8 Transit Mode Evaluation and Recommendation

The transportation, environmental, and cost analyses presented in Chapters 5, 6, and 7 evaluated the transit modes against a wide variety of criteria. In the course of those analyses, it was found that many of the criteria were not differentiators amongst the transit modes. Thus, the analysis presented here is focused on those measures of performance that distinguish among the modes. As a result, some measures, while important considerations, are not presented here because each of the alternatives/options performed in a nearly equivalent manner for those measures.

The data provided in this section, while identified by alternative/option, have been grouped into five modes or combinations of modes (Figure 8-1): BRT, CRT, combined LRT/CRT, combined BRT/CRT, and LRT. The evaluation focuses on the modes based on what has been learned about each of them from the alternatives/options developed for this corridor. In this way, the selection of a preferred mode is not made in the abstract, but in the specific corridor in which it is to be carried forward. While this introduces variations, the availability of more than one alternative/option can provide a range of possible performance for the mode.

Mode	Alternative / Options		Rockland (Suffern ←)	Hudson Line Connection	Westchester (→ Port Chester)
BRT	3A	Full Corridor Bus Rapid Transit Westchester Local	In New BRT/HOT Lanes	Transfer	Exclusive Lanes/Busway
	3B	Full Corridor Bus Rapid Transit Westchester Express	In New BRT/HOT Lanes	Transfer	Exclusive Busway
CRT	4A	Full Corridor Commuter Rail Transit		Direct TZS	
	4A-X	Full Corridor Commuter Rail Transit		Transfer	
LRT & CRT	4B	Rockland Commuter Rail Transit Westchester Light Rail Transit		Direct TZS	
BRT & CRT	4C	Rockland Commuter Rail Transit Westchester Bus Rapid Transit		Direct TZS	Exclusive Lanes
	4D	Rockland Commuter Rail Transit Full Corridor Bus Rapid Transit	+ In New BRT/HOT Lanes	Direct	Exclusive Lanes/Busway
LRT	LRT	Full Corridor Light Rail Transit		Transfer	

Figure 8-1 Description of Alternatives/Options

8.1 Planning Context

Planning for this corridor has been underway for several years, and the complex conditions of the corridor have been subject to considerable analysis. It is a circumferential corridor around New York City, connecting New Jersey to Connecticut as a northern loop around New York City, with strong elements of radial movement both to Manhattan and crossing the corridor serving a variety of other movements:

- From Rockland and Orange to the Bronx and Westchester.
- From Westchester and Putnam to Bergen and Passaic Counties in New Jersey.
- From Fairfield and New Haven Counties in Connecticut to counties west of the Hudson.

The radial movements have all been served by commuter rail services for several decades, and these services are well established. Those that are west of the Hudson have connected to Manhattan via Hoboken, and more recently, via Secaucus. The ARC tunnel will provide a direct connection to 34th Street on the West Side. East of the Hudson, the focus has been on Grand Central Terminal (GCT) at 42nd Street and Park Avenue. Express bus services also connect the corridor to Manhattan, focusing on the Port Authority Bus Terminal for routes west of the Hudson.

Cross-corridor movements are now served by buses, operating in mixed traffic on I-287 and the parallel arterials (Routes 59, 119, and 120). With the introduction of HOV/HOT lanes on I-287, the opportunity exists to provide bus services with dependable speeds, better than existing highway speeds. The concept is extended beyond the HOV/HOT lanes by using dedicated lanes elsewhere in the corridor. These dedicated lanes can be incorporated into a number of bus routes that extend beyond the corridor to several destinations. The BRT routes can also connect with the radial commuter rail services at all crossing points.

The desire for CRT service in the corridor is based on several planning issues: there is an existing rail infrastructure that can be utilized to increase the usefulness of investments in new infrastructure; the potential development benefits of commuter rail are generally considered more desirable with the plans of corridor communities than LRT or BRT; and the perceived comfort level of CRT is superior to that of BRT or LRT. CRT, as defined in Alternative 4C and Option 4D, could be designed such that it would not preclude continuation across Westchester County to the New Haven Line as a future possibility. Finally, direct service to GCT for passengers originating west of the Hudson is attractive.

There has been an attempt to utilize the existing ROWs of I-287 for the alignment of all modes of transit, wherever possible, particularly within Rockland County, where it is more readily available. Both LRT and BRT also use roadway ROWs on other roads in the corridor. While these are publicly owned, they are currently used by traffic, and conversion to exclusive ROWs will have impacts.

The criteria examined below include transportation measures, environmental issues, and cost criteria. As discussed previously, the environmental criteria were not differentiators amongst modes.

8.2 Transportation Criteria

Transportation measures used in this evaluation included total daily transit ridership on the new service and travel-time benefits. The first measure – ridership on the new service – allows a comparison between the "local" transportation market and the Manhattan market.

8.2.1 Ridership on New Transit Services

Two major travel markets will be affected by the Tappan Zee Bridge/I-287 Corridor project: the east-west market, confined largely to the study corridor, and the market of those commuting to or from Manhattan. There are other markets, but these are the two largest. Figure 8-2 shows the number of riders on new services each mode could attract. There are differences among the modes, with the combined BRT/CRT mode estimated to attract more riders than either the CRT or the BRT modes separately. The differences between the BRT mode and the CRT mode were relatively slight, with BRT edging out CRT. Finally, the LRT mode was projected to attract the fewest riders. The BRT modes attract largely cross-corridor riders, while the CRT modes, with connections to Manhattan, attract a significant number of Manhattan-bound riders as well. The combined services in Option 4D attract large numbers in both markets.

Another measure of transit-mode ridership performance on the new service relates to those commuting to Manhattan. These numbers (Figure 8-2) include many current transit users who could be expected to start using the new services and stop using the existing ones. This is likely because the new alternatives/options prove more convenient or faster than the existing ones for those commuters. Figure 8-2 shows that the differences among the modes on this measure were substantial.

The combined BRT/CRT mode would have the highest daily ridership, and the gap between it and the BRT mode would be much greater than it was for overall transit ridership. However, the gap between the combined BRT/CRT mode and the CRT mode would actually reduce. This indicates that far more current riders of transit services would be moving onto the combined BRT/CRT mode than would be the case for just the BRT mode, at least in part because some of the CRT mode provides better service to Manhattan. So for this measure, the CRT mode passed the BRT mode. Finally, the LRT mode would be least effective for those headed to Manhattan.

8.2.2 Travel-Time Benefits

Travel-time benefits accrue when the new services take less time than the existing services. Services that are not subject to delays caused by traffic congestion save more time than those that operate in mixed traffic. As a result, all alternatives with rail service have greater time savings than those that are dependent on bus operations – even when the bus operates largely in dedicated ROWs. The combined BRT/CRT mode saves the most travel time. Quantitative comparisons of the travel time saved, in 2035, for the AM peak period are displayed in Figure 8-3.

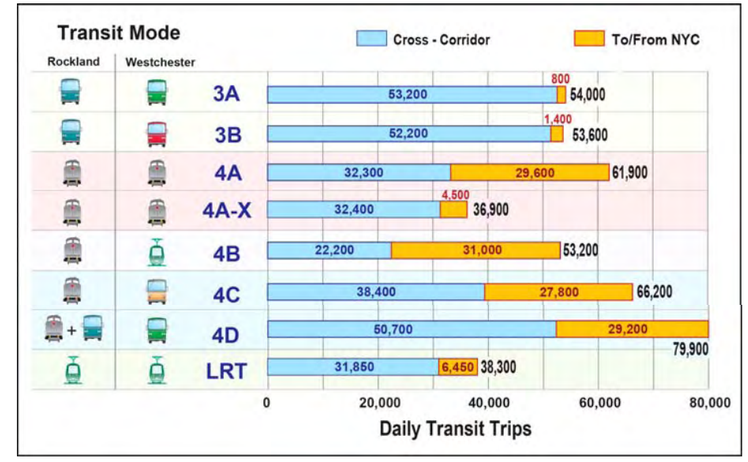

Figure 8-2 Ridership on New Transit Service (2035)

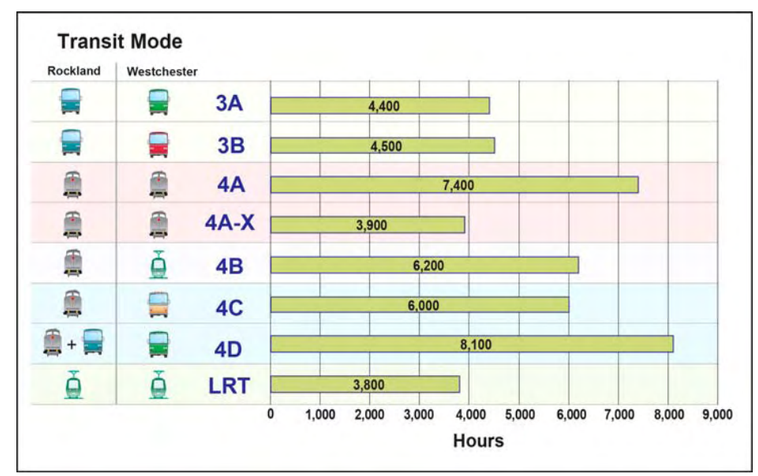

Figure 8-3 Travel-Time Savings (AM Peak Period, 2035)

8.3 Environmental Criteria

With respect to environmental criteria, the modes were generally similar (Table 8-1), largely because of the commonality of alignments and because most construction in Rockland occurs within existing Thruway right-of-way. In short, the differences over the 30-mile corridor were slight and unique to particular alternatives/options (i.e., they were not indicative of a mode's inherent characteristics). Thus, environmental criteria were not a differentiator in the transit mode recommendation.

Table 8-1

Potential Environmental Impacts/Benefits

Parameter	Impact or Benefit
Displacements	5 to 12 residential structures (Note: Option 3B had a much higher number of residential units than other modes). 10 to 20 commercial properties.
Wetlands	8 to 14 acres - most of the directly impacted wetlands are drainage courses that parallel I-287 and collect water running off the interstate. Several of the modes also impact, to a limited degree, wetlands adjacent to tributaries of several rivers.
Parklands/4f	Elizabeth Street Park, Tibbits Park, Yosemite Park, Parkways that I-287 crosses.
Historic and Archaeological Resources	4 to 7 properties: • National Historic Landmarks (Old Croton Aqueduct, Lyndhurst, and Sunnyside). • National Register-Listed (Palisades Interstate Parkway, Bronx River Parkway, Port Chester Station). • National Register-Eligible (Tappan Zee Bridge and the Piermont RR ROW). Other properties recommended eligible but not yet evaluated could be affected.
Hudson River Habitat Disturbance	10 to 15 acres (permanent) due to new or modified bridge foundations. 4 to 6 acres (temporary) associated with temporary work platforms that would be erected in the river to facilitate construction work.
Fuel Savings (2035, AM peak period, five-county area)	Savings of about 20,500 to 23,500 gallons from the 1,000,000 gallons of fuel used in the No-Build condition.
Air Emissions Reductions (2035, AM peak period, five-county area)	Reductions from the No-Build condition of: • 2 to 2.7 tons CO • 0.13 to 0.17 tons VOCs • 0.049 to 0.061 tons NOx • 0.004 to 0.005 tons PM10 • 0.002 to 0.003 tons PM2.5

8.4 Cost Criteria

The cost factors used in this evaluation are capital cost, annual operating costs and fare revenues, and cost per passenger and passenger-mile.

8.4.1 Capital Costs

Capital costs range from $1 billion to $15 billion (constant 2012 dollars). The HOV/HOT lanes will be built regardless of the transit mode selection to provide highway and existing transit improvements. For this reason, Figure 8-4, which displays transit mode capital costs, shows that BRT would be the lowest-cost mode. The modes that would have to provide their own guideways are BRT in Westchester, LRT, and CRT, with BRT and LRT requiring the least new guideway since ROWs could be shared with surface traffic in at least some areas. The combined BRT/CRT mode was the next least-expensive option, while the cross-corridor CRT would be the most expensive transit mode to build in the corridor.

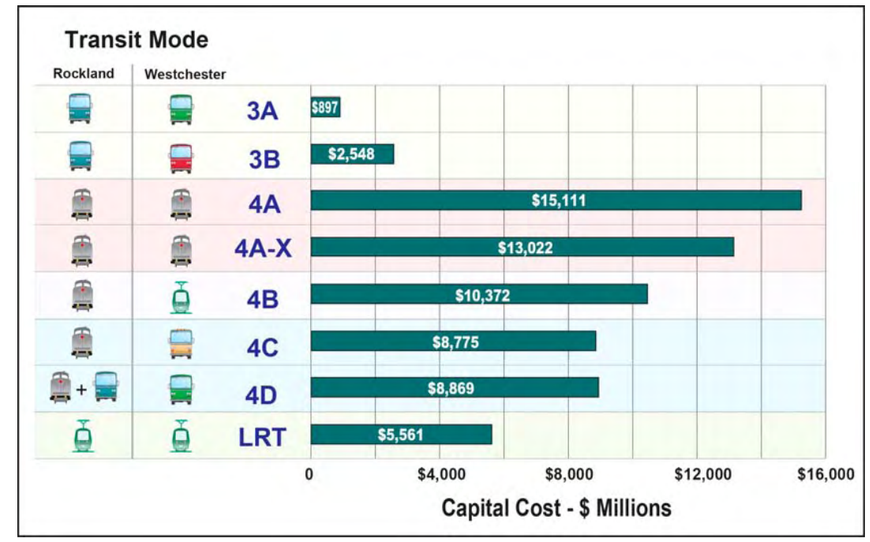

Figure 8-4 Transit Mode Capital Cost Estimate (year 2012 dollars)

8.4.2 Operating Costs and Fare Revenues

Figure 8-5 provides the projected annual operating cost for each of the alternatives/options. The CRT mode and the combined BRT/CRT mode are the alternatives/options that are most expensive to operate. LRT would have the next-lowest annual operating cost, while BRT is projected to be the least-expensive mode to operate.

Figure 8-5 also provides the projected fare revenue levels for the alternatives/options. In most cases, the more expensive modes garnered the higher revenues. The mode with the highest revenue potential is combined BRT/CRT, closely followed by CRT alone. BRT would generate far less revenue, followed by LRT. It should be noted that these figures are intended solely for comparative purposes, and are not intended for financial planning or analysis purposes.

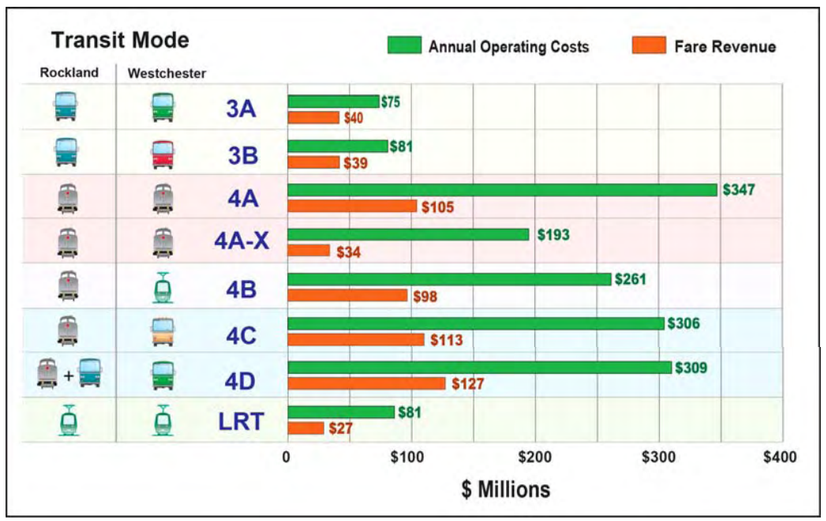

Figure 8-5 Transit Annual Operating Costs and Fare Revenues (2035)

8.4.3 Cost per Passenger and Passenger-Mile

Table 8-2 provides the cost/net cost per passenger and per passenger-mile for the modes. As discussed in Chapter 7, for each pair, cost is the sum of the annualized capital costs and annual operating cost, while net cost deducts the annual fare revenues. The lowest cost per passenger was achieved by BRT. The highest cost per passenger was recorded by CRT. Option 4A-X has the highest cost per passenger-mile, followed by full-corridor LRT. The lowest cost per passenger-mile was achieved by BRT.

Net costs range from approximately $6 per passenger to over $100 per passenger, and from less than $1 to over $5 per passenger-mile, with the BRT options having lower unit costs and Option 4A-X (cross-corridor rail without a direct connection to Manhattan) having the highest unit cost.

Table 8-2

Cost/Net Cost per Passenger and Passenger-Mile

Criterion	Mode by Alternative/Option							
	BRT		CRT		LRT/CRT	BRT/CRT		LRT
	3A Full-Corridor BRT Enhanced	3B Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	4A Full-Corridor CRT with Hudson Line (HL) Connection	4A-X Full-Corridor CRT without HL Connection	4B CRT in Rockland, HL Connection, LRT in Westchester	4C CRT in Rockland, HL Connection, BRT in Westchester	4D CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Cost per Passenger	$8.92	$17.03	$77.16	$103.23	$62.87	$46.68	$39.08	$43.51
Net Cost per Passenger	$6.39	$14.55	$71.36	$100.13	$56.52	$40.81	$33.66	$41.13
Cost per Passenger-Mile	$1.00	$1.77	$2.53	$5.52	$1.95	$1.73	$1.69	$2.54
Net Cost per Passenger-Mile	$0.72	$1.51	$2.34	$5.36	$1.75	$1.51	$1.45	$2.40

8.5 Recommendation

The recommendation of a transit mode has been developed within the context of the goals adopted for this study in the Scoping Process:

- **Goal 1:** Improve the mobility and accessibility of people, goods and services for the travel markets served by the Tappan Zee Bridge/I-287 Corridor. *All modes improve personal mobility – to differing degrees.*
- **Goal 2:** Maximize the flexibility and adaptability of new transportation infrastructure to accommodate changing long-term travel demand. *BRT is the most flexible mode, preserving CRT options provides maximum ability to meet changing demand.*
- **Goal 3:** Maintain and preserve vital elements of the transportation infrastructure. *Utilization of existing infrastructure enhances its preservation (e.g., Hudson and Port Jervis Lines).*
- **Goal 4:** Improve the safety and security of the transportation system. *CRT is the safest mode, followed by LRT and BRT. It has been established that CRT is the safest surface transportation mode (Federal Transit Administration, Commuter Rail Safety Study, November 2006), by virtue of its minimal interaction with other surface transportation modes and pedestrians.*
- **Goal 5:** Avoid, minimize, and/or mitigate any significant adverse environmental impacts caused by corridor improvements. *Initial environmental analysis indicated that none of the modes have significant unmitigatable environmental impacts and that environmental factors are not differentiators among the modes. (A more detailed environmental impacts analysis will be performed in the EIS.)*
- **Goal 6**: Develop feasible, cost-effective solutions that can be implemented within a reasonable time horizon. *Starting with BRT, while preserving the options for CRT, best meets this goal.*

Table 8-3 assigns a performance rating to each of the measures presented in the preceding analysis to arrive at an overall recommendation. The solid circles represent the highest-rated performers, while the three-quarters-hollow circles represent the lowest-rated performers. Ratings for quantitative measures were derived by applying the Quartiles method to the numerical results from the analysis. Ratings for the qualitative measures were derived by comparing the modes' performance to the elements within each goal.

The largest differences in the performance of the modes came in the financial measures, with the BRT mode able to be implemented and operated for far less of an investment than the rail modes. However, the BRT mode was also much lower on the revenue side. The combination of BRT/CRT was a consistently high-performing mode. When all the factors are considered, the summary rating indicated combined BRT/CRT and BRT alone were the highest-rated performers, followed by CRT and then LRT.

BRT better serves the circumferential movements, as it has the flexibility to reach destinations within and outside of the corridor. The CRT functions best when it uses existing infrastructure (Hudson Line) to reach Manhattan destinations. The combined BRT/CRT mode takes advantage of both. The LRT mode is less effective than BRT for cross-corridor movements and less effective than the other modes in serving Manhattan. All of the modes take advantage of the existing I-287 ROWs in Rockland County.

The transit mode selection analyses, therefore, conclude that the BRT mode offers the best opportunity to improve transit service and ridership in the corridor at the lowest cost. Implementing the combined BRT/CRT modes was also shown to offer significant benefits. The CRT mode alone was less effective than when complemented by BRT, while the LRT mode did not provide sufficient benefits to warrant further consideration.

Table 8-3

Summary Performance Ratings

Mode	BRT		CRT		LRT & CRT	BRT & CRT		LRT
Alternative/Option No.	3A	3B	4A	4A-X	4B	4C	4D	Full LRT
Goal 1: *Improve Mobility*	◕	◕	●	◔	◑	◕	●	◑
Goal 2: *Flexibility and Adaptability*	●	●	◕	◔	◑	◕	●	◑
Goal 3: *Vital Elements of the Transportation Infrastructure*	◕	◕	●	◑	◑	◕	◕	◑
Goal 4: *Improve Safety and Security*	◑	◑	●	◑	◑	●	●	◑
Goal 5: *Environmental Impacts*	◕	◕	◑	◑	◑	◕	◕	◑
Goal 6: *Feasible Cost - effective Alternatives*	●	◕	◑	◔	◑	◕	◕	◔
Daily Transit Trips for Selected Markets	◑	◑	◑	◑	◑	◑	◕	◑
Daily Transit Ridership on New Service	◑	◑	◕	◔	◑	◕	◕	◔
Capital Cost Estimate	●	◕	◔	◔	◔	◑	◑	◕
Cost/Passenger Mile	●	◕	◑	◔	◔	◑	◕	◔
Aggregate travel-time savings	◑	◑	◕	◔	◕	◕	●	◔
Summary Rating	◕	◕	◑	◔	◑	◕	◕	◑
Legend	*Very Good* ●		*Good* ◕		*Fair* ◑		*Poor* ◔	

Full-corridor BRT in combination with CRT is recommended because it best meets present and future travel demand and mobility needs. BRT/CRT provides the most flexibility to accommodate many markets and both the cross-corridor and New York City travel markets. The BRT/CRT recommendation is the transit solution that will fulfill the goals of this study by:

- Meeting corridor travel demand needs.
- Minimizing environmental impacts.
- Contributing to sustainable transportation and land use.
- Providing a flexible and adaptable transportation system with excess capacity to meet changing needs in the corridor.
- Enhancing quality of life in an energy-efficient and cost-effective manner.

8.6 Transit Components to be Studied in the DEIS

Full-corridor BRT from Suffern to Port Chester and CRT from Orange/Rockland to GCT will be studied in the DEIS at a Tier 1 level. As described in Chapter 1, the study will be performed at a planning level of detail, providing transportation and environmental analyses appropriate to a planning study and related decisions regarding transit mode(s), transit alignments, and logical termini. While proposed station locations are identified in this report, and will be analyzed at a planning level in the DEIS, it is important to note that these will form the basis for a corridor-level decision and, together with supportive infrastructure, will be subject to further studies as part of the Tier 2 transit analysis.

The DEIS analysis will include a range of reasonable alternatives likely to include the following components:

- **Bus Rapid Transit**
  - BRT/HOV Lanes in I-287 median, from Suffern and across the Tappan Zee Bridge.
  - BRT in exclusive guideway in I-287 ROW in Rockland.
  - BRT integrated into the existing street system in Westchester.
  - BRT in exclusive guideway in Westchester.
- **Commuter Rail Transit**
  - CRT in I-287 median; from Suffern and across the Tappan Zee Bridge, connecting to the Hudson Line.
  - CRT on south side I-287 ROW; from Suffern and across the Tappan Zee Bridge, connecting to the Hudson Line.