Appendix B: Transportation
B-9   Technical Report 2 – Transit

New York State Department of Transportation
New York State Thruway Authority
Metropolitan Transportation Authority/Metro-North Railroad

Technical Report 2

Transit

Tappan Zee Bridge/I-287 Corridor Project
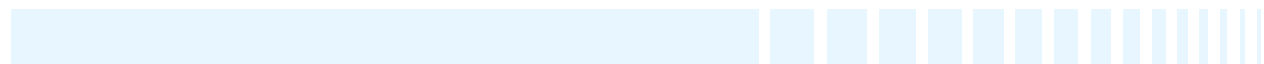**Draft Environmental Impact Statement**

April 2011

Metro-North
Railroad

New York State
Department of Transporation

Thruway
Authority

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LIST OF ACRONYMS AND ABBREVIATIONS

ARC	Access to the Region's Core
ATC	Automatic Train Control
BPM	Best Practice Model
CBD	central business district
CMT	Clarkstown Mini trans
ConnDOT	Connecticut Department of Transportation
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GCT	Grand Central Terminal
HAJ	Household Auto-Ownership Journey Frequency
IAM	Interim Analysis Model
MPO	Metropolitan Planning Organization
MTA	Metropolitan Transportation Authority
MDC	Mode-Destination Choice
MDSC	Mode Destination Stops Choice
NJT	New Jersey Transit
NJTPA	New Jersey Transportation Planning Authority
NYMTC	New York Metropolitan Transportation Council
NYSDOT	New York State Department of Transportation
OWL	Orange-White Plains Link
PTS	Positive Train Stop
PAP	Pre-Assignment Processor
RTF	Regional Travel Forecast
RMSE	root mean square error
SVJ	Spring Valley Jitney
TZX	Tappan ZEExpress
TOR	Transport of Rockland

1 Introduction

1 The Project Sponsors – New York State Department of Transportation (NYSDOT), New York State
2 Thruway Authority (NYSTA), and Metropolitan Transportation Authority/Metro-North Railroad (Metro-
3 North) – in cooperation with the Federal Highway Administration (FHWA) and the Federal Transit
4 Administration (FTA) are preparing a Draft Environmental Impact Statement (DEIS) for the Tappan Zee
5 Bridge/I-287 Corridor Project in Rockland and Westchester Counties, New York (NY). The DEIS
6 incorporates by reference and summarizes a series of technical reports addressing the technical disciplines
7 in detail. This technical report addresses the affected environment, impact of project alternatives, and
8 mitigation measures relevant to the topic of transit services and analyses, as well as travel demand
9 modeling in relation to highway improvements and the associated assessment of their impacts on future
10 traffic operations.
11
12 The purpose of the DEIS is to evaluate multimodal highway and transit alternatives that will address the
13 transportation and mobility needs of the 30-mile-long Tappan Zee Bridge/I-287 Corridor from
14 Hillburn/Suffern to Port Chester, NY. Additionally, the structural and security needs of the Tappan Zee
15 Bridge are evaluated, as are other existing highway improvement needs within the corridor. The DEIS
16 examines existing socioeconomic and environmental conditions within the corridor, evaluates potential
17 impacts of the transportation improvement alternatives (in addition to the No Build Alternative), and
18 investigates mitigation necessary to alleviate these impacts. The DEIS presents a tiered analysis of
19 environmental impacts: a Tier 1 transit analysis and a Tier 2 bridge and highway analysis.
20
21 The 30-mile corridor includes the 15-mile portion of Rockland County from Hillburn/Suffern to Nyack
22 on the Hudson River, the 3-mile river crossing, and the 12-mile section of Westchester County from
23 Tarrytown on the Hudson River to Port Chester on Long Island Sound. The corridor passes through the
24 cities and villages within the towns of Ramapo, Clarkstown, Orangetown, Greenburgh, White Plains,
25 Harrison, and Rye.
26
27 The study area for transit services is generally defined as the area within an approximately 1-mile zone
28 along either side of the 30-mile I-287 Corridor, including public transportation services that either operate
29 along the corridor itself or that intersect with the corridor (Figure 1-1). This report's discussions and some
30 of the associated figures extend well beyond the immediate vicinity of the project's study area, as public
31 transportation services that operate along this corridor or that intersect with the corridor may also likely
32 serve areas that are located outside the vicinity of the Tappan Zee Bridge/I-287 Corridor and its environs.
33

Figure 1-1 Study Area

34
35
36

The discussion of public transportation services in this technical report includes ridership statistics for the various transit modes available in the study area:

- Commuter rail transit (CRT) service operated by the Metro-North.

- Bus service operated by various transit providers, including both the Bee-Line System operated by Westchester County and the Transport of Rockland system.

Some information is also provided for various park-and-ride facilities located throughout the study area, as well as information on major improvements planned by Metro-North.

This report is organized into seven chapters, as follows:

- **Chapter 1: Introduction** – Provides background information on the reasons for the analysis and report organization.

- **Chapter 2: Background** – Provides summaries and background information on the development of the various transit alternatives, prior reports and the proposed bus and rail service plans.

- **Chapter 3: Affected Environment** – Provides information on existing transit services throughout the study area, including commuter rail service, bus service and an inventory of park-and-ride facilities. Major improvements planned for the commuter rail service are also discussed.

- **Chapter 4: Impacts** – Identifies potential impacts to or from the build alternatives related to the provision of public transportation services.

- **Chapter 5: Mitigation** – Proposes mitigation measures for any potential impacts to or from the build alternatives related to the provision of public transportation services.

- **Chapter 6: References** – Lists the references used in developing this report.

- **Chapter 7: List of Preparers** – Identifies the personnel who developed this report.

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2 Background

1 An essential element of the Tappan Zee Bridge/I-287 Corridor Project is to provide for increased mobility
2 in the study corridor, while focusing on operational and safety improvements to the highway network
3 rather than increases in capacity. Instead, the increase in long-term mobility would be provided by a series
4 of new public transportation services that would create more transportation options, while limiting
5 highway improvements to operational and safety improvements plus whatever actions would be needed to
6 accommodate these public transportation systems. In addition to improving local and regional mobility,
7 adding new public transportation options to the corridor would help minimize travel delay, foster
8 economic growth, reduce energy consumption, and improve air quality.

2.1 Development of Transit Alternatives

10 The first step in the development of the various transit alternatives was to define the different types of
11 public transportation services that could provide service in the Tappan Zee Bridge/I-287 Corridor. Several
12 public transportation modes were considered, including bus rapid transit (BRT), light rail transit (LRT),
13 and commuter rail transit (CRT). These transit modes could serve the corridor and its regional
14 connections in different ways, with each mode being better suited to certain trip types. Therefore, modes
15 were also considered in combination with each other in order to determine the best possible mobility
16 options for the study corridor.
17
18 The manner in which these different transit modes could provide service in the study corridor and the
19 ridership that each mode – or combination of modes – would attract was then more carefully examined in
20 the Transit Mode Selection Report (TMSR).
21

2.1.1 Transit Mode Selection Report

22 The TMSR examined the manner in which each mode or modal combination could provide public
23 transportation service in the Tappan Zee Bridge/I-287 Corridor. The TMSR documented baseline
24 conditions, including traffic counts, transit ridership, and transit operations to explore and forecast travel
25 behavior in the corridor.
26
27 The TMSR concluded that a combination of two public transportation modes would best serve the future
28 mobility needs of the corridor.
29

30 - CRT service between a new station at Hillburn on the existing Metro-North Port Jervis Line and
31   Grand Central Terminal in Manhattan. The CRT alignment would cross Rockland County in the
32   Thruway corridor, cross the replacement Tappan Zee Bridge, and connect to the existing Metro-
33   North Hudson Line. This new CRT service would connect Rockland and Orange Counties with
34   the east side of Manhattan.
35

36 - BRT service that would operate across the I-287 Corridor between Hillburn in Rockland County
37   and Port Chester in Westchester County, crossing the replacement Tappan Zee Bridge. This new
38   BRT service would provide a new mobility option across the corridor of a quality and reliability
39   that is presently unavailable.

2.1.2 Transit Alignment Options Report

40 Once the two new public transportation services were selected in the TMSR, the manner in which the new
41 BRT service would be provided in both Rockland and Westchester Counties defines the differences
42 among the four build alternatives described below. The DEIS examines these five alternatives:
43
44   ▪   **Alternative A – No Build** – Consistent with National Environmental Policy Act (NEPA)
45   requirements, a No Build Alternative will be analyzed in the DEIS. The key components of the
46   No Build Alternative are maintenance of the bridge structure and highway to avoid unacceptable
47   levels of deterioration that would lead to operational and safety deficiencies, and the inclusion of
48   the proposed projects listed in the latest Transportation Improvement Program (TIP), including
49   highway improvements in Westchester County. The TIP includes those projects contained within
50   the fiscally constrained portion of the Long Range Transportation Plan (LRTP) for the region.
51
52   ▪   **Alternative B – Full-Corridor Busway and Rockland CRT** – Alternative B would provide
53   BRT service between Hillburn and Port Chester in a busway (i.e., a roadway constructed for the
54   exclusive use of buses), and CRT service in Rockland County.
55
56   ▪   **Alternative C – Busway/Bus Lanes and Rockland CRT** – Alternative C would provide BRT
57   service between Hillburn and Port Chester, via a busway in Rockland County and across the
58   bridge and in dedicated bus lanes in Westchester County, as well as provide CRT service in
59   Rockland County.
60
61   ▪   **Alternative D – HOV/HOT/Busway and Rockland CRT** – Alternative D would provide BRT
62   service between Hillburn and Port Chester, via BRT service in HOV/HOT lanes in Rockland
63   County and across the bridge and in a busway in Westchester County, as well as provide CRT
64   service in Rockland County.
65
66   ▪   **Alternative E – HOV/HOT/Bus Lanes and Rockland CRT** – Alternative E would provide
67   BRT service between Hillburn and Port Chester, via BRT service in HOV/HOT lanes in
68   Rockland County and across the bridge and in dedicated bus lanes in Westchester County, as well
69   as provide CRT service in Rockland County.
70
71 The project's replacement bridge and common highway improvements in Rockland County (e.g.,
72 climbing lanes, auxiliary lanes, etc.) would be completed by 2017, while the proposed transit
73 improvements are scheduled to be completed by 2047. As shown, Alternatives B and C would have BRT
74 vehicles operating in a separate busway in Rockland County and across the bridge into Westchester
75 County, while they would operate in HOT/HOT lanes in Rockland County and across the bridge under
76 Alternatives D and E. The DEIS also analyzes these same two groups of alternatives (B-C and D-E) in
77 2017 and 2047 without transit modes to highlight the differences in highway operations without
78 HOV/HOT lanes (under Alternatives B and C) and with HOV/HOT lanes (D and E) in both those analysis
79 years.
80
81 The Transit Alignment Options Report (TAOR) examines the manner in which the specific alignment for
82 each transit mode is provided within each alternative. For example, for the proposed CRT service, the
83 TAOR specifies if the rail alignment should generally be located in the median or along the south side of
84 the Thruway for each of the four build alternatives.
85

86 Similarly, for the proposed BRT service in Rockland County, the TAOR specifies if the busway would
87 generally be located along the north or south side of the Thruway for the busway alternatives. Finally, for
88 the proposed BRT service in Westchester County, the TAOR specifies the location of the busway and bus
89 lane alignments for each of the four build alternatives, including their location through the White Plains
90 central business district. The alignments selected for analysis in the DEIS is based on the results of those
91 TAOR studies.

2.2 Bus and Rail Service Plans

2.2.1 Alignment Planning

93 The transit alignments developed in the alternatives analysis – both the cross-corridor BRT alignment and
94 the CRT alignment between Hillburn and the Metro-North Hudson Line – were intended to link all five
95 existing north-south regional commuter rail lines in the corridor by providing either a direct connection
96 with these lines or a relatively convenient transfer with them. Station locations were selected based on
97 several planning factors and corridor conditions and constraints, including:

99 ▪ Proximity to residential population/commercial/retail centers.
100 ▪ Local land use plans.
101 ▪ Proximity to I-287 interchanges and major arterials.
102 ▪ Proximity to existing north/south commuter rail lines.
103 ▪ Availability of undeveloped land and avoidance of significant property acquisition.
104 ▪ General topographic features.
105 ▪ Potential impacts to existing infrastructure, including major utilities.

107 The particular planning issues for each of the proposed modes are then summarized.

2.2.1.1 Commuter Rail Transit Alignment and Stations

109 The proposed CRT alignment between the Metro-North Port Jervis Line at Hillburn and the Hudson Line
110 via the replacement Tappan Zee Bridge has been developed to connect to the existing CRT infrastructure
111 at Hillburn and take advantage of the available rights-of-way within both the Thruway corridor and along
112 the Piermont Line between Suffern and Airmont. The Piermont Line is a freight railroad alignment that
113 parallels certain portions of the Thruway corridor, and can provide a useful alignment for future rail
114 improvements in selected locations.

116 After the analysis of a number of locations, three CRT stations were proposed between the Port Jervis
117 Line and the Hudson Line at Hillburn, Interchange 14, and the Palisades Center Mall.

2.2.1.2 Bus Rapid Transit Alignment and Stations

119 The concept of BRT has gained considerable support and momentum as a cost-effective transit solution
120 throughout the country and around the world, as it combines much of the reliability of rail modes with the
121 flexibility of bus operations. In a similar manner, the development of the BRT service plan for this project
122 represents how this concept has evolved through the planning process.

124 The proposed infrastructure improvements for this project have largely been limited to the I-287 Corridor,
125 except when it is necessary to serve the White Plains central business district. However, the BRT services
126 themselves are not limited to the corridor and can extend many miles from it. The proposed BRT services
127 will likely incorporate and modify some existing services that would logically benefit from the
128 infrastructure improvements provided.
129

2.2.2 Agency Coordination

130 The existing transit services in and near the corridor were inventoried and analyzed at the inception of the
131 service planning process. Current Metro-North operating practices east of the Hudson were applied to
132 West-of-Hudson services. Transfer centers were identified, ridership concentrations observed, and links to
133 other services determined. In particular, the role of the White Plains Transportation Center as a hub of
134 services in central Westchester County was understood. Initial proposals for BRT and CRT service across
135 the corridor were presented to the planners and operators of transit in the corridor, specifically:
136

137 ▪ Rockland County planners and Transit of Rockland operators.
138 ▪ Westchester County planners and Bee-Line operators.
139 ▪ Orange County planners.
140 ▪ New Jersey Transit.
141

142 A workshop was held in September 2007 to discuss implementation of BRT in the corridor. A major
143 change resulting from that workshop was the concept of a "trunk service" with frequent operation
144 throughout the day serving all stops on the trunk route. Additional service was then provided with feeder
145 buses that joined the trunk route during peak periods or at other times, thus providing areas not
146 necessarily located directly along the corridor with the ability to enjoy "one-seat rides," or service with
147 fewer transfers. Service plans were revised as a result.
148

2.2.3 Route Characteristics and Service Plan Concepts

149 The CRT routes developed as part of the service plan were all functional extensions of Metro-North's
150 Port Jervis Line across Rockland County. The routes suggested at the conclusion of the TMSR would
151 continue across the Hudson River on the replacement Tappan Zee Bridge to connect to the Hudson Line,
152 but without a new station in Tarrytown. Services provided would originate at Port Jervis, Harriman, and
153 Hillburn during the peak period. The first two services would operate as express services without stopping
154 at the new CRT stations across the corridor, while the third would stop at all the new CRT stations in the
155 corridor before continuing as an express service to Manhattan. The CRT service plan is shown
156 conceptually in Figure 2-26 in Chapter 2 of the EIS Description of Alternatives).
157

158 The initial effort was to develop a BRT facility within the defined project corridor. In Rockland County,
159 the concept of a two-lane expansion of I-287, with the center lanes for BRT shared with other high-
160 occupancy vehicles (HOV) and/or premium toll paying vehicles (i.e., a HOV/HOT lane) was developed
161 and refined. That concept was not applied to Westchester County due to previous studies that rejected
162 HOV in that corridor. Instead, routings using exclusive lanes on parallel county arterials or in a separate
163 busway, independent of I-287, were developed. Based on the conclusions in the TMSR, a separate
164 busway (as an alternative to HOV/HOT lanes) is also being evaluated within the Thruway right-of-way in
165 Rockland County and across the bridge to Westchester County.
166

167 The service plans in the TMSR were developed with the assistance of the transportation planners in
168 Westchester, Rockland, and Orange Counties. The plans incorporated a number of existing bus services,
169 routing them so that they utilized the infrastructure improvements developed for the BRT trunk line when
170 they were in the corridor, while retaining their current operating characteristics when they left the
171 corridor. For example, the Orange Westchester Link (OWL) bus currently operates between Middletown
172 in Orange County and the White Plains Transportation Center. Much of that route is in the I-287 Corridor,
173 and for that portion of the route the service plan calls for the OWL to be operated as BRT, stopping at
174 designated BRT stations and operating at highway speeds on reserved rights-of-way between stops. For
175 the remainder of the route, operation in mixed traffic (largely on I-87) was maintained.
176

2.2.4 Trunk Line Station Locations

177 Station locations along the proposed alignment were determined using the existing services in the corridor
178 as a basic starting concept, the structure of the physical improvements as a limitation, and the desire to
179 provide services to selected focal points across the corridor as a guiding principle. As a result of the BRT
180 Workshop held in September 2007 held by the Project Sponsors, the major cross-corridor BRT route was
181 designated as the trunk line. It would operate between Hillburn and Port Chester exclusively on dedicated
182 BRT guideways at frequent headways throughout the day. The trunk route would serve all stations.
183

184 Feeder routes would operate from off-corridor termini to the trunk line. They would utilize the BRT
185 facilities to access their destinations, exiting the facilities at the nearest exit, and using local streets to
186 reach their destination. During off-peak periods, feeder services could possibly be terminated at a trunk
187 station, with transfers provided to the more-frequent trunk service.
188

189 The proposed CRT and BRT stations would be served not only by the new transit services, but also by the
190 existing underlying local bus services in both Rockland and Westchester Counties. In addition, several of
191 the newly proposed stations would also be served by private commuter bus services (e.g., such as Coach
192 USA Short Line, Coach USA Red & Tan Lines, or Monsey Trails), which connect portions of the study
193 area with New York City. Although both of these types of services would serve the proposed stations,
194 they would not utilize the BRT trunk line but would serve these stations for intermodal transfer purposes.
195

196 There are also several intercity bus services that operate between locations in upstate New York and New
197 York City which utilize roadways in the study area. Depending upon the route and the preference of the
198 operator, some of these intercity services may or may not serve the proposed stations; however, if they do
199 serve a proposed station they would likely not be utilizing the BRT trunk line but would instead be
200 serving these stations for intermodal transfer purposes.
201

2.2.5 Proposed Rockland County Station Locations

202 Stations that were considered and included in the BPM travel demand forecast modeling that led
203 to the selection of BRT as a transit mode are described below. The station discussions review the
204 underlying local transit connections at each station in addition to the BRT routes, but not the
205 private commuter or intercity services in those areas.
206

2.2.5.1 Hillburn Multi-Modal Station

207 It was determined early in the study that connection to the NJ Transit Suffern Station was not feasible for
208 a route turning east off the Port Jervis Line. Therefore, a common CRT station north of the junction was
209 proposed at the location of an existing rail yard in Hillburn (and near Interchange 15A on the Thruway).
210 This station is accessible to Suffern but requires backtracking for those headed east or south; it would be
211 accessed from State Route 59 about two-thirds of a mile north of central Suffern. The Hillburn Station has
212 the potential to be the transfer station between NJ Transit and Metro-North services, if NJ Transit services
213 that now terminate in Suffern can continue one more stop north and instead terminate at Hillburn. Station
214 configuration has been developed, with platforms that allow cross-platform transfers, and there is space
215 available for a park-and-ride facility.
216
217 This station would also serve as the western terminus of the BRT trunk line. The specific station location
218 would be developed as part of future Tier 2 environmental planning efforts for these transit elements. For
219 modeling purposes was co-located with the proposed Hillburn Station for the CRT service, near
220 Interchange 15A on the Thruway.
221
222 TOR Routes 59 and 93, Monsey Loop L3 and the Tappan Zee Express all serve central Suffern, and it is
223 the western terminus of the Tappan Zee Express, TOR Route 59 and Monsey Loop L3. TOR Route 59
224 and Monsey Loop L3 would both likely be extended to serve the proposed Hillburn Station, which would
225 also be served by TOR Route 93, as the Hillburn Station would be an important intermodal facility. BRT
226 Route T (i.e., the trunk service) would originate at the Hillburn Station, as would BRT Routes B and C.
227 BRT Route C would replace the Tappan Zee Express, which would now originate at the Hillburn Station
228 and then operate to points east along the BRT trunk line as far as White Plains.
229

2.2.5.2 Airmont Road BRT Station

230 A BRT station at Airmont Road east of Suffern, serving the eastern Suffern area, the hospital and Avon,
231 was a logical location for a station. The precise location will depend on the route alignment option
232 selected between Hillburn and this location for either the HOV/HOT lane alternative or for the busway
233 alternative.
234
235 Locations on Airmont Road are currently served by Monsey Loop L3, which would also provide a local
236 transit connection to the Airmont Road Station. BRT Route A, which replaces the current Orange-
237 Westchester Link (OWL) bus, would access the BRT trunk line to and from Middletown via the Airmont
238 Station and would then operate east along the BRT trunk line as far as White Plains.
239

2.2.5.3 Monsey BRT Station

240 State Route 59 crosses the Thruway in Monsey, and the location provides an opportunity for a BRT
241 station along the 4-mile corridor section between Airmont Road and Interchange 14. In addition to
242 serving the Monsey community with direct access off of State Route 59, this location would allow the
243 buses on State Route 59, including TOR Route 59 and Monsey Loop L3, to provide a transfer to the BRT
244 system. In addition, Monsey Loop L1 and L2 would both likely be extended to serve the proposed
245 Monsey Station. If the proposed Interchange 14X is constructed at this location, the opportunity for buses
246 to directly enter the BRT facility might also be possible. There may also be an opportunity for park-and-
247 ride facilities.

2.2.5.4 Interchange 14 Multi-Modal Station

248 Many current transit services (including TOR Routes 91, 92 and 94) originate in Spring Valley at the
249 Pascack Valley Line NJ Transit Station and its park-and-ride lot, which is located approximately 1 mile
250 north of Interchange 14 in central Spring Valley. This train station is also served by TOR Route 59 and
251 the Spring Valley Jitney, and BRT Routes E, F and G will originate here and operate between Spring
252 Valley and the proposed Interchange 14 Multi-Modal Station before continuing east along the BRT trunk
253 line. In addition, BRT Route D will originate in Mount Ivy and serve the Spring Valley Station en route to
254 and from the proposed Interchange 14 Multi-Modal Station and points east along the BRT trunk line.
255
256 TOR Route 59, the busiest route in the TOR system, passes through the complex of park-and-ride lots at
257 Interchange 14, and TOR Route 93 and the Spring Valley Jitney both also serve the Interchange 14 area.
258 Therefore, the area at Interchange 14 is an obvious focal point for the transit services connecting to the
259 current local routes and serving the communities surrounding Spring Valley – a particularly transit
260 dependent market. The Interchange 14 area would also serve the BRT trunk line and CRT services, given
261 the proposed station location here. TOR Routes 59 and 93, and the Spring Valley Jitney, would therefore
262 serve the Interchange 14 Multi-Modal Station for intermodal transfer purposes, while TOR Route 59 and
263 BRT Routes D, E, F and G would connect the proposed Interchange 14 Multi-Modal Station with the
264 Spring Valley Station.
265
266 New or existing bus services originating at the Spring Valley NJ Transit Station would be able to enter
267 the BRT trunk line at the proposed Interchange 14 Multi-Modal Station as well. At the proposed
268 Interchange 14 Multi-Modal Station, BRT Routes D, E, F and G would access the BRT trunk line. BRT
269 Route E would replace the current Spring Valley variation of the Tappan Zee Express and would then
270 operate east along the BRT trunk line as far as Tarrytown. In addition, BRT Route K to and from Bergen
271 County in northern New Jersey would also access the BRT trunk line at the proposed Interchange 14
272 Multi-Modal Station and would then operate east along the BRT trunk line.
273
274 The BRT and CRT stations at Interchange 14 would be linked to each other and to the park-and-ride lots.
275 The exact station locations and configuration will depend on the time-frame for the implementation of
276 CRT in the corridor and the design of the BRT access to either the trunk line busway or the HOV/HOT
277 lanes.
278
279 Consideration was also given to a station that could provide transfer facilities between the new transit
280 services and the Pascack Valley Line directly at Interchange 14, which would require a new station on the
281 Pascack Valley Line as well. Coordination with the Interchange 14 BRT Station is easier for a station
282 located closer to the interchange. The proximity of the Spring Valley Station on the Pascack Valley Line
283 and the curvature on the Pascack Valley Line track complicates the location for a new Pascack Valley
284 Line station that, in any event, would be most productive with northbound service in the morning peak
285 and southbound service in the afternoon peak. With the recently constructed bypass tracks, those services
286 are possible.
287

2.2.5.5 Palisades Mall Multi-Modal Station

288 Rockland County planners have consistently emphasized the importance of the Palisades Center Mall as
289 the focal point of development in this part of the county, and the importance to transit of Parking Lot J,
290 which is the ancillary parking lot on the west end of the mall. Both Lot J and the mall itself are stops on
291 TOR Routes 59, 91, 92 and 97, Clarkstown Mini-Trans Routes A and D, as well as the Tappan Zee

292 Express and the previously mentioned private express buses to Manhattan; Lot J is therefore used as a
293 park-and-ride facility. The planners were particularly concerned that express or BRT transit services
294 traversing Rockland County be able to stop at the Palisades Center Mall from either direction, and that
295 local services would also feed this focus.
296
297 The CRT alignment would also include a station at this location, creating a multi-modal facility
298 connecting the CRT and BRT modes with each other as well as with the underlying local transit services.
299 There has been some discussion as to whether the transit station should be more centrally located at the
300 mall entrance rather than at Parking Lot J, but that is a design detail to be worked out with local and mall
301 planners, along with the design of the CRT station and BRT trunk line (i.e., busway or HOT/HOV lane)
302 access.
303
304 The proposed Palisades Mall Multi-Modal Station would be the last CRT stop in Rockland County,
305 serving the entire eastern portion of the county for CRT access. Future opportunities for transit-oriented
306 development (TOD) in the vicinity of the Palisades Center Mall exist with the redevelopment of mall
307 parking, and other underutilized commercial sites on State Routes 59 and 303.
308
309 In addition, BRT Routes I (to and from Haverstraw) and H (to and from New City) would also access the
310 BRT trunk line at the proposed Palisades Mall Multi-Modal Station and would then operate east along the
311 BRT trunk line.
312

2.2.5.6 Nyack/Interchange 11 BRT Station

313 Local planners have expressed a desire for access between Nyack and the BRT service (which would be
314 provided at the proposed Interchange 11 Station by TOR Routes 91 and 92), as well as access for buses
315 traveling along Route 9W to the BRT trunk line at Interchange 11. BRT Route J would replace the
316 portion of the current Tappan Zee Express serving Nyack and would then operate east along the BRT
317 trunk line as far as Port Chester. Nyack officials have suggested a BRT station would help revitalize this
318 "gateway area" of Nyack; therefore, a station located where State Route 59 crosses beneath the Thruway
319 is proposed. As was previously mentioned, Nyack is currently served by TOR Routes 91 and 92.
320
321 A station at Interchange 10 was also considered but rejected, because it was not readily accessible for
322 feeder buses, drivers or pedestrians, and the difficulty of locating a park-and-ride facility in the vicinity of
323 the interchange.
324

2.2.6 Proposed Westchester County BRT Station Locations

325 The proposed BRT stations in Westchester County are described below. No new CRT stations are
326 proposed in Westchester County.
327

2.2.6.1 Broadway Station and Tarrytown Multi-Modal Station

328 After crossing the replacement Tappan Zee Bridge, the CRT alignment would connect directly with the
329 Hudson Line and continue to Grand Central Terminal on the east side of Manhattan. However, the BRT
330 alignment would exit the replacement Tappan Zee Bridge and continue east across Westchester County.
331

332 Whether the busway or the bus lane alternative is selected in Westchester County, a series of busways
333 would be constructed at the eastern end of the replacement Tappan Zee Bridge. This would allow buses
334 operating eastbound along the BRT trunk line on the replacement bridge to directly access either the
335 Broadway Station or the existing Tarrytown Station on the Hudson Line. After serving the Tarrytown
336 Station, BRT buses could then also serve the Broadway BRT Station before continuing east.
337
338 In the westbound direction, buses operating along the BRT trunk line would serve the Broadway BRT
339 Station and then be able to directly access either the existing Tarrytown Station or the replacement
340 Tappan Zee Bridge. After serving the Tarrytown Station BRT buses can then directly access the
341 replacement bridge before continuing west. This complex series of connections is made possible via a
342 proposed dedicated busway (i.e., the Tarrytown Connector), which provides a new route between the
343 replacement Tappan Zee Bridge, the proposed Broadway BRT Station, and the existing Tarrytown Station
344 via an alignment adjacent to the existing Hudson Line right-of-way.
345
346 Service to central Tarrytown, and, specifically, improved access to the Tarrytown Station, has been a goal
347 of the project from its inception. The area near the Tarrytown Station serves some denser residential
348 developments, as well as office and retail concentrations; in the future, there may be some modest
349 potential for additional TOD in this area.
350
351 The Tarrytown Station is currently the focus of multi-modal transit services in Tarrytown, including the
352 Tappan Zee Express, Bee-Line Routes 13/13B (the major cross-corridor Bee-Line route), 1T (which
353 provides north-south service along Route 9), and Shuttle Loop T (which connects the Tarrytown Station
354 with several local office parks). The Tarrytown Station would continue to be served by these Bee-Line
355 services. In addition, the Tarrytown Station would be the eastern terminus of BRT Route E (which
356 replaces the existing Tappan Zee Express), and BRT Route L – which replaces the current Bee-Line
357 Route 11 service – would access the BRT trunk line to and from Ossining and Croton via the Tarrytown
358 Station and would then operate east along the BRT trunk line as far as White Plains.
359
360 BRT trunk line routes would remain on a busway at the eastern end of the Tappan Zee Bridge where the
361 proposed Broadway Station would serve the vicinity of Broadway and the various developments near
362 State Route 119. Local transit access to the Broadway Station will be provided by Bee-Line Routes 1T,
363 1W, 13 and Shuttle Loop T. The Leprechaun Connection (TLC) bus service between Poughkeepsie and
364 White Plains will also provide access to the Broadway Station. In addition, BRT Route F to and from
365 Yonkers and the Bronx via Route 9 will also access the BRT trunk line at the proposed Broadway Station
366 and would then operate west along the BRT trunk line.
367

2.2.6.2 Meadow Street BRT Station

368 The next proposed BRT station is located at Route 119 and Meadow Street; it should be noted that this
369 proposed station is only anticipated as part of the bus lane alternative in Westchester County.
370
371 While the next station further east (at Benedict Avenue) serves major office parks, and the next station
372 further west (at Broadway) serves a commercial center, Meadow Street serves as an intermediate stop.
373 Meadow Street is the only north-south connector between Route 9 and Interchange 8, providing access to
374 the Sheldon Avenue residential neighborhood south of I-287, as well as several office developments on
375 Route 119 (i.e., Reckson Corporation Offices and Talleyrand Office Park) and several residential
376 developments (i.e., Sleepy Hollow and Talleyrand Crescent).
377

378 Local transit access to the proposed Meadow Street Station would be provided by Bee-Line Routes 1W,
379 13 and Shuttle Loop T. The Leprechaun Connection (TLC) bus service between Poughkeepsie and White
380 Plains will also provide access to the Meadow Street Station.
381

2.2.6.3 Benedict Avenue BRT Station

382 The proposed Benedict Avenue Station would serve the office parks, hotel development and other
383 commercial properties in eastern Tarrytown and western Greenburgh, including the offices of Bayer
384 Pharmaceuticals. The nature of the office parks is such that a single stop is a lengthy walk from all office
385 entrances; the possibility of private shuttle services emanating from the stop to the office entrances makes
386 it a logical location for a station nonetheless.
387
388 Local transit access to the proposed Benedict Avenue Station would be provided by Bee-Line Routes 1W,
389 13/13B and Shuttle Loops F and T. The Leprechaun Connection (TLC) bus service between
390 Poughkeepsie and White Plains will also provide access to the Benedict Avenue Station.
391

2.2.6.4 Elmsford West (State Route 9A) BRT Station

392 Elmsford has redevelopment plans for the Route 9A-North Central Avenue corridor, and there is a
393 potential for TOD in the underutilized industrial district of Elmsford north of I-287. In addition,
394 NYSDOT Region 8 is advancing the Route 9A Truck Bypass project that impacts this area. This station is
395 intended to support those plans and provide access for BRT feeder buses (i.e., BRT Routes O and G)
396 traveling on State Route 9A to the BRT trunk line.
397
398 As mentioned above, BRT Routes O (to and from Yorktown and Carmel, and replacing the Bee-Line
399 Route 77) and G (to and from Hawthorne) would access the BRT trunk line at the proposed Elmsford
400 West Station and would then operate along the BRT trunk line – Route O east to White Plains, and Route
401 G west to Spring Valley.
402
403 Local transit access to the proposed Elmsford West Station would be provided by Bee-Line Routes 1C,
404 1W, 5, 13/13B, 14 and 27. The Leprechaun Connection (TLC) bus service between Poughkeepsie and
405 White Plains will also provide access to the Elmsford West Station.
406

2.2.6.5 Elmsford East (Knollwood Road) BRT Station

407 The commercial focus on Route 119 suggests a station be located in this vicinity since the inception of the
408 planning process – logically located between Tarrytown and White Plains with opportunities for park-
409 and-ride and attraction for non-work trips.
410
411 Local transit access to the proposed Elmsford East Station would be provided by Bee-Line Routes 1C,
412 1W, 3, 5, 13/13B, 14, 15 and 27. The Leprechaun Connection (TLC) bus service between Poughkeepsie
413 and White Plains will also provide access to the Elmsford East Station.
414

2.2.6.6 Hillside Avenue BRT Station

415 The Greenburgh municipal offices are located on Hillside Avenue just north of I-287 at Exit 5, along with
416 some commercial offices. There appear to be opportunities to develop a station here that serves the
417 community.
418
419 BRT Route B would not operate along the BRT trunk line between the proposed Hillside Avenue Station
420 and the proposed White Plains Avenue Station, thus bypassing central White Plains. Therefore, it would
421 access the BRT trunk line at the proposed Hillside Avenue Station.
422
423 Local transit access to the proposed Hillside Avenue Station would be provided by Bee-Line Routes 1C,
424 1W, 3, 5, 6, 13/13B, 14, 15, 27, 40 and 41. The Leprechaun Connection (TLC) bus service between
425 Poughkeepsie and White Plains will also provide access to the Hillside Avenue Station.
426

2.2.6.7 Westchester County Center BRT Station

427 The intersection of Route 119 and Central Park Avenue (Route 100) is a commercial location with
428 significant activity. The Bee-Line bus routes operating along Central Park Avenue – Routes 20, 21 and
429 the BxM4C Westchester-Manhattan Express all enter White Plains through this intersection. Westchester
430 County is implementing BRT in the Central Park Avenue corridor and the proposed County Center BRT
431 Station could be a suitable transfer point between this service and the proposed Hillburn-Suffern BRT
432 service. Additionally, the Westchester County Center frequently attracts large numbers of visitors, and
433 should be accessible with transit.
434
435 BRT Route N (to and from Yonkers and the Bronx, replacing the Bee-Line Route 21) would access the
436 BRT trunk line at the proposed Westchester County Center Station and would then operate along the BRT
437 trunk line as far east as Port Chester. BRT Route N service between White Plains and Port Chester along
438 the BRT trunk line would be an extension of the proposed Central Park Avenue BRT service.
439
440 Local transit access to the proposed Westchester County Center Station would be provided by Bee-Line
441 Routes 1C, 1W, 3, 5, 6, 13/13B, 14, 15, 17, 20, 27, 40, 41, Shuttle Loop F and the BxM4C. The
442 Leprechaun Connection (TLC) bus service between Poughkeepsie and White Plains will also provide
443 access to the Hillside Avenue Station.
444

2.2.6.8 White Plains Transportation Center

445 This is the primary multi-modal transfer facility in the I-287 Corridor, connecting a large number of Bee-
446 Line bus routes (including Bee-Line Shuttle Loops), the Tappan Zee Express, the Orange-Westchester
447 Link (OWL) bus and the CT Transit I-Bus between White Plains and Stamford with the Metro-North
448 Railroad's Harlem Line White Plains Station. The White Plains Transportation Center also serves the
449 western end of central White Plains.
450
451 Several of the proposed BRT routes would terminate at the White Plains Transportation Center, including
452 BRT Routes A, C, H, I, L, M, O and P. BRT Route M replaces the Bee-Line Route 62 service; it travels
453 between White Plains and Fordham in The Bronx east along the BRT trunk line until it accesses Interstate
454 95. BRT Route P replaces the CT Transit I-Bus service; it travels between White Plains and Stamford east
455 along the BRT trunk line until it also accesses Interstate 95.

456 Because this facility is a major focal point for public transportation in the study corridor, local transit
457 access would continue to be provided by several Bee-Line bus routes and other transit providers, unless
458 the bus route is replaced by one of the proposed BRT services.
459

2.2.6.9 Galleria Mall BRT Station

460 A BRT stop in central area of downtown White Plains is desirable, due to the distance between the
461 eastern and western ends of the central business district. Its exact location will depend on the routing of
462 the BRT through White Plains, the routing of other buses through White Plains, decisions on street usage,
463 signal timing and a variety of other factors, all to be coordinated with White Plains and Westchester
464 County planners and traffic engineers. Currently nearly every bus entering White Plains passes through
465 the intersection of Main Street and Martin Luther King, Jr. Boulevard and uses Main Street and Martine
466 Avenue as the eastbound and westbound routes through downtown, respectively.
467

468 Because the White Plains central business district is a major focal point for public transportation in the
469 study corridor, local transit access will continue to be provided by several Bee-Line bus routes and other
470 transit providers, unless the bus route is replaced by one of the proposed BRT services.
471

2.2.6.10 Westchester Mall BRT Station

472 A BRT stop near the Westchester Mall provides ready access to the commercial and office activity on the
473 eastern end of the White Plains central business district, where traffic is funneled into the Westchester
474 Avenue/I-287 corridor. Local transit access to the proposed Westchester Mall Station would be provided
475 by Bee-Line Routes 3, 12, 13/13B, 14, and Shuttle Loops A, B, C, D and E.
476

2.2.6.11 White Plains Avenue BRT Station

477 There is a need for a station between central White Plains and the center of the Platinum Mile area, in
478 which case this is the logical location. A White Plains Avenue BRT Station would also serve the
479 residential area immediately to the north of it, which is cut off from the Westchester Mall Station by the I-
480 287 right-of-way. An important consideration will be the coordination of the proposed BRT route
481 alignment through this area with the proposed reconstruction/reconfiguration of I-287 Interchange 8.
482

483 BRT Route B would not operate along the BRT trunk line between the proposed Hillside Avenue Station
484 and the proposed White Plains Avenue Station, thus bypassing central White Plains. Therefore, it would
485 access the BRT trunk line at the proposed White Plains Avenue Station.
486

487 Local transit access to the proposed White Plains Avenue Station would be provided by Bee-Line Routes
488 3, 12, 13/13B, 92, and the Shuttle Loops serving the Westchester Avenue corridor.
489

2.2.6.12 Platinum Mile BRT Station

490 The collection of office parks in the Platinum Mile area has always been a focus of transit activity east of
491 White Plains. The nature of these developments in terms of their land use patterns makes them
492 particularly difficult to serve with direct transit and therefore Bee-Line Shuttle Loops A, B, C, D and E
493 connect the area with the White Plains Transportation Center. While several alternatives have been

494 considered to serve these office complexes, in the future these shuttle buses will likely serve the proposed
495 Platinum Mile Station and connect with the various office complexes, thus becoming one likely way to
496 meet this need.
497
498 Local transit access to the proposed Platinum Mile Station would be provided by Bee-Line Routes 3, 12,
499 13/13B, 92, and – as previously mentioned – the Shuttle Loops serving the Westchester Avenue corridor.
500

2.2.6.13 Westchester Avenue BRT Station

501 The proposed Westchester Avenue Station would primarily serve the eastern area of the Platinum Mile
502 office park district east of White Plains. BRT Routes B (to and from Stamford via I-287 and I-95), P (to
503 and from Stamford via I-287 and I-95, and replacing the CT Transit I-Bus service) and M (to and from
504 Fordham in The Bronx via I-287 and I-95, replacing Bee-Line Route 62) would access the BRT trunk line
505 at the proposed Westchester Avenue Station and would then operate along westward along the BRT trunk
506 line as far as either White Plains (in the case of BRT Routes P and M) or Hillburn (in the case of BRT
507 Route B). Local transit access to the proposed Westchester Avenue Station would be provided by Bee-
508 Line Routes 13/13B, 92 and the Shuttle Loops serving the Westchester Avenue corridor.
509

2.2.6.14 South Ridge Street BRT Station

510 The proposed South Ridge Street Station would serve the residential area in this western portion of Port
511 Chester. Local transit access to the proposed South Ridge Street Station would be provided by Bee-Line
512 Route 92.
513

2.2.6.15 Boston Post Road

514 The proposed Boston Post Road Station would serve the area near the Staples and Kohl's shopping center
515 and the former United Hospital site. This area presents opportunities for transit-oriented development and
516 the redevelopment of this area is supported by the Village of Port Chester. Local transit access to the
517 proposed Boston Post Road Station would be provided by Bee-Line Routes 75, 76 and 61.
518

2.2.6.16 Port Chester Multi-Modal Station

519 The BRT trunk route would have its eastern terminus at the Port Chester Station on the New Haven Line.
520 The goal is an easy transfer between the BRT trunk line services and the New Haven Line trains, as well
521 as easy connection to the local buses in Port Chester.
522
523 BRT Routes D, J, K, N and T would terminate at the proposed Port Chester Multi-Modal Station, and
524 local transit access to the proposed station would be provided by Bee-Line Routes 13/13B, 61 and 76, and
525 CT Transit Routes 11A and 11B. BRT Route T is the main "trunk line" BRT service and serves all the
526 BRT stations between Hillburn and Port Chester; Bee-Line Route 13/13B provides the parallel local
527 service along the Westchester County portion of the corridor between Port Chester and Tarrytown.
528

2.2.7 Feeders/Connectivity

The proposed BRT Routes that feed the BRT trunk line system – those that start and/or end outside the corridor - were assumed to operate on headways every 20 to 30 minutes during the weekday peak periods (i.e., 6:00AM to 10:00AM and 3:00PM to 7:00PM), while the BRT trunk route (i.e., BRT Route T) between Hillburn and Port Chester was assumed to operate at 10-minute headways.

During the off- peak period, the feeder routes were assumed to connect to the BRT trunk route at the most convenient station and terminate, providing for convenient transfers. Trunk service ran throughout the day on headways every 10 to 15 minutes. These levels of service were used to determine fleet size and operating costs.

BRT feeder service includes some existing bus routes that would be replaced by their BRT adaptation and some newly proposed additional routes that would operate as feeders to the trunk service midday, but would utilize the BRT facilities during peak periods to provide one-seat rides. These feeder routes include:

- **Route A** – This route would replace the existing Orange-Westchester Link (OWL) bus, connecting Middletown and other stops in Orange County with White Plains. It accesses the BRT trunk line at the proposed Airmont Road BRT Station.

- **Route B** - This route would operate between Hillburn and Stamford, with stops along the BRT trunk line in both Rockland and Westchester Counties. BRT Route B would not operate along the BRT trunk line between the proposed Hillside Avenue and White Plains Avenue BRT Stations, thus operating in mixed traffic along I-287 to bypass central White Plains. On its eastern side, it would access the BRT trunk line at the proposed Westchester Avenue BRT Station. This would be a new route linking Rockland County residents to jobs in eastern Westchester and Fairfield Counties.

- **Route C** – This route would replace an existing variation of the Tappan Zee Express route, connecting Hillburn with the White Plains Transportation Center.

- **Route D** – This route would operate between Mount Ivy and Port Chester, accessing the BRT trunk line at the proposed Interchange 14 Multi-Modal Station. Both Mount Ivy and Pomona (near the intersection of Route 202 and the Palisades Interstate Parkway) accommodate higher population densities and significant employment. Farther south, the Route 45 corridor serves the additional population center of New Square, as well as employment centers associated with the County Health and Social Services complex in New Hempstead. Route 45 also passes through Spring Valley, and its associated population and employment. This route would link population in northern Rockland County and Spring Valley with jobs in Westchester County.

- **Route E** – This route would replace an existing variation of the Tappan Zee Express route, accessing the BRT trunk line at the proposed Interchange 14 Multi-Modal Station and connecting Spring Valley with the Tarrytown Station. Spring Valley is among the most densely populated areas of Rockland County and has several notable employers (e.g., Chestnut Ridge Transportation, with 600 employees).

- **Route F** – This route would operate between Spring Valley and Yonkers and the Bronx, connecting employment opportunities and potential employees at both ends of the route. It would

access the BRT trunk line at the Interchange 14 Multi-Modal Station and at the Broadway BRT Station.

▪ **Route G** – This route would operate between Spring Valley and Hawthorne, connecting potential employees in Rockland County with employment opportunities in the State Route 9A corridor. It accesses the BRT trunk line at the proposed Interchange 14 Multi-Modal Station and at the proposed Elmsford West Station.

▪ **Route H** – This route would operate between New City and the White Plains Transportation Center, providing a link for the residents of the Route 304 corridor to employment opportunities in Westchester County and access to the government center in New City. It accesses the BRT trunk line at the proposed Palisades Mall Multi-Modal Station.

▪ **Route I** – This route would operate between Haverstraw and the White Plains Transportation Center, connecting the Route 303 corridor with employment opportunities in Westchester County as well as with Metro-North service at the Palisades Mall and Tarrytown Multi-Modal Stations, and at White Plains. It would access the BRT trunk line at the proposed Palisades Mall Multi-Modal Station. Both Haverstraw and West Haverstraw have been recent population growth centers in Rockland County, and the State Route 303 corridor has also experienced substantial population growth around Congers and Valley Cottage. There are also clusters of employment in Congers and in several office parks in Valley Cottage

▪ **Route J** – This route would provide a direct connection between central Nyack and Port Chester, stopping at all the BRT trunk line stations in Westchester County, including the Tarrytown Multi-Modal Station. It would access the BRT trunk line at the proposed Nyack Station. Nyack and South Nyack are among the more densely populated areas of Rockland County and also provide some significant employment opportunities. This service would tie this population base into the Cross-Westchester service as far east as the Platinum Mile and Port Chester.

▪ **Route K** – This route would provide a direct connection between Bergen County (possibly as an extension of NJ Transit Route 165) and Port Chester, serving the BRT trunk line in both Rockland and Westchester Counties and connecting employment opportunities on both ends of the route with residents in both counties. It would access the BRT trunk line at the proposed Interchange 14 Multi-Modal Station.

▪ **Route L** – This route would replace the existing Bee-Line Route 11 and connect Croton and Ossining with White Plains. It would access the BRT trunk line at the Tarrytown Multi-Modal Station.

▪ **Route M** – This route would replace the existing Bee-Line Route 62 and connect White Plains with Fordham in the Bronx. It would access the BRT trunk line at the proposed Westchester Avenue Station, and operate between that location and the Bronx in mixed traffic on I-287, I-95, and Boston Post Road (US Route 1).

▪ **Route N** – This route would replace the existing Bee-Line Route 21, and connect Port Chester with Yonkers and the Bronx. It would access the cross-corridor BRT trunk line at the proposed Westchester County Center Station. It should be noted that Bee-Line Route 21 would be replaced in any event by the proposed Central Park Avenue BRT service; however, this proposal extends the route along the cross-corridor BRT trunk line between White Plains and Port Chester.

626 　　　▪ 　**Route O** – This route would replace the existing Bee-Line Route 77, connecting Yorktown with
627 　　　　White Plains. It would access the BRT trunk line at the proposed Elmsford West Station.
628

629 　　　▪ 　**Route P** – This route would replace the existing CT Transit I-Bus, connecting White Plains with
630 　　　　Stamford. It would access the BRT trunk line at the proposed Westchester Avenue Station, and
631 　　　　operate between that location and Stamford in mixed traffic on I-287 and I-95.

2.3 Transportation Demand Modeling

632

633 The Tappan Zee Bridge/I-287 Corridor Study is a part of the transportation planning process in the New
634 York City metropolitan area. As such, with both FHWA and FTA as sponsoring agencies, it must be a
635 part of the Continuing Comprehensive Coordinated [3C] process defined in federal planning regulations.
636 Those regulations mandate that the Metropolitan Planning Organization (MPO) develop the planning
637 process, including the adoption of urban travel demand forecasting models.

638 The tool used to forecast urban travel demand in the region is the Best Practice Model (BPM) developed
639 by the New York Metropolitan Transportation Council (NYMTC). The BPM represents a state-of-the-art
640 process for forecasting future urban travel based on assumptions regarding land use and transportation
641 facilities and services. Moreover, because potential alternatives include both major highway and major
642 transit improvements, a multi-modal model was required, and the BPM is the best and only available
643 model in the New York region that can simultaneously assess improvements to both highway and transit.
644 It has been adopted by NYMTC as the transportation planning model for the New York metropolitan
645 area.

2.3.1 Modeling Practices

646 The BPM represents a break from traditional modeling procedures. Since the 1950s travel forecasting has
647 typically relied on variations of the "four-step" process to forecast future urban travel based on
648 characteristics of the land uses and transportation network. These are:

649 　　1.　**Trip Generation (Production and Attraction)** – determining where trips are produced, and to
650 　　　where trips are attracted. This is usually based on land use and demographic data for each zone.
651

652 　　2.　**Trip Distribution** – matching each trip origin with a trip destination. This process results in the
653 　　　"trip table", a matrix of trips between zones.
654

655 　　3.　**Modal Choice** – the estimation of how many of those trips will use automobiles, buses, trains
656 　　　and other modes. This results in a trip table for each mode.
657

658 　　4.　**Assignment** – how those trips are routed through the transportation network, resulting in vehicle
659 　　　volume estimates for each roadway or passenger volumes on each transit route in the network.
660

661 This process has been studied, refined, reevaluated, recalibrated and reapplied throughout the modeling
662 world for the last 50 years. Refinements have included detailed investigation of transit access trips (how
663 people get to the train station or bus stop), analysis of goods movement, analysis of household auto
664 ownership and its impact on modal split, analysis of life cycle variables, and consideration of travel time
665 budgets.

2.3.2 Model Limitations

666 Using BPM as received from NYMTC for the Tappan Zee Bridge/I-287 Corridor had its limitations –
667 although it is better than any of the alternative software packages for most components of the travel
668 demand analyses. The specific limitations encountered in this study included:

669 ▪ The Tappan Zee Bridge/I-287 Corridor Study area is at the edge of the urban area. While the
670   BPM model was developed, calibrated and validated for the entire metropolitan area, there was
671   greater focus on travel within and to New York City. Transportation models generally perform
672   better in the middle than along the edges. As a result, initial versions of the model did not
673   adequately duplicate the distribution of trips between the counties in the corridor and between
674   Orange and Rockland Counties and Manhattan. This was addressed by using US Census journey-
675   to-work data as an origin-destination survey surrogate to re-calibrate the model specifically for
676   this project.
677
678 ▪ Introduction of high level circumferential service in this corridor, which is now served largely by
679   radial bus service to Manhattan, would create a new high-quality mode serving cross-corridor
680   movements. There are more unknowns associated with the attractiveness of new modes serving
681   new movements (because the model cannot be tested against known existing ridership levels),
682   regardless of the model used. This was addressed with a stated preference survey, which helped
683   in assessing the desirability of such a new service.
684
685 ▪ Pricing options for highway travel – the model cannot fully account for commuter discounts for
686   toll fees, EZ-Pass discounts and time savings, variable tolls by auto occupancy, variable tolls
687   based on volumes (as in HOT lanes) or variable prices for parking. This reduces the ability of the
688   model to fully reflect all of the choices facing travelers. Strategies were developed to deal with
689   the limitations of modeling HOT Lanes.
690
691 ▪ Inputs to the mode choice equations did not distinguish between HOV-2 travel times and costs
692   and HOV-3 travel times and costs. The effect of HOT lanes was not realized at the mode choice
693   stage.
694
695 ▪ BPM severely restricts transfers between express bus and commuter rail.[1] The original model was
696   presumably coded this way to prevent riders of Manhattan-bound express buses from transferring
697   to commuter rail at some intermediate location (such as Jamaica in Queens or Secaucus in New
698   Jersey), even though pure time considerations might lead one to make that transfer. Rather, most
699   people are observed to stay on an express bus once they board it. However, that dynamic has
700   significant implications for modeling a BRT system. A potential BRT system would be designed
701   specifically to connect with the commuter rail network at Suffern, Tarrytown, White Plains, and
702   Port Chester. Thus maintaining BRT as an express mode would tend to dampen ridership
703   forecasts.

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[1] Specifically, in determining best paths, the express bus portion of a path which includes commuter rail is penalized by a factor of nine. By comparison, in paths which include both local bus and commuter rail, the local bus portion of the path is penalized by a factor of two.

2.4 Model Data Inputs

The major data inputs to the model include socioeconomic data by zone (including forecasts for various years in the future), current and future highway networks, and current and future transit networks. The networks can then be modified to assess the impacts of transportation improvements.

2.5 Stated Preference Survey

To assure that the modeling would adequately reflect attitudes and behaviors within the corridor, a Stated Preference Survey was designed and administered.[2] Although the FTA does not allow the use of stated preference surveys to establish modal preferences, there were two main modeling-related objectives of the stated preference survey: first, to determine if there were significant differences between the mode choice behavior of travelers in the I-287 corridor and the behavior of travelers in the greater New York metropolitan region as a whole (as represented in the BPM mode choice model); second, to assess how corridor travelers view light rail.

The modeling and statistical analyses indicate that work commuters in the corridor have a comparable sensitivity to travel time as represented in the BPM mode choice model, but a slightly higher sensitivity to travel cost. This results in a value of time lower among I-87/I-287 travelers ($13.62) than the BPM shows for the entire region ($15.81). This value-of-time difference was not considered to be statistically significant, so the BPM model was applied without adjustment to any of the mode choice coefficients.

The stated preference survey was also designed to determine whether travelers in the corridor have different predispositions to use commuter rail and light rail. Statistical analyses of the stated preference data indicate that I-87/I-287 commuters view light rail transit in a way that is closer to their reaction to the general transit mode as represented in the BPM model than to commuter rail. As a result, for this project light rail transit was represented as a general transit mode (i.e., the same as subway and bus) in the BPM model, while commuter rail was modeled using the BPM commuter rail-specific coefficients.

Overall, the stated preference survey results indicate that the BPM mode choice model does not require adjustment and provides a suitable representation of mode choice behavior in the I-287/Tappan Zee Corridor.

2.6 Calibration

Transportation planning models are, by their nature, approximations of the actual travel behavior in the region. They are an artificial means of estimating existing travel that can then be used to forecast future travel. Their success in estimating existing travel is determined by a process known as calibration. The components of the model are all adjusted until the estimated travel matches the actual travel well enough to be used as a forecasting tool.

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[2] New York State Thruway Authority and Metro North Railroad, *Tappan Zee Bridge/I-287 Environmental Review, Technical Memorandum, Travel Survey*, October 2003.

737 Even in the best of circumstances, it does not match perfectly – there are too many variables and too
738 many complexities to achieve that kind of perfection. There is also the likelihood that adjusting too much
739 will lessen the model's responsiveness to change, hampering its ability to be applied for future scenarios.
740 Therefore, model calibration remains an art as much as a science – knowing just how much to adjust and
741 when to stop the process.
742
743 In applying BPM to the I-287/Tappan Zee Corridor, there were specific measures that were particularly
744 important to adjust the model for: mainly the transit markets between areas west of the Hudson River and
745 Westchester County, Connecticut, the Bronx, and Manhattan. After the model was re-calibrated, further
746 validation checks were made of the model's ability to replicate highway volumes along key local
747 screenlines and on the Hudson Crossings, and to replicate current transit and commuter rail ridership
748 levels in the corridor. In general, the re-calibrated BPM performed satisfactorily and was considered
749 sufficient for use in evaluating the relative performance of future scenarios. The procedures used and the
750 results of the calibration were presented to the FTA in September 2006.
751
752

Thruway
Authority

New York State
Department of Transportation

Metro-North
Railroad

753

3 Affected Environment

1 This chapter provides information on the existing public transportation services throughout the Tappan
2 Zee Bridge/I-287 Corridor. This includes CRT service, bus service, and park-and-ride facilities in the
3 study area. Major improvements currently being planned for the CRT service are also discussed.

4 ## 3.1 Commuter Rail Service

5 The Metro-North Railroad is the second largest commuter railroad system in the United States. The
6 Metro-North system covers a vast area, connecting New York City (Manhattan and the Bronx) with
7 Westchester, Putnam, Dutchess, Rockland, and Orange Counties in the State of New York, and Fairfield
8 and New Haven Counties in Connecticut. Metro-North captures a dominant market share of total peak
9 hour trips to the Manhattan central business district (CBD) from the suburbs north of New York City and
10 Connecticut. In 2008, it recorded 83 million passenger boardings on its entire network, with an average
11 ridership of about 280,000 passenger boardings on a typical fall weekday. Typical boardings in 2008 are
12 shown in Table 3-1.

13 **Table 3-1**

14 **Metro-North Inbound Station Boardings (2008)**

East-of-Hudson Network	
Hudson Line	26,748
Harlem Line	46,045
New Haven Line	62,349
Total	135,142
West-of-Hudson Network	
Port Jervis Line	2,780
Pascack Valley Line	1,094
Total	3,874

15
16 The railroad is organized around five lines, with two discrete networks: East-of-Hudson and West-of-
17 Hudson. The East-of-Hudson network consists of the Hudson, Harlem, and New Haven Lines. The New
18 Haven Line includes three branches: the New Canaan Branch, the Danbury Branch and the Waterbury
19 Branch. The West-of-Hudson network includes the Port Jervis and Pascack Valley Lines. Metro-North
20 carries its weekday ridership on over 600 daily scheduled trains on the East-of-Hudson network and over
21 40 trains on the West-of-Hudson network.

22 Each of Metro-North's five major lines crosses the Tappan Zee Bridge/I-287 Corridor in a north-south
23 direction (Figure 3-1). There are no Metro-North facilities that run in an east-west direction, either
24 parallel to the study corridor, or across the Hudson River. One of the objectives of the current study is to
25 establish the feasibility of instituting new CRT service across the Tappan Zee Bridge/I-287 Corridor and
26 the Hudson River.

27

Figure 3-1 MTA Metro-North Railroad Map

3.1.1 East-of-Hudson Commuter Rail Service

32 The Hudson Line extends to Dutchess County, and runs along the eastern bank of the Hudson River
33 through Putnam and Westchester Counties, into the Bronx and Manhattan, a distance of 76 miles from
34 Poughkeepsie to Grand Central Terminal. Besides Metro-North service, the Hudson Line is shared with
35 Amtrak services in the Empire Corridor to and from Penn Station New York.

36 The Harlem Line begins in Wassaic, Dutchess County and continues south through the heart of Putnam
37 and Westchester Counties into the Bronx, where it joins the Hudson Line at Mott Haven junction, a
38 distance of 77 miles.

39 From their junction at Woodlawn, the New Haven and Harlem Lines continue south and merge with the
40 Hudson Line at Mott Haven. From there, they continue over the Harlem River into Manhattan and onto
41 the Park Avenue Viaduct, with a station at 125th Street in Harlem. The viaduct continues to 97th Street
42 where the line goes into the Park Avenue Tunnel, feeding into Grand Central Terminal.

43 The East-of-Hudson network is mostly electrified. Rolling stock on the majority of services on the
44 Hudson and Harlem Lines are provided by electrical multiple units of the M1, M3 and M7 classes,
45 drawing power from a third rail system with an under-running current pickup.

46 The New Haven Line begins in New Haven, Connecticut, and continues into Fairfield County, in between
47 and paralleling Interstate 95 and the Long Island Sound shore, the area commonly referred to as the "Gold
48 Coast". The line enters New York State in Westchester County and then continues into the Bronx, joining
49 the Harlem Line at a point just north of Woodlawn Station. The length of the New Haven Line from New
50 Haven to the junction with the Harlem Line is 61 miles. The New Haven Line has three branches: the
51 New Canaan Branch at nearly 8 miles in length, the Danbury Branch at 24 miles in length, and the
52 Waterbury Branch at 27 miles in length. The New Haven Line is operated under a joint agreement with
53 the Connecticut Department of Transportation (ConnDOT), which provides funding to Metro-North for
54 both operating and capital expenses, and maintains all of the stations in Connecticut.

55 The New Haven Line is also mostly electrified, utilizing a combination of third rail and overhead catenary
56 wires. From its junction with the Harlem Line just north of Woodlawn Station to a point just south of
57 Mount Vernon Station, the New Haven Line is equipped with a third rail system identical to that found on
58 the Hudson and Harlem Lines. The remainder of the line to New Haven is equipped with an overhead
59 catenary. Three unique classes of EMUs, known as the M-2, M-4, and M-6 cars, provide service on the
60 New Haven Line. These cars are equipped with both third rail shoes as well as pantographs for current
61 pickup from the overhead catenary. Metro-North will soon be receiving a new class of EMUs for use on
62 the New Haven Line, known as the M8.

3.1.2 West-of-Hudson Commuter Rail Service

63 The West-of-Hudson network consists of two lines: Port Jervis and Pascack Valley. These two lines are
64 operated under an agreement with NJ Transit, utilizing a common equipment pool manned by NJ Transit
65 personnel. The Port Jervis Line originates at Port Jervis near the Pennsylvania, New Jersey, and New
66 York border. It initially loops north through Orange County before turning south again at Salisbury Mills-
67 Cornwall, from which it heads to Suffern. South of Suffern, express rail service continues along the NJ
68 Transit Main/Bergen Line to Hoboken, New Jersey via Secaucus. The Secaucus Junction is a hub for 10
69 of New Jersey's 11 commuter rail lines. It allows passengers traveling on the Main/Bergen and Port Jervis
70 Lines to transfer to NJ Transit trains directly into New York's Penn Station on Manhattan's west side.

71 The Secaucus Junction station provides a more direct trip to Penn Station New York, cutting travel time
72 by about 15 minutes. Transfer is also available at Secaucus to trains to Newark, Trenton, Long Branch
73 and Morristown. At Hoboken, passengers have the option of transferring to PATH trains to Midtown or
74 the World Trade Center site or a commuter ferry for service to Lower or Midtown Manhattan. The total
75 length from Port Jervis to Hoboken is over 95 miles.

76 The Pascack Valley Line originates in Spring Valley, Rockland County, serving Nanuet and Pearl River
77 before crossing into New Jersey. It merges with the Main/Bergen Line just north of Secaucus. It is nearly
78 31 miles from Spring Valley to Hoboken. Metro-North, in conjunction with the Village of Spring Valley
79 and NYSDOT, recently constructed a new bus intermodal area at the Spring Valley Station and
80 rehabilitated the station building, platform, and parking facilities.

81 The West-of-Hudson network is not electrified; diesel locomotives and coaches in push-pull mode
82 provide services on those lines.

3.1.3 Metro-North Planned Improvements

3.1.3.1 Capital Improvement Projects

83 Recently, the State of New York arranged for a long-term lease of the Port Jervis Line, which is currently
84 owned by the Norfolk Southern. This allows Metro-North to make much needed improvements to the
85 track and structures on the line, which will improve service. Concurrent with the opening of the Secaucus
86 Junction station for weekday service, which provides West-of-Hudson customers with a two-seat ride to
87 New York's Penn Station, Metro-North began increasing train service on the Port Jervis and Pascack
88 Valley lines. Since 1984, Metro-North ridership on the Port Jervis Line has increased by nearly 120
89 percent and by nearly 30 percent in the past few years.

90 Metro-North improvements that will affect the corridor are located primarily in the West-of-Hudson
91 service area and include:

92   ▪ **Rolling Stock** – Metro-North is making a series of investments in its West-of-Hudson fleet.
93   These investments will accommodate projected ridership and will provide West-of-Hudson
94   customers with an almost entirely new fleet.
95

96   ▪ **Infrastructure and Capacity Improvements** – Metro-North is contributing to a series of
97   capacity improvement projects on the Main, Bergen County and Pascack Valley Lines. These
98   include the installation of a track connection at Waldwick Interlocking, installation of two
99   additional track crossovers at Ridgewood Junction Interlocking (that facilitate parallel train
100   moves), installation of a second track from Paterson Junction to Interlocking XW (a distance of
101   1.7 miles), and installation of Positive Train Stop (PTS) and Automatic Train Control (ATC) on
102   the Main Line. Improvements to the Pascack Valley Line also include installation of passing
103   sidings and PTS and ATC.
104

105   ▪ **Station and Parking Improvements** – Metro-North has implemented parking improvement and
106   expansion projects at almost every facility owned by Metro-North since 1988. Metro-North owns
107   and/or controls only about 40 percent of the parking facilities at its New York State stations, but
108   this share is increasing through its Systemwide Private Operator Program. Major parking projects
109   completed or underway include the 350-space Port Chester Garage (a joint public/private
110   initiative) and 2,735 new and/or improved parking spaces for West-of-Hudson service.
111

112   ▪   **Customer Amenities** – Metro-North will enhance customer amenities at all stations on the Port
113   Jervis and Pascack Valley Lines in New York State (except at the recently constructed
114   Middletown/Town of Walkill Station).
115

3.1.3.2 2005-2024 Twenty-Year Needs Assessment Projects

116   A number of longer-term improvements are planned by Metro-North Railroad for their West-of-Hudson
117   system that would directly affect service in the study corridor. These include:

118   ▪   **Port Jervis Line Acquisition** – Metro-North plans to purchase the Port Jervis Line between Port
119   Jervis and Suffern.
120

121   ▪   **Rolling Stock** - Metro-North's seating standards will be maintained by providing additional
122   trains to West-of-Hudson customers – eight locomotives and 37 coaches are projected to be
123   required.
124

125   ▪   **Storage and Maintenance Yard Expansion** – Metro-North will provide additional storage and a
126   maintenance facility on the Port Jervis Line to accommodate the new rolling stock and increase in
127   service expected by 2025. Similarly, the expanded fleet (an additional 30 coaches and five
128   locomotives) on the Pascack Valley Line will require expansion of the Woodbine Yard.
129

130   ▪   **Station and Parking Improvements** – Metro-North will continue implementing parking
131   improvement and expansion projects. Due to land constraints on the Pascack Valley Line, parking
132   garages will be considered.
133

134   ▪   **Systemwide Improvements** – Metro-North plans to install new high-level platforms and
135   canopies at all West-of-Hudson Line stations as part of a package to improve safety, customer
136   service, and improved operations from Pearl River to Spring Valley on the Pascack Valley Line
137   and from Sloatsburg to Port Jervis on the Port Jervis Line.
138

139   ▪   **Track Improvements Program** – Metro-North's track standards will be met by replacing track
140   and upgrading system components to reduce maintenance, improve reliability and customer
141   satisfaction. This cyclical project will improve the track to the limits specified by the Federal
142   Railroad Administration (FRA) and continues the rehabilitation program undertaken in the
143   previous Capital Program.
144

145   The need for additional improvements on the Port Jervis and Pascack Valley Lines has been identified by
146   both Metro-North and NJ Transit. These projects, which are in the early planning stage, include:

147   ▪   The need to eliminate grade crossings on the Pascack Valley Line in New York and New Jersey to
148   improve safety and traffic concerns related to the increased service frequency.
149

150   ▪   Potential expansion of Hoboken Terminal and line capacity (including Bergen Tunnel) to handle
151   the increased service.
152

3.1.3.3 West-of-Hudson 2030 Service Plan

153   Metro-North plans to increase service on the Pascack Valley and Port Jervis Lines to keep pace with
154   projected ridership demand (which is expected to approximately triple by 2025). Peak period service is

Thruway
Authority

New York State
Department of Transportation

Metro-North
Railroad

155 expected to nearly double from the 6 trains operating today to 11 trains on the Port Jervis Line. On the
156 Pascack Valley Line, service is expected to increase from the 7 trains operating today to 12 trains during
157 the four-hour peak periods.

3.1.4 Planning Context

158 Several ongoing planning studies in the region are analyzing projects that could have implications for
159 commuter rail service in the Tappan Zee Bridge/I-287 Corridor:

160 ▪ NJ Transit is exploring starting passenger service on an improved West Shore Line from West
161   Nyack to Hoboken, with possible connections to the Hudson-Bergen Light Rail Line.
162

163 ▪ NJ Transit's Access to the Region's Core (ARC) program proposed an additional rail tunnel
164   across the Hudson River to increase trans-Hudson rail capacity, and construction of a Secaucus
165   loop to connect NJT's Main/Bergen County and Pascack Valley Lines and the Northeast Corridor
166   tracks to Penn Station New York and a new station under 34th Street. This connection would
167   allow commuters from Bergen, Passaic, Rockland, and Orange Counties a one-seat ride to
168   Midtown Manhattan's west side. The plans for these improvements were cancelled in Fall 2010
169   by New Jersey. Amtrak has made initial proposals to develop two new "Gateway" tunnel into
170   Manhattan for use by commuter and intercity trains. That concept, along with related
171   improvements on the Manhattan and New Jersey side, are in the early planning stages.
172

173 ▪ Metro-North and NYSDOT are jointly studying ways of extending CRT service to Stewart
174   Airport in Newburgh.
175

176 ▪ Amtrak and NYSDOT have been examining means of increasing running speeds along the
177   Empire Corridor (which includes the Hudson Line) between New York City and Albany.
178

179 ▪ As part of their Strategic Intermodal Facilities Program, Metro-North is conducting the following
180   studies:
181

182   ▪ In conjunction with Westchester County, preparation of an EIS for access and parking
183   improvements to the North White Plains Station on the Harlem Line.
184

185   ▪ An EIS to study alternatives to meet increasing demand for parking in the Harriman-
186   Salisbury corridor of the Port Jervis Line. Alternatives include construction of a new station
187   and intermodal area at the Woodbury Common Outlet Center, using 1,800 existing under-
188   utilized spaces, parking expansion at the existing Harriman station.
189

190   ▪ Long term planning at the Cortlandt Station, which may result in acquisition of several key
191   properties to allow for substantial parking and station access improvements in the future.
192

193   ▪ Long Term Station Area Master Planning at the Beacon Station.
194

195   ▪ The Village of Sleepy Hollow and General Motors/Roseland are conducting an EIS for a new
196   mixed-use development in the Village of Sleepy Hollow that might include a proposed new
197   station and related parking. With the Village and the developer, Metro-North is assessing the
198   feasibility of a new station on the former GM site.

3.2 Bus Service

3.2.1 Westchester County

The Bee-Line bus system is Westchester County's major bus transit service provider. It includes a network of bus lines that extend throughout Westchester County and into neighboring areas as well. There are significantly more Bee-Line bus routes operating in southern Westchester than in the northern part of the county. Some of the bus routes are intended to primarily serve commuters and are limited to weekday, non-holiday service. Table 3-2 illustrates the Bee-Line bus routes that intersect or run parallel to I-287 within the study area. A Westchester County Bee-Line bus map is provided in Figure 3-2.

In addition to the Bee-Line services, the Poughkeepsie-White Plains Express service operated by The Leprechaun Line runs 13 trips per day between Dutchess and Westchester Counties. In 2008, this service carried 54,280 annual boarding riders. Another commuter express service in the Westchester County portion of the study corridor is the I-Bus, operated by CT Transit. This service operates 46 times every weekday between White Plains and Stamford and in 2008 carried 144,442 annual boarding riders.

The Westchester County Department of Transportation has an ongoing capital replacement program for its Bee-Line bus system. The primary focus of the program is to maintain the Bee-Line bus service through the continued replacement of vehicles as they become eligible under federal rules. Specifications for all new buses include diesel engine retrofit technology to reduce emissions.

3.2.2 Tappan Zee Bridge Bus Routes

Over 480,000 bus passengers cross the Tappan Zee Bridge annually. There are two express bus routes which run along the I-287 Corridor and cross the Tappan Zee Bridge: 1) the Tappan ZEExpress (TZX) originates at either the Spring Valley Railroad Station or Suffern in Rockland County and terminates at the White Plains TransCenter in Westchester County; and 2) the Orange-Westchester Link (OWL) bus service, which is operated by Coach USA Short Line. Table 3-3 shows bus routes that cross the Tappan Zee Bridge. The Tappan ZEExpress route is shown on the Transport of Rockland (TOR) map that is provided on Figure 3-3.

3.2.3 Rockland County

Rockland County has several privately operated bus services in addition to the county-operated local transit service – Transport of Rockland (TOR) – for intra-Rockland trips. Table 3-4 shows the bus service providers with the total ridership for 2009. The largest of the privately operated services was Coach USA – Red & Tan Lines, which provides service between Rockland County and New York City. Nonetheless, the TOR system was the busiest bus transit service in Rockland County. Information on ridership on individual routes was not available. These routes are shown on the Rockland County Transit Bus Map presented on Figure 3-3.

231

Table 3-2

232

Bee-Line Bus Routes

Bus No.	Route	2007 Annual Ridership	Frequency (Number of Trips/Weekday)
1C/1W/1T/1X	W.242 St. & B'wy Subway Station, Bronx to Yonkers, Tarrytown and White Plains	1,903,638	29 (1C)24 (1W) 74 (1T) 4 (1X)
3*	W.242 St. & B'wy Subway Station, Bronx to White Plains	270,945	17
5	Riverside Ave & Hudson Street, Yonkers to White Plains and Harrison	1,068,085	81
6	Yonkers RR station, Hudson Line to White Plains and Pleasantville	1,069,802	88
11*	Croton Express- Croton RR Station to White Plains	26,314	4
12	Yorktown-Purchase-White Plains	224,766	27
13/ 13B	Ossining-Tarrytown-Port Chester RR Station	1,407,416	93 (13) 15 (13B)
14	Peekskill-Ossining-White Plains	717,718	36
15	Peekskill and Yorktown to White Plains	160,895	16
17*	Peekskill to White Plains Express	39,985	6
20/ 21*	Bedford Park Subway Station, Bronx to White Plains (21 is limited stops)	3,552,127349,444	172 (20) 22 (21)
27*	White Plains to Elmsford and Hawthorne	93,303	10
34*	Orchard Hill Commuter - Hartsdale RR Station to Elmsford	19,727	9
38*	Secor Road Commuter – Hartsdale Sta. Along Secor to Westway.	14,042	8
40	Mount Vernon to Westchester Medical Center, White Plains	1,807,924	90
41*	White Plains Road & E.241 St. Subway Sta; Bronx to Westchester Medical Center, White Plains	223,620	13
60	Fordham Rd & Tiebout Ave, Bronx to TransCenter, White Plains	1,989,952	78
61	Willet Ave & Putnam Ave Port Chester to Fordham Road & Tiebout Ave, Bronx	743,994	42
62*	Fordham Rd & Tiebout Ave, Bronx to TransCenter, White Plains	135,863	7
63	White Plains to Scarsdale	230,351	42

233
234

235

Table 3-2 (Cont'd)

236

Bee-Line Bus Routes

Bus No.	Route	2007 Annual Ridership	Frequency (Number of Trips/Weekday)
76	Rye-Port Chester Loop	42,385	16
77[1]	Taconic Express – Carmel to Yorktown and White Plains	27,689	8
91/92**	White Plains to Playland	24,618	N/A
Loop A*	White Plains Bus Terminal to Westchester Avenue	40,921	23
Loop B*	White Plains Bus Terminal to Westchester Avenue	55,177	28
Loop C*	White Plains Bus Terminal to Westchester Avenue	21,113	16
Loop D*	White Plains Bus Terminal to Westchester Avenue	35,283	22
Loop E*	White Plains Bus Terminal to Manhattanville Road	42,543	16
Loop F*	White Plains Bus Terminal to Taxter Road and White Plains Road	19,253	17
Loop H*	White Plains Bus Terminal to Route 120	50,566	17
Loop T*	Tarrytown RR Station to White Plains Road	22,452	15
BxM4C	White Plains-Manhattan Express	427,016	83
Notes: * Monday thru Friday service only; ** Seasonal service Source: Westchester County DOT, 2008 Annual Route Analysis			

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Figure 3-2 Westchester County Bee-Line Bus Map

247

Table 3-3

248

Tappan Zee Bridge Bus Routes

Route	Frequency (Number of Trips/Weekday)	2009 Annual Ridership
TZ Express	85	415,130
Orange-Westchester Link (OWL)	10	65,621*
Notes: * Data shown for 2008 Source: Rockland County Department of Planning and NYSDOT (State Transportation Operating Assistance Program), 2009.		

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Table 3-4

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Rockland County Bus Service Providers

Provider	2009 Annual Ridership
Clarkstown Mini-Trans	154,441
Kaser Bus	29,777
Coach USA Short Line (Leisure Lines)	309,458
Monsey / New Square Bus Trails	468,741
Coach USA Red & Tan Lines (Rockland Coaches)	1,316,582
Spring Valley Jitney	32,827
T.R.I.P.S.	78,200
TOR (Transport of Rockland)	3,193,365
Source: Rockland County Department of Planning and NYSDOT (State Transportation Operating Assistance Program), 2009.	

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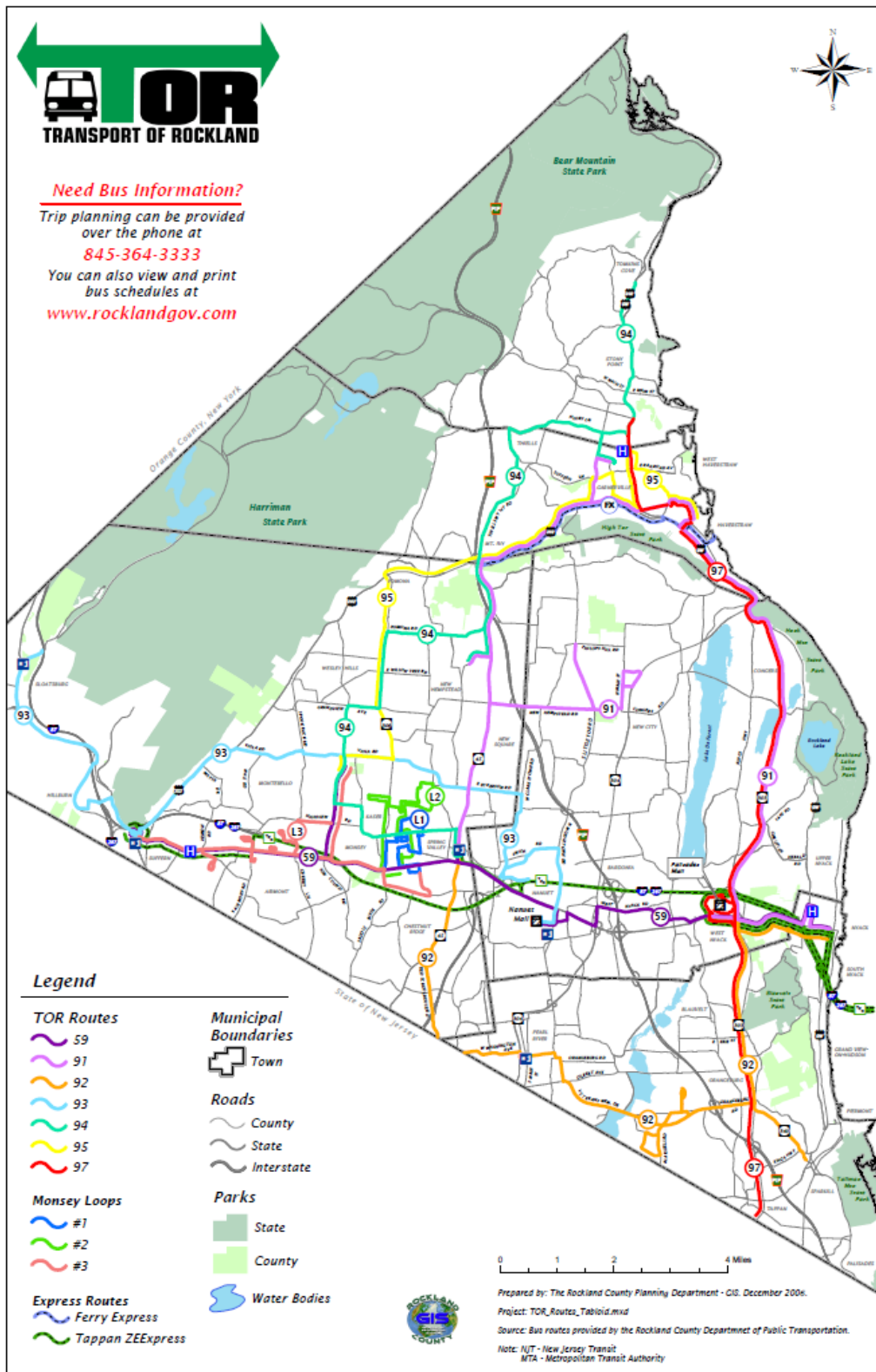
Figure 3-3 Rockland County Transit Bus Map

3.2.4 Orange County

257 There are 23 bus companies that operate in Orange County. Table 3-5 shows Orange County bus
258 operators with total annual ridership for 2008. In addition to those listed, Coach USA – Short Line offers
259 commuter service between Orange County and New York City. The ridership for this commuter express
260 service was not available.

3.2.5 Interstate Bus Service

261 As was previously mentioned, CT Transit offers an interstate commuter express bus service (i.e., the I-
262 Bus) between Stamford, Connecticut and White Plains. The route generally follows I-95 in Connecticut
263 and I-287 in Westchester. This service operates 46 times every weekday between White Plains and
264 Stamford and in 2008 carried 144,442 annual boarding riders. In addition, CT Transit operates local bus
265 routes 11A and 11B between Port Chester and Stamford 70 times every weekday. The ridership for this
266 CT Transit bus route was not available.

267 NJ Transit operates 17 bus routes in northern Bergen County that may affect the Tappan Zee Bridge/I-287
268 Corridor. Table 3-6 shows 2008 annual ridership for NJ Transit bus operations.

269 It should be noted that NJ Transit also operates two bus routes – Routes 196 and 197 – that serve
270 Warwick, in New York State. The 2008 ridership for these bus routes is indicated in Table 3-5, with the
271 Orange County bus services.

3.2.6 Bus Line Haul Analysis

272 Bus line haul capacity is typically evaluated when transportation improvements are anticipated to
273 generate a considerable increase in number of passengers. If a substantial number of new bus trips are
274 anticipated for a bus route, its peak load point is evaluated to identify the potential for the buses to exceed
275 their capacities. If the demand for additional riders because of the transportation improvements exceeds
276 bus capacities, it may be considered as a potential significant adverse impact. While subject to operational
277 and fiscal constraints, bus impacts can typically be mitigated by increasing service frequency or could
278 include larger capacity buses such as articulated buses.
279
280 An increase in ridership is anticipated on Westchester and Rockland County buses. Thus, bus lines with
281 routes that stop within a quarter-mile of the I-287 Corridor were analyzed as these lines are most likely to
282 see an increase in ridership as a result of the project build alternatives. In total, 12 bus lines in Rockland
283 County and 38 bus lines in Westchester County were analyzed, and are illustrated on Tables 3-7 and 3-8.
284
285 The Rockland County bus lines analyzed in this study are operated by Rockland County Department of
286 Transportation (RCDOT) and the Town of Clarkstown (Clarkstown Mini-Trans). All analyzed
287 Westchester County bus lines are operated by Westchester County Department of Transportation
288 (WCDOT) and are part of the Westchester Bee-Line system. Privately operated commuter bus routes that
289 traverse the I-287 Corridor (such as Coach USA – Short Line) were not analyzed since it is assumed that
290 the proposed BRT service would not generate a significant number of additional trips to these lines.
291
292
293

294

Table 3-5

295

Orange County Bus Operators

Provider	2008 Annual Ridership
Goshen-Chester DAB	14,274
Highlands DAB	2,266
International Bus Services	13,895
Village of Kiryas Joel	78,043
Lester Lines, Inc.	N/A
Main Line Trolley Bus	29,100
Middletown Transit Corp.	52,176
Monroe Bus Corp.	276,670
Monroe DAB	27,550
Monsey New Square Trails Bus	63,504
Montgomery-Crawford DAB	12,388
Netzach Transportation	N/A
Newburgh DAB	5,889
Newburgh-Beacon Bus Corp.	73,176
New Jersey Transit (Routes 196 and 197)	166,407
New Windsor-Cornwall DAB	9,983
O.C. Paratransit-Middletown	5,350
O.C. Paratransit-Newburgh	11,347
Port Jervis DAB	13,055
Wallkill DAB	32,859
Warwick DAB	37,067
Newburgh Beacon Shuttle	58,839
Notes: DAB = "Dial-A-Bus" Service Source: NYSDOT (State Transportation Operating Assistance Program), 2008.	

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297

298   **Table 3-6**

299   **New Jersey Transit Bus Operations**

Route	2008 Annual Ridership
1. Route 160	379,162
2. Route 161	1,988,588
3. Route 144	230,076
4. Route 162	312,462
5. Route 163	2,268,395
6. Route 164	819,985
7. Route 165	3,580,252
8. Route 166	4,201,870
9. Route 167	2,558,748
10. Route 155	113,037
11. Route 157	85,679
12. Route 158	1,563,257
13. Route 168	946,528
14. Route 171	527,668
15. Route 175	474,481
16. Route 178	502,937
17. Route 182	394,288
Source: NJT, 2008 Comparative Operating Year Statistics Report	

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Table 3-7

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Westchester County Park-and-Ride Lots

Municipality	Location – Proximate Major Roadway	Bus/ Rail Lines	No. Spaces/ No. Occupied	Ownership/ Type
City of Yonkers	Cross County Shopping Center – CCP, I-87, BRP, SBP	20, 25, 26, 55 / None	NA / 8	Private/ Informal
Village of Briarcliff Manor	Food Emporium in Chilmark Shopping Center, Pleasantville Rd - Route 9A	19 / None	NA / 5-10	Private/ Informal
Village of Briarcliff Manor	Route 100 and Chappaqua Road former Gristedes Parking Lot – Route 9A and TSP	15 / None	NA / NA	Private/ Informal
Village of Ossining	Arcadian Shopping Center – Route 9	11, 13 / Scarborough Station, Hudson Line	NA / NA	Private/ Informal
Village of Port Chester	Route 1, Caldor Shopping Center – I-287, I-95, Route 1	61 / Port Chester Station, New Haven Line	NA / 5-15	Private/ Informal
Town of Mount Pleasant	Saw Mill River Parkway @ Eastview (exit 23) Northwest Quadrant – SMRP	None / None	25 / 5-14	DOT ROW/ Formal
Village of Elmsford	Staples Parking Lot – Route 119 & Route 100A, I-287 Exit 4 – I-287, Route 119	1W, 5, 13, 14, 15 / None	NA / NA	Private/ Informal
Village of Elmsford	Syms Parking Lot - Route 119, I-287 Exit 4- I-287, Route 119	1W, 5, 13, 14, 15 / None	NA / NA	Private/ Informal
Village of Harrison	550-600 Mamaroneck Ave Office Building – I-95 HRP	60 / None	NA / NA	Private/ Informal
Town of North Castle	I-684 at Route 22, along Route 22 Shoulder – I-684, Route 22	None / None	10 / 10	ROW/ Informal

Source: Westchester County Park-and-Ride Master Plan Study, Technical Memorandum Number 1, Westchester County's Existing Characteristics, May 1996. This list is current as of 1996 and has not been field verified.

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307

308

Table 3-8

Rockland County Park-and-Ride Lots

Lot	Location – Proximate Major Roadway	Bus/Rail Lines	No. Spaces/ Permit Fee	Ownership/ Administration
Suffern Rail Park and Ride	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	120/ $240 year	Village of Suffern
Suffern Lot A	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	57/ $240 year	Village of Suffern
Suffern Lot B	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	65/ $240 year	Village of Suffern
Suffern Lot C	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	15/ $240 year	Village of Suffern
Suffern Lot D	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	61/ $240 year	Village of Suffern
Suffern Lot E	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	171/ $240 year	Village of Suffern
Suffern Lot L	I-287/I-87, Route 59, Route 202	TOR 59, USA Coaches/ Metro-North Suffern Station	24/ $240 year	Village of Suffern
Suffern Hallet Place	I-287/I-87, Route 59, Route 202	TOR 59 & 93, USA Coaches, TZX/ Metro-North Suffern Station	63/ $240 year	Village of Suffern
Village of Sloatsburg	I-87, Route 59	TOR, USA Coaches/Metro-North Sloatsburg Sta.	85/ $28 year residents $103 non-residents	Village of Sloatsburg
Spring Valley Bus & Rail Terminal	N/A	TZX, TOR, Spring Valley Jitney (SVJ)/ Metro-North Spring Valley Station	210/ $90 year	Village of Spring Valley
Spring Valley Lot A	I-287/I-87, Route 45 and Route 59	TZX, TOR, SVJ	8/ $35 year residents $90 non-residents	Village of Spring Valley

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Table 3-8 (Cont'd)

Rockland County Park-and-Ride Lots

Lot	Location – Proximate Major Roadway	Bus/Rail Lines	No. Spaces/ Permit Fee	Ownership/ Administration
Spring Valley Lot	I-287/I-87, Route 45 and Route 59	TZX, TOR, SVJ	13/ $35 year residents $90 non-residents	Village of Spring Valley
Spring Valley Lot C	I-287/I-87, Route 45 and Route 59	TZX, TOR, SVJ	20/ $35 year residents $90 non-residents	Village of Spring Valley
Spring Valley Lot E	I-287/I-87, Route 45 and Route 59	TZX, TOR, SVJ	13/ $35 year residents $90 non-residents	Village of Spring Valley
Spring Valley Market Place[1]	NYS Thruway Exit 14, I-287/I-87, Route 59	TZX, TOR, SVJ	51/ none	N/A
Exit 14 – North Lot	NYS Thruway Exit 14, North side of Rte. 59 I-287/I-87	TZX, TOR, USA Coaches	225/ none	Town of Clarkstown
Exit 14 – West Lot	NYS Thruway Exit 14, South side of Rte. 59 I-287/I-87	TZX, TOR, USA Coaches	80/ none	Town of Clarkstown
Exit 14 – East Lot	NYS Thruway Exit 14, South side of Rte. 59 I-287/I-87	TZX, TOR, USA Coaches	188/ none	Town of Clarkstown
Monsey	Route 59 I-287/I-87	Monsey Trails	271/ none	Town of Ramapo
Chestnut Ridge Park-and-Ride	Route 45 at Summit Road Garden State Parkway	Monsey Trails	100/ $27	Town of Ramapo
North Ramapo	Route 45 n/o Sanatorium Road Palisades Interstate Parkway	45 EXP, TOR, USA Coaches	80/ $15	Town of Ramapo
Nanuet Mall[1]	Route 59 I-287/I-87, Route 59	TOR, USA Coaches	≈ 90/ none	N/A
Nanuet Railroad Sta. – Lot 1	South Side of Prospect St @ Station	Clarkstown Mini trans (CMT)/Nanuet Railroad Station	332/ none	Town of Clarkstown

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Rockland County Park-and-Ride Lots

Lot	Location – Proximate Major Roadway	Bus/Rail Lines	No. Spaces/ Permit Fee	Ownership/ Administration
Nanuet Railroad Sta. – Lot 2	North Side of Prospect St @ Station	CMT/Nanuet Railroad Station	229/ none	Town of Clarkstown
North Middletown Road	North Middletown Rd at Palisades Interstate Pkwy Exit 10,	USA Coaches	101/ none	Town of Clarkstown
Smith St.	Smith Street, at the NW corner of Routes 59, and 304	Route 59 Bus, CMT, SVJ	286/ none	Town of Clarkstown
MiddletownRoad Park & Ride	Middletown Road at 59	CMT	25/ none	Town of Clarkstown
Cinema 304	North Main St and Calvary Drive	CMT	185/ none	Town of Clarkstown
Valley Cottage	Rockland Lake Road and Kings Highway	CMT	75/ none	Town of Clarkstown
Blockbuster Video[1] Town of Clarkstown	Route 59 & Smith St. I-287/I-87, Route 59	-	≈ 81/ none	N/A
Exit 12 – Lot J-Palisades Center	Palisades Center Drive I-287/I-87, Route 59	CRX, USA Coaches, OWL, SVS, NRS, New City Route 304 Bus, TZX, Monsey Trails	900/ none	Town of Clarkstown
Exit 12 – Lot 1	Northeast corner Routes 59 & 303 I-287/I-87, Route 59	USA Coachs, CMT, TZX, TOR	230/ none	Town of Clarkstown
Exit 12 – Lot 2	Southeast corner Routes 59 & 303 I-287/I-87, Route 59	USA Coaches, CMT, TZX, TOR	200/ none	Town of Clarkstown
Kings Highway	PIP rest area s/o exit 5	-		Town of Orangetown
Pearl River – Lot 1	South Main Street at Station	USA Coaches/ Pearl River Station	65/ none	Town of Orangetown
Pearl River – Lot 2	South William Street off Franklin	USA Coaches/ Pearl River Station	73/ $5.36 year	Town of Orangetown
Pearl River – Lot 3	Central Ave	USA Coaches/ Pearl River Station	41/ $85	Town of Orangetown

Sources: "Rockland County Park-and-Ride Master Plan Update Study", February 2002; "NYSDOT Evaluation and Analysis Report Park-and-Ride Conditions Inventory and Origin-Destination Survey, Phase 2", February 2002
Notes: 1. Indicates informal parking lot.

318

3.2.6.1 Rockland County

319 Rockland County bus ridership data was obtained from the *Rockland County Bus Stop Study* (2006)
320 except for the TOR Route 59 and Tappan Zee Express lines. TOR Route 59 data was obtained from the
321 *Route 59 Corridor Transit Operations Study* (2005), and Tappan Zee Express data was obtained from
322 boarding-alighting counts conducted by RCDOT in 2007. TOR Route 59 data was collected in 2005
323 while all other line data was collected in either 2006 or 2007. Since RCDOT annual bus ridership figures
324 indicate steady growth since 2005, data only available for 2006 and 2007 was used and assumed to be
325 slightly conservative.
326
327 The 12 Rockland County bus lines analyzed operate below capacity in the peak direction during weekday
328 peak hours (Table 3-9). Bus line haul capacity is determined when the average volume-to-capacity (v/c)
329 ratio of a line reaches 1.00. All bus lines except for the TOR Route 91 (during the weekday AM peak
330 hour) and the Tappan Zee Express (during the AM and PM peak hours) operate with less than 50 percent
331 occupancy (a v/c of 0.50 or less) during all peak hours.
332

3.2.6.2 Westchester County

333 All Westchester County bus ridership data was obtained from the *Bee-Line System Data Project 2003-*
334 *2004* study, which provides detailed line haul data for 2003. Annual Bee-Line estimates indicate an
335 overall decrease in ridership between 2003 and 2005; however, to be conservative, the 2003 data was not
336 adjusted.
337
338 All but one of the 38 Westchester County bus lines analyzed operates below capacity in the peak direction
339 during weekday peak hours. According to the ridership surveys, the average weekday ridership on the 76
340 line exceeds its AM peak hour capacity by two riders per hour. Overall, 20 bus lines operate with an
341 average occupancy of less than 50 percent (a v/c ratio of 0.50 or below) in the peak direction during the
342 AM peak hour while 26 bus lines operate below 50 percent occupancy during the PM peak hour. Detailed
343 existing bus line haul conditions are included in Table 3-10.
344

3.3 Park-and-Ride Facilities

346 As part of its *1996 Master Plan Study*, Westchester County inventoried park-and-ride facilities throughout
347 the county. The inventory included formal and informal carpool, vanpool, and/or bus park-and-ride lots.
348 Ten lots were identified south of Briarcliff Manor, as shown in Table 3-7. There is no parking permit
349 required for any of the lots shown, and therefore, there is no cost to park.

350 Two park-and-ride studies have covered Rockland County. In February 2002, Rockland County published
351 "*Rockland County Park & Ride Master Plan Update Study*". Also, NYSDOT, Region 8 is in the process
352 of a "*Park-and-Ride Conditions Inventory and O-D Survey*." The draft report was completed in February
353 2002. Table 3-8 summarizes park-and-ride lots in the vicinity of the Tappan Zee Bridge/I-287 Corridor
354 from these two studies. In total, these lots provide over 4,800 spaces.

355 In addition, the *Suffern Commuter Parking Study*, produced by the Rockland County Department of
356 Public Transportation in November 2002 was reviewed. This study found that the daily occupancy rate
357 for Suffern park-and-ride spaces averaged 83 percent.

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Table 3-9

Rockland County Existing Bus Conditions

Bus Route	AM Peak Hour					PM Peak Hour				
	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio
TOR Route 59	EB	Pascack Road/ Route 59	186	32	0.17	EB	Pascack Road/ Route 59	186	20	0.11
TOR Route 91	EB	Main Street/ New Hempstead Road	62	43	0.69	EB	Main Street/ New Hempstead Road	62	27	0.44
TOR Route 92	EB	Chestnut Ridge Road/ Old Nyack Turnpike	62	15	0.24	EB	Chestnut Ridge Road/ Old Nyack Turnpike	62	9	0.15
TOR Route 93	EB	Eckerson Road/ Buena Vista Avenue	62	13	0.21	EB	Eckerson Road/ Buena Vista Avenue	62	8	0.13
TOR Route 97	SB	Route 303/ Executive Boulevard	124	6	0.05	NB	Route 303/ Leif Boulevard	124	4	0.02
Tappan Zee Express	EB	Broadway/ Clinton Avenue	456	320	0.70	WB	Broadway/ Clinton Avenue	285	175	0.61
Clarkstown Mini A	SB	Route 59/ Mountainview Avenue	22	2	0.09	SB	Route 59/ Mountainview Avenue	22	2	0.09
Clarkstown Mini B	SB	Main Street	22	5	0.23	SB	Main Street	22	3	0.14
Clarkstown Mini C	SB	West Clarkston Road/ Grand Street	22	5	0.23	SB	West Clarkston Road/ Grand Street	22	3	0.14
Clarkstown Mini D	WB	Old Nyack Turnpike	22	6	0.27	WB	Old Nyack Turnpike	22	4	0.18
Clarkstown Mini E	EB	Nanuet Mall	22	2	0.09	WB	Route 304/ Route 59	22	1	0.05
Monsey Loop 3	EB	Route 59/ Walmart	62	2	0.03	EB	Route 59/ Walmart	62	2	0.03
Note: Off-peak direction data is analyzed, but not included in the bus line haul capacity summary tables in this subchapter.										

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Table 3-10
Westchester County Existing Bus Conditions

Bus Route	AM Peak Hour					PM Peak Hour				
	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio
1C	SB	South Central Avenue/ West Main Street	240	137	0.57	NB	North Central Avenue/ East Main Street	160	55	0.34
1T	SB	South Broadway/ Kraft Tech Center	80	39	0.49	NB	South Broadway/ White Plains Road	80	42	0.53
1W	NB	South Broadway/ Kraft Tech Center	160	64	0.40	SB	South Broadway/ Kraft Tech Center	80	43	0.54
3	NB	Tarrytown Road/ Aqueduct Road	372	223	0.60	SB	Tarrytown Road/ Central Avenue	279	123	0.44
5	NB	White Plains Transit Center	445	125	0.28	SB	South Central Avenue/ Babbitt Court	445	199	0.45
6 (includes 6C and 6U)	NB	Main Street/ Court Street	469	340	0.72	NB	Dobbs Ferry Road/ Terrace Street	268	91	0.34
11	NB	Saw Mill River Road/ Payne Street	67	27	0.40	NB	North Central Avenue/ Paulding Street	67	11	0.16
12	NB	Purchase Street/ Meadow Lane	122	63	0.52	NB	Westchester Avenue/ South Kensico Avenue	122	24	0.20
13	WB	East Main Street/ North Central Avenue	134	77	0.57	EB	Tarrytown Road/ Chatterton Avenue	134	93	0.69
13B	EB	Tarrytown Road/ Chatterton Avenue	134	72	0.54	EB	Tarrytown Road/ Chatterton Avenue	67	50	0.75
15	SB	Tarrytown Road/ Greenvale Circle	67	32	0.48	NB	Tarrytown Road/ Central Avenue	134	46	0.34
17	SB	Tarrytown Road/ Aqueduct Road	134	45	0.34	NB	White Plains Transit Center	134	51	0.38

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Table 3-10 (con't)
Westchester County Existing Bus Conditions

Bus Route	AM Peak Hour					PM Peak Hour				
	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio
20	NB	Central Avenue/ Harding Avenue	654	234	0.36	SB	Central Avenue/ Harding Avenue	545	199	0.37
21X	NB	Central Avenue/ Harding Avenue	436	282	0.65	SB	Central Avenue/ Harding Avenue	327	184	0.56
27	NB	Saw Mill River Road/ Payne Street	134	100	0.75	SB	East Main Street/ Stone Avenue	134	49	0.37
40	NB	East Post Road/ Longview Avenue	396	220	0.56	SB	East Post Road/ Court Street	396	115	0.29
41X	NB	West Post Road/ South Lexington Avenue	396	240	0.61	SB	East Post Road/ Winchester Street	297	144	0.48
60	SB	Mamaroneck Avenue/ Martine Avenue	534	311	0.58	NB	Mamaroneck Avenue/ Martine Avenue	356	136	0.38
61	NB	Purchase Street/ Hillside Road	178	87	0.49	NB	Purchase Street/ Wappanocca Avenue	178	74	0.42
62X	NB	Westchester Avenue/ Kenilworth Road	267	131	0.49	SB	Westchester Avenue/ IBM	178	104	0.58
63 (includes 63C)	SB	Mamaroneck Avenue/ Martine Avenue	201	34	0.17	NB	Mamaroneck Avenue/ Martine Avenue	134	35	0.26
76	SB	Midland Avenue/ Eldredge Street	19	21	1.11	NB	Westchester Avenue/ East Broadway	19	6	0.32
77	SB	White Plains Transit Center	58	12	0.21	NB	White Plains Transit Center	116	28	0.24
BxM4C	SB	Central Park Avenue/ Palmer Road	522	300	0.57	NB	Madison Avenue/ 99th Street	348	195	0.56

371

Thruway Authority **New York State Department of Transportation** **Metro-North Railroad**

Table 3-10 (con't)
Westchester County Existing Bus Conditions

Bus Route	AM Peak Hour					PM Peak Hour				
	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio	Peak Direction	Maximum Load Point	Hourly Line Capacity	Hourly Peak Load Volume	Volume/ Capacity Ratio
A Loop	EB	Main Street/ South Broadway	162	38	0.23	EB	Westchester Avenue/ Westchester Medical Group	108	20	0.19
B Loop	EB	Main Street/ South Broadway	162	34	0.21	EB	Westchester Avenue/ US Post Office Sectional Center	216	49	0.23
C Loop	EB	Main Street/ South Broadway	38	8	0.21	EB	Westchester Avenue/ near Purchase Park	38	14	0.37
D Loop	EB	Main Street/ South Broadway	162	25	0.15	EB	West Red Oak Lane/ Westchester Avenue	216	44	0.20
E Loop	EB	Main Street/ South Broadway	54	11	0.20	WB	Manhattanville Road/ Centre at Purchase	108	26	0.24
F Loop	WB	Tarrytown Road/ Central Avenue	19	8	0.42	EB	Taxter Road/ White Plains Road	19	4	0.21
G Loop	NB	North White Plains Railroad Station	57	16	0.28	NB	Westchester Medical Center (Munger Pavilion)	38	9	0.24
H Loop	NB	King Street/ South American Lane	42	11	0.26	SB	King Street/ South American Lane	42	12	0.29
T Loop	EB	Warburton Road/ Hudson Terrace	108	22	0.20	EB	Benedict Avenue/ Bayer	108	12	0.11

Note: Off-peak direction data is analyzed, but not included in the bus line haul capacity summary tables in this subchapter.

375 ## 3.4 Travel Demand Forecasts

376 The BPM was calibrated to better represent 2005 travel conditions. However, due to regulatory
377 requirements for data to be more current, an "existing conditions" analysis was conducted by running the
378 BPM for the analysis year 2010.
379
380 The inputs to this model were:
381
382 1.   New York Metropolitan Transportation Council's (NYMTC)socio-economic and demographic
383   forecast (*NYMTC 2009 Socio-Economic and Demographic Forecasts, received February 25th*
384   *2010 from NYMTC*).
385
386 2.   Programmed improvements in the Transportation Improvement Plan.
387
388 3.   Rail and bus service plans similar to those used in the year 2005.

3.4.1 Socio-Economic and Demographics

389 A key input into the transportation modeling process that drives growth in travel is socio-economic and
390 demographic forecasts. These forecasts were developed by NYMTC and have been approved by the
391 participating agencies. Figure 3-4 compares 2005 with 2010 socio-economic and demographic (SED)
392 percentage growth and Table 3-11 contains the actual forecast numbers . The percentage population
393 growth in Rockland and Westchester Counties is forecast to be approximately 1.5 percent over the five
394 year period, as compared to 3 percent in Orange County. Rockland County, on the other hand, has a
395 significantly higher employment growth rate of approximately 5 percent as does Orange County (6
396 percent), when compared to Westchester County (1 percent), which has been considered the employment
397 center in the Tappan Zee corridor. Manhatan has a healthy employment growth of approximately 5
398 percent over the same period.
399
400 The Bronx and Orange County appear to have an extremely high five year employment labor force (ELF)
401 growth, 26 nd 17 percent respectively. Given that the popultion in the Bronx grows by about 10,000 over
402 a five year period, the labor force growth of over one hundred thousand is questionable.
403
404 The absolute population, employment and labor force growth between 2005 and 2010 is presented in
405 Table 3-11. Table 3-12 presents the difference between labor force and employment for select counties.
406 A positive number represents a higher labor force compared to available jobs in the county, making the
407 county an expoter of jobs, which is the case for most counties listed in the table, except Manhattan. This
408 phenomenon is a key driver of travel trends.
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Thruway
Authority

New York State
Department of Transportation

MTA Metro-North
Railroad
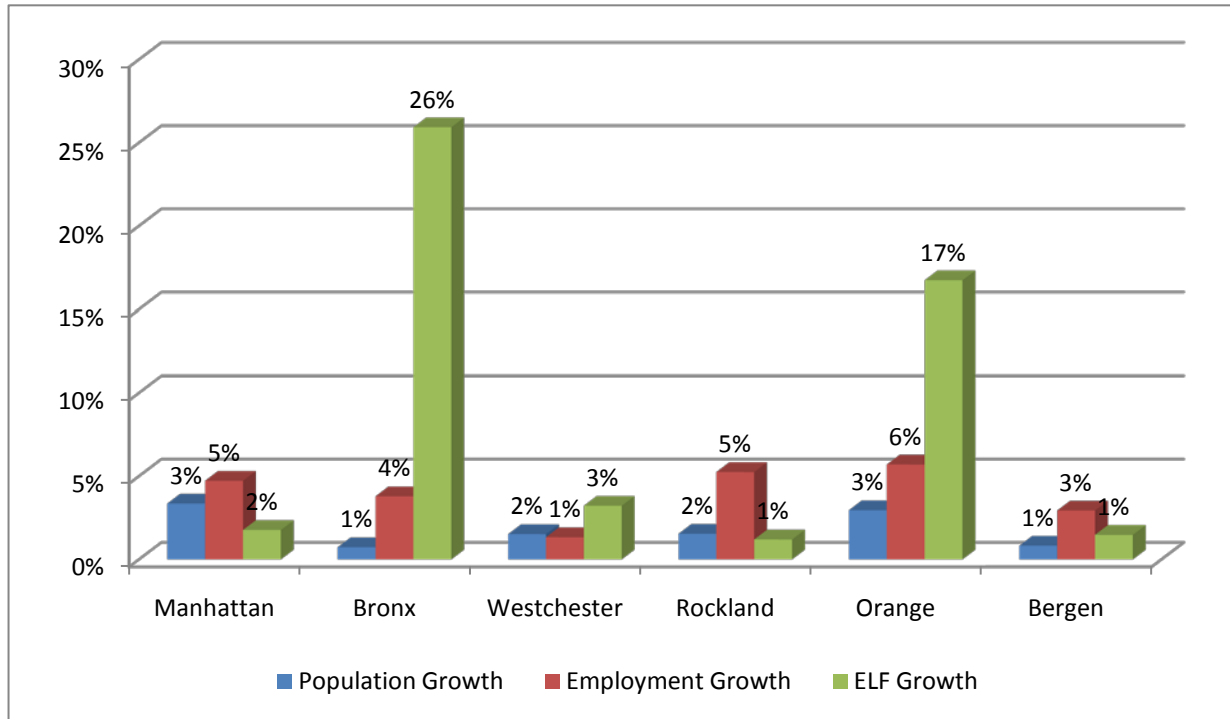
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415   **Figure 3-4 2005 and 2010 Comparison of the Percentage Growth in Population, Employment, and**
416   **Employment Labor Force**
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419
420   **Table 3-11**
421
422   **Comparison of the Absolute 2005 and 2010 Population, Employment, and Employment Labor**
423   **Force**
424

County	Population			Employment			Employment Labor Force		
	2005	2010	Diff	2005	2010	Diff	2005	2010	Diff
Manhattan	1,544,199	1,596,045	51,846	2,044,134	2,140,812	96,678	830,700	845,400	14,700
Bronx	1,317,104	1,326,763	9,659	295,178	306,380	11,202	465,900	586,712	120,812
Westchester	919,626	933,581	13,955	407,542	412,976	5,434	465,294	480,301	15,007
Rockland	286,779	291,193	4,414	122,404	128,833	6,429	145,999	147,750	1,751
Orange	358,649	369,255	10,606	133,423	141,034	7,611	170,796	199,384	28,588
Bergen	890,996	898,346	7,350	425,145	437,635	12,490	451,700	458,373	6,673
Source: NYMTC 2009 Socio-Economic and Demographic Forecasts, received February 25th 2010 from NYMTC)									

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428   **Table 3-12**
429
430   **Balance of Labor Force and Employment in Select Counties**
431

County	Employment		Labor Force		Labor Force-Employment	
	2005	2010	2005	2010	2005	2010
Manhattan	2,044,134	2,140,812	830,700	845,400	1,213,434	1,295,412
Bronx	295,178	306,380	465,900	586,712	170,722	280,332
Westchester	407,542	412,976	465,294	480,301	57,752	67,325
Rockland	122,404	128,833	145,999	147,750	23,595	18,917
Orange	133,423	141,034	170,796	199,384	37,373	58,350
Bergen	425,145	437,635	451,700	458,373	26,555	20,738
Source: NYMTC 2009 Socio-Economic and Demographic Forecasts, received February 25th 2010 from NYMTC)						

432
433

3.4.2 Daily Trips for Select Markets

434 Figure 3-5 represents daily 2005 and 2010 (in parentheses) daily work trips in select markets, as forecast
435 by the BPM.
436
437 Two trends that stand out are a drop in work trips between Rockland and Westchester Counties (14,250 to
438 12,610) and the relatively high growth (28 percent) of Orange County to Manhattan work trips (10,836 to
439 13,819).
440
441 The drop in Rockland County to Westchester County work trips could be attributed to a combination of
442 reasons:
443
444   1.   The balance of employment and labor force – In 2005, there were approximately 23,600 more
445   people in the Rockland work force compared to the available jobs in Rockland County. This
446   number reduces to approximately 18,900 in 2010, a drop of approximately 4,700 potential work
447   trips generated from Rockland County destined for other counties.
448
449   2.   A high number of jobs west of the Hudson which would serve as as an incentive, for both new
450   workers and existing workers, to work west of the Hudson.

451 The approximately 28 percent increase in Orange County to Manhattan work trips could be attributed to
452 the high growth in the Orange County employment labor force (17 percent) and the robust projected
453 growth in Manhattan employment, 5 percent or marginally under one hundered thousand jobs. As a
454 percentage of the total Orange County labor force, the percentage of Orange County residents working in
455 Manhattan changes from 6.3 to 6.7 percent, between 2005 and 2010. Rockland County to Manhattan
456 work trips increase nominally by approximately 6.5 percent.
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458
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5,724 (6,111)

14,250 (12,302)

4,559 (4,955)

17,366 (18,752)

10,836 (13,819)

2005 Trips (2010 Trips)
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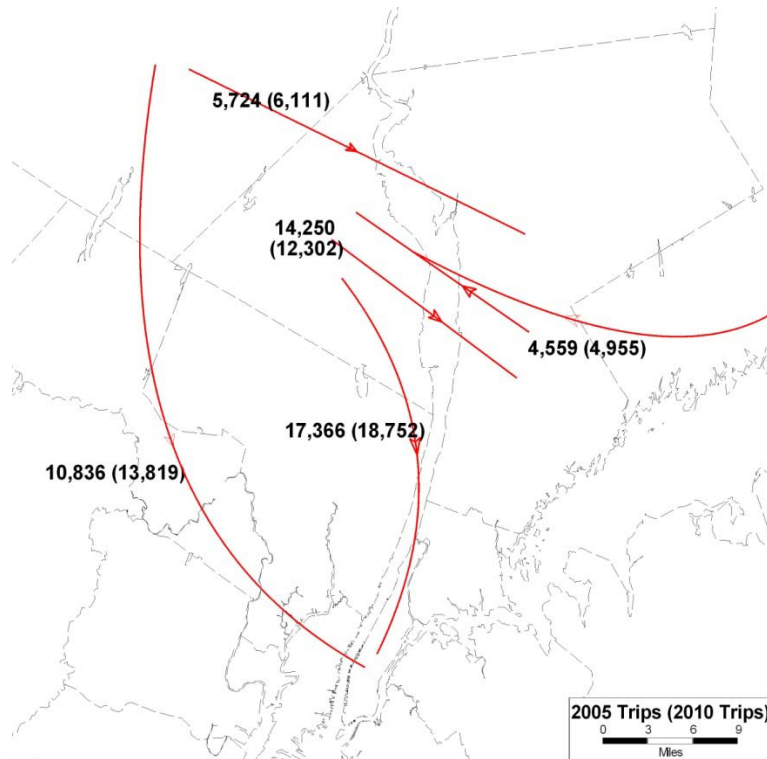
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461
462 **Figure 3-5 Work Trips in Select Markets**
463

3.4.3 Mode Share

464 The change in mode share between 2005 and 2010 is insignificant except for the Rockland County and
465 Orange County to Manhattan markets (Figure 3-6). Both Orange and Rockland to Manhattan markets are
466 projected to see an increase in transit share (2.5 and 2 percent, respectively) and a resulting decrease in
467 auto share.
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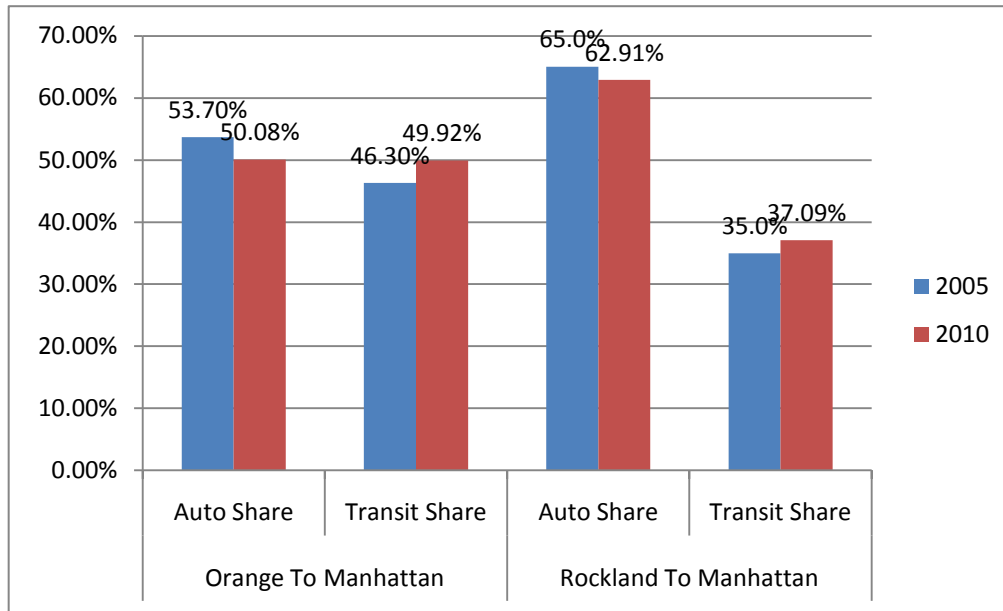
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471 **Figure 3-6 2005 and 2010 Change in Mode Share Rockland County and**
472 **Orange County to Manhattan**
473
474

3.4.4 Highway Volume

475 Figure 3-7 represents the change in AM peak period (6 to 10), predominanlty work, highway volumes
476 across major Hudson River crossings. The BPM forecasts a reduction in the eastbound AM peak period
477 volumes on both the Tappan Zee and George Washington Bridges. Although it is true that bridge
478 crossings reduced in reality due to the economic downturn, the reduction observed in the forecast
479 highway volumes can be attributed to the increase in west-of-hudson employment. This theory is
480 supported by the increase in westbound Tappan Zee, George Washington, and the Newburgh Beacon
481 bridge traffic. The 2005 and 2010 Hudson Crossing volumes are presented in Table 3-13.
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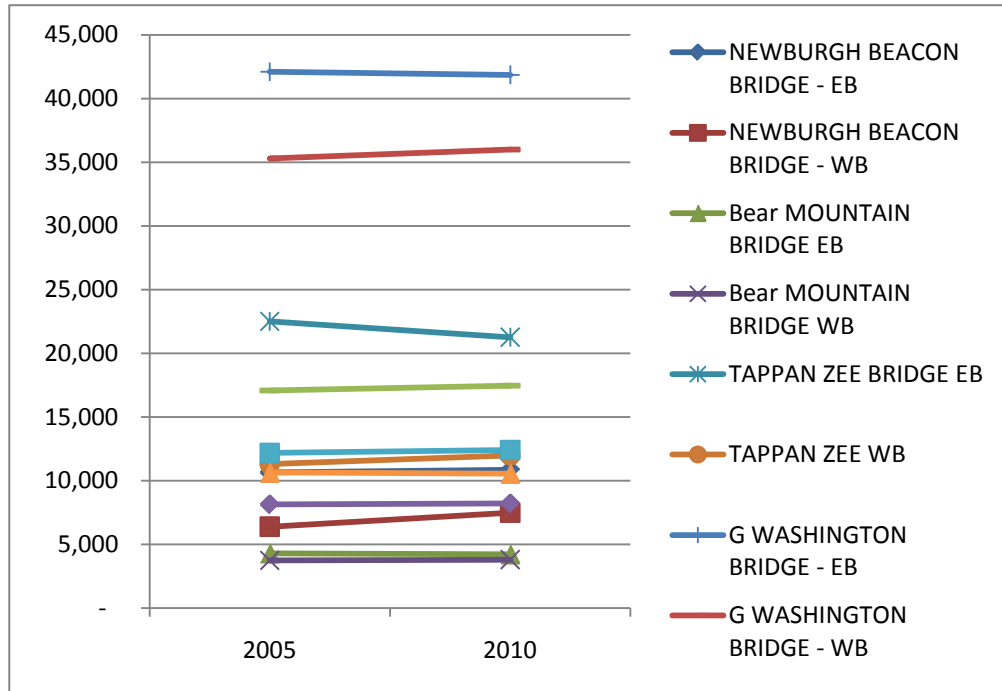
496
497
498 Figure 3-7 Change in 2005 and 2010 AM Peak Period (6-10) Eastbound and Westbound Hudson
499 River Crossing Highway Demand
500
501
502
503 Table 3-13
504
505 2005 and 2010 Hudson River Crossing Highway Demand
506

Hudson River Crossings	2005	2010
Newburgh Beacon Bridge - EB	10,657	10,859
Newburgh Beacon Bridge - WB	6,402	7,503
Bear Mountain Bridge - EB	4,314	4,228
Bear Mountain Bridge - WB	3,759	3,813
Tappan Zee Bridge - EB	22,511	21,268
Tappan Zee Bridge - WB	11,302	12,001
George Washington Bridge - EB	42,094	41,859
George Washington Bridge - WB	35,291	35,990
Lincoln Tunnel - EB	17,090	17,468
Lincoln Tunnel - WB	8,150	8,225
Holland Tunnel - EB	12,193	12,424
Holland Tunnel - WB	10,647	10,571

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3.4.5 Transit Ridership

510   Tables 3-14 shows the projected southbound boardings on the Port Jervis line in the AM peak period. As
511   discussed earlier the number of work trips is projected to increase significantly between Orange County
512   and Manhattan and at a nominal rate between Rockland County and Manhattan. This growth is reflected
513   in the transit ridership on the Port Jervis Line, which grows by approximately 34 percent. The difference
514   in growth on the Port Jervis Line is attributable to the difference in population and employment labor
515   force rates in Orange and Rockland Counties.
516
517   **Table 3-14**
518
519   **2005 and 2010 Port Jervis Line AM Peak Period Boardings**
520

AM Peak Period Boardings		
Station	2005	2010
Port Jervis	106	151
Otisville	83	103
Middletown	551	844
Campbell Hall	83	111
Salisbury Mills	650	1002
Harriman	457	469
Tuxedo	42	34
Sloatsburg	41	36
Suffern	369	486
Total	**2,382**	**3,236**

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4 Impacts

1 This chapter discusses the measures used to evaluate the DEIS alternatives based on results primarily
2 from the New York Best Practice Model (referred to as the BPM). Transit ridership within the corridor
3 and travel time savings for a representative sample of transit trips were developed. The alternatives were
4 also evaluated in terms of their ability to attract carpools and transit riders. Large-scale impacts on
5 roadway traffic were measured in terms of volumes across the Hudson and total vehicle miles traveled
6 (VMT).
7
8 The analysis was based on model years 2017 (the estimated time of completion –"ETC" for the project's
9 highway and bridge elements) and 2047 (ETC+30, representing the 30-year planning horizon used for
10 projects that include major bridges or similar infrastructure elements). A sub-area Paramics traffic
11 microsimulation model was used to provide a more comprehensive and detailed assessment of traffic
12 impacts (see *Traffic Technical Report* for further details).
13
14 This chapter begins with an overview of the BPM, followed by a discussion of the demographic forecasts
15 for the DEIS analysis years, and an overview of No Build and build alternatives. Corridor-wide VMTs,
16 Vehicle Hours Traveled (VHT), travel time in select markets, work trip distribution, highway demand,
17 and ridership are also reviewed.
18

4.1 Travel Demand Modeling

4.1.1 BPM Overview

19 BPM represents a state-of-the-art process for forecasting future urban travel based on assumptions
20 regarding land use and transportation facilities and services. The model region consists of 28 counties in
21 the New York Metropolitan Area, including 14 counties in northern New Jersey and two counties in
22 southwestern Connecticut (Figure 4-1). The regional roadway network is represented in BPM with about
23 40,000 links. A separate transit network includes about 3,300 transit routes.
24
25 The counties are divided into 3,586 internal zones and 111 external stations (i.e., points where vehicles
26 from outside the model area enter the model network). In Manhattan and other dense areas, the zones are
27 typically equivalent to census tracts, and in some places are subdivisions of tracts. In the study area in
28 Rockland County and Westchester County, several zones are composed of multiple tracts, and the tracts
29 themselves are quite large.
30
31 Demographic variables are prepared by NYMTC for each zone and are available between 2005 and 2035
32 in five to ten-year increments through 2030 (2047 forecasts are described in Section 4.1.3). These
33 variables are:
34
- Household Population.
- Population in Group Quarters (Total).
- Population in Group Quarters (in institutions, i.e., college dormitories, prisons, etc.).
- Population in Group Quarters (street population).
- Population in Group Quarters (other).
- Number of Households.
- Average Household Size.

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42

BPM Study Area

1. Manhattan	11. Orange	21. Middlesex
2. Queens	12. Dutchess	22. Monmouth
3. Bronx	13. Fairfield	23. Ocean
4. Brooklyn	14. Bergen	24. Hunterdon
5. Staten Island	15. Passaic	25. Warren
6. Nassau	16. Hudson	26. Sussex
7. Suffolk	17. Essex	27. New Haven
8. Westchester	18. Union	28. Mercer
9. Rockland	19. Morris	
10. Putnam	20. Somerset	
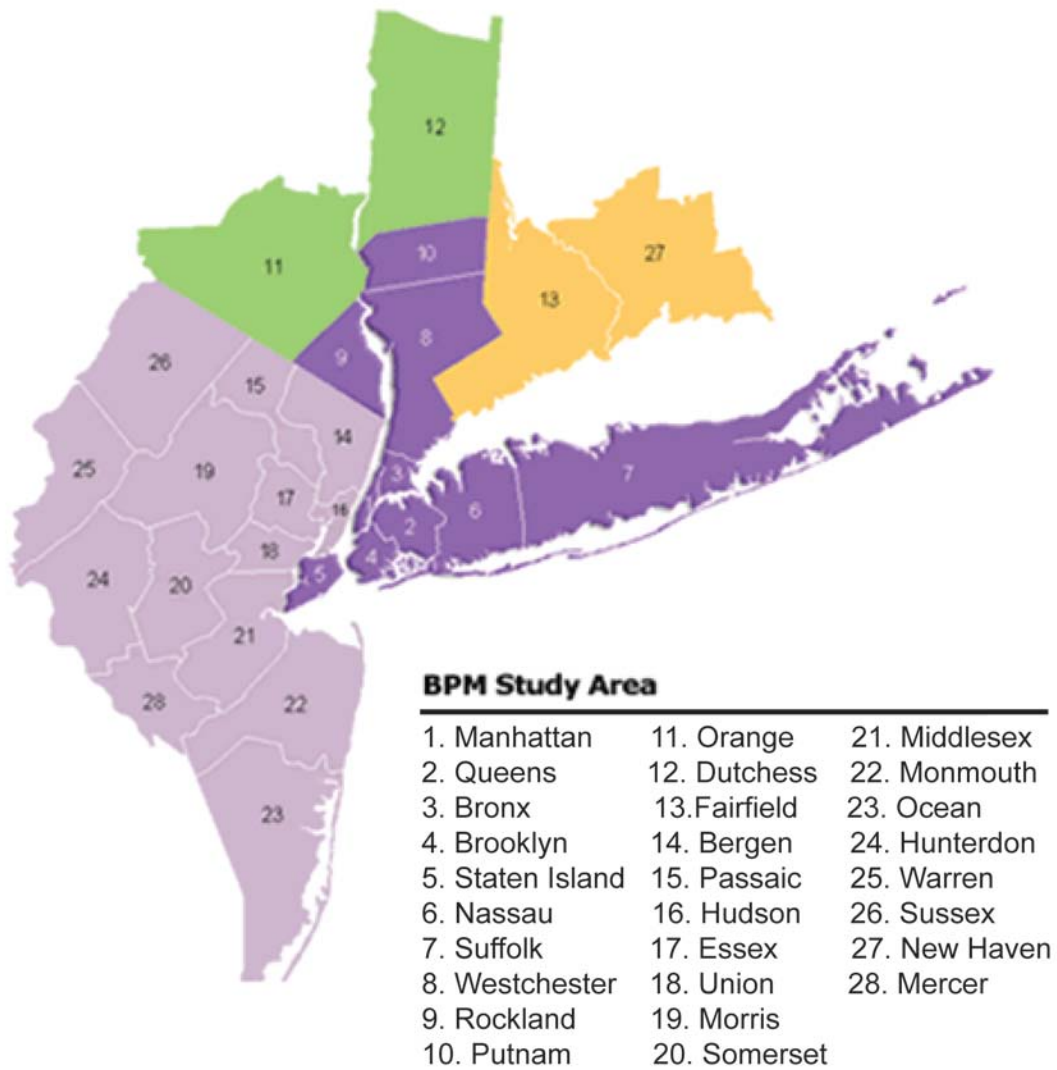
43

44   Source: NYBPM Modeling General Final Report, January 30, 2005.
45

46   **Figure 4-1 BPM Study Area**

47

48   ▪ Employed Labor Force (by place of residence).
49   ▪ Median Household Income.
50   ▪ Total Employment (by place of work).
51   ▪ Retail Employment.
52   ▪ Office Employment.
53   ▪ Median Earnings of Employees.
54   ▪ University Enrollment (by location of university).
55   ▪ K-12 Enrollment (by location of school).
56
57   The model is structured as a series of modules (Figure 4-2). The outputs of each module are used as
58   inputs to successive modules. Starting with the socioeconomic data for a given year, the Household Auto-
59   Journey (HAJ) module generates a list of households and trip-makers with various characteristics for each
60   zone. It then generates a list of typical weekday journeys by six different purposes:
61
62   ▪ Work.
63   ▪ School (K-12).
64   ▪ University.
65   ▪ Household maintenance.
66   ▪ Discretionary activity.
67   ▪ At-work journeys (i.e., office-to-office, lunch time trips).
68
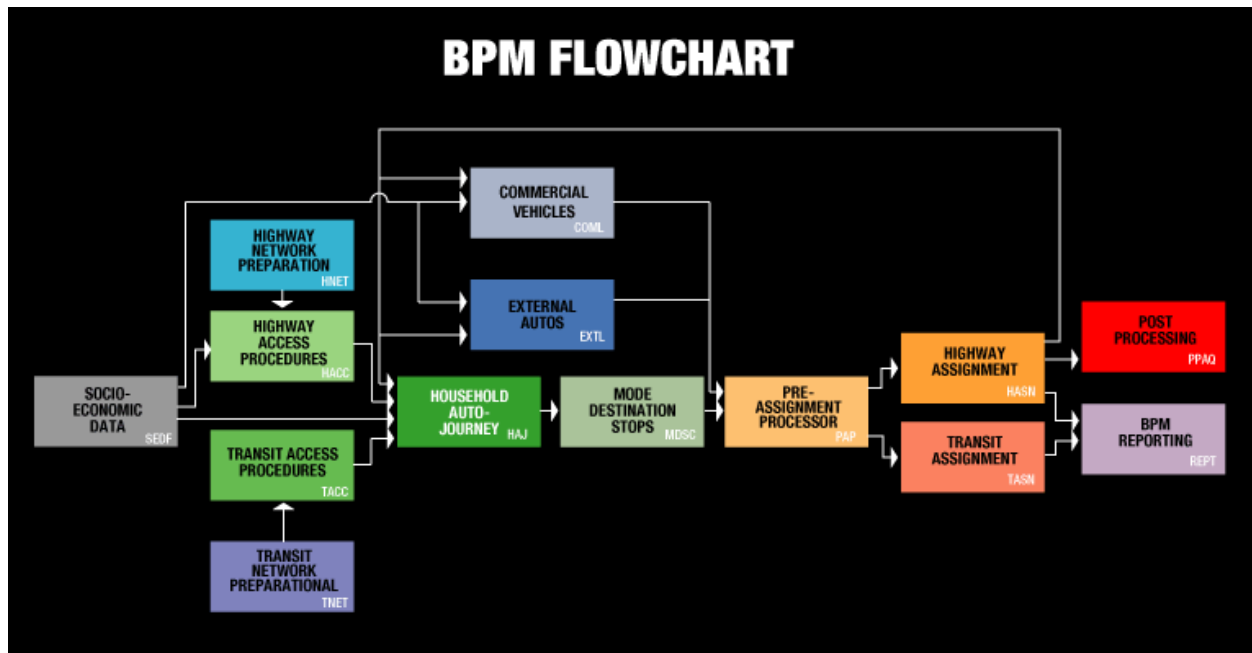
69
70   Source: NYBPM Modeling General Final Report, January 30, 2005.
71
72   **Figure 4-2 BPM Flow Chart**

73
74   The generation rates of each type of trip from each type of household are based on an extensive 1997
75   household survey conducted by NYMTC.
76
77   The destinations and modes of journeys are modeled in the BPM's **"Mode Destination Stops Choice"**
78   (MDSC) module. The key variable in determining mode choice is the comparison of best paths by various

79 modes – by commuter rail, by transit (i.e., subway and bus only) and by highway. These paths are
80 expressed as matrices that describe the travel time and costs between any two zones by a given mode.
81
82 The project team made enhancements to the model where needed to ensure that it more accurately
83 replicated existing transportation operations in the corridor and would provide more realistic projections
84 of future conditions with and without the proposed project.
85

Additional Modules

86 The BPM has additional modules listed below:
87

88 a. *Time-of-Day* - Converts daily journey data to trip tables by time period (AM(6-10), Midday(10-
89   4), PM (4-8) and Night(8-6))
90

91 b. *External Model* - This is a separate module that forecasts trips external to the BPM region, which
92   comprise external-internal, internal to external and external-external trips for automobiles
93

94 c. *Truck Model* – The truck model forecasts truck and commercial vehicle demand. Although this
95   module is not accessible to the BPM user, trip tables are developed during a BPM run. The truck
96   model forecasts are developed by using growth factors that are dependent on household
97   population and employment (retail, office, other). The commercial vehicle forecasts are done
98   using a gravity model.
99

4.1.1.1 BPM Calibration

100 The BPM was calibrated to 2005 conditions. The model was calibrated and validated to several data
101 sources for trip distribution, mod shares, highway volumes and transit ridership. The key data sources
102 used for calibration were Census Journey to Work data, the Tappan Zee I-287 Origin-Destination Survey,
103 Ridership information and bridge crossing demand. The calibration process focused on understanding
104 different aspects of commuter trips and also the reduction of the inherent biases within the model.

4.1.1.2 Validation of Forecasts

105 An exercise to "validate" the BPM forecasts was undertaken to assess the reasonableness of the model
106 projections. The goals of the validation analyses were to validate the travel projections in relation to the
107 socio-economic and demographic projections, compare current travel demand forecasts with previous
108 travel demand forecasts bearing in mind the dramatic changes in demographic projections, and determine
109 what actions were needed, based on findings of the analyses, to strengthen the validity of the
110 transportation analyses in the DEIS. This effort was documented in a memorandum titled, "Validation of
111 Preliminary Year 2047 DEIS Forecasts," dated September 29, 2010.

4.1.2 Analysis Years

112 As noted above, the transportation and other analyses reported in the EIS were completed for three
113 analysis years:

114 ▪ 2010 – Existing Conditions;

115   ▪   2017 – Expected Time of Completion (ETC) for the project's highway and bridge elements; and

116

117   ▪   2047 – ETC+30 -- the design year planning horizon for the highway and bridge elements and the
118   year by which all proposed transit elements are projected to be completed and in operation.

119

4.1.3 Demographic Projections – 2017 and 2047

120   NYMTC demographic projections were available in five year increments between 2005 and 2035. Since a
121   set of official forecasts were not available from NYMTC, forecasts for 2047 were developed by linear
122   interpolation with adjustments (see below), using 2015 and 2020 NYMTC projections. The methods used
123   and the resulting projections were reviewed with NYMTC staff to ensure their reasonability for such a
124   distant planning period.

125

4.1.3.1 2047 Forecasts

126   The 2047 forecasts were extrapolated using 2030 and 2035 data. Straight linear extrapolation caused
127   dramatic changes in population and employment at the transportation analysis zone (TAZ) level (the
128   BPM's 28-county area is comprised of almost 3,600 TAZs, with more numerous smaller zones in core
129   urban areas – e.g., 538 in Brooklyn – and fewer large zones in suburban/rural areas – e.g., 38 zones in
130   Rockland County). These large changes occurred especially when population and employment data
131   changed significantly between 2030 and 2035, thereby upwardly skewing the extrapolated estimates. To
132   avoid such dramatic change, a revised methodology similar to the above straight-line extrapolation was
133   developed. The entire 28-county BPM study area was grouped into districts. Data in each TAZ was
134   grown using a straight-line extrapolation based on the growth of the district it belongs to. The growth
135   factor was then applied to each TAZ within the district to develop 2047 forecasts, as follows:

136

Districts

138

139   The 28-county BPM study area was divided into 11 subareas:

140

141   1.   Manhattan
142   2.   The Bronx
143   3.   Rest of New York City + Long Island (Brooklyn, Queens, Staten Island, Nassau, and Suffolk)
144   4.   Westchester
145   5.   Rockland
146   6.   Orange
147   7.   Rest of New York State (Putman and Dutchess)
148   8.   Bergen
149   9.   Hudson
150   10. Rest of New Jersey (Passaic, Essex, Union, Morris, Somerset, Middlesex, Monmouth, Ocean,
151   Hunterdon, Warren, Sussex and Mercer)
152   11. Connecticut (Fairfield and New Haven)

153

154

155 **Growth Factors**
156
157 The straight-line method entails using two available data points (data from two years) to extrapolate to a
158 required forecast year. The analysis was performed at a Traffic Analysis Zone (TAZ) level with a growth
159 factor obtained from district level, for every TAZ, using the following formula:
160

161   Where:
162
163   = population for TAZ i in year C (2047)
164   = population for TAZ i in year C (2030)
165   = population for District I that contains TAZ i in year B (2035)
166   = population for District I that contains TAZ i in year A (2030)
167   = growth factor for District I that contains TAZ i
168
169 The growth factor   , based on the growth between two forecast years, was developed by district. Growth
170 trends for each data field were analyzed within the district. These growth factors were applied at a TAZ
171 level to develop 2047 forecasts.
172

4.1.4 2017 No Build Alternative

173 The No Build Alternative was developed as a baseline, with other alternatives subsequently built upon the
174 No Build network. The future forecasts described above combined with future (including programmed
175 improvements) transit and highway networks were the key inputs to the future runs. The No Build
176 included network improvements from NYMTC's Transportation Improvement Program (TIP). Notable
177 highway improvements included the programmed improvements to I-287 in Westchester County, Transit
178 improvements as discussed in Chapter 3, East Side Access, Second Avenue Subway, and the extension of
179 New York City Transit (NYCT) train #7. The planned Access to the Region's Core (ARC) project to
180 enhance commuter rail access into Manhattan from New Jersey and other West-of-Hudson markets was
181 cancelled in 2010. Although there are presently no replacement plans for the ARC project, various
182 transportation agencies are reviewing a range of options to meet these important regional travel needs.
183 The analyses in the DEIS assumed that some form of trans-Hudson rail improvements similar to the ARC
184 project would occur over the next 10-20 years, and those improvements were therefore assumed in the
185 BPM modeling for No Build and build alternatives conditions. The lack of such improvements would
186 limit future ridership on existing West-of-Hudson CRT operations while subsequently increasing the
187 number of riders likely attracted to the proposed Tappan Zee Bridge CRT service across Rockland
188 County and south on the Metro-North Hudson Line into Grand Central Terminal. These projections and
189 the underlying planning assumptions will be reviewed in much greater detail in the future Tier 2
190 environmental documentation of the proposed project's transit elements.
191

4.1.5 Coding of Build Alternatives

192 The highway elements of the build alternatives were coded in addition to the base network and the
193 programmed improvements. The build highway elements comprised additional highway lanes on
194 segments where such improvements are planned and the addition of HOV/HOT lanes and their associated

195 slip ramps where applicable. All 2017 and 2047 build alternatives contain what are known as the
196 "common highway improvements", which include, climbing lanes, the expansion of the Tappan Zee
197 Bridge from seven to eight lanes, and interchange improvements (which were not coded in the BPM but
198 are reflected in the Paramics traffic model).
199
200 All build alternatives included identical highway improvements – an eight-lane bridge and climbing lanes.
201 For modeling purposes, HOT lanes, where applicable, were assumed and a range of tolls on the HOT
202 lanes was iteratively tested until traffic assignments reached target HOT-lane volumes and speeds (about
203 1,600 vehicles per hour and a minimum speed of 45 MPH).
204
205 For each build alternative, new transit services were coded in addition to the routes that exist in the No
206 Build, and the entire model process was re-run. Each route corresponds to a column in the service plans
207 described in Appendix B (i.e., every service with a unique set of stops is considered a route, so there can
208 be multiple routes over the same physical space). Only AM (6-10) and Midday (10-4) periods are
209 modeled, and assignments by route are only produced for the AM period.
210
211 BRT routes were coded as express bus routes. In the course of the project, it was determined that using
212 the express bus designation led to conservative ridership results, due to the way BPM handles the
213 interaction of express bus routes with CRT[1].
214
215 Commuter rail fares were set at one fortieth (1/40) of the monthly commuter fares, to represent the
216 discounted one-way fare to which BPM modeling is calibrated. (See Appendix B for station-to-station
217 fares). BRT routes were given flat fares, ranging from $1.25 to $2.85. (Distance-based fares cannot be
218 simulated on bus routes.) Note that while BPM transit procedures are able to simulate free or discounted
219 transfers between bus routes, they cannot simulate any discount on transfers between BRT and CRT.
220
221 All new fixed rail stations were modeled with effectively unlimited parking, to determine the
222 unconstrained demand. Parking costs at new stations and park-and-rides were made comparable to costs
223 at the existing CRT stations in the vicinity.
224
225

---

[1] In determining best paths, the express bus portion of a path which includes commuter rail is assigned a relatively high weight to discourage transfers between the two modes. Transfers between the two modes are discouraged since traditionally, express buses are not feeders to commuter rail and vice-versa. By comparison, in paths which include both local bus and commuter rail, the local bus portion of the path is assigned a relatively lower weight. Since the BRT was conceived in part to specifically serve such transfers, the Project Sponsors also tested sensitivity runs with BRT coded as "local bus", but with identical service characteristics (stopping patterns, headways and run times). These runs showed substantially higher ridership, particularly for longer-distance trips, such as the GCT-bound riders connecting at Tarrytown, and trips between Connecticut and the corridor connecting at Port Chester.

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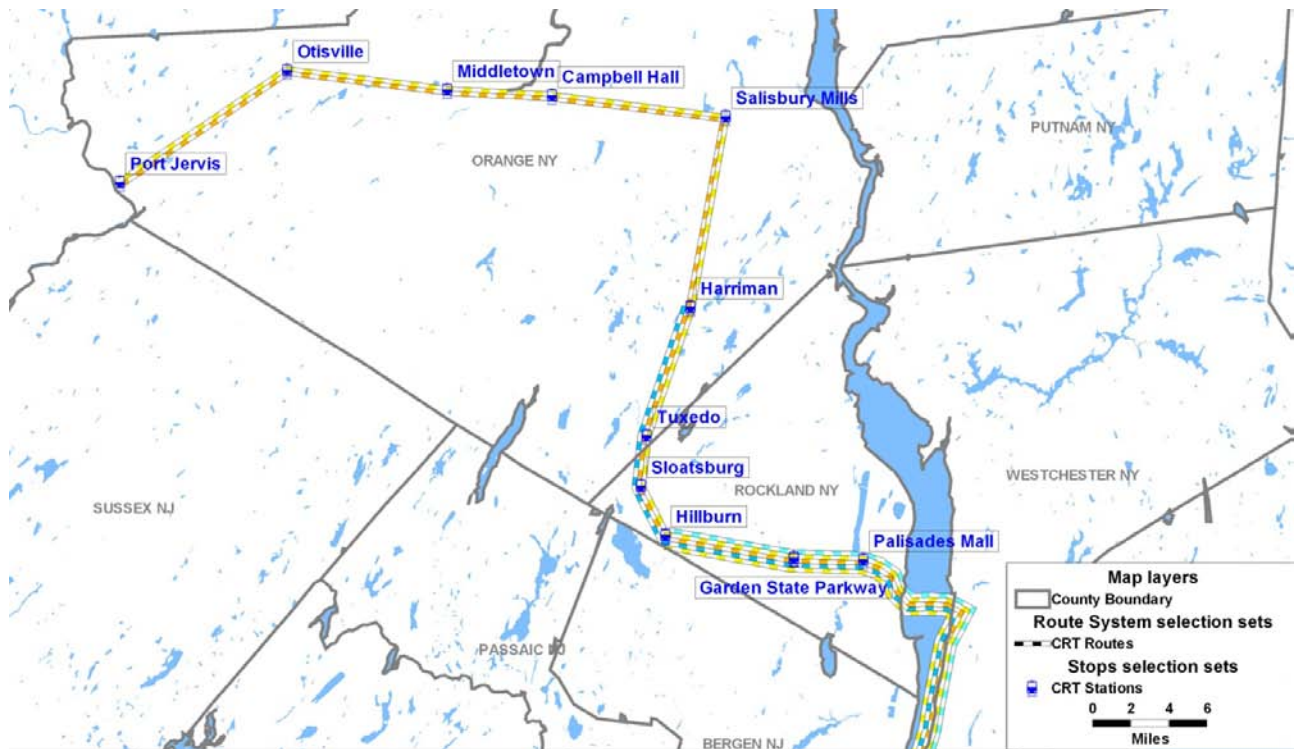
229   **Figure 4-3 CRT Route Coding**

230

231
232
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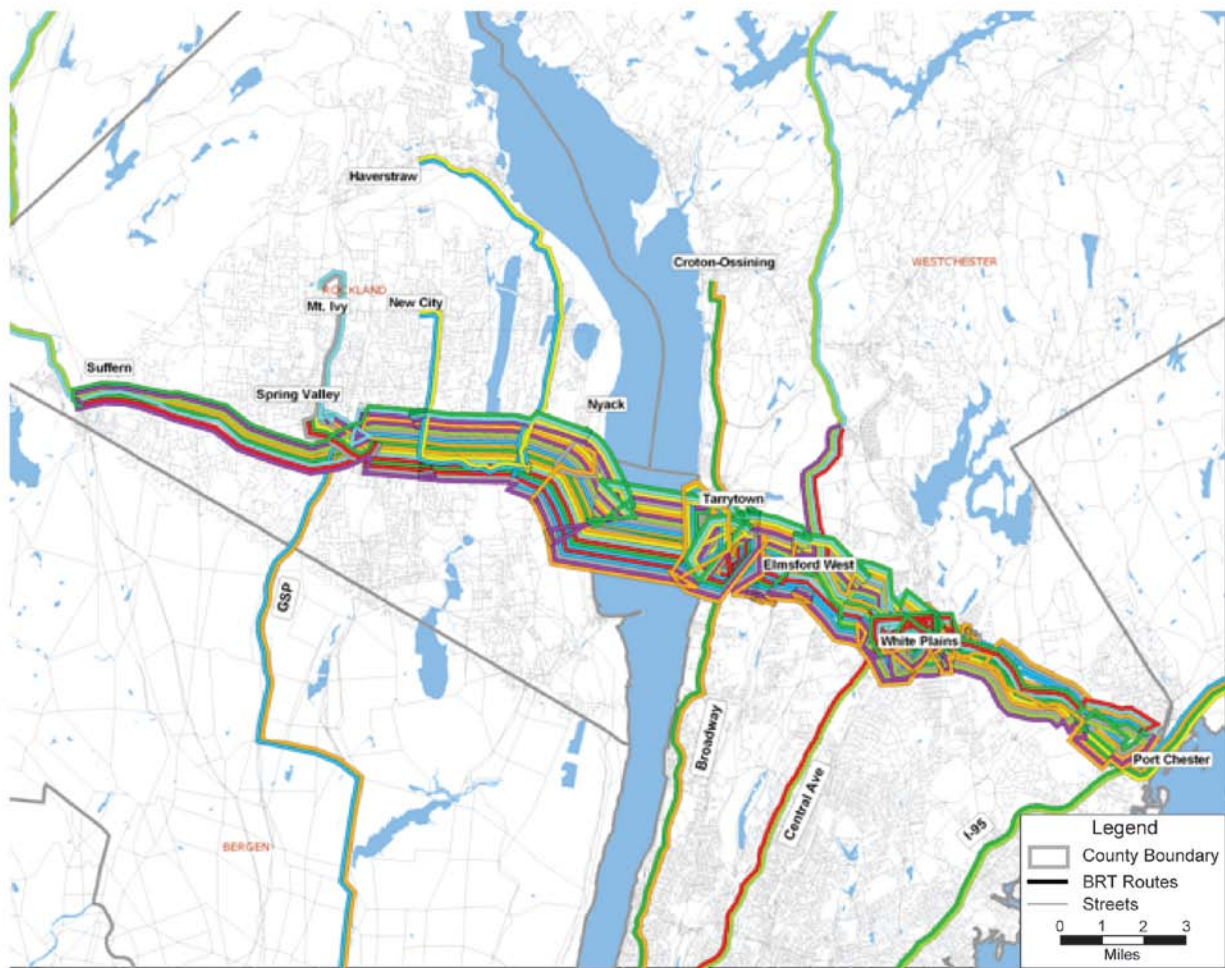
Figure 4-4 BRT Route Coding

234
235
236
237

238   ## 4.2 Evaluation of Alternative Impacts

4.2.1 Existing Conditions versus No Build Alternative

4.2.1.1 Demographic Forecasts

239   Compared to the rest of the region, the forecasts show higher than average percentage growth in Orange,
240   Rockland and Westchester Counties (Figure 4-5). The employment labor force (ELF) to employment
241   balance is an indicator to whether the county is an "importer" or an "exporter" of labor. A higher
242   employment than ELF suggests the county is an exporter and vice-versa. Rockland and Westchester
243   Counties are forecast to have a balance of ELF to employment, while Orange County appears to be more
244   of an exporter of workers (Table A-1). Manhattan continues to grow as a large importer of employees.
245
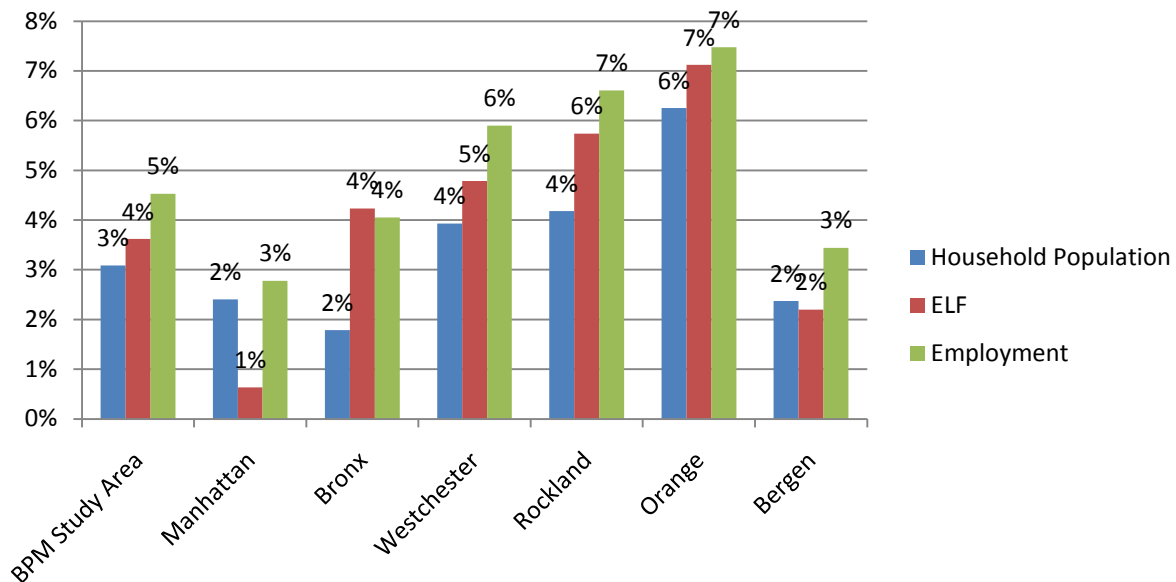
246
247
248   **Figure 4-5 Comparison of 2010 and 2017 Demographic Forecasts**

249
250
251   Further details on these and other data on 2017 No Build conditions are contained in Appendix A.
252

4.2.1.2 Corridor Vehicle Miles and Vehicle Hours Traveled

253   VMT and VHT are macro-scale indicators of the total vehicle miles and hours traveled within a certain
254   region. The growth in VMT and VHT within the I-287 Corridor (an envelope of approximately 1 mile
255   around I-287), between 2010 and 2017 was projected to be 5 and 7 percent, respectively.
256
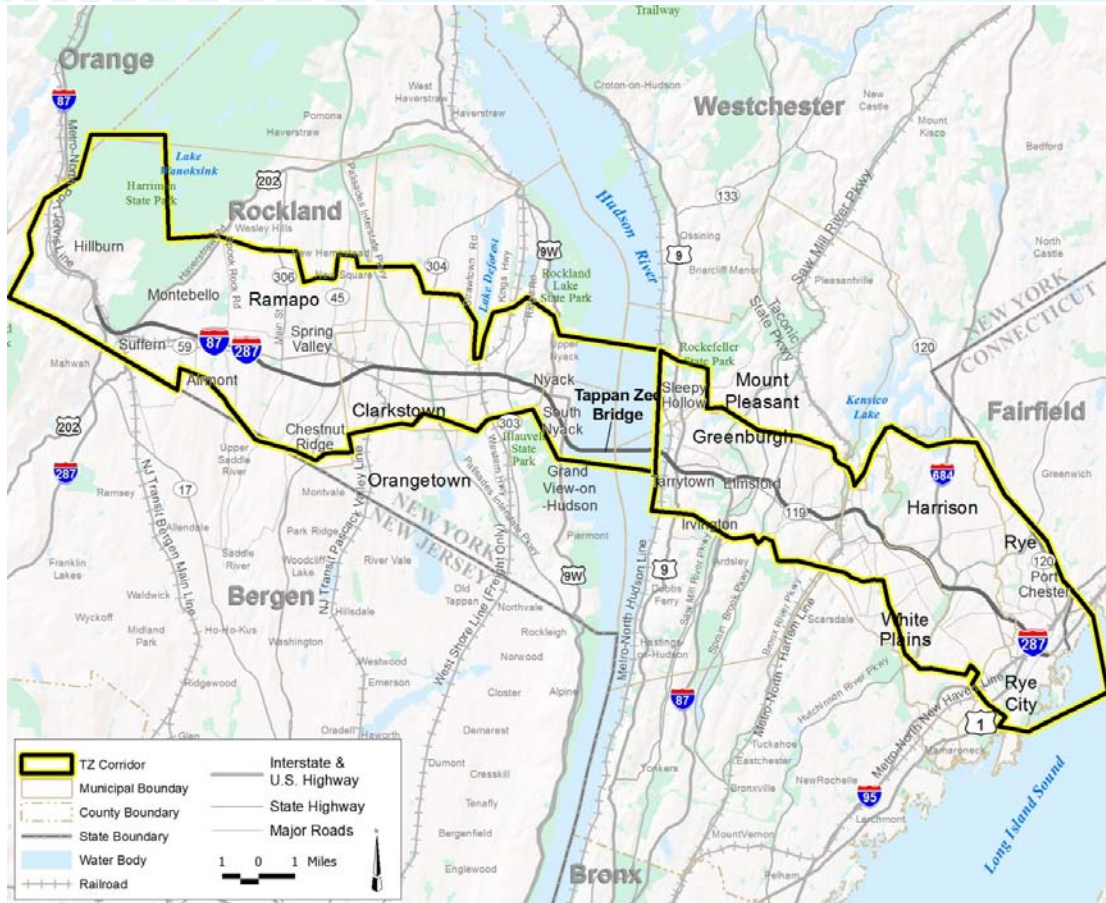
257
258 **Figure 4-6 I-287 Corridor Study Area**

259
260

4.2.1.3 Travel Time Savings

261 A measure used to evaluate alternatives and better understand travel was travel times, for several origin-
262 destination pairs affected by proposed projects in the I-287 Corridor.

263
264 AM peak-period (and PM peak-period in select markets) highway times in minutes were calculated from
265 BPM runs (Table A-4). A best path is determined for an origin-destination pair. The travel times represent
266 congested travel times.

267
268 Corridor travel times changed minimally between 2010 and 2017. Of the origin-destination pairs that
269 were projected to experience a travel time difference greater than 2 minutes, most had one trip end in
270 Orange County.

271

4.2.1.4 Trip Distribution and Mode Share

272 The mode share in 2017 is similar to 2010 levels, except for the Orange and Rockland to Manhattan
273 markets, which change significantly. This change can be attributed to the availability of a one-seat ride
274 into Manhattan on the ARC service, assumed to be a part of the 2017 network. The Orange and Rockland

275 to Manhattan commuter rail shares increased from approximately 29 percent to approximately 40 percent
276 and 14 to 21 percent respectively (Table A-5).
277

4.2.1.5 Mainline Tappan Zee Bridge Volumes

278 Over a 7 year period between 2010 and 2017, the daily Tappan Zee Bridge demand increases by 6 and 7
279 percent, in the eastbound and westbound directions respectively (Table 4-1). The peak periods are also
280 expected to grow at approximately the same rate. Truck traffic across the bridge is expected to grow by
281 approximately 6 to 10 percent across the bridge.
282
283
284

Table 4-1
Mainline Tappan Zee Bridge Volumes

285

	2010 Existing		2017 No Build		Growth	
	EB	WB	EB	WB	EB	WB
AM (6-10)	22,215	12,013	23,809	12,824	7%	7%
PM (4-8)	13,788	20,352	14,569	22,032	6%	8%
Daily	64,849	62,547	68,724	66,828	6%	7%

286
287
288 As a reasonableness check, 2010 to 2017 work trip growth in markets contributing more than 80 percent
289 of the eastbound trips across the Tappan Zee Bridge was compared (Table 4-2). As indicated, the daily
290 eastbound work growth is approximately 10 percent; comparable to a 7 percent AM peak period Tappan
291 Zee demand growth (assuming that most work trips occur during the AM peak period). It must be noted
292 that these markets are served by other crossings as well, as a result the growth within these markets
293 cannot be directly compared with the growth across the Tappan Zee Bridge.
294
295
296

Table 4-2
Daily Work Trip Growth in Select Markets - 2010 to 2017

297

	2010	2017	% Change
Orange to Westchester	6,111	7,252	19%
Rockland to Other NYC	9,172	9,613	5%
Rockland to Westchester	12,302	14,037	14%
Rockland to Manhattan	18,752	19,934	6%
Rockland to CT	627	685	9%
Bergen/Passaic to Westchester	3,865	4,153	7%
Total	**50,829**	**55,674**	**10%**

298
299

4.2.1.6 Ridership

300 Ridership on the Port Jervis and Pascack Valley Line are projected to grow significantly between 2010
301 and 2017, based on the assumption that a project with improvements similar to the ARC project would be
302 in place in 2017. During the 4-hour AM Peak period the inbound ridership on the Port Jervis Line and
303 Pascack Line would increase by approximately 2,700 and 1000, respectively between 2010 and 2017.
304

4.2.2 2017 Build Alternatives

4.2.2.1 Overview

305 Two 2017 build alternatives are analyzed - 2017 Highway Improvements and 2017 Highway
306 Improvements with HOV/HOT Lanes. The Highway Improvements referred to are climbing lanes, the
307 expansion of the Tappan Zee Bridge.
308
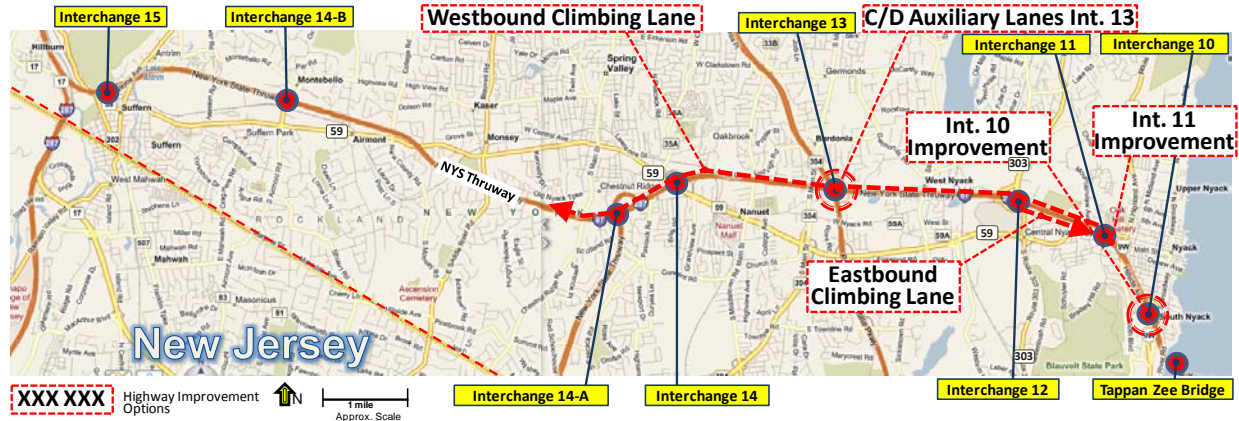
311 **Figure 4-7 Potential Highway Improvements in Tappan Zee Bridge / I-287 Corridor**

314 HOV/HOT lanes are those separated from general purpose lanes for the exclusive use of buses, high
315 occupancy vehicles (registered carpools with three or more passengers) (HOVs), and other automobiles
316 willing to pay a premium toll. The toll would be dynamic – varying over time based on the volume of
317 traffic in the HOT lane and the volume of traffic in the general purpose lanes – and would increase to
318 keep the HOT lane from becoming congested. The dynamic aspect of HOV/HOT lanes was modeled in
319 Paramics.
320

321 HOT lanes are a means of providing premium service on the roadway for buses and HOVs and fully
322 utilizing that capacity provided by allowing only as many other vehicles into the lane as can be
323 accommodated. The objective of HOT lanes is to improve the level of service for transit and HOV
324 operations yet allow usage by others willing to pay a toll. By allowing toll operations, HOT lanes
325 generate revenue and their higher occupancy levels avoid the perception of being underutilized that can
326 arise from typical HOV lanes. In this way, the tolls HOT lanes generate directly or indirectly subsidize
327 transit and HOV operations. Ideally, HOT lanes carry as many or more commuters than general purpose
328 lanes.
329

330　Measures used to evaluate the various build alternatives are discussed below. Further details on these and
331　other data on 2017 Build conditions are contained in Appendix A.
332

4.2.2.2 Corridor Vehicle Miles and Vehicle Hours Traveled

333　The VMT and VHT change comparing the 2017 Highway Builds to the 2017 No Build, within the
334　Tappan Zee Bridge Corridor, is minimal. The largest change in VMT observed was projections for the
335　Build with HOV/HOT lanes (148,562 miles), which is a 1.3 percent increase over the daily No Build
336　VMT.
337
338　As shown in Table 4-3, the VMTs increase in the 2017 Highway Improvements +HOV/HOT Lanes
339　alternative, due to the increase in the number of lanes. VHT is seen to decrease across the periods in the
340　2017 Highway Improvements (without HOV/HOT Lanes) alternative, attributable to the climbing lanes in
341　both directions.
342
343　**Table 4-3**
344　**Corridor-Wide VMT and VHT – 2017 Builds compared to 2017 No Build**
345

Time Period	2017 No Build		2017 Highway Improvements		2017 Highway Improvements + HOV/HOT Lanes	
	VMT	VHT	VMT	VHT	VMT	VHT
AM (6-10)	2,853,260	82,888	2,845,158	82,140	2,893,782	83,362
PM (4-8)	2,928,937	85,145	2,934,014	84,806	2,962,537	84,975
Daily	11,151,524	308,925	11,167,970	307,745	11,300,086	310,402
Absolute Difference (compared with 2017 No Build)						
AM (6-10)	--	--	(8,102)	(748)	40,522	474
PM (4-8)	--	--	5,077	(339)	33,600	(170)
Daily	--	--	16,446	(1,180)	148,562	1,477

346
347

4.2.2.3 Travel Time Savings

348　The 2017 No Build and Build AM peak-period (and PM peak-period in select markets) highway times (in
349　minutes) were calculated from the BPM. Table A-9 provides a comparison between 2017 Build
350　alternatives with the No Build. The travel times represents congested general purpose lane travel times.
351　The projected travel time savings in the 2017 Builds over the No Build were minimal. This could be due
352　to 2017 projected demand that is comparable with existing volumes, and therefore minimal congestion in
353　the future.
354
355　Table A-10 presents travel times and savings in the HOV/HOT lanes compared to the No Build. The
356　maximum savings of 5 minutes is observed between Suffern and Tarrytown. Trips to/from Tarrytown are
357　expected to have the largest savings, attributable to the direct flyover from the HOV/HOT lanes.
358
359

4.2.2.4 Trip Distribution and Mode Share and Tappan Zee Bridge Throughput

Highway Improvements (without HOV/HOT lanes)

The change in demand between the 2017 Highway Improvement build alternative and the No Build is within the noise of the model except for the midday, where an increase of over 1,000 (less than 5 percent of the No Build midday peak) vehicles is projected in the eastbound direction. Approximately 20 percent of this increase is an increase in truck traffic. The effect on operations of climbing lanes in the corridor was evaluated in more detail in Paramics, the traffic microsimulation model.

Table 4-4
Tappan Zee Bridge Demand - No Build and 2017 Highway Improvement Alternatives

	2017 No Build		2017 Highway Improvements		Difference	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
AM(6-10)	23,809	12,824	23,692	12,722	-117	-101
MD (10-3)	21,444	21,931	22,489	21,867	1,045	-64
PM (4-8)	14,569	22,032	14,835	22,251	266	219
NT (7-6)	8,902	10,041	8,801	9,980	-101	-62
DAILY	68,724	66,828	69,818	66,821	1,093	-8

Highway Improvements (with HOV/HOT lanes)

The demand across the Tappan Zee Bridge in Highway Build alternative with HOV/HOT lanes, on the other hand, is projected to grow considerably during the peak and off-peak periods. The increase in total daily two-way demand is close to 8,500 vehicles (Table 4-5) and the largest increase is in the midday period.

Table 4-5
Tappan Zee Bridge - Highway Improvements Plus HOV/HOT Lanes vs. No Build

	2017 No Build		2017 Highway Improvements + HOV/HOT Lanes		Difference	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
AM(6-10)	23,809	12,824	25,029	13,913	1,220	1,089
MD (10-3)	21,444	21,931	23,740	23,200	2,296	1,269
PM (4-8)	14,569	22,032	15,239	23,255	670	1,223
NT (7-6)	8,902	10,041	9,196	10,520	294	478
DAILY	68,724	66,828	73,204	70,888	4,480	4,060

386   **Key HOT Lane Impacts:**
387
388   *AM Peak Period:*
389

390   ▪   The westbound PM peak period demand across the Tappan Zee Bridge increases by
391   approximately 1,200 vehicles compared to the No Build. The westbound throughput increased by
392   about 1,000 vehicles, most of which was an increase in truck demand.
393

394   ▪   The increase in truck demand is projected to be the largest (888), followed by HOV3+ vehicles
395   (186). The increase in truck traffic across the Tappan Zee bridge results from an increased
396   number of truck trips to Westchester and Connecticut predominantly, compared to the No Build.
397   This could be due to freeing up of general purpose lane capacity along the I-287 Corridor. Since
398   the truck model is primarily a gravity model, improved access (time) therefore could contribute to
399   an increased number of truck trips. Also the truck growth compared to the No Build is
400   significantly higher compared to general traffic (Tables A11 and A12).
401

402   ▪   Although the total HOV2 demand remains similar to that of the No Build, a large proportion
403   (1,780) now uses HOT lanes. Similarly with HOV3+ (857) and commercial vans (606).
404

405   ▪   The total AM peak period eastbound throughput increases by approximately 800 people
406   compared with the No Build (Table 4-7).
407
408   **Table 4-6**
409   **Eastbound AM Modal Distribution Across the Tappan Zee Bridge – 2017 No Build versus**
410   **HOV/HOT Lanes Build**
411

	Drive Alone	HOV 2	HOV 3+	Taxi	Trucks	Vans	Total
No Build	18,085	2,103	747	90	2,109	650	23,784
HOV/HOT Lanes - General Purpose	17,722	370	73	4	2,997	87	21,253
HOV/HOT Lanes - HOT Lanes	343	1779	859	165	-	605	3,751
HOV/HOT Lanes Total	18,065	2,149	933	169	2,997	691	25,004
Difference	(20)	46	186	79	888	41	1,220

412
413
414   **Table 4-7**
415   **Change in Person Trips (AM Peak Period Eastbound)**
416

	Drive Alone	HOV 2	HOV 3+	Taxi	Total
No Build	18,085	4,206	2,315	126	24,732
HOV/HOT Lanes Total	18,065	4,298	2,891	237	25,490

417
418
419

PM Peak Period Westbound:

- The westbound PM peak period demand across the Tappan Zee Bridge increases by approximately 700 vehicles compared to the No Build.

- The increase in truck demand is projected to be the largest (318), followed by HOV2 vehicles (158). The truck growth compared to the No Build is significantly higher compared to general traffic (Tables A11 and A12).

- The total PM peak period westbound throughput increases by approximately 700 people compared with the No Build (Table 4-9).

Table 4-8
Westbound PM Modal Distribution Across the Tappan Zee Bridge – 2017 No Build vs. HOV/HOT Build

	Drive Alone	HOV 2	HOV 3+	Taxi	Trucks	Vans	Total
No Build	9,752	2,405	1,158	41	911	293	14,560
HOV/HOT Lanes General Purpose	9,884	2,570	243	13	1,230	264	14,205
HOV/HOT Lanes HOT Lanes	0	0	985	40	-	0	1,025
HOV/HOT Lanes Total	9,884	2,570	1,228	53	1,230	264	15,230
Difference	132	165	70	12	319	(29)	670

Table 4-9
Change in Person Trips (PM Peak Period Eastbound)

	Drive Alone	HOV 2	HOV 3+	Taxi	Total
No Build	9,752	4,810	3,590	58	18,209
HOV/HOT Lanes Total	9,884	5,140	3,807	75	18,905

443   **2017 HOT Lane Demand**
444

2047 Highway Improvements + Hot Lane AM

445
446
447   **Figure 4-8**

448
449

2047 Highway Improvements + Hot Lane PM

450
451
452   **Figure 4-9**

453
454
455
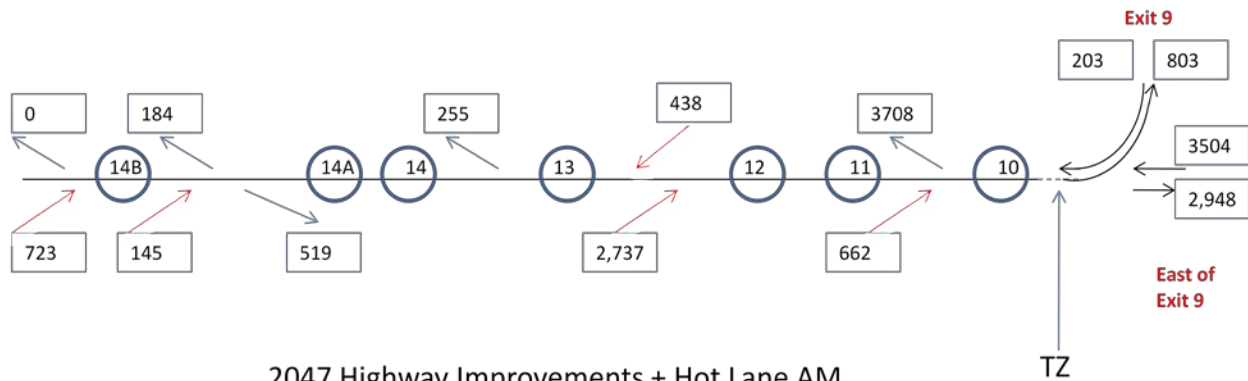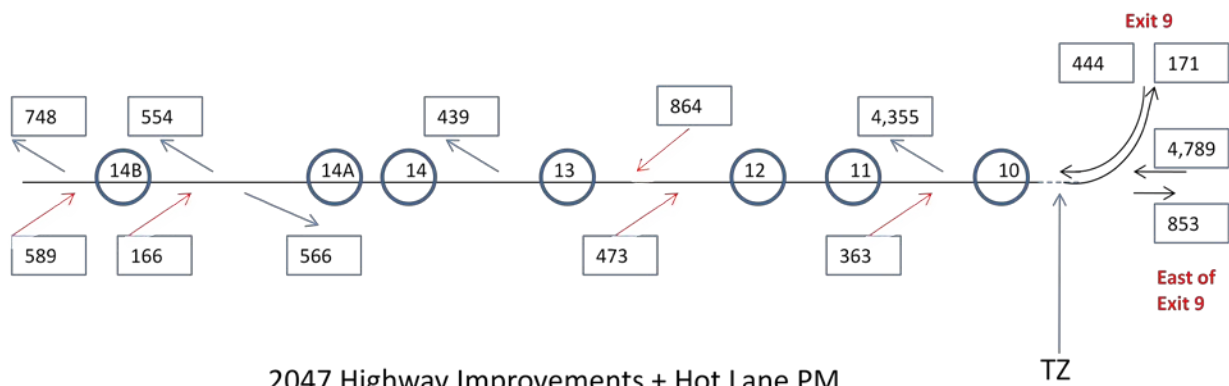
4.2.3 2047 No Build Alternative

4.2.3.1 Demographic Forecasts

456   Compared to the rest of the region, Orange County population forecast grows at a higher rate between
457   2010 and 2047, than the rest of the region (39 percent). Rockland and Westchester are projected to have
458   the highest employment growth (37 percent and 39 percent, respectively). The magnitude of Westchester
459   job growth will be greater than three times the Rockland growth. The Manhattan job growth is projected
460   to be close to three and a half times the Westchester growth (approximately 360, 000 jobs).
461
462   The employment labor force (ELF) to employment balance is an indicator to whether the county is an
463   "importer" or an "exporter" of labor. A higher employment than ELF suggests the county is an exporter
464   and vice-versa. Rockland, Westchester, Manhattan and Bergen County employment are forecast to
465   significantly outpace ELF, making them importers of workers.
466
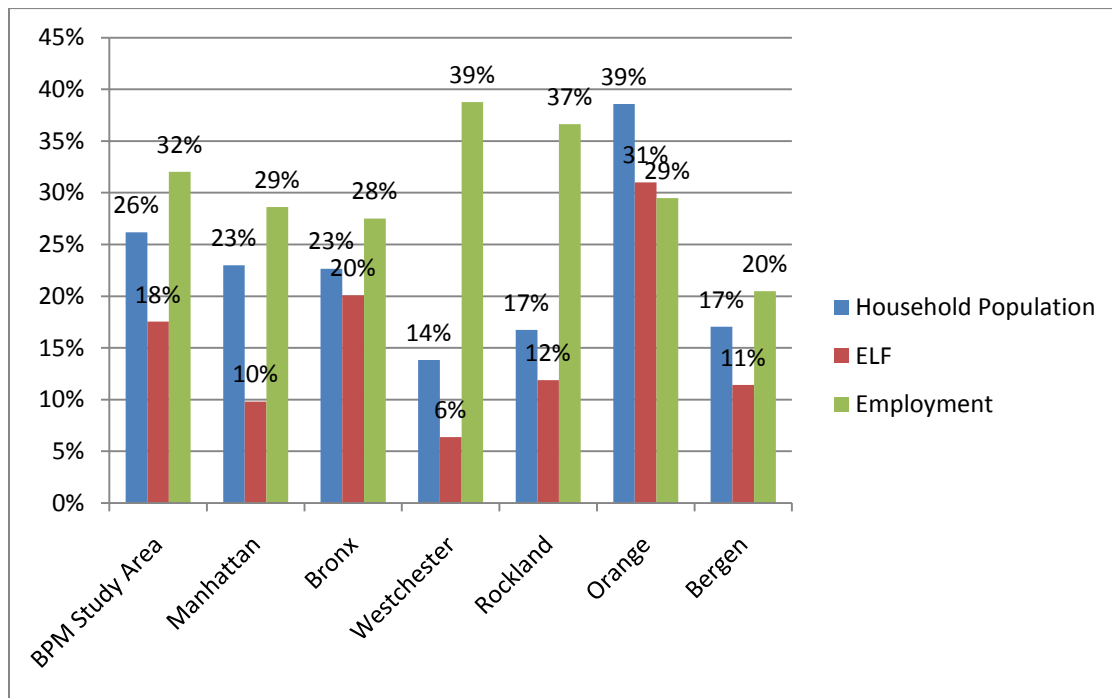
Figure 4-10

471   Further details on these and other data on 2047 No Build conditions are contained in Appendix A.

4.2.3.2 Corridor Vehicle Miles and Vehicle Hours Traveled

474　The growth in VMT and VHT within the I-287 Corridor (an envelope of approximately one mile around
475　I-287), between 2010 and 2047 was projected to be 30 and 41 percent, respectively. The gap between
476　VMT and VHT is likely due to high congestion levels.
477
478
Table 4-10
479
Corridor-Wide VMT and VHT – 2047 No Build compared to 2010
480

2010 Existing		2047 No build		Percentage Change	
VMT	VHT	VMT	VHT	VMT	VHT
10,576,143	289,013	13,722,851	407,259	30%	41%

481

4.2.3.3 Highway Travel Time Savings

482　Highway travel times for origin-destination pairs affected by proposed projects in the I-287 Corridor were
483　used as a measure to evaluate the forecasted No Build and build conditions.
484
485　The AM and PM peak period travel time increase, between 2010 and 2047, in the Rockland-Westchester
486　market, is projected to be in of the order of 10 minutes (Table A18). The increase in travel time between
487　Harriman and White Plains for example, is in the order of 20 minutes approximately, indicating
488　congestion on the I-87/Route 17 corridor in 2047, as well.
489

4.2.3.4 Trip Distribution and Mode Share

490　Consistent with the employment projections, work trips to Westchester County increase dramatically
491　(Table A-19). Due to the large employment potential, Westchester County attracts trips from surrounding
492　counties (Rockland, Orange and counties to the east in Connecticut), predominantly auto trips.
493
494　Orange to Manhattan work trips by auto are projected to grow minimally (203 trips). Transit work trips
495　on the other hand grow by approximately 3,300 trips, with the significant growth being on commuter rail
496　(29 percent to 41 percent) (Table A-20). Rockland to Manhattan work auto trips are forecast to reduce
497　(1,527) whereas transit trips are expected to increase (559). The decrease in Rockland to Manhattan auto
498　trips could be attributed to the robust employment opportunities forecast in the Tappan Zee corridor and
499　surrounding areas.
500

4.2.3.5 Mainline Tappan Zee Bridge Volumes

501　The daily Tappan Zee Bridge growth is estimated to be 31 and 34 percent in the eastbound and westbound
502　directions (Table 4-11). The AM and PM peak periods experience a 26 percent (eastbound) and 31
503　percent (westbound) increase, respectively.
504
505

506
507
508

Table 4-11
Mainline Tappan Zee Bridge Volumes – 2010 vs. 2047

	2010 Existing		2047 No Build		Growth	
	EB	WB	EB	WB	EB	WB
AM	22,215	12,013	28,078	14,887	26%	24%
MD	20,446	20,506	26,272	28,768	28%	40%
PM	13,788	20,352	17,830	26,756	29%	31%
NT	8,401	9,676	12,612	13,194	50%	36%
DAILY	64,849	62,547	84,793	83,604	31%	34%

509

	Direction	2010	2047	Growth
Daily Truck Demand	WB	6,162	8,733	42%
	EB	5,915	8,639	46%

510

4.2.3.6 Ridership

511
512 Ridership on the Port Jervis and Pascack Valley Line are projected to grow significantly between 2010
513 and 2047, based on substantial growth in the corridor and the assumption that a project with
514 improvements similar to ARC would be operational by 2017. Table 4-12 provides a comparison of
515 inbound AM peak period ridership in 2010, 2017, and 2047.
516
517
518 **Table 4-12**
519 **AM Peak Period Inbound Boardings in Orange and Rockland County on Port Jervis and Pascack Valley Line: 2010, 2017 and 2047**
520

	2010	2017	2047	Change: 2010 - 2047	Change: 2017 - 2047
Port Jervis Line	3,104	5,821	7,788	4,684	1,967
Pascack Valley Line	2,213	3,234	3,435	1,222	201
Total	5,317	9,055	11,223	5,906	2,168

521

4.2.4 2047 Build Alternatives

4.2.4.1 Overview

522 The 2047 build alternatives that are being analyzed for the DEIS are:

523 Highway Build Alternatives:

524 ▪ Highway Improvements
525 ▪ 2047 Highway Improvements + HOV/HOT Lanes

526
527 Transit Build Alternatives:
528
529 ▪ Alternative A: No Build
530 ▪ Alternative B: Corridor Busway
531 ▪ Alternative C: Busway/Bus Lanes
532 ▪ Alternative D: HOV/Busway
533 ▪ Alternative E: HOV/Bus Lanes
534
535 Further details on these and other data on 2047 Build conditions are contained in Appendix A.
536

4.2.4.2 Corridor Vehicle Miles and Vehicle Hours Traveled

537 Daily Corridor VMTs increase in both highway build alternatives, compared to the No Build, due to an
538 increase in lane miles. Transit appears to reduce VMTs. This is demonstrated by comparing Alternatives
539 B and C against the highway build alternative without HOV/HOT lanes, alternatives D and E with the
540 highway build alternative with HOV/HOT lanes. In both cases, the transit alternatives have a lower VMT
541 compared to the highway only builds (Tables 4-13 and 4-15). The same applies to VHT (Table 4-14).
542
543 **Table 4-13**
544 **Daily Corridor-Wide VMT– Builds vs. No Builds**
545

2047 Alt	No Build	Highway Improvement	2047 Highway Improvements + HOV/HOT Lanes	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
Daily	13,722,851	13,793,186	14,096,557	13,733,499	13,638,331	14,036,797	13,993,429
Difference	-	70,335	373,706	10,648	-84,520	313,946	270,578

546
547
548 **Table 4-14**
549 **Daily Corridor-Wide VHT– Builds vs. No Builds**
550

2047 Alt	No Build	Highway Improvement	Highway Improvement + Hot Lanes	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
Daily	407,259	406,153	411,144	401,745	398,068	407,634	406,972
Difference	-	(1,106)	3,885	(5,514)	(9,191)	375	(287)

551
552
553 **Table 4-15**
554 **Daily Corridor-Wide VMT– 2047 Transit Builds vs. Respective Highway Builds**

Alternative B: Corridor Busway		Alternative C: Busway/Bus Lanes		Alternative D: HOV/Busway		Alternative E: HOV/Bus Lanes	
VMT	VHT	VMT	VHT	VMT	VHT	VMT	VHT
13,733,499	401,745	13,638,331	398,068	14,036,797	407,634	13,993,429	406,972
(59,687)	(4,408)	(154,855)	(8,085)	(59,760)	(3,510)	(103,128)	(4,172)

4.2.4.3 Travel Times

Highway Travel Times

555
556
557 A comparison between highway build and no build travel times reveals that general purpose lanes in the
558 HOV/HOT builds are projected to experience a travel time saving. Markets using the flyover to Exit 9
559 experience a savings of up to 6 minutes (See Table A-22).
560
561 Traffic in HOV/HOT lanes experience a significant travel time savings compared to the general purpose
562 lanes. Up to 7 minutes in some cases (Table A-23).
563
564 ### Transit Travel Times
565
566 AM peak-period transit times in minutes were calculated from BPM runs (Table A-26). The BPM uses
567 four different transit "modes" – drive to commuter rail, walk to commuter rail, drive to other transit, and
568 walk to other transit. For any alternative, a best path is determined for each of these four modes. The
569 transit times shown here represent the fastest of those four times, with all components of time (i.e., in-
570 vehicle time, wait time, walk time, etc.) weighted equally. In some cases, the best path remains a path
571 using No Build service. Travel-time savings were calculated by comparing the results of each alternative
572 to the No Build Alternative (Table A-27).
573

4.2.4.4 Mainline Tappan Zee Bridge Volumes

574 The eastbound and westbound Tappan Zee Bridge demands are presented in Tables A-28 and A-29. Both
575 highway builds carry a significantly larger number of vehicles due to increased capacity compared to the
576 No Build.
577
578 ### Highway Improvements (without HOV/HOT lanes)
579
580 The change in daily demand between the 2047 Highway Improvement build alternative and the No Build
581 is approximately 5 percent eastbound and 2 percent westbound.
582
583 ### Highway Improvements (with HOV/HOT lanes)
584
585 The demand across the Tappan Zee Bridge in Highway Build alternative with HOV/HOT lanes is
586 projected to grow considerably. The increase in daily demand is approximately 12 percent in both
587 directions compared to the No Build. A fair share of the increase in daily demand, 30 percent
588 approximately, was projected to be due to the increase in truck demand.
589
590 **HOT Lane Demand:**
591
592 Figure 4-12 presents AM peak period HOT lane demands in the Tappan Zee corridor for the highway
593 build alternative with HOT lanes. The highest demand in the peak direction (eastbound) is at the slip ramp
594 east of Interchange 13 that draws traffic from the Garden State Parkway and the Palisades Interstate
595 Parkway (approximately 35 percent of total demand). A significant percentage is drawn from Orange
596 County and New Jersey. It appears that the number of vehicles exiting the HOT lanes west of Interchange
597 14A is overestimated, given that the travel time savings is minimal on the stretch between 14B and 14A.
598 Approximately 30 percent of the eastbound HOT lane traffic takes the exit 9 flyover. The travel time

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599 savings are expected to be reasonably large in magnitude as indicated in earlier sections. The AM
600 westbound demand is significantly to Rockland County.

601

2047 Highway Improvements + Hot Lane AM

602

603 **Figure 4-11**

604
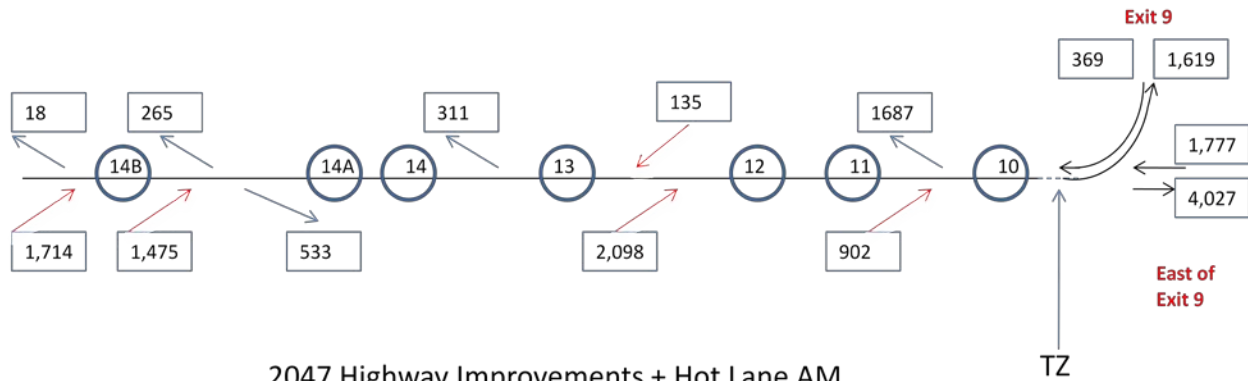
605 The majority of the westbound PM peak HOT lane traffic is expected to enter the HOT lanes east of Exit
606 9 (Figure 4-13). Slightly over 10 percent enters the Exit 9 flyover. Although a significant number of
607 vehicles exit the HOT lanes in Rockland County, a large majority exit at the western most end of the
608 facility, proceeding to either Orange County or New Jersey.

2047 Highway Improvements+ Hot Lane PM

609
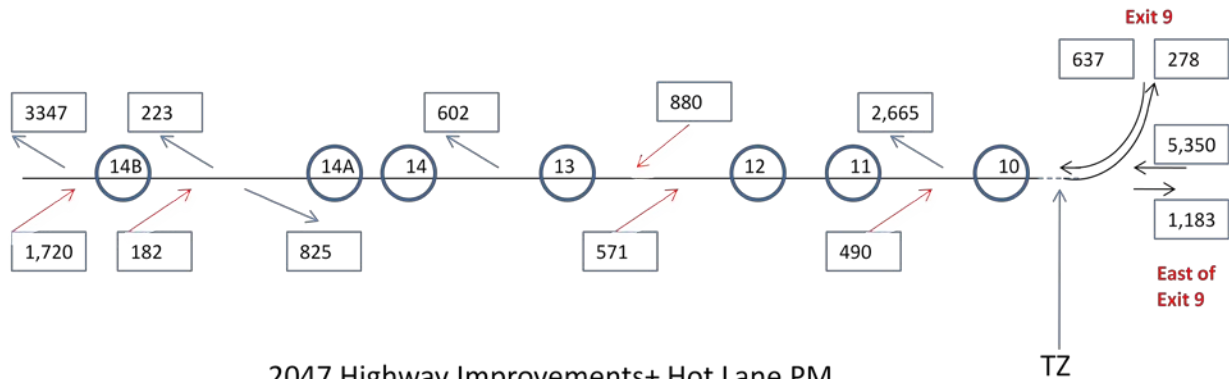
610 **Figure 4-12**

611
612 Approximately 2,200 more people transported in the AM Peak Period across the Tappan Zee Bridge
613 (Table 4-16).

614 **Table 4-16**
615 **AM Person Throughput**
616

	Drive Alone	HOV 2	HOV 3+	Taxi	Total
No Build	21,576	4,676	2,591	125	28,969
HOV/HOT Lanes Total	22,454	5,752	3,678	265	32,150

617
618 Approximately 1,900 more people would be transported in the PM Peak Period across the Tappan Zee
619 Bridge (Table 4-17). The exact number of vehicles and persons estimated based on the Paramics traffic
620 simulation is somewhat different than these totals due to the more refined treatment of network capacity
621 and highway operations under that analyses. However, the overall range and patterns of the numbers are
622 essentially the same.

623   **Table 4-17**
624   **PM Person Throughput**
625

	Drive Alone	HOV 2	HOV 3+	Taxi	Total
No Build	11,784	6,180	4,324	74	22,363
HOV/HOT Lanes Total	12,710	6,578	4,932	77	24,297

626
627
628 ## Tappan Zee Bridge Demand
629
630 The daily demand across the Tappan Zee bridge increases across alternatives, compared to the No Build
631 (Table 4-18 and Table 4-19). The increase can be attributed to an increase in capacity and relatively high
632 truck demand growth. The lower eastbound AM peak period (and westbound PM peak) demand in
633 Alternatives B and C (no HOV/HOT lanes) compared to the No Build are likely to be an effect of transit.
634
635   **Table 4-18**
636   **Eastbound Tappan Zee Bridge Demand**
637

	2047 No Build	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
AM	28,078	27,834	27,595	30,514	30,570
MD	26,272	28,948	28,093	31,370	30,808
PM	17,830	18,854	18,662	19,784	19,505
NT	12,612	12,637	12,483	13,610	13,591
DAILY	84,793	88,274	86,833	95,277	94,474

638
639   **Table 4-19**
640   **Westbound Tappan Zee Bridge Demand**
641

	2047 No Build	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
AM	14,887	15,641	15,497	17,149	17,137
MD	28,768	29,529	28,706	32,306	31,739
PM	26,756	26,724	26,616	29,234	29,192
NT	13,194	13,122	12,996	13,997	13,914
DAILY	83,604	85,015	83,816	92,686	91,982

642

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4.2.4.5 Transit Ridership

Transit Builds

643
644
645 All four build alternatives have the same CRT service across the Tappan Zee Bridge to Grand Central
646 Terminal. The alternatives also have similar BRT service plans with differing travel times and speeds,
647 shown in Table 4-20. Tables 4-21 and 4-22 provide detailed information for CRT ridership under No
648 Build and the four build alternatives in 2047 and similar information for BRT service by key markets. The
649 proposed Tappan Zee Bridge CRT Service would decrease ridership on the Port Jervis and Pascack
650 Valley Lines (as measured by AM peak period boardings) by approximately 3,600 (-32 percent) but the
651 approximately 16,200 riders using the Tappan Zee Bridge CRT service would result in an overall increase
652 in CRT ridership in the corridor by approximately 4,700 or 40 percent. Patterns projected for BRT
653 ridership in 2047 would see a modest drop in express bus service ridership into Manhattan due to the
654 availability of new corridor CRT service in some areas of the corridor, with overall BRT ridership in the
655 corridor, as measured by two-way ridership in the four-hour AM peak period, would be approximately
656 16,000.

657
658 **Table 4-20**
659 **Summarized BRT Speeds Across Build Alternatives**
660

	Segment	Speed (with dwell time) mph	Speed (without dwell time) mph	Total Time (min)	Average Speed
Alternative B: Corridor Busway	Rockland Segment	51	68	45.7	40
	Westchester Segment	38	49		
	White Plains	21	37		
Alternative C: Busway/Bus Lanes	Rockland Segment	51	68	50.3	37
	Westchester Segment	31	38		
	White Plains	20	33		
Alternative D: HOV/Busway	Rockland Segment	44	56	48.3	38
	Westchester Segment	38	49		
	White Plains	21	37		
Alternative E: HOV/Bus Lanes	Rockland Segment	44	56	52.9	35
	Westchester Segment	31	38		
	White Plains	20	33		

661
662

663 **Table 4-21**
664 **2047 AM Peak Period Rail Boarding – Port Jervis, Pascack Valley Line and the Tappan Zee CRT**
665 **Ridership – 2047 No Build and Build Alternatives**
666

	2047 No Build		Alternative B		Alternative C		Alternative D		Alternative E	
	On	OFF	On	OFF	On	OFF	On	OFF	On	OFF
Port Jervis Line										
Port Jervis	362	15	311	10	304	2	299	8	315	-
Otisville	289	6	182	6	198	5	193	8	147	3
Middletown	1,853	2	1,611	17	1,572	15	1,633	25	1,553	3
Campbell Hall	266	1	193	1	173	0	205	2	161	0
Salisbury Mills - Cornwall	2,876	6	2,272	1	2,226	2	2,155	1	2,264	0
Harriman	1,333	20	629	9	710	4	694	15	711	3
Tuxedo	141	6	77	2	63	3	72	2	66	-
Sloatsburg	118	12	46	5	58	7	42	12	51	3
Suffern	875	704	425	1,170	354	1,370	405	973	92	905
Total	8,113	772	5,746	1,221	5,656	1,409	5,698	1,045	5,359	918
Tappan Zee Bridge Service										
Port Jervis			142	7	148	7	147	10	169	-
Otisville			119	-	123	1	133	1	110	-
Middletown			1,057	15	1,036	7	1,082	18	973	2
Campbell Hall			139	-	108	1	147	3	132	0
Salisbury Mills - Cornwall			1,480	3	1,370	4	1,502	6	1,381	5
Harriman			814	13	676	17	750	12	679	6
Tuxedo			122	2	100	1	111	2	104	-
Sloatsburg			97	14	65	12	72	10	55	4
Suffern			1,342	458	1,516	294	1,177	390	1,500	-
Garden State Parkway CRT	-	-	1,409	1,020	1,405	852	1,417	1,122	1,268	216
Palisades Mall New	-	-	1,796	277	1,789	243	1,651	255	1,614	125
125th	-	-	-	1,131	-	1,180	-	1,041	-	1,111
GCT	-	-	-	6,326	-	6,587	-	6,082	-	6,513
Total			8,516	1,810	8,337	1,439	8,191	1,830	7,982	358
Spring Valley Line										
Spring Valley	1752	0	1120	0	1232	0	1186	0	1142	0
Nanuet	1073	98	585	84	571	70	610	82	602	88
Pearl River	610	110	518	112	593	104	556	90	557	105
Orange Boarding	7,120		9,148		8,806		9,125		8,762	
Rockland Boarding	4428		7338		7583		7116		6880	
Total	11,548		16,486		16,389		16,241		15,642	

667

Summary – Change in Corridor CRT Ridership (AM Peak Period Boardings)								
Existing CRT Services	2047	2047				Bld Average (Rounded)	Change from No Build	Change from No Build-%
Port Jervis Line	No Build	Alt. B	Alt C	Alt. D	Alt. E			
Orange	7,120	5,275	5,246	5,251	5,217	5,200	(1,920)	-27%
Rockland	993	471	412	447	143	400	(593)	-60%
Total	8,113	5,746	5,658	5,698	5,360	5,600	(2,513)	-31%
Spring Valley Line	3,435	2,223	2,396	2,352	2,301	2,300	(1,135)	-33%
Corridor Totals – Existing CRT Lines	11,548	7,969	8,054	8,050	7,661	7,900	(3,648)	-32%
TZB CRT Service		8,517	8,336	8,189	7,985	8,300		
Total Corridor CRT	11,548	16,486	16,390	16,239	15,646	16,200	4,652	40%

668
669
670

Table 4-22

AM Peak Period – Bus ridership by Market – 2047 No Build and Project Alternatives

671

	Southbound Boarding	Difference Compared to 2047 No Build			
	2047 No Build	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
Orange to Manhattan	2,600	(500)	(300)	(700)	(500)
Rockland to Manhattan	6,400	(300)	100	(200)	100

672
673

AM Peak – BRT Within Project Corridor

674

	2047 NB		Alternative B: Corridor Busway		Alternative C: Busway/Bus Lanes		Alternative D: HOV/Busway		Alternative E: HOV/Bus Lanes	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
Intra-Rockland/ Orange -Rockland			3,411	2,135	3,407	2,118	3,286	2,032	3,246	2,042
Rockland-Westchester	488	286	987	832	1,005	1,020	953	724	921	772
Intra-Westchester/ Westchester-Connecticut			4,865	4,351	4,546	4,055	4,797	4,441	4,610	4,054

675

5 Mitigation Measures

5.1.1 Highway and Bridge Mitigation

The Highway and Bridge Elements would not adversely impact transit operations. As such, no mitigation would be required for the Highway and Bridge Elements.

5.1.2 Transit Mitigation Strategies

The Transit Elements would have beneficial effects on overall travel mobility, accessibility, and capacity in the corridor and region. The analyses performed for CRT and BRT did not indicate any potentially adverse impacts on existing or other planned transit operations in the corridor or elsewhere in the region. The reduction in CRT ridership on the existing Port Jervis and Pascack Valley Lines would not represent an impact on those operations, but rather a shift among existing and proposed new operations as part of an overall regional transit network.

The Hudson Line Connector would need to be implemented so existing services on the Hudson Line would not be disrupted. Further, the additional trains and passengers heading into Midtown Manhattan would potentially impact some components of GCT (e.g., track capacity, platforms, stairways, passenger corridors, etc.). The potential impacts of the Tappan Zee CRT service on the Hudson Line and at GCT would be further evaluated during the future Tier 2 Transit environmental documentation, including any associated mitigation measures.

Similarly, while existing bus operations in the corridor would utilize the BRT system or be replaced by proposed BRT services, the exact nature of those adjustments would require more detailed analysis as development trends and travel patterns shift over the years. Feeder bus routes into stations also would need to be considered. This analysis would be conducted as part of the future Tier 2 Transit environmental documentation, with coordination among the various bus operators.

During the future Tier 2 Transit environmental documentation, the Project Sponsor would coordinate with the respective transit operators to develop a comprehensive Operations and Service Integration Plan for the Tappan Zee Bridge/I-287 Corridor Project. This plan would document agreed upon changes in CRT and BRT services in the corridor, as well as integration with existing transit services. Interagency Agreements would be developed between the Project Sponsors and impacted transit agencies, as required.

6 References

1   1997 Regional Transportation Statistical Report, NYMTC

2   Metro-North 2002 Inbound Station Boardings, June 2003

3   Metro-North Operating Data provided by Jay Fiegerman, MNR Operations Planning Department,
4   September 2003

5   Metro-North Railroad West-of-Hudson Quarterly Report, Third Quarter, 2003

6   MTA 2002 Annual Report

7   NYSDOT Evaluation and Analysis Report Park-and-Ride Conditions Inventory and Origin-Destination
8   Survey, Phase 2, February 2002

9   NYSDOT, Region 8, Draft Park-and-Ride Conditions Inventory and O-D Survey

10 NYSDOT, State Transportation Operating Assistance Program (STOA) Data

11 Private Bus Operators (OWL, Coach USA)

12 Rockland County Department of Public Transportation, TOR and Tappan Zee Express Systemwide
13 Timetables

14 Rockland County Park-and-Ride Master Plan Update Study, February 2002

15 Rockland County Website

16 Suffern Commuter Parking Study, Rockland County Department of Public Transportation, November
17 2002

18 Westchester County DOT, Passengers by Route 2008 Annual Route Analysis

19 Westchester County Park-and-Ride Master Plan Study, Technical Memorandum 1, Westchester County
20 DOT, May 1996

21 Westchester County Website (Bee-Line bus system)

22

23

Thruway
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Railroad

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Appendix A
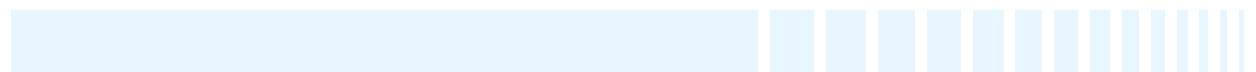
A No Build and Build Analysis Results

A.1 2017 No Build

Table A-1

Population, Labor Force and Employment – 2010 and 2017

County	Household Population			Employment Labor Force			Employment		
	2010	2017	Difference	2010	2017	Difference	2010	2017	Difference
BPM Study Area*	21,489,572	22,153,047	663,475	10,876,030	11,269,664	393,634	9,887,252	10,335,260	448,008
Manhattan	1,596,045	1,634,441	38,396	845,400	850,747	5,347	2,140,812	2,200,322	59,510
Bronx	1,326,763	1,350,461	23,698	586,712	611,552	24,840	306,380	318,788	12,408
Westchester	933,581	970,288	36,707	480,301	503,284	22,983	412,976	437,337	24,361
Rockland	291,193	303,373	12,180	147,750	156,226	8,476	128,833	137,344	8,511
Orange	369,255	392,352	23,097	199,384	213,581	14,197	141,034	151,575	10,541
Bergen	898,346	919,678	21,332	458,373	468,459	10,086	437,635	452,702	15,067
* Refer to Figure 4-1									

Table A-2

Corridor-Wide VMT and VHT – 2010 Existing and 2017 No build

	2010 Existing		2017 No Build		Change	
	VMT	VHT	VMT	VHT	VMT	VHT
	2010 Existing		2017 No Build		Change	
Daily	10,576,143	289,013	11,151,524	308,925	5%	7%

Table A-3

Highway Travel times in Select Markets

	From	To	2010 Existing Conditions (min)	2017 No Build (min)	Difference
Intra Rockland	Suffern	Palisades Mall	12	12	0
	Palisades Mall	Suffern	11	11	0
Westchester Bound	Suffern	White plains	34	36	2
	Suffern	Tarrytown	31	33	2
	Spring valley	White plains	26	28	2
	Spring valley	Tarrytown	23	25	2
	Nyack	White plains	24	26	2
	Nyack	Tarrytown	21	23	2
	Harriman	White plains	49	52	3
	Harriman	Tarrytown	46	49	3
Rockland Bound	White plains	Suffern	33	34	2
	Tarrytown	Suffern	29	31	2
	White plains	Spring valley	24	26	1
	Tarrytown	Spring valley	21	22	1
	White plains	Nyack	22	23	1
	Tarrytown	Nyack	18	19	1
	White plains	Harriman	46	49	3
	Tarrytown	Harriman	42	45	3
CT-Westchester	Stamford	White plains	29	30	2
	Stamford	Tarrytown	37	39	2
Manhattan Bound	Suffern	Midtown	74	77	3
	Spring valley	Midtown	66	68	2
	Nyack	Midtown	67	69	2
	Harriman	Midtown	86	90	4
Intra Westchester	Tarrytown	White Plains	13	13	0
	Port Chester	White Plains	14	14	0

Table A-4

2010 Existing and 2017 No Build Work Trips

	2010 Existing		2017 No Build		Difference	
	Auto	Transit	Auto	Transit	Auto	Transit
Orange To Manhattan	6,920	6,899	6,914	8,167	(6)	1,268
Rockland To Manhattan	11,796	6,956	12,060	7,874	264	918
Orange to Westchester	5,988	123	7,112	140	1,124	17
Rockland to Westchester	12,136	166	13,814	223	1,678	57
Westchester/CT to Rockland	4,833	122	4,993	146	160	24
Westchester/CT to Orange	1,572	12	1,606	15	34	3
Westchester/CT to Bergen Passaic	5,614	78	6,029	111	415	33
Connecticut to Westchester	21,204	261	23,285	275	2,081	14
Bergen/Passaic To Westchester	3,850	15	4,140	13	290	(2)

Table A-5

2010 Existing and 2017 No Build Mode Share

Select Markets	2010 Existing				2017 No Build			
	Auto Share	Transit Share	Commuter Rail Share	Bus Share	Auto Share	Transit Share	Commuter Rail Share	Bus Share
Orange To Manhattan	50.1%	49.9%	28.5%	21.5%	45.8%	54.2%	38.7%	15.5%
Rockland To Manhattan	62.9%	37.1%	14.4%	22.7%	60.5%	39.5%	20.9%	18.6%
Orange to Westchester	98.0%	2.0%	0.5%	1.6%	98.1%	1.9%	0.3%	1.7%
Rockland to Westchester	98.7%	1.3%	0.2%	1.2%	98.4%	1.6%	0.2%	1.4%
Westchester/CT to Rockland	97.5%	2.5%	1.5%	0.9%	97.2%	2.8%	1.5%	1.3%
Westchester/CT to Orange	99.2%	0.8%	0.8%	0.0%	99.1%	0.9%	0.9%	0.0%
Westchester/CT to Bergen Passaic	98.6%	1.4%	0.6%	0.8%	98.2%	1.8%	1.1%	0.7%
Connecticut to Westchester	98.8%	1.2%	0.8%	0.4%	98.8%	1.2%	0.7%	0.5%
Bergen Passaic To Westchester	99.6%	0.4%	0.0%	0.4%	99.6%	0.3%	0.1%	0.2%

Table A-6

Mainline Tappan Zee Bridge Volumes

	2010 Existing		2017 No Build		Growth	
	EB	WB	EB	WB	EB	WB
AM	22,215	12,013	23,809	12,824	7%	7%
MD	20,446	20,506	21,444	21,931	5%	7%
PM	13,788	20,352	14,569	22,032	6%	8%
NT	8,401	9,676	8,902	10,041	6%	4%
DAILY	64,849	62,547	68,724	66,828	6%	7%

Table A-7

2010 Existing and 2017 No Build Port Jervis Line Ridership

	2010 Existing				2017 No Build			
	SB		NB		SB		NB	
	On	OFF	On	OFF	On	OFF	On	OFF
Port Jervis Line								
Port Jervis	151	-	2	9	279	-	-	10
Otisville	102	1	-	2	199	-	-	3
Middletown	841	-	-	1	1,419	1	5	5
Campbell Hall	111	-	-	2	179	1	1	2
Salisbury Mills - Cornwall	996	1	2	-	1,931	4	4	1
Harriman	468	1	-	-	980	5	3	6
Tuxedo	34	1	2	2	76	-	-	-
Sloatsburg	35	6	1	-	101	4	1	4
Suffern/Hillburn New	366	194	-	6	657	126	7	155
Pascack Valley Line								
Spring Valley	1198	0	0	0	1638	0	0	0
Nanuet	687	67	0	0	1011	81	0	0
Pearl River	328	72	0	0	585	75	0	0
Orange Boarding	**2,703**		**6**		**5,063**		**13**	
Rockland Boarding	**2615**		**1**		**3993**		**8**	

A.2 2017 Build

Table A-8

Corridor-Wide VMT and VHT – 2017 Builds compared to 2017 No build

	2017 NB		2017 Highway Improvements		2017 Highway Improvements + H/H Lanes	
	VMT	VHT	VMT	VHT	VMT	VHT
Daily	11,151,524	308,925	11,167,970	307,745	11,300,086	310,402
Difference	-	-	16,446	(1,180)	148,562	1,477

Table A-9

Highway Travel Times Between Select Origin/Destination Pairs –Builds compared to 2017 No Build (General Purpose lanes)

	From	To	2017 No Build	2017 Highway Improvements	2017 Highway Improvements + H/H Lanes	Savings 2017 Highway Improvements	Savings 2017 Highway Improvements + H/H Lanes
Intra Rockland	Suffern	Palisades Mall	12	12	12	0	0
	Palisades Mall	Suffern	11	11	11	0	0
Westchester Bound	Suffern	White plains	36	35	35	0	1
	Suffern	Tarrytown	33	33	32	0	1
	Spring valley	White Plains	28	28	27	0	0
	Spring valley	Tarrytown	25	25	24	0	1
	Nyack	White Plains	26	25	26	1	0
	Nyack	Tarrytown	23	23	22	0	1
	Harriman	White plains	52	51	51	0	0
	Harriman	Tarrytown	49	49	48	0	1
Rockland Bound*	White Plains	Suffern	34	34	33	1	2
	Tarrytown	Suffern	31	30	29	1	2
	White Plains	Spring valley	26	25	24	0	2
	Tarrytown	Spring valley	22	22	20	0	2
	White plains	Nyack	23	23	22	0	1
	Tarrytown	Nyack	19	20	18	0	1
	White Plains	Harriman	49	48	47	0	2
	Tarrytown	Harriman	45	45	43	0	2

*PM Peak Period Times

Table A-10

Travel Time Savings in H/H Lanes Compared to the No Build

	From	To	2017 No Build	H/H Times - 2017 Highway Improvements + H/H Lanes	H/H Savings Compared to No build
Intra Rockland	Suffern	Palisades Mall	12	12	0
	Palisades Mall	Suffern	11	11	0
Westchester Bound	Suffern	White plains	36	32	4
	Suffern	Tarrytown	33	28	5
	Spring valley	White Plains	28	25	3
	Spring valley	Tarrytown	25	22	4
	Nyack	White Plains	26	24	2
	Nyack	Tarrytown	23	20	3
	Harriman	White plains	52	49	3
	Harriman	Tarrytown	49	45	4
Rockland Bound	White Plains	Suffern	34	32	3
	Tarrytown	Suffern	31	28	3
	White Plains	Spring valley	26	23	2
	Tarrytown	Spring valley	22	19	3
	White plains	Nyack	23	22	1
	Tarrytown	Nyack	19	18	1
	White Plains	Harriman	49	47	2
	Tarrytown	Harriman	45	43	2

Table A-11

2017 Tappan Zee Demand Percentage Growth Compared with the No Build

Time Period	Direction	2017			Growth	
		NB	2017 HIGHWAY IMPROVEMENTS	2017 HIGHWAY IMPROVEMENTS +H/H LANES	2017 HIGHWAY IMPROVEMENTS	2017 HIGHWAY IMPROVEMENTS +H/H LANES
AM	WB	12824	12722	13913	-1%	8%
	EB	23809	23692	25029	0%	5%
MD	WB	21931	21867	23200	0%	6%
	EB	21444	22489	23740	5%	11%
PM	WB	22032	22251	23255	1%	6%
	EB	14569	14835	15239	2%	5%
NT	WB	10041	9980	10520	-1%	5%
	EB	8902	8801	9196	-1%	3%
Daily	WB	66828	66821	70888	0%	6%
	EB	68724	69818	73204	2%	7%

Table A-12

2017 Tappan Zee Truck Demand Percent Growth Compared with the No Build

Time Period	Direction	2017			Growth	
		NB	2017 HIGHWAY IMPROVEMENTS	2017 HIGHWAY IMPROVEMENTS +H/H LANES	2017 HIGHWAY IMPROVEMENTS	2017 HIGHWAY IMPROVEMENTS +H/H LANES
AM	WB	2136	2226	3057	4%	43%
	EB	2109	2099	2997	0%	42%
MD	WB	2408	2455	3372	2%	40%
	EB	2384	2539	3382	7%	42%
PM	WB	870	856	1209	-2%	39%
	EB	911	956	1230	5%	35%
NT	WB	1207	1183	1543	-2%	28%
	EB	1090	1007	1423	-8%	31%
Daily	WB	6621	6720	9182	1%	39%
	EB	6494	6601	9032	2%	39%

Table A-13

Rail Ridership Information

	2017 No Build				2017 Highway Improvements				2017 H/H Lanes			
	SB		NB		SB		NB		SB		NB	
	On	OFF	On	OFF	On	OFF	On	OFF	On	OFF	On	OFF
Port Jervis	279	-	-	10	248	-	-	12	246	-	-	20
Otisville	199	-	-	3	202	1	1	2	207	3	5	1
Middletown	1,419	1	5	5	1,404	2	4	3	1,355	-	5	-
Campbell Hall	179	1	1	2	192	-	-	1	192	1	2	3
Salisbury Mills - Cornwall	1,931	4	4	1	1,896	-	2	2	1,886	1	4	3
Harriman	980	5	3	6	993	9	2	7	1,019	5	0	3
Tuxedo	76	-	-	-	107	3	-	2	110	1	-	-
Sloatsburg	101	4	1	4	103	2	1	6	112	6	-	8
Suffern/Hillburn New	657	126	7	155	680	141	7	170	627	144	6	177
Orange Boarding	**4,987**		**13**		**4,935**		**9**		**4,905**		**16**	
Orange Boarding	**758**		**8**		**783**		**8**		**739**		**6**	

A.3 2047 No Build

Table A-17

Population, Labor Force and Employment – 2010 and 2047

County	Household Population			Employment Labor Force			Employment		
	2010	2047	Difference	2010	2047	Difference	2010	2047	Difference
BPM Study Area*	21,489,572	27,111,393	5,621,821	10,876,030	12,783,036	1,907,006	9,887,252	13,054,649	3,167,397
Manhattan	1,596,045	1,962,928	366,883	845,400	928,391	82,991	2,140,812	2,753,295	612,483
Bronx	1,326,763	1,627,427	300,664	586,712	704,569	117,857	306,380	390,666	84,286
Westchester	933,581	1,062,598	129,017	480,301	510,875	30,574	412,976	573,119	160,143
Rockland	291,193	339,922	48,729	147,750	165,295	17,545	128,833	176,036	47,203
Orange	369,255	511,676	142,421	199,384	261,168	61,784	141,034	182,614	41,580
Bergen	898,346	1,051,408	153,062	458,373	510,728	52,355	437,635	527,222	89,587

* Refer to Figure 4-1

Table A-18

AM (eastbound) and PM (westbound) Highway Travel Times Between Select Origin/Destination Pairs – 2010 and 2047

	Origin	Destination	Travel Times (Min)		
			2010 Existing Condition	2047 No Build	Difference
Intra Rockland	Suffern	Palisades Mall	12	16	4
	Palisades Mall	Suffern	11	12	1
Westchester Bound	Suffern	White plains	34	44	10
	Suffern	Tarrytown	31	42	11
	Spring valley	White plains	26	35	9
	Spring valley	Tarrytown	23	33	10
	Nyack	White plains	24	32	8
	Nyack	Tarrytown	21	30	9
	Harriman	White plains	49	68	19
	Harriman	Tarrytown	46	68	22
Rockland Bound*	White plains	Suffern	33	42	9
	Tarrytown	Suffern	29	39	10
	White plains	Spring valley	24	32	8
	Tarrytown	Spring valley	21	29	8
	White plains	Nyack	22	29	7
	Tarrytown	Nyack	18	25	7
	White plains	Harriman	46	63	17
	Tarrytown	Harriman	42	59	17
CT-Westchester	Stamford	White plains	29	36	7
	Stamford	Tarrytown	37	45	8
Manhattan Bound	Suffern	Midtown	74	86	12
	Spring valley	Midtown	66	76	10
	Nyack	Midtown	67	75	9
	Harriman	Midtown	86	106	20
Intra Westchester	Tarrytown	White Plains	13	15	2
	Port Chester	White Plains	14	16	1

*PM Peak Period Times

Table A-19

Work Trips in Select Regional Markets – 2010 vs. 2047

Market	2010		2047		Difference	
	Auto	Transit	Auto	Transit	Auto	Transit
Orange To Manhattan	6,920	6,899	7,123	10,157	203	3,258
Rockland To Manhattan	11,796	6,956	10,269	7,515	(1,527)	559
Orange to Westchester	5,988	123	13,419	329	7,431	206
Rockland to Westchester	12,136	166	16,811	371	4,675	205
Westchester/CT to Rockland	4,833	122	5,035	145	202	23
Westchester/CT to Orange	1,572	12	1,360	13	(212)	1
Westchester/CT to Bergen Passaic	5,614	78	5,418	171	(196)	93
Connecticut to Westchester	21,204	261	32,930	434	11,726	173
Bergen Passaic To Westchester	3,850	15	5,406	27	1,556	12

Table A-20

Work Mode Share in Select Regional Markets – 2010 vs. 2047

Market	2010				2047			
	Auto Share	Transit Share	Commuter Rail Share	Bus	Auto Share	Transit Share	Commuter Rail Share	Bus Share
Orange To Manhattan	50.1%	49.9%	28.5%	21.5%	41.2%	58.8%	40.7%	18.1%
Rockland To Manhattan	62.9%	37.1%	14.4%	22.7%	57.7%	42.3%	21.3%	20.9%
Orange to Westchester	98.0%	2.0%	0.5%	1.6%	97.6%	2.4%	0.4%	2.0%
Rockland to Westchester	98.7%	1.3%	0.2%	1.2%	97.8%	2.2%	0.2%	2.0%
Westchester/CT to Rockland	97.5%	2.5%	1.5%	0.9%	97.2%	2.8%	1.5%	1.3%
Westchester/CT to Orange	99.2%	0.8%	0.8%	0.0%	99.1%	0.9%	0.9%	0.0%
Westchester/CT to Bergen Passaic	98.6%	1.4%	0.6%	0.8%	96.9%	3.1%	1.9%	1.1%
Connecticut to Westchester	98.8%	1.2%	0.8%	0.4%	98.7%	1.3%	0.8%	0.5%
Bergen Passaic To Westchester	99.6%	0.4%	0.0%	0.4%	99.5%	0.5%	0.1%	0.4%

Table A-21

Ridership – Port Jervis Line AM Peak Period Boardings – 2010 vs. 2047

Station	2010 Existing				2047 No Build			
	SB		NB		SB		NB	
	On	OFF	On	OFF	On	OFF	On	OFF
Port Jervis Line								
Port Jervis	151	-	2	9	362	0	0	15
Otisville	102	1	-	2	284	4	5	2
Middletown	841	-	-	1	1849	1	4	1
Campbell Hall	111	-	-	2	266	0	0	1
Salisbury Mills - Cornwall	996	1	2	-	2873	2	3	4
Harriman	468	1	-	-	1331	16	2	4
Tuxedo	34	1	2	2	140	3	1	3
Sloatsburg	35	6	1	-	118	8	0	4
Suffern/Hillburn New	366	194	-	6	565	304	8	223
Spring Valley Line								
Spring Valley	1198	0	0	0	1752	0	0	0
Nanuet	687	67	0	0	1073	98	0	0
Pearl River	328	72	0	0	610	110	0	0
Orange Boarding	**2,703**		**6**		**7,105**		**15**	
Rockland Boarding	**2615**		**1**		**4118**		**8**	

A.4 2047 No Build

Table A-22

Highway Travel Times Between Select Origin/Destination Pairs –Builds (General Purpose lanes) compared to 2047 No Build

Market	Origin	Destination	2047 No Build	2047 Highway Improvement	2047 Highway Improvement + Hot Lanes	Difference* 2047 Highway Improvement	Difference * 2047 Highway Improvement + Hot Lanes
Intra Rockland	Suffern	Palisades Mall	16	16	15	0	-1
	Palisades Mall	Suffern	12	11	11	0	0
Westchester Bound	Suffern	White plains	44	45	43	1	-1
	Suffern	Tarrytown	42	43	38	1	-4
	Spring valley	White plains	35	36	35	0	-1
	Spring valley	Tarrytown	33	33	30	0	-3
	Nyack	White plains	32	32	32	1	0
	Nyack	Tarrytown	30	30	27	1	-3
	Harriman	White plains	68	68	66	0	-1
	Harriman	Tarrytown	68	68	62	1	-6
Rockland Bound** (PM)	White plains	Suffern	42	42	39	0	-4
	Tarrytown	Suffern	39	38	34	-1	-5
	White plains	Spring valley	32	32	29	0	-3
	Tarrytown	Spring valley	29	28	24	-1	-4
	White plains	Nyack	29	30	27	1	-2
	Tarrytown	Nyack	25	17	22	-8	-3
	White plains	Harriman	63	62	60	-1	-3
	Tarrytown	Harriman	59	58	55	-1	-4
CT-Westchester	Stamford	White plains	36	36	36	0	0
	Stamford	Tarrytown	45	45	45	1	1
Manhattan Bound	Suffern	Midtown	86	87	87	1	1
	Spring valley	Midtown	76	75	75	-1	-1
	Nyack	Midtown	75	74	74	-1	-1
	Harriman	Midtown	106	105	105	-1	-1

*Possible Rounding Error
**PM Peak Travel Times

Table A-23

2047 Highway Improvement + Hot Lanes Travel Times - H/H Lane vs. General Purpose Lane

Market	Origin	Destination	Congested Time General Purpose Lane	Congested Time H/H Lane	Difference
Intra Rockland	Suffern	Palisades Mall	15	14	-1
	Palisades Mall	Suffern	11	11	0
Westchester Bound	Suffern	White Plains	43	36	-7
	Suffern	Tarrytown	38	32	-6
	Spring valley	White Plains	35	30	-5
	Spring valley	Tarrytown	30	26	-5
	Nyack	White Plains	32	30	-2
	Nyack	Tarrytown	27	24	-3
	Harriman	White Plains	66	62	-4
	Harriman	Tarrytown	62	58	-4
Rockland Bound (PM)	White plains	Suffern	39	35	-4
	Tarrytown	Suffern	34	34	0
	White plains	Spring valley	29	26	-3
	Tarrytown	Spring valley	24	25	1
	White plains	Nyack	27	25	-2
	Tarrytown	Nyack	22	23	1
	White plains	Harriman	60	58	-2
	Tarrytown	Harriman	55	56	1
CT-Westchester	Stamford	White plains	36	37	1
	Stamford	Tarrytown	45	46	1
Manhattan Bound	Suffern	Midtown	87	82	-5
	Spring valley	Midtown	75	73	-2
	Nyack	Midtown	74	74	-1
	Harriman	Midtown	105	105	0

Table A-24

Highway Travel Times in Select Markets

	From	To	2047 NB	2047 Highway Improvements	2047 Highway Improvements + H/H Lanes	2047 B	2047 C	2047 D	2047 E
Intra Rockland	Suffern	Palisades Mall	16	16	14	16	15	14	14
	Palisades Mall	Suffern	12	11	11	11	11	11	11
Westchester Bound	Suffern	White plains	44	45	36	43	43	36	36
	Suffern	Tarrytown	42	43	32	41	41	32	32
	Spring valley	White plains	35	36	30	35	34	30	30
	Spring valley	Tarrytown	33	33	26	33	32	25	25
	Nyack	White plains	32	32	30	31	31	28	28
	Nyack	Tarrytown	30	30	24	29	29	24	23
	Harriman	White plains	68	68	62	66	66	62	62
	Harriman	Tarrytown	68	68	58	67	67	57	57
Rockland Bound	White Plains	Suffern	42	42	35	41	41	35	35
	Tarrytown	Suffern	39	38	34	37	37	33	33
	White Plains	Spring valley	32	32	26	31	31	26	26
	Tarrytown	Spring valley	29	28	25	27	27	24	24
	White Plains	Nyack	29	30	25	29	29	25	25
	Tarrytown	Nyack	25	17	23	25	25	23	23
	White Plains	Harriman	63	62	58	61	61	57	57
	Tarrytown	Harriman	59	58	56	57	57	55	55
CT-Westchester	Stamford	White plains	36	36	37	36	35	36	36
	Stamford	Tarrytown	45	45	46	45	44	46	46
Manhattan Bound	Suffern	Midtown	86	87	82	84	81	86	85
	Spring valley	Midtown	76	75	73	74	73	74	74
	Nyack	Midtown	75	74	74	74	72	73	73
	Harriman	Midtown	106	105	105	103	102	104	103

Table A-25

Highway Travel Times Savings

	From	To	2047 NB	2047 Highway Improvements	2047 Highway Improvements + H/H Lanes	2047 B	2047 C	2047 D	2047 E
Intra Rockland	Suffern	Palisades Mall	0	0	2	0	1	2	2
	Palisades Mall	Suffern	0	1	1	1	1	1	1
Westchester Bound	Suffern	White Plains	0	-1	8	1	1	8	8
	Suffern	Tarrytown	0	-1	10	1	1	10	10
	Spring valley	White Plains	0	-1	5	0	1	5	5
	Spring valley	Tarrytown	0	0	7	0	1	8	8
	Nyack	White Plains	0	0	2	1	1	4	4
	Nyack	Tarrytown	0	0	6	1	1	6	7
	Harriman	White Plains	0	0	6	2	2	6	6
	Harriman	Tarrytown	0	0	10	1	1	11	11
Rockland Bound	White plains	Suffern	0	0	7	1	1	7	7
	Tarrytown	Suffern	0	1	5	2	2	6	6
	White plains	Spring valley	0	0	6	1	1	6	6
	Tarrytown	Spring valley	0	1	4	2	2	5	5
	White plains	Nyack	0	-1	4	0	0	4	4
	Tarrytown	Nyack	0	8	2	0	0	2	2
	White plains	Harriman	0	1	5	2	2	6	6
	Tarrytown	Harriman	0	1	3	2	2	4	4
CT-Westchester	Stamford	White Plains	0	0	-1	0	1	0	0
	Stamford	Tarrytown	0	0	-1	0	1	-1	-1
Manhattan Bound	Suffern	Midtown	0	-1	4	2	5	0	1
	Spring valley	Midtown	0	1	3	2	3	2	2
	Nyack	Midtown	0	1	1	1	3	2	2
	Harriman	Midtown	0	1	1	3	4	2	3

Table A-26

Door-to Door Transit Travel Times in Select Markets

	From	To	2047 No build	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
			Min	Min	Min	Min	Min
Intra Rockland	Suffern	Palisades Mall	51	32	32	32	32
	Palisades Mall	Suffern	72	29	29	33	33
Westchester Bound	Suffern	White plains	92	43	45	48	50
	Suffern	Tarrytown	69	40	40	44	44
	Spring valley	White plains	77	45	47	46	48
	Spring valley	Tarrytown	52	38	38	39	39
	Nyack	White plains	67	38	40	38	40
	Nyack	Tarrytown	43	29	29	29	29
	Harriman	White plains	127	98	100	99	101
	Harriman	Tarrytown	119	94	94	96	96
Rockland Bound (Reverse Commute)	White plains	Suffern	106	44	46	48	51
	Tarrytown	Suffern	83	36	36	40	40
	White plains	Spring valley	95	48	50	49	51
	Tarrytown	Spring valley	71	37	37	38	38
	White plains	Nyack	91	56	58	56	58
	Tarrytown	Nyack	101	47	47	48	48
	White plains	Harriman	203	131	131	131	131
	Tarrytown	Harriman	221	149	149	149	149
CT-Westchester	Stamford	White plains	68	54	55	54	55
	Stamford	Tarrytown	88	67	70	67	70
Manhattan Bound	Suffern	Midtown	102	75	75	75	75
	Spring valley	Midtown	100	100	100	100	100
	Nyack	Midtown	114	65	65	65	65
	Harriman	Midtown	126	100	100	100	100
Intra Westchester	White Plains	Port Chester	40	35	37	35	37
	Tarrytown	White Plains	51	29	31	29	31
	Port Chester	White Plains	42	34	36	34	36
	Port Chester	Tarrytown	64	49	53	49	53

Table A-27

Door-to Door Transit Travel Time SAVINGS in Select Markets

Market	Origin	Destination	2047 No Build Travel Times	Savings			
				Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
Intra Rockland	Suffern	Palisades Mall	51	19	19	19	19
	Palisades Mall	Suffern	72	43	43	39	39
Westchester Bound	Suffern	White Plains	92	49	47	44	42
	Suffern	Tarrytown	69	29	29	25	25
	Spring valley	White Plains	77	31	29	30	28
	Spring valley	Tarrytown	52	14	14	13	13
	Nyack	White Plains	67	30	27	29	27
	Nyack	Tarrytown	43	14	14	13	13
	Harriman	White Plains	127	30	27	28	26
	Harriman	Tarrytown	119	25	25	23	23
Rockland Bound (Reverse Commute)	White Plains	Suffern	106	62	60	57	55
	Tarrytown	Suffern	83	47	47	42	42
	White plains	Spring valley	95	48	45	46	44
	Tarrytown	Spring valley	71	34	34	33	33
	White Plains	Nyack	91	36	34	35	33
	Tarrytown	Nyack	101	53	53	53	53
CT-Westchester	Stamford	White Plains	68	14	13	14	13
	Stamford	Tarrytown	88	21	18	21	18
Manhattan Bound	Suffern	Midtown	102	27	27	27	27
	Nyack	Midtown	114	49	49	49	49
	Harriman	Midtown	126	26	26	26	26
Intra Westchester	White Plains	Port Chester	40	4	2	4	2
	Tarrytown	White Plains	51	21	19	21	19
	Port Chester	White Plains	42	7	6	7	6
	Port Chester	Tarrytown	64	15	11	15	11

Table A-28

Tappan Zee Bridge Truck Demand

		2047				
		NB	B	C	D	E
AM	WB	2,627	2,953	2,737	3,955	4,003
	EB	2,560	2,681	2,533	3,813	3,802
MD	WB	3,190	3,273	3,261	4,434	4,529
	EB	3,155	3,303	3,264	4,652	4,599
PM	WB	1,130	1,166	1,216	1,660	1,584
	EB	1,187	1,200	1,224	1,682	1,718
NT	WB	1,786	1,731	1,814	2,316	2,245
	EB	1,738	1,792	1,745	2,219	2,233
Daily	WB	8,733	9,123	9,028	12,364	12,361
	EB	8,639	8,976	8,766	12,367	12,353

Transit CRT Ridership

	No Build		B		C		D		E	
	On	OFF	On	OFF	On	OFF	On	OFF	On	OFF
Port Jervis Line										
Port Jervis	362	15	311	10	304	2	299	8	315	-
Otisville	289	6	182	6	198	5	193	8	147	3
Middletown	1,853	2	1,611	17	1,572	15	1,633	25	1,553	3
Campbell Hall	266	1	193	1	173	0	205	2	161	0
Salisbury Mills - Cornwall	2,876	6	2,272	1	2,226	2	2,155	1	2,264	0
Harriman	1,333	20	629	9	710	4	694	15	711	3
Tuxedo	141	6	77	2	63	3	72	2	66	-
Sloatsburg	118	12	46	5	58	7	42	12	51	3
Suffern	875	704	425	1,170	354	1,370	405	973	92	905
	8,113	772	5,746	1,221	5,656	1,409	5,698	1,045	5,359	918
Tappan Zee Bridge Service										
Port Jervis			142	7	148	7	147	10	169	-
Otisville			119	-	123	1	133	1	110	-
Middletown			1,057	15	1,036	7	1,082	18	973	2
Campbell Hall			139	-	108	1	147	3	132	0
Salisbury Mills - Cornwall			1,480	3	1,370	4	1,502	6	1,381	5
Harriman			814	13	676	17	750	12	679	6
Tuxedo			122	2	100	1	111	2	104	-
Sloatsburg			97	14	65	12	72	10	55	4
Suffern			1,342	458	1,516	294	1,177	390	1,500	-
Garden State Parkway CRT	-	-	1,409	1,020	1,405	852	1,417	1,122	1,268	216
Palisades Mall New	-	-	1,796	277	1,789	243	1,651	255	1,614	125
125th	-	-	-	1,131	-	1,180	-	1,041	-	1,111
GCT	-	-	-	6,326	-	6,587	-	6,082	-	6,513
			8,516	1,810	8,337	1,439	8,191	1,830	7,982	358

Table A-29

Transit CRT Ridership

	No Build		B		C		D		E	
	On	OFF	On	OFF	On	OFF	On	OFF	On	OFF
Spring Valley Line										
Spring Valley	1752	0	1120	0	1232	0	1186	0	1142	0
Nanuet	1073	98	585	84	571	70	610	82	602	88
Pearl River	610	110	518	112	593	104	556	90	557	105
Orange Boarding	7,120		9,148		8,806		9,125		8,762	
Rockland Boarding	4428		7338		7583		7116		6880	
Total	**11,548**		**16,486**		**16,389**		**16,241**		**15,642**	

Appendix B
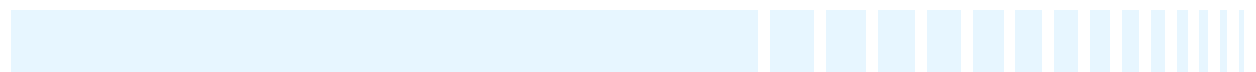
B Assumptions

B.1 No Build Input Assumptions

B.1.1 Transit

Table B-1

Port Jervis Line Service Plan
(As Received from Metro-North June 23 2006)

Origin-Destination	Number of Inbound Peak Period Trains (6-10)	Comments
Port Jervis- Hoboken	6	5 express from Suffern and 1 express from Harriman
Port Jervis to 34th Street	5	4 express from Suffern and 1 express from Harriman

Table B-2

Pascack Valley Line Service Plan
(As Received from Metro-North June 23 2006)

Origin-Destination	Number of Inbound Peak Period Trains (6-10)	Comments
Spring Valley to Hoboken	5	3 make all stops; 1 express from Pearl River; 1 express from North Hackensack
Spring Valley to 34th Street	5	3 make all stops; 2 express trains from North Hackensack;

B.1.2 Highway Tolls

Table B-3

Highway Tolls

	Newburgh-Beacon Bridge	Bear Mountain Bridge	Tappan Zee Bridge	George Washington Bridge	Lincoln Tunnel	Holland Tunnel
NYMTC 2005 ($)	$1.00	$1.00	$3.72	$4.83	$4.83	$4.83
Revised 2005 Tolls ($)	$1.33	$1.33	$3.72	$6.64	$6.64	$6.64

B.2 Build Alternative BRT Service Plans

Service plans have been developed for the BRT alternatives. Station locations by alternative and route are shown in Table B-4.

Table B-4

BRT Stations by Alternative/Option

Station	Alternative B: Corridor Busway	Alternative C: Busway/Bus Lanes	Alternative D: HOV/Busway	Alternative E: HOV/Bus Lanes
Rockland				
Suffern NJ Transit Station	✓	✓	✓	✓
Airmont Road	✓	✓	✓	✓
Monsey/Route 59	✓	✓	✓	✓
Interchange 14	✓	✓	✓	✓
Palisades Mall	✓	✓	✓	✓
Nyack Interchange 11	✓	✓	✓	✓
Westchester				
Tarrytown Metro-North Station	✓	✓	✓	✓
Broadway	✓	✓	✓	✓
Meadow Street		✓		✓
Benedict Avenue	✓	✓	✓	✓
Elmsford West	✓	✓	✓	✓
Elmsford East	✓	✓	✓	✓
Hillside Avenue	✓	✓	✓	✓
Westchester County Center	✓	✓	✓	✓
White Plains Transportation Center	✓	✓	✓	✓
Galleria Mall	✓	✓	✓	✓
Westchester Mall	✓	✓	✓	✓
White Plains Avenue	✓	✓	✓	✓
Platinum Mile (Corporate Park Dr.)	✓	✓	✓	✓
Westchester Avenue	✓	✓	✓	✓
South Ridge Street	✓	✓	✓	✓
Boston Post Road	✓	✓	✓	✓
Port Chester Metro-North Station	✓	✓	✓	✓

The service plans (Figure B-1) include routes, frequencies, fares, stop locations and termini. This permits the coding of the complete route into the Best Practice Model (BPM). Travel speeds on the busways are determined by analysis of the design characteristics of the busway. Bus travel speeds in general traffic are determined by BPM based on the street functional class and the area that the street is located in. Transfers are possible wherever the coded stops coincide with the stops of other routes, and all potential connecting routes have been modified to assure that possibility. Timed connections, where schedules are meshed so that both services arrive at the stop simultaneously, cannot be coded in BPM, so waiting times equivalent to half the headway of the second bus are assumed.

Commuter Rail Transit Service Plan

No. of Trains	Headways (minutes)		
1	60	A	Port Jervis - Hoboken
1	60	B¹	Port Jervis - New York Penn Station
1	60	C	Port Jervis - Hoboken
1	60	D¹	Port Jervis - New York Penn Station
2	30	E	Port Jervis - Grand Central Terminal
4	15	F	Harriman - Grand Central Terminal
4	15	G	Hillburn - Grand Central Terminal

* Additional trains in 2017 & 2047 using the Trans Hudson Express Tunnel

Bus Rapid Transit Service Plan

A	Middletown	- White Plains Transportation Center
B	Suffern	- Stamford
C	Suffern	- White Plains Transportation Center
D	Mt. Ivy	- Port Chester
E	Spring Valley	- Tarrytown
F	Spring Valley	- Yonkers and Bronx
G	Spring Valley	- Hawthorne (Rt. 9A)
H	New City	- White Plains Transportation Center
I	Haverstraw	- White Plains Transportation Center
J	Nyack	- Port Chester
K	Bergen County	- Port Chester
L	Croton Ossining	- White Plains Transportation Center
M	Fordham	- White Plains Transportation Center
N	Yonkers	- Port Chester
O	Yorktown	- White Plains Transportation Center
P	Stamford	- White Plains Transportation Center
T	Suffern	- Port Chester
	Current bus service	

BRT Service

NOTES:
*Not a Station.
**Bus Lane only.

Commuter Rail Service

Service Branch
- Hoboken/New York Penn
- Grand Central Terminal

NOTES:
In addition to the direct service to each terminal, customers will have additional service to each terminal via transfers at Harriman or the new Hillburn Stations.
Reverse peak and off peak Bergen Line and Main Line trains will terminate at Hillburn instead of Suffern.
***Additional trains in 2017 & 2047 using the Trans Hudson Express tunnel.

Figure B-1 Service Plans

Table B-5

Alternative 3 Service Plans

BRT Route	Fare (1996 dollars)	Currently	Description	Enter Busway	Terminus	Alt. B Headway		Alt. C Headway		Alt. D Headway		Alt. E Headway	
						Peak	Off Peak	Peak	Off Peak*	Peak	Off Peak*	Peak	Off Peak
A	2.85	OWL	Middletown-White Plains	Airmont	WPTC	30	30	30	30	30	30	30	30
B *	2.00		Suffern-Stamford – Bypass White Plains	Suffern	Stamford TC	15	20	15	60	15	20	15	20
C	1.25	TZExpress	Suffern-White Plains	Suffern	WPTC	30	x	30	x	30	x	30	x
D	1.50		Mt Ivy-Spring Valley-Port Chester	Int 14	Port Chester	20	60	20	60	20	60	20	60
E	1.25	TZExpress	Spring Valley-Tarrytown	Int 14	Tarrytown Station	20	x	20	x	20	x	20	x
F*	1.50		Spring Valley-Bronx via Rt. 9	Int 14	Bronx subway	30	60	30	60	30	60	30	60
G	1.50		Spring Valley to Route 9A	Int 14	Rt 9A and Beverly	30	60	30	60	30	60	30	60
H	1.25		New City-White Plains	Palisades Mall	WPTC	20	60	20	60	20	60	20	60
I	1.25		Haverstraw-White Plains	Palisades Mall	WPTC	30	60	30	60	30	60	30	60
J	1.50		Nyack-Port Chester	Int 11	Port Chester	30	60	30	60	30	60	30	60
K	2.00		Bergen County-Port Chester via GSP	Int 14	Port Chester	30	60	30	60	30	60	30	60
L	1.30	BeeLine 11	Croton-Ossining-White Plains via Rt. 9	Route 119	WPTC	60	x	60	x	60	x	60	x
M	1.30	BeeLine 62	Fordham-New Rochelle-White Plains via I-95 and I-287	Westchester Ave	WPTC	30	60	30	60	30	60	30	60
N	1.30	BeeLine 3 and BeeLine 21	Yonkers-Port Chester via Central	Route 119	Port Chester	30	60	30	60	30	60	30	60
O	1.30	BeeLine 77	Yorktown-White Plains via Taconic	Sprain Brook Parkway	WPTC	30	60	30	60	30	60	30	60
P**	1.30	I-Bus	Stamford-White Plains	Westchester Ave	WPTC	15	30	15	30	15	30	15	30
T**	1.50	Trunk Route	Suffern-Port Chester	Suffern	Port Chester	5	5	5	5	5	5	5	5

Note: * = Route traveling towards WPTC is defined as Peak (direction) and Route traveling off WPTC is defined as Off Peak (direction).
Note: ** = Routes operate at peak headways in both directions.

B.3 Transit Fares

Table B-6

Travel Time Between Stops – Alt B: Busway & Busway

From	To	Time
Hillburn	Airmont	2.9
Airmont	Monsey	2.3
Monsey	Garden State Parkway	3.7
Garden State Parkway	Palisades Mall	4
Palisades Mall	Nyack	2.3
Nyack	Broadway	5.1
Broadway	Benedict Avenue	2.4
Benedict Avenue	Elmsford West	1.7
Elmsford West	Elmsford East	1.7
Elmsford East	Hillside Avenue	1.3
Hillside Avenue	Westchester County Center	2
Westchester County Center	White Plains TC	1.3
White Plains TC	Galleria Mall	1.3
Galleria Mall	Westchester Mall	2
Westchester Mall	White Plains Avenue	2
White Plains Avenue	Platinum Mile	2
Platinum Mile	Westchester Avenue	3.1
Westchester Avenue		1.6
South Ridge Street	Boston Post Road	1.3
Boston Post Road	Port Chester	1.7

Table B-7

Travel Time Between Stops - Alt. C: Busway & Buslane

From	To	Time
Hillburn	Airmont	2.9
Airmont	Monsey	2.3
Monsey	Garden State Parkway	3.7
Garden State Parkway	Palisades Mall	4
Palisades Mall	Nyack	2.3
Nyack	Broadway	5.1
Broadway	meadow st.	1.6
meadow st.	Benedict Avenue	1.8
Benedict Avenue	Elmsford West	2.5
Elmsford West	Elmsford East	2.3
Elmsford East	Hillside Avenue	1.6
Hillside Avenue	Westchester County Center	2.1
Westchester County Center	White Plains TC	2.1
White Plains TC	Galleria Mall	1.3
Galleria Mall	Westchester Mall	2
Westchester Mall	White Plains Avenue	2
White Plains Avenue	Platinum Mile	2.7
Platinum Mile	Westchester Avenue	3.4
Westchester Avenue	South Ridge Street	1.6
South Ridge Street	Boston Post Road	1.3
Boston Post Road	Port Chester	1.7

Table B-8

Travel Time Between Stops - Alt. D: Buslane & Busway

From	To	Time
Hillburn	Airmont	3.8
Airmont	Monsey	2.3
Monsey	Garden State Parkway	4.3
Garden State Parkway	Palisades Mall	4.7
Palisades Mall	Nyack	2.5
Nyack	Broadway	5.3
Broadway	Benedict Avenue	2.4
Benedict Avenue	Elmsford West	1.7
Elmsford West	Elmsford East	1.7
Elmsford East	Hillside Avenue	1.3
Hillside Avenue	Westchester County Center	2
Westchester County Center	White Plains TC	1.3
White Plains TC	Galleria Mall	1.3
Galleria Mall	Westchester Mall	2
Westchester Mall	White Plains Avenue	2
White Plains Avenue	Platinum Mile	2
Platinum Mile	Westchester Avenue	3.1
Westchester Avenue	South Ridge Street	1.6
South Ridge Street	Boston Post Road	1.3
Boston Post Road	Port Chester	1.7

Table B-9

Travel Time Between Stops - Alt. E: Buslane & Buslane

From	To	Time
Hillburn	Airmont	3.8
Airmont	Monsey	2.3
Monsey	Garden State Parkway	4.3
Garden State Parkway	Palisades Mall	4.7
Palisades Mall	Nyack	2.5
Nyack	Broadway	5.3
Broadway	meadow st.	1.6
meadow st.	Benedict Avenue	1.8
Benedict Avenue	Elmsford West	2.5
Elmsford West	Elmsford East	2.3
Elmsford East	Hillside Avenue	1.6
Hillside Avenue	Westchester County Center	2.1
Westchester County Center	White Plains TC	2.1
White Plains TC	Galleria Mall	1.3
Galleria Mall	Westchester Mall	2
Westchester Mall	White Plains Avenue	2
White Plains Avenue	Platinum Mile	2.7
Platinum Mile	Westchester Avenue	3.4
Westchester Avenue	South Ridge Street	1.6
South Ridge Street	Boston Post Road	1.3
Boston Post Road	Port Chester	1.7

Thruway
Authority

New York State
Department of Transportation

Metro-North
Railroad

Appendix C
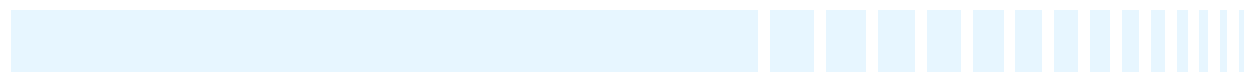
C1 Introduction

The Tappan Zee Bridge/I-287 Corridor Project is part of an on-going program to improve mobility in the corridor connecting Hillburn/Suffern to Port Chester, New York (NY). Key objectives of this project include: (1) resolving the structural needs of the Tappan Zee Bridge; (2) identifying a potential transit link for the region; and (3) determining the safest, most efficient, environmentally sound, and responsible way to address the transportation needs of the Tappan Zee Bridge/I-287 Corridor for the next century. A key element of this analysis is an assessment of how different options for improving transportation infrastructure in this corridor affect mobility, traffic volumes, and transit ridership.

As required by the federal co-lead agencies, the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), this project is part of the region's Continuing, Comprehensive, Coordinated (3C) process developed by the New York Metropolitan Transportation Council (NYMTC). As part of that process, NYMTC has developed and adopted an urban travel demand forecasting model and supporting demographic forecasting assumptions. The adopted travel demand forecasting model is known as the Best Practice Model (BPM) and represents a state-of-the art process that forecasts future urban travel based on assumptions regarding land use and transportation facilities and services. This model is an integrated, multimodal forecasting tool that includes the capability of evaluating both the highway and transit options that are proposed for the corridor.

In applying the BPM to study travel in the Tappan Zee Bridge/I-287 Corridor, several adjustments referred to as calibration of the model were made to the model to fully represent travel characteristics that are unique to the corridor. In particular, the model was updated to better match existing transit markets between areas of the region west of the Hudson River and Westchester County, Connecticut, and New York City. As part of this update, modeled highway volumes, bus ridership, and commuter rail ridership were checked against observed values crossing the Hudson River and key local screenlines to confirm that the model has an appropriate understanding of these markets.

NYMTC calibrated the BPM in 1996, 2002, and 2008. In 2007, the project team further calibrated the BPM to better reflect travel patterns in applicable markets as the study assessed alternative transit modes and service levels. This same process was completed again in 2009 in preparation for the full environmental review process. This report focuses on this most recent recalibration process.

The report provides an introduction to the overall BPM and additional detail on the modifications made for specific application to this project. This report is organized as follows:

- An overview of the BPM model and study area (Section C1).
- A description of key model inputs (Section C2).
- A description of key model processes (Section C3).
- The model calibration process for the Tappan Zee Bridge/I-287 Corridor (Section C4).

C1.1 BPM Model Overview

C1.1.1 Traditional Models versus BPM

The BPM represents a break from traditional modeling procedures. Since the 1950s travel forecasting has typically relied on variations of the "four-step" process to forecast future urban travel based on characteristics of the land uses and transportation network. These are:

1. **Trip Generation (Production and Attraction)** – determining where trips are produced, and to where trips are attracted. This is usually based on land use and demographic data for each zone.

2. **Trip Distribution** – matching each trip origin with a trip destination. This process results in the "trip table", a matrix of trips between zones.

3. **Modal Choice** – the estimation of how many of those trips will use automobiles, buses, trains and other modes. This results in a trip table for each mode.

4. **Assignment** – how those trips are routed through the transportation network, resulting in vehicle volume estimates for each roadway or passenger volumes on each transit route in the network.

This process has been studied, refined, reevaluated, recalibrated and reapplied throughout the modeling world for the last 50 years. Refinements have included detailed investigation of transit access trips (how people get to the train station or bus stop), analysis of goods movement, analysis of household auto ownership and its impact on modal split, analysis of life cycle variables, and consideration of travel time budgets.

The BPM differs in at least two major respects from those traditional models; it uses "microsimulation", and it is a "journey-based" model. Instead of considering the aggregate trips at the zone level prior to trip assignment, "micro-simulation" individually simulates every trip in each household in the region. With 9 million households in the New York region in 1996, and an estimated 25 million daily paired journeys, this was not possible until recent advances in computing power. Based on a household survey conducted in 1997 and 1998, the model creates a list of households, each with certain characteristics - size, employed persons, students, income, and auto ownership.

Instead of treating each trip individually, the BPM generates "journeys" from these households, linked trips that may include several stops. For example, a journey may include driving to work, then leaving on the way home from work, stopping off to shop, and then picking up a child. This single "journey" would be represented as four separate unrelated trips in traditional models. The advantage of a journey-based model is that the locations of intermediate stops can be based on the location of work and the location of home. Moreover, each household's journey affects the others. Thus, when one member of a one-car household uses the car for a trip, then no other member of that household can drive during that time period and must use transit, taxi, or carpool to complete their trip.

Decisions on where and how to travel are modeled in the BPM's Mode Destination Stops Choice (MDSC) module. This part of the model uses random number generation to distribute individual journeys probabilistically, which introduces an element of variance in the process. As a result, multiple runs will not generate identical results any more than detailed travel patterns on any given day are identical to detailed travel patterns the next day. Therefore, duplication of results between model runs is not always possible.

These processes create a set of trip tables by several modes. Once the trip tables are in place, highway and transit assignments in BPM basically follow the same procedures as traditional four-step models.

C1.1.2 BPM Model Structure

The BPM is structured as a series of modules (Figure C1-1). Most of the modules use a TransCAD platform. The outputs of each module are used as inputs to successive modules.
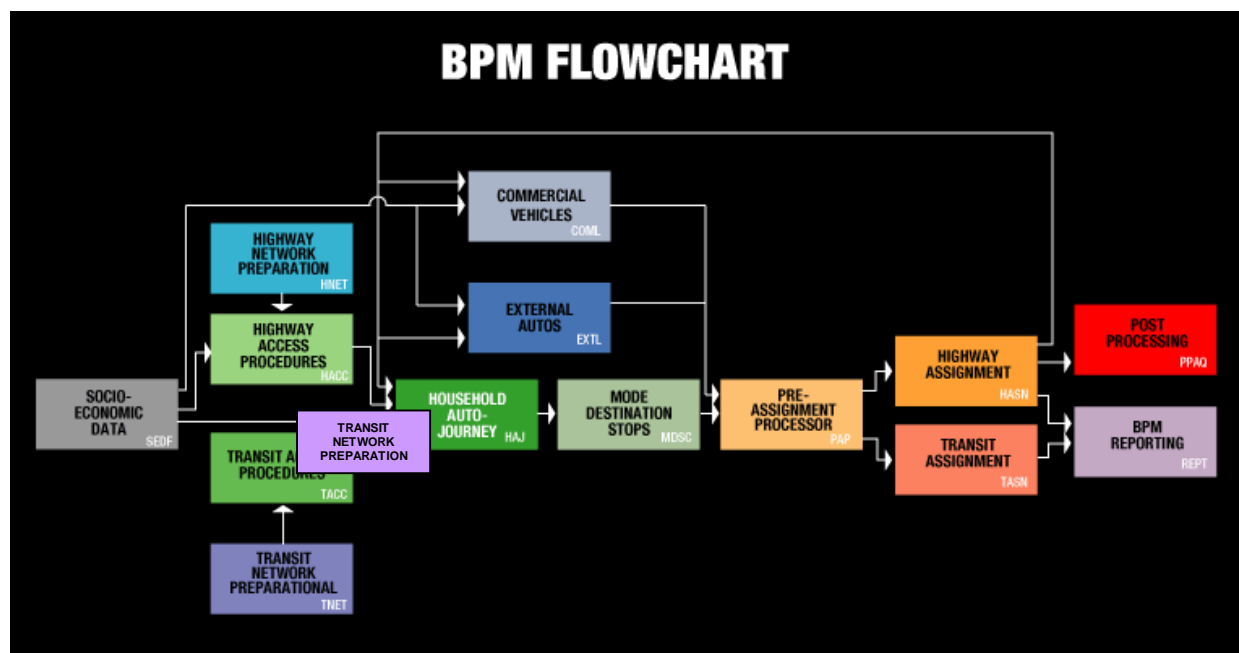
Source: NYMTC, January 30, 2005.

Figure C1-1 BPM Flow Chart

There are a series of input and data processing modules that collectively determine the ultimate highway and transit assignments:

- **Key Inputs** (described in Section C2):
  Socioeconomic Data
  Highway Data
  Transit Data

- **Key Modules** (described in Section C3):
  Household Auto-Ownership Journey-Frequency (HAJ)
  Mode Destination Stops Choice (MDSC)
  Highway and Transit Assignments

Metro-North
Railroad

New York State
Department of Transportation

Thruway
Authority

C1.2 Geographic Scope of Analysis

The modeled region consists of 28 counties in the New York Metropolitan Area, including 14 counties in northern New Jersey and two counties in southwestern Connecticut (Figure C1-2). The counties are divided into 3,586 internal zones and 111 external stations (i.e., points where vehicles from outside the model area enter the model network). In Manhattan and other dense areas, the zones are typically equivalent to census tracts, and in some places are subdivisions of tracts.

In the study area in Rockland and Westchester Counties, several zones are composed of multiple tracts, and the tracts themselves are quite large (Figure C1-3). Westchester County has 1.31 tracts per zone and Rockland County 1.53 tracts per zone. This has implications for the level of detail to which traffic and transit assignments can be used.

BPM Study Area

1. Manhattan
2. Queens
3. Bronx
4. Brooklyn
5. Staten Island
6. Nassau
7. Suffolk
8. Westchester
9. Rockland
10. Putnam
11. Orange
12. Dutchess
13. Fairfield
14. Bergen
15. Passaic
16. Hudson
17. Essex
18. Union
19. Morris
20. Somerset
21. Middlesex
22. Monmouth
23. Ocean
24. Hunterdon
25. Warren
26. Sussex
27. New Haven
28. Mercer
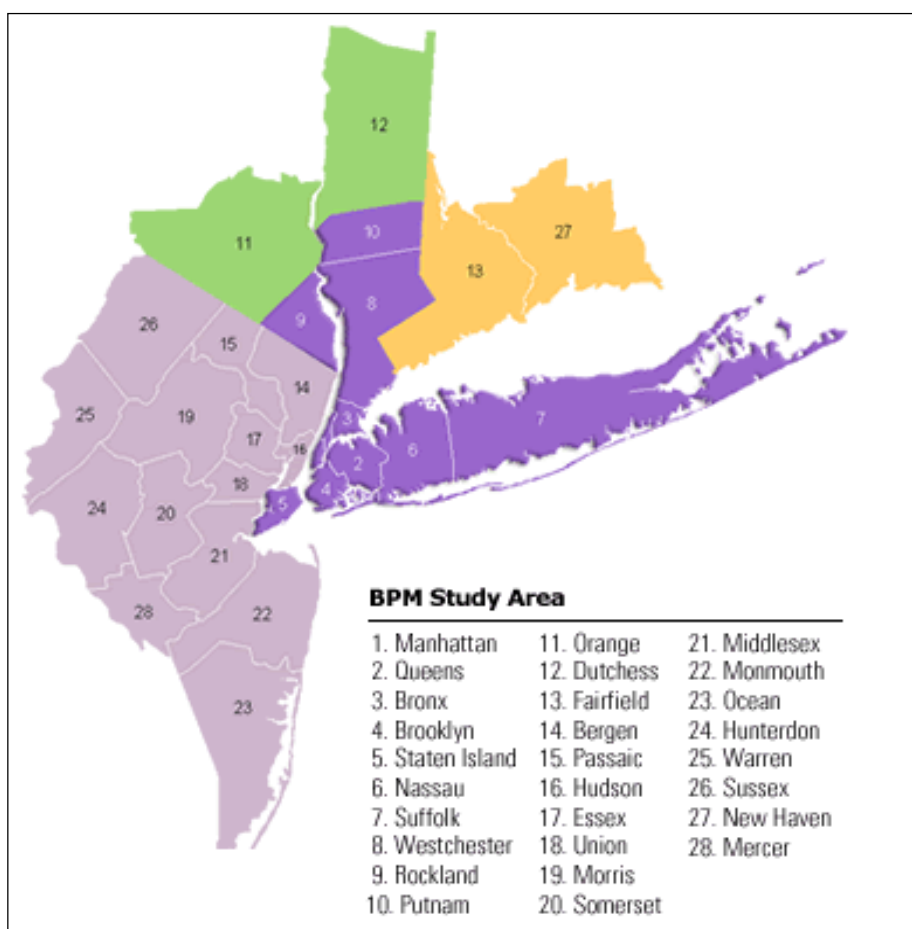
Source: NYMTC, January 30, 2005.

Figure C1-2 BPM Study Area

Source: New York Best Practice Model, 2007.
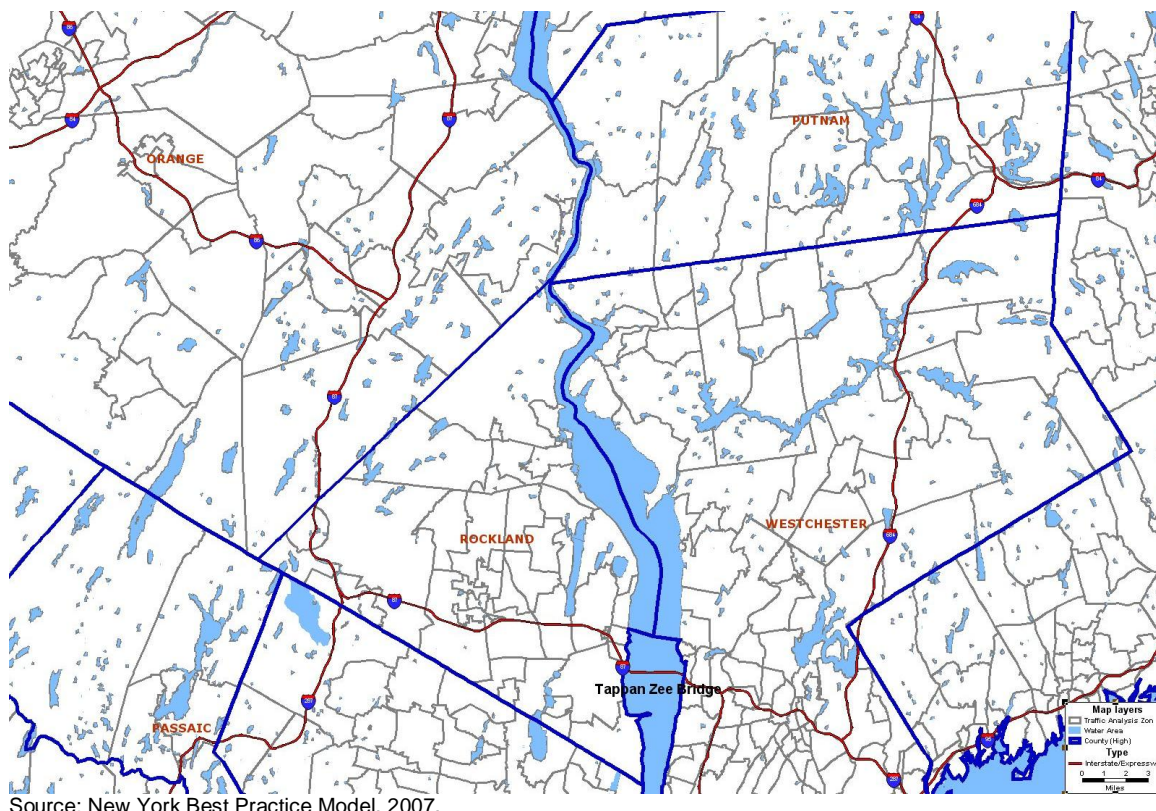
Figure C1-3 Zone Structure in the Corridor

C1.3 Years of Analysis/Baseline Definition

The model calibration process was conducted for 2005 by comparing BPM results to US Census journey-to-work data, the 2003 Hudson Crossing origin-destination survey conducted as a part of this study, actual transit system ridership and observed traffic counts.

A series of project alternative model runs will be done for years 2010 (Existing Condition), 2017 (Proposed Build year for the Tappan Zee Bridge and highway improvements), and 2047, the project's long-term planning year horizon. The No Build Alternative was initially developed as a baseline for each analysis year, with other alternatives subsequently built upon changes to the No Build network. The No Build Alternative includes network improvements from NYMTC's Transportation Improvement Program (TIP).

C2 Key BPM Inputs

The major elements of the model include socioeconomic data by model zone (including forecasts for various years in the future), current and future highway networks, and current and future transit networks. These model inputs are described below.

C2.1 Socioeconomic and Demographic Data

Demographic variables are prepared by NYMTC for each zone and are available for 1996, 2000, 2002, 2005 and 5-year increments through 2035. It is from these variables that BPM synthesizes a list of individual households and trip-makers with various characteristics for each zone. These variables are:

- Household Population.
- Population in Group Quarters (Total).
- Population in Group Quarters (in institutions, i.e., college dormitories, prisons, etc.).
- Population in Group Quarters (street population).
- Population in Group Quarters (other).
- Number of Households.
- Average Household Size.
- Employed Labor Force (by place of residence).
- Median Household Income.
- Total Employment (by place of work).
- Retail Employment.
- Office Employment.
- Median Earnings of Employees.
- University Enrollment (by location of university).
- K-12 Enrollment (by location of school).

C2.1.1 Demographic Forecasts

As discussed in Section C1.3, analysis will be carried out for several years for which NYMTC forecasts are not available. Forecasts for these analysis years will be interpolated or extrapolated using a straight-line method. The socioeconomic and demographic data provided by NYMTC for various years will be plotted to ensure that a straight-line approach is reasonable and that an obvious trend is not overlooked.

Population and employment forecasts developed by NYMTC for years 2005 and 2035 are summarized in Table C2-1. Compared to the rest of the region, these forecasts show a high population growth in Orange (29 percent), compared to regional wide 19 percent. Westchester population is forecasted to grow at a much slower (only 14 percent) than average pace, although its job growth (26 percent) is projected to be closer to average (27 percent). The Rockland employment growth is estimated to be 30 percent.

Table C2-1

Demographic Forecasts by County

County	Population			Employment		
	2005	2035	Growth	2005	2035	Growth
Rockland	286,779	330,844	15%	122,404	159,360	30%
Orange	358,649	461,066	29%	133,423	170,005	27%
Westchester	919,626	1,051,040	14%	407,542	512,830	26%
Putnam	98,312	122,170	24%	26,983	35,448	31%
Dutchess	275,964	355,714	29%	127,796	176,081	38%
Fairfield	882,608	1,072,302	21%	426,592	506,474	19%
New Haven	815,970	977,668	20%	356,459	438,215	23%
Manhattan	1,544,199	1,807,476	17%	2,044,134	2,504,114	23%
Queens	2,230,464	2,693,935	21%	596,940	737,411	24%
Bronx	1,317,104	1,482,472	13%	295,178	359,543	22%
Kings	2,470,992	2,833,905	15%	684,109	957,559	40%
Richmond	465,907	548,902	18%	124,572	230,010	85%
Bergen	890,996	990,797	11%	425,145	495,124	16%
Passaic	485,682	564,161	16%	167,084	205,058	23%
Rest of North NJ	5,353,726	6,501,666	21%	2270064	2958294	30%
Nassau	1,307,729	1,459,969	12%	562,865	644,993	15%
Suffolk	1,441,894	1,742,378	21%	580,801	757,406	30%
Total	20,324,554	24,100,657	19%	9,352,091	11,847,925	27%

Source: 2005 and 2035 data from NYMTC forecast series adopted by NYMTC in Feb 2010.

C2.1.2 Socioeconomic Data Corrections

The project team observed that the income distribution in the 2005 and 2035 No Build models were considerably different. Considering all other variables including tolls, transit fares etc are kept constant, which is standard modeling practice, the difference was of concern. NYMTC confirmed that the income distribution should in fact remain the same across all analysis years.

C2.2 Highway Data

The BPM highway network is derived from several networks that predated development of the model, among them NYMTC's Interim Analysis Model (IAM) highway model, NJDOT's Tranplan network, and ConnDOT's network for Fairfield and New Haven Counties. There are about 40,000 highway links and an additional 13,000 links connecting the network to zones. All Interstate highways, state and US numbered routes, and parkways and most local arterials and collectors are coded in GIS format. Data are attached to each link describing each included roadway's characteristics, such as number of lanes, access control, signal density and unconstrained speeds. Not every street is coded. A sample portion of the network (in Rockland County) is shown in Figure C2-1.

The highway networks vary by period, so that lane configurations that change during the day can be simulated. This is a significant feature of BPM for the corridor because it enables appropriate modeling of the reversible lane on the Tappan Zee Bridge. Auto and truck tolls can be specified separately.
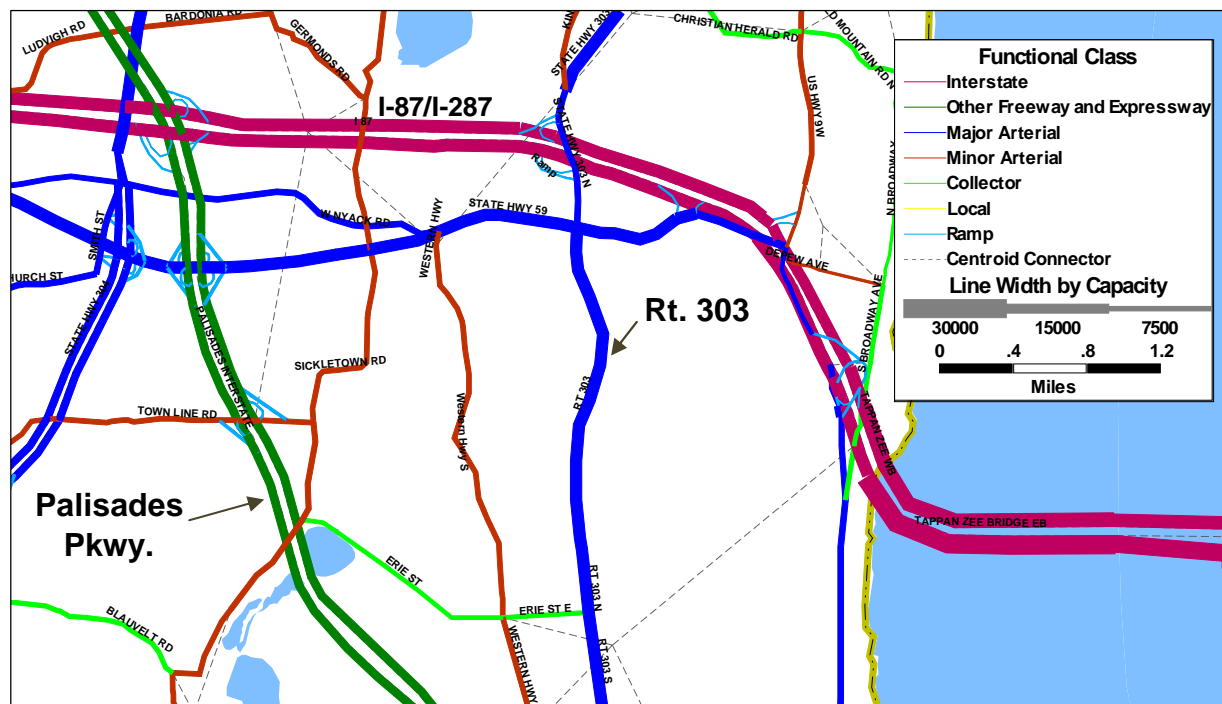
Source: New York Best Practice Model, 2007.

Figure C2-1 BPM Highway Network (Detail in Rockland County)

C2.2.1 Highway Network Corrections

In Stage 1 of the Tappan Zee Bridge/I-287 Corridor Project, the BPM's highway network was refined to more accurately represent the roadway facilities in the corridor. These adjustments were later incorporated by NYMTC into the revised version of BPM. For example, I-287 in New Jersey had not been linked to I-287 in New York at Interchange 15, nor was the connection between I-287 and Highway 17 up-to-date.

In review of the BPM 2005 release, a few additional errors in the highway network were discovered. For example, certain connections between I-287 and Westchester Avenue east of White Plains that are planned improvements within the Transportation Improvement Program (TIP) were prematurely coded into the 2005 network and had to be removed. (Those connections are maintained in future year networks). The westbound segment of I-287 from the foot of the Tappan Zee Bridge to Exit 11 was incorrectly coded as three lanes instead of four lanes.

C2.2.2 Tolls

All tolls on Hudson River crossings were adjusted to represent relative tolls in effect on October 1, 2005. Peak period tolls for E-ZPass users were used for all river crossings, based on the market penetration of

E-ZPass for those markets. Other tolls were adjusted where discrepancies were noted. NYMTC is planning for future BPM versions to be able to reflect time-of-day tolls, but due to present model restrictions peak period tolls were used.

Tolls at relevant facilities were coded in as shown in Table C2-2.

Table C2-2

River Crossing Tolls

Crossing	2005 Toll
Newburgh-Beacon Bridge	$1.33
Bear Mountain Bridge	$1.33
Tappan Zee Bridge	$3.72
George Washington Bridge	$6.64
Lincoln Tunnel	$6.64
Holland Tunnel	$6.64
Source: Port Authority of New York and New Jersey, New York Thruway Authority, Metropolitan Transportation Authority, and the MTA Bridges and Tunnels.	

C2.2.3 Auto Operating Costs

The most recent version of the BPM assumes auto operating costs of $0.20/mile (NYMTC 2008 Calibration).

C2.3 Transit Data

The BPM transit network is derived mainly from the Metropolitan Transportation Authority's (MTA) Regional Travel Forecast (RTF) model, and from the conversion of NJ Transit's networks from MinUTP software into TransCAD. All commuter rail, subway, bus, and ferry routes in the region have been coded with routes, fares, schedules, and transfer locations. There are a total of 3,300 transit routes. Each transit route represents a particular service (i.e., a set of stops and running times). In many cases routes overlap each other to represent different bus routes or trains on the same alignment. For example, approximately 42 different routes operate on the Hudson Line representing mix of express and local stop trains. The number of trains or buses per period defines frequency, not the specific time of day for any given train. Timed transfers, therefore, cannot be represented. Instead, transfer wait times are calculated as half of the headway (the time between trains or buses).

Within the BPM, bus operating times in the study area are mostly based on default values using the roadway type (highway, arterial, etc.) and the area type (urban, suburban, and rural). However, more accurate bus run times can be directly coded into the model. (For example, for alternatives with exclusive

busways or HOV/HOT lanes, the run times of express buses operating in those facilities were manually coded). The model does not adjust bus travel times to reflect changes in highway and roadway congestion among scenarios (e.g., greater congestion in 2047 No Build versus 2017 No Build), except where bus times are manually adjusted for each route. To more accurately reflect the effect of congestion levels on bus running times, future bus travel times will be increased to account for congestion and associated increased highway travel times, based on projected congestion level changes on the highways and other roadways.

A roadway network (different from the highway network) is used to define transit routes. It is also used to create access and egress links between zone centroids and transit stops, either by driving or by walking. The 2005 transit network in the corridor is shown in Figure C2-2.
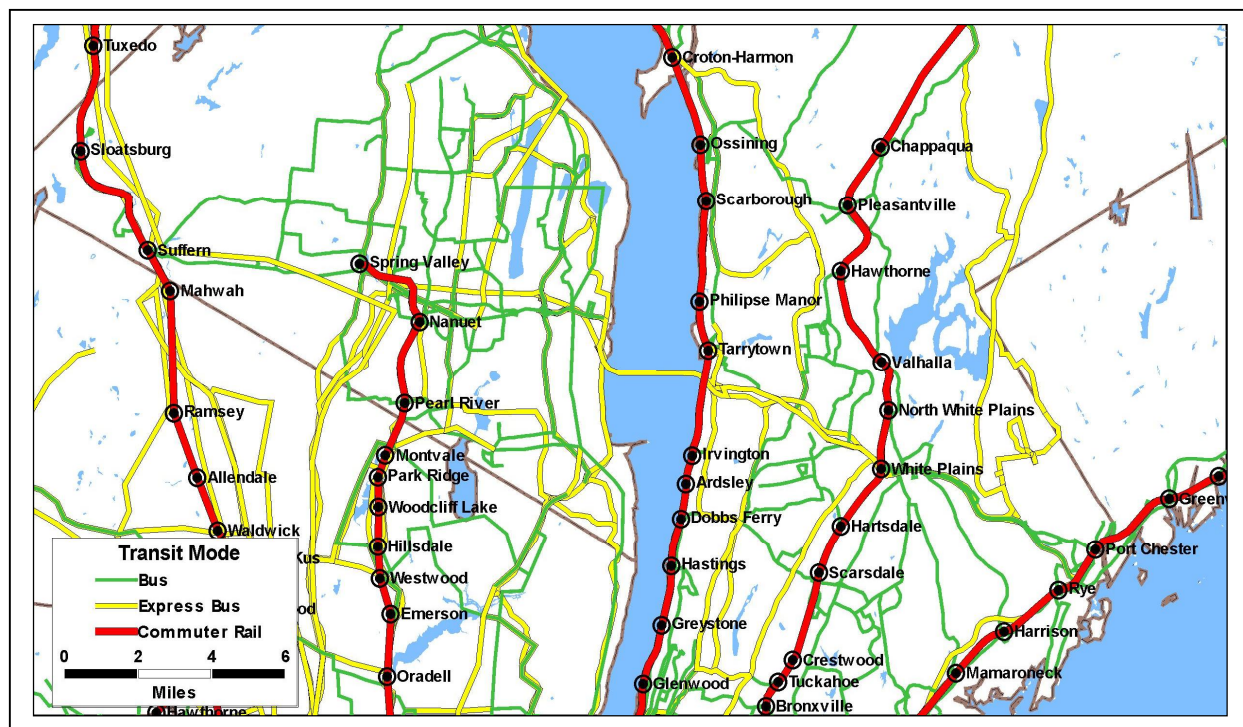
Source: New York Best Practice Model, 2007.

Figure C2-2 BPM Transit Network in Corridor

C2.3.1 Transit Network Corrections

Several corrections made to the transit network during the previous recalibration were carried forward. Some examples of the corrections are listed below.

- Stewart International Airport to the Metro-North Beacon Station was added.
- Orange to Westchester bus (OWL line) coding was corrected.
- Rockland County buses that were inactive in the model were activated.

C2.3.2 Parking at Transit Stations

The transit network includes a stations file that defines several station characteristics, notably the number of available parking spaces, whether those spaces are unrestricted or restricted to town residents, and the cost of parking. This information is used to define the extent of park-and-ride "connector links" between the station and surrounding zones. Therefore, the parking parameters define the size of the station's capture area for park-and-ride travelers.

The model, however, does not use the number of spaces to precisely limit drive-access demand. In other words, it is possible for the model results to show more people driving to a given station than the number of available spaces. In examining assignment results, however, few instances were found where projected demand did, in fact, exceed parking supply. This phenomenon can be attributed to kiss-and-ride trips that are accounted for in the trip tables.

C2.3.3 Transit Fares

Fares for commuter rail services are based on a fare zone to fare zone basis using 1/40th of the monthly fare for MTA-operated services and 70 percent of the one-way fare for NJ Transit. All other services are coded using a flat fare for each service type. In cases where distance-based fares are charged, the coded flat fare is set to the fare for the predominant market for the service, typically the fare to travel to Manhattan. All fares are coded in equivalent to 2005 dollars.

Discounts on transfer fares can be represented within the BPM in a relatively coarse manner – for example all Bee-Line bus riders can be charged a small surcharge to board any MTA bus route (or allowed to transfer for free). However a discount between specific bus routes and a commuter rail station cannot be represented.

Transit fares were adjusted to 2005 levels based on updated information from Metro-North and New Jersey Transit. Station-to-station fare matrices for Metro-North and New Jersey Transit were updated accordingly. The updated fares are shown in Tables C2-3 and C2-4.

Table C2-3

2005 Metro-North Fares

Stations	125TH/ GCT	BRONX	MOUNT VERNON W., LUDLOW	SCARSDALE, HASTINGS	VALLAHALLA, TARRYTOWN	MT. KISCO, COURTLAND	PURDY'S, MANITOU	PATTERSON, BEACON
CITY TERMINAL ZONE - 125TH/GCT	308	358	408	460	433	628	723	803
BRONX (MELROSE/MORRIS HEIGHTS) - HARLEM & HUDSON		120	120	140	178	275	385	490
WESTCHESTER CO - MOUNT VERNON W./LUDLOW - HARLEM & HUDSON			120	120	168	250	315	435
WESTCHESTER CO - SCARSDALE/HASTINGS - HARLEM & HUDSON				120	123	195	275	365
WESTCHESTER CO - VALLAHALLA/TARRYTOWN - HARLEM & HUDSON					123	123	223	303
WESTCHESTER CO - MT. KISCO/COURTLAND - HARLEM & HUDSON						123	123	220
PUTNAM CO - PURDY'S/MANITOU - HARLEM & HUDSON							123	140
DUTCHESS CO - PATTERSON/BEACON - HARLEM & HUDSON								123

Table C2-3

2005 Metro-North Fares (con't)

Stations	HARLEM VALLEY, POUGHKEEPSIE	Wassaic, Tenmile River	MOUNT VERNON, NEW ROCHELLE	LARCHMONT, HARRISON	RYE, PORT CHESTER
CITY TERMINAL ZONE - 125TH/GCT	883	883	408	460	493
BRONX (MELROSE/MORRIS HEIGHTS) - HARLEM & HUDSON	578	593	n/a	n/a	n/a
WESTCHESTER CO - MOUNT VERNON W./LUDLOW - HARLEM & HUDSON	538	538	n/a	n/a	n/a
WESTCHESTER CO - SCARSDALE/HASTINGS - HARLEM & HUDSON	480	480	n/a	n/a	n/a
WESTCHESTER CO - VALLAHALLA/TARRY TOWN - HARLEM & HUDSON	420	433	n/a	n/a	n/a
WESTCHESTER CO - MT. KISCO/COURTLAND - HARLEM & HUDSON	303	323	n/a	n/a	n/a
PUTNAM CO - PURDY'S/MANITOU - HARLEM & HUDSON	210	213	n/a	n/a	n/a
DUTCHESS CO - PATTERSON/BEACON - HARLEM & HUDSON	140	155	n/a	n/a	n/a
DUTCHESS CO - HARLEM VALLEY/POUGHKEEPSIE - HARLEM & HUDSON	140	123	n/a	n/a	n/a
DUTCHESS CO - Wassaic/Tenmile River - HARLEM & HUDSON		123	n/a	n/a	n/a
BRONX (FORDHAM) - NEW HAVEN			120	140	178
WESTCHESTER CO (MOUNT VERNON-NEW ROCHELLE) - NEW HAVEN			120	120	123
WESTCHESTER CO (LARCHMONT-HARRISON) - NEW HAVEN				120	123
WESTCHESTER CO (RYE-PORT CHESTER) - NEW HAVEN					120

Table C2-3

2005 Metro-North Fares (con't)

Stations	GREENWICH, OLD GREENWICH	STAMFORD	GLENBROOK, NEW CAANAN	NOROTON HEIGHTS, ROWAYTON	S. NORWALK, E.NORWALK	WESTPORT, FAIRFIELD
CITY TERMINAL ZONE - 125TH/GCT	593	660	660	660	710	770
BRONX (MELROSE/MORRIS HEIGHTS) - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - MOUNT VERNON W./LUDLOW - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - SCARSDALE/HASTINGS - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - VALLAHALLA/TARRYTOWN - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - MT. KISCO/COURTLAND - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
PUTNAM CO - PURDY'S/MANITOU - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - PATTERSON/BEACON - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - HARLEM VALLEY/POUGHKEEPSIE - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - Wassaic/Tenmile River - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
BRONX (FORDHAM) - NEW HAVEN	195	258	258	258	303	363
WESTCHESTER CO (MOUNT VERNON-NEW ROCHELLE) - NEW HAVEN	195	258	258	258	303	363
WESTCHESTER CO (LARCHMONT-HARRISON) - NEW HAVEN	153	218	218	218	216	318
WESTCHESTER CO (RYE-PORT CHESTER) - NEW HAVEN	135	185	185	185	230	285
FAIRFIELD CO (GREENWICH-OLD GREENWICH) - NEW HAVEN	125	125	125	125	140	178
FAIRFIELD CO (STAMFORD) - NEW HAVEN		125	125	125	125	135
FAIRFIELD CO (GLENBROOK-NEW CAANAN) - NEW HAVEN			125	125	145	188
FAIRFIELD CO (NOROTON HEIGHTS-ROWAYTON) -				125	125	135

NEW HAVEN						
FAIRFIELD CO (S. NORWALK - E.NORWALK) - NEW HAVEN						125	125
FAIRFIELD CO (WESTPORT-FAIRFIELD) - NEW HAVEN							125

Table C2-3

2005 Metro-North Fares (con't)

Stations	BRIDGEPORT	STRATFORD, MILFORD	NEW HAVEN	MERRITT 7 , CANONDALE	BRANCHVILLE, DANBURY	DERBY, SHELTON, WATERBURY
CITY TERMINAL ZONE - 125TH/GCT	840	883	985	730	770	888
BRONX (MELROSE/MORRIS HEIGHTS) - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - MOUNT VERNON W./LUDLOW - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - SCARSDALE/HASTINGS - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - VALLAHALLA/TARRYTOWN - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
WESTCHESTER CO - MT. KISCO/COURTLAND - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
PUTNAM CO - PURDY'S/MANITOU - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - PATTERSON/BEACON - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - HARLEM VALLEY/POUGHKEEPSIE - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
DUTCHESS CO - Wassaic/Tenmile River - HARLEM & HUDSON	n/a	n/a	n/a	n/a	n/a	n/a
BRONX (FORDHAM) - NEW HAVEN	433	475	578	330	398	500
WESTCHESTER CO (MOUNT VERNON-NEW ROCHELLE) - NEW HAVEN	433	475	578	323	363	480
WESTCHESTER CO (LARCHMONT-HARRISON) - NEW HAVEN	380	423	525	280	330	435
WESTCHESTER CO (RYE-PORT CHESTER) - NEW HAVEN	363	390	493	248	298	405
FAIRFIELD CO (GREENWICH-OLD GREENWICH) - NEW HAVEN	248	290	393	173	240	330
FAIRFIELD CO (STAMFORD) - NEW HAVEN	183	223	325	143	200	280
FAIRFIELD CO (GLENBROOK-NEW CAANAN) - NEW HAVEN	240	268	355	185	240	330
FAIRFIELD CO (NOROTON HEIGHTS-ROWAYTON) -	183	223	325	143	200	280

NEW HAVEN						
FAIRFIELD CO (S. NORWALK - E.NORWALK) - NEW HAVEN	148	173	275	110	145	253
FAIRFIELD CO (WESTPORT-FAIRFIELD) - NEW HAVEN	125	125	230	145	215	215
FAIRFIELD CO (BRIDGEPORT) - NEW HAVEN	125	125	150	195	253	133
NEW HAVEN CO (STRATFORD-MILFORD) - NEW HAVEN		125	150	215	268	133
NEW HAVEN CO (NEW HAVEN) - NEW HAVEN			128	293	373	253
INNER DANBURY BRANCH (MERRITT 7 -CANONDALE) - NEW HAVEN				110	110	295
OUTER DANBURY BRANCH (BRANCHVILLE-DANBURY) - NEW HAVEN					110	373
WATERBURY BRANCH (DERBY-SHELTON-WATERBURY) - NEW HAVEN						110

Source: NYMTC BPM 2009 Update.

Table C2-4

2005 NJT Fares Adjusted

Stations	Newark Penn Station	Secaucus	Lyndhurst Kingsland	Woodridge, Delwanna, Rutherford	Anderson St, Essex St, Clifton Plauderville	River Edge, Paterson, Radburn, Broadway	Oradell, Hawthorne	Emerson, Glen Rock	Hillsdale, Westwood, Ridgewood
NY PENN STATION	253	213	253	285	350	378	423	450	495
Hoboken Terminal	138	138	163	213	285	305	350	378	423
Newark Penn Station	138	138	163	213	285	305	350	378	420
Secaucus		138	213	238	305	350	413	438	463
Lyndhurst, Kingsland			100	100	100	138	173	213	240
Woodridge, Delwanna, Rutherford				100	100	100	138	163	213
Anderson St, Essex St, Clifton Plauderville					100	100	100	100	138
River Edge,Paterson,Radburn,Broadway						100	100	100	100
Oradell,Hawthorne							100	100	100
Emerson,Glen Rock								100	100
Hillsdale,Westwood,Ridgewood									100

Table C2-4

2005 NJT Fares Adjusted (con't)

Stations	Montvale, Waldwick, Ho-Ho-Kus	Allendale	Spring Valley, Ramsey Rt. 17	Suffern	Tuxedo, Sloatsburg	Harriman	Salisbury Mills	Campbell Hall, Stewart Airport Station	Middleton	Otisville	Port Jervis
NY PENN STATION	518	560	588	658	728	753	675	698	720	763	820
Hoboken Terminal	450	495	518	530	543	560	548	570	593	635	693
Newark Penn Station	450	495	518	530	543	560	688	710	733	775	833
Secaucus	488	495	518	530	543	560	548	570	593	635	693
Lyndhurst, Kingsland	285	308	350	423	445	470	448	488	513	533	578
Woodridge, Delwanna, Rutherford	240	285	305	378	445	470	433	475	503	525	573
Anderson St, Essex St, Clifton Plauderville	163	213	240	305	378	470	403	448	473	508	548
River Edge,Paterson,Radburn,Broadway	138	163	213	285	350	450	383	433	463	500	538
Oradell,Hawthorne	100	138	163	240	305	450	370	420	443	488	533
Emerson,Glen Rock	100	100	138	213	285	445	350	403	430	470	525
Hillsdale,Westwood,Ridgewood	100	100	100	163	240	445	330	388	418	460	508
Montvale,Waldwick,Ho-Ho-Kus	100	100	100	138	213	423	310	368	398	448	500
Allendale		100	100	100	163	378	293	350	380	428	468
Spring Valley,Ramsey Rt. 17			100	100	138	350	273	335	368	415	458
Tuxedo,Sloatsburg					100	240	205	225	283	310	350
Harriman						100	108	153	218	270	318
Salisbury Mills							100	88	153	218	283
Campbell Hall,Stewart Airport Station								100	108	173	260
Middleton									100	128	223
Otisville										100	160
Port Jervis											100

Source: NYMTC BPM 2009 Update.

C3 Key BPM Modules

The BPM is structured as a series of modules as illustrated previously in Figure C1-1. Most of the modules use a TransCAD[1] platform. The outputs of each module are used as inputs to successive modules. The three key BPM modules, which are discussed further below, are:

- Household Auto-Ownership Journey-Frequency (HAJ) Module, which in the BPM replaces the traditional trip generation model. It predicts the total number of households by income, size, number of children, number of workers and number of autos, and then determines the number of journeys that will be produced for each household over a 24-hour period.

- The Mode Destination Stop Choice (MDSC) module replaces the traditional trip distribution and mode choice models. Based on the person and household characteristics, and land-use densities around the journey origin, this model predicts where the person goes and if the person stops along the way on the journey, and which modes of travel each person chooses. If a person does make a stop on his/her way to work or school or university, this model will predict the location of the stop.

- The Highway and Transit Assignment Modules, which assign travelers to specific roadways or transit routes on a standard aggregate (i.e., zone-to-zone) basis, using assignment algorithms built into TransCAD.

C3.1 Household Automobile-Ownership Journey-Frequency (HAJ) Module

The HAJ journey-generation module of BPM consists of three successive models:

- Household population synthesizer.
- Auto-ownership model.
- Journey-frequency choice model.

The household and auto-ownership models constitute the first essential step in the demand modeling procedure. The purpose of this step is to prepare all necessary input components for the subsequent set of core travel demand models applied in a micro-simulation environment. The output of the procedure is a list of households in each zone with their main attributes (e.g., household size, income group, number of persons of each type, and number of cars). These attributes are then used as independent variables in subsequent travel demand models. The number of journeys is then estimated over a 24-hour period. The procedure is divided into two sub-models that are applied in succession – the household synthesis model and the auto ownership model.

Both the list of households and the journeys generated by each household are modeled in this module. The mixture of households (and individuals within the household) is defined by the following variables:

---

[1] TransCAD is a transportation planning software package developed by Caliper Corporation

Metro-North
Railroad

New York State
Department of Transportation

Thruway
Authority

- **Three Household Income Groups**
  Low.
  Medium.
  High.

- **Four Household Car-Sufficiency Groups**
  Without any cars.
  Fewer cars than workers.
  Cars equal to workers.
  More cars than workers.

- **Three Personal Categories**
  Worker.
  Non-working adult.
  Child.

The module then generates journeys by eight different purposes:

- Work trips made by Low income population.
- Work trips made by medium income population.
- Work trips made by High income population
- School (K-12).
- University.
- Household maintenance.
- Discretionary activity.
- Non-home-based at-work journeys.

The generation rates of each type of trip from each type of household are based on the 1997-98 household survey. The major data inputs to this module are the socioeconomic data by zone. The parameters used in the HAJ module are described in *NYMTC-Best Practice Model – Final Report* (NYMTC, January 30, 2005).

C3.2 Mode Destination Stops Choice (MDSC) Module

The destination and mode of journeys are modeled in the BPM's MDSC module. Its main function is to estimate a generalized cost (a combination of time and monetary cost) between all origins and all destinations for all modes in the model (low-occupancy auto, high-occupancy auto, walk-transit, drive-transit, walk-commuter rail, and drive-commuter rail). The model uses these generalized costs to determine the probability that a traveler will elect to travel to a particular destination and select a particular mode. This computation is repeated for each of the approximately 20 million trips made in the area.

The key variable in determining mode choice is the comparison of times and costs by various modes: by commuter rail, by transit (i.e., subway and bus only), and by highway. Travel time and cost estimates for each origin-destination pair, also known as skims, are developed as part of the "highway access procedures" and "transit access procedures" for a given mode.

The highway and transit networks are used to develop "skim matrices." The shortest path between all zone pairs is calculated for each mode using a composite "generalized cost" composed of several variables. The total for each of those individual variables are then calculated, or "skimmed," for that shortest path.

Highway skim measures (or "impedances") include:

- Length
- Congested Time
- Toll

Transit skims are calculated for each of the four mode groups used in transit assignment – commuter rail with walk access, commuter rail with drive access, transit with walk access, and transit with drive access. The transit skim measures are as follows:

- Fare.
- Initial wait time.
- Transfer wait time.
- Number of transfers.
- In-vehicle time (IVT) (broken out by the time spent on each mode used).
- Access out-of-vehicle time.
- Egress out-of-vehicle time.
- Transfer out-of-vehicle time (walking time, does not include the transfer wait time).
- Auto Time (for drive access).
- Auto Cost (for drive access).

The best path for any given mode is determined by the relative weights for different types of impedances (see Table C3-1).

The mode destination choice model is structured as a multi-level nested logit model with three levels of decisions: destination choice on the upper level, choice of mode (auto vs. transit) on the middle level, and submode choices (walk access vs. drive access to transit or commuter rail vs. bus/subway) on the lowest levels. The mode and destination choice models are linked so that a change in modal characteristics can influence the choice of destination.

A logit model computes that probability of selecting one particular option, *i*, out of the all possible options, jϵ*I*, as being equal to the ratio of the exponentiated *utility* of *i* to the sum of the exponentiated utilities for all options:

$$P_i = \exp(v(x_i))/\sum_{j\epsilon I} \exp(v(x_j))$$ Equation 1

Where:

P_i = the probability of choosing mode *i*
$v(x_i)$ = the utility of mode *i*
$\exp(v(x_i))$ = the exponential of $v(x_i)$

Table C3-1

Path-Building Weighting Factors

Category		Weights for Path-Building
IVT in Secondary Modes	Subway/Bus	0.9-1.2
	Comm. Rail	0.9-9.0
1st Wait 1st 7 minutes	Subway/Bus	1.25
	Comm. Rail	0.5
1st Wait After 7 minutes	Subway/Bus	1.25
	Comm. Rail	0.5
Transfer Wait*		1.5
Transfer OVT (i.e. Transfer walk)		1.1
Walk Access/Egress Time		1.5
Drive Access Time		2.5
VOT	Subway/Bus	$13.2
	Comm. Rail	$10.8

Note: *The penalty (impedance) in minutes for each transfer is 4.7 minutes (in addition to the waiting and walking time incurred).
Source: NYMTC. December, 2008.

Assuming that a mode choice is made between two modes, Drive Alone (DA), and Transit (T), the probability of selecting Drive Alone is:

$$P_{DA} = \exp(v(x_{DA}))/(\exp(v(x_{DA})) + \exp(v(x_T)))$$ Equation 2

This is mathematically equivalent to:

$$P_{DA} = 1/(1 - \exp(v(x_{DA}) - v(x_T)))$$ Equation 3

Figure C3-1 illustrates the relationship between the probability of selecting the Drive Alone mode and the difference in Utility between Drive Alone and the competing Transit mode. The probability of selecting Drive Alone is highest when the utility of Drive Alone is substantial higher than the Utility for transit. Conversely, the chance of using the drive alone mode is near zero when the Drive Alone utility is substantially worse than transit. When both utilities are about the same, then each mode splits the market equally.
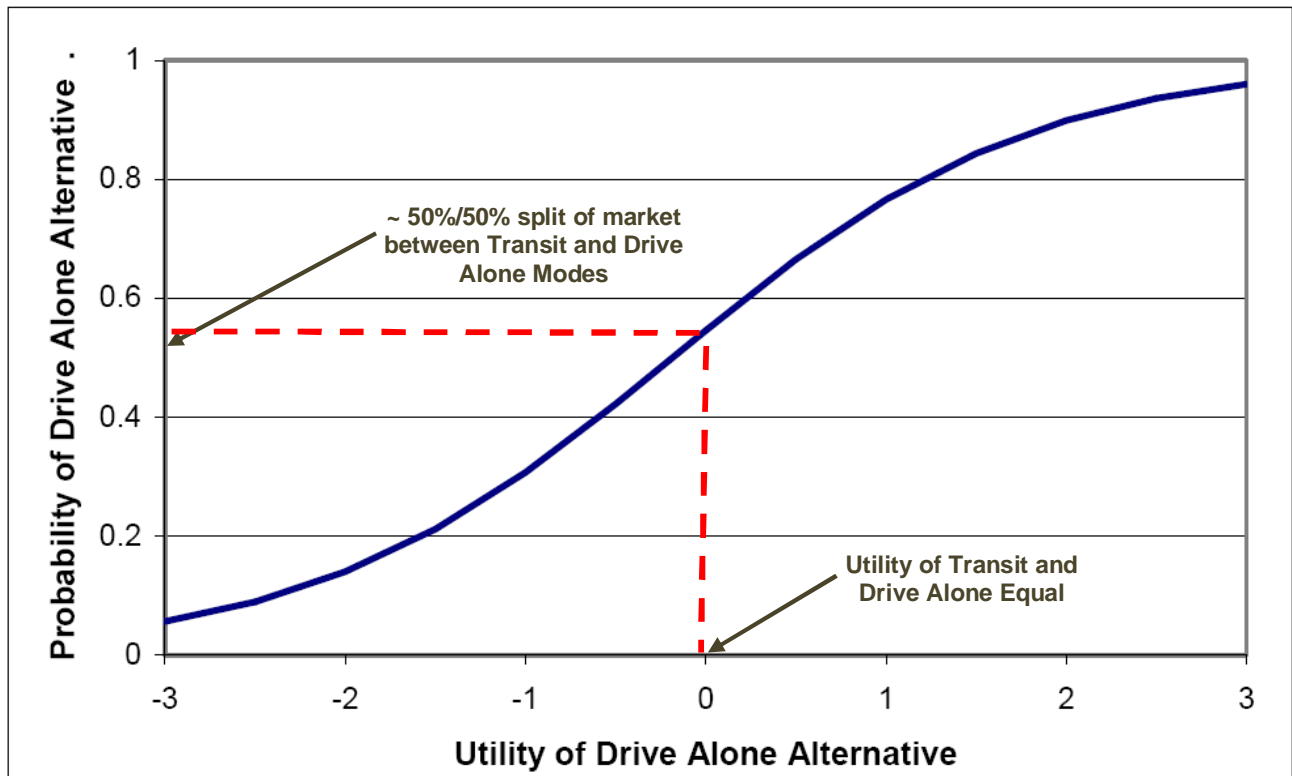
Figure C3-1: Multinomial Logit Curve: Relation of Drive-Alone Utility to Probability of Mode Choice

Source: Koppelman and Bhatt, June 2006.

Another important attribute of this function is that the slope of the curve is flat near the extremes meaning that changes to the utility function result in relatively little change to the computed shares. The slope is highest at the point where the Drive Alone utility equals the Transit utility. This is also the point where the probability of selecting the drive alone mode equals 50 percent.

The utility function, $v(x_i)$, an expression that describes the usefulness of each choice in satisfying the travel needs. Typically the utility includes the characteristics of each mode, origin, and destination, and traveler that describes the attractiveness of each option for an individual. In the BPM, the utility is constructed as a linear expression of the different explanatory variables:

$v(x_i) = \beta_0 + \beta_1 X_1 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n$ 　　　　　　　Equation 4

Where:
$\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are statistically estimated coefficients that express the importance of each variable

$X_1, X_2, \ldots, X_n$ are explanatory variables such as cost, in-vehicle travel time, and walk access time

The relationships among the various coefficients establish the relative importance of the different variables that determine mode and destination choice. In the BPM, the relationship between in-vehicle

time and cost coefficients help to illustrate the value of time. As shown in Table C3-2, the BPM values an hour of in-vehicle travel time savings as being worth $6.50 to $40.00 of additional cost, depending on the journey purpose.

Table C3-2

Mode Choice Value of In-Vehicle Time in Dollars

Journey Purpose	Work	School	University	Maintenance	Discretionary	At-Work Journeys
Value of Time	$ 15.81	$ 6.50	$ 11.72	$ 12.38	$ 10.74	$ 40.01

Source: NYMTC. January 30, 2005.

In addition, the relative values of in-vehicle and out-of-vehicle time coefficients imply that time spent waiting or walking is weighed more heavily than in-vehicle time. (Drive access to transit is considered to be out-of-vehicle time). This extra weight varies by journey purpose. Table C3-3 provides the values for work trips and Table 3-4 for all other journey purposes. For all of the non-work trips, the various types of out-of-vehicle time are treated identically and are valued as two to three times more burdensome than in-vehicle time. For journey-to-work trips distinctions are made between various categories of wait time as well as walking time. Wait time is calculated as half of the scheduled headway.

Table C3-3

Mode Choice Relative Weights of Out-of-Vehicle Time vs. In-Vehicle Time (IVT) for Work Trips

Type of Out-of-Vehicle Time	Weight vs. IVT
First Wait <=7 minutes (Comm. Rail)	2.60
First Wait <=7 minutes (Subway & Bus)	7.66
First Wait >7 minutes (Comm. Rail)	1.42
First Wait >7 minutes (Subway & Bus)	4.89
Transfer Wait	2.57
Walk Time	3.36
Drive Access IVT	2.00

Source: NYMTC. January 30, 2005.

Table C3-4

Mode Choice Relative Weights of Out-of-Vehicle Time vs. In-Vehicle Time for All Other Trips

Journey purpose	School	University	Maintenance	Discretionary	At-Work Journeys
Out-of-Vehicle Time	3.00	3.00	2.00	2.50	3.00
Drive Access IVT	1.50	1.50	1.50	1.50	N/A

Source: NYMTC. January 30, 2005.

The first 7 minutes of waiting time are the most burdensome (7.66 times greater than in-vehicle time for subway and bus), while the wait time after 7 minutes is somewhat discounted. This is because services with headways greater than 14 minutes tend to have known schedules, and travelers can plan their trip accordingly. Similarly, because commuter rail schedules are better known than subway and bus schedules, and because their on-time performance is perceived as more reliable, the wait time for commuter rail is less onerous than for subway and bus. The wait time at transfers is weighed the same for all modes. As described previously, the model cannot account for timed transfers, and thus must again define transfer wait as half of the headway (e.g., if a train leaves every 20 minutes, then the assumed waiting time for a person transferring to that train would be approximately 10 minutes).

The mode choice equations include an additional distance-based term that favors commuter rail. All else being equal, this term causes each additional 10 miles of the journey distance to approximately double the relative share of commuter rail in the modal split. This implies that commuter rail offers additional convenience and gains advantage for long-distance trip makers. The distance term had significant consequences for the calibration effort in the Tappan Zee Bridge/I-287 Corridor. For a complete description of the structures of the mode choice equations and a full list of all constants and coefficients, see Chapter 5 of *NYMTC's NYBPM General Final Report* (January 30, 2005).

Note that the weights that the model uses in calculating the optimal auto and transit travel path between origin-destination points, as described in Table C3-1 above, are not entirely consistent with the coefficients used for the eventual transit mode choice. For example, the factor on initial wait time for subway/bus trips is 1.25 in the path selection ("building") procedures, but 7.65 in the mode choice equations for work trips. Table C3-5 describes some differences in travel time weighting factors used in the MDSC verses the path-building component.

Table C3-5

Comparison of Travel Time Weighting Factors – Path Building vs. Mode Destination Stop Choice

Category		Weights for Path-Building	MDSC Coefficient		
			Work	Maintenance	Discretionary
IVT in Secondary Modes	Subway/Bus	0.9-1.2	1	1	1
	Comm. Rail	0.9-9.0	1	1	1
1st Wait 1st 7 minutes	Subway/Bus	1.25	7.65	2.0	2.5
	Comm. Rail	0.5	2.60	2.0	2.5
1st Wait After 7 minutes	Subway/Bus	1.25	4.89	2.0	2.5
	Comm. Rail	0.5	1.42	2.0	2.5
Transfer Wait		1.5	2.57	2.0	2.5
Transfer OVT (i.e. Transfer walk)		1.1	3.35	2.0	2.5
Walk Access/Egress Time		1.5	3.35	2.0	2.5
Drive Access Time		2.5	2	1.5	1.5
VOT	Subway/Bus	$13.2	$15.81	$12.38	$10.74
	Comm. Rail	$10.8	$15.81	$12.38	$10.74
Source: NYMTC. January 30, 2005.					

After the mode destination stop choice model is run, a **"Pre-Assignment Processor"** (PAP) creates a set of trip tables by several modes for four time periods: am peak (6AM-10AM), midday (10AM-4PM), PM peak (4PM-8PM), and night (8PM-6AM). Besides the outputs of the MDSC, additional inputs are used from modules that forecast commercial vehicles and external auto trips (i.e., auto trips with either origins or destinations from beyond the model area).

A separate trip table is prepared for each mode. The six highway modes include:

- Drive Alone.
- Shared Ride-2 (a driver plus one passenger).
- Shared Ride-3+ (a driver plus two or more passengers).
- Taxi
- Truck.
- Other Commercial Vehicles.

Bus and subway are considered as one mode, while any trip using commuter rail is in a separate commuter rail mode (if a trip includes both bus or subway and commuter rail, it is considered to be commuter rail). For both of these modes, there is a sub-division between those who drive to the first transit mode, and those who walk. Thus, the transit trip tables are divided into four modes:

- Commuter Rail (with transit feeder lines) with walk access.
- Commuter Rail with drive access.
- Other Transit (including bus, subway and ferry) with walk access.
- Other Transit with drive access.

C3.3 Highway and Transit Assignment Modules

Once the trip tables are in place, highway and transit assignments in BPM basically follow traditional multi-path models. The assignment process is capacity restrained – trips are first assigned to the minimum time path, volumes are compared to capacities, speeds are adjusted, then traffic is reassigned in an iterative process. Note that in both the highway and transit assignment modules, travelers will be divided among multiple paths between any two zones. Highway assignments are generated for all four periods with 100 iterations, but transit assignments are only run for the am period. Weekend travel forecasts are not available for either transit or highway assignments.

C4 Model Calibration and Validation

Transportation planning models are, by their nature, approximations of the actual travel behavior in the region. They are a means of estimating existing travel that can then be used to forecast future travel. Their success in estimating existing travel is determined by a process known as calibration. The components of the model are all adjusted until the estimated travel matches the actual travel well enough to be used as a forecasting tool. Even in the best of circumstances, it does not match perfectly – there are too many variables and too many complexities to achieve that kind of perfection. There is also the likelihood that adjusting too much will lessen the model's responsiveness to change, hampering its ability to be applied for future scenarios. Therefore, model calibration remains an art as much as a science – knowing just how much to adjust and when to stop the process.

The BPM was developed by NYMTC during the period from 1996 and 2002. It was initially calibrated to the 1997 and 1998 Home Interview Survey conducted by NYMTC, which was factored back to a baseline year of 1996. This initial calibration effort is documented by NYMTC in its *General Final Report: New York Best Practice Model* (January 30, 2005). The major concerns in the NYMTC calibration process were the magnitude and modal distribution of travel to Manhattan, and the magnitude of travel crossing the Hudson River screenline.

As a result, the complexities of the Tappan Zee Bridge Corridor were not fully accounted for in this version of BPM. Therefore, in Stage 2 of the Tappan Zee Study, a 2005 recalibration exercise was performed specifically for markets that were thought to be affected by proposed alternatives across the Tappan Zee Bridge. This effort was documented in the *Technical Report, BPM Methodology, Tappan Zee Bridge/I-287 Corridor Draft Environmental Impact Statement, July 2008.*

A similar undertaking was performed for the DEIS stage of the project in Fall of 2009. This recalibration was necessary because NYMTC upgraded the BPM from a version that ran on a combination of TransCAD 4.5 and 4.8, to a version that ran on TransCAD 4.8. The upgrade required NYMTC to calibrate and the project team to recalibrate for the project, for the same reason mentioned earlier. This report is a description of the methodology adopted for the recalibration and the results of the recalibration effort.

In 2008, an updated version of BPM was released by NYMTC with major revisions. The updates were documented in *Final Report, 2005 Update and Re-Calibration of the NYMTC New York Best Practice Model (NYBPM), June 29, 2005.*

C4.1 NYMTC Calibration

The updated BPM was run (based on the BPM update received in October 2008, and referred to as NYMTC Calibration or NYMTC in the text and figures) and results were compared with the US Census journey-to-work data (referred to as Target). The US Census journey-to-work data includes information on the distribution and mode of work trips from each county in the region to all other counties.

The initial run of the MDSC module of BPM yielded highly inaccurate distribution results for work trips in most of the key markets. As shown in Table C4-1, notable among these were:

- Trips from Rockland County to Manhattan were underestimated by approximately 50 percent.

- Trips from Rockland to Bergen Passaic were overestimated by 85 percent
- Orange to Hudson and Essex counties were overestimated by 65 percent.

- Trips from Rockland to Westchester were overestimated by approximately 100 percent. Rockland to Connecticut trips were underestimated by 70 percent.

- Westchester/Connecticut trips to Rockland were overestimated by 156 percent.
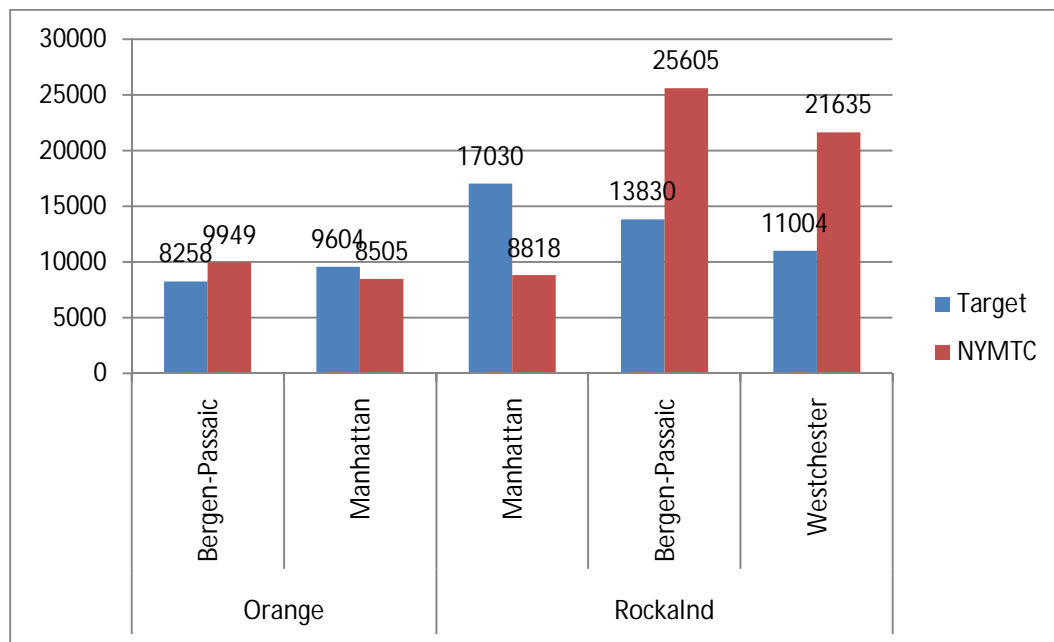
Figure C4-1 Comparison of JTW vs NYMTC calibration trips in select markets

The same journey-to-work data was used to test the performance of NYMTC Calibration in terms of mode choice for study markets. The main problems here were commuter rail shares from Orange and Rockland Counties to Manhattan were highly overestimated (Table C4-1). The overestimation of commuter rail market share over express bus also led to BPM transit assignments that greatly exceeded known ridership on the existing West of Hudson lines (Table C4-1).

Metro-North
Railroad

New York State
Department of Transportation

Thruway
Authority

Table C4-1

Trip Distribution: NYMTC Calibration Work Journeys vs Census Journey-to-Work Data

(Daily Journeys)

Origin	Destination	Target	NYMTC Calibration	Percent Change
Orange	Manhattan	9604	8505	-11%
	Bronx	2413	1898	-21%
	Rest of NYC	2174	4170	92%
	Bergen-Passaic	8258	9949	20%
	Hudson-Essex	1127	1856	65%
	Other NJ	1971	4569	132%
	Westchester	5569	4355	-22%
	Dutchess-Putnam	5652	2789	-51%
Rockland	Manhattan	17030	8818	-48%
	Bronx	6254	4172	-33%
	Rest of NYC	3402	3433	1%
	Bergen-Passaic	13830	25605	85%
	Hudson-Essex	1861	2281	23%
	Other NJ	1706	939	-45%
	Westchester	1159	349	-70%
	Dutchess-Putnam	425	17	-96%
Westchester/ Connecticut	Rockland	4044	10371	156%
	Orange	1579	529	-66%
	Bergen-Passaic	4538	7889	74%
Conecticut	Westchester	19174	39297	105%
Bergen-Passaic	Westchester	4156	964	-77%
	Connecticut	1401	9052	546%

Table C4-2

Mode Shares for Key Markets: NYMTC Calibration vs. Census Journey-to-Work

(Daily Journeys)

		NYMTC Calibration			Census JTW		
Origin	Destination	Auto %	Bus	CRT	Auto %	BRT	CRT
Rockland	Manhattan	37%	28%	36%	66%	22%	12%
Orange	Manhattan	27%	1%	72%	56%	20%	24%

Table C4-3

Ridership on West of Hudson Rail

	2005 Metro-North Ridership Counts, AM Peak				Assignment Results 2005 AM Peak As NYMTC Calibration	
Station	SB		NB (Est)		SB+NB Combined	
	On	Off	On	Off	On	Off
Port Jervis Line						
Port Jervis	71	-	-	3	174	25
Otisville	34	1	-	-	129	5
Middletown/Town of Wallkill	418	1		7	1,032	-
Campbell Hall	137	-		1	121	3
Salisbury Mills/Cornwall	440	-			1,053	-
Harriman	731	-		3	842	19
Tuxedo	96	-	3	3	81	-
Sloatsburg	61	1	-	-	73	187
Suffern	425	16	no data	no data	704	444
Total Port Jervis Line	**2,413**	**19**	**3**	**17**	**3,505**	**239**

C4.2 Tappan Zee Project Recalibration

The significant differences between the NYMTC results and the targets led the team to further explore issues with the NYMTC calibration results, and methods to resolve them. Further analysis revealed that the NYMTC calibration was performed at a coarse level in the context of the Tappan Zee Bridge project. As indicated in Table C4-4, the focus was Manhattan and to a lower extent the rest of New York City. Rockland, Orange and Westchester counties, for example, were clumped into one category - "Within Upper NY/CT."

Given the changes to the NYMTC model, the availability of new data, and the poor calibration results in markets relevant to this study, the BPM was recalibrated for the Tappan Zee DEIS with 2005 as the base year. Major components of the recalibration effort included adjusting factors affecting trip distribution and mode choice, which in turn affected highway and transit assignments. The calibration targets included journey-to-work data from the census, as well as known ridership counts on transit lines, the 2003 Hudson crossing origin-destination survey conducted as a part of this project, Tappan Zee Bridge crossing volumes, and total vehicles crossing major screenlines. A significant effort was spent on reducing biases within the model – specifically a distance-based term that favors commuter rail and mode-specific constants.

After the model was recalibrated for use in the Tappan Zee Bridge/I-287 Corridor, further validation checks were made of the model's ability to replicate current transit and commuter rail ridership levels in the corridor, and to replicate highway volumes on Hudson River crossings. In general, the re-calibrated BPM performed satisfactorily and was considered sufficient for use in evaluating the relative performance of future alternatives/options.

The first step in the recalibration of the BPM was to redefine markets that needed calibration to better represent travel trends affecting the Tappan Zee corridor. The project team defined several markets, listed in Table C4-5, that were recalibrated.

Table C4-4

NYMTC Calibrated Markets

In Manhattan
From Manhattan
Queens_Bronx_Brooklyn to Manhattan
Long Island to Manhattan
New Jersey/Staten Island to Manhattan
Upper NY/CT to Manhattan
Within Queens_Bronx_Brooklyn
Within New Jersey/Staten Island
Within Long Island
Within Upper NY/CT
All Others

Table C4-5

Markets Calibrated for the Tappan Zee Project

1	Orange To Manhattan
2	Rockland To Manhattan
3	Orange to Bronx
4	Rockland to Bronx
5	Orange to Other NYC
6	Rockland to Other NYC
7	Orange to Bergen Passaic
8	Rockland to Bergen Passaic
9	Orange to Hudson Essex
10	Rockland to Hudson Essex
11	Orange to Other New Jersey
12	Rockland to Other New Jersey
13	Orange to Dutchess & Putnam
14	Rockland to Dutches s& Putnam
15	Orange to Westchester
16	Rockland to Westchester
17	Orange to Connecticut
18	Rockland to Connecticut
19	Bergen Passaic to Orange
20	Bergen Passaic to Rockland
21	Westchester/CT to Rockland
22	Westchester/CT to Orange
23	Westchester/CT to Bergen Passaic
24	Connecticut to Westchester
25	Bergen Passaic to Manhattan
26	Bergen Passaic To Westchester
27	Bergen Passaic To Connecticut

C4.2.1 Calibration to US Census Journey-to-Work Data

The US Census journey-to-work data provides information on the place-of-work and journey-to work characteristics of workers 16 years and over who were employed and at work during the reference week. Data are available at a state, county, tract, and traffic analysis zone level (in certain cases). Journey-to-work data includes information on the distribution and mode of work trips from each county in the region to all other counties.

Trip distribution and mode shares in the BPM were calibrated to journey-to-work numbers at a county level. The calibration effort focused on adjusting the BPM to better match known county-to-county

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distribution patterns and mode choice behavior in the major markets served by the corridor. Those targets were largely developed from the 2000 Census Journey-to-Work data. The calibration was then validated against assignment targets. On the transit side, the main targets were total boardings on the New York portions of the Port Jervis and Pascack Valley Lines, and the Westchester portion of the Hudson Line. On the highway side, total vehicular crossings of the Hudson River were the major target.

To achieve a better match to existing data, a number of strategies were used:

- Realistic network adjustments to make destinations more or less attractive were made.

- K-factors to discourage or encourage trips between districts were used.

- The MDSC module was refined to meet mode choice targets within corridor and from corridor counties to Manhattan and the Bronx.

As described below, these strategies succeeded in bringing the distribution outputs of BPM to within 10 percent of most key movements in the corridor. In markets where a major component of trips already uses transit, the recalibrated BPM was able to match target mode shares adequately.

Given the nature of the BPM modeling process and the ways in which the software has been coded, there are limited options to correct problems. The modal coefficients in the MDSC logit equations are "hard-wired". They can only be changed by the software developers. However, other variables in the modeling formulation are available for adjustment, and these were used to correct the anomalies found in this corridor.

To adjust trip distribution values, BPM uses county-to-county factors, similar to K-factors. (Note that Manhattan is sub-divided into four districts). For this calibration effort, these factors were interactively tested until reasonable values approximating journey-to-work distribution patterns were achieved. Some of the changes to these factors were substantial, particularly in the Orange County to Manhattan market.

Table C4-6 shows the resulting distribution patterns (i.e., county-to-county movements). Above seventy five percent of the markets are within 10 percent of the target journey-to-work data.

Table C4-6

Comparison of Distribution – JTW vs NYMTC Calibration vs Tappan Zee Bridge Recalibration in Select Markets

Origin	Destination	Census JTW	NYMTC Calibration	% Difference	Tappan Zee Bridge Recalibration	% Difference
Orange	Begen-Passaic	8,258	9,949	17%	9165	11%
	Bronx	2,413	1,898	-27%	2644	10%
	Connecticut	618	388	-59%	693	12%
	Dutchess-Putnam	5,652	2,789	-103%	6371	13%
	Hudson- Essex	1,127	1,856	39%	1268	13%
	Manhattan	9,604	8,505	-13%	10836	13%
	Other NJ	1,971	4,569	57%	2144	9%
	Other NYC	2,174	4,170	48%	2360	9%
	Westchester	5,569	4,355	-28%	5724	3%
Rockland	Begen-Passaic	13,830	25,605	46%	11708	-15%
	Bronx	6,254	4,172	-50%	6104	-2%
	CT	1,159	349	-232%	993	-14%
	Dutchess-Putnam	425	17	-2400%	364	-14%
	Hudson- Essex	1,861	2,281	18%	1774	-5%
	Man	17,030	8,818	-93%	17366	2%
	Other NJ	1,706	939	-82%	1674	-2%
	Other NYC	3,402	3,433	1%	2921	-14%
	Westchester*	14,601	21,635	49%	14250	-2%
Begen-Passaic	CT	1,401	9,052	85%	1521	9%
	Man	69,644	40,178	-73%	69593	0%
	Westchester	4,156	964	-331%	4346	5%
	Orange	704	140	-403%	749	6%
	Rockland	6,820	994	-586%	7423	9%
Westchester/CT	Begen-Passaic	4,538	7,889	42%	4883	8%
	Orange	1,579	529	-198%	1629	3%
	Rockland	4,044	10,371	61%	4559	13%
CT	Westchester	19,174	39,297	51%	19558	2%

* Based on a 2003 I-287/Tappan Zee Corridor Origin-Destination Survey.

One of the risks of using large factors to match specific conditions is that they can distort distribution patterns when simulating different conditions. To test this, the distribution model was run again with the revised adjustment factors and with future demographic inputs. Growth trends were then checked for reasonableness.

Overall, regional growth in journeys was projected to be 20 percent. As expected, based on demographic trends, growth originating from Westchester County (12 percent) was lower than regional totals, journeys from Rockland County (22 percent) slightly exceeded regional totals, and journeys from Orange County

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(45 percent) greatly exceeded the region. Growth in Manhattan-bound journeys from Rockland and Orange Counties grew by 48 and 96 percent, respectively.

The Orange County figure in particular is quite large, but is a plausible result as Orange County is expected to become increasingly "Manhattanized" with higher shares of residents oriented towards Manhattan-based jobs. Somewhat problematic are decreases in the Rockland County to Connecticut and Westchester County to Connecticut markets over time. Given that these are not the largest transit markets in the corridor, such problematic results have all been pointed out to FTA officials and were not deemed significant enough to merit further work on this part of the calibration.

Manhattan-bound trips were further examined (Table C4-7) at a sub-county level on both the production side and the attraction side and illustrate the BPM's performance at that level. As expected, the disaggregated measures do not match census data as accurately as the county totals. However, there was a significant improvement in the overall distribution at this level, compared to the NYMTC calibration.

Table C4-7

Comparison of Distribution at a Manhattan Sub-county Level

| Origin	Destination	JTW	NYMTC Calibration	Tappan Zee Bridge Calibration	% Difference Compared to JTW NYMTC BPM	% Difference Compared to JTW Tappan Zee Bridge Calibration
Rockland	Lower Man	2,125	679	1468	-68%	-31%
	Midtown Man	6,129	4,390	6491	-28%	6%
	Upper Man	4,105	4,105	5030	0%	23%
	Valley Man	4,669	2,434	4377	-48%	-6%
	Manhattan	**17,028**	**11,608**	**17366**	**-32%**	2%
Orange	Lower Man	1,441	674	1415	-53%	-2%
	Midtown Man	3,277	2,714	4342	-17%	32%
	Upper Man	1,731	2,151	1400	24%	-19%
	Valley Man	3,161	1,747	3679	-45%	16%
	Manhattan	**9,610**	**7,286**	**10836**	**-24%**	13%

C4.2.2 Mode Choice Recalibration

Table C4-8 illustrates the difference between NYMTC and target journey-to-work mode shares for the additional markets that were defined. The Orange to Manhattan market, for example, was represented in the NYMTC model by one set of constants, which represented "Upper NY/CT to Manhattan". The commuter rail mode share for the Orange to Manhattan market was estimated to be 72 percent, when in reality it is closer to 24 percent. The estimated commuter rail mode share east of the Hudson is over 60 percent and is the predominant commuter rail market. It is likely that the NYMTC calibration was biased by the dominance of the east of the Hudson market which could account for the high commuter rail estimates for the other markets as well.

Similarly, the Rockland to Manhattan (also represented by the same set of constants as the Orange to Manhattan market) commuter rail market was estimated at 35 percent when in reality it is closer to 12 percent. The distance factor, which favors commuter rail for longer journeys over buses or autos, combined with the fact that Orange County has better commuter rail coverage compared to Rockland County, are likely reasons for higher rail share from Orange to Manhattan compared to Rockland to Manhattan.

Table C4-8

Comparison of Mode Shares – Target vs NYMTC

	Target Mode Shares (Census Data)			NYMTC 4.8 Mode Shares		
	Auto Share	**CRT Share**	**Other Transit Share**	**Auto Share**	**CRT Share**	**Other Transit Share**
Orange to						
Manhattan	55.3%	24.1%	20.0%	26.5%	72.0%	1.4%
Rockland to						
Manhattan	65.9%	12.1%	21.6%	36.6%	35.6%	27.8%
Orange –Rockland to						
Other NYC	91.5%	3.0%	4.9%	95.1%	4.1%	0.7%
Bergen- Passaic	97.8%	0.3%	1.0%	97.5%	0.9%	1.6%
Hudson-Essex	88.1%	8.8%	2.4%	96.7%	2.8%	0.5%
Other NJ	99.3%	0.0%	0.3%	99.8%	0.2%	0.0%
Westchester	97.9%	0.2%	1.3%	98.4%	0.3%	1.3%
Connecticut	98.9%	0.6%	0.6%	98.9%	0.7%	0.4%
Dutchess Putnam	99.4%	0.0%	0.0%	99.3%	0.7%	0.0%
Bergen- Passaic to						
Orange- Rockland	99.0%	0.0%	0.7%	98.9%	0.2%	0.9%
Westchester to						
Orange - Rockland	96.3%	0.6%	1.1%	99.2%	0.3%	0.5%
Bergen- Passaic to						
To Manhattan	44.8%	12.2%	42.6%	20.6%	13.7%	65.7%
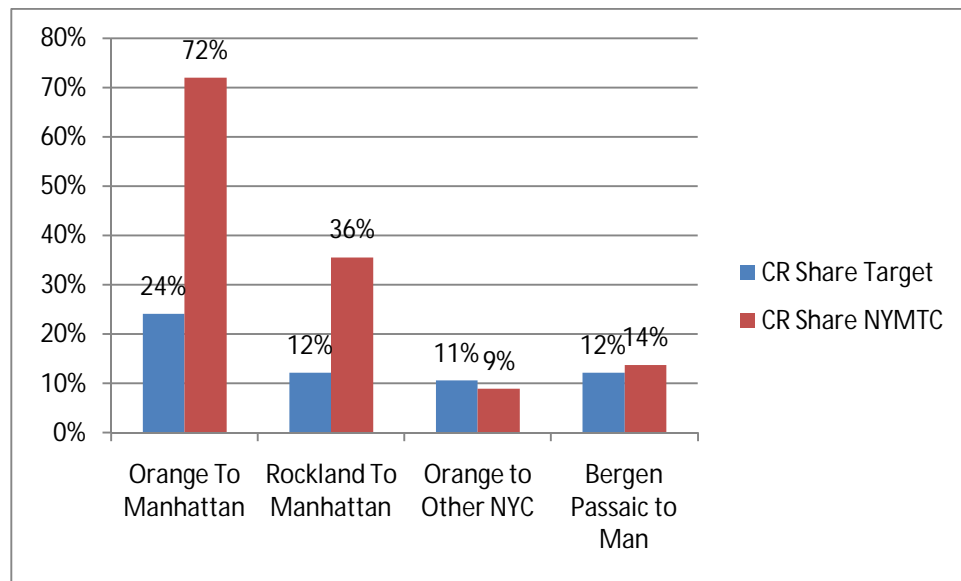
Figure C4-2 Comparison of NYMTC Calibration and JTW Mode Shares

Two major issues emerged in how BPM handled mode choice and transit assignments:

- Orange County bus ridership to Manhattan was greatly underestimated compared to commuter rail ridership. This was true to a lesser extent with Rockland to Manhattan trips.

- Low current transit shares within suburban corridors are difficult targets to calibrate against.

The justification for this is that the importance of the relative comfort of commuter rail over bus grows as the trip distance grows. However, Orange and Rockland Counties are served by relatively comfortable commuter buses (as opposed to less comfortable local buses). Since the model was estimated for the entire region with local and express bus journeys combined into a single "transit" mode (which also includes subway and ferry), commuter rail in the study area may not truly enjoy such a large distance-based advantage over bus.

Similarly, commuter rail is given a significant bias when comparing relative wait times. Wait time in BPM is broken into two segments - the first 7 minutes of waiting, versus wait time in excess of 7 minutes. The penalty on the first 7 minutes is nearly three times greater for bus trips, and the penalty on wait time after that is 3½ times greater for bus.

The reasoning for this bias is that commuter rail works on known schedules whereas the schedules for other transit service are generally not known, or are considered less reliable by the riding public. Again, this reasoning does not apply to the sort of commuter bus routes serving the corridor. Mode choice coefficients from the NYMTC calibration for work journeys are shown in Table C4-9.

Table C4-9

BPM Mode Choice Coefficients Favoring or Disfavoring CRT (In Work Journeys)

BPM Mode Choice Coefficients	Drive to CR	Drive to Bus	Difference*
IVT	-0.025	-0.025	0.000
Initial Wait Time, First 7 Minutes	-0.064	-0.190	-0.125
Initial Wait Time, Beyond 7 Minutes	-0.035	-0.121	-0.086
Distance	0.082	0.000	-0.082
Autos=Workers/Low Income	-6.188	-5.628	0.560
Autos=Workers/Med Income	-4.865	-4.305	0.560
Autos=Workers/High Income	-5.246	-4.758	0.488
Autos<Workers/Med Income	-2.572	-2.243	0.329
Autos<Workers/High Income	-3.368	-1.391	1.977
Autos>Workers/Med Income	-6.384	-4.786	1.599
Autos>Workers/High Income	-6.056	-4.605	1.452

Note: * Positive values favor subway/bus, negative values favor CRT.
Source: NYMTC. January 30, 2005.

C4.2.3 Tappan Zee Bridge Mode Choice Recalibration Methodology

The objective of the mode choice calibration was to match the Census journey-to-work mode share data within acceptable standards, without irrational changes in the mode-specific constants. Mode-specific constants are factors within the model that the user has access to, that can be manipulated to produce desired mode share results. The risk is in adjusting these factors to such an extent that they diminish the inherent sensitivity of the model.

Commuter Rail (CR) and Transit constants were adjusted by adding the log of the target mode share (derived from journey-to-work data) by the estimated mode share, to the existing constants. The highway constants were unchanged. For example, the adjustment factors for commuter rail were calculated using the following formula:

$$\text{Rail adj} = Ln(T_{\text{share rail}} / E_{\text{share rail}}) - Ln (T_{\text{share highway}} / E_{\text{share highwy}})$$

Where, T_{share} and E_{share} represent target and estimated shares.

The Tappan Zee project mode choice recalibration was done in three stages described below. The steps can be broadly described as:

    a)   Initial adjustment of mode specific constants
    b)   Adjustment of mode specific constants with compensation for the distance factor
    c)   Adjustment of mode specific constants with improved skims- resolved initial wait time issue.

 a)   Initial adjustment of mode specific constants

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The initial adjustment of work mode-specific constants included several iterations to match target mode shares. The mode shares attained were reasonably close to the targets, although it was observed that the modal bias was sizeable. Modal bias could be described as an inherent preference of one mode over the other within the model and is expressed as the difference in model constants of two modes.

b) Adjustment of mode specific constants with compensation for the distance factor

One of the concerns often raised during the adjustment of mode share constants is the difference in magnitude of mode constants. This could indicate a bias of one mode over another.

The distance coefficient in the BPM is a positive 0.0822 and is applicable solely to the commuter rail mode. This implies that commuter rail is preferred to all other modes (including buses) as the distance of a trip increases. To put it into perspective, the coefficient for IVT is -0.0248. This implies a reduction in the utility of a mode by 0.0248 for every minute increased. By contrast, the utility of commuter rail increases for every additional mile traveled by a value of 0.0822, which is about three times the magnitude of the IVT penalty. Long distance express buses, such as those originating in Orange County headed to Manhattan, are in many ways similar to commuter rail – comfortable, reliable and relatively fast. Despite the fact that these buses are perceived to be similar to commuter rail in the region, the distance factor does not apply to them.

The distance between Orange and Manhattan could range between 40 and 85 miles. In trying to match mode shares to observed values, we are in essence compensating for the fact that this bias exists toward commuter rail but not long distance express buses. This phenomenon could account for the fact that the model underestimates long-distance bus travel by as much as it does.

With reference to the modal constants, the largest differences between the 'other transit' (bus in this case) and commuter rail constants appear to be for the markets to/from Orange County. The difference is possibly larger for the low income category because the commuter rail fares in the model are typically higher compared to express buses, especially for long distance trips. For the Rockland to Manhattan market, the difference in magnitude of transit and commuter rail constants is much less compared to those for trips originating in Orange and this is attributable to the average distance from Rockland being much less compared to the average trip distance originating in Orange.

The pattern for the Rockland to Manhattan market changes across purposes. Low income travelers are less likely to drive and more likely to take buses than commuter rail for cost reasons, and that could be a possible reason for these travelers wanting to take buses. As the income level increases, the likelihood of driving increases (more negative transit and CR constants) which translates to relatively lower transit (bus) usage, but higher commuter rail (less negative constants) usage compared to the lower income category .

Several options have been considered as a workaround to the distance factor bias including: 1) re-estimating coefficients such that a similar factor is applied to long distance buses; 2) recoding the long distance buses as commuter rail; and 3) changes to the shortest path times to compensate for the bias.

The first option requires re-estimating coefficients, which will involve approaching the developer. This approach could be considered a more long term approach. Recoding long-distance buses as commuter rail could have its inherent problems, especially when parts of the corridor have competing BRT and CRT modes.

Option 3 involves adjusting the in-vehicle time (IVT) for specific markets that have long-distance bus (express buses) paths to compensate for the distance factor bias. The rationale behind this approach is that in-vehicle time, which is a component of the transit skim (shortest path) matrix, is correlated to travel distance and is accessible to the user, unlike model coefficients.

When trying to compensate for the distance factor, which has a positive value with in-vehicle time which has a negative coefficient, the in-vehicle times come out to be negative in many cases. A test run was carried out with negative in-vehicle times which resulted in the mode being negatively impacted from a ridership perspective.

Utility= B_0-0.0248*(IVT) +0.0822*(Distance) + Y

Where Y is the remaining part of the utility equation

Another run was conducted replacing all the negative numbers by "1", which is still a sizeable drop in travel time compared to the original travel times without compensating for the distance factor. The bus shares in the markets that were adjusted increased dramatically. In effect, replacing the in-vehicle times with "1" implied the application of a distance factor to long-distance buses, albeit a smaller magnitude (about 0.05 instead of 0.0822). This test illustrated that the process works, although the principle applied could be questionable.

The method of replacing IVT with "1"assumes an arbitrarily lower distance factor for long-distance buses (it can be argued that although these buses have similar characteristics compared to commuter rail, they are not necessarily as attractive a choice, justifying the lower factor. The magnitude of the difference in factor is not easy to estimate). It also favors origins that are closer to the destinations.

Another method that was tested essentially relied on a similar principle of altering the IVT to compensate for the distance factor. Due to the resulting negative IVTs and the problems associated with using negative IVTs, selected IVTs were increased by a constant number after which the express bus skims for selected markets were adjusted to compensate for the distance factor.

Bearing in mind that such changes could affect the distribution of trips due to the variable trip table methodology that the BPM works on, the constant number added was between Rockland and Orange and all other destinations. This was done for commuter rail as well as other transit modes for non-zero origin destination pairs. In the case of "Other Transit", which includes rail (excluding commuter rail), buses, express buses and ferries, the constant is added to the drive-to and walk-to "Other transit " if the sum of all the IVTs for the "Other transit" modes is not zero.

The adopted methodology did involve adjustment of the in-vehicle time and is described below. It involved shifting out-of-vehicle time (cost, initial wait time, transfer wait time, auto time) to long-distance express bus IVT.

Equation (1) is the original utility function for express bus between any *ij* origin-destination pair. Equation (2) is an altered version of equation (1) and can be used for markets that have long-distance express buses.

$$U_{xbus,ij} = \beta_{time} \times IVT_{xbus,ij} + U(\cos t, wait,...) \tag{1}$$

$$U_{xbus,ij} = \beta_{time} \times IVT_{xbus,ij} + \beta_{dist} \times Dis\tan ce_{ij} + U(\cos t, wait,...) \tag{2}$$

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Equation (2) can be rewritten as:

$$U_{xbus,ij} = \beta_{time} \times (IVT_{xbus,ij} + \frac{\beta_{dist}}{\beta_{time}} \times Dis\tan ce_{ij}) + U(\cos t, wait,...)$$

$$= \beta_{time} \times pseudoIVT_{xbus,ij} + U(\cos t, wait,...)$$

(3)

As indicated in equation (3) the distance factor could be compensated by changing the actual express bus in-vehicle time to pseudo express bus in-vehicle time ($pseudoIVT_{xbus,ij}$) for any origin-destination pair in the skim matrix (a matrix that contains information such as in-vehicle time, out-of-vehicle time, etc, for each origin-destination pair) created. The pseudo express bus in-vehicle time equals.

$$IVT_{xbus,ij} - \frac{\beta_{dist}}{\beta_{time}} \times Dis\tan ce_{ij} .$$

C4.2.4 Markets Compensated

The market selected for express bus compensation includes: Orange to and from Manhattan, Rockland to and from Manhattan, New Jersey (except for Warren, Hudson) to and from Manhattan, Orange to and from Westchester, Orange to and from Rockland, Orange to and from Putnam, Orange to and from Dutchess, Orange to and from Fairfield, Orange to and from Bergen, Orange to and from Hudson, and Orange to and from Sussex. The chosen market is also shown in the following figure represented by the counties connected by black lines. Figure C4-3 illustrates the markets where long-distance express buses were compensated.

c)   Adjustment of mode specific constants with improved skims- resolved initial wait time issue.

One of the observed issues with the model was that the initial-wait time element of a transit trip was not reflected in the skim matrix. As a consequence, changes in levels of service, headways for example, in service plans were not reflected in skim matrices and eventually in ridership results.

This issue was resolved and it was observed that the overall bias within the model decreased considerably as a result.

Figure C4-3 Compensated Markets

Figures C4-4 to C4-7 are comparisons of the modal bias, in specific markets, for work purposes (low, medium and high income). The bias was compared between the original NYMTC calibration, the initial adjustment, calibration with compensation, and calibration with compensation and improved transit skims (initial wait times). The changes made in the readjustment process met the objective of matching the mode shares well. A consequence of the compensation was improvement of modal bias. Bias, in this case, is measured by taking the difference of the average of drive and walk access to transit (buses), and commuter rail.

Mode Constant Difference: (DT+WT)/2-(DC+WC)/2

Where DT and WT represent drive and walk access to Transit. Here Transit refers to all transit modes excluding commuter rail. DC and WC represent drive and walk access to commuter rail.

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It can be observed (Figures 4-4 to 4-6) that the low and medium income categories have amongst the most significant differences between transit and commuter rail constant magnitudes, and therefore biases. The final Tappan Zee Bridge project recalibration considerably reduced this bias and matched mode shares.

Legend for Figures 4-4 to -6:

1. *Re Cal. with correct ini. time* – Refers to the Tappan Zee Bridge recalibration, with compensation and resolution of an issue where initial wait times were not being reflected in the skims matrices. This was the final recalibration iteration.
2. Cal with Compensation –Represents the Tappan Zee Bridge recalibration effort with compensation but the initial wait time issue had not been resolved
3. Cal without compensation – refers to the original Tappan Zee Bridge recalibration effort before the focus on reduction in modal bias
4. NYMTC Constants – refers to the 2005 NYMTC calibration

As a result of the calibration and reduction in bias, a comparison of the mode share with respect to the target was made in figure C4-7.
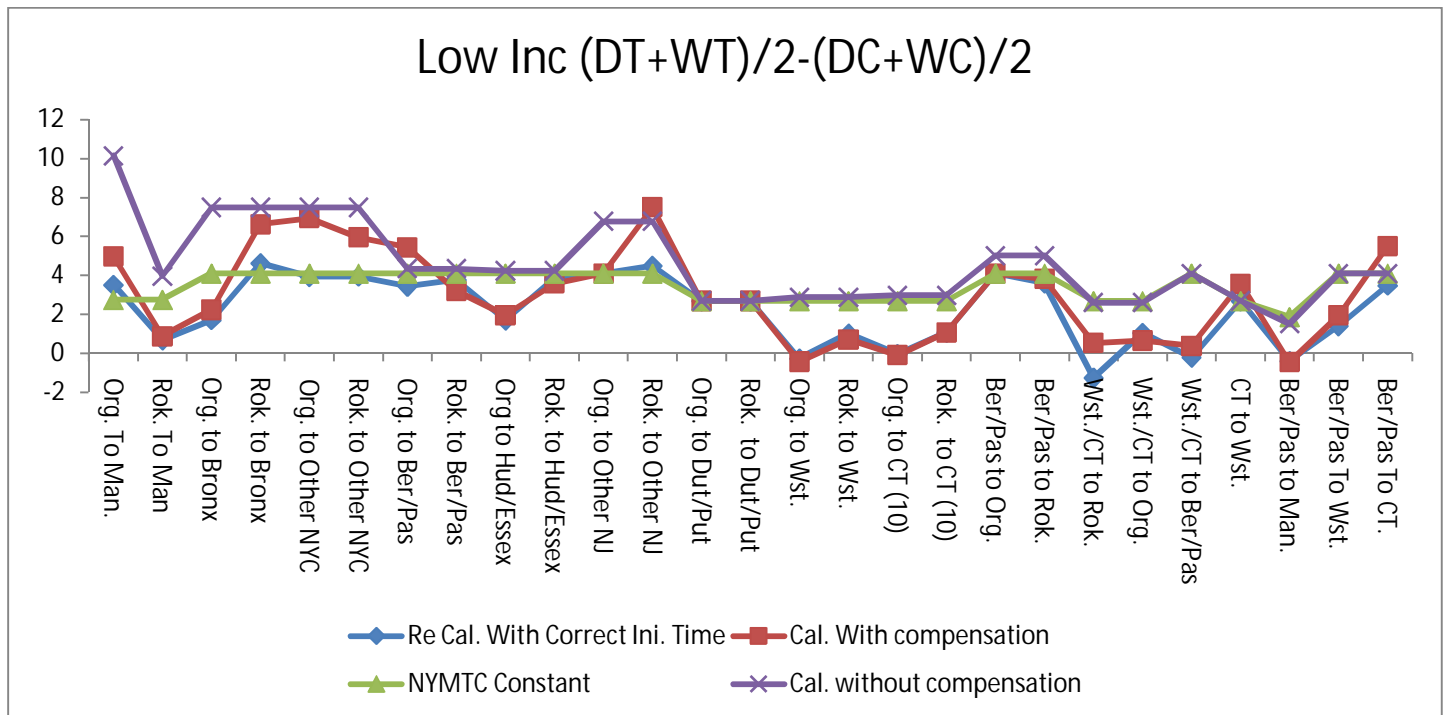
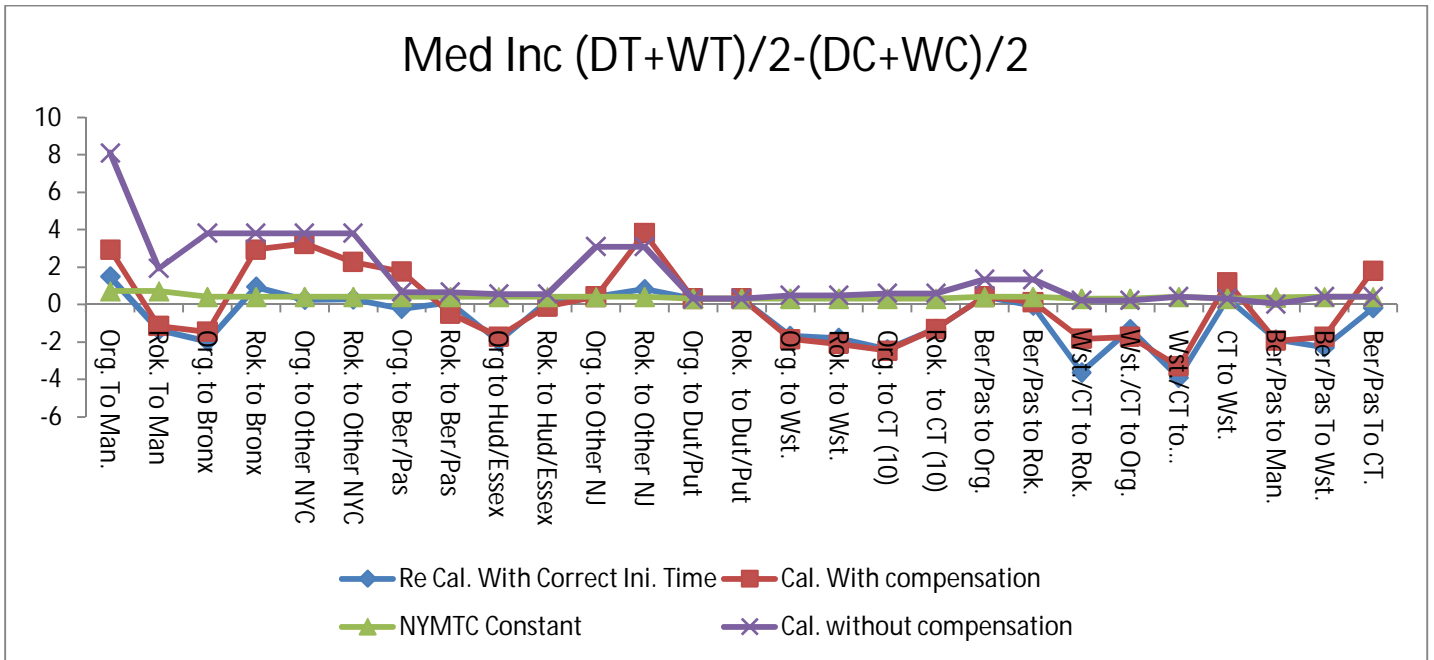**Figure C4-4 Modal Bias for the Low Income Purpose**

Med Inc (DT+WT)/2-(DC+WC)/2

Figure C4-5 Modal Bias for the Medium Income Purpose

High Inc (DT+WT)/2-(DC+WC)/2
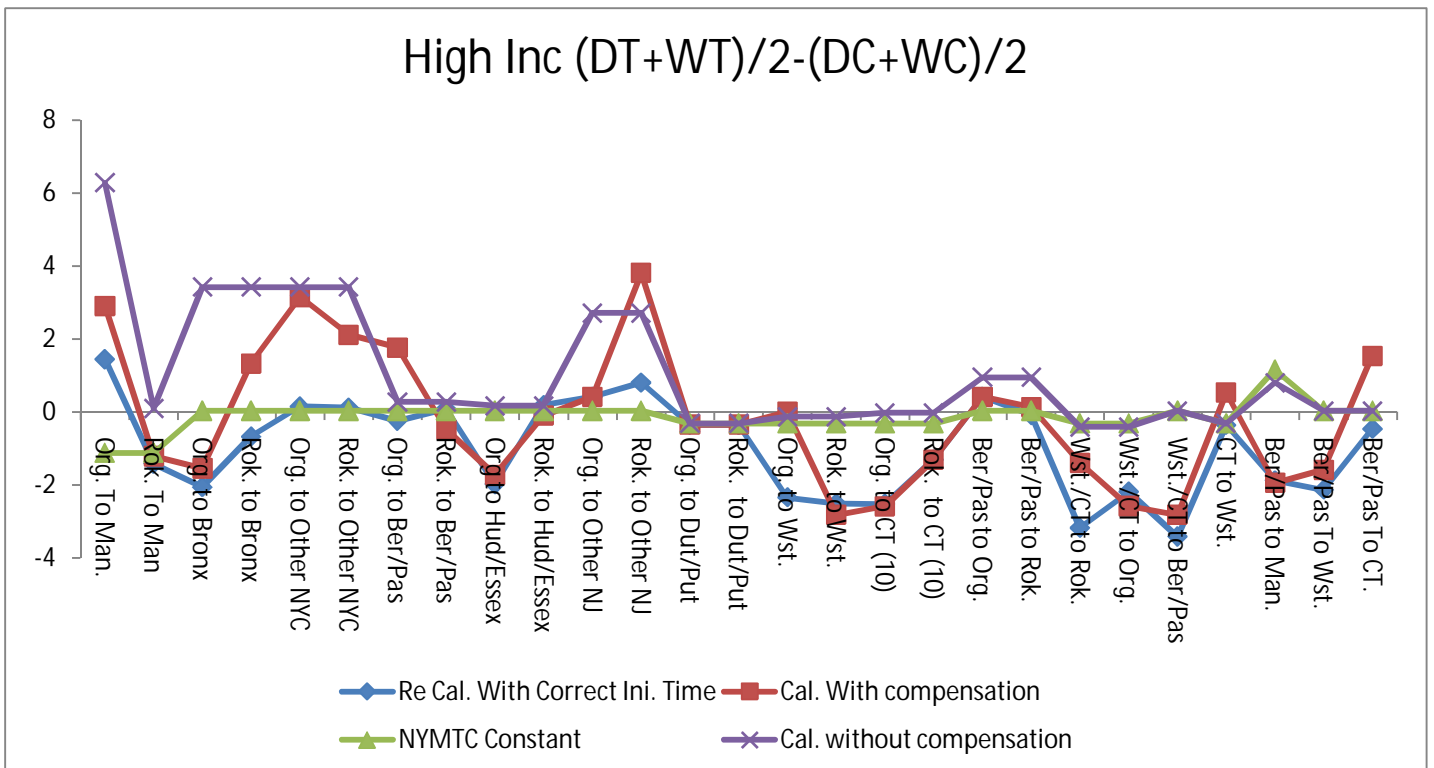
Figure C4-6 Modal Bias for the High Income Purpose

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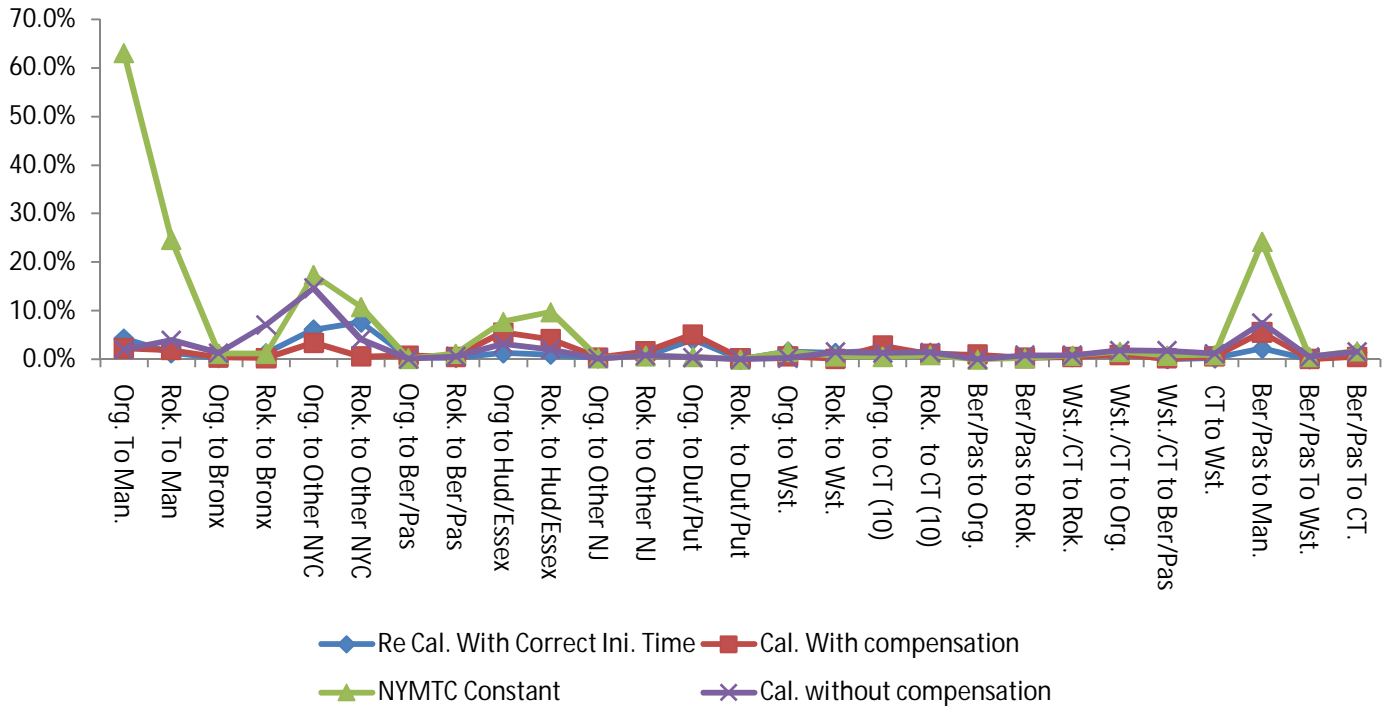# Transit Mode Share Bias : ABS(Target - Estimate)

Figure C4-7 Transit mode share for select markets – Targets vs model estimates

In order to recalibrate BPM for the corridor, the team sought to test the impact of nullifying these built-in biases. As described above, it is not possible to adjust the mode choice coefficients. However, BPM does make use of "mode adjustment factors" for specific county pairs, which, while somewhat blunt, could be used to reduce impact of built-in commuter rail bias resulting from coefficients.

Another approach to evaluating model bias was to test actual model impedance values for sample zone pairs were examined. Table C4-10 illustrates the modal constants, based on the NYMTC and Tappan Zee Bridge project calibrations, by income group. The difference between the 'other transit' and commuter rail , within a particular income group, expressed in terms of in-vehicle time, reflects the bias of one mode over the other, depending on the sign of the result.

For example, in the low income Rockland County to Manhattan market, the bias in mode choice constants was equivalent to 154 minutes of in vehicle time which was reduced to 61 minutes after the Tappan Zee Bridge recalibration. This represents a bus bias in both cases, although to a lower extent under the Tappan Zee Bridge calibration. However, under the medium income category, the modal bias changed from 40 minutes of bus bias to 53 commuter rail (negative sign).The bias in the Orange Manhattan market was minimally higher in the Tappan Zee Bridge calibration, but there was significant improvement in the Rockland-Westchester market.

Initial tests without compensation used the mode adjustment factors to cancel out that bias – constants were used that gave bus an advantage roughly equal to the advantage given to commuter rail by the coefficients. Since the constants can only be applied on a county-to-county bias, this strategy is inherently coarse (particularly for the Orange County to Manhattan market where trip distances range from 30 to 60

miles. Nevertheless, a few iterations after that starting point yielded mode choice results that reasonably matched journey-to-work data. In addition, relatively minor adjustments were made to the Westchester County-to-Manhattan market and to markets wholly within the New York suburbs. The values of the constants used are shown in Table C4-10.

Table C4-10

Mode Adjustment Factors
Relative Bus and Commuter Rail Constants for Mode Choice Model

	Purpose	Original NYMTC		Most Recent Tappan Zee		NYMTC Difference AS IVT*	Tappan Zee Bridge Recalibration Difference AS IVT
		Bus	CR	Bus	CR		
Rockland-Man	1-Low Income	3.38983	-0.43006	-1.2955	-2.82011	154	61
	2-Medium Income	1.55527	0.57253	-3.13006	-1.81752	40	-53
	3-High Income	-0.3679	0.95784	-3.43488	-2.06665	-53	-55
Orange-Man	1-Low Income	3.38983	-0.43006	0.024543	-4.09652	154	166
	2-Medium Income	1.55527	0.57253	-1.81002	-3.09393	40	52
	3-High Income	-0.3679	0.95784	-2.1223	-3.38192	-53	51
Rockland-Westchester	1-Low Income	3.67601	-0.10649	1.568708	-0.53869	153	85
	2-Medium Income	-0.07296	-1.05166	-2.91193	-1.78212	39	-46
	3-High Income	N/A		N/A			
Bergen Passaic-Man	1-Low Income	-1.2448	-5.40148	-5.1433	-7.02405	168	76
	2-Medium Income	0.53755	-0.91162	-3.36095	-2.53419	58	-33
	3-High Income	0.58009	-0.44154	-3.3184	-2.0641	41	-51

Note: * Positive values favor subway/bus, negative values favor CRT.

The net impact of these constants when combined with the impact of coefficients is shown in Tables C4-11 through C4-14. For most Rockland to Manhattan trips, commuter rail does retain some mode bias over express bus, but not nearly as large as the NYMTC calibration of the BPM was creating. The mode bias for the Orange to Manhattan is more in favor of long distance express buses, attributable to some extent to the compensation of the distance factor.

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Specific origins and destinations between Orange/Rockland to Manhattan have been presented for medium and high income purposes, since it is assumed that these two income groups are more likely to make trips to Manhattan. For example, in the case of a medium income journey (Table 4-11) from Spring Valley to 42nd Street and 5th Avenue in Manhattan, if both an express bus and commuter rail line have an initial wait time of 9.7 minutes, the express bus would need to be 66 minutes faster than the commuter rail to be equally attractive, opposed to 116 minutes in the NYMTC recalibration. Similarly, a bus from Newburg, NY to GCT would need to be 21 minutes faster than the commuter rail to be equally attractive, opposed to 110 minutes in the NYMTC recalibration.

Table C4-11

**Net Impact of Bias from Mode Choice Coefficients and
Mode Constants for Middle Income Work Journeys (Tappan Zee Bridge Recalibration)**

Trip	Zones	Coefficient Bias As IVT	Bias from Constant	Net "Bias"	Total CRT Time (includes access, wait time)
Spring Valley – 42nd & 5th	2288-106	-13	-53	-66	116
Nyack – Penn St.	2300-80	-13	-53	-66	104
Nyack – GCT	2300-102	-18	-53	-71	85
Spring Valley – WTC	2288-8	-13	-53	-66	102
Suffern – Columbus Circle	2291-87	-6	-53	-59	112
Harriman – 42nd & 5th	2372-106	-18	52	34	121
Harriman – City Hall	2372-16	-18	52	34	130
Goshen – Madison Sq.	2350-91	-18	52	34	161
Newburgh – GCT	2320-102	-31	52	21	110
Newburgh – Penn St.	2320-80	-18	52	34	142

Note: * Positive values favor subway/bus, negative values favor CRT.

Table C4-12

**Net Impact of Bias from Mode Choice Coefficients and
Mode Constants for Middle Income Work Journeys (NYMTC Calibration)**

Trip	Zones	Coefficient Bias As IVT	Bias from Constant	Net "Bias"	Total CRT Time (includes access, wait time)
Spring Valley – 42nd & 5th	2288-106	-116	40	-76	116
Nyack – Penn St.	2300-80	-122	40	-82	104
Nyack – GCT	2300-102	-128	40	-88	85
Spring Valley – WTC	2288-8	-126	40	-86	102
Suffern – Columbus Circle	2291-87	-129	40	-89	112
Harriman – 42nd & 5th	2372-106	-190	40	-150	121
Harriman – City Hall	2372-16	-200	40	-160	130
Goshen – Madison Sq.	2350-91	-247	40	-207	161
Newburgh – GCT	2320-102	-287	40	-247	110
Newburgh – Penn St.	2320-80	-227	40	-187	142

Note: * Positive values favor subway/bus, negative values favor CRT.

Table C4- 13

**Net Impact of Bias from Mode Choice Coefficients and
Mode Constants for High Income Work Journeys (Tappan Zee Bridge Recalibration)**

Trip	Zones	Coefficient Bias As IVT	Bias from Constant	Net "Bias"	Total CRT Time (includes access, wait time)
Spring Valley – 42nd & 5th	2288-106	23	-55	-32	116
Nyack – Penn St.	2300-80	23	-55	-32	104
Nyack – GCT	2300-102	18	-55	-37	85
Spring Valley – WTC	2288-8	23	-55	-32	102
Suffern – Columbus Circle	2291-87	30	-55	-25	112
Harriman – 42nd & 5th	2372-106	18	51	69	121
Harriman – City Hall	2372-16	18	51	69	130
Goshen – Madison Sq.	2350-91	18	51	69	161
Newburgh – GCT	2320-102	5	51	56	110
Newburgh – Penn St.	2320-80	18	51	69	142

Note: * Positive values favor subway/bus, negative values favor CRT.

Table C4-14

**Net Impact of Bias from Mode Choice Coefficients and
Mode Constants for High Income Work Journeys (NYMTC Calibration)**

Trip	Zones	Coefficient Bias As IVT	Bias from Constant	Net "Bias"	Total CRT Time (includes access, wait time)
Spring Valley – 42nd & 5th	2288-106	-80	-53	-133	-80
Nyack – Penn St.	2300-80	-86	-53	-139	-86
Nyack – GCT	2300-102	-92	-53	-145	-92
Spring Valley – WTC	2288-8	-90	-53	-143	-90
Suffern – Columbus Circle	2291-87	-93	-53	-146	-93
Harriman – 42nd & 5th	2372-106	-155	-53	-208	-155
Harriman – City Hall	2372-16	-164	-53	-217	-164
Goshen – Madison Sq.	2350-91	-211	-53	-264	-211
Newburgh – GCT	2320-102	-251	-53	-304	-251
Newburgh – Penn St.	2320-80	-191	-53	-244	-191

Note: * Positive values favor subway/bus, negative values favor CRT.

The resulting mode shares produced by the recalibrated BPM are shown in Table 4-15. Modeled transit shares from Rockland County to Manhattan were 35 percent compared to census data at 34 percent, while the model produces a 46 percent transit share for Orange County to Manhattan trips compared to the observed value of 44 percent. Commuter rail as a share of total transit is within three percentage points for both markets. Other markets served by the corridor are also shown, and are within acceptable calibration limits.

Table C4-15

Comparison of mode share results in select markets

Origin	Destination	Census			NYMTC Calibration			Tappan Zee Bridge Recalibration		
		Auto	CRT	Other Transit	Auto	CRT	Other Transit	Auto	CRT	Other Transit
Orange	Bergen-Passaic	99%	0%	0%	99%	1%	0%	100%	0%	0%
	Bronx	96%	2%	1%	96%	4%	0%	95%	2%	3%
	CT	98%	2%	0%	99%	1%	0%	97%	3%	0%
	Dutchess-Putnam	100%	0%	0%	99%	1%	0%	95%	0%	5%
	Hudson-Essex	89%	10%	0%	96%	4%	0%	89%	11%	0%
	Man	55%	24%	20%	27%	72%	1%	54%	27%	19%
	Other NJ	99%	0%	0%	100%	0%	0%	100%	0%	0%
	Other NYC	76%	11%	12%	91%	9%	0%	85%	10%	5%
	Westchester	97%	0%	0%	99%	1%	0%	98%	0%	2%
Rockland	Bergen-Passaic	97%	0%	2%	97%	1%	2%	98%	0%	2%
	Bronx	98%	0%	1%	98%	1%	1%	99%	0%	1%
	CT	99%	0%	0%	98%	1%	1%	99%	0%	1%
	Dutchess-Putnam	98%	0%	0%	100%	0%	0%	100%	0%	0%
	Hudson-Essex	88%	8%	4%	97%	2%	1%	88%	8%	4%
	Man	66%	12%	22%	37%	36%	28%	65%	14%	21%
	Other NJ	99%	0%	1%	100%	0%	0%	100%	0%	0%
	Other NYC	86%	4%	10%	96%	2%	2%	93%	3%	3%
	Westchester	98%	0%	0%	98%	0%	2%	99%	0%	1%
Bergen-Passaic	CT	95%	0%	1%	99%	1%	0%	98%	1%	1%
	Man	45%	12%	43%	21%	14%	66%	45%	12%	43%
	Westchester	99%	0%	0%	99%	0%	0%	100%	0%	0%
	Orange	100%	0%	0%	100%	0%	0%	99%	0%	1%
	Rockland	99%	0%	1%	99%	0%	1%	99%	0%	1%
Westchester /CT	Bergen-Passaic	98%	1%	1%	98%	1%	1%	99%	1%	0%
	Orange	96%	1%	1%	100%	0%	0%	100%	0%	0%
	Rockland	96%	1%	1%	99%	0%	1%	98%	1%	1%
CT	Westchester	98%	1%	1%	97%	2%	1%	99%	1%	0%

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C4.2.5 Model Validation

Figures C4-8 to C4-10 illustrate the improvement in mode share results after the Tappan Zee Bridge project recalibration for "other transit", commuter rail and auto, respectively. As it can be seen from all three figures, the Tappan Zee Bridge recalibration was a considerable improvement of mode share over the NYMTC calibration and a better match to the observed data.
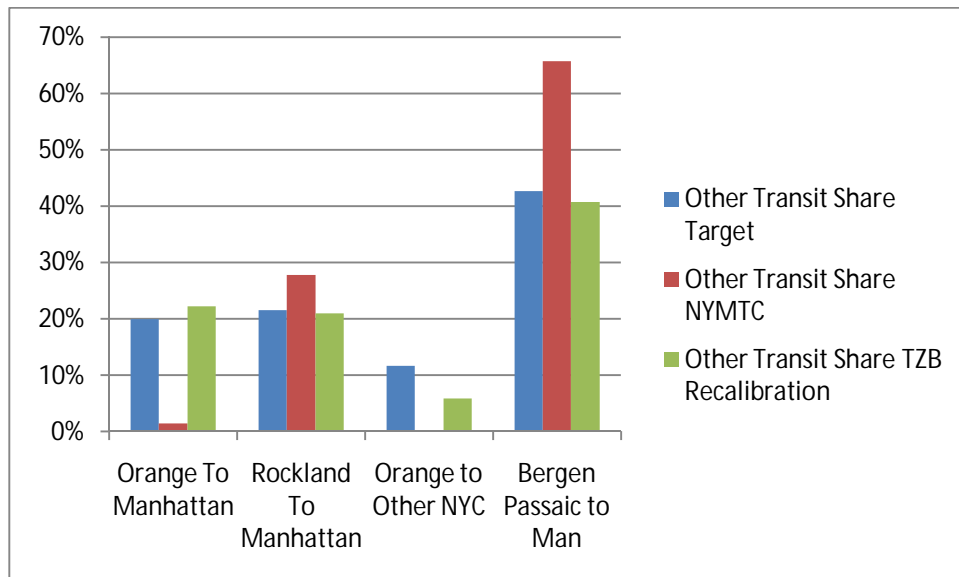

Figure C4-8 Comparison of Other Transit (besides commuter rail) Mode Share
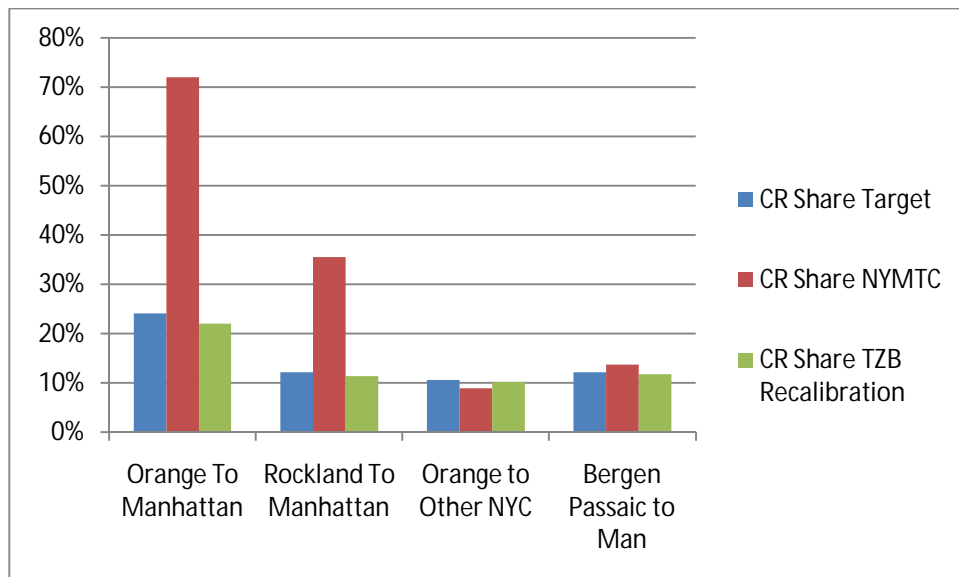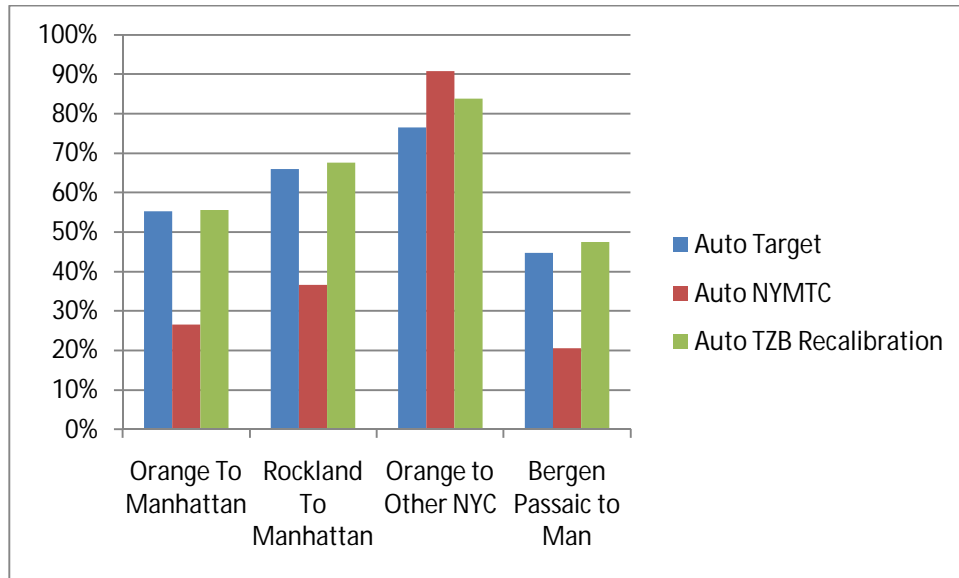

Figure C4-9 Comparison of Commuter Rail Mode Share

Figure C4-10 Comparison of Auto Mode Share

A validation of modeled results was conducted on the transit and the highway calibrations. Ridership results were compared to observed data at a station group level and highway assignment results were compared on the Hudson River crossings. In addition to these validations, since calibration entailed several iterations, the trip distribution and mode shares were validated and the results reflect results from the final recalibration effort.

After calibration of the MDSC module, resulting trip tables were assigned to the transit and highway networks. Transit assignments are only available for the AM peak period (6AM – 10AM). Ridership at Metro-North stations was also examined for discrepancies, within groups of stations. The calibration greatly improved assigned boardings on the Port Jervis line, which now match actual counts well: 2,476 as compared to 2,413 (Table C4-16).

Table C4-16

BPM and Observed West of Hudson Boardings and Alightings

2005 Metro-North Ridership Counts, AM Peak					Assignment Results 2005 AM Peak As Delivered by NYMTC				Assignment Results 2005 AM Peak BPM			
Station	SB		NB (Est)		SB		NB		SB		NB	
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
PORT JERVIS LINE												
Port Jervis	71	-	-	3	174	25	-	29	106	-	-	5
Otisville	34	1	-	-	129	5	6	-	82	1	1	-
Middletown/Town of Wallkill	418	1		7	1,032	-	8	-	549	-	2	1
Campbell Hall	137	-		1	121	3	-	2	83	-	-	-
Salisbury Mills/Cornwall	440	-			1,053	-	2	-	648	1	3	-
Harriman	731	-		3	842	19	4	21	458	5	-	3
Tuxedo	96	-	3	3	81	-	2	-	42	-	-	2
Sloatsburg	61	1	-	-	73	187	-	46	40	8	1	-
Suffern	425	16	no data	no data	704	444	44	37	287	126	82	159
TOTAL PORT JERVIS LINE	**2,413**	**19**	**3**	**17**	**3,505**	**239**	**66**	**135**	2476	180	**89**	**170**
PASCACK VALLEY LINE												
Spring Valley	71	No data			1,056	147			1052	0		
Nanuet	481	No data			628	452			579	79		
Pearl River	259	No data			393	195			324	52		
TOTAL PASCACK VALLEY LINE	**811**				**2,077**	**794**			1955	131		

In addition to the transit validation, highway volumes were checked across the Hudson River screenline (Table C4-17). On a 24-hour basis, total cross-Hudson model volumes were within 5.5 percent of observed volumes (Table C4-18). Daily two-way volumes across the Tappan Zee Bridge were within 8 percent of annual average counts. The recommended FHWA validation standard for freeway facility is 7 percent on a freeway facility[2]. Corridor highway volumes, however, were validated to a finer level (within 3 percent) using the traffic microsimulation package, used to analyze traffic impacts. It must be noted that the focus of this calibration effort was for the model to better understand overall travel patterns as opposed to matching traffic counts alone. The model underestimates daily two-way traffic flows by 6 percent in the AM peak and 8 percent over the entire day (Table C4-19). AM peak and daily east-west directionality is well-represented by the model.

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[2] http://tmip.fhwa.dot.gov/resources/clearinghouse/docs/mvrcm/ch7.htm

Table C4-17

Observed vs Tappan Zee Bridge Recalibration Hudson Line Boardings and Alightings

Station	MNR Ridership Counts 2005*		Tappan Zee Bridge Recalibration	
	SB		**SB**	
	ON	OFF	ON	OFF
HUDSON LINE				
Poughkeepsie	916	-	4,344	-
New Hamburg	767	1	2,492	39
Beacon	1,573	10	2,328	20
Dutchess Total	**3,256**	**11**	**9,163**	**59**
Cold Spring	328	3	143	2
Garrison	244	3	107	1
Putnam Total	**572**	**7**	**250**	**3**
Peekskill	1,046	50	652	36
Cortlandt	674	17	85	14
Croton-Harmon	2,593	145	1,660	251
Ossining	1,123	15	801	22
Scarborough	769	3	423	37
Philipse Manor	300	-	120	11
Tarrytown	1,899	37	1,089	62
Irvington	578	12	356	12
Ardsley	230	14	-	-
Dobbs Ferry	865	15	638	28
Hastings	781	18	477	22
Greystone	423	3	892	18
Glenwood	243	2	2	-
Yonkers	514	98	2,432	75
Ludlow	200	5	920	20
Westchester Total	**12,238**	**436**	**10,548**	**607**
Riverdale	439	7	495	29
Spuyten Duyvil	806	10	616	16
Marble Hill	66	168	35	1,227
University Heights	7	16	8	26
Morris Heights	16	8	50	33
Bronx	**1,334**	**208**	**1,203**	**1,331**
125th St	5	384	-	981
New York-Grand Central	-	16,359	-	18,184
Total Hudson Line	**17,405**	**17,405**	**21,165**	**21,165**

Note: Inbound Ons are from 2005 ridership reports. Inbound Offs are based on earlier ridership reports and factored up to 2005 levels

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Table C4-18

Comparison of Two-Way Daily Hudson River Highway Volumes

Parameters	Tappan Zee Bridge	George Washington Bridge	Lincoln Tunnel	Holland Tunnel	Bear Mountain Bridge	Newburgh-Beacon Bridge	Total
Traffic Count	138,263	296,893	120,788	93,334	17,754	70,506	738,489
Tappan Zee Recalibration	127,263	319,836	126,742	101,859	30,119	71,405	777,223

Table C4-19

2005 Average Annual Daily Highway Volumes across the Tappan Zee Bridge by Time Period

	Tappan Zee Bridge EB			Tappan Zee Bridge WB			Tappan Zee Bridge Two Directions		
	Year 2005 Average	Model Run	Difference with Year 2005	Year 2005 Average*	Model Run	Difference with Year 2005	Year 2005 Average	Model Run	Difference with Year 2010
AM	23749	22,511	-5%	12207	11,302	-7%	35,955	33,813	-6%
MD	20132	19,963	-1%	23365	20,711	-11%	43,497	40,674	-6%
PM	15103	13,204	-13%	21782	21,329	-2%	36,885	34,533	-6%
NT	11476	8,271	-28%	10450	9,972	-5%	21,926	18,243	-17%
Total	70460	63,949	-9%	67804	63,314	-7%	138,263	127,263	-8%

Note: Westbound volumes based are on August 2010 NYS Thruway counts, adjusted for to represent 2005 volumes and seasonal variation (August vs. annual average).

The model underestimates usage of the Tappan Zee by travelers from Orange, Bergen, and Passaic Counties to Westchester County. This means that the model tends to underestimate Tappan Zee Bridge usage by two of the higher-growth markets crossing the Hudson and while overestimating traffic between Rockland and Westchester. Raw model results will be rebalanced so that the proportion of each market utilizing the Tappan Zee conforms to survey findings.

Table C4-20

Tappan Zee Bridge/I-287 Origin Destination Survey (2003) vs. Model (2005) Distribution of Trans-Hudson Travel by Bridge Crossing

County-County Market	Newburgh Beacon		Bear Mountain		Tappan Zee		George Washington	
	Survey	Model	Survey	Model	Survey	Model	Survey	Model
Orange to Westchester	27%	17%	42%	60%	32%	24%	0%	0%
Rockland to Westchester	0%	0%	5%	5%	91%	95%	4%	0%
Bergen/Passaic to Westchester	0%	0%	4%	2%	83%	42%	13%	56%

To understand why the Orange County-Westchester Market is overestimated by the model on the Bear Mountain Bridge and underestimated on the Tappan Zee Bridge, sub-county markets (Figure C4-11) were examined to determine the degree to which the model properly represents travel in the various portions of each county that have convenient access to the Bear Mountain and Tappan Zee Bridges.

The comparison of the modeled and observed estimates of work travel match total Orange County to Westchester County flows quite well but overestimates the degree to which this travel is oriented towards the northern half of Westchester County—the section that is most conveniently accessed by the Bear Mountain Bridge (Tables C4-21 and C4-22).

Raw forecasts of Orange County to Westchester County travel will be rebalanced to reflect observed sub-county distributions.
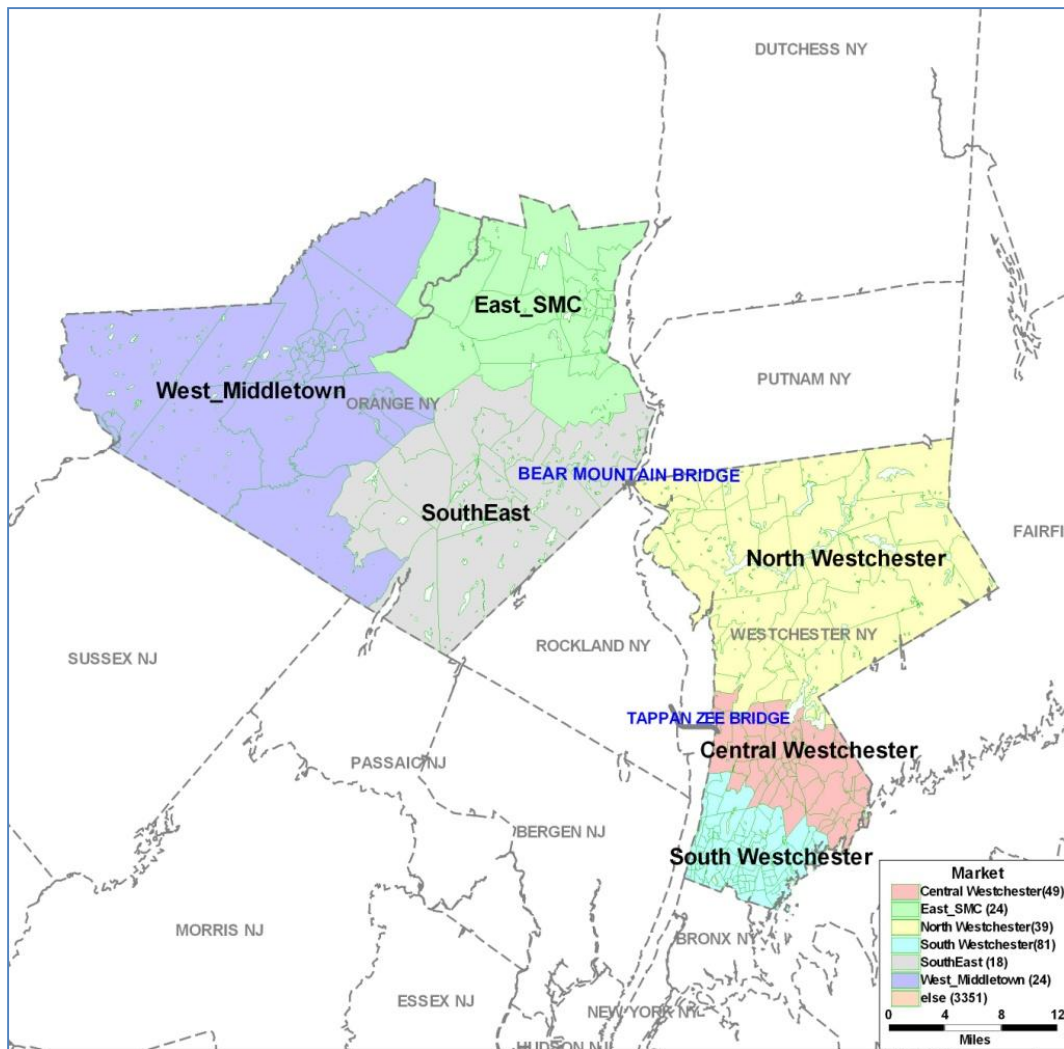

Figure C4-11 Orange County and Westchester County Subdistricts

Table C4-21

Census Journey to Work (2003) Distribution of Sub-County Travel for Work Trips between Orange County and Westchester County

	Central Westchester	North Westchester	South Westchester	Total Westchester
East SMC Orange County	1,000	1,024	426	2,450
Southeast Orange County	895	502	351	1,748
West Middletown Orange County	547	302	254	1,103
TOTAL Orange County	2,442	1,828	1,031	5,301

Table C4-22

Model (2005) Distribution of Sub-County Travel for Work Trips between Orange County and Westchester County

	Central Westchester	North Westchester	South Westchester	Total Westchester
East SMC Orange County	398	930	131	1,458
Southeast Orange County	611	1,728	259	2,599
West Middletown Orange County	279	273	112	664
TOTAL Orange County	1,289	2,931	502	4,721