REPORT ON BOMBAY

ANNEX III:

TRANSPORTATION

B. B. KING and Others

March 31, 1971
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REPORT ON BOMBAY

ANNEX III - TRANSPORTATION

I. COMMUTER PASSENGER RAIL SERVICES

Introduction

1. Bombay's commuter railroads are simultaneously benefactors, victims, and villains. The city cannot function today without them; there is no other way to carry the daily surges of workers from home to office and factory and back again. For their efforts to carry these ever-increasing masses, the railroads draw more criticism than praise: complaints about overcrowding in the trains, deteriorating quality and reliability of services, shocking accident records, and the like. Their patrons, on several occasions, have expressed their dissatisfaction by burning the trains. While some of the complaints may be unjust and the ways of voicing them extreme, there are certainly symptoms of malaise in the railroads. Unfortunately, the railroads, through their service and pricing policies - with a helping hand from regional geography and a distorted urban land market - have helped to foster the pattern of urban development which is one of the sources of their troubles. Unrealistically low rail fares and the availability of relatively cheap and uncontrolled suburban land have encouraged the location of residences farther and farther from places of work, thereby producing ever-longer work trips and ever-greater demands on the rail system. In addition to creating many of the problems which now beset the railroads, this suburban growth has allowed decision makers to postpone a confrontation with the redevelopment needs and opportunities within the city. Particularly now that proposals are being put forth for major new rail transit facilities, it is important that they be viewed in the context of overall urban development needs, plans, and resources.

Existing Facilities, Services and Traffic

2. There is no single and separate entity responsible for providing rail commuter services in Bombay. Both the Western Railway and the Central Railway, which have their headquarters in Bombay, have developed commuter services as an adjunct to their main line passenger and freight services. The Western Railway main line comes from Ahmadabad and enters the Greater Bombay area at the north, crosses Bassein Creek, runs the full length of the island near its western edge, and terminates at Churchgate Station in the Fort Area. The suburban tracks of Western Railway parallel the main line and extend 34 km from Churchgate Station to Borivli; from there, commuter trains use the main line tracks to Virar, another 26 km to the north. The Central Railway, coming from the two crossings of the Ghats near Nasik and Poona, approaches Bombay from the northeast through Kalyan and Thana. Separate commuter tracks start at Kalyan and parallel the main line tracks to Kurla where the commuter lines split into two branches which both eventually end at Victoria Terminus. The main line and one commuter branch generally follow the main axis of the island, and the 15 km Harbour Line branch skirts the eastern shoreline before reaching Victoria Terminus. There is
an additional 6 km feeder line from the Trombay area to Kurla, and another 2 km connection from Raoli Junction, on the Harbour Line, to Mahim Station on the Western Railway line. This is the only track link between the Western and Central Railways, although passengers may connect from one railway to the other through a common station at Dadar. Kalyan to Victoria Terminus is 54 km; beyond Kalyan, the Central Railway operates commuter trains on the two main line tracks to Kasara (67 km further) and Karjat (46 km further). In total, the "commuter-shed" for Bombay extends 60 km to the north, 121 km to the northeast, and 100 km to the east and southeast. All the suburban commuter operations for both the Central and Western railways are on electrified broad-gauge track. Both railways, however, operate meter-gauge and narrow-gauge in their nonsuburban systems.

3. The distinction between main lines and commuter lines is more a matter of nomenclature than practice. From Borivli to Virar on the Western Railway and beyond Kalyan on the Central Railway, all trains run on the same lines. Between Borivli and Churchgate Station or Kalyan and Victoria Terminus, inter-regional trains do use only the main lines but commuter trains run on both the main line and commuter tracks in order to provide greater service capacity. An average of about 15 long distance main line trains operate each direction daily at Bombay Central, the main line terminal for Western Railways, and 21 at Victoria Terminus. The present procedure is to permit "fast" commuter trains—i.e., those which do not stop at all suburban stations—to use main line tracks jointly with scheduled main line trains during peak traffic periods. The Western Railway runs approximately 469 commuter trains per average weekday. 1/ This is a fairly high frequency, considering that the Churchgate to Grant Road section is only double tracked and a turn-around is required at Churchgate. The Central Railroad operates 352 trains on the major line and 238 on the Harbour Branch, plus 100 trains in the Kurla and Kalyan areas. 1/ The high frequency of suburban commuter service on both railroads makes it difficult to operate main line freight and passenger services in Bombay on tracks which are used in common. The railroads would like to segregate the quadruple track, using a double track for suburban service and the other double track for mainline services. In view of the substantial congestion on the railroads at the present time, and probably the achievement of capacity in terms of headways—at least at the peak hours, it does not seem appropriate to segregate the tracks in this manner. The effect that the present mixed use of tracks has on passenger capacity has not been precisely determined but the presence of main line trains (and the priority which they apparently have) is certain to reduce the capability for carrying commuters below the potential capacity of a purely commuter service—a point which is discussed further in relation to possibilities for future improvements. (para. 43.)

4. Table 1 shows the growth in daily commuter passenger traffic on the Western and Central Railways from 1950 to 1967, and the corresponding changes in numbers of trains run. The total daily traffic now exceeds 2.2

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1/ 1967 data.
million passengers and is nearly equally divided between the two railways. An even more impressive figure is that, of the 2.2 billion total passengers carried by all Indian Railways in 1967 (the date of the Bombay Traffic Cell studies), 35% were Bombay commuter service passengers. The growth of traffic for the Western Railway, for which data were provided back to 1965-66, suggests an annual growth rate for the period 1965-66 to 1969-70 of about 4 percent per year. While this is not very rapid growth, it should be noted that the growth in the period 1965-66 to 1966-67 was about 12 percent, and the next three years' growth in total is only about 5 percent. Similar patterns are seen to exist when individual, first-class, and third-class services are considered. While first-class services on the Western and Central Railroads run about 10 percent of the total traffic, the growth rate of first-class service on the Western Railroad for the period 1965-1966 to 1969-70 has been 9 percent per year. In the first year of that period, it exceeds 20 percent. A similar pattern of growth appears on the Central Railroad. However, both roads appear to have declining traffic in 1968-69. The figures strongly suggest that the shortage of capacity is imposing a substantial constraint on traffic growth.

5. The railways have about reached the limit in numbers of trains they can operate during a peak hour, given their present facilities, equipment, and operating procedures. The growth is now being absorbed by increases in the average number of passengers per train and by spreading traffic over longer morning and evening peak periods. These periods now extend from about 8:30 to 11:00 a.m. and 4:30 and 7:30 p.m. Loads reach their absolute peaks at terminals in the Fort Area between 9 - 10 a.m. and 5 - 6 p.m., when some 90,000 passengers enter (a.m.) and leave (p.m.) the Fort Area each hour through four downtown terminals (Churchgate, Marine Lines, Victoria Terminus, Masjid).

6. Peak period operations, as in all urban transportation systems, are the crucial considerations: they are the basis for establishing schedules and equipment requirements, they strain the capacity of lines and stations, and they largely determine the financial situation for the operators. Presently the Western Railway runs 18 trains and the Central Railway runs 26 trains during the peak hour. (The Central Railway figure includes both the Center Island and Harbour Line branches.) Trains normally consist of 9 car rakes, although some old 7 and 8 car rakes are still being used until they can be replaced by new stock.

7. The "Marked Carrying Capacity" of these trains depends on the number of Class I and III 1/ cars which are included and the particular stock being used; it usually ranges between 1674 and 1778 passengers per 9-car rake. This "capacity" is described as that which enables passengers to ride in tolerable standing comfort (plus, of course, the seated passengers). For

1/ The Central Railroad uses Class III and composite Class I-III coaches, the latter being divided roughly two-thirds for Class I and one-third for Class III and having slightly lower capacity.
the newest rakes, this marked capacity is 867 seated and 867 standing passengers, or 1,734 in all. Actual peak period loading practice bears little resemblance to this "marked capacity," however. The railways estimate that peak period trains carry 70% overloads, or about 3,000 passengers instead of 1,700. The 3,000 passenger figure would be more in line with peak period space utilization elsewhere; i.e., it is equivalent to full seat occupancy plus 1.3 sq. ft. per standing passenger.

8. Scarcely any information is available regarding the actual numbers of riders on peak period trains, aside from the estimated hourly arrivals of passengers and the known numbers of trains at terminals in the Fort Area. For the Western Railways, the highest number of arrivals in the Fort Area (at Marine Line Station) in a single hour of an average weekday is 45,000, or about 2,500 passengers per train. Of these, about 2,000 passengers per train debark at Churchgate Station. The numbers for the Central Railways are not strictly comparable since some rakes on the Harbour Line have 8 instead of 9 cars. However, 47,700 total passengers arrive at Masjid and Victoria Terminus during a single hour, about the same as on the Western Railway, and this load is spread over 26 rather than 18 trains. Assuming the same loading per car on both Central Railway Lines (which may not be the case), the average train load for an 8-car rake is about 1,700 and for a 9-car rake, about 1,900 passengers. These figures suggest that, although the marked capacity is regularly exceeded, comparatively few trains on either railway arrive in the Fort Area with 3,000-passenger loads even during the highest traffic hour.

9. This is not to say that the railways are not having capacity problems, but rather that all the problems are not clearly identifiable from existing information about passenger movements. Part of the difficulty stems from the fact that traffic studies have been largely concerned with the "Fort Area problem" and have tended to ignore conditions and travel patterns at other locations. There is evidence from the studies that, at least on a daily basis, the maximum rail-passenger traffic (peak load point) occurs not at the Fort Area but considerably further north on the Island, near Dadar. It is a reasonable expectation that traffic would start diminishing before reaching the last stations of a dead-end line. It seems particularly likely to be the case in the specific situation of Bombay where textile mills and other large industrial employers, commercial sub-centers and other intensive activities are located between the Fort Area and the major residential areas in the northern suburbs. Virtually no data are available, however, to describe passenger movements into, out of, and through these intervening areas during peak periods.

10. What is not clear from discussions of corridor capacities and train loading characteristics is that there are also problems related to passenger collection and dispersion at some stations in the Fort Area. Although Churchgate and Victoria Terminus are packed with people during the rush hours, passengers are able to move quite rapidly through the stations themselves. The main problems, at the moment, are outside. People spill out of the stations and block the sidewalk with queues waiting for buses and taxis and disrupt movements of traffic on the abutting main streets.
11. Safety is another serious problem for the railroads. In the past year, more than 600 fatal railway accidents were reported in the Bombay area, mostly involving either passengers falling from moving trains or pedestrians who were struck while walking on the tracks. Passenger accidents are largely attributable to crowded conditions on trains, the absence of doors on the coaches, and the common practice of riding outside the coaches on the footboards (or even on top of coaches), frequently when the train is not even filled. The pedestrian accidents continue to occur despite the railways' efforts to keep persons off the tracks by building walls and fences at the right-of-way limits. If, in addition to the fences, pedestrian bridges were provided at more frequent intervals in densely developed areas, this trespassing problem might be alleviated. However, many accidents occur at stations when passengers alight from trains (often still moving) and short-cut across adjacent tracks to board another train or to beat the crowd to the exits. Some reduction in these accidents might be achieved by barriers between lines, but a solution to the problem is probably more a matter of training and discipline than physical controls.

12. Although not identified by the railroads in terms of being a problem, certainly one of the important needs which should be considered is the replacement and modernization of rolling equipment. Much of the equipment used is very old. Of 383 electric multiple units, 116 are considered by the railroad to be over age (over 40 years old). The Central Railroad does not give specific ages for their equipment but 232 of their 448 units are classified as "new." The remainder are apparently quite old. The annual reports refer frequently to the maintenance difficulties with the 1928 stock and the difficulties of getting replacement parts because of foreign exchange limitations.

13. Six basic types of tickets are sold to commuters on the Bombay suburban railway services. The principal classifications are first class and third class. Within each of these classes, one can buy a single-journey ticket, a monthly season ticket, or a quarterly season ticket. For purposes of calculating passengers, the railroads assume that a monthly season ticket is equivalent to 50 passengers and a quarterly season ticket to 150 passengers. In terms of price, however, very substantial discounts are available for season ticket holders. Monthly ticket holders may pay as much as 13 times the price of a single-journey ticket but probably use the ticket about 50 times. For very long trips, the monthly ticket price is only about 6 times the single-journey fare. Additional discounts occur when quarterly tickets are purchased. The quarterly ticket is approximately 2-1/2 times the price of a monthly season ticket. For third-class tickets, the multiples are also fairly low, with monthly season tickets ranging from about 20 to about 8 times the price of a single journey. Again the quarterly season ticket is only 2-1/2 times the price of the monthly season ticket. Not surprisingly, as a result of this type of fare structure, about 2-1/2 times as many season tickets are sold as single-journey tickets for third class and about 20 times as many first-class season tickets are sold as first class single-journey tickets on the Central Railroad.
14. Several recent fare changes have taken place, but they were generally of a minor nature. In 1968, third class monthly season tickets were increased in price by 25 paise, and first class tickets by Rs. 1. On the first of October 1969, quarterly season tickets were increased in price by 75 paise for third class tickets and Rs. 3 for first class tickets. The management of the two railroads indicate that fare increases are politically very difficult in Bombay and that it would be difficult to raise the fares sufficiently to offset the present estimated deficit from suburban services. The present fare structure has a very substantial taper. For monthly third class season tickets, the rate per kilometer tapers from Rs. 1.23 down to 20 paise per kilometer. For trips from the most northern point in Bombay City served by the Central Railroad (Sion) to Victoria Terminus, the monthly season ticket is Rs. 5.05 and the price per kilometer is about 45 paise. For the trip from Kalyan Junction to Victoria Terminal, the third class monthly season ticket is Rs. 13.60 for a 54-kilometer trip, or about 25 paise per kilometer. In addition to the substantial fare taper and very pronounced discounts for season tickets, the railroad also provides student fares. First class, student season tickets are sold at half the monthly adult price. One might speculate as to why students should be permitted half fare for first class service, when they can travel third class at less than even half the first class fare. If the first class service is indeed a luxury, preferred type of service, there appears to be little reason to provide students with half fare for that quality.

15. The earnings from suburban rail service have grown somewhat faster than the number of passengers principally as a result of the fare increases that have taken place in the last few years. First class earnings on the Western Railroad, for example, have grown 14 percent annually from 1965-66 to 1969-70. Third class earnings during the same period have grown 12 percent annually, with total revenues in lakhs going from 554 in 1965-66 to 876 in 1969-70. Total revenues for the Central Railroad in 1968-69 from suburban services were Rs. 772 lakhs, with about 1/8 of the revenue coming from first class passengers.

16. Prior to 1966-67, the railroads reported estimated allocations of cost and earnings from electric, multiple unit suburban trains. In 1966-67, the requirement to report such data was eliminated. Using 1965-66 as a guide, they earned 1.15 paise per passenger kilometer at a cost per passenger kilometer of 1.02 paise, while 10.6 rupees were earned per train kilometer and the cost per train kilometer was 9.51 rupees. Thus, in 1965-66, according to the railroad allocations, the suburban train service generated a profit. No notes are available, however, in the reports, telling how these allocations were made or what are included in the numbers. In particular, it should be recognized that the railroad facilities and operations of the suburban services are common with those for the non-suburban services, including freight services. Thus the allocations may tend to be arbitrary and have little basis in fact. The report for the Central Railroad for 1966-67 was not supplied, so comparable figures are not available. Nevertheless, the following estimate was given for the loss on electric, multiple-unit services of the Central Railroad of Bombay in 1968-69.
Rs. Crores

1. Total Working Expenses 7.606
2. Depreciation Charges on Rolling Stock at Current Prices and Depreciation as Booked in respect of Other Assets 1.291
3. Interest on Dividend Charges as Booked 1.311
4. Fully Distributed Costs (1+2+3) 10.208
5. Gross Earnings 7.720
6. Loss 2.488

17. It is clear from these figures that gross earnings exceed what the Central Railroad calls "Total Working Expenses" which, in turn, exclude depreciation and interest charges. It would appear that total working expenses are greater than out-of-pocket costs and probably are greater than marginal costs. In any event, the figures suggest moderately sizeable losses in the year 1968-69.

18. It appears that both the Western and Central Railroads are moderately profitable, although, in evaluating railroads' capital stock, it is often difficult to place appropriate values on their assets. For the year ending March 31, 1969, the Central Railroad reported a profit after all expenses of Rs. 26.2 crores. In the previous year, a profit of Rs. 39.3 crores was reported. The Western Railroad was formed in 1951 and has had a return on capital -- as they measure it -- in excess of 9 percent in every year since its formation. In 1969-70, the Western Railroad reported a profit of Rs. 33.2 crores. If, in fact, the suburban services are operated at a loss, there are sufficient revenues in both railroads to subsidize the suburban operations as the accounting is presently reported. However, the cross-subsidies implied are terribly complex, with freight and mainline passenger service subsidizing low-priced rail commuter service. This may have the effect of distorting the allocation of freight between rail and truck in addition to distorting the land use allocation decisions within the Bombay metropolitan area.

Studies of Future Requirements

19. Studies by the Traffic Cell have estimated the daily volumes of transit passenger trips crossing screenlines 1/ in 1968 and 1981 as shown in Table 2. These are derived from estimates of the present and future distributions of population, land uses and economic activities by using

1/ Arbitrary lines (shown on Map No. 2) running generally east-west across Bombay, dividing it into a series of strip zones.
multiple regression analyses techniques. The estimates are for both rail-passenger and bus-passenger trips. Besides the usual caveats about the accuracy of forecasts based on other forecasts which themselves are of doubtful validity, these estimates of future transit passenger trips have some built-in procedural weaknesses. However, they are the best estimates available and serve to illustrate orders-of-magnitude of expected increases in transit passenger trips.

The Traffic Cell studies preceded the preparation of the Metropolitan Regional Plan; consequently, these estimates do not reflect the population and activity patterns proposed by that plan. The entire Twin-City concept, with its resultant impacts on the shape of regional development and travel patterns, has been excluded from consideration. The estimates do include an assumption that the Backbay Reclamation Scheme will be carried out and will result in the employment of 150,000 additional persons in that area (which explains the unusually large jump in trips across Screenline No. 1).

Two features stand out in Table 2: the volumes crossing Screenlines 3 - 6 (roughly the Bombay Central-Dadar vicinity) are substantially higher than in other areas, and traffic growth is highest in the northern suburbs (crossing Screenlines 7 and 8).

Using these estimates of total transit passenger trips, the Traffic Cell made a further subdivision into estimates of rail passengers and bus passengers. The split of transit passengers between these modes was based on a "minimum time path" traffic assignment technique. Travel times between all zones were compared via the shortest (time) rail routes and bus routes, and an "all-or-nothing" assignment was made; i.e., if the travel time was shorter by rail than by bus, all trips were assigned to the rail system. This technique has serious shortcomings. If the estimated travel time between two zones is 40 minutes by bus and 39 minutes by rail, for example, all trips are assigned to the rail system and none to the bus system. The technique also ignores any difference in travel costs between the two modes. The modal split is obviously highly sensitive to assumptions about locations of facilities and their operating speeds. Present (1968) travel times, as observed by actual measurements, were used for the road system while new rail transit facilities were assumed to have 60 kph operating speeds.

The estimates are for transit trips only; no comparison has been made with separate estimates of automobile passenger trips (by Wilbur Smith) or with independent estimates of total trips which would be generated. The equations for estimating transit are based solely on presently observed behavior without regard to possible variations in trip pricing, automobile ownership, or other factors.

See paras. 26-27 for further discussion of this point.
23. Traffic assignments were made for two alternative rail transit plans; the bus routes (road plan) remained the same for both. Plan A included a new rail transit corridor between the Central Railroad and P.D. Hello Road, crossing the Harbour branch at Raoli Junction, extending along the Sewri Expressway at Wadala, and terminating at Chatkopar near the Eastern Express Highway. Another new corridor generally follows along the west side of the Western Railway to Bandra and Santacruz Airport. These corridors would be linked between Santacruz and Chatkopar, and between Churchgate and Victoria Terminus. Several other intermediate cross connections were proposed but after preliminary testing it was decided that bus connections would be more suitable than rail. Plan B included all of the features of Plan A plus a rail corridor frum Kurla, running through the center of the island and meeting the western corridor near Marine Lines Station. The central-island corridor was added after traffic assignments on the two-corridor system of Plan A indicated overloading of the western corridor.

24. Table No. 3 shows the daily transit passenger trip assignments to the two rail transit plans, based on the Traffic Cell's estimates of trip-making patterns for 1981. Only trips which were assigned either to the existing rail lines or to the proposed rail transit lines are shown in this table; bus passenger trips are not included.

25. Recalling the sequence of the Traffic Cell's studies, Plan A was the first proposal which was tested. When the traffic assignments indicated the Eastern and Western Transit Corridors would be "tremendously overloaded," a new plan was tested which included a central corridor. Several observations should be made. First, the traffic assignments are based on estimates of total daily rail passenger movements in both directions. In order to draw any conclusion about overloading, it is necessary to convert these daily figures into directional movements during peak hours, recognizing that the percentage of total travel occurring in the peak hour and the directional split of that traffic will vary for each section of line.

26. A second, and seemingly more important criticism of these assignments, may be seen by comparing the daily volumes assigned to the Western Transit Corridor and to the Western Railway. As was previously pointed out, the assignments were made on an "all or nothing" basis and, moreover, they were made without regard to the available capacity of each facility. The result was that Plan A, for example, had 1,552,940 daily trips assigned to the new Western Transit Corridor where it crosses Screenline No. 5, while the existing Western Railroad was assigned only 7,000 daily trips, or about 4 trainloads for both directions of travel. These heavy assignments of traffic on the proposed new transit line are principally the result of assumed

1/ Interestingly, neither assignment plan assumed that the freeways proposed by the Wilbur Smith Study would be built or available for transit use.

higher operating speeds (and therefore reduced travel times) than on the existing lines. The assigned volumes, in turn, were interpreted as the justification for an additional Central Transit Corridor which was tested in Plan B. The Central Transit Corridor does divert 344,000 trips from the Western Transit Corridor at Screenline No. 5, but still leaves the Western Railway with only 7,900 daily trips. 1/

27. Although the reports do not explicitly state it in this way, the implication in finding that heavy 1981 traffic volumes "justify" the construction of new Western, Central, and Eastern Transit corridors is that commuter passenger traffic on the Western Railway will virtually cease and on the Central Railway lines will be cut to a fraction of the present levels. Obviously this would be inconsistent with the need to make maximum use of available resources and facilities before embarking on costly new investment programs for new facilities. Furthermore, it is contrary to the railroad's present studies and construction programs which are aimed at expanding the capabilities of their existing systems.

Current Improvement Programs and Proposals

28. The Western Railway is quadrupling its tracks in the section between Churchgate and Grants Road Stations. This work, estimated to cost Rs. 4.15 crores, has been underway since 1966 and is intended to provide additional capacity and operating flexibility in the southern portion of the island. 2/ When completed at the end of 1972, the Western Railway will have four suburban lines extending the full distance from Churchgate to Borivli. (A later stage would extend the quadruple lines from Borivli to Virar.) The most difficult problems encountered in carrying out this work have been those related to right-of-way acquisition, despite a fairly complete kit of administrative and legislative tools for accomplishing this. One of the knottiest problems is still unresolved: the detailed method for bringing the new lines into Churchgate Station. The railroad proposes to widen the station to the east and build new platforms in the space now taken by Maharishi Karve Road. This, in turn, requires that the road be shifted about half the roadway width eastward along several block lengths, taking nearly all of the property between the present edge of street and the building line. Judging from previous difficulties in acquiring land under much less complicated circumstances, it would not be surprising if the track widening were completed for the remainder of the project before the right-of-way problems are settled in this last and most crucial section.

1/ There are other peculiarities in the Plan B assignment. For example, although the Central Transit Corridor is very near the Central Railway line, no traffic is diverted from the railway but traffic is diverted from the more distant Eastern Transit Corridor.

2/ There may, in fact, be more capacity in this section in relation to traffic demands than on sections further north, where passenger loads are apparently much higher.
29. The Central Railway has made a preliminary study of the costs of modifying its lines and stations to permit the use of 12 car rakes instead of the present 8 or 9 car rakes. This study estimates that it would cost about Rs 40 crores to make this change, including the revisions in stations, tracks, and train control systems and the purchase of additional rolling stock. 1/ This investment would increase peak period capacity on the Central Railway by about 50% over present limits. No decision to proceed with this work has yet been made. The Western Railway does not consider that it is feasible to expand its rakes from 9 to 12 cars, as proposed for the Central Railway, although a detailed study apparently has not been made to determine what the costs and benefits would be for a similar modification of the Western Railway lines.

30. With respect to longer range rail-transit services, there is a profusion of differing proposals.

31. At the conclusion of its lengthy analyses of travel patterns in the Bombay Metropolitan Area, the Traffic Cell report makes the following rather cautious recommendation:

"In the context of the continued development in the Backbay Reclamation area on the southern tip of Bombay and expansion of suburban areas, it will be necessary to have a loop consisting of three corridors joining Santacruz, Kurla, Chembur areas to south of Bombay. It is, however, recommended for the present, to implement only one of the corridors in addition to the third terminal at Ballard Estate to relieve the existing overcrowding and for catering to the increased traffic to some extent." 2/

The "third terminal at Ballard Estate" is a reference to an earlier recommendation (1968) by the Metropolitan Transport Team of the Planning Commission. That team concluded that the commuter problems in the Fort Area could be substantially relieved by using the lines of the Bombay Port Trust Railroad (generally following along the east side of P.D; Mello Road) for commuter traffic and building a new passenger terminal at Ballard Pier. This proposal was intended to add line capacity and to relieve the passenger dispersal problem in the Fort Area by providing the new station in an area of heavy concentration of trips. 3/ The same Metropolitan Transport Team, after reviewing the traffic and transportation problems of Bombay, recommended a mass rapid transit system should be provided in a north-south direction in

1/ The study itself was not available to the mission so it is not clear whether the Rs. 40 crores include the elimination of grade level crossings on these lines.


3/ See paras. 174-175 for further discussion of this proposal.
corridors to be identified by further studies. These were the studies which subsequently were conducted by the Traffic Cell.

32. Map No. 2 shows the Plan B rail transit system proposed by the Traffic Cell. Its main features are the three north-south corridors, a loop connecting Churchgate and Victoria Terminus, and a northern loop between Ghatkopar and Santa Cruz. In presenting this proposal, the Traffic Cell suggested that engineering feasibility studies of all three corridors should be undertaken but that only one of the corridors (unidentified) be implemented, in addition to the Ballard Estate Terminal, until major decisions are reached about further Backbay Reclamation, Bandra-Kurla development, and the Twin City. 1/

33. The Metropolitan Transport Team of the Planning Commission accepted the findings of the Traffic Cell studies concerning the general locations of the three north-south corridors, but proposed actual rail transit alignments which were significantly different. The Port Trust Railroad, converted to passenger commuter service, was proposed for the Eastern Transit Corridor in lieu of the Traffic Cell's alignment further to the west. The Central Corridor proposal was nearly the same as suggested by the Traffic Cell except that it would terminate at Matunga, just west of Raoli Junction, rather than extending across Mahim Creek to Kurla. Also, at the southern end, it would loop around the Oval Maidan, staying to the east of Churchgate Station rather than joining the Western Transit Corridor near Marine Lines. The Western Transit Corridor would be shortened considerably, veering south-eastward at a point near Lower Parel Station and joining the Central Corridor about opposite Bombay Central. A separate loop was then proposed to start at Charni Road and follow the Backbay shoreline to the southern end of the reclamation area before looping back to Victoria Terminus. No traffic assignments were made for this proposed system, although the results could be expected to differ appreciably from Plan B.

34. As a result of the Metropolitan Transport Team's recommendations that further studies should be conducted, the Bombay Metropolitan Transport Project (Railways) was established in 1969 and given the responsibility to:

(i) assess commuter traffic demands at present and for the next 10/15/20/25 years,

(ii) study methods for optimizing commuter transport capabilities on existing rail lines;

(iii) make preliminary engineering feasibility studies for the Ballard Estate Terminal and connecting lines from Wadala;

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1/ Traffic Cell Report, pp. vii - 23. Although this report recommends construction of the Ballard Estate Terminal, the traffic assignment studies did not include the Port Trust Railroad line, which would serve this terminal, in their transit system so no estimate was made of passenger traffic which would use this line and station.
(iv) study passeng : dispersal problems in the Fort Area; and
(v) make techno-economic feasibility studies for a Mass Rapid Transit System. 1/

35. After reviewing the previous studies and making some rough calculations of traffic demands and rail line capacities, the Metropolitan Transport Project (Railways) proposed that the following additional rail lines should be studied:

(i) pair of lines, Malad-Bombay Central,
(ii) pair of lines, Thana-Kurla,
(iii) Jogeshwari - Churchgate corridor,
(iv) Chatkopar - Victoria Terminus corridor,
(v) Kurla-Bandra,
(vi) northern connector between (iii) and (iv),
(vii) Churchgate - Victoria Terminus loop via Backbay,
(viii) Churchgate - Victoria Terminus loop via Museum and Sachivalaya.

These studies would be in addition to the Ballard Estate Terminal Study (reportedly already underway) and the studies for optimization of existing rail lines.

36. These proposals are confined to the Greater Bombay area and do not consider what additional and complementary facilities are needed in the remainder of the metropolitan area. The proposals would add about 110 km of new rail lines to the 90 km now existing in Greater Bombay. Of these 110 km, about 62 km are proposed to be underground and 48 km on the surface. The Metropolitan Transport Project assumed surface lines would cost Rs. 1 crore per km and underground lines would cost Rs. 6 crores per km, resulting in an estimated cost of Rs. 48 crores for surface lines and Rs. 372 crores for underground lines. The combined total of Rs. 420 crores does not appear to include the costs of additional stations, land acquisition, or the rolling stock and other accessory equipment required to operate on these lines.

37. To complete the picture of current proposals for rail transit improvements, the Metropolitan Regional Planning Board has also made transit recommendations in its report "Strategy for Bombay Metropolitan Region." 2/

This report makes the following statements about mass transit:

2/ Published January 27, 1970.
(ii) Mass Transit. The following railway programmes for augmentation of commuter travel facilities within the metropolitan area will have to be included in the Regional Development Plan.

(a) Quadruplication of Railway tracks between Churchgate-Grant Road and Borivli-Virar sections of the Western Railway and the sections beyond Kalyan on the Central Railway is immediately required. Of these, work on Churchgate-Grant Road section is already on hand.

(b) Introduction of twelve coach trains on the Central Railway and related improvements.

(c) Measures for improving frequency of trains by improvements in signalling systems, yard-remodelling, etc.

(d) The development of one additional traffic corridor for mass transportation and provision of a third terminal in Ballard Estate.

(e) Shifting of the mainline terminus to be between Dadar and Parel is possible.

(f) Feasibility studies for the underground railway.

(g) Augmentation of bus fleet by adding large capacity buses.

(h) Increased bus depot and workshop facilities.

"Other Urban Areas: Organization of Mass Transit services and City bus services in existing cities would be a matter of details. Adequate provision for mass transportation services will also certainly be needed in the two major townships viz., Trans-Thanal and Metro Centre. The goods lines proposed/existing in these areas will have to be in course of time upgraded to passenger-cum-goods lines and additional lines and stations will also be necessary."

Observations on Mass Transit Studies and Proposals

38. The mission had neither the time nor the necessary information to make an exhaustive examination of the various proposals which have been put forth for rail mass transit improvements. However, there is sufficient basis for making the following general observations which may suggest possible directions for further studies.

(i) To state a point which is so obvious that it hardly needs stating, the groups which have studied Bombay's mass transit problems have
widely differing viewpoints about what should be done to improve the present situation and to accommodate the expected future travel demands. 1/

(ii) None of the proposals (except for modification of the Central Railway to handle 12-car rakes) are yet supported by studies which would give a valid preliminary indication of their capital and operating costs, their economic and other benefits, or their physical and financial feasibility. Although some useful background studies have been carried out, none of these studies have dealt specifically with the proposals which are being presented. Even the Traffic Cell's rather elaborate traffic assignment studies tested systems which differ substantially from those which are now proposed. (The testing procedures, as pointed out in para. 19, had inherent weaknesses which severely limited their usefulness even for the systems which were tested.)

(iii) All of the proposals involve high financial costs and must therefore be considered in the context of total resource availability and other competing demands. The initial cost of the Metropolitan Transport Project proposals (roughly estimated at Rs 420 crores), for example, would impose a severe burden on the total resources of the metropolitan region, regardless of the "need" that might be demonstrated for these investments.

(iv) Studies which have been conducted to date do not reflect current proposals for the future development of the Bombay Metropolitan Region, as described by the draft plan and report of the Metropolitan Regional Planning Board. Conversely, the Metropolitan Regional Plan has not been examined in the light of its implications for future transport requirements. As a result, the mass transit proposals have not been integrated, either in area of coverage or substance, with the proposals for metropolitan regional development. There is at least a reasonable possibility that the two sets of proposals may be working at cross-purposes.

39. The Metropolitan Transport Project (Railways) has clearly indicated its recognition that additional studies are needed to provide an adequate basis for decisions about future mass transit projects. It has recommended a specific list of studies 2/ which it considers should be carried out and has suggested that all of these should be undertaken simultaneously. The studies are identified by location only; the precise scope and nature of the proposed studies are not described.

40. The notion of simultaneous studies should be carried one step further. What is needed is a coordinated study program which begins with the consideration of the entire transport system, including both highways and

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1/ It might also be pointed out that there has been a series of earlier studies, not mentioned here, which have made recommendations differing from all of the present proposals and from each other. They are all so out of date that they have not been included in this discussion.

2/ See para. 35.
mass transit facilities, and the plans for regional development. After ex-
aming various system alternatives within this physical, social and economic
planning framework (observing reasonable order-of-magnitude constraints on
investments), the details and timing of the component projects can then be
determined. Assurance that the best investment decisions are being made,
given the present and forecast future circumstances and the constraints on
resources, can only be gained by looking first at the system and then at
the projects. The reverse procedure, starting with detailed examinations of
projects, does not yield the same results.

41. When one considers the size and complexity of transport analyses,
as well as the importance of updating decisions to reflect changing condi-
tions, it becomes apparent that a continuing planning program is required,
not simply an ad hoc study. Moreover, the transit planning activity should
be carried on by, or at least have substantial participation of, the agency
or agencies which ultimately have the responsibility for building and operat-
ing the system. At least during the early stages and for highly specialized
tasks throughout the planning program, consultants' services will undoubtedly
be required; however, a concerted effort should be made to develop in-house
staff capabilities for the major portion of the planning activity.

Alternatives to Consider

42. When identifying alternative courses of action to consider, it is
important to know the desired objectives and, equally important, to eliminate
any artificial constraints which might cause worthwhile possibilities to be
overlooked. This is particularly true in the case of decisions for urban
transport investments, where the goal is not simply to move more people. The
best urban transport "solution" may be one in which new investments in trans-
port services are a relatively minor part. For example, the mass transit
projects which have been proposed for Bombay are aimed at improving the
quality of present services (by reducing crowded conditions, improving re-
liability and punctuality, etc.) and at providing for anticipated future
growth. The present proposals would try to accomplish this by providing
additional rail lines, more trains, bigger stations, etc. at considerable
capital and operating cost. A non-transit solution to the same problem
which might be equally effective and less costly would include the reloca-
tion of job sites from the Fort Area to the northern suburbs in order to re-
duce the number of persons entering the Fort Area, to shorten the trip for
persons now living in the suburbs, and to permit commuters from the Fort Area
to use vacant space on existing outbound trains. (Some of the railroad's own
90,000 employees might be a good starting point for this kind of movement!) This
approach has the advantage of easing the problem on three fronts—re-
ducing overall travel, reducing passenger dispersion difficulties in the
Fort Area, and making more efficient use of present facilities—while pro-
viding additional capacity is certain to worsen the passenger dispersal
situation and the unbalanced directional movement.

43. Another alternative which appears to merit serious study would be
to move all main-line passenger services from Victoria Terminus and Church-
gate to a new terminal, possibly in the Bandra-Kurla or Mahim-Sion vicinity.
A new rail passenger terminal in either area could be part of a complete transportation complex, with connecting services to suburban commuter lines, metropolitan buses, taxis, airport shuttles, etc. A transportation terminal of this type would also be a focal point for stimulating other commercial and office development. The main advantages from a transportation viewpoint would be to free the existing rights-of-way and stations in the island for exclusive use by metropolitan commuter trains during peak traffic periods.  

This would permit track layouts to be modified for more efficient operations and would permit complete flexibility of track scheduling. The current proposals by the Metropolitan Transport Project are based on assumptions that no commuter trains will be permitted to use main-line tracks by 1981. This assumption should be carefully reexamined in terms of the trade-offs which are involved, considering that daily passengers on the main line trains number in the thousands while the daily commuter passengers already exceed 2 million. There is no evidence to indicate that the main-line passengers would be inconvenienced by moving to a new metropolitan area terminal, given the present patterns of development in Bombay and the wide range of connecting services which could be provided at a new location further north.

44. A new metropolitan transportation center could also provide better interconnection between both the main-line and the commuter passenger services of the Central and the Western Railways. This capability for interchanging between lines will become increasingly important as new growth extends further to the north and eastward across Thana Creek. Some capability exists for inter-line transfers at Dadar and Mahira-Raoli Junction but the transfer arrangements are inconvenient and probably inadequate to cope with growing demands. In any event, the full capability for suburban-mainline-interline passenger exchange does not now exist.

45. One feature that has been included in several of the mass transit proposals is the construction of a connecting rail loop between Churchgate and Victoria Terminus. Among the possible advantages of this loop would be:

(i) the dispersion of some passengers who now use Churchgate and Victoria Terminus to one or two new stations nearer their places of work; and,

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1/ Freight traffic also uses these lines but could be moved during off peak hours. There also appear to be opportunities for longer range modifications in freight handling facilities and operations which would alter the track-use requirements in Bombay. (See para. 178.)

2/ In planning and carrying out all track improvements, including those now underway, possibilities for future changes in operations should be kept in mind. There may be opportunities for improved operations which could be preserved or enhanced at relatively nominal costs at the time of construction but which would be much more costly to provide by revisions at a later date.
(ii) the elimination of dead-end train turnarounds at both stations, thereby permitting closer headways and improved operations.

For the full realization of either of these benefits, the loop would have to be an extension of the incoming tracks at both stations. This would be very costly, regardless of how it might be accomplished. Existing buildings and cross-streets would make it difficult, if not completely impractical, to construct the loop at ground level to meet existing tracks. If the loop were constructed underground, the present tracks should also go underground before reaching both stations (a costly solution, but one that could have some attractive features). A separate underground line would require passenger transfers at Churchgate and Victoria Terminus and would not permit the straight-through train operations. Detailed studies would be required to compare the potential benefits and costs of the loop. The number of passengers who would use this loop is quite small in comparison to the ridership on existing sections of either railway (and also highly dependent on whether the Backbay Reclamation continues or not). Provision of a loop between the Central and the Western lines would certainly make it essential to reconsider the entire question of separate or unified passenger transport operations in the metropolitan area.

Improvements of Existing Services

46. Regardless of whatever shortcomings they now have, it is clear that the present railroads must continue to bear the main burden of commuter traffic in Bombay for some time to come. If it were possible to decide immediately that a new and separate rail transit system should be built (and there is not yet an adequate basis for making that decision), seven to ten years can easily elapse before such a system would be in operation. Further studies are needed of system configuration, preliminary and detailed engineering designs must be prepared, financial plans and schedules must be worked out, rights-of-way acquired, etc. before actual construction could begin. In short, if the mass transit passenger traffic which has been forecast for 1981 actually develops, the probability is high that these passengers will be riding on existing rail and bus systems.

47. There are at least two clear conclusions to draw from this. First, the continuing program of metropolitan area transport and planning studies which is required to guide investment decisions should be initiated as soon as possible. Second, the highest priority should be given to the studies and resulting investments which will permit better utilization of the existing rail systems. In fact, only after the optimum capabilities of the existing system have been identified will it be possible to assess the need for building new systems.

48. The "optimization" studies should consider all possibilities for improving present services. Some of the more obvious ways include the following:
(i) **Equipment modernization.** The 1928 rakes still being used by the Western Railway carried 20% fewer passengers than the 1964 rakes \(^1/\) and even the 1952 rakes carry 140 fewer passengers than the 1964 rakes. Replacement of old cars would increase train capacities and also improve train operations, besides reducing maintenance and repairs. Serious consideration should be given to modifying car interiors, possibly removing space-wasting bulkheads and revising the seating arrangements. By removing some of the seats, at least in trains operating on shorter runs, capacity could be increased substantially.

(ii) **Longer trains.** The preliminary findings of the Central Railway regarding the use of 12-car rakes should be examined in more detail and similar studies should be made for the Western Railway. Even changing to 10-car rakes would increase the capacity of each train by 11%. Before making a definite decision to change to 12 car rakes, other possibilities should be examined to determine which is the most economic size, in terms of costs and benefits.

(iii) **Level-grade crossing elimination.** Train delays would be reduced and safety and punctuality improved if separated crossings were provided at major roads and if more effective crossing protection were provided at minor streets. Road traffic would also benefit from the uninterrupted flow at separated crossings.

(iv) **"Bottleneck" elimination.** Sharp curves and other track layout features restrict operating speeds on some sections and add to the turnaround time at stations. Even if the correction of these conditions requires additional right of way, the benefits may still justify this.

(v) **Operational Revisions.** Train scheduling and operating procedures should be examined to assure that the most appropriate and efficient techniques are being used, including shuttling, station-skipping, express trains, and different allocations of tracks for commuter and mainline operations.

49. The foregoing suggestions all relate to possibilities for improving line capacity. Most of the measures which might improve the collection and dispersion of passengers in the vicinity of Churchgate and Victoria Terminus are not the railroad's responsibilities and require actions by other agencies. Some of the possibilities that are worth investigating include:

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\(^1/\) Based on Traffic Cell's calculations of seated capacity plus standing capacity, allowing 1.3 sq. ft. per standing passenger.
(i) **Bus service improvements.** Frequent shuttle buses, operating from off-street loading zones near the railroad stations directly to a few key locations in the Fort Area and Colaba which are beyond a convenient walking distance, could ease congestion around the stations and provide a very useful service.

(ii) **Intersection traffic control improvements.** Modern traffic control equipment and improved intersection designs, coupled with better regulation of pedestrians, at main street intersections near the stations would permit faster and safer movements of vehicles and pedestrians.

(iii) **Separated pedestrian crossings.** There may be justification for constructing separated pedestrian crossings, leading directly from the stations and passing either over or under the adjacent streets, in order to remove the pedestrian-vehicle interference completely when both flows are very high.

50. It should be emphasized that these suggestions for better utilization of existing facilities, for the most part, are neither new nor startling. Similar suggestions have been made by the Metropolitan Regional Planning Board, the Metropolitan Transport Team and the Traffic Cell, and others. For example, engineers who studied the operations of the Western Railway for the Juhu Chamber of Commerce concluded that the speed and frequency of suburban commuter services could be improved significantly, simply by revising scheduling and operating procedures for existing equipment and facilities. Generally, however, these suggestions have not been followed by the necessary detailed studies which would analyze their feasibility in terms of costs and benefits and would provide a basis for decisions and improvement programs.
II. RAIL GOODS TRAFFIC

51. The total broad gauge rail car interchanges between the Western and Central railways are very substantial. The Central Railway in the fiscal year 1968/69 received 1,732 wagons per day from the Western Railway, including 1,031 loaded and 701 empty. The average daily dispatches from the Central Railway to the Western Railway amounted to approximately the same number of cars, 1,750 of which 1,365 were loaded and 385 were empty. Although the numbers seem extremely large, there is fair agreement between the Central Railway report and the Western Railway report for the year 1968/69. Of this very large number of interchanges between the two principal railroads serving Bombay, approximately 400 are made in the metropolitan area of Bombay, at Dadar Junction and at the Bombay Port Trust at Wadala.

52. In 1969/70, 196 cars were dispatched from Dadar Junction including 179 loaded and 17 empty, and 242 were dispatched from the Wadala Terminal, 157 loaded and 85 empty. In the same year, the average daily receipts were 220 cars (208 loaded and 12 empty) at Dadar Junction and 240 cars per day (168 loaded and 72 empty) at Wadala. This interchange at each of the stations Dadar and Wadala amounts to approximately the equivalent of 4 trains at each station in each direction for the Western Railroad. In 1969/70 the Western Railroad handled 959 million wagon-kilometers and 16,193,000 goods train-kilometers or a weighted average of about 59 wagon-kilometers per train-kilometer, suggesting a train length of slightly under 60 wagons in the broad gauge operation of the Western Railway.

53. Although this interchange does not represent a very large proportion of the total interchanges made by either the Central Railway or the Western Railway, the volume of interchange taking place in the already very congested railway operations in the Bombay metropolitan area may make for an intolerable situation. The railroads have suggested, and indeed plan to construct, a new link in the northern, less dense part of the metropolitan area to avoid congestion in Bombay City. As of the 1969/70 reports of the two railroads, however, the project has not yet been surveyed and no cost estimate is given.

54. In addition to the congestion within the Bombay metropolitan area, a major problem for the railroads is the inadequate track capacity through the Ghats. There are presently two Ghat lines that are utilized to nearly full capacity. The capacity limitation is principally the result of operating procedures which require large separations between trains to prevent accidents that may be caused by runaway trains. There are proposals for adding a third Ghat line, but no detailed proposal or justification of the project has been developed. It would appear that since such a large portion of the movement of freight over the Ghats is petroleum and petroleum products, it would be worthwhile to consider as an alternative the construction of a pipeline rather than a third Ghat line. In 1968/69, the Central Railway originated 716,000 tons of mineral oils, nearly all of which was bulk. In the same year, they terminated 928,000 tons, again principally all bulk.
All of this traffic—except for a very insignificant amount—moved on the broad gauge sections of the Central Railroad, but no information is available on the amount moving over the Chats.

55. Before expending large amounts of money on the development of a new Chat line, it would be appropriate to consider a large number of other alternatives, including the provision of devices to stop runaway trains in the event of brake failure such as in-track braking and the provision of extra motive power so that longer trains may be moved over the Chats.

56. The problem of the Chat line may indirectly affect the Bombay area, since it eliminates some of the flexibility in scheduling that could assist in relieving the main lines in the metropolitan area during the peak hours of commuter traffic. Also, because of scheduling, the storage of trains and freight is longer than might be necessary if the capacity problem did not exist. The extent of these problems is not entirely clear; however, it would seem desirable to remove any unnecessary freight problems from the already overburdened rail system in Bombay.

57. In addition to the storage and yard facilities located in Bombay City, the two railroads have extensive workshops in the City. These are principally at Parel. The Central Railway workshops at Parel perform all of the work required on the Central Railway locomotives, both broad gauge and narrow gauge. Carriage and wagon work is done elsewhere. The Central Railway also performs some special repairs at their Parel workshop for the Western Railway. The Western Railway has extensive workshops for carriage repairs at Parel. Parel is the only broad gauge carriage workshop of the Western Railway. Thus the possibilities of moving these activities out of Bombay City appear remote in the short run. The difficulties of moving the extensive facilities needed to repair locomotives and carriages would probably preclude any immediate change.

58. The third Bombay railway, that of the Bombay Port Trust, has some entirely different problems that are related to serving ships at dockside. Rail cars frequently are not available when they are needed for unloading ships, and material being brought in to be loaded onto the ships must be brought to the port earlier to assure its availability when the ship arrives. Compounding the congestion at the port is the presence of rail cars blocking the access to the ships. The port consultants have suggested that the railway be abandoned and a road be provided to replace it (see para. 174). If the movements of cargo from the port and to the port originate and terminate outside the Bombay metropolitan area, the use of truck transportation rather than rail directly from the ships does not seem entirely satisfactory. Long-distance hauls would require a truck movement from the docks to an intermediate warehouse or transfer point where goods would be transferred to a railroad car and then moved by rail to the destination area. Such double handling is very expensive. It would seem that a major attempt at coordinating the rail operations so that the demands of ship loading and unloading could be met would be most appropriate. In this way double handling of import and export merchandise would not be required.
59. Part of the problem of port movement results from difficulties in clearing Customs, both inbound and outbound. It would seem that effective coordination between the Customs operations and the transportation operations of the port would provide greatly improved transportation and handling of freight through the Bombay port. It might also relieve some of the problems presently creating a demand for the new port at Nhava Sheva. To the extent that loading and unloading operations at the port would be expedited so that ships could be turned around more quickly, some of the need for the new port might be alleviated.
III. BUS TRANSPORTATION IN BOMBAY

The Operating Company

60. All internal bus transportation in Greater Bombay is provided by the Bombay Electric Supply and Transport Undertaking of the Municipal Corporation of Greater Bombay (BES&T), except for some very limited privately operated bus services to a few factories and other special places. Outside Greater Bombay, bus services are provided by the Maharashtra State Road Transport Corporation (a nationalized corporation), which also provides intercity service and service between Greater Bombay and other areas. Thus, although Maharashtra State Road Transport Corporation operates in Bombay, it does not carry any internal local traffic. 1/

Route Structure and Schedules

61. The BES&T operates slightly less than 120 bus routes consisting of approximately 1,360 kilometers. This system is divided into 10 depot areas for which traffic and route information are reported. The route structure provides very extensive coverage of both the city and the suburban areas of Bombay that are within the Bombay municipal limits.

62. Although buses operate on the comparatively few existing east-west roads, the bulk of the routes in the suburban area tend to run north and south as do the railroads. Indeed, many of the bus routes are nearly parallel to the rail commuter system. Much greater and more ubiquitous coverage is available in the city, although there is some fairly extensive paralleling of railroad operations. One would expect the bus system to provide extensive feeder service to the basically north-south oriented rail commuter service. While this is probably the case, the route system does not have great focus on the railroad station pattern, although all stations are served by the bus system. There does appear to be a closer relationship between railroad stations and bus operations in the suburban area than in the city.

63. If the buses serve as important feeders and distributors of rail passengers, it is surprising that very few bus routes originate at the rail station, particularly Churchgate and Victoria Terminus. Large numbers of passengers embarking and disembarking from buses at these principal terminals create long delays to schedules, and buses cannot generally be available to accumulate passengers as they leave the terminal. Since buses generally wait at their point of origin, a logical place to wait and provide a service while doing so is at the main railroad stations.

1/ The geographic area served by the electric supply operation of the BES&T is confined to the city of Bombay, which may cause cross subsidies to arise between transportation and electric supply operations. Cross subsidisation within the bus transport system is discussed below.
The BES&T provides excellent route maps of its system with detailed routing described. Separate maps and descriptions are provided for city and suburban services. In addition, the BES&T makes a complete fare table available which gives for each route the time of the first bus, the last bus, and the headways in addition to the fares between any points along the route. According to those tables, the shortest headways are 4 minutes and there are very few that are longer than 8 minutes. Thus, it would appear that present schedules do not reach saturation on individual routes. It is difficult to say, however, whether individual stations or stops serving large numbers of routes are oversaturated owing to the confluence of a large number of longer headways. While congestion at stations can be alleviated somewhat through the scattering of bus stops, such an answer is not entirely satisfactory because it would inconvenience passengers requiring a transfer.

The Fleet

The transport operations of the BES&T are provided through conventional and trolley buses. The bus fleet totaled 1,291 at the end of August 1970, divided into 714 single-deck and 577 double-deck buses. Of the latter, 50 were articulated trailer double-deck buses. The fleet composition is even more variable. There are buses of at least three manufacturers; there are 8 different model single-deck buses in the fleet and a total of 29 different types when seating configuration is considered. A large number of seating/model combinations appear in the fleet only two or three times. There are 26 seating/model combinations which appear in the fleet five or fewer times! This abundance of model types and seating configurations probably results in some uneconomic maintenance and operating practices; it suggests the need for larger inventories of spare parts and a larger number of maintenance practices and rules to handle the large variety of buses in the fleet. It is difficult, however, to know exactly what the cost of such high variety might be or to recommend a procedure to correct it without an infusion of substantial new capital that could quickly make the fleet more uniform. If equipment is added and replaced gradually, there are bound to be changes in models and manufacturers, but the abundance in Bombay is far greater than one might reasonably expect.

Most of the single-deck buses have total seating and standing capacities of 50 passengers. The bulk of these have approximately 40 seats and room for approximately 10 standees. Of the single-deck buses, however, 18 have 45 or 46 seats and room for approximately 35 standees. The range of capacity for the double-deck buses is approximately 80 to 90. The articulated trailer buses have a capacity of approximately 100, almost entirely seated. The remainder of the double-deck buses also have most of their capacity in seats, with more, but still relatively few standees -- approximately

1/ Trolley buses are relatively insignificant in the total transport operation. In the 1969/70 fiscal year, there were only 12 trolley buses operated by the BES&T, and the average number of such buses in service was 11.
11 or 12. The capacities of the single-deck buses with large numbers of standees are nearly equivalent to the smaller double-deck buses but have approximately 20 percent less capacity than the articulated trailers. Of course these "standee" buses do not provide equivalent service in terms of seating.

67. Detailed data was not provided on the age distribution of the fleet. The outward appearance of the fleet is that of very old equipment. This may be somewhat deceiving, however, because double-deck buses may tend to look ancient even if they are currently produced. Furthermore, it appeared that maintenance efforts are directed more toward the mechanical running of the buses than to their physical appearance. The buses appear to be somewhat banged up, and body repair work is poor. This may be a reflection of the BESAT's priority on the continued operation of the bus over its outward appearance. Certainly the BESAT's fleet utilization of about 70 percent must be regarded as quite good when the problems of spare parts are considered. The utilization figure may be somewhat distorted as the effective fleet excludes buses undergoing major overhaul. According to the statistics, however, never more than 3 percent of the fleet is being overhauled at one time.

Road Traffic

68. Any public transport system utilizing public roads must operate in an environment with many other vehicles. In Bombay, the problem is compounding very substantially by the presence on the roads of many pedestrians, handcarts, oxcarts, horsecarts, stray oxen, and other vehicles, principally taxis and trucks. Insufficient attention has been paid in Bombay to adequate traffic control and vehicular discipline on the roadway. Very few traffic lights exist, and in many places roundabouts or traffic circles are used in place of appropriate signalization. While at the present time traffic is not as severe as it is in many other cities, the poor utilization of roadway capacity does result in substantial congestion and dangerous practices. Pedestrians utilize the streets as sidewalks, cross the roadway apparently at whim, with the result that traffic is considerably slowed down. This, of course, has substantial repercussions on bus operating performance and economics. If the buses could travel at higher speeds, they could be utilized more effectively and produce higher revenues per day.

69. A program of strict enforcement, keeping pedestrians on the sidewalk and permitting crossing only at specified intersections under appropriately signaled conditions, may produce a significant improvement in roadway operations in Bombay. Such enforcement, however, would be an enormous task. In particular, the sidewalks are presently occupied by vendors and sidewalk residents who restrict the flow of pedestrian traffic. These "zero" rent activities on the sidewalk provide a high penalty for transportation on the roadway.

70. The presence of other non-motor vehicular traffic, such as animal-drawn carts, handcarts, and stray animals, appears to be a serious problem in only a few areas of Bombay. Nevertheless, they have a substantial impact
on traffic flow when and where they occur. Before embarking on a substantial construction program for new roads, more consideration should be given to improving the traffic flow on existing roads and streets. Through controlling traffic, substantial increases in road capacity may be achievable at far lower expense than building new facilities. Furthermore, the added discipline required and produced would increase safety and make travel more comfortable. Buses and taxis, which have to stop suddenly to avoid hitting pedestrians or animals, cannot produce a comfortable ride. Furthermore, sudden weaving and turning to avoid such obstacles also diminishes quality of service. At some time in the future, it will be necessary to improve traffic conditions in Bombay; it would seem that the sooner this is done, the better. Such improvements may have far-reaching effects on the accuracy and operating efficiency of the present BES&T bus system.

Capacity and Growth

71. Data are not given in the BES&T's reports for capacity utilization. Figures are given for passengers carried and effective kilometers but are not broken down as to bus type, nor are comparisons made between passenger kilometers and available seat kilometers. Such statistics would be very useful in evaluating the performance of the system with respect to passenger service. Furthermore, it may suggest differences between bus types that are not apparent from physical measurements. The absence of detailed load factor information makes it difficult to determine whether there are constraints on supply which are restricting the growth in passenger transportation. In the simplest case, of course, if all buses were filled all of the time and there was no increase in either the number of buses or the seats per bus, one could not expect any growth in traffic. On the other hand, if traffic grew while capacity was well in excess of traffic at all times of day, one could argue that such growth is due to increasing demand.

72. Because of the way passenger information is obtained, it is difficult to obtain the true number of passengers using the system. This is unfortunate as such statistics could be very valuable in planning and managing the system. The principal reason for losing that information is that BES&T's data comes from single ticket sales, which do not always represent single trips. For example, some very long trips require two or more tickets. While there probably are not very many such trips on the bus system, there are some and they may be relatively important. In addition, data are not presented for those passengers traveling free, such as policemen.

Fare Structure

73. A zone system of fares is used by the BES&T. The minimum charge for adults is 10 paise and tickets go up to 50 paise. For adult fares exceeding 50 paise, a 45 paise ticket and an additional ticket are sold, making the total the amount of the fare. Children travel at half fare with a minimum of 5 paise. As a result of the method of charging fares in excess of 50 paise, ticket sales data for 5 paise tickets represent exclusively children's tickets in excess of 5 paise and tickets to make up fares in excess of 45 paise appear as lower price tickets, and it is impossible to distinguish between them.
The fare structure has a fairly sharp taper for both ordinary services and limited and express services. For ordinary services, the taper runs from 5 paise/kilometer for 2-kilometer trips to 2.12 paise/kilometer for 26-kilometer trips. On limited and express services, the taper runs from 7.5 paise/kilometer for 2-kilometer trips down to 2.5 paise/kilometer for 26-kilometer trips.

The ordinary fare structure was changed in 1966. For ordinary services, 5 paise were added to each previous fare, and an additional category of 10 paise for a 2-kilometer trip was introduced. For the limited and express services, the basic structure itself was changed, with a sharply increased taper. There has been essentially no change in the money fare since 1966 except for the introduction of a 35-paise fare on December 1, 1968, for limited and express service. To the extent that there has been any change in service quality, however, an implicit fare change may indeed have taken place. Such would be the case, for example, if headways have increased or if capacity were shifted from seated to standing or if fewer buses were operated. In money terms, however, it is interesting that bus fares substantially exceed third-class seasonal railroad fares. For example, a 26-kilometer bus trip would cost 65 paise for a limited and express service bus, while a third-class monthly ticket for a 27-kilometer railroad trip would cost Rs. 9.25, an amount that would be paid for 14 bus trips or 7 roundtrips. For most passengers making work trips, a monthly season ticket would probably provide for approximately 25 roundtrips.

It is not clear whether cost differences explain all of the price differences. It is difficult to determine this because for both the railroads and the bus system some common costs exist between the local commuting operation and other activities of the organization providing the service. For the railroads, in addition to the commuter service, there is mainline passenger service and freight services. Much equipment and investment and, particularly, many personnel are commonly used between the commuting operations and these other railroad services. A similar situation exists in the BES&T between the electric power services and the bus services. The problem is probably not as severe in the latter case because the services are relatively distinct in the equipment and personnel used to provide them. Nevertheless, data are not sufficiently detailed to indicate the true financial picture. It is, of course, highly likely that bus transportation is more expensive per seat mile than rail. It is just as clear, however, that there is probably a deficit in both operations given the existing fare structures.

Focusing on bus finances for the moment according to the BES&T financial accounting, during the year 1969/70, the deficit from bus operations -- even if the total of general administration allocated and the depreciation charges were subject to question and eliminated from the calculations -- would still be present. Such is not the case, however, with respect to the trolley bus.

It is impossible to evaluate the depreciation figures as presented without a great deal more detail regarding the assets being depreciated. For economic analysis purposes, production costs may be more appropriate and these may bear little relation to depreciated values. Nevertheless, it is clear that some depreciation and some allocation of administrative expenses must be charged.
operations where elimination of depreciation and the administrative allocation
would result in a slight surplus, but these expenses are trivial compared to
bus operations.

Traffic and Revenues

77. Traffic on the BES&T for the 1967/68 through 1969/70 fiscal years
is given in Table 4. The figures are not entirely accurate, however, since
they represent the total number of passenger tickets sold plus the number
of reserve and school bus passengers. Because of the multiple ticket issuance
for tickets over 50 paise, some doublecounting occurs. Unfortunately, be-
because estimates of passengers carried are based on ticket sales, when the
fare increase took place in 1966, introducing more fares in excess of 50
paise, it is likely that some additional tickets were sold offsetting the
decline in traffic that might be expected to accompany the fare increase.
The method of reporting the data does not permit such a specific assessment
of the effect of the fare increase. Perhaps more detailed information is
available at the BES&T, but it was not in the reports supplied.

78. If the data provided can be used as approximations for actual pas-
sengers carried, the rate of growth in traffic from 1967/68 to 1969/70 is
about 10 percent per year. The 1966/67 figures are obviously confounded with
the fare change that took place during that year, and it would thus be in-
appropriate to use that year in estimating the growth rate. In the BES&T's
estimates of capital requirements for the next five years, a traffic growth
rate of 2.5 percent per year is projected. In their calculations, the BES&T
says that the rate of growth during the last five years was 2.7 percent.
If that is the case, the recent annual growth of about 10 percent since the
fare change is most interesting. To some extent it might be due to a re-
covery from the loss that accompanied the fare increase or it may be due to
increases in load factors that accompanied the incentive pay practices that
were introduced. 1/

Capital Requirements and Financing

79. On the basis of assumed growth rates of 2.5 percent and 5 percent
per year, the BES&T has calculated the annual increase in buses that will be
required. Under the assumption of 2.5 percent growth, 30 buses will have to
be added annually to meet the traffic growth alone. Under the assumption of
5 percent growth, 60 buses will have to be added annually. Under either
assumption, 90 buses will be required for replacement each year. These fig-
ures probably assume -- although it is not clear in the report -- that double-
deck buses will be provided with a capacity of about 90 passengers. As in-
dicated earlier, the use of single-deck buses with more passengers standing
(total capacity seated and standing nearly equal to that of the double-deck
bus) may result in a substantial reduction in the capital requirements to

1/ These bonuses are paid to drivers, conductors, and supervisors when
their buses produce revenue over a certain level.
provide for the growth in traffic. The capital requirements estimated by
the BES&T amount to Rs. 1,986 lakhs over the next five years, 1969/70 to
1973/74. (This capital requirement for transport operations alone will also
require Rs. 34 lakhs of foreign exchange.) During the last five years less
than one-third of this amount was invested in transport operations of the
BES&T. Only about Rs. 600 lakhs were expended in the period 1964/65 to
1968/69. The bulk of the annual capital requirements results from replace-
ment demand rather than from the provision of capacity to meet the expanded
growth in traffic under the assumptions given. If bus traffic were to grow
as it has over the last three years, substantially more capacity would have
to be added if the system were to accommodate it.

80. Financing for the estimated capital requirement will have to be
provided from sources other than internally generated funds. The transport
operation revenues from the period 1966/67 to 1969/70 increased from Rs.
1,034 lakhs to Rs. 1,408 lakhs, or about 11 percent per year. At the same
time, expenditures on the bus operations increased from Rs. 1,160 lakhs to
Rs. 1,664 lakhs, or 13 percent per year. In each year, the bus operation,
according to these figures, resulted in a deficit. Estimates for the year
1970/71 indicate a slight decrease in expenditures, but nevertheless a sub-
stantial deficit of Rs. 221 lakhs. While prospects are not so grim for the
undertaking as a whole, since in three of the four years 1966/67 through
1969/70 the undertaking had a surplus, the deficit in 1969/70 was, however,
sufficient to offset the surpluses from the previous two fiscal years. (A
surplus of Rs. 11 lakhs is projected for 1970/71.) Without some major in-
fusion of capital, it will be impossible for the BES&T to add the number of
buses it estimates will be required to accommodate the growth in traffic.
The total depreciation taken by the BES&T in 1969/70 was Rs. 107 lakhs for
buses and trolley buses.

81. The BES&T indicates that if fares were raised to the level permit-
ted by the state government, additional revenue of Rs. 160 lakhs per year
would be raised. It is not clear how this estimate has been derive!, par-
ticularly with respect to the effect of a fare increase on ridership. Never-
theless, Rs. 160 lakhs per year is far from sufficient to meet the capital
requirements estimated.

Bonus Incentives

82. Apparently union rules require that the BES&T provide one con-
ductor per deck on its buses. There was a problem getting the conductors
and drivers to fill the buses prior to the introduction of an incentive sys-
tem where bonuses are given to conductors on the basis of their collec-
tions. This encourages some overloading. The conductor is given targets of Rs.
1,700 per month for city operations and Rs. 2,000 per month for suburban
operations. The conductor receives a bonus of 3 percent of the excess reve-
nue collected over these targets. If the conductor is absent three days or
if he is penalized for a disciplinary action, he loses his eligibility for
a bonus that month. The results of these incentives have been increased loads
on the buses and much improved attendance for drivers and conductors. During 1969/70, Rs. 17 lakhs were paid to conductors, drivers, and traffic supervisory staff as an incentive bonus.

83. Unfortunately detailed attendance figures for conductors and drivers are not given in the administrative reports. There is some discussion of the effect of the incentive plans on "Traffic Leave Reserves." It is not clear how these reserves are calculated, but the reports suggest that substantial savings have been achieved through the introduction of the incentive bonus and other productivity programs. According to the 1968/69 administrative report, the reduction in this account amounted to Rs. 13 lakhs yearly. The incentive pay to conductors, drivers, and supervisory staff that year was Rs. 15 lakhs. Unless revenues increased very substantially through the program, the payoff has not been spectacular. Traffic did, however, increase rather substantially in the 1968 to 1970 period.

Types of Buses

84. The BES&T made a comparative study of the economics of three different bus types: an indigenous double-deck bus, an articulated double-deck bus, and a Leyland Comet single-deck bus. A summary was made available to the mission. The study results show that any of the three types of bus will result in an operating loss. According to the assumptions made, the loss per seat (an appropriate measure for this purpose) is least for the articulated double-deck bus and is greatest for the single-deck bus. However, it is not clear why, for example, a 12-year service life was assumed for the double-deck bus, an 8-year service life for the articulated double-deck bus, and only a 6-year service life for the single-deck bus. Furthermore, the quality of capacity was neither held constant nor stated in a favorable way for all bus types. The capacity stated for the double-deck bus was 92 (about the size of a large number of double deck buses presently in the fleet), for the articulated double-deck 100, and for the single-deck only 50. Using the BES&T assumptions, except for the capacity of the single-deck bus, suggests that a break-even capacity for single-deck buses would be approximately 70 passengers. Since there are already single-deck buses in the BES&T fleet with stated capacities of 80 passengers, the study may not be entirely indicative of the economic performance of these bus types for the BES&T.

85. Aside from the capacity assumptions made, if a longer service life for the single-deck buses is assumed, the economic comparisons may change significantly. Not included in such comparisons, of course, are the demand effects of having lower capacity vehicles providing transportation service. A distinct advantage of lower capacity vehicles, up to a point of saturation, is a reduction in headways and the ability to provide service to a larger number of specific origin-destination pairs. Such improved service has, in general, been found to stimulate demand for such transportation.

86. In addition to the relatively straightforward economic analysis that one can perform on paper to compare single-deck with double-deck buses, it would appear that transit operations in most places in the world have
found sufficient disadvantages for double-deck buses so that such buses are becoming relatively uncommon. A few obvious disadvantages are:

The necessity for passengers to climb stairs on a moving vehicle leads to possible accidents and injuries and slows the boarding and exit processes.

Any sway produced through turning or weaving motions or road unevenness is magnified on the upper level leading to a relatively uncomfortable ride (although the view may be superior).

In many cases, there are requirements to have three employees per bus, i.e., conductors on each level as well as a driver.

The fact that few double-deck buses are being made today makes obtaining of spare parts somewhat more difficult than with a conventional single-deck bus, leading to a poorer fleet utilization than might be necessary.

87. For the BES&T operation, the spare parts problems may be particularly acute as many parts must be imported from England, which creates a drain on scarce foreign exchange. For that matter, many of the bus models being operated in Bombay are no longer in production.

BES&T and the Government

88. The BES&T is required by state law to pay a passenger tax, which has amounted to approximately Rs. 60 lakhs annually since September 1960. The BES&T committee has met with the state government several times to plead for an exemption from the passenger tax in view of BES&T's unsatisfactory financial circumstances. The committee requested that the government should make capital contributions to the undertaking as it has no equity resources for capital expenditures. The pleas of the committee were rejected on the grounds that a tax was imposed by the legislature and it would not be possible for the government to exempt the BES&T. Apparently the legislation provides for different rates of tax being fixed for different areas and the BES&T committee requested that the government reduce the tax to 1 percent, as had been done by other state governments in the case of municipal transport services. Clearly the abolition of the tax could be used to increase the BES&T's revenues from transport operations.

89. In 1968/69, the BES&T had also approached the government for an increase in annual payment for facilities granted to police personnel who are allowed to travel free on buses. On the basis of the data collected, the undertaking had asked for an increase in the payment to Rs. 20 lakhs against Rs. 1.5 lakhs now paid by the government. The government offered only Rs. 6 lakhs. The annual report for 1969/70 does not discuss the amount for reimbursement for free travel.
Demand or Supply?

90. Capacity figures are not available in sufficient detail to determine whether the bus system is capacity constrained during the peak hours and hence whether traffic is determined more by supply or demand. It is impossible, therefore, to know whether additional capital equipment would stimulate traffic. While the reports do not provide much information on this subject, casual observation in Bombay during the peak hours suggests that capacity is inadequate during the peak hours and long queues result. If the incentive pay plan for conductors and drivers has resulted in "overloading," as suggested by the BES&T personnel, load factors achieved may be at their maximum and additional traffic may not be absorbed. If it is true that capacity is fully utilized, we might expect that there is substantial latent demand that is presently being unsatisfied owing to the rationing of service. Certainly the long queues observed tend to confirm such a hypothesis.

91. Normally where there is excess demand we assume that prices (fares) could be increased to bring demand in line with available supply. Apparently, this is nearly impossible to accomplish politically in Bombay with the result that instead of a monetary fare increase, an implicit fare increase through reduced service quality occurs. Certainly long queues and slow rides in crowded buses must be regarded as a form of price increase. Even if capacity is severely constraining demand during the peak hours, it is not necessarily true that offpeak traffic may not continue to grow. The figures reported on income per bus kilometer suggest that some substantial growth must be taking place somewhere in the system. During the 1965/66 to 1969/70 period, income per bus kilometer increased from Rs. 1.2 to Rs. 1.59. The fare increase took place in 1966/67 when the income per bus kilometer increased about 11 percent and has increased very slightly in the following year, and in 1968/69 and 1969/70 increased very substantially. The declines are undoubtedly due to the fare increase while the increases are undoubtedly due to the incentive pay plans for conductors and drivers.

Cross Subsidies and Misallocations

92. At the present time, according to the BES&T financial statistics, the electric supply operations produce a surplus which provides the source of financing to subsidize the transportation operation. It is quite clear that present fares are not adequate for meeting the cost. This could be due to all fares being too low or could be due to a structural defect in the sharp fare taper that was observed. Without detailed accounting information and operating statistics, it is difficult to know whether it is the fare structure or its level that is more seriously out of line. The result, nevertheless, is the same, a subsidy from electricity users to commuters.

93. It is not simple to evaluate the effect of the cross subsidy from electricity users to commuters. The electricity users of the BES&T are in the city and are generally the higher income residents and industries, while for the most part, commuters have lower incomes; from the point of view of
income distribution, therefore, there is some basis for it. Moreover, the fact that fares are nonremunerative suggests that more resources are devoted to transportation under the existing system than if they were remunerative. People tend to live farther from their place of work (or shops and other non-work destinations) than they would if they had to pay more for their transportation. If they had to pay more, they would probably try to live closer to their places of work, where, however, land and housing are more expensive; indeed, if fares were to increase, the value of this land would increase as well, compounding the effect. With low-cost transportation, city employers are able to attract employees from greater distances who pay less for their housing and transportation than they should and thus the employer may find that he can pay a lower wage than would otherwise be required. To the extent that low-cost labor is a benefit to the city employer and the latter is also a large consumer of electric power, it is not entirely clear that the cross subsidy is a poor one.

94. On the other hand, the pricing system does not properly allocate the transportation resources. Employees are not given the choice of spending more money on transportation or on housing. Given the choice, an employee might choose higher priced but closer housing as opposed to lower cost housing coupled with high-cost transportation. Such a choice is not open to him under the present cost subsidy situation. Thus whether or not the cost subsidy is equitable in terms of the income redistribution effect does not address the whole question. The fact is that a misallocation takes place if the decisionmaker is not confronted with an appropriate choice.

95. The reduced fare for children is presently taken out of the BES&T budget, thus penalizing the bus operation for a basic welfare function that it provides. Children travel at half fare on the BES&T system, but they contribute to costs and capacity utilization just as adults do. While a child will take up slightly less space, the functions of driver and conductor of stopping the vehicle, allowing a child to board, selling a ticket, and disembarking a child are all functions requiring the same effort for a child as for an adult. The operating performance of the bus system should not be penalized for this activity, since it is not a transportation function but is rather a question of broad, public policy. While this form of redistribution may be entirely appropriate, it is best that it be made explicit. Without clearer data regarding child riders on the BES&T, explicit consideration cannot be given to the cost of providing reduced fare rides for children.

Management

96. The BES&T has been very cognizant of modern management methods in operating the Bombay bus service. For example, they have attempted to use modern computer techniques to schedule buses and crews as well as to analyze the bus route structure for possible improvements to provide better service to the Bombay population. While some of these efforts do not appear to be totally successful, the BES&T must be commended for making a serious effort.
In addition to their attempting such improvements in operations, recent introduction of incentive schemes for conductors, drivers, and traffic supervisory staffs appear to have improved the operating results of the system by increasing load factors on the buses, and obtaining generally greater productivity from revenue producing equipment. Beside incentives for the transportation personnel, an experimental program to provide incentives to engineering staff has been in effect. If this is successful, improved equipment utilization and lower maintenance costs may result. In studying its route structure, the BES&T has conducted extensive origin and destination surveys of its passengers to determine where passengers are actually going. While these studies have many limitations, most transit companies have not made such efforts at all.

97. The 1969/70 administration report of the BES&T describes a relatively minor problem that may have some management and engineering implications:

"The 50 new Leyland Titan (Beaver) double-deck buses have been fitted with ac alternators and with transistorized regulators for charging of batteries. The alternators are preferable to the alternate dc generators and the former can charge the batteries at low engine speeds which are mostly obtainable in city service. This results in the batteries having hardly to be removed from the buses for charging purposes."

It would seem that recently purchased buses should be equipped with ac alternators initially rather than require a modification soon after being put in operation. Similarly, all of the 50 semi-articulated double-deck trailer buses had to be fitted with transistorized inverters and fluorescent tubes for illumination because of the low capacity of the dc generators fitted on the tractors of these buses. It is not clear why the generators were not replaced with alternators on these buses. The administration report states that the capital costs of the inverters and the fluorescent tubes are considerably more than for standard fittings with 12/24 volt lamp bulbs. Individually these decisions are not crucial, but they raise interesting questions about whether such problems arise from engineering errors, from lack of attention to details of specifications, from arbitrary restrictions on procurement practices, or other reasons.

Prospects for the Future

Minibuses

98. During discussions with the BES&T staff, we asked whether they had considered a small minibus to provide service in the fort area. Such a bus would essentially compete with a taxicab and could perhaps charge premium bus fares. Furthermore, because the bus would be very small, the particular route served could be determined at the time the passenger load was established rather than a fixed route system. In effect, the system would be a jitney service providing high quality, fairly fast service for
some of the people employed in or traveling to the fort area. In particular, such services could be provided from the terminal of the Western and Central Railways, making a logical improvement in service.

99. It turned out that a scheme had been suggested for operating a minibus service, but with some different characteristics. It was to be a fixed-route, flat-fare service operating over 11 separate routes, all of about 4 - 5.5 kilometers round trip. The proposal suggests a flat fare of about 30 paise and estimates the cost of operating the vehicle at about Rs. 3.5 per roundtrip. It was planned that the vehicle would be a Tempo Station-wagon costing about Rs. 30,000 each. The attempt to serve the middle-class, short-distance travelers using the minibus was rejected and nothing further has been done about the proposal.

100. It would seem that since better service is provided by such minibuses, particularly in the highly congested fort area, a higher fare could be charged than the 30 paise proposed. Indeed, some trade-off must exist between high quality service and the price charged. If fewer passengers were allowed in the vehicle, i.e., a smaller vehicle were to be used, a more personalized service could be achieved to compete very directly with taxicab service. The minimum fare for a taxicab is 60 paise; if the minibus trip is long enough -- even on a flat-fare basis -- passengers may well be willing to pay approximately that fare.

Computerized Routes

101. The BES&T engaged a consulting firm to create a new route plan using a computer. The data used to develop the route plan were obtained by a survey of bus passengers. The problem with such a survey, of course, is that it includes only those people who are presently riding the buses and ignores the fact that service improvements or service deterioration may change the composition of riders. This is particularly true as the proposed new routes could not serve people the same way as the old routes. In some cases passengers would be served better, in others worse. An attempt was made in the survey to determine demands by specific times of day. Such data, while very desirable, may not be obtainable by interviewing people waiting for buses. They may prefer to go at other times of day but find that travel at those hours takes much longer because of congestion or requires more waiting in a queue. The basic principle for defining routes, called "demand efficiency factor", is the ratio of total demand served by the route to the roundtrip time. This is a fairly simple definition that may not correlate well with passenger desires for service. One example that comes out of the routing is the very substantial increase in the number of transfers required. According to the report, the present system of routes requires approximately 6.5 percent of all passengers to change buses, all the rest being provided with direct bus connection. The new system would require an additional 11.5 percent of all passengers to change buses in the course of their journeys. Thus, 18 percent of all passengers would have to make transfers under the new system. While this might be a very efficient way to operate the bus system, probably the most burdensome aspect of bus travel to the passenger is the need to transfer. Increasing
the need for transfers by a factor of two does not make much sense in terms of improving service. On the other hand, such an increase is an implicit fare increase and, since operating costs go down with the more effective routing, it might be a desirable way to improve the operating performance of the bus system. Further reductions in service would result from the elimination of all limited stop services, putting the buses instead on regular services and providing that all passengers change at Mahim and Sion stations. No island buses would run beyond these stations and no suburban bus to the island. The rationale for such a system is not clear. In visualizing how such a solution could occur, the most plausible hypothesis is that the entire bus network did not fit into the computer so was divided into the city and suburban areas and routes were found separately. Then the routes were linked by having passengers transfer.

102. Proper route scheduling requires detailed information not only on travel time, but it should also include consideration of revenue and service effects for passengers. The consultant report indicates that five minutes were added as a discomfort factor for passengers required to change once and fifteen minutes for passengers required to change twice. According to the report, the maximum number of passengers waiting in queues at any one time would be reduced 60 percent using the new route system. Furthermore, the queues would be cleared sooner, both in the morning and afternoon peaks. It is not entirely clear how all these calculations were made, but if substantially reduced operating costs could be achieved and better utilization of buses accomplished through the use of the system, even though service quality would deteriorate somewhat for some passengers, it may be a worthwhile approach.

103. As a large number of the proposed routes are different from existing ones, the report suggests that the whole scheme would have to be put through on a single day. It seems that some attempt should be made prior to introducing this scheme overall to test it on a few routes. The selected routes would have to be somewhat regional in nature to give the effect of the change without confounding it with the old bus system.

Maintenance Workshop

104. The BES&T reports indicate that there is a substantial need for additional maintenance capacity. There is presently a central workshop at Dadar which handles major repairs, including overhauling engines, chassis, etc., and various engineering jobs for the other departments of the undertaking. All day-to-day maintenance of buses and other minor repairs are done at the depots, of which there are presently 10, two of which have been added within the last two or three years, Matol and Deonar. The Matol depot is located north of Santa Cruz airport, while Deonar depot is located at Trombay along the Sion-Trombay road. The central workshop was originally adjacent to a workshop for trams. The workshop was designed for a fleet of 500 vehicles, and the BES&T feels that the workshop should be capable of handling 2,000 vehicles.
A new west wing has been proposed for the present workshop. This new wing would contain a complete centralized store for the BES&T bus system. The new structure would be a multi-storied, expensive, and modern bus maintenance facility. Facilities proposed include: a reclamation plant for lubricating oils, a tire repair shop with provision for expansion to include tire retreading in the future. The estimated cost of the building is about Rs. 140 lakhs. The cost of desired machinery and equipment is estimated to be Rs. 46 lakhs, which includes 34 lakhs of imported equipment.

It is not clear why the proposal for the new central workshops includes an oil reclamation plant. The 1968/69 administration report of the BES&T notes that a reclamation plant was constructed in the bus workshops and was successfully commissioned. According to that report, the cost of reclaimed oil is approximately 45 paisa per liter as against the cost of Rs. 1.80 of new oil. The estimated savings given in their report is about Rs. 60,000 - 70,000.

Rolling Stock

Tata Engineering and Locomotive Company Ltd. (TELCO) has made proposals to the BES&T for high-capacity single-deck buses that would provide capacity for 43 seated and 40 standing passengers. The seating capacity of such buses would be equal to or greater than that of most of the single-deck buses being operated today in Bombay. The total capacity, with standees, nearly matches that of the majority of double-deck buses presently in the fleet. While the details of this proposal have not been provided to the Mission, it would appear that such a proposal would be well worth careful scrutiny. The buses would use parts and equipment in common with many of the trucks Tata produces in India, thus providing a large market for spare parts and skilled mechanics that could lead to much better fleet utilization in the bus operation.
IV. BOMBAY ROAD DEVELOPMENT PLAN

108. The responsibility for planning and building the major road system in Bombay is shared by the Government of India, the State of Maharashtra, and the Bombay Municipal Corporation. Recognizing the growing problems of road transportation, these three governmental levels jointly sponsored a Bombay Traffic and Transportation Study in 1962 which was conducted by the consulting firm of Wilbur Smith and Associates. The objective was to recommend ways for improving the efficiency of traffic operations on existing streets and to provide a plan for new road construction.

109. The traffic study was patterned after the studies being carried on for U.S. cities at that time. Origin-destination surveys were conducted to establish existing travel patterns, and growth trends for population, vehicle ownership, and land use plans were used as a basis for forecasting 1981 travel patterns. The emphasis was almost entirely on automobile and truck traffic, although reference was made to the need for other studies of mass transit services. The final report for this study was presented in December 1963 and contained recommendations for building a system of freeways, expressways, and major streets. The recommended network would encircle the island with freeways (the West Island and East Island Freeways, and the Mahim and Cross Island Connectors), and would bisect the Island longitudinally with a Central Island Expressway. The report pointed out that with the proposed system, all portions of the Island would be within one mile of a freeway or expressway. The plan also called for upgrading portions of the Eastern and Western Express Highways in the suburbs to freeway standards, the construction of the Sewri Expressway leading to the Thana Creek Bridge and construction of a Tardeo Expressway link between the West Island Freeway and the Central Island Expressway (see Map 2). In all, 28 miles of freeway, 14 miles of expressway, and 75 miles of major route improvements were proposed, at a 1963-estimated cost of Rs. 96 crores. The West and East Island Freeways account for Rs. 57 crores of this total. A summary of the proposed works is shown in Table 5.

110. The Government of Maharashtra appointed a Steering Committee to examine these proposals, to consider their priorities, and to recommend a phased program for development. This Committee's report proposed a Rs. 27 crores first-phase program (Table 6), of which Rs. 18 crores was to be spent in the Fourth Five-Year Plan and the remaining Rs. 9 crores would

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1/ Both freeways and expressways are high standard highways on which vehicular access is provided at only a relatively few points; the main difference is that expressways have some surface level intersections with other roads, while the freeways have all grade-separated interchanges.

carry over to the Fifth Five-Year Plan. The detailed program which subsequently was submitted to the Government called for expenditures of Rs. 12.3 crores during the Fourth Five-Year Plan, with the remainder of the Rs. 27 crores scheduled for the next Plan period (Table 6).

Work in Progress

111. The Maharashtra State Roads Department reports that progress on these roadworks is as shown in Table 7. Surveys are still underway for the East and West Island Freeways. Construction efforts have been concentrated on the sea walls and land reclamation work for the West Island Freeway and the three northern suburban link roads (Item 3, Table 6). Although the Thana Creek Bridge is expected to be completed in late 1971, only land acquisition and the construction of a test embankment have started on the Chembur - Mankhurd approach road on the west side, and the east side connection is still under construction so it would appear that adequate access to the bridge will not be provided for several years. Alternative designs for the East Island Freeway are still being reviewed by the Government and by a local ad hoc committee in an attempt to resolve questions about its detailed location and access provisions. On the Bandra - Dharavi Link Road, the bridge across Mahim Creek is nearing completion but problems have been encountered in land acquisition and squatter resettlement at the southern approach to the bridge. Until the southern approach road is completed, this bridge will sit idle. In brief, the only usable additions to the Bombay major road network in the near future will probably be the link roads in the northern suburbs.

Road Program Issues

112. Three basic questions should be considered with respect to the present and proposed program of roadworks:

(1) Is the proposed freeway-expressway-major road system part of the most appropriate transport investment program for Bombay?

(11) Are the project priorities valid?

(111) What has been the progress in project implementation?

113. In reality, the first and most fundamental question should be stated in two parts: was this road program part of the best transport investment program when it was proposed in 1963, and, in view of developments during the past eight years, is it now the best program?

114. Some insight on these issues can be gained by recalling the background for the program proposals. The study which produced these proposals was a road traffic study. It considered only ways to improve motor vehicle movements in Greater Bombay; it did not examine the total transport situation in Greater Bombay or the metropolitan area. Mass transit requirements and opportunities for improvements on existing systems were not considered.
in any detail despite the facts that car trips accounted for only 1.4%, and train and bus trips made up about 90% of all passenger trips in Bombay, and that only 1 of every 80 persons on the Island owned an automobile. 1/

The study did not impose any limits on the availability of resources, either within the transport sector or in other sectors of urban development. The study did examine the relative merits of several different road system proposals. However, it assumed as a starting point that the West Island Freeway and Malabar Hill Tunnel would be built; no system was investigated which did not include these facilities. Inasmuch as there were no metropolitan regional development plans when the study was made, there was no possibility to study the road program in the context of proposals for Twin City development or other elements which are now under consideration.

115. The consultants' study recommendations did include a specific time framework for carrying out the road improvement program, as shown in Table 8. The proposed First Stage of the program, from 1963 through 1966, was mainly directed at widening existing streets, improving intersections and traffic regulations, and acquiring rights-of-way for new construction that was to be carried out in later phases. The Second Stage called for construction of the three main freeways on the Island plus the arterial connection to the Thana Creek and several other smaller projects, all to be completed by 1971. The Third and Fourth Stages were to consist mainly of the completion of the freeways in the area of Mahim Creek and construction of the Sewri Expressway and connecting links between the freeways and expressways, in the 1971-1981 period.

116. Actual progress in the implementation of these recommendations has been quite a different story. Details of improvements made on existing streets were not furnished to the mission, but visual inspection indicates that comparatively few were carried out. It is certain that the new construction works proposed for the 1967-71 period have not kept pace with the program. Of the major projects which were recommended to be completed by 1971, the West Island Freeway is the only one on which any construction has started, and this work has so far been confined to seawall construction, an overpass, and land reclamation. Design studies are still in progress on the freeway alignment and for the Malabar Hill Tunnels, 2/ which must be

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1/ There were only 42,000 passenger cars owned in the Bombay Study Area in 1962, and 34,000 on the Island. The forecast was that 149,000 cars would be owned in the Study Area by 1981 and 81,000 on the Island. There was 1 car for every 104 persons in the Study Area and 1 per 82 persons on the Island in 1962; these ratios were forecast to be 1:54 and 1:40, respectively, in 1981. (Source: Table 18, Bombay Traffic and Transportation Study Report; W. Smith and Associates; 1963.)

2/ A number of serious problems must still be solved, ranging from procedures for tunnel construction to questions of how traffic will operate if the West Island Freeway is constructed with six lanes and the tunnels have only two lanes each direction, as apparently is now proposed. As yet, there has been no budget allocation for construction of the tunnels.
completed before the West Island Freeway can serve as it was intended. Land acquisition has not yet started for the East Island Freeway, pending resolution of location and design questions. Construction of the Center Island Expressway is even further in the future as design surveys have not yet started.

117. There have been valid and possibly unavoidable reasons for not meeting the recommended schedule. Foremost has been the lack of funds, but there have been problems of organization and staffing, right-of-way acquisition, etc. Regardless of the contributing factors, only a small fraction of the proposed works has been carried out, or even appears possible to be completed by the 1981 target date.

118. Returning then to the original question, the road system proposals for Bombay were not supported by convincing evidence that they were the "best" in terms of overall urban transport and development needs at the time they were presented in 1963. Developments during the intervening years, including the proposal of substantially different concepts for future urban growth, make it highly questionable whether the originally proposed road system is now a valid basis for a transport investment program. The Bombay Metropolitan Regional Planning Board apparently recognized this when it commented on the road development program:

"This programme has been suggested after taking into consideration the needs of the car traffic by 1981 on the basis of the then trends of development and the proposals of the Development Plan of Bombay. It is proposed that a reassessment of the programme suggested by Wilbur Smith and Associates be made." 1/

119. However, some recommendations made by the consultants are even more appropriate now than in 1963; namely, those relating to the need for improved traffic regulations and controls. Particularly given the difficulty in obtaining sufficient funds to finance large new road construction projects, more attention should be given to measures which would permit more efficient use of existing streets. It is unfortunate that the top priority assigned to these measures by the consultants was not adopted. If the Rs. 12 crores which were allocated mainly to construction of the East and West Island Freeways and the northern link roads had been used instead for improvements on existing streets and intersections, substantial benefits would have been realized already from the improved traffic flows. As it is now, it will be at least five more years before the West Island Freeway could be opened to traffic; the East Island Freeway will be even later, and the link roads will have no effect on traffic on the Island. Unless a concerted effort to improve existing streets is made in the meantime, traffic conditions throughout the Island will continue to deteriorate.

1/ Page 27, Section 4.4.3(i); "Strategy for Bombay Metropolitan Region -- A Summary of Volumes I and II of the Report of the Draft Regional Plan 1970-1991; by the Metropolitan Regional Planning Board, January 1970."
120. All of the road project priorities should be reappraised in view of the present situation. The relatively much greater importance of public transportation for moving people in the Bombay metropolitan area is beginning to be more fully appreciated. Compared to possible mass transit improvements, the justification for costly freeways (which, as now being planned, are not even intended to carry commuter buses and which would mainly benefit the small percentage of car owners) is very doubtful. There are also the new proposals for metropolitan development, including the Twin City, to be considered. The transport investments which will be required to make the Twin City a viable development have not yet been determined. A delicate balance must be sought to assure that this area is sufficiently accessible to Bombay to make it an attractive growth center and, at the same time, not to make it so accessible that it simply becomes another 'bedroom' community for commuters. In this respect, proposals for additional road bridges between the Twin City and the Island seem unwarranted or at least vastly premature.

121. After a new look at total transport requirements in the Bombay metropolitan area and at the financial and other capabilities for making transport improvements, there is a strong possibility that major revisions to current project proposals would be suggested. The schedule for construction of the freeways and expressways on the Island has already changed drastically from that proposed by the consultants; it might even be that these projects should be deferred indefinitely.

122. This rather discouraging assessment of road planning and development in Bombay deserves a closing comment about factors which have contributed to the present situation. It would be a gross oversimplification to ascribe the blame to inadequate performance by the road traffic consultants. The faults of the 1963 traffic study lie not so much in how it was conducted as in what it was required to do. 1/ The root of the problem can be traced back to study instructions, or "terms of reference," which were too narrowly and inadequately defined and which did not focus on the right issues. This is not to say that a study leading to recommendations for road improvements should not have been undertaken. The subject was, and still is, worth careful investigation. It must be studied, however, within the context of the resources available for implementation, the overall requirements and objectives for urban development, and the full range of alternative ways for accomplishing these objectives. Operating without these guidelines, the 1963 traffic study recommended a near Rs. 100 crores road program. This was so far out of scale with then existing or foreseeable road investment capabilities that it was unavoidable that only the smallest and easiest pieces could be implemented. The remainder has necessarily slipped further and further behind the recommended schedule.

1/ Traffic study techniques have improved considerably since 1963 so the same procedures probably would not be used if the study were undertaken now, but this cannot be used as a criticism of the method used in 1963.
is one brighter aspect: program slippage, in this case, is not such a serious complaint. The delays in starting large new road works on the Island may, unintentionally, have made it possible to find a more suitable solution.
V. AIR TRANSPORTATION

Introduction and Background

123. In a country as vast as India with large distances between key urban centers, air transportation takes on even greater than ordinary significance in internal communication. Although there is an extensive network of railroads and highways linking the country, distances are sufficiently great that travel times via surface modes are often prohibitive in this era. While this may be less true in India than in the highly developed industrial nations, it is nevertheless important.

124. Airports in India are operated by the Central Government. For purposes of administering aviation facilities, India is divided into four regions, (Bombay, Delhi, Calcutta and Madras) each headed by a Regional Controller of Aerodromes. The controller's responsibilities range from the operation of airports and communication facilities to examination and licensing of pilots. The Bombay region has 19 airports in total with Santa Cruz, Bombay's international airport, by far the largest. In addition to Santa Cruz, a small general aviation airport, Juhu, is in the metropolitan area. Juhu principally serves for training and agricultural activities (crop spraying).

Domestic Passenger Travel

125. In 1968 1,749,394 passengers were carried on domestic scheduled services for all of India. 1/ About twenty percent embarked at Bombay airport. 2/ The average annual growth in scheduled domestic passenger traffic from Bombay Airport has been 12.7 percent from 1960 through 1968, and 14.5 percent through 1969. This compares with 12 percent for passengers carried 1960-1968 in worldwide scheduled services of ICAO carriers. 3/

International Passenger Traffic

126. In 1969 207,000 passengers on scheduled international services embarked at Bombay airport. Recent growth has not been as substantial for international as for domestic passenger travel, but it has been by no means insignificant; 1969 traffic is 40 percent greater than that of 1967. Of the four international airports in India, Bombay is by far the most important in terms of passenger traffic, with 70 percent more embarkations than its closest rival, Delhi.

1/ Basic Statistics of Air Transport in India, 1968, Air Transport Directorate, Civil Aviation Department, New Delhi, p. 13.

2/ Supplemental Information supplied by the Senior Aerodromes Office at Bombay Airport, Mr. R.D. Prodhah, Annex C.

International Freight and Mail Traffic

127. International cargo on-loaded and off-loaded at Bombay shows growth every year except on-loadings in 1966 and off-loadings in 1967, although the pattern of growth is somewhat erratic. Average annual growth 1960-1969 for on-loaded cargo was 13.4 percent. Except for 1956, Bombay appears to be a net air cargo international exporter in terms of weight. If the observed growth rates persist this phenomenon will continue and grow in importance. Nevertheless, international cargo movement through Bombay airport is very small (5,868,800 Kgs on-loaded and 3,739,000 Kgs off-loaded in 1969).

128. The growth in international mail handled at Bombay has also been erratic with declines both in 1963 and in 1966, the latter being very substantial. Except for the period 1963-1965, international mail off-loaded exceeded that on-loaded at Bombay. Again, the total volume of freight made up by mail is relatively small; 918,300 Kgs on-loaded and 1,028,000 Kgs off-loaded.

Domestic Freight and Mail Traffic

129. Domestic cargo operations have been extremely erratic; peak on-loaded cargo from Bombay occurred in 1961 (4,897,492 Kgs.), an increase over the previous year of 115 percent. Also, in 1961 off-loaded domestic cargo fell 55 percent from the previous year. Both on-loaded and off-loaded cargo volumes increase and decrease through the 1960-1969 period, neither moving together nor reaching peaks or troughs together. It does appear, however, that with respect to domestic cargo movements in the 1960-1969 period, again Bombay is a net exporter in weight terms. This was true in every year of the period except 1960. Domestic cargo activity in 1969 was substantially less than international (3,687,300 Kgs on-loaded and 1,910,200 Kgs off-loaded).

130. Domestic mail movements by air are nearly as erratic as domestic cargo. In most years of the 1960-69 period, more mail was on-loaded at Bombay than off-loaded. Unlike international mail which is substantially smaller in volume than international cargo, domestic mail volumes are about the same magnitude as domestic cargo.

Aircraft Movements

131. The number of aircraft movements and the size of aircraft using the facility are important factors for planning airport facilities for aircraft, e.g., runways, taxiways, aprons, communication and navigation facilities. Because of increasing aircraft size and perhaps because of generally increasing load factors (ratio of occupied to available seats), aircraft movements have not grown at nearly the rate of passenger traffic. In the period 1960 to 1968, the latest year for which data were provided, annual growth in aircraft movements (departures and landings) was about 6.5 percent. There were less than 30,000 aircraft movements in 1968 -- less than 85 movements per day on the average. To place this number in perspective, under poor weather conditions with aircraft operating under instrument
flight rules (IFR), properly equipped airports handle about 40 aircraft movements per hour. Weather conditions at Bombay are generally above such minimum. 1/ Present levels of aircraft movement at Santa Cruz do not pose serious congestion problems. With further increase in the size of aircraft operated by the world's airlines and the expected increase in size of aircraft in the fleet of India's domestic air carrier, Indian Airlines, through fleet modernization, one can expect the growth in aircraft movements to continue at rates similar to those experienced recently even with fairly substantial increases in passenger traffic.

132. Domestic load factors on Indian Airlines (the ratio of occupied seat kilometers to available seat kilometers) have been unusually high, 70.4 percent in 1968. For Bombay area operations, the load factor was 74.9 percent. The world average in 1967 was 59 percent. Generally, at load factors this large, service quality becomes poor and many reservation requests must be refused. On the other hand, such high load factors can be very profitable. Load factors may be reduced by increasing the average size of aircraft or the number of flights. If the load factors were reduced by increasing the number of flights, aircraft movements would increase. Assuming that flights into and out of Bombay Airport have the same load factor as the Bombay region, a reduction in load factor to 60% would require a 25% increase in aircraft movements, other factors remaining the same. Even this large an increase would not seriously affect the level of aircraft movements at Bombay Airport. In fact, if a reduction in load factor were to be achieved, at least some of the reduction would likely come from increased aircraft size.

133. Another important aspect of aviation activity is the distribution of flights throughout the day. Domestic flights generally take place between the hours of 6:30 a.m. and midnight, while most of the international flights are between the hours of 1:00 a.m. and 5:00 a.m. This is due to world travel and time patterns rather than considerations for travel to India. Approximately two-thirds of the aircraft movements are domestic and one-third international. This unusual pattern of operation makes for better utilization of airport capacity throughout the day than at most locations.

Airport Current Finances

134. Detailed revenue data were not provided, but conversations suggest that the bulk of airport revenues are derived from landing fees, which are established by law. The table in para. 134 summarizes the schedule of landing fees. Although a fee schedule for aircraft storage is also provided in the law, few airlines use public storage facilities and this is not an important source of revenue. The airlines have their own hangar space which they rent for about Rs 10.5 per square yard per year for various lease terms.

1/ The numbers were not provided.
135. In addition to the charges for landing and storing aircraft, there is an international passenger tax of Rs 15.00 per departing passenger. At present, there is no airport tax on domestic passengers, but such a tax is reportedly under consideration.

Schedule of Landing Fees Applied at Indian Airports

<table>
<thead>
<tr>
<th>Aircraft Cross Weight</th>
<th>International</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 10,000 Kgs.</td>
<td>Rs 4.00 per 1,000 Kgs.</td>
<td>Rs 2.50 per 1,000 Kgs</td>
</tr>
<tr>
<td>over 10,000 Kgs but less than 20,000 Kgs</td>
<td>Rs 40.00 plus Rs 3.00 per 1,000 Kgs in excess of 10,000 Kgs</td>
<td>Rs 25.00 plus Rs 5.00 per 1,000 Kgs in excess of 10,000 Kgs</td>
</tr>
<tr>
<td>over 20,000 Kgs.</td>
<td>Rs 29.00 per 1,000 Kgs in excess of 20,000 Kgs</td>
<td>Rs 75.00 plus Rs 10 per 1,000 Kgs in excess of 20,000 Kgs</td>
</tr>
</tbody>
</table>

Total reported revenue for Bombay Airport in 1968-69 was Rs. 13,817,422 and total reported expenses were Rs. 12,626,779, leaving a net revenue of Rs. 1,190,643. Net revenue in the previous fiscal year was Rs. 1,834,042.

Bombay Airport Modernization

136. A phased plan for improving Bombay Airport was prepared in 1968 by the Committee on International Airports as part of a program for improving the four major international airports in India. The three-phase plan provides for runway, taxiway, and apron additions and extensions and for improved terminal facilities. The airport has three runways:

- **Main Runway** 09/27 11,000 feet
- **Second Runway** 14/32 8,200 feet
- **Third Runway** 05/23 5,870 feet

The main runway is presently being widened to 200 feet and strengthened to not less than LCN 100 value. This work is well along and is expected to be completed by March 1971 in anticipation of 747 operations which are expected to begin in May. The second runway is being extended to 9,000 feet. The third runway is "operationally not required" and may be merged with the taxiway system.

137. Taxiways parallel to the main runway on the north are also expected to be completed by March 1971. This improvement will permit aircraft to leave the active runway quicker, clearing it for other landing or departing aircraft. With the low traffic levels at the airport and the positive aircraft control through the tower, such expedition of ground traffic may not be
prime importance. However, some improvement may be appropriate to accommodate the much larger 747 aircraft. Other runway improvements parallel to the second runway are contemplated for later phases. These should certainly be investigated carefully in the light of current and forecast traffic levels at the time of decision. The three intersecting runways can be useful supplements to the taxiway system. In the event that additional parallel taxiway construction is deferred, it may be desirable to provide large turn-around and holding areas for aircraft at the ends of the runway to permit increased activity without seriously increasing delays due to the inability to clear aircraft from the active runway.

138. The apron is being extended at the present terminal building. The extension will provide additional capacity to accommodate the 747 and some increased traffic levels. In addition, it will permit greater maneuvering room for aircraft in parking and passing.

139. Also in the third-phase plan is the construction of a new apron and extended taxiways north of the main runway at a location designated to be a proposed new international terminal complex. It is not clear why these aprons should be constructed in advance of a decision to construct the terminal complex, or whether a decision has been made to fund this additional development. Before construction can take place at this location, the plan indicates that some additional land will need to be acquired.

140. The present terminal building is being expanded now by extending on two sides and adding a large canopy the length of the building. The present terminal building is used by both domestic and international passengers and thus, in addition to ground passenger handling facilities, includes space for customs and immigration activities. The division of domestic and international traffic between daytime and nighttime hours smooths the activity levels, permitting better utilization of terminal capacity than can normally be accomplished.

141. The master plan proposes a large international terminal complex "to include all terminal facilities and services needed in a modern and expanding airport." The plan would utilize approximately 450 acres most of which is already owned by the government. While there are reasons to segregate international passengers because of the special needs for immigration control, customs, health, etc., the present natural separation of domestic and international activities by hour of the day would suggest a more flexible design of the present terminal facility to accommodate the traffic rather than have a domestic terminal unused at night and an international terminal unused during the day. For example, flexible partitions might be used to convert some areas to meet the special requirements for international passengers. It may also be necessary to have additional space, but further extensions of the existing building with modified use of interior spaces may be much more economic in the short run while traffic develops. Large capital investments may thus be deferred several years.
The master plan also recommends the acquisition by the government of additional land to be used for further airport expansion. This land acquisition is on the north and east of the present airport. It is recommended that land be acquired (123.26 acres) at the east end of the main runway so that it could be lengthened by 2,000 feet. Further, the plan recommends that the Kurla hills, sitting off the eastern end of the main runway, be cut lower to provide at least 10,500 feet of usable runway for landing with displaced threshold. The hills prevent a normal descent to the end of the runway. The present displaced landing threshold provides only 9,080 feet on the main runway. It was reported that an accident did occur on these hills some years ago. It may be possible to reduce this hazard by installing electronic or optical devices such as markers and lights on the hills. Visual approach slope indicators, and appropriately designed and placed electronic and optical instrument landing equipment, such as high intensity lights. (Some of this may already be installed.)

If the main runway is extended as recommended, a section of the Andheri-Kurla road would be relocated. No indication is given of the present use of the property to be acquired. The plan also proposes the acquisition of 67.36 acres to permit the development of the second runway. Altogether the plan calls for the acquisition of 459 acres.

The estimated total cost for all phases of the airport improvement plan is Rs 27.48 crores, with the bulk of the funds, Rs 16.10 crores, devoted to Phase I. Even if air traffic were to grow very substantially, it appears that the start of some of the planned construction could be deferred for several years. Neither the growth in passenger traffic nor the growth in aircraft movements over the last ten years suggest that extraordinary growth will take place. Indeed, the small old equipment used to provide many domestic services is likely to be replaced with newer and larger equipment, permitting improved service in the short run through reduced load factors and increased speeds. (The increased speeds and newer equipment may induce additional travel as well.)

Beyond improving and increasing the capacity of the present airport, there are no plans for a new airport by the airport authorities. However, they are presently surveying a site at the northern end of Salsette Island, since a present planning contemplate saturation of Bombay Airport in 1990. This does not seem unreasonable, although many changes can take place in such a long time period. The site being surveyed would become a second major airport. They are seeking an area where there is adequate room for parallel main runways (6,000 foot spacing). Studies to date have only been concerned with physical and potential operational characteristics of the site; no consideration has yet been given to such questions as accessibility, ground travel times and costs, or relationship to proposed strategies for metropolitan area development.

The airport authorities have not explored sites for airports in the Twin City area and speak only of providing feeder service. The present location of Santa Cruz airport may be closer, in terms of travel time, to the proposed site of the Twin City than to the Fort area when the bridge across the Thana Creek and its access roads are completed.
147. Ground access to the airport is quite good via the Bombay-Ahmadabad Road (Western Expressway) and the Bombay-Agra Road (Eastern Expressway). The airport is also accessible by train on the Western Railroad. From the Fort area to the airport is approximately Rs 13.50 via taxi. Because of the location, general improvements and expansion of commuter rail and highway services will also contribute to improvement of the airport ground access.
VI. PORT OF BOMBAY

Introduction

148. Bombay's claim to be the premier port of India is based on the facts that it is the leading oil port with over 90% of the traffic, the leading general cargo port with about 38% of the traffic, the leading port for overseas passenger traffic and the main base for the Indian Navy. The Bombay Port bore the brunt of the heavy foodgrains imports of the last decade, handling as much as 35% of the imports in the peak period. The Port of Bombay is situated almost midway along the west coast of India and is gifted with a natural deep water harbor of 70 sq. miles protected by the mainland of Konkan at its east and the Island of Bombay on its west. The deep waters in the Harbor provide secure and ample shelter for shipping.

Administration

149. The Port of Bombay is administered by a statutory, autonomous corporation known as the Bombay Port Trust, which was set up in 1873 by the Government and comprises the Chairman appointed by the Government of India and a Board of 24 Trustees presided over by the Chairman. Ten Trustees are nominated by the Government and the remainder are the elected representatives of various shipping and commercial interests connected with the Port. The day-to-day administration of the Port Trust is carried on under the supervision and control of the Chairman, assisted by the General Manager.

Finance

150. The revenue of the Port increased from Rs. 5.50 crores in 1947-48 to Rs. 23.18 crores in 1969-70. The expenditure has increased from Rs. 4.36 crores in 1947-48 to Rs. 21.49 crores in 1969-70. At the end of the financial year 1969-70, the Port had Rs. 53.79 crores in its Capital Reserves and Rs. 28.28 crores in its Reserve Funds, apart from provision for depreciation on capital assets.

151. The Port accounts have been streamlined by adopting management accounting procedures. The rate structure is also being rationalized on the basis of the costs and values of services and what the traffic can bear.

Port Facilities

152. The Port has extensive wet and dry dock accommodation to meet normal needs of ships using the Port. There are three enclosed wet docks having a total water area of 114.4 acres and quayage of nearly 28,331 feet. The leading particulars of the wet docks are given below:

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1/ The background information in paras. 148-166 is mostly from a recent brochure prepared by the Bombay Port Trust, titled "Port of Bombay - the Gateway to India."
<table>
<thead>
<tr>
<th>Wet Docks</th>
<th>Width of Entrance Ft.</th>
<th>Working Depth Maintained Ft.</th>
<th>Water Area of Basin Acres</th>
<th>No. of Berths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prince's Dock (1880)</td>
<td>66</td>
<td>21</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Victoria Dock (1888)</td>
<td>80</td>
<td>23</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>Alexandra Dock (1914)</td>
<td>100</td>
<td>30</td>
<td>59.4</td>
<td>21 6</td>
</tr>
</tbody>
</table>

153. The Hughes Dry Dock pumps have recently been electrified and are now being used also for impounding water to an extra height of 4 ft. so that the depth of water at all berths inside the Alexandra Dock including the four new berths has been increased from 32 ft. to 36 ft.

154. The Prince's and Victoria Docks are tidal docks. Alexandra Dock has an entrance lock 750 ft. long and 100 ft. wide through which vessels can enter or leave the docks at any state of the tide. There are points for supply of fresh water to shipping at all berths. Oil bunkering facilities exist at most berths. In addition, there are two dry docks - Merewether in the Prince's Dock and Hughes in the Alexandra Dock.

155. The transit sheds and warehouses at the Port aggregated 308,000 sq. metres in floor area, but a large part of this was completely destroyed in the explosions and fire on 14th April 1944. Temporary structures were built in place of those damaged and a program was instituted to reconstruct the temporary sheds on a permanent basis. The reconstruction program covered 13 sheds, of which 11 have now been completed. The new sheds have been designed with a steel frame and walls of precast concrete blocks. The column spacing has been kept wide enough to allow the use of mobile cranes, fork-lifts, and other cargo handling equipment. They have electric hoists and steel chutes for handling cargo between the ground floor and the first floor.
Storage accommodation at present is distributed as follows:

<table>
<thead>
<tr>
<th>Area Served</th>
<th>Transit Sheds</th>
<th>Warehouses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (Floor area)</td>
<td>No. (Floor area)</td>
</tr>
<tr>
<td>Prince's Dock</td>
<td>6 78,921 sq. m.</td>
<td>3 5,200 sq. m.</td>
</tr>
<tr>
<td>Victoria Dock</td>
<td>7 44,621 sq. m.</td>
<td>- -</td>
</tr>
<tr>
<td>Alexandra Dock</td>
<td>19 1,49,444 sq. m.</td>
<td>5 58,145 sq. m.</td>
</tr>
<tr>
<td>Wadi Bunder Wardhouses</td>
<td>= 8,189 sq. m.</td>
<td></td>
</tr>
<tr>
<td>Frere Basin Sheds</td>
<td>= 11,814 sq. m.</td>
<td></td>
</tr>
</tbody>
</table>

Open Berths: The deep water open berths outside the Docks are:

<table>
<thead>
<tr>
<th>Berth</th>
<th>Depth Maintained (below datum of soundings)</th>
<th>Depth below Mean High Water Spring Tides</th>
<th>Length of Quayage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballard Pier</td>
<td>30'0&quot;</td>
<td>44'6&quot;</td>
<td>800'0&quot;</td>
</tr>
<tr>
<td>Pir Pau</td>
<td>29'0&quot;</td>
<td>43'6&quot;</td>
<td>570'0&quot;</td>
</tr>
<tr>
<td>Marine Oil Terminal, Butcher Island</td>
<td>36'0&quot;</td>
<td>50'6&quot;</td>
<td>3 berths each for 650 ft. long tankers</td>
</tr>
</tbody>
</table>

157. Till 1954, dangerous petroleum imported in Bombay was handled at the Pir Pau oil berth. Non-dangerous petroleum was handled at Alexandra Dock harbour wall berths. With the installation of two oil refineries in Bombay, these facilities became inadequate and a new Marine Oil Terminal equipped with modern facilities was constructed within the Bombay Harbour. The terminal has three berths, two of which are capable of accommodating tankers up to 53,000 dwt. while the third can accommodate tankers of 36,000 dwt. The terminal is connected to the refineries at Bombay by underwater pipelines.
Besides the wet docks, there are along the harbour front a number of bunders and open wharves and basins where the traffic carried by sailing vessels is handled. These bunders are equipped with cranes and other facilities for loading, unloading and storing cargo, and have an aggregate quay-age of 41,000 ft.

There are various depots, such as Grain Depot, Cotton Depot, Manganese Ore Depot, etc. which provide for storage of grain, cotton bales, and other commodities as well as open storage of ores, coal, timber and other building materials, which are in the process of despatch either within Bombay and its suburbs or to the hinterland of the Port. Pre-shipment storage facilities have been afforded to export cargo, e.g. oilcakes, sugar, iron and steel and recently tea. 1/

Port Traffic

There has been an appreciable increase in Bombay’s seaborne trade in the last 25 years, in both volume and value. In 1938-39, the cargo handled at the Port amounted to about 5.2 million tons, made up of 3.3 million tons of imports and 1.9 million tons of exports. In 1966-67, the traffic rose to the peak level of 18.2 million tons with 13.2 million tons of imports and 5 million tons of exports. In 1969-70, the total traffic handled at the Port was about 15.03 million tons comprising 11.43 million tons of imports (with reduced imports of foodgrains) and 3.60 million tons of exports. There is also a noticeable change in the composition of the trade and the Port now handles a much larger variety of cargo than in the past. In terms of volume, the Bombay Port handles about 26 percent of the total traffic of the major ports.

There has also been an increase in the number of ships using the Port and the trend is towards the use of larger vessels carrying larger tonnage for individual ports.

<table>
<thead>
<tr>
<th>Year</th>
<th>Ships entered</th>
<th>Net regd. tonnage of ships</th>
<th>Total dead weight tonnage handled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51</td>
<td>2,946</td>
<td>7,120,751</td>
<td>6,997,000</td>
</tr>
<tr>
<td>1959-60</td>
<td>3,051</td>
<td>10,474,361</td>
<td>13,357,000</td>
</tr>
<tr>
<td>1968-69</td>
<td>2,505</td>
<td>10,266,060</td>
<td>15,035,000</td>
</tr>
</tbody>
</table>

1/ A point that is not apparent from this description of port facilities is that the Bombay Port Trust has extensive land holdings in Bombay which are not used for port-related activities.
162. Bombay is served by a number of shipping lines, whose ships ply regularly between Bombay and Africa, the Middle East, Europe and America, Ceylon, Burma, Malaysia, Australia and Japan. In addition, there are numerous steamer services which operate along the coast of India. The overseas passenger traffic is handled largely at Ballard Pier.

Port Trust Railway

163. The Port of Bombay owns and operates its own railway, which is connected to the broad-gauge main lines of Central and Western Railways at its Interchange Railway Yard at Wadala. The railway runs for about 11 kilometres of straight route between Ballard Pier and Wadala and has an extensive network of track of about 215 kilometres. It serves the Docks as well as the installations and factories in the Port Estate. It has its own fleet of about 20 Diesel and 23 Steam Locomotives, Railway Cranes and Wagon Weighbridge of 100 tons capacity. The Railway itself handles over 4 million tons of traffic annually. This figure represents about 60% of the total railborne goods traffic of Bombay City. Less than one-fourth of this Port Trust Railway traffic is into or out of the docks. \(^1\) The remainder apparently is between factories, depots and mainline tracks.

Current Developments

164. Two major development schemes - the Dock Expansion Scheme and Ballard Pier Extension - were embarked upon in 1965 and the entire project is scheduled to be completed in 1971-72. The schemes provide for the following additional facilities:

1. 4 deep water berths in the Alexandra Dock basin and 3 medium type deep water berths along the harbour wall with an annual cargo handling capacity of 1.5 to 2 million tons.

2. An additional berth at Ballard Pier for passenger vessels, where cargo can also be worked when necessary.

3. 31,000 sq. metres of reclaimed area.

4. 16,072 sq. metres of covered storage space in five transit sheds be provided, if necessary.

5. Two repair berths for coastal vessels.

165. The four new berths in the Alexandra Dock basin were commissioned on 23rd August 1969, and the three new berths at the Harbour Wall a little later. The new Ferry Wharf was commissioned on August 15th, 1969.

166. The total cost of these schemes will be about Rs. 22 crores with a foreign exchange component of nearly Rs. 4 crores.

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\(^1\) Page 253; Master Plan Report for Bombay Port; by Bertlin and Partners; 1970.
Port Master Plan Study

167. The Port Trustees appointed consulting engineers, Bertlin and Partners (India), to carry out a comprehensive port study and prepare a Master Plan for future development. The consultants were instructed:

"To prepare a Master Plan for the Port of Bombay taking into consideration the interest of all the users of the port and harbour and the probable development of the port traffic during the next 50 years." 1/

The consultants were also instructed to make the engineering, economic and traffic investigations which were needed for the preparation of this plan. The study was started on April 1964. A draft final report was submitted in 1968 and discussed throughout 1969. The final four-volume report was produced in 1970 (the first volume alone is more than 500 pages), dealing with nearly every imaginable port-related topic. The sheer size of this report makes it impossible, within the present paper, to attempt a comprehensive summary or evaluation of its findings. Two aspects of its recommendations, however, are particularly relevant to other main topics of this paper and so deserve some consideration. They are the proposals for developing a new port on the east shore of Bombay Harbour, on the mainland, and proposals for modifications in ground transport facilities which serve the present port.

New Port Development

168. The Consultants concluded that the Dock Expansion Scheme (para. 163) could only temporarily relieve congestion in the docks; by improving operating procedures, the forecast traffic can be handled until about 1978. They recommended:

"Immediate action should be taken to provide permanent specialized deep water bulk handling berths for the major bulk trades at a site removed from the existing docks so that these facilities are commissioned by 1978. Otherwise by about 1976, the docks will again be working to capacity and beyond that date traffic would have to be diverted to less suitable ports. The existing docks would thereafter be able to handle the growth in general cargo traffic through the port provided that most of the bulk cargo is diverted to new specialized facilities." 2/

169. After comparing a dozen alternative sites, the consultants recommend that new port facilities should be located across the harbour on the mainland at Nhava Sheva (Map No. 1). Among the favorable features of this

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1/ Master Plan Study, Terms of Reference.
Since its natural deepwater, extensive land area available, depth of rock below the surface (which facilitates dredging), and proximity to mainland rail connections. The recommendation was for construction of an enclosed dock with lock entrances and a depth suitable for 80,000 DWT laden bulk carriers and 100,000 DWT unladen vessels. The development would be in stages. Stage I would comprise five bulk handling berths, one container berth, a dry dock for 100,000 DWT vessels and a repair quay. Mechanized terminals for bulk cargo and container handling and road and rail loading/unloading facilities would be provided on reclaimed land. Stage II, providing additional berths and services, is forecast to be required to be completed about 1980. Capital costs (1967 prices) of the main civil engineering and ancillary works for Stage I are estimated at Rs. 35.29 crores, including Rs. 9.69 crores foreign exchange. The dry bulk cargo and container terminals would cost an additional Rs. 15.65 crores. In addition to the Nhava Sheva works, the consultants recommended the provision of a new crude oil berth on Butcher Island. The total costs of all these works and associated reclamation, dredging, etc. were estimated at Rs. 85 crores (1967 prices).

The need for the Nhava Sheva development was predicated on forecasts of dry bulk commodities traffic for 1975 (manganese ore, fertilizers and fertilizer raw materials, food grains, oilcake and sugar, cement/clinker and salt). Three years have elapsed since these forecasts were made, and traffic has not grown as expected during that time. The consultants have therefore investigated a variety of growth assumptions, ranging from no increase in traffic above 1965 levels to the full forecast growth. With zero growth, they found that only the improvements to the existing docks would be needed. For all other assumptions, they found the new port development would provide an attractive to excellent rate of return. They found, for example, that a 12% rate of return (discounted cash flow) would result if the forecast 1975 traffic is not attained until 1988. Considering the long construction period involved and the probable traffic generating effect of providing these facilities, they strongly recommend construction of the Nhava Sheva port development as rapidly as possible. They add that the opening up of the east side of the harbour presents a unique opportunity for developing a new industrial and residential area.

1/ The consultants present quite a plausible argument in favor of the new port development, especially as it is strengthened by their consideration of a range of traffic forecast assumptions. One issue that is not discussed and which might have a significant effect on the findings is whether, from the viewpoint of national interests, it would be desirable to encourage traffic to shift to other underutilized ports before expanding Bombay port. Quite understandably, this was not a subject of much interest in a study commissioned by the Bombay Port Trust but it warrants some consideration. The consultants' analyses of different traffic growth assumptions suggest that even if substantial shifts to other ports did occur, the


Nhava Sheva development would still be economically sound. However, the shift of traffic could be an important factor in determining the optimum timing for the development which, in turn, is closely related to the timing and viability of the Twin City development proposals.

172. Backers of the Twin City development have cited the proposed construction of the new port at Nhava Sheva as one of the key elements which will make the Twin City a success. The argument has some merit. Port activities and related industries which might locate there could provide part of the much-needed employment base for the Twin City. The rate and extent to which this employment materializes, conversely, will depend on the timing and size of the port development. The closest possible collaboration between the Port Trust and the Twin City developers (CIDCO) is needed to assure that these developments are consistent in their phasing and substance. There already seems to be a possible conflict, at least in concept, between planning for the port and for the city. The port is being planned to handle dry bulk cargoes. The materials handling process will be highly mechanized, and the basic industries which the port might attract will be capital-intensive bulk processing industries. The city, on the other hand, is being talked of as a second government and commercial center for headquarters offices, banking, etc. The two activities are not particularly compatible or mutually reinforcing.

Transport Modifications at Existing Docks

173. The consultants found that in the vicinity of the present docks, the land transport links are already severely strained and the future poses some serious problems; 1/ the most critical period being from now until the Nhava-Sheva dock is commissioned. 2/ The problems which are then described come under several headings: mounting financial losses of the Port Railway; truck and rail traffic interference within the dock area; and congestion on external roads and at the gates to the dock area.

174. Nearly all truck traffic into and out of the dock area uses P. D'Mello Road (see Map No. 2), the major arterial street which runs the length of the port properties. The Port Trust Railroad runs parallel to this road, between it and the docks, and the Western and Central Railways' Goods Depots are on the opposite side of the road. Truck traffic generally enters and leaves the dock area through one of eight gates situated along P. D'Mello Road and, at five of these gates, must cross the Port Trust Railway at grade level. The heaviest traffic is concentrated in the Carnac Bunder area and uses the Gamadia Road level crossing. A study made in 1961 by the Port found that this crossing was closed 70-80 times daily because of rail movements, stopping all truck traffic each time and causing serious congestion and delays. Traffic to the docks at this crossing is forecast


to increase 140% by 1975, as compared to 1966. 1/ Considering the general increase in traffic which is expected by then on P. D'Mello Road, the consultants thought it desirable to find an alternative access route for dock traffic.

175. The consultants have proposed an unusual solution. They recommend the removal of three of the Port Trust Railway's tracks between Sewri and the docks and the construction of a two-lane road adjacent to the two remaining tracks. 2/ This road would link the docks directly to the depot area at Sewri so that trucks would not have to use P. D'Mello Road or cross the tracks (except some infrequently used sidings). If the relative importance of rail traffic at dockside continues to decline, as the consultants believe it will, this would be the first step toward the eventual complete elimination of dock railways. (This may be a self-fulfilling prediction: if most of the railroad tracks are removed, it seems very likely that rail traffic will decline.)

176. Without a more detailed review of the situation, any comment on the suitability of this proposal can only reflect one's personal judgement. It would seem that the complete elimination of all direct rail links to dockside is a decision which should be approached very cautiously. If, as the consultants indicate, 3/ there are many more tracks than are now needed for the traffic carried, the conversion of part of the space they occupy to road use may be a worthwhile project. However, it would rule out the possible use of these tracks for suburban commuter services to a Ballard Estate Terminal, as has been proposed by the Metropolitan Transport Team. 4/ The consultants' comment on this:

"The suggestion that suburban passenger traffic should be routed to Ballard Pier cannot be taken seriously. To do so it would have to pass through Alexandra Dock which is not a practical proposition." 5/

177. Another proposed transport project, the East Island Freeway, is also affected by the recommended port Link Road. The consultants say:

"If (the East Island Freeway) is constructed it will not alter the recommendation and proposals already outlined...Over a considerable length of the Link Road the two are in the same line. South of the Victoria Overbridge the Freeway is elevated. North of this bridge it has been shown in the Wilbur Smith Report as running at ground

4/ See para. 31.
level. This is not acceptable as it would foul the main Port Trust Railway lines between Wadala and the docks, or the northern section of the Link Road if these railway lines are removed. It is therefore recommended that the Freeway should continue as an elevated road as far north as Sewri...Apart from the interchange at Sewri it is recommended that there should be no direct connection between the docks on the Link Road and East Island Freeway. This will serve to keep the docks traffic clear of the town traffic." 1/

178. Regardless of the decision about building the Link Road, it would seem appropriate that serious consideration be given to improving the traffic control on D'Mello Road to avoid at least some of the congestion. In particular, the use of modern traffic signals might help to assist trucks making turning movements into both the port and the rail yards. In addition to signalizing D'Mello Road, certain other kinds of traffic might be improved, particularly, the handcarts. Much movement along the road takes place using handcarts. Clearly the handcart is a much slower-moving vehicle than the truck and occupies considerable roadway space. The provision of signals would help the handcart operators to cross the road and, perhaps, by using sidewalks or additional roadway capacity of limited strength they could reduce the congestion along D'Mello Road considerably.

179. These solutions, however, are not the only possible ones. In the intermediate and longer term, the movement of the facilities creating the problems might be considered as appropriate. In particular, there is a question whether the railroad yards need be located across from the port, particularly so far down the island. The port presently has facilities further north and much space is available that could ultimately be used for additional yard and storage facilities for the railroads. If the port railroad were well coordinated with the Central and Western Railroads at some northern point, the flow of goods through Bombay might be substantially expedited.

180. With regard to both the Ballard Estate passenger service proposal and the East Island Freeway, the port consultants have taken positions which they consider to be in the best interests of the port. Whether these recommendations are also in the best interests of Bombay is another question, and one for which there is not yet a factual basis for answering. For despite the long and intensive efforts which the consultants have made on this study, their considerations and conclusions are circumscribed by terms of reference which were too narrowly defined to permit a full urban development perspective.

181. For much the same reason other consultants come to the conclusion that the solution to the congestion of D'Mello Road was a new eastern expressway, in neither case was it possible to get proper attention to the alternative solutions of reducing the congestion on D'Mello Road by going

directly to the source of that congestion, such as moving the railway storage facilities and yards and improving the operation of the Bombay Port Trust Railway. Similarly, the proposal to abandon the Port Trust Railway was considered independently of the problems of the other railroads.

182. The problems of D'Mello Road reflect a broader and more general problem of planning transportation projects in Bombay. Perhaps by further study and coordination of the solutions to the railroads' problems, the roads' problems, and the port's problems, common solutions can be found that improve the entire operation of the eastern Bombay corridor. This is not to say that such solutions will come easily or, indeed, that they may be workable. Until they have been explored in this way, it does not seem appropriate to commit large, new government expenditures to solve parts of the problem.
### Table 1

**Growth of Suburban Passenger Traffic**

<table>
<thead>
<tr>
<th>Year</th>
<th>Central Railway</th>
<th></th>
<th></th>
<th>Western Railway</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passengers (1000's per day)</td>
<td>Percent Increase over 1950-51</td>
<td>Trains per day</td>
<td>Percent Increase over 1950-51</td>
<td>Passengers (1000's per day)</td>
<td>Percent Increase over 1950-51</td>
</tr>
<tr>
<td>1950-51</td>
<td>395.1</td>
<td>-</td>
<td>525</td>
<td>-</td>
<td>437.6</td>
<td>-</td>
</tr>
<tr>
<td>1955-56</td>
<td>442.2</td>
<td>12</td>
<td>559</td>
<td>8</td>
<td>487.2</td>
<td>13</td>
</tr>
<tr>
<td>1960-61</td>
<td>607.7</td>
<td>54</td>
<td>592</td>
<td>13</td>
<td>641.9</td>
<td>50</td>
</tr>
<tr>
<td>1961-62</td>
<td>695.5</td>
<td>77</td>
<td>609</td>
<td>16</td>
<td>742.6</td>
<td>72</td>
</tr>
<tr>
<td>1962-63</td>
<td>765.3</td>
<td>97</td>
<td>649</td>
<td>24</td>
<td>765.0</td>
<td>77</td>
</tr>
<tr>
<td>1963-64</td>
<td>855.4</td>
<td>117</td>
<td>657</td>
<td>25</td>
<td>870.2</td>
<td>102</td>
</tr>
<tr>
<td>1964-65</td>
<td>939.8</td>
<td>138</td>
<td>681</td>
<td>30</td>
<td>925.0</td>
<td>114</td>
</tr>
<tr>
<td>1965-66</td>
<td>1,012.7</td>
<td>151</td>
<td>682</td>
<td>30</td>
<td>976.3</td>
<td>127</td>
</tr>
<tr>
<td>1966-67</td>
<td>1,038.2</td>
<td>163</td>
<td>690</td>
<td>31</td>
<td>1,096.0</td>
<td>154</td>
</tr>
</tbody>
</table>

**Source:** Report on Existing Mass Transportation System - Bombay; Metropolitan Transport Team, Planning Commission.
Table 2
TRANSIT PASSENGER TRIPS CROSSING SCREENLINES (BUS AND RAIL)

<table>
<thead>
<tr>
<th>Screenline Number</th>
<th>Daily two-way volume crossing screenline</th>
<th>Ratio</th>
<th>1961/1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132,000</td>
<td>1,078,000</td>
<td>8.2</td>
</tr>
<tr>
<td>2</td>
<td>880,000</td>
<td>1,692,000</td>
<td>2.2</td>
</tr>
<tr>
<td>3</td>
<td>1,177,000</td>
<td>2,648,000</td>
<td>2.3</td>
</tr>
<tr>
<td>4</td>
<td>1,190,000</td>
<td>2,977,000</td>
<td>2.6</td>
</tr>
<tr>
<td>5</td>
<td>1,266,000</td>
<td>3,190,000</td>
<td>2.5</td>
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<tr>
<td>6</td>
<td>1,157,000</td>
<td>3,264,000</td>
<td>2.8</td>
</tr>
<tr>
<td>7</td>
<td>961,000</td>
<td>3,181,000</td>
<td>3.2</td>
</tr>
<tr>
<td>8</td>
<td>538,000</td>
<td>1,991,000</td>
<td>3.7</td>
</tr>
<tr>
<td>9</td>
<td>N.A.</td>
<td>936,000</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

SOURCE: Traffic Cell Report and Metropolitan Transport Project data

1/ Includes 21G,000 daily trips across all screenlines, from areas beyond Thana, which reportedly were omitted from Traffic Cell data.
### Table 3.

**DAILY TRANSIT PASSENGER ASSIGNMENTS (1981)**

#### PLAN A

<table>
<thead>
<tr>
<th>Crossing Screenline Number</th>
<th>Western Transit Screenline</th>
<th>Western Central Railway</th>
<th>Central Harbour Line</th>
<th>Eastern Transit Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>335,920</td>
<td>-</td>
<td>-</td>
<td>329,940</td>
</tr>
<tr>
<td>2</td>
<td>543,800&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>3,760</td>
<td>204,440</td>
<td>460,120</td>
</tr>
<tr>
<td>3</td>
<td>1,301,440</td>
<td>3,920</td>
<td>223,260&lt;sup&gt;2/&lt;/sup&gt;</td>
<td>98,260 560,000&lt;sup&gt;1/&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>1,327,940</td>
<td>15,340</td>
<td>461,680</td>
<td>141,620 634,900</td>
</tr>
<tr>
<td>5</td>
<td>1,552,940</td>
<td>7,900</td>
<td>381,220</td>
<td>141,460 768,940</td>
</tr>
<tr>
<td>6</td>
<td>1,081,860</td>
<td>14,000</td>
<td>324,680</td>
<td>199,440 606,200</td>
</tr>
</tbody>
</table>

#### PLAN B

<table>
<thead>
<tr>
<th>Crossing Screenline Number</th>
<th>Western Transit Screenline</th>
<th>Western Central Railway</th>
<th>Central Harbour Line</th>
<th>Eastern Transit Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>335,920</td>
<td>-</td>
<td>-</td>
<td>329,940</td>
</tr>
<tr>
<td>2</td>
<td>543,800</td>
<td>3,760</td>
<td>204,440</td>
<td>460,120</td>
</tr>
<tr>
<td>3</td>
<td>1,301,440</td>
<td>3,920</td>
<td>223,260&lt;sup&gt;2/&lt;/sup&gt;</td>
<td>98,260 560,000&lt;sup&gt;1/&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>1,327,940</td>
<td>15,340</td>
<td>461,680</td>
<td>141,620 634,900</td>
</tr>
<tr>
<td>5</td>
<td>1,552,940</td>
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<td>381,220</td>
<td>141,460 768,940</td>
</tr>
<tr>
<td>6</td>
<td>1,081,860</td>
<td>14,000</td>
<td>324,680</td>
<td>199,440 606,200</td>
</tr>
</tbody>
</table>

<sup>1/</sup> Estimated, figure not recorded

<sup>2/</sup> Closest recorded figure

**SOURCE:** Traffic Cell Report, Volume 2
<table>
<thead>
<tr>
<th>Year</th>
<th>Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969/70</td>
<td>2,223,826</td>
</tr>
<tr>
<td>1968/69</td>
<td>2,044,355</td>
</tr>
<tr>
<td>1967/68</td>
<td>1,837,811</td>
</tr>
<tr>
<td>1966/67</td>
<td>1,805,490</td>
</tr>
</tbody>
</table>

1/ See text for clarification; para 77.

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Length (Miles)</th>
<th>Cost (Rs. Crores)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Construction</td>
<td>Right-of-way</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>West Island Freeway</td>
<td>10.32</td>
<td>23.42</td>
<td>.70</td>
<td>24.12</td>
<td></td>
</tr>
<tr>
<td>East Island Freeway</td>
<td>8.91</td>
<td>29.72</td>
<td>3.15</td>
<td>32.88</td>
<td></td>
</tr>
<tr>
<td>Mahim Creek Connector</td>
<td>1.64</td>
<td>1.63</td>
<td>.06</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>Cross Island Connector</td>
<td>0.95</td>
<td>4.80</td>
<td>.05</td>
<td>4.85</td>
<td></td>
</tr>
<tr>
<td>Central Island Freeway</td>
<td>7.69</td>
<td>3.27</td>
<td>2.17</td>
<td>5.44</td>
<td></td>
</tr>
<tr>
<td>Eastern Expressway</td>
<td>2.50</td>
<td>1.02</td>
<td>-</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Western Expressway</td>
<td>4.00</td>
<td>1.35</td>
<td>-</td>
<td>1.35</td>
<td></td>
</tr>
<tr>
<td>Sewri Expressway</td>
<td>4.89</td>
<td>2.61</td>
<td>1.55</td>
<td>4.16</td>
<td></td>
</tr>
<tr>
<td>Tardeo Expressway</td>
<td>0.68</td>
<td>.17</td>
<td>1.80</td>
<td>1.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freeway-Expressway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>41.78</td>
<td>67.99</td>
<td>9.79</td>
<td>77.78</td>
<td></td>
</tr>
<tr>
<td>Major Street Improvements</td>
<td>74.34</td>
<td>6.68</td>
<td>11.66</td>
<td>18.14</td>
<td></td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>116.12</td>
<td>74.67</td>
<td>21.25</td>
<td>95.92</td>
<td></td>
</tr>
</tbody>
</table>

1/ 1963 estimates

SOURCE: Traffic and Transportation Study; Wilbur Smith and Associates, 1963
Table 6

BOMBAY ROAD PROGRAM

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Cost</th>
<th>Proposed Expenditures</th>
<th>Present Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IVth Plan</td>
<td>Carry-over</td>
<td>IVth Plan</td>
</tr>
<tr>
<td></td>
<td>(Rs. crores)</td>
<td>(Rs. crores)</td>
<td>(Rs. crores)</td>
</tr>
<tr>
<td>1. Malabar Hill Tunnel and West Island Freeway to Haji Ali</td>
<td>8.40</td>
<td>6.00</td>
<td>2.40</td>
</tr>
<tr>
<td>2. East Island Freeway (Carnac Road - Reay Road)</td>
<td>9.00</td>
<td>3.30</td>
<td>5.70</td>
</tr>
<tr>
<td>3. Link Roads joining Express Highways (Bandra - Dharavi, 0.40)</td>
<td>3.00</td>
<td>3.00</td>
<td>-</td>
</tr>
<tr>
<td>(Andheri - Chatkopar, 1.20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Goregaon - Mulund, 1.40)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Chembur - Mankhurd Link to Thana Creek Bridge</td>
<td>1.50</td>
<td>1.50</td>
<td>-</td>
</tr>
<tr>
<td>5. East Island Freeway (land and structures)</td>
<td>4.60</td>
<td>3.70</td>
<td>0.90</td>
</tr>
<tr>
<td>6. Engineering Surveys</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>TOTAL</td>
<td>27.00</td>
<td>18.00</td>
<td>9.00</td>
</tr>
</tbody>
</table>

1/ Costs based on 1963 estimates. The Malabar Hill Tunnel and West Island Freeway to Haji Ali are currently estimated to cost Rs. 10.6 crores.

2/ Source: Note, Maharashtra Road Board.
<table>
<thead>
<tr>
<th>Description</th>
<th>Estimated Cost (Rs. crores)</th>
<th>Expenditure to March 1970</th>
<th>Budget for 1970-71</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey Works&lt;sup&gt;1/&lt;/sup&gt;</td>
<td>0.21</td>
<td>.03</td>
<td>.02</td>
<td>Surveys for the first phase works are completed except for the East Island Freeway for which the feasibility study report has been submitted to Government for decision on the alternative to be adopted. The survey for the remaining works of the report of Wilbur Smith is in progress.</td>
</tr>
<tr>
<td>2. Seawall construction and land reclamation near Napean Sea Road (West Island Freeway)</td>
<td>1.07</td>
<td>.40</td>
<td>.18</td>
<td>The estimate has been sanctioned and the work awarded on contract in February 1969; expected to be completed during the 1971 working season.</td>
</tr>
<tr>
<td>3. Overbridge construction for Napean Sea Road</td>
<td>.24</td>
<td>.05</td>
<td>.05</td>
<td>The estimate has been sanctioned and the work awarded on contract in January 1970. The diversion of traffic is completed and foundation of the main bridge work is started. The work is expected to be completed in the year 1971-72.</td>
</tr>
</tbody>
</table>

---

<sup>1/</sup> Survey work is reported in progress on the following projects: (a) West Island Freeway - portion between Chowpatty and Haji Ali. (b) West Island Freeway - portion between Nariman Point to Chowpatty. (c) West Island Freeway - portion between Haji Ali and Mahim. (d) East Island Freeway - portion between Carnac Bridge to the junction of D'Mello Road and Reay Road. (e) East Island Freeway - remaining length (excluding portion from Carnac Bridge to junction of D'Mello Road and Reay Road. (f) Cross Island Connector. (g) Chembur Kankurd Link Road. (h) Sewri Expressway. (i) Ghatkopar Mankhurd Link Road. (j) Tardec Expressway. (k) Borivali Mulund Link Road.
<table>
<thead>
<tr>
<th>Description</th>
<th>Estimated Cost (Ps.crores)</th>
<th>Expenditure to March 1970</th>
<th>Budget for 1970-71</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Construction, Bandra-Dharavi Link Road</td>
<td>0.49</td>
<td>0.06</td>
<td>0.07</td>
<td>The estimate has been sanctioned and the road and bridge works have been awarded on contract in January 1967 and February 1969 with a time limit of 30 months for both.</td>
</tr>
<tr>
<td>5. Construction, Andheri-Ghatkopar Link Road, Stage I</td>
<td>0.60</td>
<td>0.05</td>
<td>0.08</td>
<td>The estimate has been sanctioned and the work was awarded on contract in June 1969; scheduled to be completed in 1971-72. The entire road will be completed by 1973. Earth work is in progress. Railway overbridge is yet to be started.</td>
</tr>
<tr>
<td>6. Construction, Goregaon-Mulund Link Road, Stage I</td>
<td>0.58</td>
<td>0.02</td>
<td>0.08</td>
<td>The estimate has been sanctioned and the road work was awarded on contract in April 1969; scheduled to be completed in 1971-72. The entire road including the overbridge will be completed by 1973. Earth work is in progress. Railway overbridge estimate is yet to be sanctioned.</td>
</tr>
<tr>
<td>7. Construction, Chembur-Mankhurd Link Road</td>
<td>1.09</td>
<td>0.01</td>
<td>0.05</td>
<td>The estimate has been sanctioned and the land acquisition started. Road construction will be started after studying the behavior of a test embankment.</td>
</tr>
<tr>
<td>8. Construction, Andheri-Ghatkopar Link Road, Stage II</td>
<td>0.84</td>
<td>-</td>
<td>0.03</td>
<td>Administrative approval is received. Detailed plans and estimates for technical sanction are under preparation. Land acquisition is in progress.</td>
</tr>
<tr>
<td>9. Construction, Goregaon-Mulund Link Road, Stage II</td>
<td>1.17</td>
<td>-</td>
<td>-</td>
<td>The work is administratively approved and plans and estimates are under preparation for technical sanction.</td>
</tr>
<tr>
<td>Description</td>
<td>Estimated Cost (Rs.crores)</td>
<td>Expenditure to March 1970</td>
<td>Budget for 1970-71</td>
<td>Status</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
<td>--------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10. Land acquisition, East approach, Malabar Hill Tunnel</td>
<td>0.28</td>
<td>-</td>
<td>0.73</td>
<td>Technical sanction was recently received and the Land Acquisition proposal is under finalization.</td>
</tr>
<tr>
<td>11. Seawall construction and land reclamation, Embassy Apt. to Haji Ali</td>
<td>4.11</td>
<td>-</td>
<td>-</td>
<td>The estimate has been administratively approved and tenders for the work between Breach Candy and Haji Ali are invited.</td>
</tr>
</tbody>
</table>
Table 8

BOMBAY ROAD PROGRAM

RECOMMENDED STAGE DEVELOPMENT

First Stage - 1963-1966

1. Projections and enactment of rules, laws, and by-laws needed to carry out the proposed traffic regulations and restrictions, and route development.

2. Intersection re-design and signalization.

3. Commencement of right-of-way acquisition for all portions of the freeway and expressway plan. Special attention should be given to acquisition of land that is to be put to new uses, or on which improvements are to be made.

4. Preparation of design and preliminary surveys for Stage B programmes.

Total cost of First Stage - 6.9 crores of rupees.

Second Stage - 1967-1971


2. Construction of the East Island Freeway between Museum and Matunga.

3. Construction of Central Island Expressway between Sion and Matunga.

4. Construction of the Sion-Trombay arterial from the Eastern Expressway and the Thana Creek Bridge.

5. Construction of Sardar Vallabhbhai Patel Road, between the East Island Freeway and Bhendi Bazar.

6. Improvements to Victoria Road, King Edward Road, Hughes Road, Bellasis Road, Delisle Road (north), Tulsi Pipe Road and Elphinstone Road extension.

Total cost of Second Stage - 47.1 crores of rupees.
Third Stage - 1972-1976

1. Upgrade southern sections of the Eastern and Western Expressways to freeway standards.

2. Construction of Mahim Creek connector and remainder of East Island Freeway between Sion and Western Expressway.

3. Construction of Sewri Expressway between Thana Creek Bridge and East Island Freeway.

4. Construction of East Island Freeway from Mahim Creek to Matunga.

5. Construction of the West Island Freeway from Haji Ali to Mahim Creek.

6. Improvements to Delisle Road (south), Sardar Vallabhbhai Patel Road, Shankar Sett Road, Wadby Road, Cross Maidan Road, Princess Street, Carnac Road, and Lady Jehangir Road extension.

Total cost of Third Stage - 24.8 crores of rupees.

Fourth Stage - 1977-1981

1. Construction of West Island Freeway between Malabar Hill and Back Bay area.

2. Construction of a Cross Island connector.

3. Construction of the Central Island Expressway between Chowpatty and Matunga.

4. Construction of the Tardeo Expressway.

5. Construction of connector between West Island Freeway at Mafatlal Bath, to Folkand Road.

Total cost of Fourth Stage - 17.2 crores of rupees.
