Appendix C

Transit Investment Condition and Investment Requirements Methodology

This appendix contains a technical description of the methods used to determine transit asset conditions (see Chapter 3) and future investment requirements (see Chapter 7). It is primarily a description of the Transit Economic Requirements Model (TERM).

Transit Economic Requirements Model

TERM estimates the physical conditions of U.S. transit assets, as reported in Chapter 3, and the total annual capital expenditures that will be required by all urbanized areas from Federal, State, and local governments to maintain or improve the physical condition and level of service of the U.S. transit system infrastructure. TERM also projects how investment will need to be allocated among transit assets vehicles, guideways, systems, stations, and maintenance facilities—over a 20-year period and the sensitivity of the investment requirements to variations in the rate of growth in transit use.

TERM Investment Scenarios

TERM projects transit capital investment requirements for the following four investment scenarios:

- **Maintain Conditions**

  In the Maintain Conditions scenario, transit assets are replaced and rehabilitated over a 20-year period with the target of reaching an average asset condition at the end of the period (2020) that is the same as the asset condition that existed at the beginning of the period (2000). The model does not necessarily maintain the weighted-average condition of the assets in each year over the 20-year period because replacements and rehabilitations are only made when the condition of assets falls below industry standards. These minimum condition levels vary according to asset type. With TERM, the average condition of the asset base improves during the initial year of investment and then fluctuates between this improved level and the initial condition level, which is reached at the end of the 20-year period.

- **Maintain Performance**

  The Maintain Performance scenario assumes that passenger miles traveled (PMT) increase over time at the same rate as a weighted-average of transit PMT projections by Metropolitan Planning Organizations (MPOs). Based on a sample of PMT forecasts available from the Nation's 33 largest metropolitan areas, passenger miles are assumed to increase at an average annual rate of 1.6 percent between 2001 and 2020. TERM adds assets at a rate necessary to accommodate the increase in PMTs to achieve the base year (2000) level of average vehicle utilization and average vehicle speed at the end of the 20-year period (2020).

- **Improve Conditions**

  In the Improve Conditions scenario, transit asset rehabilitation and replacement is accelerated in order to improve the average condition of each asset type in the existing asset base to at least a level 4, or "good" level, by 2020. Assets are replaced at a higher level of condition than under the Maintain Conditions scenario meaning that they are not allowed to depreciate as much before they are replaced. This scenario eliminates any backlog of deferred investments that are needed to reach a "good" condition level. Asset conditions make their most significant improvement in the first year trending down gradually with year-to-year variations to a "good" condition level by 2020.

- **Improve Performance**

  The Improve Performance scenario simulates capital investments that increase average vehicle speeds and lower average vehicle occupancy to threshold levels by the end of the 20-year period (2020). To improve the nationwide average operating speed, TERM replaces investments in bus vehicles and bus-related infrastructure with investments in rail vehicles and rail-related infrastructure by transit operators in urbanized areas with populations over 500,000 and with average operating speeds below a specified minimum threshold. This minimum is set as the average operating speed of all urban transit operators less a specified fraction of the standard deviation of these operators' average operating speeds. TERM continues to shift from bus to rail investments until each of the operators in these urbanized areas has an average transit speed at or above this minimum threshold. To lower the nationwide vehicle occupancy rate, TERM makes investments by agency and by specific mode (e.g., articulated buses) when these agency-specific modal services have vehicle occupancy rates above a maximum acceptable threshold level. This maximum is set individually for each mode at the national average occupancy rate for that mode, plus a specified percentage of the standard deviation of the occupancy rate for that mode for all operators. Investments are continued until there are no operators with occupancy rates above the maximum threshold levels.

Description of Model

TERM is comprised of four distinct modules:

- Asset Rehabilitation and Replacement Module
  - Reinvests in existing assets to improve their physical condition.

- Asset Expansion
  - Invests in new assets to maintain operating performance to meet projected increases in transit use.

- Performance Enhancement
  - Invests in new assets to improve operating performance as measured by speed and capacity utilization.

- Benefit-Cost Tests
  - Only investments with a cost-benefit ratio greater than 1.0 are included in TERM's estimate of investment requirements. This process roughly corresponds to the "Maximum Economic Investment" concept in BIAS.

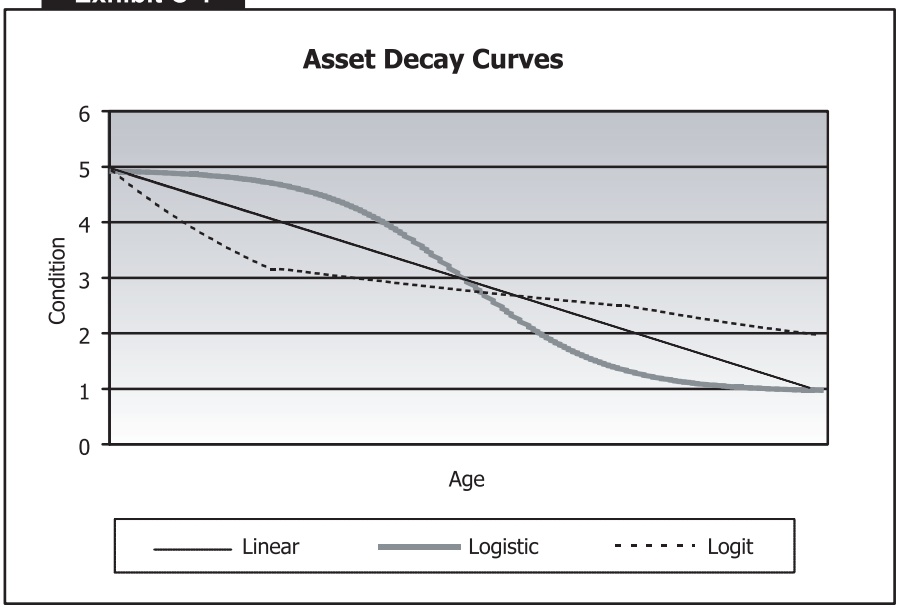
Asset Rehabilitation and Replacement Module

The Asset Rehabilitation and Replacement Module uses statistically determined decay curves to simulate the deterioration of transit vehicles, facilities, and other infrastructure components. As the assets deteriorate, their condition declines, requiring investments in rehabilitation and replacement.

The vehicle, maintenance facility, and station decay curves are based on data collected by the Federal Transit Authority (FTA) through engineering surveys performed between 1999 and 2001. The surveys found that these assets depreciate rapidly in early years, followed by slower decay for an extended period, and with a sharp decline in asset condition towards the end of the asset's useful life. These

newly estimated decay curves for vehicles, maintenance facilities, and stations, which are in the form of a "logit" function, differ significantly from the decay curves that continue to be used for other asset types. National Transit Database (NTD) data are applied to these "logit" decay curves to estimate conditions, which are subsequently used to estimate rehabilitation and replacement costs. Decay curves for commuter rail vehicles, for which no condition surveys were undertaken, continue to follow the same decay pattern as the remaining transit assets as discussed in the next paragraph.

Exhibit C-1



The decay curves for other non-vehicle infrastructure—guideways, systems, and stations—are "logistic." These decay curves were estimated using extensive data sets collected by the Regional Transportation Authority in Northeastern Illinois and the Chicago Transit Authority in the mid-1980s and 1990s. Data applied to these decay curves were collected by FTA with a special survey in 1995. Transit operators were asked to list all their assets in operation as well as the type, age, purchase price, and—when available—the quantity of each. This information has been inflated to a 2000-dollar basis by TERM. TERM generates data estimates for agencies with missing data records on the basis of these agencies' characteristics, such as the number of vehicles, stations, track miles and original year of construction.

Starting with the 1999 Report, TERM has been able to consider varying replacement scenarios for each of the five major asset categories. Each asset type is assigned a target condition level on the basis of the same 1 to 5 rating used to determine condition. Multiple iterations of TERM are run until the "target" condition for each asset type is achieved at the end of the 20-year investment horizon. Under the Maintain Conditions scenario, the target condition for each of the five asset types is set to its initial level. In the Improve Conditions scenario, the target condition for each asset type is set to "good" (Condition Rating "4").

Asset Expansion Module

The Asset Expansion Module identifies the level of investment that will be required in each major asset category to continue to operate at the current level of service as transit travel (PMT) increases, i.e., to Maintain Performance. TERM adds assets at a rate necessary to maintain current vehicle occupancy rates over the 20-year analysis period. Investments undertaken by the Asset Expansion Module during the first part of the 20-year forecast period are depreciated, rehabilitated, and replaced by the Asset Rehabilitation and Replacement Module as required.

TERM uses the most recent PMT projections (in most cases 2000) available from the 33 largest MPOs. These are the most comprehensive projections of transit travel growth available. Projected passenger trips were used in lieu of projected PMT when the latter was unavailable. Transit travel growth rates for the 370 urbanized areas for which transit travel projections were either unavailable or not collected were assumed to be equal to the average growth rate of the FTA region in which that metropolitan area is located. For New York, a simple average of the forecasts from all reporting east coast metropolitan areas was used, since The New York Metropolitan Transportation Council does not forecast transit travel growth. The weighted-average transit PMT growth rate calculated from the MPO forecasts and used in TERM was 1.6 percent. Passenger travel forecasts for individual urbanized areas range from an average annual rate of -0.05 percent in Philadelphia to 3.56 percent in Los Angeles.

Performance Enhancement Module

The Performance Enhancement Module simulates investments that "Improve Performance" either by increasing the average transit operating speed or reducing the average vehicle occupancy rate. Investment is shifted from bus to rail infrastructure in urbanized areas with average operating speeds below the national average and additional infrastructure is purchased for areas and modes with vehicle utilization rates (occupancy) above the threshold level.

Benefit-Cost Tests

All investments identified by TERM are subject to a benefit-cost test. The Rehabilitation and Replacement and Asset Expansion modules, apply a benefit-cost test to all investments on a by mode and by agency basis, i.e., these modules consider the value of investing in a particular transit mode by a particular agency, but do not evaluate the benefit of purchasing each piece of equipment separately or on the basis of the location where the investment will be made within each agency's operating area. In the case of transit, where investments are comprised of a wide range of capital goods, it is more practical to evaluate transit investments as a package. In the Performance Enhancement module, investments to decrease vehicle utilization are also evaluated by agency and by mode, but investments to increase operating speeds are evaluated on urbanized area basis rather than on an agency and modal basis to take into account the shift from bus to rail investments. TERM calculates and compares for each mode in each agency, or in the case of speed improvements for each urbanized area, the discounted stream of capital investment and operating and maintenance expenditures combined with the discounted stream of anticipated benefits accruing from the particular type of transit service investment being evaluated during a 20-year period. If the benefit cost ratio is greater than 1.0, i.e., the discounted stream of benefits exceeds the discounted stream of costs, the model's estimate of the capital investment is included in the overall national investment needs estimate. If the benefit-cost ratio is less than 1.0, the investment is excluded.

The Benefit-Cost module identifies three categories of benefits:

- Transportation System User Benefits
  - Travel-time savings, reduced highway congestion and delay, and reduced automobile costs (parking costs and taxi expenditures).

- Social Benefits
  - Reduced air and noise emissions, roadway wear, and transportation system administration.

- Transit Agency Benefits
  - Increased revenues from increases in ridership and reductions in operating and maintenance costs.

Whenever possible, the total level of benefits associated with each investment type is modeled on a per-transit PMT or per-auto VMT basis. Most of the benefits from transit investment are estimated by TERM to be "Transportation System User Benefits" and accrue to both new and existing passengers under both the Asset Expansion and the Performance Enhancement modules. Transit agency benefits—increased fare revenues and reduced operating and maintenance costs—are used to evaluate investments recommended by the Rehabilitation and Replacement and Asset Expansion modules, while social benefits—reduced air and noise emissions, roadway wear, and transportation system administration—are used to evaluate both Asset Expansion and Performance Enhancement investments.

The cost-benefit analysis performed by TERM does not incorporate demand or supply demand elasticities. On the demand side, TERM does not analyze how changes in transit service improvements will affect future ridership growth, i.e., the demand for transit. On the supply side, TERM does not take account the cost interactions between concurrent transit investments in the same urbanized area or between current and future investments**.**

Investment Requirements for Rural and Specialized Transit Service Providers

Investment requirements for rural areas are based on data collected in 2000 by the Community Transportation Association of America (CTAA). These data include the number and age of rural transit vehicles, according to vehicle type, such as buses classified according to size or vans. Requirements are estimated by determining the number of vehicles that will need to be replaced in each year over the 20-year investment period, totaling them and multiplying the total number of vehicles in each vehicle category by an estimated average vehicle purchase price based on information reported to FTA by transit operators for vehicle purchases made between 1998 to 2000. (These average prices are also used in TERM.) The number of rural vehicles that will need to be purchased to Maintain/Improve Conditions is calculated by dividing the total number of each type of bus vehicle or van by its replacement age, with different assumptions made of the replacement ages needed to "Maintain" or "Improve" conditions. The replacement age to "Maintain Conditions" is assumed to be higher than the industry recommended replacement age because surveys have revealed that transit vehicles are often kept beyond their recommended useful life. The "Maintain Conditions" replacement age is calculated by multiplying the industry recommended replacement age for each vehicle type by the ratio of the average age to the industry recommended age of large buses. The Improve Conditions replacement age is assumed to equal the industry recommended age. The Improve Conditions scenario also assumes additional vehicle purchases in the first year to eliminate the backlog of overage vehicles. The number of vehicles necessary to Improve Performance was estimated by increasing fleet size by an average annual rate 3.5 percent over the 20-year projection period. As discussed in Chapter 7, a 1994 study by CTAA, and more recent studies examining rural transit investment requirements in five states, identified considerable unmet rural transit needs, in areas where there is either no transit coverage or substandard coverage. The assumed 3.5 percent growth to fulfill these unmet rural investment requirements is less than half the 7.8 percent average annual increase in the number of rural vehicles in active service between 1994 and 2000, but is

believed to be sufficient since the populations of rural areas are declining. Between 1990 and 2000, the population in areas with less than 50,000 inhabitants decreased by 3.4 percent.

A similar methodology was applied to estimate the investment requirements of Special Service Vehicles, comprised principally of vans. A replacement age of 7 years was assumed to Maintain Conditions and 5 years to Improve Conditions. The Improve Conditions scenario also assumes additional vehicle purchases in the first year to eliminate the backlog of overage vehicles. No projections were made for performance enhancements.