ 2,970	$ 3,083	$ 2,173	$ 2,173
Westchester	$ 2,782	$ 953	$ 480	$ 480	$ 53	$ 480	$ 953
Equipment	$ 367	$ 142	NA	$ 265	$ 411	$ 250	$ 299
Total Capital Costs	$ 7,434	$ 3,040	$ 2,100	$ 5,942	$ 7,628	$ 5,015	$ 5,537
Annualized Capital Costs	$ 346	$ 142	$ 98	$ 277	$ 355	$ 233	$ 258
O&M Costs	$ 52	$ 41	$ 30	$ 64	$ 83	$ 52	$ 63
Annual Total Costs	$ 398	$ 183	$ 128	$ 341	$ 438	$ 285	$ 321
Fare Revenue	$ 69	$ 20	$ 32	$ 69	$ 63	$ 70	$ 66
Travel Time Savings Benefit Existing Riders	$ 25	$ 16	$ 21	$ 29	$ 24	$ 24	$ 22
Transit Benefits - New Riders	$ 8	$ 2	$ 4	$ 9	$ 7	$ 7	$ 6
Net Costs	$ 297	$ 144	$ 70	$ 234	$ 345	$ 185	$ 226
Annual Ridership	17	8	14	19	16	18	16
Net Costs/Rider	$ 18	$ 18	$ 5	$ 13	$ 21	$ 10	$ 14
Passenger Miles	575	122	196	564	530	541	526
Net Cost/Passenger Mile	$ 0.52	$ 1.19	$ 0.36	$ 0.41	$ .65	$ .34	$ 0.43

Notes:
All figures are in millions except the cost/rider and cost/passenger mile.
HOT lane costs are 10% of the cost of the HOT lane construction, based on the estimated roadway capacity used by transit.
Bridge crossing costs are the incremental costs of adding transit infrastructure to a newly constructed highway bridge.
O&M and equipment costs include costs associated with bus service changes (both feeder bus and cross-corridor, depending on the mode) and change in Metro-North equipment and O&M costs as compared to No Build conditions.
Annual riders were assumed to be 291 times average weekday riders, based on Metro-North experience.
Revenues were based on existing fares and yields per passenger on Metro-North.
Travel time savings compared new services to No Build for existing riders.
Transit benefits for new riders are calculated using the average travel time savings for existing riders.

The principal trade-offs are summarized below:

- **Transit Ridership** – CRT would attract the highest ridership for the Connecticut/Westchester and Manhattan-bound markets, while BRT and LRT (in particular, in-street LRT) would provide greater transit access to residents and businesses in Rockland and Westchester due to location and number of station stops. This is reflected in the intra-county ridership on BRT and LRT, which is up to 285 percent higher than the intra-county ridership on CRT. CRT, on the other hand, captures 43 percent more than either LRT or BRT in the Connecticut-Westchester market and 365 percent more in the Manhattan-bound market.

- **Mode Split** – CRT provides the largest shifts from auto to transit modes, particularly in the markets where parking is limited and has associated costs. This is particularly true in the Manhattan market, where driving is the most expensive and least dependable option, but is also valid for travel to White Plains and Stamford. CRT works better for longer trips; in suburban environments CRT requires that parking be provided at the home end to facilitate drive access. LRT can be better for short trips, with operation along major commercial routes and frequent stops, facilitating walk access. BRT can more successfully serve the suburban residential development, providing a one-seat ride with higher speeds in the exclusive right-of-way. Mode split percentages vary from market to market, from 4 to 6 percent transit in suburban markets to 70 to 80 percent transit for service to Manhattan.

- **Corridor Mobility** – CRT would offer the greatest service reliability and fastest travel times. While every attempt would be made to offer signal prioritization to both LRT and BRT (on the in-street segments in Westchester County), other vehicular traffic and movements would still need to be accommodated. The availability of sufficient "green" time to allocate priority to BRT or LRT will be investigated in the DEIS stage.

  CRT would offer the greatest potential to satisfy demand over the next 20 years and beyond. As compared to BRT, rail has a superior ability to respond to growth pressures by increasing capacity efficiently (adding another car to a train to carry more riders without affecting labor costs). CRT, capable of 12-car train lengths, also outperforms LRT, whose trains are never more than four cars in length.

- **Support to Efficient Land Development** – As described in Subchapter 6.1.1.4, CRT would further support transit-oriented development at established Metro-North stations on the Port Jervis and New Haven Lines (in particular), which would be better served with the new service. In addition, transit-oriented development opportunities would be available at the proposed new station sites. LRT would also attract transit-oriented development, although potentially to a lesser density, at a greater number of new stations. Outside studies have been inconclusive on BRT impacts to land use and economic development along its corridors. While BRT has the potential to distinguish itself from the poor image of regular bus service, it is less likely to spur private investment than LRT or CRT.

- **Transportation System Integration** – CRT and BRT provide good connectivity to the existing regional transit system and to the existing central business districts and activity centers in the corridor. These destinations include Stamford, Greenwich, White Plains (including the County Center, White Plains TransCenter, Westchester Mall), Palisades

Mall, and Suffern. With CRT, connecting the west-of-Hudson service to the Hudson and New Haven Lines would improve customer utilization of the railroad, accommodate new trip patterns (to Yonkers, the Bronx, east Midtown Manhattan, Westchester and Connecticut), and create opportunities for more flexible operations.

- **Costs and Cost-Effectiveness** – While full corridor CRT is the most expensive of the uni-modal transit options, its many benefits outweigh its costs, particularly when examined with cost per passenger mile as a criterion. The Manhattan-bound segment would be particularly cost-effective, largely because it most effectively uses the existing transit infrastructure.

  Capital costs for the Manhattan-bound CRT with LRT in Westchester would be competitive with the Manhattan-bound CRT with BRT in Westchester ($5.5 billion vs. $5.0 billion) and considerably less costly than the $7.4 billion full-corridor CRT. Net costs per passenger mile for all of these options would be competitive and range from $0.34 to $0.52.

6.2.3 Conclusions from Second Level Transit Screening

The second level of transit screening, the more detailed analysis of the seven transit modal options that were identified from analysis of the original 15 scenarios, led to the elimination of the following transit modal options from further consideration:

- **Full-Corridor Hybrid LRT (Modal Option 2)** – this combination of high-speed and in-street LRT mode was the least cost-effective transit mode studied and was ineffective in serving many potential markets, including Orange/Rockland-to-Manhattan (only 5,200 riders compared to 32,600 utilizing the directly connected CRT) and Intra-Westchester/Connecticut (2,800 riders less than CRT and 9,300 less than BRT). Option 2 had the least favorable cost-effectiveness of the seven options, at a net cost of $1.18 per passenger mile, more than $0.50 higher than the next most costly option.

- **Duplicative Transit Modes (Modal Options 4 and 5)** – ridership forecasts did not justify the duplication or construction of two transit modes (CRT and LRT or CRT and BRT) anywhere in the corridor, in particular having both CRT and LRT modes on a replacement bridge. Providing sufficient space for dual modes through some points in the corridor created substantial right-of-way problems. The exclusive busway option in Rockland County was eliminated, as the HOT lane busway was more effectively used for high occupancy vehicles and single-occupant vehicles willing to pay a premium. In addition to transit users, the facility carried all multi-occupant vehicles and an additional 1,100 single-occupant vehicles every hour.

The remaining four options (1, 3, 6, and 7) were thus recommended for further study as alternatives in the DEIS.

6.3 Rail Freight

The ability of a CRT alignment to accommodate rail freight in the corridor was assessed. A full description of the analysis and results is included in the document *Freight White Paper* (NYSTA/Metro-

North, August 2004) supporting this alternatives analysis report. The study concluded that such a proposal would provide only a minimal measure of additional flexibility in the rail freight network and would require a significant upfront investment of funds. Rail freight in the corridor would do little to alter the underlying infrastructure and institutional problems that constrain the movement of rail freight to either New England or to the east side of the Hudson River (along the Hudson Line south to Westchester County, New York City, and Long Island). The following conclusions were reached:

- There is no demonstrated market (existing or projected) for rail freight in the corridor.

- Any regional rail freight market demand that exists would be better served through implementation of the Cross Harbor Rail Freight Tunnel, whose DEIS is under public review and for which federal funding is in process.

- The CRT bridge options under consideration would not preclude future freight service; however, only trailer/container-on-flatcar (TOFC/COFC) freight with axle loadings of up to 65,000 lbs could be accommodated on the bridge without significant additional bridge strengthening. Heavier intermodal and commodity freight service would require bridge strengthening. The additional costs incurred at the time of construction to accommodate the possibility of heavier freight are estimated to be between \$300 and \$500 million. In addition to strengthening the bridge, there are a number of infrastructure improvements and support systems that would be needed to accommodate larger freight vehicles, such as expanded capacity of the ventilation systems, intermodal rail yards, and possible raising of clearances in the shoulder tunnels and elsewhere in the rail network, bringing the total estimated incremental cost to at least \$1 billion.

A number of primary points were considered to determine the reasonableness of including rail freight as part of a CRT alternative:

- Commuter rail operations and rail freight operations have significantly different operating and infrastructure requirements. A potential new freight crossing cleared for double-stack service (per national freight system standards) in the corridor would connect to a predominantly commuter rail system on the east side of the Hudson River that, due to vertical clearance and other infrastructure issues, is only capable of single-stack (COFC, TOFC) service from Croton-Harmon to New York City, a distance of approximately 34 miles, and on to Long Island. Furthermore, horizontal clearance is an issue since existing third rail systems utilized by Metro-North and Long Island Rail Road are not compatible with modern well cars used for double-stack intermodal service. Other significant issues that limit the movement of freight in a commuter rail environment include weight restrictions, hours of operations, and operating rules.

- There are major differences between the west-of-Hudson freight system ("national system") and the existing freight system serving the east-of-Hudson River region, e.g. the Hudson Line. The east-of-Hudson rail system is predominantly commuter-oriented, whereas the west-of-Hudson system has a more prominent freight orientation. The rail freight infrastructure, lines, and yards in northern New Jersey are far superior to the rail infrastructure on the east side of the Hudson River and can accommodate modern double-stack service with origins and destinations across the country. For example, there are approximately 12 major freight rail yards and terminals in northern New Jersey that comprise approximately 1,200 acres. The rail yards are operated by Class I and regional rail freight carriers and accommodate a full range of services including: double-stack intermodal, tri-level automotive, carload, and bulk transfer. Conversely, there are only six major freight rail yards and terminals in the east-of-Hudson area of New York State, which comprise some 200 acres and provide fewer services, including single-stack trailer/container-on-flatcar (TOFC, COFC), carload, and bulk transfer services.

- There is minimal available system capacity east-of-Hudson for expansion of needed commuter rail service, without consideration of adding a proposed rail freight operation. Beyond the Tappan Zee Bridge crossing requirement, the connection to the Beacon Line on the east side of the Hudson River would only add to the congestion problems experienced on the Hudson Line, with limited up-side rail freight potential, since existing Beacon Line rail infrastructure does not extend into New England beyond Connecticut.

  Furthermore, a connection to the Port Jervis Line and Norfolk Southern's Southern Tier Line on the west side of the Hudson River would not significantly improve the movement of freight to the region for two main reasons: (1) the majority of Norfolk Southern's existing east-of-Hudson rail traffic terminates in Eastern Pennsylvania and is forwarded via truck, and (2) the proposed rail route would likely be circuitous and consist of several at-grade crossings, both of which negatively impact the cost-competitiveness of rail freight as compared to over-the-road transport.

- Existence of a third rail for the operation of commuter rail precludes the ability of rail freight to utilize well cars for double-stack intermodal service – the current standard for rail freight. While it is possible to build the east-of-Hudson freight system infrastructure to permit double-stack service, it would be extremely costly and would require significant new freight-only trackage without a third rail power system. The system would have to be cleared to 23 feet, and would require several new intermodal yards 75 to 100 acres each in size, ideally surrounded by industrial-zoned land.

- There would be no significant diversion from trucks to rail resulting from a new TZB/I-287 rail freight crossing because of the significant restrictions placed on rail freight operating over a predominantly commuter-owned and operated east-of-Hudson rail system. The east-of-Hudson market would not change significantly in the foreseeable future and the means of satisfying the market demand would remain predominantly truck-oriented because it is in most cases faster, more reliable, and less costly. Significant additional investments in regional rail freight infrastructure (i.e., new rail freight-only routes, new general merchandise and intermodal yards, large classification yards and adjacent industrial parks to reduce cost and improve the reliability of rail freight service) would be required to improve market demand. Without such an investment, rail freight service to the east side of the Hudson River is more costly and less efficient compared to trucks, which are the dominant mode of freight transportation.

As a result of these considerations, it is practical and reasonable to assume that only single-stack TOFC freight will be carried on any new rail line, compatible with commuter rail. No additional structure will be provided for freight service.

6.4 Conclusions

The following transit modal options will be advanced into the DEIS as components of the DEIS alternatives (which are described in detail in Chapter 8):

- **Option 1** – Full-Corridor CRT with Connection to the Hudson Line and New Haven Line, as the transit element of DEIS Alternative 4A.

- **Option 3** – Full-Corridor BRT (modified to include HOT lanes in Rockland as opposed to exclusive busway), as the transit element of DEIS Alternative 3.

- **Option 6** – Manhattan-Bound CRT with LRT in Westchester, as the transit element of DEIS Alternative 4B.

- **Option 7** – Manhattan-Bound CRT with BRT in Westchester, as the transit element of DEIS Alternative 4C. While DEIS Alternative 4C will also include some bus services using the HOT lanes in Rockland County, it would not be the equivalent of BRT1 in the county, due to the difficulty in providing direct bus connections to the HOT lanes from corridor park-and-ride lots because of the commuter rail construction.

The following transit modal options will not be advanced into the DEIS for the reasons discussed above:

- **Option 2** – Full-Corridor LRT.
- **Option 4** – Manhattan-Bound CRT with Full Corridor BRT.
- **Option 5** – Manhattan-Bound CRT with Full Corridor LRT.

With respect to transit alignments, CRT would follow the I-287 alignment from the Suffern North Station East Side location, remaining south of I-287 until entering a tunnel east of Palisades Mall. CRT would emerge from that tunnel to cross the Hudson either on the lower level of a two-level bridge or the deck of a single-level bridge, entering a tunnel on the Westchester shore. After a stop at a new Tappan Zee Station, the CRT would continue underground to a connection with the Hudson Line just north of Lyndhurst, and in the full CRT option, would continue underground to Elmsford, where it would emerge and follow the freeway corridor to Exit 5. There it would enter a tunnel under White Plains, reconnecting to the highway alignment on the east and continuing to its connection with the New Haven Line south of Port Chester.

LRT would begin at the Tarrytown Station, follow the Hudson Line to the bridge alignment, enter a tunnel to the Tappan Zee station for a cross-platform transfer to the Manhattan-bound commuter rail, then continue east, emerging at grade on the Route 119 alignment, and follow Route 119 to Elmsford, where it would rejoin the highway alignment to Exit 5. There it would rejoin Route 119 into downtown White Plains and use street rights-of-way through downtown, rejoining the I-287 alignment on the east to the vicinity of I-95, where it would tunnel under the I-287/I-95 interchange to reach the Port Chester New Haven Line Station.

BRT would follow an alignment similar to LRT, with the cross-platform transfer to the Manhattan-bound commuter rail and the portal on Route 119. Buses could continue to Stamford to provide through-service.

Rail freight service would be limited to TOFC freight, single-stacked, compatible with third rail commuter service. Thus, no structural additions would be required for freight service.