C. RIDERSHIP MODELING AND OVERALL TRAVEL PROJECTIONS

To evaluate the effect of the project alternatives on transit ridership throughout the city as well as on particular subway lines, a mode-choice transit model was used. To use this model, existing transit ridership on the system was first projected to the future analysis year (2020), based on such inputs as projections of population, employment, and changes to the system itself. Then, the model was used to assign the future ridership to the transit network that would exist for each of the four alternatives under consideration.

Based on this information, the model outputs provide data on the volumes (i.e., transit riders) on different subway links, passengers boarding and exiting trains and transferring at different stations, and summary statistics on passenger hours and miles traveled by mode (e.g., subway, bus, etc.). These data were used to evaluate and compare the changes in ridership and service operations for the different alternatives. Potential improvements and decline in service were compared using such measures as volume-to-capacity (v/c) ratios, number of crowded trains, and passenger hours in congested conditions.

The steps involved in creating this transit model are described below and illustrated in Figure 9C-1. The work entailed five steps: 1) development of the highway and transit network for the entire city (including coding and validation); 2) the development of existing and future “trip” tables; 3) development of a multimodal mode choice model to evaluate ridership and market share among the alternatives; 4) application of the model for the different project alternatives; and 5) assignment of future trips to the future networks for the different alternatives. A full discussion of the modeling efforts is presented in Appendix A, “Service and Patronage Impacts Methodology and Results Report.”

DEVELOPMENT OF THE HIGHWAY AND TRANSIT NETWORK

Development of a Zone System

When developing the network of different travel modes, a zone system was created to allow delineation of the origins and destinations of trips made in the network. Census tracts were selected as the zones for the study so that 1990 census data could be used. To provide greater detail close to the alternatives’ routes, a number of the census tracts that extended between Lexington and Second Avenues were split into smaller units (census block groups).

Creation of AM Peak Hour Street and Transit Networks

Street and transit networks were created for existing conditions in the base year (1995) and for each project alternative in the future analysis year (2020).

Street Network. The street network consists of a series of links, with specific attributes relating to speed and capacity, to which the zone-to-zone traffic was assigned. Similar to the zone system, the representation of the street network was more detailed for the Manhattan portion of the study area. The street network outside of Manhattan follows the network developed by the New York Metropolitan Transportation Council (NYMTC). The MESA network was then calibrated through trip table adjustments using the “Origin-Destination Matrix Estimator” (ODME), a procedure of TransCad (a transportation modeling software package produced by Calliper Corp.); the goal was to replicate actual traffic flows in Manhattan as closely as possible.
The application of the ODME procedure and the resulting trip table adjustments are described in the Appendix A, “Service and Patronage Impacts Methodology and Results Report.” This appendix also compares the assigned traffic volumes at study area portals and screenlines with the peak hour traffic counts, used as inputs to the traffic assignment model development process.

Transit Network. The transit network is a computer-based model of the travel paths and service frequencies available to passengers during the AM peak hour. It was designed with sufficient detail to represent accurately the numerous transit choices available for travel to areas such as Manhattan south of 60th Street and downtown Brooklyn. The components of the transit network include the following:

- All NYCT subway and Staten Island Railway (SIR) routes with AM peak hour service frequencies and passenger carrying capacities.
- All subway and SIR stations with walking times and capacities for passageways between routes.
- All NYCT and New York City Department of Transportation (NYCDOT)-franchised local and express bus routes with AM peak hour service frequencies and passenger carrying capacities.
- All NYCT and NYCDOT bus stops by route.
- A walk network covering Manhattan south of 60th Street, the Upper East Side, and East Harlem to 125th Street, part of the Upper West Side, and all of downtown Brooklyn.
- Access and egress links for connecting zones with subway stations and/or bus stops or with street intersections in the walk network areas.
- Intermodal transfer links among subway, bus, and walk modes.
- Fares and transfer fares. A full fare is required to board either a bus or a subway in both the 1995 and 2020 networks. The fare to transfer between bus and subway was a full fare in the 1995 base network (since free transfers were not yet permitted) and is a free fare in the 2020 networks.

This information was used by TransCad to build a special type of network file from which the shortest paths between zones were computed in the process of assigning trips by route. Besides the information listed above, path choice includes certain factors that are used to account for passengers’ assessments of varying wait times, transfer times, and crowding.

The coding of the future alternatives into the model required a service plan for all routes expected to be operating in the analysis year. For example, the No Build Alternative’s service plans accounted for the completion of the 63rd Street Tunnel Connector and the expectation that full subway service will return to the Manhattan Bridge.

**DEVELOPMENT OF TRIP TABLES**

A trip table is a matrix of passenger movement volumes between each origin and destination zone. A composite trip table was created for the MESA study, combining data from the 1990 Census Transportation Planning Package (CTPP), which reflects the “primary” travel modes for
journeys to work, i.e., subway, bus, auto, taxi and walk, with a more recent trip table created in 1995 by NYCT for transit trips only. The resulting trip table created represents the “primary” modes of travel, but excludes bicycle and other modes with a very small mode shares. The 1995 NYCT transit trip table has been extensively checked and calibrated by NYCT and has formed the basis for similar analyses over the past few years. In this study, it was used as a base for all origin-destination pairs where transit was used. This peak hour transit trip table is based on the 1990 CTPP journey-to-work database, has been adjusted for all trip purposes, and has been calibrated by NYCT for the 1995 base year. The 1990 CTPP peak period trip table, as adjusted by the 1989 Comprehensive Telephone Travel Survey (CTTS) to account for all trip purposes, was used for peak hour auto, taxi, and walk trips in origin-destination pairs that did not have any transit trips and did not appear in the NYCT transit trip table. See Appendix A, “Service and Patronage Impacts Methodology and Results Report” for details. Table 9C-1 summarizes the results of the model runs and compares these results with 1995 trips.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Existing</th>
<th>No-Build</th>
<th>2020 TSM</th>
<th>Build 1</th>
<th>Build 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>480,173</td>
<td>556,575</td>
<td>556,450</td>
<td>556,237</td>
<td>556,096</td>
</tr>
<tr>
<td>Taxi</td>
<td>22,974</td>
<td>25,559</td>
<td>25,552</td>
<td>25,464</td>
<td>25,407</td>
</tr>
<tr>
<td>Bus</td>
<td>134,332</td>
<td>152,610</td>
<td>152,560</td>
<td>152,086</td>
<td>152,044</td>
</tr>
<tr>
<td>Subway</td>
<td>513,455</td>
<td>607,386</td>
<td>607,555</td>
<td>608,365</td>
<td>608,617</td>
</tr>
<tr>
<td>Walk Only</td>
<td>238,263</td>
<td>272,418</td>
<td>272,432</td>
<td>272,396</td>
<td>272,382</td>
</tr>
<tr>
<td>Total</td>
<td>1,389,197</td>
<td>1,614,548</td>
<td>1,614,549</td>
<td>1,614,548</td>
<td>1,614,546</td>
</tr>
</tbody>
</table>

As can be seen from the Table 9C-1, trips are expected to grow from a level of about 1.39 million to 1.61 million, an increase of about 16 percent. This equals an average annual growth rate of 0.6 percent. The mode with the highest growth rate is the subway, the use of which is expected to increase by 18 percent, or almost 0.7 percent per year.

The future (2020) trip table was factored up from the 1995 composite trip table, using growth factors developed based on forecasts made by NYMTC of population, employment, and labor force for the city’s five counties. These countywide forecasts were allocated to specific areas within the MESA study area based on localized trends. Application of the mode choice model (see below) divided the trip table by mode of travel, allowing the highway and transit assignment portions of the model to be run separately.

ESTIMATION OF A MULTIMODAL MODE CHOICE MODEL

The objective of the model estimation task was to estimate the “mode choices” made by travelers in the MESA study area—i.e., to estimate which transportation mode, whether subway, bus, auto, taxi, or walking, would be chosen by individual travelers. The model developed was sensitive to a range of policy-relevant variables, including in-vehicle and out-of-
vehicle travel times, fare levels and costs of travel, time and money spent parking, and variables representing the transferring activity between transit modes. The model differentiated among the five primary modes of transportation of interest for this study: auto, taxi, subway, bus, and walking. The journey-to-work database maintained by the U.S. Department of Commerce, Bureau of the Census, was used as the basis for model estimation; this created an integrated database with information on both the number of origin-destination trips by mode and the level of service attributes for each mode.

The base model was then refined in response to the testing of several research hypotheses. After model validation, the value of time was determined to be higher for auto and taxi riders, but transit riders exhibited higher cost sensitivity. Geographical differences in cost sensitivity in relation to income levels were also apparent. The specifications for the preferred mode choice model and other details are provided in Appendix A, “Service and Patronage Impacts Methodology and Results Report.”

**MODEL APPLICATION**

After calibration of the base year model, the model was applied to the different project alternatives for the year 2020. This involved coding the highway network for each alternative, developing a model application module to evaluate the ridership for each of the proposed transit alternatives, and assigning the estimated future year highway trip table. Subway and bus travel times between each origin and destination were estimated by the model for each alternative.

**ASSIGNMENT OF FUTURE TRIPS**

The final step in the modeling process was the assignment of trips between an origin zone and a destination zone via each possible route in the network. The transit assignment was constructed in TransCad and the highway assignment was conducted by TRANPLAN for the base year and each future year network. The highway and transit trip tables, derived from the application of the mode choice model, were assigned to their corresponding networks.

The user equilibrium assignment method was used for traffic assignment; it assumed rational decision-making and allowed users to select routes that minimized their origin-destination travel time. As a result of this assignment method, all paths serving a particular origin-destination pair had the same travel time and a traveler’s change of paths did not result in a decrease in his or her travel time. The outputs of the model assignment process included volumes and volume-to-capacity (v/c) ratios, which measure the level of crowding, along each segment of roadway. TransCad also produced summary statistics, such as vehicle miles, that were used in the evaluation of benefits for each of the alternatives under study.

A stochastic (random, probabilistic) user equilibrium assignment was used in the transit model. The user equilibrium feature distributed passenger trips between a particular origin-destination pair to different paths when crowding on part of the path increased beyond practical capacity. The stochastic feature produced assignment results that accurately reflect behavioral responses of passengers to perceived differences in waiting or travel time on one route compared with another. This resulted in an assignment in which many reasonable paths may be used for each origin-destination pair, even when congestion is not an issue. For each of the alternatives tested, the transit model assignment process forecasted ridership for each portion of the transit system.