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FOREWORD

Government agencies throughout the country are becoming more interested in committing public funds to preserve and modernize existing transit facilities and equipment. To assist these agencies, UMTA has been funding, through the Section 8 Technical Studies Program, local studies to assess future capital needs and develop funding priorities for capital investment.

This document summarizes the experience gained by the Metropolitan Transportation Commission in a project to develop an estimate of the capital readiness of the San Francisco area to maintain ther public transportation system. We believe that this report is an excellent example of capital planning and will be interesting to transit systems of all sizes.

Additional copies of this report are available from the National Technical Information Service (NTIS), Springfield, Virginia, 22161 at cost.

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I. INTRODUCTION

Government agencies throughout the country are becoming more interested in committing public funds to preserve and modernize existing facilities and equipment. This interest reflects a growing awareness of the long-range financing implications of major investment programs (which are often overlooked until these implications loom on the immediate horizon).[1] It also reflects a growing fiscal conservatism which challenges public officials to manage limited public funds in a manner that preserves and enhances government services. Finally, within the transit industry it reflects a recognition on the part of transportation professionals that the deterioration of existing plant and equipment, which plagued the transit industry in the 1950s and 1960s, can be avoided in the 1980s and 1990s only if serious attention is given to replacing and modernizing existing systems.

At the same time, in addition to the substantial capital funds needed to sustain the existing capital assets of transit systems, there are inevitably plans to improve and expand available levels of service. These plans involve a range of capital improvements which vary in complexity and cost.

Within this context, the San Francisco area Metropolitan Transportation Commission (MTC) initiated a project to complement its ongoing efforts with the Bay Area transit operators to set regional priorities for capital investment. Borrowing a concept from private sector strategic planning, the MTC undertook a project to provide the region with a preliminary estimate of its capital readiness to maintain and enhance the public transportation system in the San Francisco Bay Area over the long term.

The assessment of the region's capital readiness was designed to highlight the minimal capital needs required to modernize and sustain the existing plant and equipment within the region. It was also designed to provide a profile of the region's capital requirements over a sufficiently long period of time to demonstrate the continuing commitment of funds necessary to maintain and enhance the existing transportation infrastructure.

The intent of the project was to provide a sound and consistent foundation for future programming of projects and for

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[1] The Interstate Highway Program, for example, is only recently reflecting concern for the financing requirements to restore and maintain the national highway network.

obtaining a long-range commitment of federal and state funds for the maintenance of the transportation infrastructure in the Bay Area. The project was completed in December 1980 and has been used by MTC in preparing testimony presented before the California State Legislature and in congressional hearings on federal appropriations for public transportation investment and operation.

The objective of this report is to share the experience gained in this project with other regional and state agencies that may be initiating similar efforts to outline future funding requirements for publicly funded transportation programs. Including this introduction, the report consists of six chapters; the subsequent chapters are described below:

- Chapter II: Project Setting describes the context within which the project was undertaken.

- Chapter III: Methodology for Analysis of Capital Requirements outlines the analysis process that was used, including the requirements for input data, the underlying assumptions, and the steps involved in the application of the methodology.

- Chapter IV: Illustrated Application of the Methodology provides an example of how the methodology was applied by MTC.

- Chapter V: Conclusion describes potential extensions of the methodology to other users and program areas. It also discusses issues to be considered in the application of the methodology. The section concludes with suggestions for potential refinements to the methodology and briefly highlights the significance and key findings of this report.

Included as an appendix to the report is the Executive Summary from the final report of the MTC study. The Executive Summary describes the Analysis of the Capital Requirements of the San Francisco Bay Area Transit System for the period 1981-1995.

II. PROJECT SETTING

The San Francisco area Metropolitan Transportation Commission was created in 1970 by the California State Legislature to oversee and support comprehensive transportation planning and programming activities for the nine-county San Francisco Bay Area. This area covers 9,000 square miles. The 1980 population of the area was 5.1 million persons.

MTC is the designated Metropolitan Planning Organization (MPO) for the Bay Area. Through changes in state and federal legislation over the past 12 years, its responsibilities have increased to include:

- transportation planning;
- maintenance of the region's eligibility for state and federal funds;
- financial planning and programming of state and federal capital and operating funds for all modes of transportation;
- approval of transportation projects that receive state or federal funding;
- allocation of specific sources of funds;
- evaluation of the performance of transportation systems and of the provision of transportation services;
- promotion and development of guidelines for transit system coordination; and
- development and pursuit of legislative solutions to regional transportation concerns.

The MTC is, in effect, the trustee of regional transportation resources. As such, it is responsible for guiding the implementation of needed transportation improvements and the maintenance of existing transportation facilities and services.

As the trustee of regional resources for public transportation investment and operation, the MTC coordinates priority-setting activities for regional investment decisions in seven large public transportation systems and several medium-to-small transit operations serving nearly 50 cities and counties in the Bay Area. The seven large public transportation systems serve the densely populated areas of the MTC region, with service available to approximately 4.2 million or over 80 percent of the region's residents. The seven large systems include:

- Alameda-Contra Costa Transit District (AC Transit). AC Transit operates fixed-route bus services for portions of Alameda and Contra Costa counties between Richmond and Fremont, west of Oakland-Berkeley Hills. AC Transit provides transbay services from Eastbay cities to San Francisco. It also provides fixed-route services on a contractual basis for the central, eastern, and western Contra Costa transit authorities. AC Transit operates a fleet of 874 buses. In fiscal year 1981, AC Transit's fleet served 78.0 million unlinked transit trips.

- Golden Gate Bridge, Highway and Transportation District (GGBHTD). The GGBHTD operates fixed-route bus services in Marin and Sonoma counties and between San Francisco and Marin and Sonoma counties along the Highway Route 101 Corridor. The GGBHTD also operates ferry services between San Francisco and the cities of Sausalito and Larkspur. GGBHTD additionally sponsors vanpool, carpool, and club bus services, all intended to promote the best vehicular use of the bridges and highways in Marin and Sonoma counties. GGBHTD operates a fleet of 262 buses and four ferries. In fiscal year 1981, GGBHTD's fleet served a combined 12.5 million unlinked transit trips.

- San Francisco Bay Area Rapid Transit District (BARTD). The BART rail system consists of four lines, three of which connect San Francisco with Fremont, Concord, and Richmond. The fourth line serves the Eastbay communities between Fremont and Richmond. In contract with AC Transit, BART also operates express buses to serve eastern Alameda and central, eastern, and northern Contra Costa counties. The BART express bus system acts as a feeder to BART rail lines. In addition, BART operates, in contract with local agencies, bus shuttle service to the Oakland International Airport and to the Alameda County Government Center in Hayward. BART operates a fleet of 441 rail cars. In fiscal year 1981, BART's fleet served 49.2 million unlinked transit trips.

- San Francisco Municipal Railway (SF MUNI). MUNI operates fixed route services in virtually all parts of San Francisco to within one-quarter mile of all residences. The service is provided by a combination of streetcars, trolleys, buses, and cable cars. In 1980, MUNI initiated operation of its light rail vehicles (MUNI Metro). With full implementation of MUNI Metro, streetcars will be phased out. MUNI is in the process of adjusting its routing pattern to a basic grid system, with heavy emphasis on bus and trolley routes feeding MUNI Metro lines. MUNI owns a fleet of 78 streetcars, 345 trolley coaches, 528 buses, 100 articulated light rail vehicles, and 40 cable cars. In fiscal year 1981, MUNI's fleet served a combined 254.5 million unlinked transit trips.

- San Mateo County Transit District (SamTrans). SamTrans operates fixed-route services in the urbanized portions of San Mateo County with a fleet of 327 buses. SamTrans contracts with Greyhound for its intercity services. SamTrans services connect with AC Transit, BART, SF MUNI, and Santa Clara County transit systems. In addition, SamTrans operates 13 vans on a wheelchair-accessible fixed-route service called Redi-Wheels, intended for elderly and handicapped persons who have difficulty using conventional transit. San Mateo County is also served by the Southern Pacific/Caltrans rail service, connecting San Francisco and San Jose. SamTrans provides feeder service to 13 stations. In fiscal year 1981, SamTrans' fleet served 16.4 million unlinked transit trips.

- Santa Clara County Transit District (SCCTD). SCCTD operates fixed-route services in the urbanized portions of central and northern Santa Clara County. In addition, the Dial-a-Ride system is in operation in the south, in the cities of Gilroy and Morgan Hill. Santa Clara County is also served by the Southern Pacific commuter rail service. SCCTD is a party to the agreement to maintain and improve this service. SCCTD has conducted an alternatives analysis for a possible light rail system. Significant expansion of services is planned for the future with a combination of light rail and commuter rail systems and the expansion of the existing bus system. SCCTD owns a fleet of 654 buses as of June 1982. In fiscal year 1981, SCCTD's fleet served 24.1 million unlinked transit trips.

. Southern Pacific Commuter Service. The California Department of Transportation (Caltrans), authorized by the legislature, negotiated a purchase-of-service agreement with the Southern Pacific Transportation Company (SP) to maintain and upgrade the Peninsula Passenger Rail Service. SP/Caltrans operates 46 trains (23 each way), serving 26 stations along the 47-mile route connecting San Jose and San Francisco. The SP commuter service utilizes 46 double-deck and 27 regular suburban coaches. In fiscal year 1981, SP's fleet served 6.3 million unlinked transit trips.

The size and diversity of these systems place significant demands on funding resources and require careful planning. This planning must address the dual objectives of sustaining existing plant and equipment as well as undertaking expansion and improvement in services for new and growing markets.

The objective of this report is to describe the efforts undertaken by the MTC to methodically outline the requirements for achieving these objectives. The report documents the process through which the methodology was developed and illustrates the application of the methodology to Bay Area transit operators. Although the report is based on the experience of the MTC, the approach is generally applicable to other regional or state agencies administering funding programs and could be extended to other modal program areas including highway program development.

III. METHODOLOGY FOR THE ANALYSIS OF CAPITAL REQUIREMENTS

MTC's effort to determine funding requirements to sustain and improve the public transportation infrastructure in the San Francisco Bay area was intended to:

- illustrate the long-range financing implications of recent investment programs.
- provide the data and information necessary for MTC to:
  - respond to the challenge of a growing fiscal conservatism that emphasizes the prudent expenditure of public funds to preserve and enhance existing services; and
  - offset the deterioration of existing plant and equipment through a balanced program of investment in replacement, modernization, and expansion.

To achieve these objectives, MTC required a projection of its capital funding needs by year for a period of 15 or more years into the future.

In order to project these funding needs, it was considered useful to separate capital program requirements into two categories:

- <u>Needs to improve and expand the level of service</u>. This category includes the capital investments planned by transit operators to improve or expand their existing level of service.
- <u>Needs to modernize and sustain existing plant and equipment</u>. This category reflects the replacement cost of existing assets with no remaining useful life and the ongoing cost to replace existing assets at the end of their useful lives.

The first category of requirements is normally developed through the ongoing planning process of transit agencies. In this process agencies determine the timing and extent of needed capital improvements by analyzing projected demands for transit service and the capacity of the existing system to serve these demands. Through this assessment process, data on funding requirements for capital expansion are typically available for evaluation, and new and innovative methods for determining these needs is unnecessary.

The requirements in the second category, however, are often considered only in the short-range program budgeting framework of the transit agency. A longer range perspective on the capital requirements to sustain and modernize existing plant and equipment is unusual. Accordingly, a new and innovative method for quickly, efficiently, and economically determining these needs is required to ascertain the full range of capital funding requirements faced by the transit agency.

CONCEPTUAL DEVELOPMENT OF THE METHODOLOGY

In order to determine the capital funding requirements to sustain and modernize existing plant and equipment, it is necessary to develop a method for establishing a replacement schedule for the capital assets owned and used by the transit agency. This replacement schedule should reflect the agency's consideration of the cost of replacing the asset in comparison with the ongoing and increasing costs to maintain the asset as a productive resource. If done on an asset-by-asset basis, this cost comparison would be time consuming and expensive. A simpler method, therefore, is desirable.

The method chosen by MTC was to determine the replacement schedule for existing assets using the average useful life of these assets established by each transit agency. Useful lives of assets are generally estimated for the purposes of calculating depreciation for deductions against taxable income and for properly representing the assets and liabilities of private and public enterprises. Accordingly, estimates of useful lives are intended to represent, on average, the number of years an asset is expected to be economically productive. On average, an asset that is in service beyond its useful life is more costly to maintain than to replace. As with any average, some assets will have a shorter economic life than their estimated useful life, and others will have a longer economic life. The useful life of an asset can, nevertheless, provide an objective and consistent guide for determining the replacement schedule for assets owned and used by a transit agency.

UNDERLYING ASSUMPTIONS AND THEIR IMPLICATIONS

Basing the replacement schedule of assets on the useful life of the assets involves a significant simplification of a complex capital programming activity. The simplified approach described in this report was intended to provide a rough estimate--what some managers call an "order of magnitude" estimate--of the replacement costs for the existing capital assets of a transit system.

The maintenance and replacement of capital assets is critical to the ongoing vitality of transit systems, and the scheduling of replacement financing requirements is essential for setting priorities for the use of limited capital funding resources. Exhibit 1 summarizes some of the most important factors influencing the scheduling and cost of a replacement program and indicates how these factors are treated in the simplified analysis based on the useful lives of assets. As shown in this exhibit, a number of assumptions were made in the simplified analysis. The principal assumptions are:

- Assets were assumed to be replaced at the end of their useful life, not when money is available. If a transit operator assumes a useful or economic life of 12 years for a bus, this approach asumes that a bus will be replaced in the first full year following its twelfth year of service.

  The simplified analysis process disregards the impact of availability of funds on the replacement schedule. Similarly, it does not recognize the potential influence of federal, state and local program priorities which can postpone replacement in favor of investment in necessary service expansion.

- Useful life estimates were based on the individual assumptions of each operator. Therefore, the results will reflect the fact that one operator may assume 10 years and another 12 years as a useful life for the same asset. These differences should reflect appropriate replacement cycles for each operator, given that the operating conditions and maintenance practices differ among operators.

  It was also assumed that the current maintenance and operating practices would continue. No explicit adjustments were made for possible trade-offs between maintenance and replacement.

  If an operator changes its policy and invests in maintenance efforts intended to prolong the useful life of assets, or if he chooses to save on maintenance costs during the early years but risk higher maintenance costs, operating problems, and earlier replacement in later years, the effect of these changes would not be reflected in the results of the simplified analysis.

- No recognition was made for the possibility of rehabilitating assets or replacing worn out assets by acquiring rehabilitated assets. This is an emerging trend, particularly for certain vehicles

EXHIBIT 1

FACTORS AFFECTING CAPITAL REPLACEMENT COSTS

FACTORS AFFECTING CAPITAL REPLACEMENT COSTS	HOW CONSIDERED IN SIMPLIFIED ANALYSIS	COMMENTS
Inventory Factors		
• Units purchased	Implicit	This factor is considered, to the extent that estimated replacement assumes the same number of units are purchased. purcnasea.
Scheduling Factors		
• In-service dates	Explicit	
• Useful life of assets	Explicit	
• Maintenance practices	Implicit	This factor is considered to the extent that maintenance practice influences useful life estimates.
• Availability of funds	Excluded	
• Local/regional priorities	Excluded	
• Federal priorities	Excluded	
Cost Factors		
• Acquisition cost of units	Explicit	
• Cost escalation assumptions	Explicit	
• Technological innovation	Excluded	

and equipment, and the extent to which it is an active part of a transit agency's capital improvement program can affect the need for financial resources for modernization and improvement.

- Similarly, the simplified process does not explicitly address the implications of an operator's replacement of assets that were purchased used or rehabilitated. If a transit property had 10 rehabilitated transit vehicles in its fleet that were past their estimated useful lives, these 10 vehicles would be replaced by 10 new vehicles in the first year of the analysis period at the current estimated cost of new vehicles, not at the inflated cost of their purchase price as rehabilitated assets.

- The simplified process does not incorporate the effects of technological innovation in the estimation of replacement costs. This omission probably results in an overstatement of replacement costs for certain items such as data processing equipment, where technological innovation continues to improve quality and reduce cost. In addition, as a result of this omission the analysis overlooks probable technological substitutions as assets are replaced, such as the substitution of articulated coaches for standard coaches.

- It was assumed that the service level would remain constant or increase. The simplified method does not reflect consideration of possible reductions in or abandonment of service.

The assumptions and data explicitly reflected in the simplified analysis include:

- in-service dates for assets;

- useful lives of assets;

- acquisition cost of assets; and

- cost escalation or effects of inflation on asset replacement.

In summary, the analysis of replacement costs outlined in this report is based on a set of simplifying assumptions intended to provide projections that can be refined and modified in the future. Not all of the information needed for a more sophisticated approach is used in the analysis approach, and changes in major assumptions could change the projections significantly.

IV. APPLICATION OF THE METHODOLOGY

Exhibit 2 illustrates the process used to project the needs to modernize and sustain the existing plant and equipment and to improve and expand the level of service for the seven large transit systems under MTC's jurisdiction. As shown in this exhibit, the cost to sustain the existing plant and equipment was projected through an analysis of the age of existing assets compared with the estimated useful life of these assets in active service.

The approach assumed that equipment and other assets should be replaced at the end of their useful lives. Since this is not currently done, the approach defines a replacement schedule for the transit operators.

As shown in Exhibit 2, the following procedure was used to project the requirements to modernize and sustain the existing plant and equipment:

- Obtain the capital asset listings of each transit operator at a common and recent point in time.

- Restate the asset listings into a common asset classification system. In the application for MTC, the MTC Reporting System classification was used. This system is illustrated in Exhibit 3. The reclassification of operator asset listings into a common system required some judgment and was reviewed with each operator prior to proceeding with the next step.

- Estimate the useful lives of the assets by asset classification. Generally, the useful or economic lives used for depreciation by the transit operators were also used for this analysis.

- Develop future escalation assumptions for each class of asset. Typically, the annual cost escalation rates for 1981 to 1995 were assumed to follow historical averages.

- Calculate the replacement cost of each asset class as follows:

  - immediately replace all equipment older than its useful life;

EXHIBIT 2

OVERVIEW OF ANALYSIS APPROACH

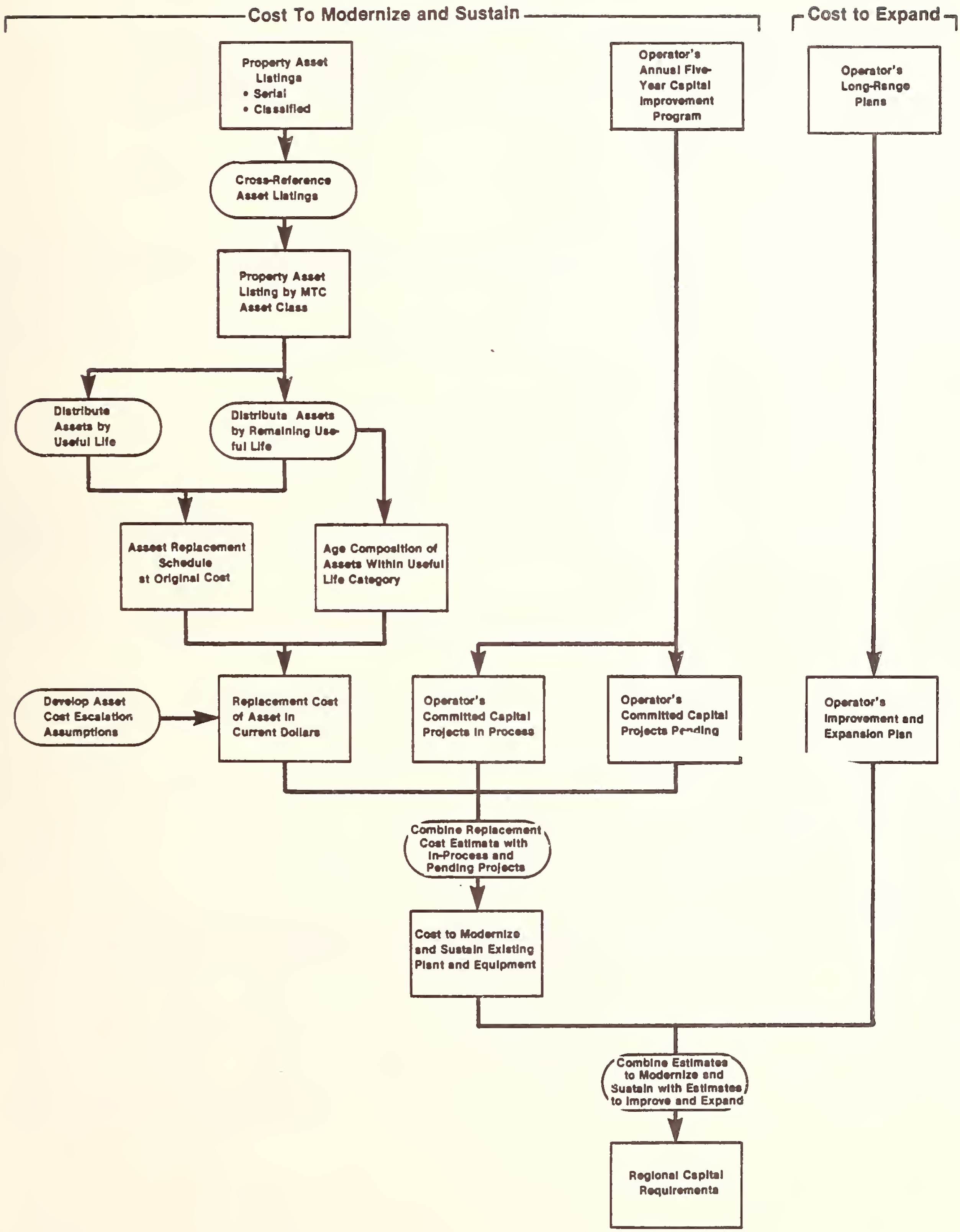

EXHIBIT 3

MTC ASSET CLASSIFICATION SYSTEM

MTC Asset Class
New, Used, or Reconditioned Revenue Vehicles
Service Vehicles
Transit Way
Power Generation and Distribution Facilities
Passenger Stations
Passenger Parking Facilities
Operating Yards and Stations
Vehicle Maintenance Shops and Garages
Other General Administrative Facilities
Revenue Vehicle Movement Control
Revenue Collection and Processing
Data Processing
Communications
Office Equipment
Other Fixed Assets
Capitalized Engineering

SOURCE: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995," Metropolitan Transportation Commission, December 1980.

- estimate timing of replacement cycles by combining the date that the asset was initially placed in service with the estimated useful life of the asset; and

- estimate the replacement cost by escalating the original acquisition cost at the assumed annual escalation rates up to each projected replacement date.

- Add in the estimated cost of committed capital projects.

The full cost to sustain the existing system is determined by combining the estimates of replacement costs with the committed capital projects for which funding obligations have been formally recognized for each operator. Total capital requirements are determined by adding planned expenditures for service expansion to this projection.

EXAMPLE APPLICATION OF THE METHODOLOGY

To illustrate the process outlined above, an application of the methodology is presented here showing the development of the estimate to modernize and sustain a portion of BART's existing plant and equipment.

Step 1: Restate BART's Assets Into MTC Asset Classification Structure

The purpose of this step was to provide a uniform and consistent definition of assets for all operators under MTC's jurisdiction. In this application, the MTC asset classification structure shown in Exhibit 3 was used. Because each operator maintained its own inventory of assets and asset classification code, the individual asset inventories were regrouped and restated in a uniform format to simplify comparisons and to organize the presentation of the results.

Using the asset inventory maintained by BART as of June 30, 1980, this restatement is illustrated in Exhibit 4. As shown in this exhibit, BART's asset inventory is maintained at a more detailed level than the MTC classification structure. This was true for each of the operator inventories and, consequently, the resulting restatement reflected groups of assets with varying useful lives. The category Trucks, Autos and Other Service Vehicles, for example, includes assets with useful lives of 5 and 20 years for BART.

EXHIBIT 4

BART/MTC ASSET CLASS CROSS-WALK FOR ANALYSIS OF CAPITAL REPLACEMENT REQUIREMENTS

MTC Asset Class		BART Asset Class(es)		
Rapid Transit Cars	$95,623,868	41-10, 20	Revenue Vehicles	$91,267,670
		71-XX	Vehicle Components	4,356,198
Motor Buses	49,619	42-10	Motor Buses	49,619
Trucks, Autos, and Other Service Vehicles	4,053,622	53-01, 02, 03, 04, 05 to 21	Service Vehicles	3,574,657
		54-01	Locomotives	478,965
Transit Way	481,977,294	24-XX	Transit Way Equipment	41,877,327
		22-XX	Transit Way	429,134,791
		26-20	Vent Buildings	10,965,176
Power Generation and Distribution	41,827,815	26-10	Substations	3,861,780
		31-XX	Electrication Equipment	36,845,729
		76-XX	Power Control	149,050
		77-XX	Power Equipment	14,492
		78-XX	Power Equipment	692,640
		79-XX	Power Equipment	179,073
		81, 82, 83, 85, 86	Power Equipment	85,051
Passenger Stations	230,479,759	21-10	Passenger Stations	219,538,907
		27-XX	Escalators/Elevators	10,011,469
		33-40	Station Signs	929,383
Passenger Parking Facilities	15,071,061	26-40	Parking Lots	11,103,810
		26-50	Lot Landscaping	3,967,251
Operating Yards and Stations	25,374,942	26-30	Yard Access	200,598
		60-09, 10	Operating Yards and Stations	25,174,344
Vehicle Maintenance Shops and Garages	22,030,518	23-10	Maintenance Yards and Support Capital	16,535,711
		51-XX	Maintenance Equipment	5,282,092
		52-01, 02	Trainwasher; Vehicle Lifts	212,715
Other General Administrative Facilities	3,843,687	25-10	Administration Building	3,843,687
Revenue Vehicle Movement Control	28,673,105	32-XX	Train Control Equipment	27,753,912
		75-XX	Train Control Equipment	919,193
Revenue Collection and Processing	18,764,406	34-XX	Fare Equipment	17,047,001
		57-01	Revenue Counting	748,686
		74-XX	Fare Gates	968,719
Data Processing	1,052,908	56-XX	Computer Equipment	1,052,908
Communications	11,951,261	33-10, 20	Radio Equipment, etc.	11,625,018
		30	Video Equipment	326,243
Office Equipment	1,817,607	55-XX	Office Equipment	1,817,607
Capitalized Engineering and Construction Management	227,221,947	60-01, 02	Capitalized Engineering	127,245,256
		60-05	Capitalized O.E.	99,976,691
Subtotal Replaceable Capital	1,209,813,419			
Land and Other Non replaceable Assets	310,659,911	60-03, 04	Utility Relocation	54,030,778
		60-20, 30	Property Improvements	61,452,247
		10-10	Land	114,294,529
		99-99	Unallocated Property	80,882,357
TOTAL ALL ASSETS	1,520,473,330			

Step 2: Estimate the Useful Life of Assets By Asset Class

The methodology developed and applied by MTC was based on the use of each operator's own estimate of the useful life of specific assets, as recorded in the operator's asset inventories. The purpose of using the individual operator estimates of useful life was to reflect the effects of different operating conditions, maintenance practices, and the type of facilities and equipment owned on the useful life of specific assets.

The methodology did not include a review of the useful life estimates of the individual operators to determine the extent to which they truly reflected these differences between systems. Accordingly, there were substantial differences between operators in certain categories that were not evaluated in detail. BART, for example, indicated a useful life distribution for assets in the category Vehicle Maintenance Shops and Garages as follows:

Asset Class	Value of Assets at Cost	Useful Life
Shops and Garages	16,535,711	80 years
	5,494,807	20 years

For the same category, GGBHTD indicated a useful life of 55 years.

Step 3: Estimate the Timing of Replacement Cycles

In this step, the dates that assets were initially placed in service are combined with the estimated useful lives of these assets to determine a schedule for replacement and modernization for the transit system. This schedule is developed following a rule of replacing each asset at the end of its useful life.

The schedule is developed by first preparing a profile of the acquisition dates, age, and remaining useful lives of existing assets. Exhibit 5 provides an illustration of this profile for a portion of BART's assets in the asset class Cars, Trucks, and Other Service Vehicles.

The profile presented in Exhibit 5 is converted directly into a schedule of replacement and modernization, as shown in Exhibit 6. This profile illustrates the repetitive replacement of assets in this class over the analysis period and demonstrates the modernization feature of the analysis process: the transit system replaces all assets with no remaining useful life in 1980 in the first year of the analysis period. It should be

EXHIBIT 5

ILLUSTRATED PROFILE OF EXISTING ASSETS

Asset Class :	Cars, Trucks, and Other Service Vehicles
Estimated Useful Life:	5 years
Transit Operator :	BART

Year of Acquisition	Cost of Assets At Acquisition	Age of Assets (Years in 1980)	Remaining Useful Life (Years in 1980)	Scheduled* Replacement Year
1970	0	10	0	1981
1971	$35,476	9	0	1981
1972	295,277	8	0	1981
1973	488,722	7	0	1981
1974	115,186	6	0	1981
1975	367,100	5	0	1981
1976	56,824	4	1	1981
1977	119,399	3	2	1982
1978	170,934	2	3	1983
1979	51,573	1	4	1984
1980	6,725	0	5	1985

* Based on Useful Life Methodology

EXHIBIT 6

ILLUSTRATED PROFILE OF REPLACEMENT AND MODERNIZATION

Asset Class :	Cars, Trucks, and Other Service Vehicles
Estimated Useful Life:	5 years
Transit Operator :	BART

Year of Replacement/ Modernization*	Assets Replaced (Value at Original Cost)
1981	$1,318,585
1982	119,399
1983	170,934
1984	51,573
1985	6,725
1986	1,318,585
1987	119,399
1988	170,934
1989	51,573
1990	6,725
1991	1,318,585
1992	119,399
1993	170,934
1994	51,573
1995	6,725

* Based on Useful Life Methodology

noted that this process discounts any implications of shortages of funds or other investment priorities on the programming of modernization and replacement.

Step 4: Develop Escalation Assumptions for Each Asset Class

The cost to modernize and sustain the existing plant and equipment of Bay Area transit operators needs to reflect the effect of inflation on the expense to acquire and construct new facilities and equipment. This effect was estimated in the MTC application of the methodology using the following equation:

$$\text{Projected asset replacement cost} = \text{Initial cost of asset} \times \frac{\text{Inflation index in replacement year}}{\text{Inflation index in year of original acquisition}}$$

The key to the application of this equation is the development of appropriate inflation indices.

To ensure consistency in the results, and to provide as strong a foundation for the projection as possible, the methodology applied inflation indices reported routinely by the U.S. Department of Commerce for the cost of the production of goods and services. The specific indices used in the application of the methodology were the Producer's Price Indices for machinery and equipment, office equipment, motor vehicles, and railroad equipment. For the period of the analysis from 1981 through 1995, these indices were projected to increase at the compound annual rate experienced between 1970 and 1980. The resulting indices are shown in Exhibit 7.

In the application of the methodology for MTC, these indices were used as follows:

- The indices were first assigned to specific asset classes for the purposes of relating cost escalation in a particular asset class to an appropriate measure of historical experience. The assignment used in the MTC application is summarized in Exhibit 8.

- Using the equation described above, the indices were then applied to the projected requirements for replacement and modernization measured at their initial cost. For example, the replacement cost of 20 vehicles, acquired at an initial cost of $3 million in 1979, and with an estimated useful life of 15 years, was estimated as follows:

EXHIBIT 7

INFLATION INDICES USED IN ANALYSIS OF CAPITAL REQUIREMENTS

	PPI-all items (1939 = 100)	Machinery & Equipment (1939 = 100)	Office Equipment (1939 =100)	Motor Vehicles (1939 = 100)	RR Equipment (1939 = 100)
1940	101.8	101.6	100.7	101.5	101.9
1941	113.4	112.1	105.0	111.0	114.0
1942	128.0	125.2	110.1	122.9	129.3
1943	134.1	130.6	112.1	127.7	135.6
1944	134.9	131.2	112.3	128.4	136.5
1945	137.4	133.4	113.1	130.4	139.2
1946	156.8	150.5	119.1	145.7	159.6
1947	192.5	181.7	129.2	173.2	197.5
1948	208.3	195.1	133.2	185.0	214.3
1949	197.9	188.3	130.6	179.2	203.1
1950	205.6	194.9	132.6	185.0	211.5
1951	229.1	215.0	138.3	202.4	236.6
1952	222.9	209.8	136.9	197.9	230.0
1953	219.8	206.9	136.2	195.5	226.5
1954	220.2	207.3	136.3	195.9	227.0
1955	220.7	207.7	136.5	196.3	227.4
1956	227.9	213.9	137.9	201.6	235.2
1957	234.1	219.1	139.2	206.1	241.8
1958	237.4	221.9	139.9	208.5	245.4
1959	237.8	222.3	140.0	208.9	245.9
1960	238.1	222.6	140.0	209.2	246.1
1961	237.1	221.7	139.9	208.5	245.1
1962	237.8	222.3	140.0	208.9	245.9
1963	237.1	221.7	139.9	208.5	245.1
1964	237.6	222.1	140.0	208.9	245.6
1965	242.3	226.1	141.0	212.5	250.8
1966	249.6	232.2	142.6	217.8	258.6
1967	250.1	232.7	142.7	218.2	259.1
1968	256.4	238.0	144.0	222.8	265.8
1969	266.4	246.4	146.2	230.0	276.7
1970	276.2	254.7	148.2	237.1	287.2
1971	285.1	262.1	150.0	243.3	296.7
1972	298.2	273.1	152.5	252.5	311.0
1973	337.2	305.7	160.0	279.8	353.2
1974	401.0	357.9	171.2	323.4	422.8
1975	437.9	387.6	177.0	348.0	463.4
1976	458.0	403.9	180.0	361.2	485.7
1977	485.9	426.1	184.2	379.3	516.3
1978	523.4	455.9	189.5	403.5	557.6
1979	589.3	507.9	198.4	445.5	630.6
1980	674.8	574.9	209.1	499.0	725.8
1981	737.5	623.3	216.5	537.4	796.2
1982	806.1	675.6	224.0	578.8	873.5
1983	881.1	732.4	231.9	623.3	958.2
1984	963.0	793.9	240.0	671.3	1051.1
1985	1052.6	860.6	248.4	723.0	1153.1
1986	1150.5	932.9	257.1	778.7	1265.0
1987	1257.4	1011.2	266.1	838.7	1387.7
1988	1374.4	1096.2	275.4	903.2	1522.3
1989	1502.2	1188.3	285.0	972.8	1669.9
1990	1641.9	1288.1	295.0	1047.7	1831.9
1991	1794.6	1396.3	305.3	1128.4	2009.6
1992	1961.5	1513.6	316.0	1215.2	2204.5
1993	2143.9	1640.7	327.1	1308.8	2418.4
1994	2343.3	1778.5	338.5	1409.6	2652.9
1995	2561.2	1927.9	350.4	1518.1	2910.3

EXHIBIT 8

ASSIGNMENT OF INFLATION INDICES TO ASSET CLASSES

	INFLATION INDEX			
MTC Asset Class	Machinery and Equipment	Office Equipment	Motor Vehicles	Railroad Equipment
Rapid Transit Cars				X
Motor Buses			X	
Cars, Trucks, and Service Vehicles			X	
Transitway				X
Power Generation				X
Passenger Stations				X
Passenger Parking Facilities				X
Operating Yards and Stations				X
Shops and Garages				X
Other General Administrative				X
Revenue Vehicle Movement				X
Revenue Collection	X			
Data Processing	X			
Communications	X			
Office Equipment		X		
Capitalized Engineering				X

$$\text{Projected asset Replacement cost} = (\$3 \text{ million}) \times \frac{\text{Inflation index in 1994}}{\text{Inflation index in 1979}}$$

$$= (\$3 \text{ million}) \times \frac{1409.6}{445.5}$$

$$= \$9.5 \text{ million}$$

This is the cost that was projected to occur in 1994 at the end of the useful life of the vehicles acquired in 1979.

As in any projection of possible future financial results, the impact of inflation is uncertain. Consequently, it is appropriate, and advisable, to consider the use of a range of inflation indices to test the sensitivity of the resulting projection. This test was not conducted in the MTC application of the methodology.

Step 5: Estimate Cost of Modernization and Replacement

In this step, the results of Steps 3 and 4 are combined to project the cost of replacement and modernization by escalating the original acquisition cost at appropriate annual inflation rates. Exhibit 9 shows the results of this step applied to the replacement and modernization schedule presented in Exhibit 6.

Step 6: Add in Committed Capital Projects

Projects that have previously been funded but are not accounted for in the analysis conducted in the first five steps outlined above should be added to the cost to replace and modernize the existing system. These projects, as they have been approved and funded, are considered part of the existing system whether they represent replacement or expansion and improvement efforts. In this step, special care needs to be taken to prevent double counting of items previously identified for replacement in Step 5.

Step 7: Add in Plans for Expansion of Service

Total capital financing requirements are obtained by adding the cost of planned expansion in service to the cost to modernize and sustain the existing plant and equipment. This is the final step in the analysis process.

ILLUSTRATION OF THE RESULTS OF THE PROCESS: BART

The analysis of capital replacement requirements within the San Francisco Bay Area relied upon data maintained by operators to describe their asset inventories. For the analysis conducted, BART provided the best data base of the operators in the region.

EXHIBIT 9

ILLUSTRATED PROJECTION OF COST TO MODERNIZE AND SUSTAIN EXISTING ASSETS

Asset Class :	Cars, Trucks and Other Service Vehicles
Estimated Useful Life:	5 years
Transit Operator :	BART

Year of Replacement/ Modernization	Replacement Schedule (from Step 3)	Inflation Multiplier (from Step 4)	Cost of Replacement/ Modernization
1981	$1,318,585	[a]	$2,181,237
1982	119,399	1.526 [b]	182,199
1983	170,934	1.545	264,047
1984	51,573	1.507	77,712
1985	6,725	1.449	9,744
1986	1,318,585	[c]	3,404,173
1987	119,399	2.211	264,012
1988	170,934	2.238	382,621
1989	51,573	2.184	112,616
1990	6,725	2.100	14,120
1991	1,318,585	[d]	4,580,028
1992	119,399	3.204	382,530
1993	170,934	3.244	554,445
1994	51,573	3.164	163,181
1995	6,725	3.042	20,450

Modernization Component + Replacement Component

(a) $\frac{537.4}{323.4} \times 1,261,761 + \frac{537.4}{361.2} \times 56,824$

(b) $\frac{578.8}{379.3} = 1.526$

Modernization Component + Replacement Component

(c) $\frac{838.7}{323.4} \times 1,261,761 + \frac{838.7}{361.2} \times 56,824$

Modernization Component + Replacement Component

(d) $\frac{1,128.4}{323.4} \times 1,261,761 + \frac{1,128.4}{361.4} \times 56,824$

Because it is a relatively new system, BART was expected to have minimal capital replacement needs in the short run and growing replacement requirements as the system ages. This expectation is confirmed by the results of the analysis shown in Exhibit 10. As shown in this exhibit, BART's expected replacement requirements grow from just under $8 million from 1981 to 1985 to over $400 million from 1991 to 1995.

Of BART's total asset inventory, however, only slightly under 6 percent is replaced between 1981 and 1995, and all of the assets replaced during this period have useful lives recorded by BART at under 20 years. Exhibit 11 summarizes the composition of BART's assets by useful lives for the remaining replaceable assets owned by BART. As shown in this exhibit, of the 94 percent of BART's assets not replaced during the time frame of the analysis period, over 20 percent have useful lives of either 20 or 30 years. These assets will be wearing down and will require replacement at the turn of the century.

The largest replacement costs for BART between 1991 and 1995 are for the following asset classes:

- Power Generation and Distribution Facilities: $42.6 million;
- Operating Yards and Stations: $46.5 million;
- Revenue Vehicle Movement Control: $191.5 million;
- Revenue Collection and Processing: $41.0 million; and
- Communications: $64.5 million.

The magnitude of these estimated replacement costs is based on the combination of the original asset cost and the effect of cost escalation on the price of asset replacement. The $42.6 million in the power generation and distribution category, for example, replaces $6.3 million in assets purchased between 1968 and 1971 and inflated over the 20 years of their useful life. The largest single-year replacement in this category occurs in 1991 and results from the replacement of the following assets acquired in 1971:

. Electrification System	
. Lake Merritt to Hayward Yard	$4,191,708
. Hayward Yard to Fremont	991,996
. Downtown Oakland	1,037,216
. "N" Division	289
	6,221,129
. Ground/Test Devices	
. 9 units at $4,342 per unit	39,078
	$6,260,207

EXHIBIT 10

ILLUSTRATION OF THE RESULTS OF THE ANALYSIS PROCESS: BART
(Thousands of Inflated Dollars)

MTC Asset Class	1981-1985	1986-1990	1991-1995
New, Used, or Reconditioned Revenue Vehicles	-	107	-
Service Vehicles	3,384	5,389	15,812
Transitway	-	-	-
Power Generation and Distribution Facilities	-	-	42,489
Passenger Stations	-	-	2,443
Passenger Parking Facilities	-	-	-
Operating Yards and Stations	-	53	46,470
Vehicle Maintenance Shops and Garages	-	3,369	19,066
Other General Administrative Facilities	-	-	-
Revenue Vehicle Movement Control	-	2,318	191,508
Revenue Collection and Processing	1,149	611	40,953
Data Processing	1,711	2,560	3,833
Communications		794	64,539
Office Equipment	1,708	906	2,411
Other Fixed Assets	-		-
Subtotal: Modernize and Sustain	7,952	16,107	429,524
Committed Capital Projects in Process[1]	26,411	-	-
Committed Capital Projects Pending[2]	49,580	-	-
TOTAL	83,943	16,107	429,524

1 Committed Capital Projects in Process reflect funded projects budgeted for FY 1980 (FY 1979 and FY 1980 for MUNI) that would not be expected to be recorded in the asset registers of each operator used to develop replacement cost estimates (sources: Form 141, April 1980.

2 Committed Capital Projects Pending reflect funded projects programmed for FY 1981 that may include expansion, improvement, and replacement but are counted as part of the existing system.

Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995," Metropolitan Transportation Commission, December 1980.

EXHIBIT 11

COMPOSITION OF BART'S REPLACEABLE ASSETS BY USEFUL LIFE CLASS
(in thousands of dollars at original cost)

MTC Asset Class	Value at Cost	Proportion of Original Cost Replaced During 15 Years	Proportion of Original Cost Not Replaced During Period	Useful Life Distribution of Assets Not Replaced During 15-Year Period				
				5 years	10 years	20 years	30 years	80 years
New, Used, or Reconditioned Revenue Vehicles	$ 95,677	-	100%	-	-	-	100%	-
Service Vehicles	4,054	99%	1	-	-	100%	-	-
Transitway	481,977	-	100	-	-	-	-	100%
Power Generation and Distribution Facilities	41,834	15	85	-	-	86	3	11
Passenger Stations	230,480	1	99	-	-	1	-	99
Passenger Parking Facilities	15,071	-	100	-	-	-	-	100
Operating Yards and Stations	25,375	23	77	-	-	-	-	100
Vehicle Maintenance Shops and Garages	22,031	15	85	-	-	11	-	89
Other General Administrative Facilities	3,844	-	100	-	-	-	-	100
Revenue Vehicle Movement Control	28,673	96	4	-	-	9	91	-
Revenue Collection and Processing	18,016	45	55	-	-	91	9	-
Data Processing	1,053	100	-	-	-	-	-	-
Communications	11,951	100	-	-	-	-	-	-
Office Equipment	1,818	100	-	-	-	-	-	-
Other Fixed Assets	-	-	-	-	-	-	-	-
Capitalized Engineering	227,222	-	100	-	-	-	44	56
Total - All Replaceable Assets	$1,209,076	6%	94%	-	-	4%	17%	79%

Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995," Metropolitan Transportation Commission, December 1980.

Inflating these assets over their 20-year useful life to determine an estimated replacement cost results in a projected outlay of $42.4 million in 1991.

In addition to replacement of assets held at June 30, 1980, BART's capital requirements to sustain the existing system include the cost of committed projects in process and committed projects pending. These projects represent all funded capital formation during the FY 1980 budget and FY 1981 to FY 1985 program years, respectively, and include a mix of investment activity for capital/service expansion and service improvement (including operational efficiency improvements). As shown in Exhibit 10, BART's committed capital projects total $76 million ($26.4 million in process, $49.580 million pending) and bring the total cost required to sustain the existing system to $83.943 million over the period 1981 through 1985.

In addition to the cost to modernize and sustain its existing plant and equipment, BART's service expansion and improvement plans continue to require significant capital funding. These plans, developed by BART in the course of its ongoing capital programming activities, were estimated to cost $197 million over the period 1981-1985 and an additional $287 million over the period 1986-1990. Combining these capital requirements with the projected needs to sustain and modernize the system provides a projection of BART's total capital funding demands over the period 1981-1995. This summary profile is shown in Exhibit 12.

ILLUSTRATION OF THE RESULTS OF THE PROCESS: REGIONAL TOTALS

On a regional scale, the analysis indicated a capital requirement of $2.1 billion to modernize and sustain the existing plant and equipment of the seven large transit systems under MTC's jurisdiction. The composition of this requirement by asset class and five-year increment is summarized in Exhibit 13. This estimate exceeds the amount of planned capital improvement and expansion identified by these systems, which adds an estimated $1.6 billion (Exhibit 14) to bring the total capital funding projection to $3.7 billion over the 15-year period 1981-1995.

On the assumption that historical patterns of state and federal assistance for transit capital funding held firm over this period, a projected $2 billion in non-local assistance was estimated to help fund this requirement.[1] This suggests that

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[1] Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995", Metropolitan Transportation Commission, December 1980.

EXHIBIT 12

SUMMARY OF BART'S PROJECTED CAPITAL FUNDING REQUIREMENTS (1981-1995)
(millions of inflated dollars)

	1981-1985	1986-1990	1991-1995	TOTAL
Projected cost to sustain and modernize existing plant and equipment[1]	83.9	16.1	429.5	529.5
Projected cost to expand and improve service	197.5	287.2	-	484.7
Total projected capital funding requirement	281.4	303.3	429.5	1014.2

[1] Summary totals taken from Exhibit 10.

Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995", Metropolitan Transportation Commission, December 1980.

EXHIBIT 13

SUMMARY OF ANALYSIS RESULTS: REGIONAL TOTALS

MTC Asset Class	Regional Total 1981-1985	1986-1990	1991-1995	Period Total
New, Used, or Reconditioned Revenue Vehicles	232,970	194,944	453,715	881,629
Service Vehicles	11,284	16,121	27,261	54,666
Transitway	23,041	1,056	35,476	59,573
Power Generation and Distribution Facilities	31,191	5,790	47,049	84,030
Passenger Stations	5,555	5,533	41,577	52,665
Passenger Parking Facilities	-	98	34,648	34,746
Operating Yards and Stations	61,226	61	46,480	107,767
Vehicle Maintenance Shops and Garage	20,434	13,714	39,329	73,477
Other General Administrative Facilities	-	15,079	37	15,116
Revenue Vehicle Movement Control	4,882	6,339	194,373	205,594
Revenue Collection and Processing	2,692	3,546	44,295	50,533
Data Processing	2,070	2,651	3,961	8,682
Communications	817	2,115	64,891	67,823
Office Equipment	3,051	1,670	5,105	9,826
Other Fixed Assets	626	281	704	1,611
Subtotal: Modernize and Sustain	400,839	268,998	1,038,901	1,708,738
Committed Capital Projects in Process	228,265	-	-	228,265
Committed Capital Projects Pending	172,980	-	-	172,980
Total	802,084	268,998	1,038,901	2,109,983

Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995," Metropolitan Transportation Commission, December 1980.

EXHIBIT 14

PLANNED CAPITAL IMPROVEMENTS AND EXPANSIONS

Transit Operator	Period 1981-1995	1986-1990 (in thousands of dollars)	1991-1995	Total
AC Transit	$ 9,500	$ 3,400	-	$ 12,900
BART	197,520	287,183	-	484,703
GGBHTD	14,800	-	-	14,800
MUNI	452,523	272,800	-	725,323
SamTrans	27,800	-	-	27,800
SCCTD	294,235	-	-	294,235
Caltrans/SP	2,100	-	-	2,100
Total	$998,478	$563,383	-	$1,561,861

Source: "Analysis of the Capital Requirements of the San Francisco Bay Area Transit Systems 1981-1995," Metropolitan Transportation Commission, December 1980.

nearly 50 percent of the total capital program, or $1.7 billion, will need to be raised from local sources. Alternatively if local public assistance cannot be increased the program requirements will have to be scaled back to reflect priority application of the limited resources.

REACTION OF TRANSIT OPERATORS TO PROJECTIONS RESULTING FROM THE ANALYSIS

During the course of the study, a number of transit operators suggested that the bounds or limits of the data be used to identify the "most" and "least" likely occurrences within the range of information developed. Because the estimate of the capital funds required to sustain the Bay Area transit systems is dependent on the useful lives used by the transit operators and on the implicit replacement schedule, a few transit operators believe that the replacement cost data represent the high end, or a pessimistic view, of the required investment. The argument may be correct for some asset categories. Of the $2.1 billion estimated as required to sustain the transit systems over a 15-year period, $427 million (or 20 percent of the total) is required for replacing major capital asset which may not actually need replacement over the 15-year period: transit way, power generation and distribution facilities, passenger stations, passenger parking facilities, operating yards and stations, vehicle maintenance shops and garages, and other general administrative facilities. The capital asset categories comprised by the $427 million figure are not likely to need replacement if they are well maintained. However, as two of the older transit systems have recently learned, major capital assets such as maintenance facilities or operating yards can wear out and land acquisition costs alone can be more expensive than the historical cost of constructing a facility and acquiring land.

Further, the estimate of the replacement costs for revenue vehicle movement control, data processing, and communications equipment--$282 million, or 13 percent of the total--was questioned as being a high estimate. Some dollar amount is viewed as reasonable because the equipment will wear out, but costs are expected to decrease not increase, over time, as a result of technological innovation.

V. CONCLUSION

This chapter discusses ways in which the methodology described in this report could be extended to other transit operators. It also suggests potential refinements to the methodology and briefly highlights the significance and key findings of the report.

GENERAL APPLICABILITY OF METHODOLOGY

The methodology described in this report is applicable to the wide range of services and functions provided by transit systems. The methodology provides a simplified approach for assessing the capital required to sustain existing plant and equipment and provides the necessary context for considering the capacity for improving and expanding the infrastructure beyond its current level of service. The approach can be applied to other transit operators, given the following provisions:

- Data describing the asset inventories of the transit system are available. These inventories should include in-service dates of assets and estimated useful lives of assets.

- Data on historical cost escalation for replacement of assets are available. These data need not be maintained by each transit operator; industry trends can be used in lieu of agency-specific data if necessary. The example shown in Chapter IV illustrates the use of national inflation indices for this purpose.

With this data, the analysis for an individual transit system can be completed within a period of one week.

POTENTIAL REFINEMENTS OF THE METHODOLOGY

Several refinements of the methodology have been suggested throughout this report. The principal refinements suggested for potential users of the approach include:

- more accurate estimates of useful lives, giving consideration to optimizing life cycle costs (both capital costs and operating costs).

- evaluation of capital requirements by category of asset to better determine the impact of deferring the expenditures. For example, the assets could be stratified into two broad categories reflecting:

  - assets that have a relatively predictable and certain useful life and have a very high probability of requiring replacement on a regular schedule. Vehicles used in revenue service are a good example of this type of asset.

- assets that have a less predictable useful life and may be productively used well beyond the average useful life for the asset category. Buildings and other fixed assets, for example, may have a very low probability of requiring replacement on a regular schedule because the productive useful lives of these fixed assets vary widely.

- sensitivity analysis of the capital requirement projections to test the effects of alternative rates of cost escalation or alternative estimates of useful lives. In the application of the methodology for MTC, historical rates of inflation were used as the basis for projecting cost escalation into the future. The historical period used to develop cost escalation assumptions will have a significant impact on the projected results and there is always a high degree of uncertainty in these projections. This uncertainty is demonstrated by the recent, dramatic decrease in the cost of living index which is now far below the rate that would be extrapolated from the experience of the last decade. This uncertainty emphasizes the need to conduct analysis of the sensitivity of projected results to key assumptions such as projected cost escalation.

- the use of current market cost data to estimate the capital requirements for assets replaced in the first year of the analysis period. The methodology used by MTC projects these costs based on the escalation of original acquisition costs to the year of replacement. For certain items, particularly those with long useful lives, existing market cost data will provide a better estimate of replacement costs than the escalation of original acquisition costs.

- evaluation of the effect of potential technological changes on capital requirements.

KEY FINDINGS AND SIGNIFICANCE OF REPORT

The experience gained in the San Francisco Bay Area through the MTC's efforts to determine funding requirements to sustain the existing transit infrastructure is summarized in this report to assist other agencies in developing similar projections for long-range program requirements. These projections are critical for agencies to:

- understand the long-range financing implications of major investment programs;
- respond to the challenge of a growing fiscal conservatism which emphasizes the prudent expenditure of public funds to preserve and enhance existing services; and
- avoid the deterioration of existing plant and equipment through a balanced program of investment in replacement, modernization, and expansion.

The approach is straightforward and systematic, relying on readily available data and several simplifying assumptions. These assumptions can be modified to test the sensitivity of the results and provide a range of financing requirements to assess the capital readiness of an agency or region under a variety of circumstances.

The results of the methodology, however, are only as useful as their application by the regional planning agency and the operators it represents. A great deal of institutional and political cooperation is required to take appropriate advantage of the strategic implications of long-range capital planning. With the proper leadership and agency cooperation, this planning effort can be used to lobby for and secure a more stable long-range financing program. The MTC and the Bay Area Transit Operator Coordinating Committee (TOCC) complemented each other in achieving this outcome within the San Francisco Bay Area.

APPENDIX

REPORT TO

METROPOLITAN TRANSPORTATION COMMISSION

ANALYSIS OF THE CAPITAL REQUIREMENTS OF THE SAN FRANCISCO BAY AREA TRANSIT SYSTEMS 1981 - 1995

EXECUTIVE SUMMARY
December, 1980

Prepared by

Peat, Marwick, Mitchell & Co.

The Metropolitan Transportation Commission (MTC), working with transit operators in the San Francisco Bay Area, engaged Peat, Marwick, Mitchell & Co. (PMM&Co.) to:

- o Develop a preliminary estimate of future financial requirements to sustain and improve the capital plant and equipment of the transit systems;
- o Identify the capital reserves currently held by each operator; and
- o Determine the adequacy of the reserves in light of the future financing requirements.

This summary briefly outlines the study approach and conclusions.

STUDY APPROACH

Total capital financial requirements of the region are separated into two categories:

- o Cost To Sustain Existing Plant and Equipment Assuming Existing Levels of Service.

  This category is defined to be the cost to replace all fully-depreciated assets, that is, existing assets with no remaining "book" or useful life, and the ongoing cost to replace existing assets at the end of their useful lives. Committed capital expenditures that are either in process or pending are also included.

- o Cost to Improve and Expand the Level of Transit Service.

  This category includes the capital expenditures currently being planned by the transit operators to improve or expand the existing level of service. The cost estimates were developed by the operators and included in the region's Transportation Improvement Program (TIP), Capital Priorities Study, or other financial plans.

PMM&Co. used the following procedure to develop estimates to sustain the existing plant and equipment over the 15-year period from 1981 to 1995:

- o Obtain, where available, the capital asset listings of each transit operator as of June 30, 1980. Where such listings were not available, PMM&Co. had to use other ways to estimate the amount of the assets.

- o Restate the asset listings into MTC's Reporting System classifications.
- o Estimate the useful lives of the assets. Generally the useful or economic lives used for depreciation by the transit operators were also used for this analysis.
- o Develop future escalation assumptions for each class of assets. Typically the annual cost escalation rates for 1981 to 1995 are assumed to follow historical averages.
- o Calculate the replacement cost of each asset class in future dollars as follows:
  - immediately replace all equipment older than its useful life,
  - estimate timing of replacement cycles by combining the date that the equipment was initially placed in service with the estimated useful life of the asset, and
  - estimate the replacement cost by escalating the original acquisition cost at the assumed annual escalation rates up to each projected replacement date.
- o Add in the estimated cost of committed capital projects.
- o Total the estimated costs by five-year period and by asset class.

The study breaks new ground in several important ways:

- o The primary focus is on estimating the cost required to sustain existing assets. Therefore, the study is a first step in estimating funding needs for long-term asset replacements and renovations, as well as for capital expansions.
- o The time frame is 15 years as opposed to the 5 or 10 years used in the other MTC budgets and plans.

Because the study is a first step, it is not intended to provide final or hard estimates of future capital expenditures. Assumptions had to be simplified to make the analysis consistent among transit operators, even though the operating practices and availability of information differed among operators. Therefore, the assumptions define an idealized "standard" for sustaining plant and equipment. The key assumptions are:

- o Assets are assumed to be replaced at the end of their useful lives, not when money is available. Changing the timing of the replacements cycles to fit funding availability will greatly change the amount of funding needed.

- No adjustments are made to the replacement cycles for maintenance practices. The study uses the useful life assumptions of each operator, even though they may differ among operators. These assumptions are intended to represent the ideal replacement cycle for each operator on the basis that the operating conditions and maintenance practices will differ among operators.

- No adjustments are made for technological innovations or economic changes (for example, substituting articulated buses for standard buses, or decreasing the future inflation rates). The standard assumes that assets are replaced by "like-kind" assets, whose cost continues to increase at historical inflation rates.

Future refinements to the analysis can improve the accuracy of the estimates. For the purpose of this study, however, the estimates are sufficiently accurate to evaluate the adequacy of the existing reserves and to estimate the approximate magnitude of future funding gaps.

FINDINGS AND CONCLUSIONS

The key findings and conclusions are as follows:

- $2.1 Billion Is Estimated to Sustain Existing Bay Area Transit Systems from 1981 to 1995.

  Exhibit A shows the total estimate to sustain by five-year period and by asset class. Over 40% of the total $2.1 billion is required by one class: revenue vehicles. The next largest category is the committed capital projects, which constitutes nearly 25% of the total. Therefore, two categories of expenditures constitute about two-thirds of the total estimate. Note that the expenditures are greatest in the first and third five-year periods, indicating the continual impact of the replacement cycles. That is, some of the assets (for example, vehicles) that are replaced in the 1981-1985 period are replaced again in the 1991-1995 period.

- $1.6 Billion Is Estimated to Finance Planned Improvements and Expansions.

  Exhibit B graphically shows the breakdown of this $1.6 billion by five-year period in comparison to the cost to sustain the transit systems. Since expansions are planned only for 10 years, no amount is shown for 1991 to 1995. Therefore, the estimate is low for the 15-year study period. The estimated cost to expand exceeds the cost to sustain for the first two five-year periods. However, by the 1990's the cost to sustain begins to escalate as more of the existing equipment reaches the end of its life cycle.

- <u>Existing Regional Reserves Are Inadequate to Fund Future Regional Capital Expenditures</u>.

  Non-operating reserves held by transit operators totaled about $437 million as of June 1980. However, some of these reserves are designated for purposes such as pension funds and self-insurance claims and cannot be considered to be available for capital expenditures. After subtracting these reserves, only about $260 million in reserves are potentially available to fund capital projects, either directly or as matching funds. On a regional basis, the reserves are clearly inadequate.

- <u>About $2 Billion in Public Assistance is Probable Over The 15-Year Period</u>.

  Exhibit C shows a breakdown of probable Federal and state assistance over the 15-year period, assuming that historical patterns of funding continue over the next 15 years. A portion of this funding is already committed and cannot be considered to be new money. The balance of the estimate is politically uncertain. Therefore, we took the lower figure of $2 billion as a probable estimate.

- <u>The Funding Gap Is $1.4 Billion During 1981 to 1995</u>.

  Exhibit D shows how a funding gap of about $1.4 billion is estimated when the funding requirements are matched against known and probable funding sources. Total funding requirements are $3.7 billion, of which $2.1 billion is needed to sustain the existing assets and $1.6 billion is needed to improve or expand the transit systems. The potential sources of funds are $260 million in existing reserves and about $2 billion in public support. These figures are also shown as an average annual amount for the 15 years. An average of $141 million per year is needed to sustain the transit systems over the 15 years based on the replacement cycle assumptions in the analysis. The funding gap averages out to $94 million per year. These average annual amounts can be misleading. For example, the funding gap is at least $900 million in the first five-year period, or an average of over $180 million per year. It is important to remember that any average annual estimate will vary depending upon the number of years used in the average and the actual timing of the expenditures.

- The Funding Requirement to Sustain The Transit Systems is Not Sensitive To Changes In Assumptions For Asset Classes Other Than Revenue Vehicles.

  Exhibit E shows how the estimate to sustain is reduced by only $400 million if the 15-year estimates for all asset categories except revenue vehicles and committed projects are reduced by 50%. The critical category is revenue vehicles, and changes in useful lives can greatly change the amount required in the future. If useful life is increased, the estimate to sustain for the 15-year period is significantly decreased. However, there are a number of items that could increase the estimate. For example, the cost of certain very old equipment cannot be estimated accurately using the study approach. It is likely that the cost of this equipment is underestimated, and the difference would offset any potential reductions in other costs. We conclude that the $2.1 billion estimate to sustain is a reasonable estimate for the purposes of this study, given the assumptions for revenue vehicle replacements.

- The Capital Funding Requirements to Sustain The Transit Systems Should Increase After 1995.

  Exhibit F compares replacement cycles for the 15-year time frame of the study with a longer period of 40 to 50 years. Between 1981 to 1995, only 16% of the plant and equipment is replaced at least once. This is equivalent to an average annual rate of 1.1%. Over 40 to 50 years, however, all of the plant and equipment would need to be replaced or renovated at least once, which is an average of 2% to 2.5% per year. This means that the amount of equipment to be replaced or renovated should increase significantly after 1995. The transit operators must not only begin to develop a plan for closing the short-term capital funding gap.

Exhibit A

$2.1 BILLION IS NEEDED TO SUSTAIN TRANSIT SYSTEMS FROM 1981 TO 1995. THE MAJOR COSTS ARE FOR REVENUE VEHICLES, PROJECTS ALREADY COMMITTED AND REVENUE VEHICLE MOVEMENT CONTROLS.

	Regional Totals ($ Millions)			
MTC Asset Class	1981-1985	1986-1990	1991-1995	1981-1995 Total
New, Used, or Reconditioned Revenue Vehicles	$ 233.8	195.0	453.7	882.5
Service Vehicles	11.3	16.1	27.3	54.7
Transit Way	23.0	1.1	35.5	59.6
Power Generation and Distribution Facilities	31.2	5.8	47.0	84.0
Passenger Stations	5.6	5.5	41.6	52.7
Passenger Parking Facilities	0	.1	34.6	34.7
Operating Yards and Stations	61.2	0	46.5	107.7
Vehicle Maintenance Shops and Garages	20.4	13.7	39.3	73.4
Other General Administrative Facilities	0	15.1	0	15.1
Revenue Vehicle Movement Control	4.9	6.3	194.4	205.6
Revenue Collection and Processing	2.7	3.5	44.3	50.5
Data Processing	2.1	2.7	4.0	8.8
Communications	.8	2.1	64.9	67.9
Office Equipment	3.1	1.7	5.1	9.9
Other Fixed Assets	.6	.3	.7	1.6
Subtotal	400.7	269.0	1,038.9	1,708.6
Committed Capital Projects in Process(1)	228.3	0	0	228.3
Committed Capital Projects Pending(2)	173.0	0	0	173.0
Total to Sustain	$ 802.0	269.0	1,038.9	2,109.9

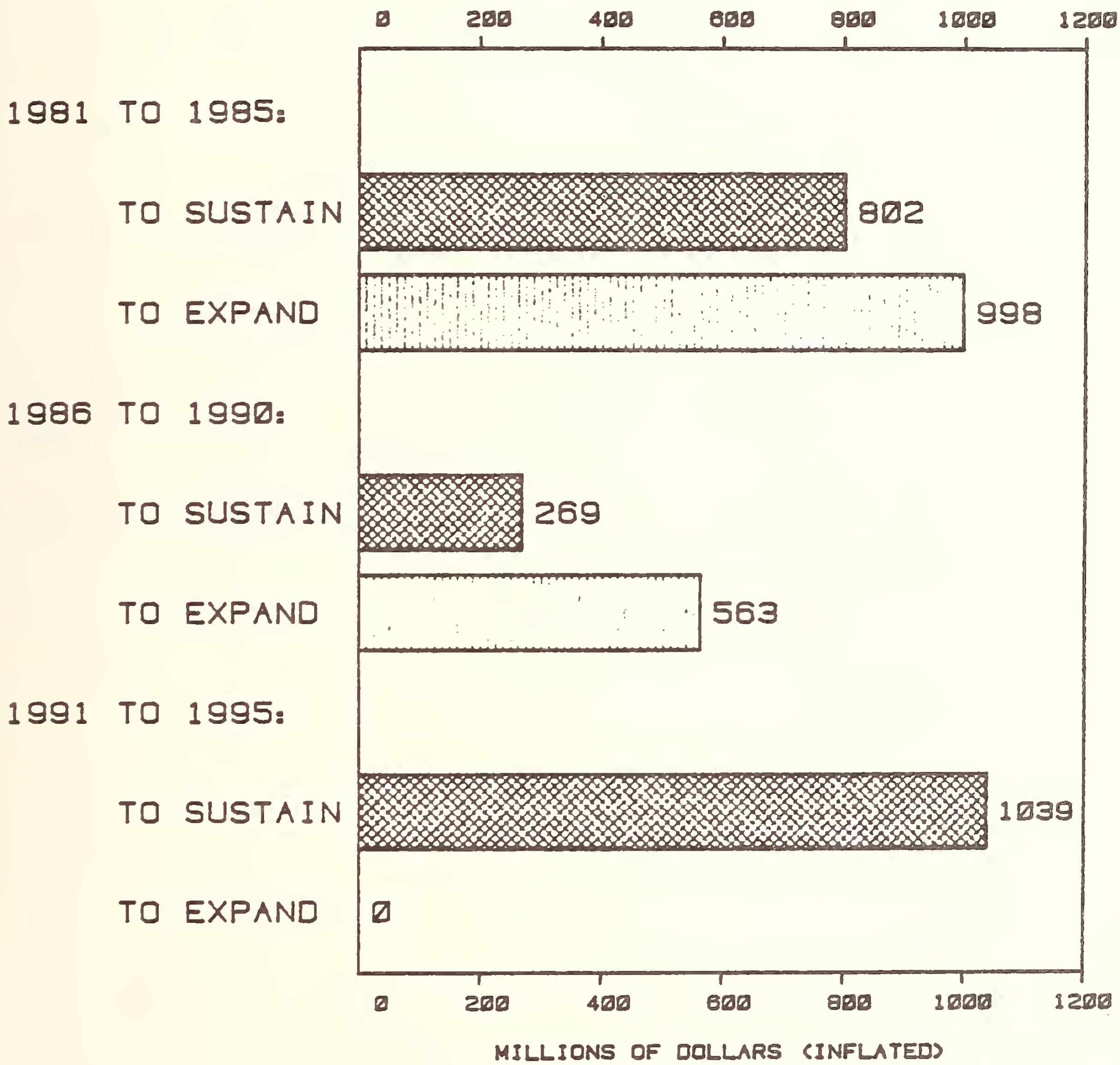
Notes:

(1) Committed Capital Projects in Process reflect funded projects budgeted for FY 80 (FY 79, and FY 80 for MUNI) that would not be expected to be recorded in the asset registers of each operator used to develop replacement cost estimates (source: Form 141, April 1980).

(2) Committed Capital Projects Pending reflect funded projects programmed for FY 81 that may include expansion, improvement and replacement but are counted as part of the existing system.

Exhibit B

$2.1 BILLION IS ESTIMATED TO SUSTAIN
$1.6 BILLION IS ESTIMATED TO EXPAND
BAY AREA TRANSIT SYSTEMS
FROM 1981 TO 1995



NOTE: ESTIMATES ARE PRELIMINARY. ACTUAL RESULTS ARE LIKELY TO DIFFER FROM THE PROJECTIONS, AND THE DIFFERENCES MAY BE MATERIAL.

OVER THE 15-YEAR PERIOD, PUBLIC ASSISTANCE IS NOT LIKELY TO EXCEED $2 BILLION.

	(Dollars in Millions)			
	1981-1985	1986-1990	1991-1995	1981-1995 Total
Maximum Probable Public Funds:				
Federal	$ 570 - 643	627 - 707	690 - 778	1,887 - 2,128
State	55 - 115	44	44	143 - 203
Total	$ 625 - 758	671 - 751	734 - 822	2,030 - 2,331

Exhibit D

THE FUNDING GAP IS $1.4 BILLION, OR ABOUT $94 MILLION ON AVERAGE PER YEAR, OVER 15 YEARS. BECAUSE MUCH OF THE GAP OCCURS IN 1981 TO 1985, THE AVERAGE ANNUAL ADDITIONAL FUNDING NEEDED IS $183 MILLION FOR THESE YEARS.

	1981 - 1995		1981 - 1985	
	Total	Average Annual	Total	Average Annual
Funding Required:				
To Sustain	$ 2,110	141	802	160
To Improve and Expand	1,562	104	998	200
Total	3,672	245	1,800	360
Less:				
Available Reserves	260		260	
Public Support	2,000		625	
Total	2,260	151	885	177
Funding Gap	$(1,412)	(94)	(915)	(183)

Exhibit E

IF THE ESTIMATES FOR ALL ITEMS EXCEPT REVENUE VEHICLES AND COMMITTED PROJECTS ARE REDUCED BY 50%, THE ESTIMATE IS REDUCED BY ONLY $400 MILLION:

	$ (millions)
Total 1981-1995 Estimate	$ 2,109.9
Less:	
Revenue Vehicles	882.5
Committed Projects	401.3
	1,283.8
Remaining Estimate	826.1
Less 50% of Revenue Vehicles	413.0

Exhibit F

ONLY 16% OF THE PLANT AND EQUIPMENT IS REPLACED AT LEAST ONCE DURING THE 15-YEAR STUDY PERIOD, OR 1.1% ON AVERAGE PER YEAR. OVER A 40- TO 50-YEAR PERIOD, ALL OF THESE ASSETS WOULD NEED TO BE REPLACED AT LEAST ONCE, WHICH WOULD BE EQUIVALENT TO 2.0% TO 2.5% PER YEAR ON AVERAGE. THUS, THE REQUIREMENTS FOR REPLACING AND RENOVATING THE SYSTEMS' ASSETS SHOULD INCREASE AFTER 1995:

Time Frame	Percent of Assets Replaced	Average Per Year
15 years	16%	1.1%
40 to 50 years	100%	2.0% to 2.5%

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